

# Puspa Shrestha

Best Quality Resource Site for Class 11 And 12 Students  
(Based on Updated Curriculum 2077)

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Puspa Shrestha

# Physics

## NEW SYLLABUS

Teaching hours: 150T + 50P  
Nature of course: Theory + Practical

Full marks: 100 (75T + 25 P)  
Pass Marks: 27T + 8P

### Course Contents

#### Unit-1 Waves and Optics

##### Waves

- Wave motion**- Wave motion; Longitudinal and transverse waves; Progressive and stationary waves; Mathematical description of a wave.
- Mechanical waves**- Speed of wave motion; Velocity of sound in solid and liquid; Velocity of sound in gas; Laplace's correction; Effect of temperature, pressure, humidity on velocity of sound.
- Wave in pipes and strings**- Stationary waves in closed and open pipes; Harmonics and overtones in closed and open organ pipes; End correction in pipes; Resonance Tube experiment; Velocity of transverse waves along a stretched string; Vibration of string and overtones; Laws of vibration of fixed string.
- Acoustic phenomena**- Sound waves: Pressure amplitude; Characteristics of sound: Intensity, loudness, quality and pitch; Beats; Doppler's effect; Infrasonic and ultrasonic waves; Noise pollution: Sources, health hazard and control.

##### Physical Optics

- Nature and propagation of Light**- Nature and sources of light; Electromagnetic spectrum; Huygen's principle; Reflection and Refraction according to wave theory; Velocity of light: Foucault's method; Michelson's method.
- Interference**- Phenomenon of Interferences; Coherent sources; Young's two slit experiment; Newton's ring
- Diffraction**- Diffraction from a single slit; Diffraction pattern of image; Diffraction grating; Resolving power of optical instruments
- Polarization**- Phenomenon of polarization; Brewster's law; transverse nature of light; Polaroid

#### Unit-2 Electricity and Magnetism

##### Current Electricity

- D.C. Circuit**- Electric Currents; Drift velocity and its relation with current; Ohm's law; Electrical Resistance; Resistivity; Conductivity; Super conductors; Perfect Conductors; Current-voltage relations; Ohmic and Non-Ohmic resistance; Resistances in series and parallel, Potential Divider, Conversion of galvanometer into voltmeter and ammeter; Ohmmeter; Electromotive force: Emf of a source, internal resistance; Work and power in electrical circuits; Joule's law and its verification.
- Electrical circuits**- Kirchhoff's laws; Wheatstone bridge circuit; P.O.Box, Meter Bridge; Potentiometer; Comparison of e.m.f.s., measurement of internal resistance of a cell.
- Thermoelectric Effect**- Seebeck Effect; Thermocouples, Peltier effect: Variation of thermoelectric emf with temperature, Thermopile, Thomson effects.
- Chemical effect of current**- Faraday's laws of electrolysis; Faraday's constant, Verification of Faraday laws of electrolysis.

##### Magnetic Field of current

- Magnetic Field**- Magnetic field lines and magnetic flux; Oersted's experiment; Force on moving charge, Force on Conductor; Force and Torque on rectangular coil, Moving coil galvanometer; Hall effect; Magnetic field of a moving charge; Biot and Savart law and its application to (i) a circular coil (ii) a long straight conductor (iii) a long solenoid; Ampere's law and its application to (i) a long straight conductor (ii) a straight solenoid (iii) a toroidal solenoid; Forces between two parallel conductors carrying current- definition of ampere.
- Magnetic properties of materials**- Elements of earth magnetism and their variation; Dip and Dip circle; Flux density in magnetic material; Relative permeability; Susceptibility; Hysteresis, Dia-, Para- and Ferro-magnetic materials.
- Electromagnetic Induction**- Faraday's laws; Induced electric fields; Lenz's law, Motional electromotive force; AC generators; eddy currents; Self inductance and Mutual inductance; Energy stored in an inductor; Transformer.
- Alternating Currents**- Peak and RMS Value of AC current and Voltages, AC through resistor, capacitor and inductor; Phasor diagram, Series circuits containing combination of resistor, capacitor and inductor; Series Resonance, Quality factor; Power in AC circuits: Power factor; choke coil.

#### Unit-3 Modern Physics

- Electrons and Photons**- Electrons: Milikan's oil drop experiment, Gaseous discharge at various pressure; Cathode rays; Motion of electron beam in electric and magnetic fields; Thomson's experiment to determine specific charge of electrons. Photons: Quantum nature of radiation; Einstein's photoelectric equation; Stopping potential; Measurement of Planck's constant, Milikan's experiment
- Solids and Semiconductor devices**- Structure of solids; Energy bands in solids (qualitative ideas only); Differences between metals, insulators and semi-conductors using band theory; Intrinsic and extrinsic semi-conductors; P-N Junction; Semiconductor diode: Characteristics in forward and reverse bias; Full wave rectification; Filter circuit; Zener diode; Transistor: Common emitter characteristics, Logic gates; NOT, OR, AND, NAND and NOR, Nanotechnology (introductory idea)

3. **Quantization of energy-** Bohr's theory of hydrogen atom; Spectral series; Excitation and ionization potentials; Energy level, Emission and absorption spectra, De Broglie Theory; Duality; Uncertainty principle. **Lasers:** He-Ne laser, Nature and production, properties and uses. **X-rays:** Nature and production; uses: X-rays, X-rays diffraction, Bragg's law. LH9
4. **Nuclear physics-** Nucleus: Discovery of nucleus; Nuclear density; Mass number; Atomic number; Atomic mass; Isotopes, Einstein's mass-energy relation, Mass Defect; Binding energy; Fission and fusion. LH6
5. **Radioactivity-** Alpha-particles; Beta-particles, Gamma rays; Laws of radioactive disintegration; Half-life and decay constant, Geiger-Muller Tube; Radio carbon dating; Medical use of nuclear radiation; Health hazards and safety precautions. LH7
6. **Nuclear energy and other sources of energy-** Sources of energy; Conservation and degradation of energy, Transformation of energy. Nuclear energy: Energy released from fission and fusion; Thermal and Hydroelectric power, Wind energy, Biofuels; Solar energy; Solar constant; Solar devices; Global energy consumption pattern and demands; Energy use in Nepal. Fuels and pollution: Global Warming; Acid rain. LH9
7. **Particle physics and cosmology-** particles and antiparticles, Quarks and Leptons, baryons, mesons. Universe- Hubble's law; Big Bang; Critical density; Dark matter LH3

### Practical

A student will perform at least 24 experiments from the given list:

#### Introduction

**General instruction:** Students are expected to learn general ideas of errors, order of accuracy and graphical analysis. Students are also expected to learn the physical principles and theory of experiments on magnetism not covered in the theory curriculum.

### List of Experiments

#### A. Wave and Optics

1. Determination of the wavelength of sodium light by measuring the diameter of Newton's rings.
2. Determination of the wavelength of a given monochromatic source of light by passing a plane diffraction grating.
3. Determination of the refractive index of a given transparent medium and calculation of the speed of the light in the medium.
4. Uses of laser beams:
  - i. Determination of the wavelength of He-Ne laser light
  - ii. Determination of the diameter of a given hair
5. Uses of Sonometer:
  - i. Determination of the frequency of a given tuning fork
  - ii. Comparison of frequencies of two tuning forks
6. Determination of the frequency of A.C. Mains.
7. Use of Resonance tube:
  - i. Determination of velocity of sound in air at NTP
  - ii. Comparison of frequencies of two tuning forks
8. Determination of the end correction of the resonance tube apparatus.

#### B. Electricity

9. Verification of Ohm's Law
10. Use of P.O. Box:
  - i. Determination of the resistivity of the material of a given wire
  - ii. Verification of the laws of series and parallel resistances
11. Use of meter bridge:
  - i. Comparison of resistances of two given wires
  - ii. Determination of the resistivity of the material of a given wire
  - iii. Verification of the laws of series and parallel resistances
12. Determination of high resistance by substitution method.
13. Determination of the capacitance of the capacitor by charging and discharging a capacitor.
14. Use of potentiometer:
  - i. Comparison of emf's of two cells
  - ii. Comparison of resistances of two given wires
  - iii. Determination of the internal resistance of a cell
15. Conversion of given galvanometer into an ammeter and a voltmeter of desired range.
16. Calibration of a given ammeter and voltmeter.
17. Determination of the half-life of a circuit containing a pure capacitor in series with a resistance in a D. C. circuit.
18. Uses of a series LCR circuit:
  - i. Determination of the resonant frequency of a series LCR circuit
  - ii. Determination of the quality factor of a series LCR circuit

#### C. Magnetism

19. Determination of the pole strength and magnetic moment of a bar magnet by locating the neutral points keeping:
  - i. North pole pointing towards the geographical south
  - ii. North pole pointing towards the geographical north

20. Use of deflection magnetometer:
  - i. Determination of the pole strength and magnetic moment of a bar magnet
  - ii. Comparison of the magnetic moments of two bar magnets
21. Use of oscillation magnetometer:
  - i. Determination of the pole strength and magnetic moment of a bar magnet
  - ii. Comparison of the magnetic moments of two bar magnets
22. Use of dip circle: Determination of the angle of dip in the laboratory

**D. Modern Physics**

23. Study the characteristics of a junction diode.
24. Study the characteristics of a transistor.
25. Study the characteristics of a Zener diode.
26. Determination of Planck's constant using a photocell

**List of Activities**

1. To assemble a household circuit comprising three bulbs, three switches, a fuse and a power source. Measure current and voltage across each component and then interpret the data.
2. Use of multimeter to (a) identify base of transistor and terminal of IC (b) Check whether a given electronic component (e.g. diode, transistor, and IC) is in working order.
3. To study the relation between frequency and length of a given wire under constant tension using sonometer.
4. Study of AND, OR, and NOT gates.
5. To identify the difference between emf and p.d. of a cell.

**Note:** The above are only the specimens of activities. In order to arouse creativity, the students must be encouraged to take up new activities (other than mentioned above) in consultation with the teacher concerned.

**Laboratory Manual**

- i. Certificate Level Physics Practical Guide, U.P. Shrestha, Ratna Pustak Bhandar, Kathmandu
- ii. Elementary Practical Physics, Dr. Narayan Hari Joshi, Taleju Prakashan

**Teaching Strategies**

- Lecturing
- Group interaction
- Problem solving
- Demonstration
- Evaluation

**Instructional materials**

OHP, LCD, demonstration kits, writing boards etc.

**Evaluation Scheme**

Unit	Teaching hours	LAQ	SAQ	NP	Mart Distribution			Total
					LAQ	SAQ	NP	
Waves and Optics	23 +17	1/2 +1/2	3/3	1/1 +1/1	4+4	6	3+3	20
Electricity and magnetism	55	3/4	4/6	2/3	4+4+4	8	5+3	28
Modern physics	55	3/4	4/6	2/2	4+4+4	8	4+3	27
<b>Total</b>	<b>150</b>	<b>8/12</b>	<b>10/15</b>	<b>6/7</b>	<b>32</b>	<b>22</b>	<b>21</b>	<b>75</b>

**Note:** LAQ: Long Answer Questions; SAQ: Short Answer Questions; NP: Numerical Problems

- a. Q.No. 1, 4 and 8, the first questions of group A, B, and C respectively, should contain 3, 6 and 6 conceptual questions each carrying 2 marks, out of which students should give answers as indicated in the table.
- b. In the table numerator denotes the number of questions to be attempted and denominator denotes the number of questions asked. For example, 3/4 means 3 questions are to be answered out of 4 questions.
- c. Short answer questions should cover the entire course as far as possible. These questions should be of conceptual type.
- d. Each of the questions numbering 2, 3, 5, 6, 9 and 10 contains a long answer theory question and a numerical problem carrying marks as specified in the table. Q. No. 7 and 11 contain only a long answer theory question.
- e. There should be two short answer questions from wave unit and one from optics unit.
- f. There will be only one specific 'or' choice in one of the questions of LAQ type in each group.
- g. There will be only one specific 'or' choice for numerical problems in mechanics.

**Practical**

Every student will perform at least 20 experiments and 4 activities during the academic year.

**Evaluation Scheme for Practical examination:**

One experiment	12 Marks
One activity	3 Marks
Practical record of experiments and activities	5 Marks
Viva on experiment and activity	5 Marks
<b>Total</b>	<b>25 Marks</b>

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**NEW MODEL QUESTIONS - 2066**

Time 3 hours

(All answers of numerical problems should be expressed in S.I. system)

Full Marks: 75

Pass Marks: 27

**Group A**

1. **Attempt any FOUR questions:** [4×2=8]  
 a. Two wires, one of copper and other of iron, have the same diameter and carry the same current. In which wire will the drift velocity of electrons be more?  
 b. Differentiate between fuse wire and a heating wire.  
 c. Why are the pole-pieces of magnets cut into cylindrical form in a galvanometer?  
 d. Hall voltage is much more measurable in semi-conductor than in metals. Why?  
 e. Explain why two parallel wires carrying current in the opposite direction repel each other?  
 f. 220V a.c. is more dangerous than 220V d.c., why?

2. **Attempt any Four questions:** [4×2=8]  
 a. If the discharge tube is filled up with various gases in turn, will the discharge in all gases take place at the same electrode potential?  
 b. A photon and an electron have got the same de-Broglie wave length. Explain which has greater total energy.  
 c. How is NOT gate realised?  
 d. It is said that a very powerful crane is required to lift a nuclear mass of microscopic size. Comment on this.  
 e. Comment on the statement "a nucleus contains no electrons and yet can eject them."  
 f. What are the effects of pollution on living organisms?

3. **Attempt any ONE question:** [1×2=2]  
 a. How can bats fly around without colliding with objects that come in their way?  
 b. Longitudinal waves cannot be polarized. Why?
4. **Attempt any ONE question:** [1×2=2]  
 a. Differentiate between wave-front and wavelet?  
 b. What is the difference between Fresnel and Fraunhofer diffraction?

**Group B**

5. **Attempt any THREE questions:** [3×4=12]  
 a. State Biot and Savart's law and use it to obtain an expression for the magnetic field at the centre of the circular coil.  
 b. What are the categories in which magnetic materials are classified? Explain their differences.  
 c. State Faraday's laws of electrolysis. How will you verify Faraday's second law experimentally?  
 d. Show that Lenz's law is an example of conservation of energy.

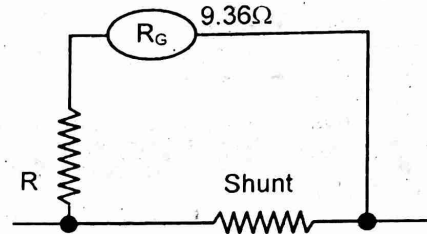
6. **Attempt any THREE questions:** [3×4=12]  
 a. Show, in Bohr's model, that radii of electronic orbits increase as  $n^2$ , where  $n$  is the quantum number of the orbit.  
 b. Define decay constant of a radioactive element. How is it related to half-life?  
 c. Discuss a zener diode and its use as voltage stabilizer.  
 d. Describe a theory which accounts for the origin and evolution of the universe.

7. **Attempt any ONE question:** [1×4=4]  
 a. Show that both harmonics, odd and even, can be produced in an organ pipe open at both ends.

- b. What is Doppler's effect? Obtain an expression for the apparent pitch when a source moves towards a stationary observer.
8. **Attempt any ONE question:** [1×4=4]  
 a. Show that in Young's double slits experiment widths of dark and bright fringes are equal.  
 b. Describe Foucault's method of determining the speed of light.

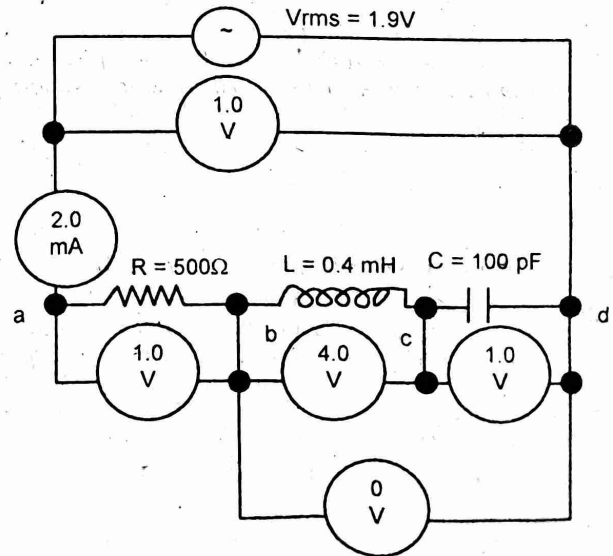
**Group C**

9. **Attempt any TWO questions:** [2×4=8]  
 a. The resistance of the coil of a pivoted-coil galvanometer is  $9.36 \Omega$  and a current of  $0.0224 \text{ A}$  causes it to deflect full scale. We want to convert this galvanometer to an ammeter reading  $20.0 \text{ A}$  full-scale. The only shunt available has a resistance of  $0.025 \Omega$ . What resistance  $R$  must be connected in series with the coil?



Ans: 12.94  $\Omega$

- b. A standard cell of  $1.0185 \text{ V}$ , when used in a one meter long slide wire potentiometer balances at  $60 \text{ cm}$ . Calculate the percentage error in a voltmeter which balances at  $65 \text{ cm}$  when reading is  $1.1 \text{ volt}$ .  
 Ans: 0.31%
- c. The series circuit in figure is a similar to arrangements that are sometimes used in radio tuning circuits. The circuit is connected to the terminals of an a.c. source with a constant r.m.s. terminal voltage of  $1.9 \text{ V}$  and a variable frequency. Find (i) the resonance frequency (ii) the inductive reactance and the impedance at the resonance frequency (iii) the r.m.s. current at the resonance and (iv) the r.m.s. voltage across each circuit element at resonance.



Ans: (i)  $\omega_0 = 5.0 \times 10^6 \text{ rad s}^{-1}$  (ii)  $X_L = 2000 \Omega$ ;  $X_C = 2000 \Omega$   
 (iii)  $I_{\text{rms}} = 2.0 \text{ mA}$  (iv)  $V_{R-\text{rms}} = 1 \text{ V}$ ,  $V_{L-\text{rms}} = 4 \text{ V}$ ;  $V_{C-\text{rms}} = 4 \text{ V}$



(ii) The equation of wave with double amplitude but traveling in the opposite direction. [4]

$$\text{Ans: } 4.77 \text{ Hz, } 1.57 \text{ m, } 7.6 \text{ ms}^{-1}, y = 0.04 \sin(30t + 4x)$$

## 2. MECHANICAL WAVES

### FORMULAE

- Speed of sound,  $v = \sqrt{\frac{E}{\rho}} = \frac{\text{Elasticity}}{\text{Density}}$
- Speed of longitudinal wave,
  - In solid,  $v = \sqrt{\frac{E}{\rho}}$ , In liquid,  $v = \sqrt{\frac{K}{\rho}}$
  - In gas,  $v = \sqrt{\frac{\gamma P}{\rho}}$ ,  $\gamma = \frac{C_p}{C_v}$
- Factors affecting the speed of sound in gas,
  - Temperature,  $v \propto \sqrt{T}$ , so  $\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}}$
  - Pressure, no effect at constant temperature
  - Density,  $v \propto \frac{1}{\sqrt{\rho}}$ , so  $\frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}}$  (for different gases)
  - Molar mass,  $v \propto \frac{1}{\sqrt{M}}$ , so  $\frac{v_1}{v_2} = \sqrt{\frac{M_2}{M_1}}$
  - Humidity,  $v_{\text{humid}} > v_{\text{dry}}$
- Temperature coefficient of speed of sound,
 
$$\frac{v_1}{v_0} = \sqrt{\frac{273 + \theta}{273}} = v_0 \left( 1 + \frac{1}{2} \alpha \theta \right)$$
 Where,  $\alpha$  temperature coefficient of speed of sound
- Speed of transverse wave in a stretched string,
 
$$v = \sqrt{\frac{T}{\mu}}$$
 where  $T$  = tension on string and  $\mu$  = mass per unit length

### Short Answer Questions [2 Marks]

- 2074 Set B Q.No. 3a** Velocity of sound in solids is more than that in liquids, why? [2]
- 2073 Set C Q.No. 3b** The velocity of sound in solid is generally greater than that in gas at STP. Why? Give reason. [2]
- 2072 Set C Q.No. 3b** When sound waves travel through a medium, does the temperature at various points remain constant? Explain. [2]
- 2071 Set D Q.No. 3 a** **2066 Supp Q.No. 1c** Why does sound travel faster in metals than in air? [2]
- 2070 Supp. Set B Q.No. 3 a** The speed of sound in humid air is more than that in dry air, why? [2]
- 2070 Set C Q.No. 3 a** **2063 Q.No. 2 a** Although the density of solid is high, the velocity of sound is greater in solid, explain. [2]
- 2069 Supp Set B Q.No. 3 b** Is it possible that the velocity of sound is greater in solid than that in a gas at STP? Justify your answer. [2]
- 2066 Q.No. 1c** Velocity of sound increases on a cloudy day. Why? [2]
- 2065 Q.No. 1 c** **2060 Q.No. 2 c** **2052 Q.No. 1 c** Sound at a distance can be heard distinctly at night than in the day time. Why? [2]
- 2064 Q.No. 2 d** Explain why the velocity of sound in solids is greater than that in gases, though the densities of solids are greater than that of gases. [2]
- 2062 Q.No. 1 c** Do sound waves need a medium to travel from one point to other point in space? What properties of the medium are relevant? [2]
- 2056 Q.No. 1 c** Why are sounds heard better on a wet day than on a dry day? [2]
- 2054 Q.No. 1 b** Is velocity of sound more in damp air or in dry air? Explain. [2]

### Long Answer Questions [4 Marks]

- 2076 GIE Set B Q.No. 7a** Discuss Newton's formula for the velocity of sound in air and explain why and how this formula was modified by Laplace. [4]
- 2076 Set B Q.No. 7a** Does the propagation of sound wave cause change in thermodynamic condition of medium? Derive Laplace formula of velocity of sound in air. [4]
- 2075 GIE Q.No. 7a** **2068 Can. Q.No. 7a** **2067 Sup Q.No. 7b** Discuss Newton's formula for the velocity of sound in a gas medium with Laplace's correction. [4]
- 2074 Supp Q.No. 7a** Describe Laplace's correction in Newton's formula for velocity of sound in air. Also discuss the effect of temperature and pressure in the velocity of sound in air. [4]
- 2074 Set A Q.No. 7a** Describe Newton's formula for the velocity of sound in air. Explain why and how this formula is modified by Laplace. [4]
- 2073 Set C Q.No. 7b** What correction was made in Newton's expression for the velocity of sound? Also explain, how change of temperature and pressure affect the velocity of sound. [4]
- 2072 Supp Q.No. 7a** Write the Newton's formula for the velocity of sound in air. Explain why and how this formula is modified by Laplace. [4]
- 2072 Set D Q.No. 7a** **2071 Supp. Q.No. 7a** Write down the Newton's formula for the velocity of sound in air. Explain why this formula has to be modified. Discuss Laplace's correction on it. [4]
- 2071 Set C Q.No. 7 a** Describe the Newton's formula for velocity of sound in air with Laplace's correction. [4]
- 2070 Supp. Set A Q.No. 7 a** Deduce Newton's formula for velocity of sound in a gas. Why was the correction needed? What correction made by Laplace? [4]
- 2069 Supp Set B Q.No. 7 a** Describe Laplace's correction to find the velocity of sound and discuss how the velocity of sound is affected by different physical parameters. [4]
- 2069 Set A Old Q.No. 5a** What is the Newton's formula for the velocity of sound? What correction was made by Laplace? [1+3]
- 2069 Set B Q.No. 7b** Discuss the significance of Laplace's correction to Newton's formula for the velocity of sound. Also explain how different factors affect the velocity of sound. [4]
- 2068 Old Q.No. 5 a** Write an expression for the speed of sound in an ideal gas. Discuss the effect of change in temperature on the speed of sound. [1+3]
- 2067 Old Q.No. 5a** Discuss the Laplace's correction for the velocity of sound in air. [4]

29. **2066 Q.No. 5 a** Write down the factors on which the velocity of sound in air depends with necessary explanation. [4]
30. **2065 Q.No. 5 a OR** Explain the significance of Laplace's correction of Newton's formula for the velocity of sound and derive the corrected formula. [1+3]
31. **2061 Q.No. 5 a OR** State Newton's formula for the velocity of sound in gases. What correction was done by Laplace on it? [1+3]
32. **2060 Q.No. 5 a** Derive an expression for the velocity of sound in a medium by dimensional method. Discuss the effect of change in pressure and temperature on the velocity of sound in air. [2+2]
33. **2056 Q.No. 2** Discuss Laplace's correction and derive the formula for the velocity of sound in a gas. [4]
34. **2055 Q.No. 2** Describe Newton's expression for the velocity of sound in a gas with Laplace correction. [4]
35. **2053 Q.No. 2** What is Newton's formula for the velocity of sound? What correction was made by Laplace? [4]
36. **2052 Q.No. 2** Discuss the effect of pressure, temperature and density of elastic medium on the velocity of sound. [4]

**Numerical Problems [4 Marks]**

37. **2077 Set D Q.No. 3c** At what temperature, the velocity of sound in air is increased by 60% to that at 27°C? [4]  
Ans: 495° C
38. **2076 GIE Set A Q.No. 11** In a stormy day a person observes a lightning flash which is followed by a thunder 3s later. How would you estimate the distance of the lightning striking from the person.  
[velocity of sound = 340 m/s, velocity of light =  $3 \times 10^8$  m/s] [4]  
Ans: 1020 m
39. **2076 Set C Q.No. 11** A source of sound of frequency 550Hz emits waves of wavelength 60 cm in air at 20°C. What would be the wavelength of sound from the source in air at 0°C? [4]  
Ans: 0.58 m
40. **2075 Set A Q.No. 11** What is the difference between the speed of longitudinal waves in air at 27°C and at -13°C? What is the speed at 0°C? [4]  
Ans: 23.96m /sec, 331.1 m/sec
41. **2075 Set B Q.No. 11** **2058 Q.No. 5 b** At what temperature, the velocity of sound in air is increased by 50% to that at 27°C? [4]  
Ans: 675 K
42. **2074 Supp Q.No. 11** In a resonance air column apparatus, the first and second resonance positions were observed at 18 cm and 56 cm respectively. The frequency of tuning fork used was 480 Hz. Calculate the velocity of sound in air and end correction of the tube. [4]  
Ans: 364.8 m/sec and 0.01 m
43. **2073 Set D Q.No. 11** Calculate the bulk modulus of a liquid in which longitudinal waves with frequency of 250 Hz have the wavelength of 8 m if the density of liquid is  $900 \text{ kg m}^{-3}$  [4]  
Ans:  $3.6 \times 10^9 \text{ N/m}^2$
44. **2072 Set E Q.No. 11** A source of sound produces a note of 512 Hz in air at 17°C with wavelength 66.5 cm. Find the ratio of molar heat capacities at constant pressure to constant volume at NTP. Densities of air and mercury at NTP are  $1.293 \text{ kg/m}^3$  and  $13600 \text{ kg/m}^3$  respectively. [4]  
Ans: 1.36

45. **2071 Set D Q.No. 11** A Source of sound of frequency 512 emits waves of wavelength 64.5 cm in air at 20°C. What would be the velocity of sound at 0°C? [4]  
Ans: 318.77 m/s
46. **2070 Supp. Set B Q.No. 11** In a stormy day a boy observes a lightning flash which is followed by a thunder 3 sec later. How would you estimate the distance of the lightning striking from the boy. (given velocity of sound on that day =  $332 \text{ m/s}$ , velocity of light  $c = 3 \times 10^8 \text{ m/s}$ ) [4]  
Ans: 996 m from boy
47. **2069 Set A Q.No. 11** When a detonator is exploded on a railway line, an observer standing on the rail 2 km away hears two sounds. What is the time interval between them (Young's modulus of steel =  $2 \times 10^{11} \text{ Nm}^{-2}$ , density of steel =  $8 \times 10^3 \text{ kg m}^{-3}$ , density of air =  $1.4 \text{ kgm}^{-3}$ ,  $\gamma$  for air = 1.4, atmospheric pressure =  $10^5 \text{ Nm}^{-2}$ ) [4]  
Ans: 5.92 s
48. **2064 Q.No. 5 b** A source of sound of frequency 512 Hz emits waves of wavelength 670 mm in air at 20°C. What is the velocity of sound in air at this temperature? What would be the wavelength of sound from the source in air at 0°C? [4]  
Ans:  $343.04 \text{ ms}^{-1}$ ,  $646.7 \times 10^{-2} \text{ m}$
49. **2057 Q.No. 5 b** A man standing at one end of a closed corridor 57 m long blows a short blast on a whistle. He finds that the time from the blast to the sixth echo was 2 seconds. If the temperature was 17°C, what was the velocity of sound at 0°C? [4]  
Ans: 331.8 m/s
50. **2052 Q.No. 3 OR** The interval between the flash of lightning and the sound of thunder is 2 seconds, when temperature is 10°C. How far is the storm if the velocity of sound in air at 0°C is  $330 \text{ m s}^{-1}$ ? [4]  
Ans: 670 m

**3. WAVE IN PIPES AND STRINGS**

**FORMULAE**

1. Waves in Pipe:
- The fundamental frequency in closed organ pipe,  
$$f_1 = \frac{v}{4l} = \frac{1}{4l} \sqrt{\frac{\gamma P}{\rho}} = \frac{1}{4l} \sqrt{\frac{\gamma RT}{M}}$$
  - The fundamental frequency of organ pipe,  
$$f_1 = \frac{v}{2l} = \frac{1}{2l} \sqrt{\frac{\gamma P}{\rho}} = \frac{1}{2l} \sqrt{\frac{\gamma RT}{M}}$$
  - End correction:
    - $e = \frac{l_2 - 3l_1}{2}$
    - $e = 0.3d$ ,  $d$  = diameter of resonance tube
- b. Fundamental frequency in closed organ pipe,  
$$f_1 = \frac{v}{4(l + e)}$$
2. Waves in string:
- The fundamental frequency,  $f_1 = \frac{1}{2l} \sqrt{\frac{T}{\mu}}$   
The speed of transverse vibration,  $v = \sqrt{\frac{T}{\mu}}$
  - For a cylindrical wire,  
$$\mu = A \cdot \rho = \frac{\pi d^2}{4} \cdot \rho \text{ or } \pi r^2 \cdot \rho,$$
  
where  $\rho$  = Mass per unit length

Short Ans  
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## Short Answer Questions [2 Marks]

1. **2074 Set B Q.No. 3b** **2068 Can. Q.No. 3b** The frequency of a fundamental note of a closed organ pipe and that of an open organ pipe are the same. What is the ratio of their lengths? [2]
2. **2073 Set C Q.No. 3a** **2073 Set D Q.No. 3b** By what factor does the velocity of transverse wave in the string change when the tension in the stretched string is increased by four times [2]
3. **2072 Supp Q.No. 3a** The six strings of a guitar are of the same length and are under nearly the same tension, but have different thickness. On which string do waves travel the fastest? [2]
4. **2072 Supp Q.No. 3b** How does the pitch of an organ pipe change with temperature? [2]
5. **2071 Supp. Q.No. 3a** Does the frequency of sound produced by an organ pipe change with its diameter? Explain. [2]
6. **2071 Set C Q.No. 3 b** **2069 Set A Q.No. 2b** What happens to the frequency of transverse vibration of a stretched string if its tension is halved and the area of cross section of the string is doubled? [2]
7. **2071 Set D Q.No. 3 b** A tuning fork produces a feeble sound. But when it is pressed against a table, a loud sound is heard. Why? [2]
8. **2070 Set C Q.No. 3 b** Why is sounding board used in a string instrument? [2]
9. **2070 Set D Q.No. 3 a** When the tension in a given string is increased by four times, by what factor does the velocity of wave in the string change? [2]
10. **2069 Supp Set B Q.No. 3 a** Explain, with figure, the formation of second overtone of waves in an open organ pipe. [2]
11. **2068 Old Can. Q.No. 1c** A loud sound is heard at resonance. Why? [2]
12. **2068 Q.No. 3 b** Is it possible to have a longitudinal wave on a stretched string? Why or why not? [2]
13. **2067 Q.No. 3a** Would you expect the pitch of an organ pipe to change with an increase in temperature? How? [2]
14. **2067 Q.No. 3b** Is the wave speed the same as the speed of any part of the string for transverse waves? Explain the difference between these two speeds. [2]
15. **2067 Old Q.No. 1d** Why are the bells made of metal not of wood? [2]
16. **2067 Sup Q.No. 3a** When the tension in a given stretched string is increased by four times, by what factor does the velocity of transverse wave in the string change? [2]
17. **2066 Q.No. 2 c** Why are all string instruments provided with hollow boxes? [2]
18. **2066 Supp Q.No. 2c** What is the use of sounding board on stringed musical instrument? [2]
19. **2061 Q.No. 2 c** How does the temperature affect the frequency of an organ pipe? [2]
20. **2059 Q.No. 2 d** One of the 'Nine Jewels' of Emperor Akbar, widely known as Tansen, the king of Music was able to break a glass by singing the appropriate note. What physical phenomenon could account for this? [2]

21. **2057 Q.No. 1 d** What do you mean by resonance? [2]
22. **2056 Q.No. 1 a** Why is sonometer box hollow from inside? [2]
23. **2055 Q.No. 1 a** Relate the fundamental note with overtones for an open pipe. [2]
24. **2054 Q.No. 1 a** Why is an end correction necessary for an organ pipe? [2]
25. **2053 Q.No. 1 a** The frequency of organ pipe changes with temperature. Does it increase with increase in temperature? [2]
26. **2053 Q.No. 1 c** Explain why soldiers are ordered to break steps while crossing a bridge. [2]
27. **2052 Q.No. 1 a** The frequency of fundamental note of an open organ pipe is double than for closed pipe of same length. Why? [2]
28. **2052 Q.No. 1 b** Differentiate between forced vibration and free vibration. [2]

## Long Answer Questions [4 Marks]

29. **2077 Set D Q.No. 2c** Prove, with necessary diagrams, that both types of harmonics odd and even can be obtained in an organ pipe open at both ends. What is end correction of a pipe? [4]
30. **2076 GIE Set A Q.No. 7a** What is meant by end correction? Discuss the vibration of air column of open organ pipe and show that both harmonics are produced on it. [4]
31. **2076 Set C Q.No. 7a** **2074 Supp Q.No. 7b** **2070 Set C Q.No. 7b** Define end correction of a pipe. Prove that both odd and even types of harmonics can be obtained from an organ pipe open at both ends. [4]
32. **2075 GIE Q.No. 7b** State the laws of transverse vibration in a stretched string. Describe various modes of vibration in a stretched string. [4]
33. **2075 Set A Q.No. 7a** **2065 Q.No. 5a** What do you understand by harmonics and overtones in the case of organ pipes? Prove that only odd harmonics are produced in closed organ pipes. [4]
34. **2075 Set B Q.No. 8a** **2069 Set A Old Q.No. 5a OR** What are harmonics? Explain the formation of overtones in an open and a closed organ pipe. [4]
35. **2074 Set A Q.No. 7b** **2073 Supp Q.No. 7a** **2067 Q.No. 7a** Describe an experiment with the necessary theory by which the speed of sound in air is determined by using resonance tube method. [4]
36. **2073 Set D Q.No. 7a** What is the difference between an open and a closed pipes? Explain with proper sketches for the formation of second overtones in each case. Also express the length of pipes in terms of the wavelength of sound. [4]
37. **2072 Set D Q.No. 7b** What is end correction of a pipe? Describe the different modes of vibration of air column in an organ pipe closed at one end. [4]
38. **2071 Supp. Q.No. 7b** Prove, with necessary diagrams, that both types of harmonics odd and even can be produced in an organ pipe open at both ends. [4]
39. **2071 Set D Q.No. 7 a** What is resonance? Describe an experiment to determine the velocity of sound in air and end correction of the tube by resonance method. [4]

40. **2069 Supp Set B Q.No. 7 b** Write the laws of transverse vibration of string. Explain how the law of length is verified experimentally. [4]
41. **2069 Set A Q.No. 7a** Show that both harmonics, odd and even can be produced in an open organ pipe. What is end correction? [4]
42. **2068 Old Can. Q.No. 5a OR** What is a closed pipe? Describe the natural modes of vibration of air in an organ pipe closed at one end. Also explain the term 'end correction'. [1+2+1]
43. **2068 Q.No. 7 a** What is meant by resonance? Explain in detail how you would use sonometer to determine frequency of a given tuning fork. [4]
44. **2068 Old Q.No. 5 a OR** What are harmonics? Explain the formation of the overtones in a closed organ pipe. [4]
45. **2067 Old Q.No. 5a OR** Describe the resonance tube experiment to determine the velocity of sound in Laboratory and obtain the expression of end correction. [3+1]
46. **2064 Q.No. 5a OR** State and explain principle of superposition and formation of stationary waves. Show that the frequency of the fundamental note of a closed organ pipe is half as compared to that of an open pipe of the same length. [2+2]
47. **2063 Q.No. 6a OR** **2057 Q.No. 5a OR** Discuss the different modes of vibrations of air column in closed pipe. [4]
48. **2062 Q.No. 6a OR** State the laws of transverse vibration of string. Describe an experiment to verify the law of mass, and law of length. [4]
49. **2059 Q.No. 5 a OR** State the laws of transverse vibrations of string. Using only dimensions, show that the speed of propagation of a transverse wave depends only on tension and mass per unit length. [1+3]
50. **2058 Q.No. 5 a OR** Prove that both types of harmonics, odd and even, can be produced in an organ pipe open at both ends. [4]
51. **2054 Q.No. 2** Describe the various modes of vibrations of the air column in an organpipe. [4]

**Numerical Problems [4 Marks]**

52. **2076 GIE Set B Q.No. 11** One day when speed of sound is 340 m/s the fundamental frequency of a closed organ pipe is 220 Hz (a) How long is this pipe? (b) The second overtone of this pipe has the same wavelength as third harmonic of an open pipe. How long is the open pipe? [4]  
 Ans: 0.386 m, 0.31 m
53. **2076 Set B Q.No. 11** A wire whose mass per unit length is  $10^{-3}$  kg/m is stretched by a load of 4 kg over the two bridges of a sonometer wire 1 m apart. It is struck at its middle point, what would be the wavelength and frequency of its fundamental vibration? [4]  
 Ans: 100 Hz
54. **2074 Set B Q.No. 11** A steel wire of length 20 cm and mass 5 gram is under the tension of 500N and is tied down at both ends. Calculate the frequency of fundamental mode of vibration. [4]  
 Ans: 353.55 Hz

55. **2073 Supp Q.No. 11** **2069 Supp Set B Q. No. 11** A piano wire having a diameter of 0.90 mm is replaced by another wire of the same material but with diameter 0.93 mm. If the tension of the wire is as before, what is percentage change in the frequency of fundamental note? [4]  
 Ans: 3.2%
56. **2072 Supp Q.No. 11** On a day when the speed of sound is 345 m/s, the fundamental frequency of a closed organ pipe is 220 Hz. The second overtone of this pipe has the same wave length as the third harmonic of an open pipe. How long is the open pipe? [4]  
 Ans: 0.47 m
57. **2072 Set C Q.No. 11** A wire with mass 40 g is stretched such that its ends are tied down at points 80 cm apart. The wire vibrates in its fundamental mode with frequency 60 Hz. Calculate the speed of propagation of transverse waves in the wire and the tension in the wire. [4]  
 Ans: 96 m/sec, 460.8 N
58. **2071 Supp. Q.No. 11** A cord of length 1.5 m is fixed at both ends. Its mass per unit length is 1.2g/m and the tension is 12N.  
 a. What is the frequency of fundamental oscillation?  
 b. What tension is required if the  $n = 3$  mode has frequency of 0.50 kHz? [4]  
 Ans: (a) 33.33 Hz, (b) 300 N
59. **2071 Set C Q.No. 11** **2070 Set D Q.No. 11** In a resonance tube experiment, the first and the second resonance positions were observed at 17cm and 52.6cm respectively. The tuning fork used was frequency 512Hz and the temperature was 27°C. Calculate the velocity of sound in air at 0°C and the end correction of the tube. [4]  
 Ans: 347.75 m/sec and 0.008 m
60. **2069 Set B Q.No. 11** **2068 Q.No. 11** **2067 Sup Q.No. 11** An open pipe 30 cm long and a closed pipe 23 cm long, both of the same diameter, each sounds their first overtone. If they are in resonance find the end correction of these pipes. [4]  
 Ans: 1 cm
61. **2068 Can. Q.No. 11** A piano string 1.5m long is made of steel of density 7800 kg/m<sup>3</sup> and Young's modulus  $2 \times 10^{11}$  N.m<sup>2</sup>. It is maintained at a tension which produced an elastic strain of 1% in the string. Calculate the frequency of transverse vibration of the string when it is vibrating in its second mode of vibration. [4]  
 Ans: 168.79 Hz, 337.6 Hz
62. **2066 Q.No. 5 b** A uniform tube 60 cm long stands vertically with its lower end dipping into water. When the length above the water is 14.8cm and again when it is 48 cm, the tube resonates to a vibrating tuning fork of frequency 512Hz. Find the lowest frequency to which the tube will resound when it is open at both ends. [4]  
 Ans: 267.27 Hz
63. **2066 Supp Q.No. 5b** A steel wire of length 40 cm and diameter 0.25 mm vibrates in unison with a tube, open at both ends and of effective length 60 cm, when each is sounding its fundamental notes. The air temperature is 27°C. Find the tension in the wire. Given - velocity of sound in air at 0° C = 332 ms<sup>-1</sup> and density of steel = 7800 kg m<sup>-3</sup>. [4]  
 Ans: 20.6 N

64. **2061 Q.No. 5** 2.0m and a string produced... Calculate the... string.

65. **2060 Q.No.** and made of... tension of 8... cause it to v...

66. **2056 Q.No.** 440 Hz wh... when the t... the pipe op...

67. **2052 Q.No.** under tens... Calculate... mode of vib...

**4. ACOU**

1. Intensity  
 i.  $I = \frac{\text{Power}}{\text{surface}}$   
 ii.  $\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2}$  (ii)  
 iii. Thresho  
 iv. Intensity  
 v. Compar  
 vi. Energy  
 vii. Intensit  
 2. Beats:  
 $f_b = f_2 - f_1$   
 3. Dopple  
 i. Appare  
 ii. Appare  
 hill (i.e.  
 $f' = \frac{v + v_o}{v - v_s}$   
 iii. Appare  
 driver  
 $f' = \frac{v + v_o}{v - v_s}$   
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64. **2061 Q.No. 5 b** **2055 Q.No. 3** A piano string has a length of 2.0 m and a density of  $8000 \text{ kg m}^{-3}$ . When the tension in the string produces a strain of 1%, the fundamental note obtained from the string in transverse vibration is 170 Hz. Calculate the Young's modulus value for the material of string. [4]

Ans:  $3.7 \times 10^{10} \text{ Nm}^{-2}$

65. **2060 Q.No. 5 b** **2053 Q.No. 3** A wire of diameter 0.04 cm and made of steel of density  $8000 \text{ kg m}^{-3}$  is under a constant tension of 80 N. What length of this wire should be plucked to cause it to vibrate with a frequency of 840 Hz? [4]

Ans: 0.168 m

66. **2056 Q.No. 3 OR** An organ pipe is turned to a frequency of 440 Hz when the temperature is  $27^\circ\text{C}$ . Find its frequency when the temperature drops to  $0^\circ\text{C}$ . Assume both ends of the pipe open. [4]

Ans: 419.73 Hz

67. **2052 Q.No. 3** A steel wire of 2 m long whose mass is 3 g is under tension of 500 N and is tied down at both ends. Calculate the frequency and wavelength for fundamental mode of vibration. [4]

Ans: 144.3 Hz, 4 m

#### 4. ACOUSTIC PHENOMENA

##### FORMULAE

1. Intensity

$$i. I = \frac{\text{Power transfer}}{\text{surface area}} = \frac{P}{A} = 2a^2f^2a^2pv = \frac{P^2_{\text{max}}}{2pv}$$

$$ii. \frac{I_1}{I_2} = \frac{r_2^2}{r_1^2} \text{ (inverse square law)}$$

iii. Threshold of hearing,  $L_0 = \log I_0$ ,  $I_0 = 10^{-12} \text{ W m}^{-2}$

iv. Intensity level,  $\beta = 10 \log \frac{I}{I_0}$  (decibel)

v. Comparison,  $\Delta\beta = \beta_1 - \beta_2 = 20 \log \left( \frac{r_2}{r_1} \right)$

vi. Energy density,  $U = \frac{\text{Energy transfer}}{\text{volume}}$

viii. Intensity, point source (spherical wave)  $I = \frac{P}{4\pi r^2}$ ,  $a \propto \frac{1}{\sqrt{r}}$

2. Beats: The beat frequency,  $f_b = f_1 - f_2$  (for  $f_1 > f_2$ ) and  $f_b = f_2 - f_1$  (for  $f_2 > f_1$ )

3. Doppler's effect:

i. Apparent frequency heard by the observer,  $f' = \frac{v \pm v_0}{v \pm v_s} f$

ii. Apparent frequency heard by driver moving towards a hill (i.e. reflector)

$$f' = \frac{v + v_0}{v - v_s} \times f$$

iii. Apparent frequency of echo of horn of his car heard by driver moving towards the hill (i.e. reflector)

$$f' = \frac{v + v_0}{v - v_s} \times f$$

iv. Doppler's effect in light: Apparent frequency of light

$$\text{received by an observer, } f' = \left( \frac{c \pm v}{c} \right) f$$

Positive sign is chosen when the source and the observer are approaching each other and negative sign is chosen when the source and the observer are receding away.

#### Short Answer Questions [2 Marks]

- 2077 Set D Q.No. 1d** What is quality of sound? [2]
- 2076 GIE Set A Q.No. 3b** Can you distinguish two notes, one produced by violin and the other by a sitar, having the same frequency? Explain. [2]
- 2076 GIE Set B Q.No. 3b** How can bats fly around without colliding with objects that come in their way? [2]
- 2076 Set B Q.No. 3b** **2073 Supp Q.No. 3b** **2070 Set D Q.No. 3b** **2058 Q.No. 2c** An empty vessel sounds more than a filled one when it is struck. Why? [2]
- 2076 Set C Q.No. 3b** Sound waves are called pressure waves. Why? [2]
- 2075 GIE Q.No. 3b** **2074 Set A Q.No. 3b** **2072 Set E Q.No. 3b** What is the threshold of hearing? Define one bel. [2]
- 2075 Set A Q.No. 3b** Justify the proverb "An empty vessel makes much noise". [2]
- 2075 Set B Q.No. 3b** Why is the voice of a woman more intelligible than that of a man? [2]
- 2074 Supp Q.No. 3a** **2074 Set A Q.No. 3a** Why are longitudinal waves called pressure waves? [2]
- 2074 Supp Q.No. 3b** **2054 Q.No. 1 c** What are ultrasonic and infrasonic waves? [2]
- 2073 Set D Q.No. 3a** **2055 Q.No. 1 c** Explain the difference in characteristics between ultrasonic and supersonic waves. [2]
- 2072 Set C Q.No. 3a** **2071 Set C Q.No. 3a** **2060 Q.No. 1c** Whistle of an approaching train is shriller, why? [2]
- 2072 Set D Q.No. 3b** If the pressure amplitude of a sound wave is halved, by what factor does the intensity of the wave change? [2]
- 2072 Set E Q.No. 3a** A tuning fork has two prongs. Why? [2]
- 2071 Supp. Q.No. 3b** How can we consider sound waves as pressure waves? [2]
- 2070 Supp. Set A Q.No. 3 a** 'An empty vessel makes much noise'. How would you justify the proverb? [2]
- 2070 Supp. Set A Q.No. 3 b** Bats catch their prey in the dark even when they don't see the prey. How can this happen? [2]
- 2070 Supp. Set B Q.No. 3 b** How can we recognize a person just by hearing her voice without seeing her face? [2]
- 2069 Set A Q.No. 3a** An empty vessel sounds more than a filled one. Why? [2]
- 2069 Set A Old Q.No. 2c** **2053 Q.No. 1b** How are beats produced? What is beat frequency? [2]
- 2069 Set B Q.No. 3a** Is there a physical difference between intensity and intensity level of a wave? How are these quantities related? [2]
- 2068 Old Can. Q.No. 2c** Two notes, one produced by violin and the other by a sitar, may have the same frequency, yet we can distinguish between them. Why? [2]
- 2068 Q.No. 3 a** Which has a more direct influence on the loudness of a sound wave: the displacement amplitude or the pressure amplitude? Explain your reasoning. [2]
- 2068 Old Q.No. 2 c** What is meant by threshold of hearing? [2]
- 2065 Q.No. 2 d** Explain with a figure, the meaning of beats. [2]
- 2064 Q.No. 1 c** Bells are made of metal and not of wood, why? [2]

27. **2061 Q.No. 1 c** Define beats and beat frequency. [2]  
 28. **2059 Q.No. 1 c** What do you mean by the term threshold of hearing? [2]  
 29. **2057 Q.No. 2 d** Why is the roaring of a lion different than the sound of a mosquito? [2]  
 30. **2056 Q.No. 1 b** How is it that one can recognize a friend from his voice without seeing him? [2]

**Long Answer Questions [4 Marks]**

31. **2076 GIE Set A Q.No. 7b** Define intensity of sound and show that  $I = \frac{1}{2} \rho v r^2 \omega^2$  where symbols have their usual meaning. [4]  
 32. **2076 GIE Set B Q.No. 7b** Describe sound wave as a pressure wave and deduce an expression for the pressure amplitude. [4]  
 33. **2076 Set B Q.No. 7b** **2057 Q.No. 5 a** What is Doppler's effect? Derive an expression for the apparent frequency received by a stationary observer when a source of sound is moving away from the observer. [4]  
 34. **2076 Set C Q.No. 7b** **2075 Set B Q.No. 8b** **2074 Set B Q.No. 7b** **2073 Set D Q.No. 7b** **2072 Supp Q.No. 7b** What is Doppler's effect? Derive an expression for the apparent frequency when a source of sound and the observer are moving towards each other. [4]  
 35. **2075 Set A Q.No. 7b** What is Doppler's effect? Obtain an expression for the apparent pitch when a source moves away from a stationary observer. [4]  
 36. **2073 Supp Q.No. 7b** **2064 Q.No. 5 a** Define intensity of sound. Show that the intensity of sound for a given frequency is directly proportional to the square of amplitude of vibration. [4]  
 37. **2073 Set C Q.No. 7a** How are beats formed when two waves are superimposed? Deduce expression for the frequency of beats so formed. [4]  
 38. **2072 Set C Q.No. 7b** Describe sound wave as a pressure wave and deduce an expression for the pressure amplitude. [4]  
 39. **2072 Set E Q.No. 7b** What is Doppler's effect? Find the change in frequency when an observer moves towards a stationary source and then moves away from the source. [4]  
 40. **2071 Set C Q.No. 7 b** Define intensity of sound. Prove that it is proportional to the square of the amplitude of vibration for the given source of sound. [4]  
 41. **2071 Set D Q.No. 7 b** **2069 Set A Q.No. 7b** **2059 Q.No. 5 a** What is Doppler's effect in sound? Obtain an expression for the apparent frequency of the sound when an observer moves towards a stationary source of sound. [4]  
 42. **2070 Set D Q.No. 7 b** **2060 Q.No. 5 a OR** What are beats? Show that the number of beats heard per second is equal to the difference between the frequencies of two superposing waves. [4]  
 43. **2070 Supp. Set B Q.No. 7 a** **2067 Sup Q.No. 7a** What are beats? Obtain an expression for the beat frequency produced by the superposition of two waves of slightly different frequencies. [4]  
 44. **2070 Supp. Set B Q.No. 7 b** Define Doppler's effect. Derive an expression for the change in frequency observed by a stationary observer when a moving source just crosses the observer. [4]

45. **2069 Set B Q.No. 7a** How does the frequency of sound change when sound source is moving:  
 i. towards the stationary listener and  
 ii. away from the stationary listener.  
 46. **2068 Can. Q.No. 7b** What is Doppler's effect? Deduce an expression for the apparent frequency heard by a stationary observer when a source approaches towards him.  
 47. **2067 Q.No. 7b** Define intensity and deduce it in terms of amplitude of vibration, density of medium, angular velocity and velocity of the wave.  
 48. **2066 Q.No. 5 a OR** Define the intensity of sound and prove that  $I = \frac{1}{2} \rho v r^2 \omega^2$  where the symbols have their usual meaning.  
 49. **2066 Supp Q.No. 5a OR** What is the Doppler effect in sound? Obtain an expression for the apparent frequency of the sound when the source and observer both move in the same direction.  
 50. **2062 Q.No. 6 a** Discuss the phenomenon of Doppler's effect. Find the change in frequency when a moving source of sound passes a stationary observer.  
 51. **2058 Q.No. 5 a** What do you mean by intensity and intensity level of sound? Define bel and decibel.  
 52. **2055 Q.No. 2 OR** Deduce the expression for the frequency heard by an observer, when the observer is approaching the stationary sound source.
- Numerical Problems [4 Marks]**
53. **2075 GIE Q.No. 11** A train is approaching a cliff at 20 m/s. The driver sounds a whistle of frequency 800 Hz. What will be the frequency of echo as heard by the driver? Velocity of sound in air is 350 m/s.  
 Ans: 896.97 Hz
54. **2074 Set A Q.No. 11** A car is approaching towards a cliff at a speed of 20m/s. The driver sounds a whistle of frequency 800 Hz. What will be the frequency of the echo as heard by the car driver? Velocity of sound in air = 350m/s.  
 Ans: 896.97 Hz
55. **2073 Set C Q.No. 11** A car travelling with a speed of 60 Kmhr<sup>-1</sup> sounds a horn of frequency 500Hz. The sound is heard in another car travelling behind the first car in the same direction with a speed of 80 Kmhr<sup>-1</sup>. What frequencies will the driver of the second car hear before an after overtaking the first car if the velocity of sound is 340ms<sup>-1</sup>?  
 Ans: 507.8 Hz and 491.4 Hz
56. **2072 Set D Q.No. 11** A stationary motion detector sends sound waves of 150 KHz towards a truck approaching at a speed of 120 km/hr. What is the frequency of wave reflected back to detector? (Velocity of sound in air = 340 m/s)  
 Ans: 182.6 kHz
57. **2070 Supp. Set A Q.No. 11** A car traveling at 20ms<sup>-1</sup> blows its horn which has a frequency of 600Hz. A stationary observer notices that the frequency of the horn changes considerably as the car passes by him. Calculate the change in frequency heard by the observer as the car approaches and moves away from the observer. (Given velocity of sound = 330ms<sup>-1</sup>)  
 Ans: 73 Hz

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58. **2070 Set C Q.No. 11** note of 500 Hz is heard by an observer at a distance of 340 ms<sup>-1</sup>.  
 59. **2069 Set A Q.No. 7b** elevation of sound is 30°. What would be the elevation if the source is moving towards the observer?  
 60. **2068 Old Q.No. 7b** waves which are heard if the source is moving towards the observer with a speed of 30 m/s.  
 i. The sound heard by the observer with a speed of 30 m/s.  
 ii. The sound heard by the observer with a speed of 30 m/s.  
 iii. Both sound heard by the observer with a speed of 30 m/s.  
 61. **2068 Old Q.No. 7b** of 1000m/s. What would be the frequency heard if the source is moving towards the observer with a speed of 30 m/s.  
 62. **2067 Q.No. 7b** constant frequency of source of sound is 500 Hz. What would be the frequency heard by the observer if the source is moving towards the observer with a speed of 30 m/s.  
 63. **2065 Q.No. 7b** listener is moving towards the source of sound with a speed of 30 m/s. What frequency would be received by the listener if the source is moving towards the listener with a speed of 30 m/s.  
 64. **2063 Q.No. 7b** 100 dB. What would be the distance between the source and the listener if the source is moving towards the listener with a speed of 30 m/s.  
 65. **2062 Q.No. 7b** 100 dB. What would be the distance between the source and the listener if the source is moving towards the listener with a speed of 30 m/s.  
 66. **2059 Q.No. 7b** of frequency 500 Hz. Find the frequency heard by the observer if the source is moving towards the observer with a speed of 30 m/s.  
 67. **2056 Q.No. 7b** an observer is moving towards the source of sound with a speed of 30 m/s. What would be the frequency heard by the observer if the source is moving towards the observer with a speed of 30 m/s.  
 68. **2054 Q.No. 7b** note of frequency 500 Hz is heard by an observer at a distance of 340 m. What would be the frequency heard by the observer if the source is moving towards the observer with a speed of 30 m/s.

58. **2070 Set C Q.No. 11** A car, sounding a horn and producing a note of 500 Hz, approaches and then passes a stationary observer at a steady speed of  $20\text{ms}^{-1}$ . Calculate the change in frequency heard by the observer. Velocity of sound is  $340\text{ms}^{-1}$ . [4]

Ans: 59 Hz

59. **2069 Set A Old Q.No. 5b** When a jet plane is flying on elevation of 1000m the sound level on the ground is 4.0db. What would be the intensity level on the ground when its elevation is as low as 100m? [3]

Ans: 24 db

60. **2068 Old Can. Q.No. 5b** A source of sound generates sound waves which travel with a speed of  $340\text{ms}^{-1}$ . The frequency of the source is 500 Hz. Find the frequency of the sound heard if:

- The source is moving towards the stationary observer with a speed of  $30\text{ms}^{-1}$ .
- The observer is moving towards the stationary source with a speed of  $30\text{ms}^{-1}$ .
- Both source and observer move with a speed of  $30\text{ms}^{-1}$  and approach one another. [3]

Ans: 550 Hz, 545.45 Hz, 600 Hz

61. **2068 Old Q.No. 5 b** When a jet plane is flying at an elevation of 1000m the sound level on the ground is 4.0 db. What would be the intensity level on the ground when its elevation is as low as 50 m? [3]

Ans: 30 dB

62. **2067 Q.No. 11** **2067 Old Q.No. 5b** An observer traveling with constant velocity of 20 m/s, passes close to a stationary source of sound and notices that there is a changes of frequency of 50 HZ as he passes the source. What is the frequency of the source? Speed of the sound in air =  $340\text{m/s}$ . [4]

Ans: 425 Hz

63. **2065 Q.No. 5 b** A car is moving away from a stationary listener with a velocity of  $20\text{m/s}$ . If the horn is sounding at frequency 512 Hz, calculate the change in pitch of the sound received by the listener. (Velocity of sound in air =  $330\text{ms}^{-1}$ ) [2]

Ans: 29.26 Hz

64. **2063 Q.No. 6 b** The intensity level from a loud speaker is 100 dB at a distance of 10m. What is its intensity level at a distance of 200m? [4]

Ans: 74 dB

65. **2062 Q.No. 6 b** The intensity level from a loud speaker is 100 dB at a distance of 10 m. What is its intensity level at a distance of 100 m? [4]

Ans: 80 dB

66. **2059 Q.No. 5 b** A note produces 2 beat/s with a tuning fork of frequency 480 Hz and 6 beats/s with a tuning fork of 472 Hz. Find the frequency of the note. [4]

Ans: 478 Hz

67. **2056 Q.No. 3** The noise from an airplane engine 25.0 m from an observer is found to have an intensity of 45.0 db. What will be the intensity, in decibel when the plane flies overhead at an altitude of 2.0 km? [4]

Ans: 6.94 dB

68. **2054 Q.No. 3** A column of air is set into vibration and the note emitted gives 10 beats per second when a tuning fork of frequency 440 Hz is sounded, the temperature being  $20^\circ\text{C}$ . The frequency of beats decreases when the tuning fork is loaded with a small piece of wax. At what temperature will the unloaded fork and the air column will be in unison? [4]

Ans: 306.33 K

69. **2054 Q.No. 3 OR** Two observers A and B are provided with source of sound of frequency 500 Hz. A remains stationary and B moves away from him at a velocity of  $1.8\text{ms}^{-1}$ . How many beats per second are observed by B, the velocity of sound in air being  $330\text{ms}^{-1}$ ? [4]

Ans: 27 beats/S [4]

## B. PHYSICAL OPTICS

### 1. NATURE AND PROPAGATION OF LIGHT

#### FORMULAE

- Speed of light in vacuum,  $c = 3 \times 10^8\text{ms}^{-1}$ .
- Foucault's method: Speed of light,  $c = \frac{4\pi fa}{\theta} = \frac{8\pi fa^2x}{(a+b)y}$
- Michelson's method: speed of light,  $c = 2mf d$ , for octagonal mirror,  $c = 16fd$ .
- Refractive index:  $\eta = \frac{\text{wavelength of light in vacuum}}{\text{wavelength of light in medium}} = \frac{\lambda}{\lambda'}$

#### Short Answer Questions [2 Marks]

- 2076 GIE Set A Q.No. 4b** **2073 Supp Q.No. 4a** **2062 Q.No. 2 d** Differentiate between a plane wave front and a spherical wave front. [2]
- 2076 GIE Set B Q.No. 4a** What are meant by wave front and wavelets? [2]
- 2076 Set B Q.No. 4a** **2067 Supp Q.No. 4a** State Huygen's principle. Does it apply to sound wave in air? [2]
- 2076 Set C Q.No. 4a** **2075 Set A Q.No. 4a** **2075 Set B Q.No. 4a** **2074 Supp Q.No. 4a** **2072 Set C Q.No. 4a** **2071 Set C Q.No. 4a** **2070 Set C Q.No. 4 b** Differentiate wave front and wavelet. [2]
- 2074 Set A Q.No. 4a** Explain with proper sketch, the differences between wavefronts and wavelets. [2]
- 2073 Set D Q.No. 4a** What is the difference between wave front and wavelets in the explanation of Huygen's wave theory? [2]
- 2072 Set E Q.No. 4a** Explain with proper sketch, the differences between wavefronts and wavelets. [2]
- 2071 Supp. Q.No. 4a** If light travels from one medium to another, its velocity changes? Is it due to change in frequency or wavelength? Explain. [2]
- 2070 Supp. Set B Q.No. 4 a** A normally incident wave front does not deviate, when it travels from one medium to another. Explain. [2]
- 2069 Supp Set B Q.No. 4 b** Can Snell's law be verified from wave theory? Explain with figure only. [2]
- 2069 Set A Old Q.No. 2g** **2068 Q.No. 4 b** What is wavefront? [2]
- 2067 Q.No. 4b** What is Huygens's principle? [2]
- 2067 Old Q.No. 2c** When monochromatic light incidents on a surface, the reflected and refracted wave will have same frequency. Why? [2]
- 2063 Q.No. 2 c** Which parameters of light does not change on refraction? [2]

#### Long Answer Questions [4 Marks]

- 2077 Set D Q.No. 2d** State and explain Huygen's construction and use it to verify laws of refraction. [4]
- 2076 GIE Set A Q.No. 8a** Explain laws of reflection of light on the basis of wave theory. [4]

17. [2076 GIE Set B Q.No. 8a] [2076 Set B Q.No. 7a] [2072 Set B Q.No. 8a] [2071 Set C Q.No. 8a] [2069 Supp Set B Q.No. 8b] [2067 Q.No. 8a] Describe Michelson's method to measure velocity of light. [4]
18. [2076 Set B Q.No. 8b] [2076 Set A Q.No. 8b] [2070 Supp. Set A Q.No. 8a] [2069 Set A Q.No. 8a] [2068 Q.No. 8a] Describe Foucault's method of determining the speed of light. [4]
19. [2076 Set C Q.No. 8a] [2072 Set D Q.No. 8a] State and explain Huygen's principle and use it to verify laws of reflection on the basis of wave theory. [4]
20. [2075 GIE Q.No. 8a] [2071 Supp. Q.No. 8a] What is meant by wave front? Verify Snell's law on the basis of wave theory. [4]
21. [2074 Set B Q.No. 8a] What is a wavefront? Using Huygen's principle prove that for a parallel beam of light incident on a reflecting surface, the angle of incidence is equal to angle of reflection. [4]
22. [2073 Set C Q.No. 8b] Describe Huygen's principle with figure to prove the laws of reflection and refraction of light. [4]
23. [2072 Supp. Q.No. 8a] What is Huygen's principle? Show how refraction of light at a plane interface can be explained on the basis of wave theory of light. [4]
24. [2071 Set D Q.No. 8 a] State and explain Huygen's principle and use it to verify Snell's law. [4]
25. [2070 Supp. Set A Q.No. 8 b] State Huygen's principle of wave theory of light and also use this principle to verify the laws of reflection of light. [4]
26. [2070 Supp. Set B Q.No. 8 b] State and use Huygen's principle of wave theory of light to verify the laws of refraction of light. [4]
27. [2070 Set D Q.No. 8 a] State and explain Huygen's principle. Use it to prove Snell's law. [4]
28. [2069 Set B Q.No. 8b] Describe Foucault's experimental method for the measurement of, the velocity of light with necessary theory. [4]
29. [2068 Can. Q.No. 8a] [2066 Supp. Q.No. 6a] State and explain Huygen's principle. Use the principle to show that a plane wave incident obliquely on a plane mirror is reflected as a plane wave so that the angle of incidence is equal to the angle of reflection. [4]
30. [2067 Sup. Q.No. 8b] Describe Michelson's method to determine the speed of light. Write advantages of the method over foucault's method. [3+1]
31. [2064 Q.No. 6 a] State and explain Huygen's principle. Use the principle to verify the laws of refraction of light on the basis of wave theory. [1+3]
32. [2063 Q.No. 5 a OR] Define Huygen's principle and prove Snell's law by the help of wave theory of light. [4]
33. [2061 Q.No. 6 a] Prove the laws of reflection of light using the wave theory. [4]
34. [2060 Q.No. 6 a] State and explain Huygen's principle. Use the principle to show that a plane wave front incident obliquely on a plane mirror is reflected as a plane wave front so that the angle of incidence is equal to the angle of reflection. [2+2]

**Numerical Problems [4 Marks]**

35. [2074 Supp. Q.No. 12] In Michelson's rotating prism method the distance between the rotating prism and the distant mirror is 45 km. A minimum speed of 416.7 revolutions per second is needed to view the source in the same position when the prism is at rest. Calculate the speed of light.   
 Ans:  $3 \times 10^8$  m/sec
36. [2074 Set A Q.No. 12] A plane mirror is placed at the centre of a concave mirror having radius of curvature 40 m. The plane mirror rotates at the speed of 2600 revolutions per second. Calculate the angle between ray incidents on the plane mirror and then reflected from it after the light has travelled to the concave mirror and back to the plane mirror. Given speed of light is  $3 \times 10^8$  m/s.   
 Ans: 0.92 degree
37. [2073 Supp. Q.No. 12] The radius of curvature of the curved mirror is 200m and the plane mirror is rotated at 20 rev/s. Calculate the angle in degrees between ray incidents on the plane mirror and then reflected from it after the light has travelled to the curved mirror and back to the plane mirror ( $C = 3 \times 10^8$  ms<sup>-1</sup>)   
 Ans: 0.0192 degree
38. [2072 Set C Q.No. 12] [2070 Supp. Set B Q.No. 12] A beam of light after reflection at a plane mirror, rotating 2000 times per minute, passes to a distant reflector. It returns to the rotating mirror from which it is reflected to make an angle of 1° with its original direction. If the distance between the mirrors is 6250 m, calculate the velocity of light.   
 Ans:  $3 \times 10^8$  m/sec
39. [2071 Supp. Q.No. 12] In a Michelson experiment for measuring speed of light, the distance travelled by light between two reflections from the rotating mirror is 4.8km. The rotating mirror has a shape of regular octagon. At what frequency of rotation of mirror the image is formed at the position where non-rotating mirrors forms it?   
 Ans: 7812.5 rev/sec
40. [2070 Set C Q.No. 12] [2067 Old Q.No. 6b] A beam of light is reflected by a rotating mirror on to a fixed mirror, which sends it back to the rotating mirror which it is again reflected making an angle of 18° with its original direction. The distance between the two mirrors is 10 km and the rotating mirror is making 375 revolutions per second. Calculate the velocity of light.   
 Ans:  $3 \times 10^8$  m/sec
41. [2063 Q.No. 5 b] A beam of light is reflected by a rotating mirror onto a fixed mirror which sends back to the rotating mirror from which it is again reflected and then makes an angle of 3.6° with the original direction. The distance between the two mirrors is 1 km and the rotating mirror is make 750 revs<sup>-1</sup>. Calculate the velocity of light.   
 Ans:  $3 \times 10^8$  m/sec
42. [2058 Q.No. 6 b] The radius of curvature of the curved mirror is 20 m and the plane mirror is rotated at 20 revs<sup>-1</sup>, calculate the angle in degrees between a ray incident on the plane mirror and then reflected from it after the light has travelled to the curved mirror and back to the plane mirror ( $c = 3 \times 10^8$  m s<sup>-1</sup>)   
 Ans:  $1.92 \times 10^{-3}$  degree

**2. INTERFER**

- The resultant  $a = \sqrt{a_1^2 + a_2^2}$
- Intensity of re Where  $\phi$  is th
- Constructive  $x = n\lambda$ , where
- Destructive in  $x = (2n - 1) \frac{\lambda}{2}$
- Relation bet Optical path
- $\phi = \frac{2\pi}{\lambda} x$
- The angula double slit  $\theta = \frac{\beta}{D} = \frac{\alpha}{D}$
- The fringe  $\alpha = \beta = \frac{\lambda D}{d}$
- Radius of
- Radius of
- Waveleng  $\lambda = \frac{D^2}{4}$

**Short Answer**

- [2075 GIE] in a Youn moved aw shorter wa
- [2074 Set] Can two coherent
- [2073 Set] notation are  $I_1$  and when  $I_1$
- [2072 S] setup an whole a pattern
- [2072 S] obey th
- [2071] constru
- [2070 s] energy
- [2070] between and d
- [2068] slit e separ between
- [2068] cohe

## 2. INTERFERENCE

### FORMULAE

- The resultant amplitude in interference of two waves,  

$$a = \sqrt{a_1^2 + a_2^2 + 2a_1a_2 \cos \phi}$$
- Intensity of resultant wave,  $I = I_1 + I_2 + 2\sqrt{I_1I_2} \cos \phi$ ,  
 Where  $\phi$  is the phase difference between two waves
- Constructive interference is obtained, when  $\phi = 2n\pi$  and  
 $x = n\lambda$ , where,  $n = 0, 1, 2, \dots$
- Destructive interference is obtained, when  $\phi = (2n - 1)\pi$  and  
 $x = (2n - 1) \frac{\lambda}{2}$ , where  $n = 1, 2, 3, \dots$
- Relation between optical path and geometric path:  
 Optical path (L) = refractive index ( $\eta$ )  $\times$  geometric path (x)
- $$\phi = \frac{2\pi}{\lambda} x$$
- The angular width of a fringe produced by Young's double slit experiment,  

$$\theta = \frac{\beta}{D} = \frac{\alpha}{D} = \frac{\lambda D}{dD} = \frac{\lambda}{d}$$
- The fringe width for both bright and dark pattern is  

$$\alpha = \beta = \frac{\lambda D}{d}$$
- Radius of  $n^{\text{th}}$  dark Newton's ring,  $r_n = \sqrt{n\lambda R}$
- Radius of  $n^{\text{th}}$  bright Newton's ring,  $r_n = \sqrt{(2n + 1) \frac{\lambda}{2} R}$
- Wavelength of light by Newton's Ring Method,  

$$\lambda = \frac{D_n^2 + m^2 - D_n^2}{4mR}$$

### Short Answer Questions [2 Marks]

- 2075 GIE Q.No. 4a** What happens on the interference fringes in a Young's double slit experiment when (i) the screen is moved away (ii) the source is replaced by another source of shorter wavelength? [2]
  - 2074 Set B Q.No. 4a** What are coherent sources of light? Can two different bulbs, similar in all respects, act as coherent sources? [2]
  - 2073 Set C Q.No. 4a** Two waves are represented in usual notation as  $y_1 = a_1 \sin \omega t$  and  $y_2 = a_2 \cos \omega t$ . Their intensities are  $I_1$  and  $I_2$ . What would be the ratio of their amplitudes when  $I_1 = 2I_2$ ? [2]
  - 2072 Supp Q.No. 4a** A two-slit interference experiment is setup and the fringes are displayed on a screen. Then the whole apparatus is immersed in a water. How does the fringe pattern change? [2]
  - 2072 Set D Q.No. 4a** Does the interference of light waves obey the law of conservation of energy? Explain. [2]
  - 2071 Set C Q.No. 4 b** What are the conditions for constructive and destructive interference of light waves? [2]
  - 2070 Supp. Set A Q.No. 4 b** Is the law of conservation of energy obeyed in case of interference of light? Explain. [2]
  - 2070 Set C Q.No. 4 a** What should be the path difference between two interfering waves for constructive interference and destructive interference? [2]
  - 2068 Can. Q.No. 4a** **2066 Supp Q.No. 2d** In Young's double slit experiment, how is the fringe width altered if the separation between the slits is doubled and the distance between the slits and the screen is halved? [2]
  - 2068 Old Q.No. 1d** **2065 Q.No. 2c** What do you mean by coherent sources of light? [2]
  - 2067 Old Q.No. 1c** What are the conditions for sustained interference of light? [2]
  - 2064 Q.No. 1 d** Distinguish between interference and diffraction. [2]
  - 2058 Q.No. 2 c** Why have the two sources of light to be close to each other for the production of good interference pattern? [2]
  - 2057 Q.No. 2 c** Can two independent sources of light produce interference? [2]
- ### Long Answer Questions [4 Marks]
- 2076 GIE Set B Q.No. 8b** Discuss Young's double slit experiment and show that bright and dark fringes are of equal width. [4]
  - 2076 Set B Q.No. 8a** Describe Newton's ring experiment and derive expression for wavelength of light. [4]
  - 2075 Set A Q.No. 8a** Discuss the Young's double slit experiment and show that the width of bright and dark fringes are equal. [4]
  - 2074 Supp Q.No. 8a** **2074 Set D Q.No. 8b** Describe Young's double slit experiment and obtain an expression for the fringe width. [4]
  - 2074 Set A Q.No. 8a** Define coherent sources of light. Prove that the dark and bright fringes are equally spaced in Young's double slit experiment. [4]
  - 2073 Supp Q.No. 8a** **2069 Set A Q.No. 8b** **2068 Old Can. Q.No. 6a OR** **2067 Supp Q.No. 8a** Prove analytically that the bright and dark fringes in Young's double slit experiment are equally spaced. [4]
  - 2073 Set C Q.No. 8a** **2072 Set C Q.No. 8a** **2070 Set D Q.No. 8b** What are coherent sources of light? Describe double slit experiment to find the fringe width from the experiment performed with light waves. [4]
  - 2072 Supp Q.No. 8b** What are the conditions for constructive and destructive interference of light waves? Show that in Young's double slit experiment, the dark and bright fringes are equally spaced. [4]
  - 2070 Supp. Set B Q.No. 8 a** Discuss the Young's double slit experiment and determine the expression for fringe width. [4]
  - 2069 Supp Set B Q.No. 8 a** Describe Young's double slit experiment of interference to estimate the fringe width of the pattern. [4]
  - 2069 Set A Old Q.No. 6a** What do you mean by constructive and destructive interference of light? Describe Young's double slit experiment for the measurement of wavelength of monochromatic source of light. [1+3]
  - 2069 Set B Q.No. 8a** What are the main characteristics of coherent sources? Describe Young's double slit interference experiment to determine the wavelength of the source of light. [4]
  - 2068 Old Q.No. 6 a Or** Describe Young's double slit experiment, in brief, for the measurement of wave-length of a monochromatic source of light. [4]
  - 2066 Q.No. 6 a** Describe Young's double slits experiment for the interference of light and show that widths of bright and dark fringes are the same. [1+3]
  - 2062 Q.No. 5 a** What do you understand by interference of light? Derive an expression for the fringe width in a Young's double slit experiment. [4]

30. **2057 Q.No. 6 a** Derive the fringe width from Young's double slit experiment. [4]

**Numerical Problems [3 or 4 Marks]**

31. **2077 Set D Q.No. 3d** In a Newton's rings experiment, the diameter of 15<sup>th</sup> ring was found as 0.594 cm and that of 5<sup>th</sup> ring was 0.332 cm. Calculate the radius of curvature of the plano-convex lens if the wavelength of light used is 5890Å. [4]

Ans: 1.03 m

32. **2076 GIE Set A Q.No. 12** In Young's experiment two slits spaced 0.45 mm apart are placed 75 cm from a screen. What is the distance between second and third dark lines in the interference pattern on a screen when slits are illuminated with light of 500nm? [3]

Ans:  $0.833 \times 10^{-3}$  m

33. **2076 Set C Q.No. 12** In a Young's double slit experiment, the separation of four bright fringes is 2.5 mm. The wavelength of light used is  $6.2 \times 10^{-7}$  m. If the distance from the slits to the screen is 80 cm, calculate the separation of two slits. [3]

Ans:  $5.95 \times 10^{-4}$  m

34. **2075 GIE Q.No. 12** The distance between two coherent sources in Young's double slit experiment is 0.3 mm and the interference pattern is observed on a screen 60 cm from the sources. If the wavelength of light used is  $6 \times 10^{-7}$  m, calculate the fringe width of the interference pattern. [3]

Ans:  $1.0 \times 10^{-3}$  m

35. **2075 Set B Q.No. 12** In a Newton' rings experiment, the diameter of 15<sup>th</sup> ring was found as 0.590 cm and that of 5<sup>th</sup> ring was 0.336 cm. Calculate the radius of curvature of the plano-convex lens if the wavelength of light used is 5880Å. [3]

Ans: 100 cm

36. **2074 Set B Q.No. 12** In a Young's double slit experiment, the separation of four bright fringes is 2.5 mm. The wavelength of light used is  $6.2 \times 10^{-5}$  cm and the distance from the slits to the screen is 80 cm. Calculate the separation of slits. [3]

Ans:  $5.95 \times 10^{-4}$  m

37. **2073 Set D Q.No. 12** The separation between the consecutive dark fringes in a Yourn's double slit experiment is 1 mm. The screen is placed at a distance of 2 m from the slits 1.0 mm separation. What is the wavelength of light used in the experiment? [4]

Ans:  $5 \times 10^{-7}$  m

38. **2072 Set D Q.No. 12** In young's double slit experiment, the slits are 0.03 cm apart and the screen is placed 1.5 m away. The distance between the central bright fringe and fourth bright fringe is 1 cm. Calculate the wave length of light used. [3]

Ans:  $5 \times 10^{-7}$  m

39. **2072 Set E Q.No. 12** Two coherent sources A and B of radio waves are 5m apart. Each source emits waves with wavelength 6m. Consider points along the line between two sources, at what distances, if any, from A is the interference constructive. [3]

Ans: 2.5 m

40. **2068 Can. Q.No. 12** Two slits spaced 0.45 mm apart are placed 75 cm from a screen. What is the distance between the second and third dark lines of the interference pattern on the screen when the slits are illuminated with monochromatic light of wavelength 500 nm? [3]

Ans: 0.833 mm

41. **2068 Q.No. 12** In a Young's slits experiment, the separation of four bright fringes is 2.5 mm when the wavelength used is  $6.2 \times 10^{-7}$  m. The distance from the slits to the screen is 0.80m. Calculate the separation of the two slits. [4]

Ans: 0.794 mm

42. **2067 Q.No. 12** In a two-slit interference experiment, the slits are 0.200 mm apart, and the screen is at a distance of 1.00 m. The third bright fringe is found at 9.49 mm from the central fringe. Find wavelength of the light used. [4]

Ans:  $6.33 \times 10^{-7}$  m

43. **2064 Q.No. 6 b** In a Young's double slit experiment, the separation between the first and fifth bright fringes is 2.5 mm when the wavelength of light used is  $6.2 \times 10^{-4}$  mm. The distance from the slits to the screen is 80 cm. Calculate the separation of the two slits. [4]

Ans:  $8 \times 10^{-4}$  m

44. **2060 Q.No. 6 b** In an experiment using Young's slits the distance between the centre of the interference pattern and the tenth bright fringe on either side is 3.44 cm. Distance between the slits and the screen is 2.0 m. If the wavelength of the light used is  $5.89 \times 10^{-7}$  m, determine the slit separation and the angle made by the central bright fringe at the slit. [4]

Ans:  $3.42 \times 10^{-4}$  m,  $1.72 \times 10^{-3}$  radian

45. **2059 Q.No. 6 b** Two slits are 0.3 mm apart and placed 50 cm from a screen. What is the distance between the second and third dark lines of the interference pattern when the slits are illuminated with a light of 600 nm wavelengths? [4]

Ans:  $10^{-3}$  m

**3. DIFFRACTION**

**FORMULAE**

- Condition of n<sup>th</sup> minimum is,  $d \sin \theta = n\lambda$ , where  $n = 1, 2, 3, \dots$
- Condition of n<sup>th</sup> secondary maximum,  $d \sin \theta = (2n + 1) \frac{\lambda}{2}$ , where  $n = 1, 2, 3, \dots$
- The angular position of n<sup>th</sup> minimum,  $\theta_n = \frac{n\lambda}{d}$
- The distance of n<sup>th</sup> minimum from the center of the screen,  $x_n = \frac{n\lambda D}{d}$
- The angular position of n<sup>th</sup> secondary maximum,  $\theta_n = (2n + 1) \frac{\lambda}{2d}$
- Distance of n<sup>th</sup> secondary maximum from the center of the screen  $x_n = \left(\frac{2n + 1}{2}\right) \frac{\lambda D}{d}$
- Width of central maximum, width  $\beta_0 = 2\beta = \frac{2\lambda D}{d}$
- Angular spread of central maximum on either side,  $\theta = \pm \frac{\lambda}{d}$
- Total angular spread of central maximum  $2\theta = \frac{2\lambda}{d}$
- The resolving power =  $\frac{1}{\text{limit of resolution}}$
- Limit of resolution,  $\theta = \frac{1.22\lambda}{D}$

The resolving  
12. Grating equat  
Short Answer Qu  
1. 2074 Supp Q.N  
of sound wave  
2. 2072 Supp Q.N  
an edge. Can s  
3. 2071 Set D Q.  
of sound wave  
of light waves  
4. 2070 Supp.  
diffraction eff  
5. 2070 Set D  
diffract aroun  
6. 2069 Supp S  
difference be  
figures.  
7. 2069 Set B  
associated  
transmissio  
8. 2068 Q.No  
diffraction  
wave lengt  
9. 2062 Q.No  
10. 2059 Q.No  
up for me  
Explain.  
Long Answer  
11. 2076 GIE  
through  
maxima  
12. 2076 Set  
2074 S  
Fraunho  
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$$\text{The resolving power} = \frac{D}{1.22\lambda}$$

$$12. \text{ Grating equation, } \sin \theta_n = Nn\lambda, \text{ where, } N = \frac{1}{(a+b)}$$

### Short Answer Questions [2 Marks]

- 2074 Supp Q.No. 4b | 2069 Set A Q.No. 4a Why is diffraction of sound waves easier to observe than that of light waves? [2]
- 2072 Supp Q.No. 4b Light waves undergo diffraction around an edge. Can sound wave diffract around an edge? Explain. [2]
- 2071 Set D Q.No. 4 a | 2068 Old Can. Q.No. 2d The diffraction of sound waves is more evident in daily experience than that of light waves. Why? [2]
- 2070 Supp. Set A Q.No. 4 a Why can we readily observe diffraction effects for sound waves but not for light? [2]
- 2070 Set D Q.No. 4 a | 2067 Sup Q.No. 4b Radio waves diffract around buildings but not light waves, why? [2]
- 2069 Supp Set B Q.No. 4 a What is the fundamental physical difference between interference and diffraction? Explain with figures. [2]
- 2069 Set B Q.No. 4a What are the characteristic elements associated with a diffraction grating? How is plane transmission grating constructed? [2]
- 2068 Q.No. 4 a Describe what happens to the single slit diffraction pattern when the width of the slit is less than the wave length of the wave. [2]
- 2062 Q.No. 1 d What is diffraction of light? [2]
- 2059 Q.No. 2 c Diffraction grating is better than a two-slit set up for measuring the wave length of a monochromatic light. Explain. [2]

### Long Answer Questions [4 Marks]

- 2076 GIE Set A Q.No. 8b Describe the diffraction of light through a single slit. Find the conditions of formation of maxima and minima. [4]
- 2076 Set C Q.No. 8b | 2075 GIE Q.No. 8b | 2075 Set B Q.No. 7b | 2074 Set B Q.No. 8b | 2071 Set C Q.No. 8 b Discuss Fraunhofer diffraction at a single slit. [4]
- 2074 Set A Q.No. 8b What is diffraction grating? Discuss the formation of diffraction pattern due to a diffraction grating. [4]
- 2073 Supp Q.No. 8b | 2061 Q.No. 6 a OR Describe the diffraction of light at a single slit and find the condition for secondary maxima and minima. [4]
- 2073 Set D Q.No. 8a What is diffraction of light? Explain the case of diffraction at a single slit. Hence show the intensity distribution is the figure. [4]
- 2072 Set C Q.No. 8b Define Fraunhofer diffraction. How is transmission grating constructed? Describe necessary theory of diffraction grating. [4]
- 2072 Set D Q.No. 8b Discuss the formation of maxima and minima due to Fraunhofer diffraction at a single slit. [4]
- 2072 Set E Q.No. 8b What do you mean by diffraction of light? Explain the diffraction pattern due to a single slit to find the angular width of the central band. [4]
- 2071 Supp. Q.No. 8b Explain the formation of maxima and minima due to diffraction through a single slit. [4]
- 2070 Set C Q.No. 8 a Discuss the theory of diffraction of light at single slit. [4]
- 2068 Can. Q.No. 8b What is the basic difference between interference and diffraction? Discuss Fraunhofer diffraction at a single slit. [4]
- 2068 Q.No. 8 b What is Fraunhofer diffraction? Explain the formation of maxima and minima due to diffraction? Show that the width of central maxima is inversely proportional to the distance between the two slits. [4]
- 2067 Q.No. 8b Describe diffraction of light through a single slit. [4]
- 2065 Q.No. 6 a OR What are the differences between interference and diffraction? Explain the theory of diffraction of light through a single slit. [1+3]
- 2058 Q.No. 6 a OR What is diffraction of light? How does it differ from interference of light? [4]

### Numerical Problems [3 or 4 Marks]

- 2076 GIE Set B Q.No. 12 How wide is the central diffraction peak on a screen 5 m behind 0.010 mm slit illuminated by 450 nm light? [3]  
Ans: 0.45 m
- 2076 Set B Q.No. 12 How wide is the central diffraction peak on a screen 5 m behind a 0.01 mm slit illuminated by 500 nm light source? [3]  
Ans: 0.5 m
- 2075 Set A Q.No. 12 | 2062 Q.No. 5 b How wide is the central diffraction peak on a screen 3.5 m behind a 0.01 mm slit illuminated by 500 nm light source? [3]  
Ans: 0.35 m
- 2073 Set C Q.No. 12 A plane transmission grating having 500 lines per mm is illuminate normally by light source of 600 nm wavelength. How many diffraction maxima will be observed on a screen behind the grating? [4]  
Ans: 3
- 2071 Set D Q.No. 12 | 2069 Supp Set B Q.No. 12 | 2069 Set B Q.No. 12 A parallel beam of sodium light is incident normally on a diffraction grating. The angle between the two first order spectra on either side of the normal is  $27^\circ 42'$ . Assuming that the wavelength of light is  $5.893 \times 10^{-7}$  m, find the number of rulings per mm on the grating? [3]  
Ans: 406 lines/mm
- 2069 Set A Q.No. 12 A diffraction grating has 400 lines per mm and is illuminated normally by a monochromatic light of wavelength 6000 Å. Calculate the grating spacing, the angle at which first order maximum is seen and the maximum number of diffraction maxima obtained. [3]  
Ans:  $0.25 \times 10^{-5}$  m,  $13.90$ ,  $n = 4$
- 2068 Old Can. Q.No. 6b A Parallel beam of sodium light of wavelength  $5.893 \times 10^{-7}$  m is incident normally on a diffraction grating. The angle between the two first order spectra on either side of the normal is  $28^\circ$ . Find the number of ruling lines per mm on the grating. [3]  
Ans: 410 lines/mm

### 4. POLARIZATION

#### FORMULAE

1. Malus law:  $I \propto \cos^2 \theta$
2. Brewster's law:  $\eta = \tan \theta_p$

Where,  $\eta = \frac{c}{v}$  = refractive index and  $\theta_p$  = polarizing angle

#### Short Answer Questions [2 Marks]

1. **2077 Set D Q.No. 1a** Can sound waves be polarized? Explain. [2]
2. **2076 GIE Set A Q.No. 4a** State Brewster's law. [2]
3. **2076 GIE Set B Q.No. 4b** **2076 Set C Q.No. 4b** **2074 Set B Q.No. 4b** **2060 Q.No. 1d** Can sound wave be polarized? Justify your answer. [2]
4. **2076 Set B Q.No. 4b** Differentiate unpolarized and polarized light. [2]
5. **2075 GIE Q.No. 4b** **2074 Set A Q.No. 4b** **2073 Supp Q.No. 4b** **2070 Set D Q.No. 4 b** **2068 Can. Q.No. 4b** What is polarizing angle? Does it depend on the wavelength of light used? [2]
6. **2075 Set A Q.No. 4b** Does the polarizing angle for a transparent medium depend upon the wavelength of the light? [2]
7. **2075 Set B Q.No. 4b** Can ultrasonic waves be polarized? [2]
8. **2073 Set C Q.No. 4b** Are light waves longitudinal? Justify your answer. [2]
9. **2073 Set D Q.No. 4b** State and explain Brewster's law of polarization. [2]
10. **2072 Set C Q.No. 4b** Define polarizing angle. How is it related with the refractive index of the medium? [2]
11. **2072 Set D Q.No. 4b** What is polarized light? How is it represented? [2]
12. **2072 Set E Q.No. 4b** **2069 Set A Q.No. 4b** **2066 Q.No. 1d** Is polarization possible for longitudinal waves? Justify. [2]
13. **2071 Supp. Q.No. 4b** Does polarizing angle depend on wavelength of light? [2]
14. **2071 Set D Q.No. 4 b** **2067 Q.No. 4a** Light waves can be polarized. What about sound waves? Explain. [2]
15. **2070 Supp. Set B Q.No. 4 b** In which medium is the angle of polarization greater, rarer or denser? [2]
16. **2069 Set B Q.No. 4b** Is there any difference between an analyzer and a polarizer? Explain. [2]
17. **2068 Old Q.No. 2 d** The polarising angle for a transparent medium is  $60^\circ$ . What is the refractive index of the medium? [2]

#### Long Answer Questions [4 Marks]

18. **2074 Supp Q.No. 8b** What is polarization of light? Discuss polarization by reflection and prove Brewster's law. [4]
19. **2073 Set D Q.No. 8b** What is polarization? Prove that light is a transverse wave. [4]
20. **2070 Set C Q.No. 8 b** What is polarization of light? State and prove Brewster's law. [4]
21. **2067 Old Q.No. 6a OR** What is polarising angle? Derive the relation between the polarising angle and the refractive index of the medium. [1+3]

22. **2066 Supp Q.No. 6a OR** What do you mean by polarization of electromagnetic wave? Discuss the polarization of light by reflection and show that  $\mu = \tan \theta_p$ , where the symbols have their usual meanings. [1+3]
23. **2062 Q.No. 6 a OR** Distinguish between a plane polarized and unpolarized light. Show that:  $\tan \theta_p = n$   
 $n$  = refractive index of the medium.  
 $p$  = angle of polarization or polarizing angle. [3]

#### Numerical Problems [3 or 4 Marks]

24. **2072 Supp Q.No. 12** The polarizing angle for a medium is  $60^\circ$ . Calculate the velocity of light in the medium. [3]  
 Ans:  $1.73 \times 10^8$  m/sec.
25. **2071 Set C Q.No. 12** A beam of light is incident at polarizing angle on a piece of transparent material of refractive index 1.62. What is the angle of refraction for the transmitted beam? [3]  
 Ans:  $31.7^\circ$
26. **2070 Supp. Set A Q.No. 12** The critical angle for light in a certain substance is  $45^\circ$ . What is the polarizing angle? [3]  
 Ans:  $54.7^\circ$
27. **2070 Set D Q.No. 12** Calculate the polarizing angle for the light traveling from water of refractive index 1.33 to glass of refractive index 1.53. [3]  
 Ans:  $49^\circ$
28. **2067 Sup Q.No. 12** A parallel beam of unpolarized light in air is incident at an angle of  $55^\circ$  on a plane glass surface. If the reflected beam is completely plane polarized, find the refractive index of the glass and the angle of refraction of the transmitted beam. [3]  
 Ans: 1.428,  $35^\circ$

## UNIT-2 ELECTRICITY AND MAGNETISM

### A. CURRENT ELECTRICITY

#### 1. D.C. CIRCUIT

#### FORMULAE

1. Electric current ( $I$ ) =  $\frac{dq}{dt} = \frac{Ne}{t}$ , where N is total number of charge particles.
2. Drift Velocity,  $I = v_d e n A$ , Where,  $v_d$  is drift velocity of electron.
3. Current density ( $J$ ):  $J = \frac{I}{A} = nev_d$
4. Combination of resistors:
  - i. Series combination:  $R = R_1 + R_2 + R_3 + \dots$
  - ii. Parallel combination,  $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$
  - iii. The equivalent resistance of n equal resistors of equal resistance (r) when connected in series is  $R = nr$ .
  - iv. The equivalent resistance of n equal resistors of equal resistance (r) when connected in parallel,  $R = \frac{r}{n}$ .
  - v. The ratio of n identical resistors of equal resistance when connected in series to parallel is,  $\frac{R_{series}}{R_{parallel}} = n^2$
5. Variation of resistance with temperature:

puspa

The resistance where  $R_0$  = resistance  $\alpha$  = temperature

Conversion of Value of shu

Conversion of internal resist Value of mu

Electric pov

Electric ene

Emf, termin Relation, E

Efficiency

Terminal p

While cha

While disc

Short Answer

1. **2076 GIE** current der
2. **2076 GIE** emf of a co
3. **2076 GIE** ideal amn larger resi
4. **2076 GIE** the termin emf? If it
5. **2075 GIE** parallel through
6. **2075 Se** What wi
7. **2075 Se** heating
8. **2074 S** of iron, in whic
9. **2074 S** each c minim
10. **2074** paralle resista is rem
11. **2073** differ wire"

The resistance at  $0^\circ\text{C}$ ,  $R_0 = R_0(1 + \alpha\theta)$ ,

where

$R_0$  = resistance of conductor at  $0^\circ\text{C}$  and

$\alpha$  = temperature coefficient of resistance =  $\frac{R_\theta - R_0}{R_0\theta}$

6. Conversion of galvanometer into ammeter

Internal resistance of ammeter is very small,  $R_a = \frac{GS}{G+S}$

ii. Value of shunt is,  $S = \frac{I_0 G}{I - I_0}$

7. Conversion of galvanometer into voltmeter:

Internal resistance is very large;  $R_v = R + G$

ii. Value of multiplier,  $R = \frac{V}{I_0} - G$

8. Electric power:  $P = \frac{qV}{t} = IV = I^2R = \frac{V^2}{R}$

9. Electric energy:  $(E) = I^2Rt = VIt = Pt = \frac{V^2t}{R}$

10. Emf, terminal potential and internal resistance:

i. Relation,  $E = V + Ir$

ii. Efficiency of a source of emf,  $\eta = \frac{P_0}{P_1} = \frac{V}{E} = \frac{R}{R+r}$

11. Terminal potential difference,

i. While charging,  $V > E$ ;  $E = V - Ir$

ii. While discharging,  $V < E$ ,  $E = V + Ir$

### Short Answer Questions [2 Marks]

- 2076 GIE Set A Q.No. 1a** Derive relationship between current density and electric field intensity. [2]
- 2076 GIE Set A Q.No. 1b** Can terminal p.d. be greater than emf of a cell? Justify your answer. [2]
- 2076 GIE Set A Q.No. 1e** Compare the resistances of an ideal ammeter with that of an ideal voltmeter. Which has larger resistance? Why? [2]
- 2076 GIE Set B Q.No. 1a** Can potential difference between the terminals of a battery ever be opposite in direction to the emf? If it can, give an example. If it cannot, explain why not? [2]
- 2075 GIE Q.No. 1a** Two resistors  $R_1$  and  $R_2$  are connected in parallel to an emf source. What happens to the current through  $R_1$  when  $R_2$  is removed from the circuit? [2]
- 2075 Set A Q.No. 1a** A wire is stretched to double its length. What will happen to its resistivity and resistance? [2]
- 2075 Set A Q.No. 1b** Differentiate between a fuse wire and a heating wire. [2]
- 2074 Supp Q.No. 1a** Two wires, one of copper and another of iron, have the same diameter and carry the same current. In which wire the drift velocity of electrons will be more? [2]
- 2074 Set A Q.No. 1a** **2058 Q.No. 10 a** You are given  $n$  wires, each of resistance  $R$ . What is the ratio of maximum to minimum resistance obtainable from these wires? [2]
- 2074 Set B Q.No. 1a** Resistors  $R_1$  and  $R_2$  are connected in parallel to an emf source that has negligible internal resistance. What happens to the current through  $R_1$  when  $R_2$  is removed from the circuit? [2]
- 2073 Supp Q.No. 1a** **2069 Supp Set B Q.No. 1 a** Is there any difference between 'resistance of a wire' and 'resistivity of a wire'? Explain. [2]
- 2073 Supp Q.No. 1d** **2072 Set E Q.No. 1b** **2063 Q.No. 10 a** The element of heater is very hot while the wire carrying current are not. Why? [2]
- 2073 Set C Q.No. 1f** How can a galvanometer be converted into voltmeter? Explain. [2]
- 2073 Set C Q.No. 1a** Will the drift velocity of electrons change if the diameter of a connecting wire is halved? Why? [2]
- 2073 Set C Q.No. 1b** Five bulbs are connected in series across 220 volt line. If one bulb is fused, the remaining bulbs are again connected across the same line. Which one of the arrangements will be more illuminated? Justify your answer. [2]
- 2072 Supp Q.No. 1a** Explain the difference between resistance and resistivity of a wire. [2]
- 2072 Set D Q.No. 1a** Resistors  $R_1$  and  $R_2$  are connected in series to an emf source that has negligible internal resistance. What happens to the current through  $R_1$  when a third resistor  $R_3$  is connected in parallel with  $R_2$ ? [2]
- 2072 Set E Q.No. 1a** Batteries are always labeled with their emf; for instance, an A flashlight battery is labeled '1.5 volts'. Would it also be appropriate to put a label on batteries stating how much current they provide? Why or why not? [2]
- 2071 Supp. Q.No. 1a** Ammeters often contain fuses that protect them from large currents while voltmeters seldom do. Explain. [2]
- 2071 Set C Q.No. 1 a** What is the difference between an emf and a potential difference? Under what circumstances are the potential difference between the terminals of a battery and the emf of the battery equal to each other? [2]
- 2071 Set D Q.No. 1 a** A voltmeter has high resistance. Explain why? [2]
- 2070 Supp. Set A Q.No. 1 a** A cylindrical rod has resistance  $R$ . If we double its length and diameter, what is its resistance in terms of ' $R$ '? [2]
- 2070 Supp. Set A Q.No. 1 b** **2070 Set C Q.No. 1 b** Why does an electric bulb nearly always burn-out just as you turn on the light, almost never while the light is shining? [2]
- 2070 Supp. Set B Q.No. 1 a** Can the potential difference between the terminals of a battery ever be opposite in direction to the emf? [2]
- 2070 Supp. Set B Q.No. 1 b** "Good thermal conductors are also good electrical conductor" If so, why don't the connecting wires that are used to connect heaters get hot by conduction of heat from the heating element? [2]
- 2070 Set C Q.No. 1 a** Two copper wires of different diameters are joined end-to-end. If a current flows in the wire combination, what happens to the drift velocity of the electrons when they move from the larger-diameter wire to the smaller-diameter wire? [2]
- 2070 Set D Q.No. 1 a** When the ends of a wire are connected to a battery, initially the current is slightly larger, but soon it decreases slowly and becomes steady at a lower value although the emf of the battery remains unchanged. Explain. [2]
- 2069 Supp Set B Q.No. 1 b** Two bulbs of different wattage are connected in series. Which bulb will glow brighter? Why? [2]
- 2069 Set A Q.No. 1a** Batteries are always labeled with their emf. Would it also be appropriate to put a label on batteries stating how much current they provide? Why or why not? [2]

30. **2069 Set B Q.No. 1a** Give an example of non-ohmic conductor and present its current voltage characteristic graph. [2]
31. **2068 Can. Q.No. 1a** What is the ratio of maximum to minimum resistance obtainable from  $n$  wires of resistance  $R$  each? [2]
32. **2068 Can. Q.No. 1b** Why is it essential that the resistance of a voltmeter be very high? [2]
33. **2068 Old Q.No. 10 a** **2056 Q.No. 10 a** An ammeter is always connected in series. Why? [2]
34. **2068 Old Q.No. 10 b** Distinguish between resistance and resistivity of a material. [2]
35. **2068 Q.No. 1 a** Long-distance, electric power, transmission lines always operate at very high voltage, some time as much as 750 kV. What are the advantages of such high voltages? [2]
36. **2067 Q.No. 1a** The energy that can be extracted from a storage battery is always less than the energy that goes into it while charging. Why? [2]
37. **2067 Sup Q.No. 1a** The resistance of an ammeter must essentially be very small. Why? [2]
38. **2067 Sup Q.No. 1b** Water boils in an electric kettle in 15 minutes after being switched on. Using the same main supply. Should the length of the heating element be increased or decreased if the water is to boil in 10 minutes? Explain. [2]
39. **2066 Old Q.No. 10 a** A wire is stretched to double its length. What happens to its resistance? [2]
40. **2064 Q.No. 10 a** Why heat is generated across a resistor when the electric field is applied? [2]
41. **2064 Q.No. 10 b** Why do electrons acquire a steady drift velocity? [2]
42. **2064 Q.No. 10 c** Why ammeter is always connected in series? [2]
43. **2063 Q.No. 10 c** You are given 2 wires each of resistance  $R$ . What is the ratio of maximum to minimum resistance that can be obtained from these wires? [2]
- Ans: 4:1
44. **2062 Q.No. 10 a** Explain the significance of a shunt with a diagram. [2]
45. **2061 Q.No. 10 b** A large number of free electrons are present in metals. Why is there no current in the absence of electric field across it? [2]
46. **2060 Q.No. 10 a** Why are alloys constantan and manganin used to make standard resistors? [2]
47. **2059 Q.No. 10 b** Why is a voltmeter always connected in parallel with the load resistance? [2]
48. **2059 Q.No. 10 c** Two bulbs have the filament of the same length. If one is of 40 watt and the other 60 watt, which one has thicker filament? [2]
49. **2058 Q.No. 10 c** Is terminal p.d. always greater than its emf? [2]
50. **2057 Q.No. 10 a** What are the factors on which the resistance of a conductor depend? [2]
51. **2057 Q.No. 10 b** Can the potential difference across a battery be greater than its emf? [2]
52. **2057 Q.No. 10 c** Two bulbs of 60 W and 100 W are connected in series and this combination is connected across the mains. Which bulb will glow more brightly? Give reason. [2]

53. **2056 Q.No. 10 b** Why do we use connecting wires made of copper? [2]

### Long Answer Questions [4 Marks]

54. **2076 GIE Set B Q.No. 5a** What is meant by current density? Obtain an expression showing the relation between the drift velocity of free electrons and the current passing in a conductor. [4]
55. **2076 Set B Q.No. 5a** **2066 Old Q.No. 11a** **2063 Q.No. 11a** **2057 Q.No. 11a OR** What do you mean by shunt? Describe its use in converting a galvanometer into an ammeter. [4]
56. **2076 Set B Q.No. 5b** **2072 Supp Q.No. 5a** **2061 Q.No. 5a** State Joule's law of heating and verify it experimentally. [4]
57. **2076 Set C Q.No. 5a** **2060 Q.No. 11a** Discuss how the current is established in a conductor when it is connected across a source of e.m.f. Derive the relation  $J = nev$ , where the symbols have their usual meanings. [4]
58. **2075 GIE Q.No. 5a** **2074 Set A Q.No. 5a** **2071 Set C Q.No. 5a** **2069 Set A Q.No. 5a** **2068 Can. Q.No. 5a** Describe the mechanism of metallic conduction. Deduce a relation between current density and drift velocity of the electrons. [4]
59. **2075 Set B Q.No. 5a** State and explain Joule's law of heating. Deduce an expression for heat developed in a conductor due to the passage of an electric current. [4]
60. **2074 Supp Q.No. 5a** What is a galvanometer? How can you convert it into a voltmeter? Why should the resistance of a voltmeter be high? [4]
61. **2072 Set C Q.No. 5a** Define drift velocity of electrons. Establish a relation between drift velocity of electrons and current density in the conductor. [4]
62. **2072 Set D Q.No. 5b** Describe an experiment to verify Joule's Laws of heating. [4]
63. **2072 Set E Q.No. 5a** Why has an ammeter a very low resistance? How can you convert a galvanometer into an ammeter? [4]
64. **2071 Supp. Q.No. 5a** Define emf, terminal p.d. and internal resistance. Derive the relation between them for the circuit drawing current. [4]
65. **2069 Supp Set B Q.No. 5 d** Explain the theory of a) series and b) parallel combinations of resistances in an electric circuit. [4]
66. **2069 Set B Q.No. 5b** What is the difference between an electromotive force and the terminal potential difference? How are they related? [4]
67. **2068 Q.No. 5 d** Distinguish between resistance and resistivity. Derive expressions for the effective resistance of number of resistors connected in series and parallel. [4]
68. **2066 Old Q.No. 11 a or** State and explain Joule's law of heating. Deduce an expression for the heat developed in a wire by the passage of an electric current? [2+2]
69. **2064 Q.No. 11 a** State and explain Ohm's law. Two resistors are connected in parallel and third resistor be connected in series with the combination of parallel resistors. If this combination be connected with a battery of the negligible internal resistance, find the potential difference across each resistor. [4]

70. **2059 Q.No. 11 a** a relation between the drift velocity and the current per unit volume.

71. **2056 Q.No. 11 a** developed in a Numerical Problem.

72. **2076 GIE Set B Q.No. 5a** 10mm and calculate free electron is current density.

73. **2076 GIE Set B Q.No. 5a** resistance of current of 4.0 converted to a current of 5.

74. **2076 Set B Q.No. 5a** 2000Ω are junction of internal resistance potential difference reading shown.

75. **2076 Set B Q.No. 5a** galvanometer to deflect resistance series with.

76. **2075 Set B Q.No. 5a** 100 W - 200 W powers consumed.

77. **2075 Set B Q.No. 5a** 2000 Ω will be the Ω when change in.

78. **2074 Set B Q.No. 5a** mm and free electron density.

79. **2073 Set B Q.No. 5a** p.d. of 1 the current when a.

80. **2073 Set B Q.No. 5a** diameter conductor.

81. **2073 Set B Q.No. 5a** 220V resistor.

2059 Q.No. 11 a What is drift velocity of an electron? Derive a relation between the current through a metallic conductor and the drift velocity in terms of the number of free electrons per unit volume of the conductor. [1+4]

2056 Q.No. 11 a Deduce an expression for the heat developed in a wire by the passage of an electric current. [4]

**Numerical Problems [4 Marks]**

2076 GIE Set A Q.No. 9a A copper wire has a diameter of 10mm and carries a constant current of 2A. The density of free electron is  $8.5 \times 10^{28} \text{ m}^{-3}$ . Find the magnitude of (i) the current density and (ii) the drift velocity. [4]

Ans:  $2.55 \times 10^4 \text{ A/m}^2$ ,  $1.87 \times 10^6 \text{ m/sec}$

2076 GIE Set B Q.No. 9a A moving coil meter has a resistance of  $25\Omega$  and indicates full scale deflection when a current of 4.0 mA flows through it. How could this meter be converted to a milliammeter having a full scale deflection for a current of 50mA? [4]

Ans: 2.14  $\Omega$

2076 Set B Q.No. 9a Two resistors of resistance  $1000\Omega$  and  $2000\Omega$  are joined in series with a 100 V supply. A voltmeter of internal resistance  $4000\Omega$  is connected to measure the potential difference across  $1000\Omega$  resistor. Calculate the reading shown by the voltmeter. [4]

Ans: 28.57V

2076 Set C Q.No. 9a The resistance of the coil of a galvanometer is  $9.36\Omega$  and a current of 0.0224 A causes it to deflect full scale. The only shunt available has a resistance  $0.025\Omega$ . What resistance must be connected in series with the coil to make it an ammeter of range 0 - 20A? [4]

Ans: 12.94  $\Omega$

2075 Set A Q.No. 9b Two lamps rated 25 W - 220 V and 100 W - 220 V are connected to 220 V supply. Calculate the powers consumed by the lamps. [4]

Ans: 16W, 4W

2075 Set B Q.No. 9a Two resistance of  $1000 \Omega$  and  $2000 \Omega$  are placed in series with 50 V mains supply. What will be the reading on a voltmeter of internal resistance  $2000 \Omega$  when placed across the  $1000 \Omega$  resistor? What fractional change in voltage occurs when voltmeter is connected? [4]

Ans: 12 V, 25%

2074 Set B Q.No. 9a A copper wire has a diameter of 1.02 mm and carries a constant current of 1.67A. If the density of free electrons in copper is  $8.5 \times 10^{28} / \text{m}^3$ , calculate the current density and the drift velocity of the electrons. [4]

Ans:  $1.5 \times 10^4 \text{ m/sec}$  and  $2.04 \times 10^6 \text{ A/m}^2$

2073 Supp Q.No. 9a A battery of emf 1.5 V has a terminal p.d of 1.25 V when a resistor of  $25\Omega$  is joined to it. Calculate the current flowing, the internal resistance and terminal p.d. when a resistance of  $10\Omega$  replaces  $25\Omega$  resistor. [4]

Ans: 0.1 A, 5 $\Omega$ , 1V

2073 Set C Q.No. 9c Resistance of a wire of length 1m, diameter 1 mm is  $2.2\Omega$ . Calculate its resistivity and conductivity. [4]

Ans:  $1.727 \times 10^{-6} \Omega\text{m}$  and  $579038.8 \Omega^{-1}\text{m}^{-1}$

2073 Set D Q.No. 9a An electric lamp consumes 60 W at 220V. How many dry cells of emf 1.5V and internal resistance  $1\Omega$  are required to glow the lamp? [4]

Ans: 179

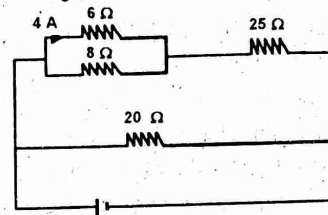
2072 Supp Q.No. 9c A copper wire has a diameter of 1.02 mm, cross-sectional area  $8.2 \times 10^{-7} \text{ m}^2$  and resistivity  $1.72 \times 10^{-8} \Omega \text{ m}$ . It carries a current 1.67 A. Find the electric field magnitude in the wire and the potential difference between two points in the wire 50 m apart. [4]

Ans: 0.0350 V/m; 1.75 V

2072 Set C Q.No. 9a The resistance of a galvanometer coil is  $9.36\Omega$ , and the current required for full scale deflection is 0.0224A. We want to convert this galvanometer to an ammeter reading 20A full scale. The only shunt available has a resistance of  $0.025\Omega$ . What resistance must be connected in series with the coil. [4]

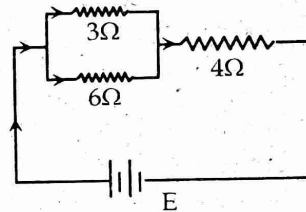
Ans: 12.94  $\Omega$

2071 Supp. Q.No. 9a Consider the figure below. The current through  $6\Omega$  resistor is 4A in the direction shown. What are the currents through the  $25\Omega$  and  $20\Omega$  resistors? [4]



Ans: 7 A, 9.95 A

2071 Set D Q.No. 9 b In the given figure, the current through the  $3 \Omega$  resistor is 0.8 A. Find the potential drop across  $4 \Omega$  resistor. [4]



Ans: 4.8 V

2070 Supp. Set A Q.No. 9 c A cell of emf 18 V has an internal resistance of  $3 \Omega$ . The terminal p.d. of the battery becomes 15 V when connected by a wire. Find the resistance of the wire. [4]

Ans: R = 15  $\Omega$

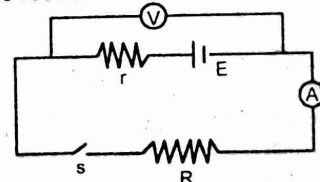
2070 Supp. Set B Q.No. 9 a A potential difference of 4.5 V is applied between the ends of wire that is 2.5 m long and has radius of 0.654 mm. The resulting current through the wire is 17.6 A. What is the resistivity of the wire? [4]

Ans:  $1.376 \times 10^{-7} \Omega\text{m}$

2070 Set C Q.No. 9 a A tightly coiled spring having 75 coils, each 3.50 cm in diameter, is made of insulated metal wire 3.25 mm in diameter. An ohm meter connected across its opposite ends reads  $1.74 \Omega$ . What is the receptivity of the metal? [4]

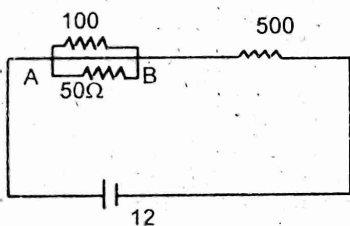
$1.75 \times 10^{-6} \Omega\text{m}$

2070 Set D Q.No. 9 a A voltmeter coil has resistance  $50 \Omega$  and a resistor of  $1.15 \text{ K} \Omega$  is connected in series. It can read potential differences upto 12 volts. If the same coil is used to construct an ammeter which can measure currents upto 2A, what should be the resistance of the shunt used? [4]



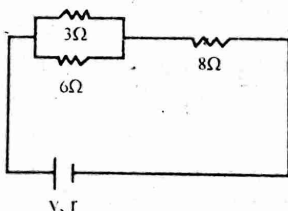
Ans: 0.25 $\Omega$

90. **2069 Set A Q.No. 9a** In the given figure, when switch *s* is open, the voltmeter *v* reads 3.08v. When the switch is closed, the voltmeter reading drops to 2.97v, and the ammeter *A* reads 1.65A. Find the emf, the internal resistance of the battery and the resistor *R*. Assume that the two meters are ideal. **Ans:  $r = 0.067\Omega$ ,  $R = 1.8\Omega$**  [4]
91. **2069 Set B Q.No. 9c** The resistance of a conductor is 10 ohm at 50°C and 15 ohm at 100°C. Calculate its resistance at 0°C. **Ans:  $5\Omega$**  [4]
92. **2068 Can. Q.No. 9a** An electric heating element to dissipate 480 watts on 240V mains is to be made from nichrome wire of 1mm diameter. Calculate the length of the wire required if the receptivity of nichrome is  $1.1 \times 10^{-6}$  ohm-meter. **Ans: 85.7m**
93. **2068 Q.No. 9 a** A resistor of 500 Ohms and one of 2000 Ohms are placed in series with a 60 volt supply. What will be the reading on a voltmeter of internal resistance 2000 Ohms when placed across (i) the 500Ω resistor and (ii) the 2000Ω resistor? **Ans: 10V and 40V** [4]
94. **2068 Old Q.No. 11 b** An electric heating element to dissipate 1.2 KW on 240 V mains is to be made from Nichrome ribbon 1mm wide and 0.05 mm thick. Calculate the length of the ribbon required if the resistivity of nichrome is  $1.1 \times 10^{-6}\Omega \text{ m}$ . [3] **Ans: 85.6 m**
95. **2067 Sup Q.No. 9a** What is the potential difference across 100Ω resistor in the circuit given below. [4]



**Ans: 3/4 V**

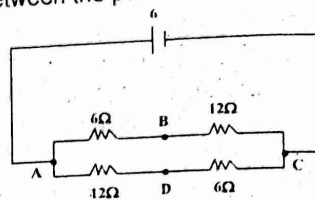
96. **2062 Q.No. 11 b** Twelve cells each of emf 2V and of internal resistance 0.5 ohm are arranged in a battery of *n* rows and an external resistance 0.4 ohm is connected to the poles of the battery. Estimate the current flowing through the resistance in terms of *n*. [3] **Ans:  $\frac{60n}{15+n^2}$**
97. **2061 Q.No. 11 b** As shown in the figure, a battery of emf 24v and internal resistance *r* is connected to a circuit containing two parallel resistors of 3Ω and 6Ω in series with an 8Ω resistor. The current flowing in the 3Ω is 0.8A. Calculate the current in the 6Ω resistor and the internal resistance of the cell. [3]



**Ans: 0.4A, 10Ω**

98. **2060 Q.No. 11 b** A battery of emf 1.5 V has a terminal p.d. of 1.25 V when a resistor of 25Ω is joined to it. Calculate the current flowing, the internal resistance and terminal p.d. when a resistance of 10Ω replaces 25Ω resistor. [4] **Ans: 0.05A, 5Ω, 1V**

99. **2058 Q.No. 11 b** In the given circuit, calculate the potential difference between the points B and D.



## 2. ELECTRICAL CIRCUITS

### FORMULAE

- Kirchhoff's first (current) law: Sum of incoming currents - sum of out going currents = 0, i.e.  $\Sigma I = 0$
- Kirchoff's second (Voltage) law:  $\Sigma E - \Sigma IR = 0$
- Wheat stone bridge circuit Principle: In balanced conditions,  $\frac{P}{Q} = \frac{X}{R}$
- Meterbridge: In balancing condition  $\frac{R_1}{R_2} = \frac{l_1}{l_2}$
- Potentiometer:
  - Principle,  $V \propto l$  (for *I*, *A* and *ρ* constant)
  - Comparison of emf:  $\frac{E_1}{E_2} = \frac{l_1}{l_2}$
  - Determination of Internal resistance:  $r = \left(\frac{E}{V} - 1\right) R = \left(\frac{l_1}{l_2} - 1\right) R$

### Short Answer Questions [2 Marks]

- 2077 Set D Q.No. 1a** Draw a Wheatstone bridge circuit and mention the balance condition for it.
- 2076 Set B Q.No. 1a** State the principle of potentiometer and write down its one application.
- 2075 GIE Q.No. 1b** If the current flowing in the wire of the potentiometer be decreased, what will be the effect on the position of zero deflection in potentiometer? Explain.
- 2075 Set B Q.No. 1a** **2074 Set B Q.No. 1b** Why do we prefer a potentiometer with longer wire?
- 2074 Supp Q.No. 1b** **2072 Set D Q.No. 1b** Draw a circuit diagram of meter bridge to determine the resistance of a wire. Write the formula used.
- 2074 Set A Q.No. 1b** **2072 Set C Q.No. 1a** **2070 Set D Q.No. 1b** **2069 Set A Q.No. 1b** Why do we prefer a potentiometer to measure emf of a cell rather than a voltmeter?
- 2071 Set C Q.No. 1 b** If the length of the wire be doubled what will be the effect on the position of zero deflection in a potentiometer?
- 2071 Set D Q.No. 1 b** State and explain Kirchhoff's laws of electric circuits.
- 2069 Set B Q.No. 1d** How would you convince that the principle of measurement of resistance of wire by meter bridge is based on Wheatstone bridge principle? Explain.
- 2062 Q.No. 10 c** State Kirchhoff's laws of electric circuits

### Long Answer Questions [4 Marks]

- 2076 GIE Set A Q.No. 5a** **2075 Set B Q.No. 5b** State Kirchhoff laws and use them to derive Wheatstone bridge principle.

12. **2076 Set C Q.No. 5b** **2074 Set B Q.No. 5a** **2070 Set C Q.No. 5a** State and explain Kirchoff's laws and use these laws to find the balance condition in a wheatstone bridge circuit. [4]
13. **2075 Set A Q.No. 5b** **2073 Supp Q.No. 5a** **2070 Supp. Set A Q.No. 5 a** **2070 Set C Q.No. 5 a** State the principle of potentiometer. Discuss the application of potentiometer to determine the internal resistance of a cell. [4]
14. **2073 Set C Q.No. 5a** State and apply Kirchoff's rule of electrical circuits to measure the unknown resistance of a wire by metre bridge with necessary theory and circuit. [4]
15. **2072 Set C Q.No. 5b** State principle of meter bridge. Describe how it is used to determine the resistance of a wire. [4]
16. **2071 Set D Q.No. 5 a** What is the principle of a potentiometer? Explain with necessary theory how you would determine the internal resistance of a cell using this principle. [4]

17. **2070 Set D Q.No. 5a** **2068 Old Q.No. 11a** **2059 Q.No. 11 a OR** What is Wheatstone bridge? Use Kirchoff's laws of current and voltage to obtain balance condition of it. [4]
18. **2069 Supp Set B Q.No. 5 a** State the principle of potentiometer. How do you compare the internal resistances of two cells by using a potentiometer? [4]

19. **2069 Set B Q.No. 5c** Explain Kirchoff's laws. How are the conditions of balance in Wheatstone bridge established through these laws? [4]
20. **2068 Can. Q.No. 5d** What is internal resistance of a cell? How can you measure the internal resistance of a cell by using potentiometer? [1+4]

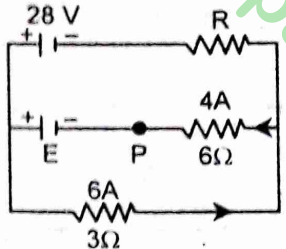
21. **2068 Q.No. 5 c** What is a Wheatstone bridge? Obtain the balanced condition for the bridge. Explain how resistance can be measured by a meter bridge. [4]
22. **2067 Q.No. 5a** What is potentiometer? How can you use it to measure internal resistance of a cell? [4]

23. **2067 Sup Q.No. 5d** What is the principle of potentiometer? Describe a method to measure the internal resistance of a cell by using potentiometer. [1+3]
24. **2062 Q.No. 11 a OR** Explain the principle of potentiometer. How is this used to measure the internal resistance of a cell? [2+3]

25. **2061 Q.No. 11 a OR** Discuss the principle of the potentiometer and use it to compare the emf's of two cells. [2+3]
26. **2060 Q.No. 11 a OR** Discuss the principle of potentiometer and use it to determine the internal resistance of a cell. [2+3]
27. **2058 Q.No. 11 a** What is a potentiometer? Explain how do you compare the emfs of two cells using a potentiometer. [4]

**Numerical Problems [4 Marks]**

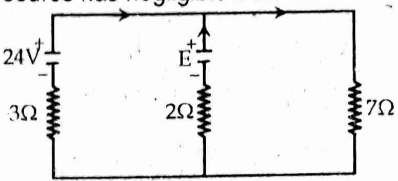
28. **2075 GIE Q.No. 9a** Using Kirchoff's rules in the circuit, find [4]
- the current in resistor R
  - the resistance R
  - the unknown emf E
  - If the circuit is broken at P, what is the current in resistor R?



Ans: 2A, 5Ω, 42V, 3.5A

29. **2074 Supp Q.No. 9a** A potentiometer is 10 m long. It has a resistance of 20 Ω. It is connected in series with a battery of 3 V and a resistance of 10 Ω. What is the potential gradient along with wire? [4]
- Ans: 0.2 V/m

30. **2074 Set A Q.No. 9a** What must be the emf E in the circuit so that the current flowing through the 7Ω resistor is 1.80A? Each emf source has negligible internal resistance. [4]



Ans: 8.6 V

31. **2072 Supp Q.No. 9a** A simple potentiometer circuit is setup as in fig Q(1), using a uniform wire AB, 1.0 m long, which has a resistance of 2Ω. The resistance of the 4V battery is negligible. If the variable resistor R were given a value of 2.4Ω, what would be the length AC for zero galvanometer deflection? [4]

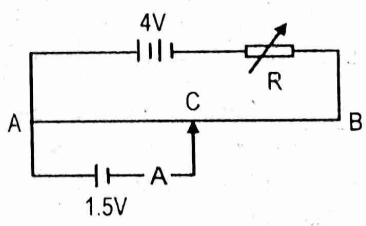


Fig. Q(1)

Ans: 0.825 m

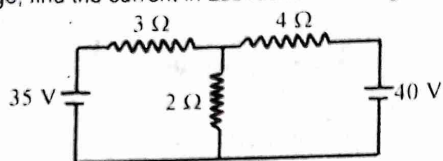
32. **2072 Set D Q.No. 9a** A battery of 6V and internal resistance 0.5Ω is joined in parallel with another of 10V and internal resistance 1Ω. The combination sends a current through an external resistance of 12Ω. Find the current through each battery. [4]

Ans: I<sub>1</sub> = 2.27A, I<sub>2</sub>: 2.86A

33. **2072 Set E Q.No. 9a** The total length of the wire of a potentiometer is 10m. A potential gradient of 0.0015 V/cm is obtained when a steady current is passed through this wire. Calculate, [4]
- the distance of null point on connecting standard cell of 1.018V.
  - the unknown p.d. if the null point is obtained at a distance of 940 cm, and
  - the maximum p.d. which can be measured by this instrument.

Ans: (I) 6.8 m (II) 1.41 V (III) 1.5 V

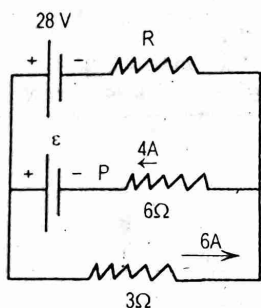
34. **2071 Set C Q.No. 9 a** Using Kirchoff's laws of current and voltage, find the current in  $2\Omega$  resistor in the given circuit: [4]



Ans: 10A

35. **2067 Q.No. 9a** In the adjacent circuit find:

- the current in resistor R.
- resistance R,
- the unknown emf  $\epsilon$ ,
- if the circuit is broken at P, what is the current in resistor R?



Ans: (i) 2A (ii)  $5\Omega$  (iii) 42V (iv) 3.5A

36. **2064 Q.No. 11 b** The driver cell of a potentiometer has an emf of 2V and negligible internal resistance. The potentiometer wire has a resistance of 3 ohm. Calculate the resistance needed in series with the wire if a p.d. 5.0 mV is required across the whole wire. The wire is 100.0 cm long and a balanced length of 60 cm is obtained for a thermocouple of emf E. What is the value of E? [4]

Ans: 1197.2  $\Omega$ , 3mV

37. **2063 Q.No. 11 b** The driver cell of a potentiometer has an emf 2V and negligible internal resistance. The potentiometer wire has a resistance of  $3\Omega$ . Calculate the resistance needed in series with the wire if a p.d. of 5mV is required across the whole wire. [4]

Ans: 1197  $\Omega$

38. **2059 Q.No. 11 b** The emf of a battery A is balanced by a length 75.0 cm on a potentiometer wire. The emf of a standard cell 1.02 volt is balanced by a length of 50.0 cm. What is the emf of A? [4]

Ans: 1.53V

39. **2056 Q.No. 11 b** The driving cell of a potentiometer has an emf of 2V and negligible internal resistance. The potentiometer wire has a resistance of  $3\Omega$ . Calculate the resistance needed in series with the wire of a p.d. of 1.5m V is required across the whole wire. [4]

Ans: 3997  $\Omega$

### 3. THERMOELECTRIC EFFECT

#### FORMULAE

- The neutral temperature,  $\theta_n = \frac{\theta_c + \theta_i}{2}$ , where  $\theta_c$  is the temperature of cold junction and  $\theta_i$  is the temperature of inversion.
- The thermo emf,  $E = \alpha\theta + \frac{1}{2}\beta\theta^2$ , where,  $\alpha$  and  $\beta$  are constants.

### Short Answer Questions [2 Marks]

- 2076 GIE Set A Q.No. 1d** Differentiate between Seebeck Effect and Peltier Effect.
- 2076 GIE Set B Q.No. 1b** What is the cause of Seebeck effect?
- 2076 Set B Q.No. 1b** **2059 Q.No. 10 a** What is thermoelectric effect?
- 2076 Set C Q.No. 1b** If the temperature of cold junction of thermocouple is lowered, what will be the effect on neutral temperature and the temperature of inversion?
- 2075 Set A Q.No. 1c** **2073 Supp Q.No. 1b** **2070 Supp. Set Q.No. 1 f** **2068 Q.No. 1 b** Does the thermoelectric effect obey the law of conservation of energy? Justify?
- 2075 Set B Q.No. 1b** Why is Lead (Pb) used as a standard reference metal in thermo-electricity?
- 2074 Supp Q.No. 1c** **2069 Set A Q.No. 1c** **2068 Can. Q.No. 1c** What is temperature of inversion? On what factors does it depend?
- 2074 Set B Q.No. 1c** What is temperature of inversion? How does it change, if temperature of cold junction decreases?
- 2073 Set C Q.No. 1d** Point out the difference between Peltier and Seebeck effect in brief.
- 2073 Set D Q.No. 1f** What is Seebeck effect? How is the effect different from Peltier effect? Explain.
- 2072 Supp Q.No. 1e** On what factors does the temperature of inversion depend?
- 2072 Set E Q.No. 1d** Is seebeck effect reversible effect? Explain.
- 2071 Set D Q.No. 1 c** What is neutral temperature? On what factors does it depend?
- 2070 Set C Q.No. 1 c** Define temperature of inversion. If the temperature of cold junction of a thermocouple is lowered what will be the effect on it?
- 2069 Supp Set B Q.No. 1 f** **2069 Set B Q.No. 1c** Peltier effect is the converse of Seebeck effect. Explain
- 2068 Old Q.No. 10 c** What do you mean by thermoelectric effect?
- 2067 Q.No. 1b** What are the factor on which thermo-emf depend?
- 2066 Old Q.No. 10 c** How does thermo emf change in a thermocouple when the temperature of the hot junction is changed?
- 2062 Q.No. 10 b** How is Seebeck effect different from Peltier effect? Explain.
- 2061 Q.No. 10 a** What are the factors on which the thermo emf produced in a thermocouple depends?
- 2060 Q.No. 10 c** Why is Sb-Bi thermocouple preferred to Fe-Cu thermocouple?
- 2058 Q.No. 10 b** What do you mean by Peltier's effect?

### Long Answer Questions [4 Marks]

- 2077 Set D Q.No. 2a** Define thermoelectric effect. How does the emf of a thermocouple vary with the temperature of hot junction?

24. **2075 GIE Q.No. 5b** **2072 Set D Q.No. 5a** What is Seebeck effect? How does the thermo emf vary with the increase in temperature of hot junction, keeping cold junction at  $0^\circ\text{C}$ ? Explain [4]
25. **2074 Set A Q.No. 5b** What is Seebeck effect? Explain the variation of thermo emf with gradual increase in the temperature of hot junction, keeping the cold junction at  $0^\circ\text{C}$ . [4]
26. **2071 Supp. Q.No. 5b** What is seebeck effect? How does the emf of thermocouple vary with temperature of the hot junction? [4]
27. **2071 Set C Q.No. 5 b** What is a thermocouple? Define neutral temperature and temperature of inversion of a thermocouple. Are they constant for a given thermocouple? [4]
28. **2070 Supp. Set B Q.No. 5 a** **2067 Sup Q.No. 5a** What is thermo electric effect? Discuss the variation of thermo emf with the change in temperature of the hot junction. [4]
29. **2070 Set D Q.No. 5 b** Define Seebeck effect. Discuss the variation of thermoelectric emf in a thermocouple with the increase of temperature of hot junction. [4]
30. **2063 Q.No. 11 a OR** **2057 Q.No. 11 a** What is Seebeck effect? How does the thermo emf of a thermocouple vary with temperature of the hot junction? [4]
31. **2056 Q.No. 11 a OR** Explain what do you mean by Seebeck Effect? How does thermoelectric emf varies with the temperature? [4]

#### Numerical Problems [4 Marks]

32. **2073 Set D Q.No. 9c** The thermo-emf  $\epsilon$  and the temperature of hot junction  $\theta$  satisfy a relation  $\epsilon = a\theta + b\theta^2$  where  $a = 4.1 \times 10^{-5} \text{ V } (^\circ\text{C})^{-1}$  and  $b = -4.1 \times 10^{-8} \text{ V}(^\circ\text{C})^{-2}$ . If the cold junction temperature is  $0^\circ\text{C}$  find the neutral temperature. [4]

Ans:  $500^\circ\text{C}$

### 4. CHEMICAL EFFECT OF CURRENT

#### FORMULAE

- Faraday's first law of electrolysis,  $m = Zq = Zit$   
Z is called electrochemical equivalent. Its unit is  $\text{gC}^{-1}$ .
- Faraday's second law of electrolysis,  $\frac{m_1}{m_2} = \frac{E_1}{E_2}$   
Where, E is chemical equivalent and m is the deposited mass of electrolytes.
- Chemical equivalent (E) =  $\frac{\text{Atomic weight}}{\text{Valency}}$
- Faraday's second law of electrolysis in alternative way,  
 $Z \propto E$   
 $Z = \frac{1}{F} E$   
 $F = \frac{E}{Z} = \frac{E}{m/q} = \frac{Eq}{m}$   
Where, F is called Faraday's constant and  
 $1 F = N_A e = 96500 \frac{\text{C}}{\text{gram equivalent}}$

#### Short Answer Questions [2 Marks]

- 2076 GIE Set B Q.No. 1c** Why is the conductivity of an electrolyte low in comparison to a metal? [2]
- 2076 Set B Q.No. 1c** **2067 Sup Q.No. 1c** Distinguish between ionic and electronic conduction. [2]

- 2076 Set C Q.No. 1a** **2074 Set B Q.No. 1f** **2072 Set C Q.No. 1b** The conductivity of an electrolyte is low as compared to that of metal at room temperature. Why? [2]
- 2075 GIE Q.No. 1c** A voltmeter measures current more accurately than an ammeter, why? [2]
- 2075 Set B Q.No. 1c** **2071 Set C Q.No. 1 e** Why is the conductivity of an electrolyte low in comparison to that of metal? [2]
- 2073 Set C Q.No. 1e** State the Faraday's laws of electrolysis. [2]
- 2072 Supp Q.No. 1b** Explain electrochemical equivalent of a substance. [2]
- 2072 Set E Q.No. 1c** Why is the conductivity of an electrolyte very low as compared to a metal at room temperature? [2]
- 2071 Supp. Q.No. 1f** **2056 Q.No. 10 c** What is meant by Faraday constant? [2]
- 2070 Set C Q.No. 1 e** The conductivity of an electrolyte is low as compared to a metal. Why? [2]
- 2070 Set D Q.No. 1 e** State and explain Faraday's laws of electrolysis. [2]
- 2066 Old Q.No. 10 b** Define one Faraday. [2]
- 2063 Q.No. 10 b** Why does voltmeter measure current more accurately than an ammeter? [2]

#### Long Answer Questions [4 Marks]

- 2075 Set A Q.No. 5c** **2071 Set D Q.No. 5b** **2069 Set A Q.No. 5c** State Faraday's laws of electrolysis. How will you verify Faraday's second law experimentally? [4]
- 2070 Supp. Set A Q.No. 5c** **2062 Q.No. 11a** State Faraday's laws of electrolysis and verify second law. [4]
- 2069 Set B Q.No. 5a** Verify Faraday laws of electrolysis. [4]
- 2068 Old Q.No. 11 a or** **2058 Q.No. 11 a OR** State and explain Faraday's Laws of electrolysis and hence define Faraday's constant. [3+2]
- 2064 Q.No. 11 a OR** State Faraday's law of electrolysis. Discuss the experiment to verify them. [5]

#### Numerical Problems [4 Marks]

- 2074 Supp Q.No. 9b** It is desired to deposit 0.254 kg of copper on the cathode of a copper voltmeter. How long will it take to deposit this amount if a steady current of 100 A is maintained? Relative Atomic mass of copper = 63.5 and Faraday's constant,  $F = 96500 \text{ C/mol}$ . [4]  
Ans: 7720 s
- 2069 Supp Set B Q.No. 9 a** Assuming Faraday constant to be  $96500 \text{ C } (\text{mole})^{-1}$  and relative atomic mass of copper 63, calculate the mass of copper liberated by 2 A current in 5 minutes. [4]  
Ans: 0.196 gm
- 2066 Old Q.No. 11 b** In a copper plating system, an electrolysis current of 3 A is used. How many atoms of  $\text{Cu}^{2+}$  are deposited in 1.5 h? ( $e = -1.6 \times 10^{-19} \text{ C}$ ). [3]  
Ans:  $5.06 \times 10^{22}$
- 2057 Q.No. 11 b** Calculate the charge needed to deposit 2g of Oxygen in the electrolysis of water. (Relative molecular mass of Oxygen is 32, Faraday constant F is  $965,000 \text{ C mol}^{-1}$ ). [3]  
Ans: 24125 C

**B. MAGNETIC FIELD OF CURRENT****1. MAGNETIC EFFECT OF CURRENT****FORMULAE****1. Lorentz Force.**

- i. The magnitude of magnetic Lorentz force experienced by moving charge in magnetic field,

$$F = q |\vec{v} \times \vec{B}| = Bqv \sin\theta$$

- ii. The magnitude of magnetic Lorentz force experienced by current carrying conductor in magnetic field B,

$$F = I (\vec{l} \times \vec{B}) = BIl \sin\theta.$$

**2. Magnetic torque and moving coil meters:**

- i. The magnetic torque in a rectangular coil  
 $\tau = BINA \cos \theta$ , where  $\theta$  is the direction of the current with respect to uniform magnetic field.

- ii. The magnetic moment of a current loop,  
 $\mu = IA$ , I = current, A = Area of loop.

- iii. The angular displacement of needle in moving coil

$$\text{meter, } \theta = \left( \frac{BNA}{k} \right) I$$

Where k is restoring torque per units twist.

- iv. The current sensitivity of coil meter,  $\frac{\theta}{I} = \frac{BNA}{k}$

- v. The voltage sensitivity of coil meter,  $\frac{V}{I} = \frac{BNA}{kR}$

**3. Biot and Savart law:**

- i. The magnitude of magnetic field dB due to a current element (dl) is,

$$dB = \frac{\mu_0}{4\pi} \frac{Idl \sin\theta}{r^2}$$

- ii. Magnetic Field at centre of circular current carrying coil,

$$B = \frac{\mu_0 NI}{2r}$$

- iii. Magnetic Field at axis of circular current carrying coil,

$$B = \frac{\mu_0 N I R^2}{2(R^2 + x^2)}$$

- iv. Magnetic Field due to an infinite long straight current

$$\text{carrying conductor, } B = \frac{\mu_0 I}{2\pi r}$$

- v. Magnetic Field due to an infinite long current carrying solenoid,

$$B = \mu_0 nI \text{ (at the center) and } B = \frac{\mu_0 nI}{2} \text{ (at the end).}$$

4. Magnetic force per unit length, due to two current

$$\text{carrying conductor, } \frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$$

**5. Hall effect:**

- i. Hall voltage,  $V_H = \frac{BI}{net}$

- ii. Hall coefficient  $H_C = \frac{1}{ne} = \frac{E_H}{BJ}$

- iii. Hall resistance,  $R_H = \frac{BH_C d}{t} = \frac{BH_C d}{A}$

**Short Answer Questions [2 Marks]**

- 2076 GIE Set A Q.No. 1c** Can a constant magnetic field set an electron at rest into motion? Explain. [2]
- 2076 GIE Set B Q.No. 1f** What do you mean by Hall Effect? Why is it more effective in semiconductors? [2]

- 2076 Set B Q.No. 1d** **2068 Q.No. 1 d** An electron beam and a proton beam are moving parallel to each other in the beginning. Do they always maintain this status? Justify your answer.
- 2076 Set B Q.No. 1e** Define one ampere current in terms of force.
- 2076 Set C Q.No. 1c** How will the magnetic field intensity at the centre of a circular coil carrying current change, if the current through the coil is doubled and the radius of the coil is halved?
- 2076 Set C Q.No. 1d** **2072 Set C Q.No. 1f** Can a charged particle move through a magnetic field without experiencing any force? Explain.
- 2075 GIE Q.No. 1d** Equal currents are flowing through two infinitely long parallel wires. What will be the magnetic field at a point mid-way, when the currents are flowing (i) in the same direction (ii) in the opposite direction?
- 2075 Set A Q.No. 1d** **2075 Set B Q.No. 1d** **2067 Sup Q.No. 1d** A solenoid tends to contract when a current passes through it. Why?
- 2073 Supp Q.No. 1c** **2060 Q.No. 2 e** Define one Ampere in terms of the force between current carrying conductors.
- 2073 Set C Q.No. 1c** How can the sensitivity of moving coil galvanometer be increased? Explain.
- 2073 Set D Q.No. 1b** A charge particle carrying a charge q moves in an electric field E. If its specific charge is 'S', write an expression of its acceleration in terms of above entities.
- 2073 Set D Q.No. 1c** Magnetic field at the centre of a solenoid is double than that at its ends. Why?
- 2072 Supp Q.No. 1c** Hall voltages are much larger for semiconductor, than for good conductors for comparable currents, fields and dimensions. Why?
- 2072 Set D Q.No. 1c** Does a charged particle moving through a magnetic field always experience a force? Explain.
- 2072 Set E Q.No. 1e** How will an electron move in a homogeneous magnetic field if the velocity of the electron at the initial moment forms an angle ' $\theta$ ' with the force lines of the field?
- 2071 Supp. Q.No. 1d** A uniform magnetic field directed upward exists in some region of space. In what directions could an electron be moving if its trajectory is (a) a straight line? (b) a circle?
- 2071 Set C Q.No. 1 c** A current was sent through a helical coil spring. The spring contracted, as if it had been compressed. Why?
- 2070 Supp. Set A Q.No. 1 c** If a magnetic force does no work on charged particles, how can it have any effect on the particles' motion?
- 2070 Supp. Set B Q.No. 1 c** Can a charged particle move through a magnetic field without experiencing any force? Explain the reason.
- 2069 Supp Set B Q.No. 1 c** Two straight current carrying rods are replaced parallel to each other. How can 1 ampere of current be defined from this arrangement?
- 2068 Old Can. Q.No. 2e** What will be the effect if the magnetic field in a moving coil galvanometer is not radial?
- 2068 Old Q.No. 2 e** State Ampere's circuital theorem.

23. **2067 Q.No. 1e** **2067 Old Q.No. 1e** **2066 Supp Q.No. 2e** A current carrying solenoid tends to contract. Why? [2]
24. **2065 Q.No. 2 e** Explain how the direction of Lorentz force is determined. [2]
25. **2061 Q.No. 2 e** How is magnetic field made radial in a moving coil galvanometer? [2]
26. **2060 Q.No. 1 e** Why is the cylindrical core of soft iron used in moving coil galvanometer? [2]
27. **2057 Q.No. 2 e** A proton moving in a straight line enters a strong magnetic field along the field direction. How will its path and velocity change? [2]
28. **2055 Q.No. 7 a** Does a charged particle moving through a magnetic field experience a force? Express with conditions, maximum, and minimum force it experiences. [2]
29. **2054 Q.No. 7 d** Under what conditions does a charge affect a magnet? [2]
30. **2054 Q.No. 7 h** State Ampere's theorem. [2]
- Long Answer Questions [4 Marks]**
31. **2076 GIE Set A Q.No. 5b** What is meant by Hall effect? Derive an expression of Hall voltage. [4]
32. **2076 GIE Set B Q.No. 5b** State Ampere's law and use it to find magnetic field due to a long current carrying solenoid. [4]
33. **2076 Set B Q.No. 5c** State Biot and Savart law. Derive an expression for the magnetic field at a point due to a long straight conductor carrying current. [4]
34. **2075 GIE Q.No. 5c** **2074 Supp Q.No. 5b** State Ampere's law and use it to find the magnetic field intensity due to a long solenoid. [4]
35. **2075 Set A Q.No. 5a** State Biot's and Savart's law and used it to obtain an expression for the magnetic field at the center of a circular coil. [4]
36. **2075 Set B Q.No. 5c** State Ampere's law and use it to find magnetic field due to a long straight current carrying conductor and toroid. [4]
37. **2074 Supp Q.No. 5d** A rectangular coil of  $N$  turns is placed in a uniform magnetic field  $B$  with its plane parallel to the field. Derive an expression for the torque produced on the coil when a current  $I$  is passed through it. Define magnetic moment in terms of torque. [4]
38. **2074 Set A Q.No. 5c** **2071 Set C Q.No. 5 c** **2069 Set A Q.No. 5b** State Biot-Savart law. Use this law, to find the magnetic field due to a current carrying circular coil at any point on the axis of the coil. [4]
39. **2074 Set B Q.No. 5b** Derive an expression for the force per unit length between two infinitely long parallel straight wires carrying current in the same direction. Hence define one ampere. [4]
40. **2073 Supp Q.No. 5b** **2072 Set D Q.No. 5c** State and explain Biot-Savart law and use it to find magnetic field due to a long straight current carrying conductor. [4]
41. **2073 Set C Q.No. 5c** State Ampere's law and deduce an expression for the force between two parallel current carrying wires. [4]
42. **2073 Set C Q.No. 5d** **2073 Set D Q.No. 5d** What is Hall effect? Explain and deduce expressions for Hall voltage and Hall electric field. [4]
43. **2073 Set D Q.No. 5a** Explain the magnetic effect on a current carrying rectangular coil. Hence obtain expression for the torque on the coil. [4]
44. **2072 Supp Q.No. 5b** Find an expression for the magnetic field on the axial line of a current carrying circular coil. [4]
45. **2072 Set C Q.No. 5c** Derive an expression for the force per unit length acting on each of the two straight parallel metallic conductors carrying current in the same direction and kept near each other. Why do such current carrying conductors attract each other? [4]
46. **2072 Set E Q.No. 5b** Derive an expression for the force per unit length between two parallel current carrying conductors. [4]
47. **2071 Supp. Q.No. 5d** Derive an expression for the force per unit length between parallel conductors carrying current in the opposite direction. [4]
48. **2071 Set D Q.No. 5 c** State and explain Ampere's theorem and use it to calculate the magnetic field due to a long solenoid. [4]
49. **2070 Supp. Set A Q.No. 5 b** Deduce an expression for a magnetic field at a point along the axis of a solenoid and at the mid point of the solenoid. [4]
50. **2070 Supp. Set B Q.No. 5 b** State Biot Savart law. Use this law to find the magnetic field intensity due to a current carrying straight conductor at a distance 'd' from it. [4]
51. **2070 Set C Q.No. 5 c** What is Ampere's circuital law? Use this law to derive an expression for the magnetic field due to a long solenoid carrying current. [4]
52. **2070 Set C Q.No. 5 d** Describe with the help of a diagram, the principle, construction and working of a moving coil galvanometer. [4]
53. **2070 Set D Q.No. 5 c** Find an expression for the force per unit length between two long parallel conductors carrying currents and hence define one ampere. [4]
54. **2069 Supp Set B Q.No. 5 c** State and explain Biot Savart law to find the magnetic field due to a current carrying solenoid at its centre. [4]
55. **2069 Set B Q.No. 5d** State and explain Biot-Savart law to find magnetic field due to a long straight current carrying conductor. [4]
56. **2068 Can. Q.No. 5c** State and explain Ampere's theorem and hence use it to find the magnetic field due to a long solenoid carrying current  $I$ . [4]
57. **2068 Old Can. Q.No. 7a OR** State and explain Biot-Savart law and hence use this law to find the magnetic field due to a long straight current carrying conductor. [1+3]
58. **2068 Old Q.No. 7 a** What is a Helmholtz coil? Derive an expression for the uniform magnetic field obtained from it. [1+3]
59. **2068 Q.No. 5 a** Deduce an expression for the force between two parallel current carrying conductors. Define one ampere current. [4]
60. **2067 Q.No. 5b** Find an expression for the magnetic field on the axis of a solenoid, carrying current, using Ampere's law. [4]

61. **2067 Old Q.No. 7a** Obtain magnetic field strength at a point on the axis of circular current loop by using Biot and Savart law [4]
62. **2067 Supp Q.No. 6b** State and explain Biot-savart law and use it to find magnetic field due to a long straight current carrying conductor. [1+3]
63. **2066 Q.No. 7 a** Derive an expression of force per unit length between two parallel conductors separated by a distance 'r' and carrying currents  $I_1$  and  $I_2$  in the same direction, [4]
64. **2066 Supp Q.No. 7a** State and explain Biot-savart law. Use it to find the magnetic field at the center of a circular coil of N turns and carrying current I. [1+3]
65. **2065 Q.No. 7 a OR** State and explain Biot-Savart law with a case of its application. [2+2]
66. **2064 Q.No. 7 a** State and explain Biot-Savart law. Use this law to find the magnetic field intensity at any point due to a long straight current carrying conductor. [1+3]
67. **2063 Q.No. 7 a** Find an expression for torque on rectangular coil in a uniform magnetic field. [4]
68. **2063 Q.No. 7 a OR** **2058 Q.No. 7 a OR** What is a Helmholtz coil? Derive an expression for the magnetic field due to this coil. [4]
69. **2062 Q.No. 7 a** State and explain Biot-Savart law and hence use it to find the magnetic field intensity at any point due to a long straight conductor. [4]
70. **2061 Q.No. 7 a** Derive the formula for the magnetic field at a point due to a long straight current carrying conductor using Biot-Savart law. [4]
71. **2060 Q.No. 7 a** State and explain Ampere's theorem and hence use it to find the magnetic field intensity due to a long current carrying solenoid. [1+3]
72. **2059 Q.No. 7 a** Derive the formula for the magnetic field at the centre of a circular coil carrying current. Explain why the magnetic field at the centre of the coil disappears when the circular coil is made infinitely large. [4]
73. **2057 Q.No. 7 a** Derive an expression for the magnetic field at a point due to a long straight conductor carrying current. [4]
74. **2056 Q.No. 7 c** Explain in brief, the motion of an electron moving normal to a magnetic field. [4]
75. **2056 Q.No. 8** Derive an expression for the magnitude of the magnetic flux density at the center of a narrow circular coil. [4]
76. **2055 Q.No. 9 OR** State Biot-Savart law and obtain the expression for the magnetic field at the centre of the circular coil. [4]
- Numerical Problems [4 Marks]**
77. **2076 GIE Set A Q.No. 9b** A closely wound coil has a radius of 6cm and carries a current of 2.5A. How many turns must it have if the magnetic field at a point 6 cm from the centre of the coil on the coil axis is  $6.4 \times 10^{-4}$  T? ( $\mu_0 = 4\pi \times 10^{-7} \text{ Hm}^{-1}$ ) [4]  
Ans: 70 turns
78. **2076 GIE Set B Q.No. 9c** Two long parallel transmission lines, 40.0 cm apart carry 25.0 A and 75.0A currents. Find location where the net magnetic field of these two wires is zero if these currents are in the same direction. [4]  
Ans: 0.1 m from 25.0 A wire
79. **2076 Set B Q.No. 9b** Two galvanometers, which are otherwise identical, are fitted with different coils. One has a coil of 50 turns and resistance  $10\Omega$  while the other has 50 turns and a resistance of  $600\Omega$ . What is the ratio of the deflection when each is connected in turns to a cell of emf 25 V and internal resistance  $50\Omega$ ?  
Ans: 12:1
80. **2076 Set C Q.No. 9b** A flat silver strip of width 1.5cm and thickness 1.5mm carries a current of 150A. A magnetic field of 2T is applied perpendicular to the flat face of the strip. The emf developed across the width of the strip is measured to be  $17.9\mu\text{V}$ . Calculate the free electron density in the silver.  
Ans:  $6.98 \times 10^{23} \text{ m}^{-3}$
81. **2075 GIE Q.No. 9b** A Silver wire has  $1 \times 10^{30}$  free electrons per cubic meter, a cross sectional area of  $2 \text{ mm}^2$  and carries a current of 5A. Calculate the force acting on each electron if the wire is now placed in a magnetic field of flux density 0.15T which is perpendicular to the wire.  
Ans:  $3.75 \times 10^{-24} \text{ N}$
82. **2075 Set B Q.No. 9b** **2061 Q.No. 7 b** A horizontal straight wire 5 cm long weighing  $1.2 \text{ gm}^{-1}$  is placed perpendicular to a uniform horizontal magnetic field of flux density of 0.6 T. If the resistance per unit length of the wire is  $3.8 \Omega \text{ m}^{-1}$  calculate the p.d. that has to be applied between the ends of the wire to make it just self-supporting.  
Ans:  $3.7 \times 10^{-4} \text{ V}$
83. **2074 Set A Q.No. 9b** A straight horizontal rod of length 20 cm and mass 30 gm is placed in a uniform horizontal magnetic field perpendicular to the rod. If a current of 2A through the rod makes it self supporting in the magnetic field calculate the magnetic field.  
Ans: 0.75 T
84. **2074 Set B Q.No. 9b** A coil consisting of 100 circular loops with radius 60 cm carries a current of 5A. Find the magnetic field at a point along the axis of the coil, 80 cm from the centre. ( $\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$ )  
Ans:  $1.13 \times 10^{-4} \text{ T}$
85. **2073 Supp Q.No. 9b** A straight conductor of length 5cm carries current of 1.5A. The conductor experiences a magnetic force of  $4.5 \times 10^{-3} \text{ N}$  when it is placed in a magnetic field of 0.9T. What angle the conductor makes with magnetic field?  
Ans:  $3.8^\circ$
86. **2073 Set D Q.No. 9b** A circular coil has 100 turns and a mean diameter of 20 cm. It carries a current of 5A. Find the strength of the magnetic field at a point on its axis at a distance of 15 cm from the centre of the coil.  
Ans:  $5.37 \times 10^{-4} \text{ T}$
87. **2072 Set C Q.No. 9b** A horizontal wire, of length 5 cm and carrying a current of 2A, is placed in the middle of a long solenoid at right angles to its axis. The solenoid has 1000 turns per meter and carries a steady current I. Calculate I if the force on the wire is equal to  $10^{-4} \text{ N}$ . ( $\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$ )  
Ans: 0.8 A
88. **2072 Set D Q.No. 9b** **2071 Supp. Q.No. 9b** **2067 Q.No. 8b** The coil of a moving coil galvanometer has 50 turns and its resistance is  $10\Omega$ . It is replaced by a coil having 100 turns and resistance  $50\Omega$ . Find the factor by which the current and voltage sensitivities change.  
Ans: 2, 2.5

89. **2072 Set E Q.No. 9c** A 60 cm long wire of mass 10 g is suspended horizontally in a transverse magnetic field of flux density 0.4 T through two springs at its two ends. Calculate the current required to pass through the wire so that there is zero tension in the springs. [4]  
 Ans: 0.42 A

90. **2074 Set C Q.No. 9 b** A horizontal straight wire of mass 0.12 gm and length 10 cm is placed perpendicular to a uniform horizontal magnetic field of flux density 0.6 T. If the resistance per unit length of the wire is  $3.8 \Omega \text{m}^{-1}$ , calculate the potential difference that has to be applied between the end of the wire to make it just self supporting. [4]  
 Ans:  $7.6 \times 10^{-3} \text{ V}$

91. **2071 Set D Q.No. 9 a** A copper wire has  $10^{29}$  free electrons per cubic meter, a cross sectional area of  $2 \text{ mm}^2$  and carries a current of 5 A. Calculate the force acting on each electron if the wire is now placed in a magnetic field of flux density 0.15 T which is perpendicular to the wire. [4]  
 Ans:  $3.75 \times 10^{-24} \text{ N}$

92. **2070 Supp. Set A Q.No. 9 a** Two long parallel conductors carry respectively currents of 12 A and 8 A in the same direction. If the wires are 10 cm apart, find where a third parallel wire also carrying a current must be placed so that the force experienced by it will be zero. [4]  
 Ans: 0.06 m

93. **2070 Supp. Set B Q.No. 9 b** An electron of K.E. 10 eV is moving in a circular orbit of radius 11 cm, in a plane at right angles to a uniform magnetic field. Determine the value of the flux density. (mass of an electron =  $9.1 \times 10^{-31} \text{ kg}$ ,  $e = 1.6 \times 10^{-19} \text{ C}$ ) [4]  
 Ans:  $9.7 \times 10^{-5} \text{ T}$

94. **2070 Set D Q.No. 9 b** A slab of copper, 2 mm thick and 1.50 cm wide, is placed in a uniform magnetic field of flux density 0.40 T, so that maximum flux pass through the slab. When a current of 75 A flows through it, a potential difference of 0.81  $\mu\text{V}$  is developed between the edges of the slab. Find the concentration of the mobile electrons in copper. [4]  
 Ans:  $1.15 \times 10^{29} / \text{m}^3$

95. **2069 Supp Set B Q.No. 9 b** A copper wire has  $1 \times 10^{29}$  free electrons per cubic meter and cross sectional area  $2 \text{ mm}^2$  carries a current of 6 A. Calculate the force acting on each electron if the wire is now placed in uniform magnetic field of flux density 0.1 T perpendicularly. [4]  
 Ans:  $3 \times 10^{-24} \text{ N}$

96. **2069 Supp Set B Q.No. 9 c** **2069 Set A Q.No. 9b** **2067 Supp Q.No. 9b** A slice of indium antimonide is 2.5 mm thick and carries a current of 150 mA. A magnetic field of flux density 0.5 T, correctly applied, produce a maximum Hall voltage of 8.75 mV between the edges of the slice. Calculate the number of free charge carries per unit volume assuming that each have a charge of  $1.6 \times 10^{-19} \text{ C}$ . [4]  
 Ans:  $2.14 \times 10^{22} \text{ m}^{-3}$

97. **2069 Set A Old Q.No. 7b** A copper wire 28 m long is wound into a flat circular coil 8.0 cm in diameter. If the current of 4.50 A flows through the coil, what is the magnetic induction at the centre? [1+2+1]  
 Ans:  $7.8 \times 10^{-3} \text{ T}$

98. **2069 Set B Q.No. 9a** An alpha particle makes a full rotation in a circle of radius 1.0 meter in 2.0 sec. Calculate the value of magnetic field induction at the centre of the circle. ( $\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$ ) [4]  
 Ans:  $10^{-16} \text{ J}$

99. **2068 Can. Q.No. 9b** A long wire carrying a current of 10 A is placed perpendicular to magnetic field of flux density 5 Tesla. Calculate the force acting on 2 m of the wire. [4]  
 Ans: 100 N

100. **2068 Q.No. 9 b** A coil consisting of 100 circular loops with radius 0.60 m carries a current of 5 A. At what distance from the center, along the axis, the magnetic field magnitude 1/8 as great as it is at the center? [4]  
 Ans: 1.04 m

101. **2065 Q.No. 7 b** A wire carrying current of 10 A and 2 m in length is placed in a field of flux density 0.34 Tesla. What is the force on the wire if it is placed at  $60^\circ$  to the field? [3]  
 Ans: 5.88 N

## 2. MAGNETIC PROPERTIES OF MATERIALS

### FORMULAE

- $\tan \delta = \frac{B_v}{B_H}$
- Apparent dip,  $\tan \delta' = \frac{\tan \delta}{\cos \theta}$
- True dip from two apparent dips,  $\cot^2 \delta = \cot^2 \delta_1 + \cot^2 \delta_2$
- $B_v^2 + B_H^2 = B^2$
- $\mu_r = 1 + \chi$
- $\mu = \mu_0 \mu_r = \frac{B}{H} = \mu_0 (1 + \chi)$
- $I = \frac{M}{V} = \frac{m}{A}$
- $H = \frac{B_0}{\mu_0}$
- $\chi_m = \frac{I}{H}$

### Short Answer Questions [2 Marks]

- 2077 Set D Q.No. 1b** What is Curie temperature? [2]
- 2076 GIE Set B Q.No. 1d** Distinguish between diamagnetic and paramagnetic substances in terms of their relative permeability and susceptibility. [2]
- 2075 GIE Q.No. 1e** **2074 Set A Q.No. 1d** Why is soft iron preferred for making the core of a transformer? [2]
- 2075 Set B Q.No. 1e** What is the significance of the area of a hysteresis loop? [2]
- 2074 Supp Q.No. 1d** Permanent magnets are made of steel. Why? [2]
- 2074 Set A Q.No. 1c** What is angle of dip? How is it related with components of earth's magnetic field? [2]
- 2073 Supp Q.No. 1c** **2069 Set A Q.No. 1d** Steel is used in making permanent magnets whereas soft iron is preferred for making the core of transformer. Why? [2]
- 2073 Set D Q.No. 1a** How do you expect about the directions of horizontal and vertical components of earth's magnetic intensity at pole and at equator? Give justification in terms of angle of dip. [2]

9. **2072 Supp Q.No. 1d** **2071 Set D Q.No. 1 d** Why should the permeability of a paramagnetic material be expected to decrease with increasing temperature? [2]
10. **2072 Set C Q.No. 1c** What is retentivity and coercivity of a ferromagnetic material? [2]
11. **2072 Set D Q.No. 1d** Define angle of dip. What will be its value at a place where the horizontal and vertical components of earth's magnetic field are equal? [2]
12. **2071 Supp. Q.No. 1e** What is the role of hysteresis loop in choosing a material for making permanent magnets? [2]
13. **2070 Supp. Set A Q.No. 1 d** Distinguish between dia and para-magnetic substances on the basis of susceptibility. [2]
14. **2070 Set D Q.No. 1 c** The magnetic susceptibility of a paramagnetic material is quite strongly temperature dependent, but that of diamagnetic material is nearly independent of temperature. Why? [2]
15. **2069 Supp Set B Q.No. 1 a** Define an angle of dip. What will be its value at the pole of the earth? [2]
16. **2068 Can. Q.No. 1e** **2063 Q.No. 8 a** Above curie temperature a ferromagnetic material becomes paramagnetic. Why? [2]
17. **2068 Old Q.No. 8 a XI** What are the characteristics of a ferromagnetic substance? [2]
18. **2068 Q.No. 1 c** A permanent magnet can be used to pick up a string of nails, tacks or paper clips, even though these are not magnets by themselves. How can this be? [2]
19. **2067 Q.No. 1c** Why does a magnet lose its magnetism when heated to high temperature? [2]
20. **2067 Sup Q.No. 1e** Permanent magnets are made of steel while the core of transformer is made of soft iron. Why? [2]
21. **2066 Old Q.No. 8 a** The angle of dip in Britain is greater than that in Kathmandu. Why? [2]
22. **2064 Q.No. 8 a** Why does a bar magnet not retain its magnetism when it is melted? [2]
23. **2059 Q.No. 8 c** How does dip vary from place to place on earth's surface? [2]
24. **2058 Q.No. 8 c** Define angle of dip and angle of declination at a place. [2]
25. **2057 Q.No. 8 b** What are magnetic domains? [2]
26. **2057 Q.No. 8 c** What is angle of dip? How does it vary from the equator to the poles? [2]
- Long Answer Questions [4 Marks]**
27. **2076 GIE Set A Q.No. 5c** Define the terms magnetic permeability and susceptibility of a substance. Obtain the relation between them. [4]
28. **2076 GIE Set B Q.No. 5c** Define true and apparent dips. Obtain the relation between them. [4]
29. **2076 Set C Q.No. 5c** Define angle of dip. If  $\delta$  is the true dip at a place,  $\delta_1$  and  $\delta_2$  are the apparent dips observed in two vertical planes at right angles to each other at that place, then prove the relation,  $\cot^2\delta = \cot^2\delta_1 + \cot^2\delta_2$ . [4]
30. **2074 Set B Q.No. 5c** Define permeability and susceptibility of magnetic materials. Derive a relation between them. [4]
31. **2073 Set C Q.No. 5b** Relate magnetic permeability and susceptibility features of a magnetic material. Can hysteresis curve be drawn in the case of diamagnetic material? Explain on the basis of above features. [4]
32. **2072 Set E Q.No. 5c** What do you mean by true dip and apparent dip? Show that  $\cos^2\delta = \cot^2\delta_1 + \cot^2\delta_2$ , where symbols have usual meanings.
33. **2070 Supp. Set B Q.No. 5 d** Prove that  $\cot^2\delta = \cot^2\delta_1 + \cot^2\delta_2$ , where symbols have usual meanings.
34. **2070 Set C Q.No. 5 b** Define magnetic susceptibility and relative permeability and establish a relation between them.
- Numerical Problems [4 Marks]**
35. **2075 Set A Q.No. 9c** A bar magnet, 10 cm in length, has pole strength of 10 AM. Determine the magnetic field at a point on its axis at a distance of 15 cm from the center of the magnet. ( $\mu_0 = 4\pi \times 10^{-7}$  H/m) Ans:  $7.5 \times 10^{-4}$  T
36. **2062 Q.No. 9 b** The needle of a dip circle shows an apparent dip of  $45^\circ$  in a particular position and  $53^\circ$  when the circle is rotated through  $90^\circ$ . Find the true dip. Ans:  $38.7^\circ$

### 3. ELECTROMAGNETIC INDUCTION

#### FORMULAE

- Magnetic Flux:  $\phi = \vec{B} \cdot \vec{A} = BA \cos \theta$ . (where  $\theta$  is the angle between  $\vec{B}$  and  $\vec{A}$ )
- Formulae about induced emf, current, charge and power:
  - Induced emf,  $E = -N \frac{d\phi}{dt}$
  - Induced current,  $I = \frac{E}{R} = -\frac{N}{R} \frac{d\phi}{dt}$
  - Induced charge,  $q = \int I dt = -\frac{E}{R} d\phi$
  - Induced power,  $P = IE = \frac{E^2}{R} = N^2 \left(\frac{d\phi}{dt}\right)^2 \cdot \frac{1}{R}$
- Magnitude of induced emf:
  - For a conducting rod moving in a uniform magnetic field,  $E = Bv \sin \theta$ ,
  - For a conducting rod rotating with angular velocity  $\omega$  in a uniform magnetic field,  $E = BAf$
  - For a disc of radius  $r$  rotating in uniform magnetic field,  $E = BAf$ .
  - For a rectangular coil rotating in a uniform magnetic field,  $E = BA\omega N \sin \omega t = E_0 \sin \omega t$
- Self induction:
  - Magnetic flux,  $\phi = LI$
  - Induced emf in the coil,  $E = -L \frac{dI}{dt}$
  - For a solenoid,  $L = \frac{\mu_0 N^2 A}{l}$
  - For a plane circular coil,  $(L) = \frac{\mu_0 N^2 A}{2r}$
  - The energy stored by an inductor,  $U = \frac{1}{2} LI^2$
- Mutual induction
  - The emf induced by neighbouring coil,  $E = -M \frac{dI}{dt}$
  - The mutual inductance of two long coaxial solenoids each of length  $l$ , area of cross-section  $A$  wound in air is,  $M = \frac{\mu_0 N_1 N_2 \pi r_1^2}{2r_2}$ ,  $r_2$  is radius of bigger coil or  $r_2 > r_1$

6. Transformer:  
 i. Relation of alternating voltage, alternating current and number of turns in two coils.  $\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$   
 ii. Efficiency,  $\eta = \frac{\text{output power}}{\text{input power}} \times 100\%$

### Short Answer Questions [2 Marks]

- 2076 Set C Q.No. 1e 2070 Set C Q.No. 1d A copper ring is suspended by a thread in a vertical plane. One end of a magnet is brought horizontally towards the ring. How will the position of the ring be affected? [2]
- 2075 Set A Q.No. 1e A bar magnet falls through copper ring. Will its acceleration be equal to 'g'? Justify. [2]
- 2075 Set B Q.No. 1f Birds sitting on a high tension line wire fly off when current is switched on. Why? [2]
- 2074 Supp Q.No. 1e State and explain Faraday's law of electromagnetic induction. [2]
- 2074 Set A Q.No. 1e 2072 Set C Q.No. 1d If the number of turns of a solenoid is doubled, keeping the other factors constant, how does the self inductance of the solenoid change? [2]
- 2074 Set R Q.No. 1d What are eddy currents? How can these be reduced in a transformer? [2]
- 2073 Set D Q.No. 1d 2069 Supp Set B Q.No. 1d Lenz law follows the principle of conservation of energy. Explain. [2]
- 2072 Set C Q.No. 1e A transformer gets heated up while in use. Why? [2]
- 2072 Set D Q.No. 1e Why does acceleration of a magnet falling through a long solenoid decrease? [2]
- 2071 Supp. Q.No. 1c A vertical magnetic field is perpendicular to the vertical plane of a loop. When the loop is rotated about a horizontal axis in the plane, the current produced in the loop reverses directions twice per rotation. Explain why there are two reversals for one rotation. [2]
- 2071 Set C Q.No. 1d 2067 Q.No. 1d A sheet of copper is placed between the poles of an electromagnet with the magnetic field perpendicular to the sheet. When it is pulled out, a considerable force is required, and the force required increases with speed. Explain. [2]
- 2071 Set D Q.No. 1e A long, straight conductor passes through the centre of a metal ring, perpendicular to its plane. If the current in the conductor increases, does current get induced in the ring? Explain. [2]
- 2070 Supp. Set A Q.No. 1e Can a transformer be used with dc? Why? Why not? [2]
- 2070 Supp. Set B Q.No. 1d Pairs of conductors carrying current into or out of the power supply components of electronic equipments are twisted together. Why? [2]
- 2070 Supp. Set B Q.No. 1e Does Lenz law violate principle of conservation of energy? Explain. [2]
- 2070 Set D Q.No. 1d A copper ring is held horizontally and a bar magnet is dropped through the ring with its length along the axis of the ring. Will the acceleration of the falling magnet be equal to the acceleration due to gravity? Explain. [2]
- 2069 Set A Q.No. 1f State and explain the lenz's law. [2]

- 2069 Set A Old Q.No. 1h A bar magnet falls through a metal ring, will its acceleration be equal to 'g'? [2]
- 2069 Set B Q.No. 1e Explain Faraday laws of electromagnetic induction. [2]
- 2068 Can. Q.No. 1d A student asserted that if a permanent magnet is dropped down a vertical copper pipe, it eventually reaches a terminal velocity even if there is no air resistance. Why should this be? [2]
- 2068 Q.No. 1d If a permanent magnet is dropped down a vertical copper pipe, it eventually reaches a terminal velocity even if there is no air resistance. Why should this be? [2]
- 2068 Old Q.No. 1e What is self inductance? Define coefficient of self inductance. [2]
- 2066 Q.No. 1e A sheet of copper is placed between the poles of an electromagnet with the magnetic field perpendicular to the sheet. When it is pulled out, a considerable force is required, and the force required increases with speed, why? [2]
- 2065 Q.No. 1e State Faraday's laws of electromagnetic induction. [2]
- 2064 Q.No. 2e A transformer cannot be used in dc circuits, why? [2]
- 2063 Q.No. 1e 2061 Q.No. 1e Why can't a transformer be used to step up or down the d.c. voltage? [2]
- 2063 Q.No. 2e What is eddy current? Write down its uses. [2]
- 2062 Q.No. 2e What are different power losses in a transformer? What measures do you take to minimize these losses? [2]
- 2059 Q.No. 2e Two closely wound circular coils have the same number of turns, but one has twice the radius of the other. What is the ratio of self inductances of the two coils? [2]
- 2058 Q.No. 1e Show that Lenz's law is an example of conservation of energy. [2]
- 2056 Q.No. 7e State Lenz's law. [2]
- 2055 Q.No. 7c Mention two types of loss in a transformer. [2]
- 2053 Q.No. 7g What is lenz's law? [2]

### Long Answer Questions [4 Marks]

- 2076 GIE Set A Q.No. 5d What do you mean by electromagnetic induction? Obtain an expression of emf induced in a moving rod in a magnetic field. [4]
- 2076 GIE Set B Q.No. 5d What are self and mutual inductances? Obtain an expression of energy stored in an inductor. [4]
- 2076 Set C Q.No. 5d 2075 GIE Q.No. 5d 2067 Sup Q.No. 5c 2064 Q.No. 7 a OR State and explain Faraday's laws of electromagnetic induction and derive an expression for the emf induced in a rectangular coil rotating in a uniform magnetic field. [4]
- 2074 Supp Q.No. 5c Describe the structure and working principle of a transformer. Define the efficiency of a transformer. [4]
- 2074 Set A Q.No. 5d 2073 Supp Q.No. 5c State and explain Faraday's law of electromagnetic induction. Obtain an expression for the emf induced in the rectangular coil rotating in a uniform magnetic field. [4]

39. **2073 Set D Q.No. 5c** Explain how the concept of self and mutual inductances are used in the working principle of a transformer. [4]
40. **2072 Supp Q.No. 5c** Describe the phenomena of self and mutual induction. Describe the construction and explain the action of a transformer. [4]
41. **2072 Set C Q.No. 5d** What is Lenz's law? Deduce an expression for the emf induced in a straight conductor moving in a uniform magnetic field. [4]
42. **2071 Set C Q.No. 5 d** Define self inductance. An inductor having self inductance  $L$  is used in a ac power supply. Calculate the energy stored in it. [4]
43. **2070 Supp. Set A Q.No. 5 d** What is meant by self inductance? Derive an expression for energy stored in an inductor. [4]
44. **2070 Supp. Set B Q.No. 5 c** **2068 Q.No. 5 b** Describe the principle and working of a.c. generator. [4]
45. **2069 Set A Old Q.No. 7a** What do you mean by electromagnetic induction? Obtain an expression for the emf induced in the conductor moving in the magnetic field. [1+3]
46. **2068 Can. Q.No. 5b** State and explain Faraday's laws of electromagnetic induction. Deduce an expression for the induced emf in a coil rotating uniformly in a uniform magnetic field. [4]
47. **2068 Old Can. Q.No. 7a** State Faraday's law of electromagnetic induction. Derive an expression for the emf induced in a straight conductor moving at right angle to the direction of a uniform magnetic field. [1+3]
48. **2068 Old Q.No. 7 a Or** A metallic rod is moving in a magnetic field. Determine the emf induced across it. [4]
49. **2067 Q.No. 5c** State Faraday's laws of electromagnetic induction. Derive an expression for induced emf in a coil rotating in a magnetic field. [4]
50. **2066 Supp Q.No. 7a OR** State Faraday's laws of electromagnetic induction. Deduce an expression for induced emf in a coil rotating in a magnetic field. [1+3]
51. **2062 Q.No. 7 a OR** State Lenz's law and explain how this law leads to the conservation of energy principle. [4]
52. **2059 Q.No. 7 a OR** State and explain Lenz's law. [4]
53. **2057 Q.No. 7 a OR** Deduce an expression for induced emf in a coil rotating in a magnetic field. [4]
54. **2053 Q.No. 10** State the laws of electromagnetic induction. Derive an expression for the emf induced in a conductor moving in a magnetic field. [4]
55. **2052 Q.No. 8** Obtain the expression for the emf induced in the conductor moving in a magnetic field. [4]
- Numerical Problems [4 Marks]**
56. **2076 Set B Q.No. 9c** The magnetic flux passing perpendicular to the plane of coil is given by  $\phi = 4t^2 + 5t + 2$  where  $\phi$  is in weber and  $t$  is in second. Calculate the magnitude of instantaneous emf induced in the coil when  $t = 2$  sec. [4]  
Ans: 21V
57. **2075 Set A Q.No. 9a** A straight conductor of length 25 cm is moving perpendicular to its length with a uniform speed of 10 m/s making an angle of  $45^\circ$  with a uniform magnetic field of 10 T. Calculate the emf induced across its length. [4]  
Ans: 17.67 V
58. **2075 Set B Q.No. 9c** **2067 Old Q.No. 7b** A coil of 100 turns each of area  $2 \times 10^{-3} \text{ m}^2$  has a resistance of  $12 \Omega$ . It lies in a horizontal plane in a vertical magnetic flux density of  $3 \times 10^{-4} \text{ Wbm}^{-2}$ . What charge circulates through the coil if its ends are short-circuited and the coil is rotated through  $180^\circ$  about a diametrical axis? [4]  
Ans:  $10^{-4} \text{ C}$
59. **2074 Set B Q.No. 9c** An aircraft with a wingspan of 40 m flies with a speed of  $1080 \text{ km hr}^{-1}$  in the eastward direction at a constant altitude in the northern hemisphere. Where the vertical component of earth's magnetic field is  $1.75 \times 10^{-5} \text{ T}$ . Find the emf that develops between the tips of the wings. [4]  
Ans: 0.21 V
60. **2073 Set C Q.No. 9a** A straight conductor of length 15 cm is moving with uniform speed of  $10 \text{ ms}^{-1}$  making an angle of  $30^\circ$  with uniform magnetic field of  $10^{-4} \text{ Tesla}$ . Calculate the emf induced across the length. [4]  
Ans:  $7.5 \times 10^{-4} \text{ V}$
61. **2072 Supp Q.No. 9b** A jet plane is flying due west at the speed of  $1800 \text{ km/hr}$ . What is the voltage difference developed between the ends of the wings 25m long of the earth's magnetic field at that location is  $5 \times 10^{-4} \text{ T}$  and the angle of dip is  $45^\circ$ ? [4]  
Ans: 6.25V
62. **2072 Set D Q.No. 9c** A long solenoid of 1000 turns and cross sectional area  $2 \times 10^{-3} \text{ m}^2$  carries a current of 2A and produces a flux density  $52 \times 10^{-3} \text{ T}$  inside it. Calculate the self inductance of the coil. [4]  
Ans: 0.052H
63. **2072 Set E Q.No. 9b** The magnetic flux passing perpendicular to the plane of a coil is given by  $\phi = 4t^2 + 5t + 2$  where  $\phi$  is in Weber and  $t$  is in seconds. Calculate the magnitude of instantaneous emf induced in the coil when  $t = 3$  sec. [4]  
Ans: 29V
64. **2071 Supp. Q.No. 9c** A plane circular coil has 200 turns and its radius is 0.10m. It is connected to a battery. After switching on the circuit a current of 2A is set up in the coil. Calculate the energy stored in the coil. ( $\mu_0 = 4\pi \times 10^{-7} \text{ Hm}^{-1}$ ) [4]  
Ans:  $1.6 \times 10^{-4} \text{ J}$
65. **2071 Set D Q.No. 9 c** Find the emf induced in a straight conductor of length 25 cm, on the armature of a dynamo and 12 cm from the axis, when the conductor is moving in a uniform radial magnetic field of 0.5 T. The armature is rotating at 1000 revolutions per minute. [4]  
Ans: 1.57 V
66. **2070 Set C Q.No. 9 b** A metal aircraft with a wing span of 40 m flies with a speed  $1000 \text{ km hr}^{-1}$  in a direction due east at constant altitude in a region of the northern hemisphere where the horizontal component of the earth's magnetic field is  $1.6 \times 10^{-5} \text{ T}$  and the angle of dip is  $41^\circ$ . Find the potential difference developed between the tips of the wing. [4]  
Ans: 0.155V
67. **2070 Set D Q.No. 9 c** A rectangular coil of 100 turns has dimensions  $15 \times 10 \text{ cm}$ . It is rotated at the rate of 300 revolutions per minute in a uniform magnetic field of flux density 0.6 T. Calculate the maximum emf induced in it. [4]  
Ans: 28.3V

68. **2069 Set A** has a small axis of the changes st induced vo

69. **2067 Q.No. and 2000**, co-axially, inductance

70. **2066 Q.N.** sectional produces Assuming solenoid,

71. **2060 Q.N.** coil and voltage if assumed is require

72. **2058 Q.N.** of 1800 between magneti is  $30^\circ$ ?

73. **2054 Q.** rotated the plan rim and

74. **2052 Q** rotated perpen field of What is

75. **2052** supply 500 t transfo in the

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68. **2069 Set A Q.No. 9c** A long solenoid with 15 turns per cm has a small loop of area  $2\text{cm}^2$  placed inside, normal to the axis of the solenoid. If the current carried by the solenoid changes steadily from 2A to 4A in 0.1 second, what is the induced voltage in the loop, while the current is changing? [4]  
**Ans:  $7.5 \times 10^{-4}\text{V}$**

69. **2067 Q.No. 6c** Two plane coils having number of turns 1000 and 2000, and radii 5 cm and 10 cm respectively are placed co-axially in the same plane. Calculate their mutual inductance. ( $\mu_0 = 4\pi \times 10^{-7}\text{ H/m}$ ) [4]  
**Ans: 0.79H**

70. **2066 Q.No. 7 b** A long solenoid of 1000 turns and cross-sectional area  $2 \times 10^{-3}\text{ m}^2$  carries a current of 2A and produces a flux density  $52 \times 10^{-3}\text{ T}$  in the middle of the coil. Assuming this value of flux density at all sections of the solenoid, calculate its self-inductance. **Ans: 0.052H [3]**

71. **2060 Q.No. 7 b** A transformer has 500 turns in the primary coil and 100 turns in the secondary coil. What is the output voltage if the input voltage is 4000 volts? If the transformer is assumed to have an efficiency of 100%, what primary current is required to draw 2000 watts from the secondary? [3]  
**Ans: 800V and 0.005 A**

72. **2058 Q.No. 7 b** A jet plane is traveling due west at the speed of 1800km/h. What is the voltage difference developed between the ends of the wings 25m long, if the earth's magnetic field at the location is  $5.0 \times 10^{-4}\text{ T}$  and the dip angle is  $30^\circ$ ? [3]  
**Ans: 3.5 V**

73. **2054 Q.No. 9** When a wheel with metal spokes 1.2m long is rotated in a magnetic field of flux density  $5 \times 10^{-5}\text{ T}$  normal to the plane of wheel, an emf of  $10^{-2}\text{V}$  is induced between the rim and axle. Find the rate of rotation of the wheel. [4]  
**Ans: 44.2 rev/S**

74. **2052 Q.No. 11** A circular metal disc of area  $3.0 \times 10^{-3}\text{ m}^2$  is rotated at 50 rev/s about an axis through its centre perpendicular to its plane. The disc is in a uniform magnetic field of flux density  $5.0 \times 10^{-3}\text{ T}$  in the direction of the axle. What is the value of induced emf? [4]  
**Ans:  $75 \times 10^{-5}\text{ V}$**

75. **2052 Q.No. 11 OR** A step down transformer transforms a supply line voltage 220 volts into 100 volts. Primary coil has 500 turns. The efficiency and power transmitted by the transformer are 80% and 80kw. Find (a) the number of turns in the secondary coil (b) power supplied. [4]  
**Ans: 227,  $10^6\text{ W}$**

**2. Parameters of Various a.c. circuits**

S. N	Parameter	R circuit	L circuit	C circuit	RL circuit	RC circuit	LCR circuit
1	Alternating voltage and current	$V = V_0 \sin \omega t$ $I = I_0 \sin \omega t$	$V = V_0 \sin \omega t$ $I = I_0 \sin \left( \omega t - \frac{\pi}{2} \right)$	$V = V_0 \sin \omega t$ $I = I_0 \sin \left( \omega t + \frac{\pi}{2} \right)$	$V = V_0 \sin \omega t$ $I = I_0 \sin(\omega t - \phi)$	$V = V_0 \sin \omega t$ $I = I_0 \sin(\omega t + \phi)$	$V = V_0 \sin \omega t$ $I = I_0 \sin(\omega t + \phi)$
2	Phase difference of current w.r.t voltage	zero	lags by $\frac{\pi}{2}$	Leads by $\frac{\pi}{2}$	Lags by $\phi$ , $\tan \phi = \frac{X_L}{R}$	Leads by $\phi$ , $\tan \phi = \frac{X_C}{R}$	Leads by $\phi$ , $\tan \phi = \frac{X_L - X_C}{R}$ or, $\frac{X_L - X_C}{R}$
3	Reactance	Zero	$X_L = \omega L$	$X_C = \frac{1}{\omega C}$	$X_L = \omega L$	$X_C = \frac{1}{\omega C}$	$X_L - X_C$ or, $X_L - X_C$
4	Impedance	$Z = R$	$Z = X_L$	$Z = X_C$	$Z = \sqrt{R^2 + X_L^2}$	$Z = \sqrt{R^2 + X_C^2}$	$Z = \sqrt{R^2 + (X_L - X_C)^2}$
5	Power factor (cos $\phi$ )	1	Zero	Zero	$\frac{R}{\sqrt{R^2 + X_L^2}}$	$\frac{R}{\sqrt{R^2 + X_C^2}}$	$\frac{R}{\sqrt{R^2 + (X_L - X_C)^2}}$
6	Average Power	$V_{rms} I_{rms}$	Zero	Zero	$V_{rms} I_{rms} \cos \phi$	$V_{rms} I_{rms} \cos \phi$	$V_{rms} I_{rms} \cos \phi$

3. Some other formula regarding a.c.  
 i. Resonant frequency,  $f_0 = \frac{1}{2\pi\sqrt{LC}}$  for L-C-R series circuit.  
 ii. Quality factor,  $Q = \frac{\omega_0 L}{R} = \frac{1}{\omega_0 CR}$  for L-C-R series circuit.

**Short Answer Questions [2 Marks]**

- 2076 GIE Set A Q.No. 1f** What do you mean by "power factor is 1" and "power factor is zero"? [2]
- 2076 GIE Set B Q.No. 1e** Explain how capacitive reactance of a capacitor changes with frequencies. [2]
- 2076 Set B Q.No. 1f** **2070 Set C Q.No. 1 f** 220 V A.C. is more danger than 220 V D.C., why? [2]
- 2076 Set C Q.No. 1f** **2069 Set B Q.No. 1f** **2068 Old Can. Q.No. 1e** **2068 Old Can. Q.No. 1e** A choke coil is preferable to a resistor in an ac circuit. Why? [2]
- 2075 GIE Q.No. 1f** The emf of an ac source is given by the expression,  $E = 300 \sin 314t$  volts. Write the values of peak voltage and frequency of that source. What will be the rms voltage of source? [2]
- 2075 Set A Q.No. 1f** **2073 Supp Q.No. 1f** **2071 Set D Q.No. 1f** **2068 Can. Q.No. 1f** **2062 Q.No. 1e** **2057 Q.No. 1e** **2056 Q.No. 7d** Why is choke coil preferred over a resistance in a.c.? [2]
- 2074 Supp Q.No. 1f** **2072 Set D Q.No. 1f** **2071 Set C Q.No. 1f** What is wattless current? [2]
- 2074 Set A Q.No. 1f** The emf of an ac source is given by the expression,  $E = 300 \sin (314 t)$  volts. Write the values of peak voltage and frequency of source. [2]
- 2074 Set B Q.No. 1e** Define rms value of ac. How is it related with the peak value of ac? [2]
- 2073 Set D Q.No. 1e** Alternating current passes through a capacitor whereas direct current does not. Explain this fact on the basis of capacitive reactance. [2]
- 2072 Supp Q.No. 1f** How does the resonance frequency of an L.C.R. series circuit change if the plates of the capacitor are brought closer together? [2]
- 2072 Set E Q.No. 1f** What are the advantages of A.C. over D.C.? [2]
- 2071 Supp. Q.No. 1b** For a capacitor in an a.c. circuit, explain why there is a phase difference between current and voltage. [2]

**4. ALTERNATING CURRENTS**

**FORMULAE**

- Alternating current and voltage:
  - Instantaneous value of alternating current is,  $i = i_0 \sin \omega t$
  - Instantaneous value of alternating voltages,  $V = V_0 \sin \omega t$
  - $i_{rms} = \frac{i_0}{\sqrt{2}} = 0.707 i_0$ ,  $i_0 =$  peak value of current
  - $V_{rms} = \frac{V_0}{\sqrt{2}} = 0.707 V_0$ ,  $V_0 =$  peak value of Voltage

14. **2070 Supp. Set B Q.No. 1f** **2068 Q.No. 1f** **2067 Supp Q.No. 1f** **2064 Q.No. 1 e** Define rms values of alternating current. [2]
15. **2070 Set D Q.No. 1f** **2059 Q.No. 1 e** Fluorescent lights often use an inductor, to limit the current through the tubes. Why is it better to use an inductor rather than a resistor for this purpose? [2]
16. **2069 Set A Q.No. 1e** At high frequencies, a capacitor becomes a short-circuit and an inductor becomes an open circuit. Explain. [2]
17. **2069 Set A Old Q.No. 2e** Define power factor in an a.c. circuit. [2]
18. **2069 Set B Q.No. 1b** Sketch the symbols of "a capacitor", "an inductor", "emf of a cell" and "a resistor" [2]
19. **2067 Q.No. 1f** **2058 Q.No. 2 e** What do you mean by wattless current? [2]
20. **2067 Old Q.No. 2e** What are the advantages of a.c. over d.c.? [2]
21. **2066 Q.No. 2 e** Fluorescent lamps often use an inductor, called a ballast, to limit current through the tubes. Why is it better to use an inductor rather than a resistor for this purpose? [2]
22. **2066 Supp Q.No. 1e** Define rms value of a.c. [2]
23. **2062 Q.No. 1 e** Why is a choke coil better than a resistor in an electrical appliances? [2]
24. **2058 Q.No. 2 e** What is meant by wattless current? [2]
25. **2056 Q.No. 7 h** What do you mean by r.m.s value of an A.C. current? [2]
26. **2055 Q.No. 7 e** Why is choke coil preferable to resistor? [2]
27. **2053 Q.No. 7 e** Why do we prefer a choke coil to rheostat in an a.c. circuit? [2]
28. **2054 Q.No. 7 g** What is meant by impedance of an a.c. circuit? [2]
- Long Answer Questions [4 Marks]**
29. **2076 Set B Q.No. 5d** **2058 Q.No. 7 a** An alternating current passes through a circuit containing an inductor and a resistor in series. Derive expressions for the current flowing and phase relation between the current and the voltage. [4]
30. **2075 Set A Q.No. 5d** What is a LCR circuit? Derive the condition for resonant frequency for an LCR series circuit with an a.c. supply. [4]
31. **2075 Set B Q.No. 5d** Derive an expression for the impedance of an a.c. circuit containing a resistor an inductor and a capacitor. Hence derive resonance frequency. Also, draw the phase diagram. [4]
32. **2074 Set B Q.No. 5d** Derive an expression for the impedance of an ac circuit with an inductor L, a capacitor C and a resistor R in series. Draw the phase diagram if the voltage across the inductor is greater than that across the capacitor. [4]
33. **2073 Supp Q.No. 5d** Derive expression for the impedance of an ac circuit containing a resistor and an inductor. Also draw the phase diagram. [4]
34. **2073 Set D Q.No. 5b** Find expression for current in the case of alternating LCR series circuit and explain the phase relation between voltage and current. [4]
35. **2072 Supp Q.No. 6d** Derive an expression for the impedance of a LCR series a.c. circuit. Show graphically how impedance varies with the variation of applied frequency. [4]
36. **2072 Set D Q.No. 5d** An alternating current passes through a circuit containing a resistor, a capacitor and an inductor in series. Derive an expression for the phase relation between the current and the voltage. [4]
37. **2072 Set E Q.No. 5d** Derive the condition for resonance frequency of LCR alternating current circuit. [4]
38. **2071 Supp. Q.No. 5c** Define a.c. power. Derive an expression for it. Also define power factor. [4]
39. **2071 Set D Q.No. 5 d** Derive an expression for the impedance of an ac circuit with an inductor L, a capacitor C and a resistor R in series. Draw the phase diagram if the voltage across the capacitor is greater than that across the inductor. [4]
40. **2070 Set D Q.No. 5 d** An ac passes through a circuit containing a resistor and an inductor in series. Derive an expression for the current and phase relation between the current and voltage. [4]
41. **2069 Supp Set B Q.No. 5 b** Derive expression for the impedance of an ac circuit containing a resistor and an inductor. Also draw the phase diagram. [4]
42. **2069 Set A Q.No. 5d** **2052 Q.No. 10 OR** Discuss the phase relationship between the voltage and current in the ac circuit containing an inductor and a resistor in series. What is power factor of the circuit? [4]
43. **2069 Set A Old Q.No. 7a OR** An expression for the impedance of the circuit when an a.c. be passed through a resistance and a coil connected in series. What do you mean by choke coil? [1+3]
44. **2067 Q.No. 5d** **2060 Q.No. 7 a OR** Discuss the phase relationship between the current and voltage in A.C. circuit containing capacitor and resistor in series and hence derive an expression for the impedance of the circuit. [4]
45. **2067 Old Q.No. 7a OR** **2066 Q.No. 7 a OR** Derive an expression for the current flowing through an a.c. circuit containing a resistor and capacitor. Obtain the expression of power factor of this circuit. [3+1]
46. **2065 Q.No. 7 a** Derive the condition for resonant frequency of an L-C-R alternating current series circuit. [4]
47. **2061 Q.No. 7 a OR** Find an expression for impedance of an a.c. circuit containing a resistance and a capacitor in series. Also discuss the phase relation of current and emf in that circuit. [3+1]
48. **2056 Q.No. 9** An alternating emf is applied across a capacitor. Show that the current in it leads to the applied emf by  $90^\circ$ . [4]
49. **2055 Q.No. 9** Find the impedance of LCR circuit in series. [4]
- Numerical Problems [4 Marks]**
50. **2077 Set D Q.No. 3a** A coil of inductance 0.5 H and negligible resistance is in series with a resistance of  $40 \Omega$ . A supply voltage of 40 V (rms) is connected across them. If the voltage across the coil is equal to that across resistor calculate the voltage across each component and frequency of the supply. [4]

51. **2076 GIE Set A Q.No. 9c** An LCR series circuit, with  $L = 0.12\text{H}$ ,  $R = 240\Omega$  and  $C = 7.3\ \mu\text{F}$ , carries current of  $0.45\text{A}$  with a frequency of  $400\text{Hz}$  (i) What are the phase angle and power factor? (ii) What is the impedance of the circuit? [4]  
 Ans:  $45.57^\circ$ ,  $0.70$ ,  $344\Omega$
52. **2076 GIE Set B Q.No. 9b** A  $100\text{V}$ ,  $50\text{Hz}$  A.C. source is connected to an LCR circuit containing  $L = 8.1\text{mH}$ ,  $C = 12.5\ \mu\text{F}$  and  $R = 100\Omega$  all are connected in series. Find the p.d. across the resistor. [4]  
 Ans:  $37\text{V}$
53. **2076 Set C Q.No. 9c** A circuit consists of a capacitor of  $2\ \mu\text{F}$  and a resistor of  $1000\Omega$ . An alternating emf of  $12\text{V}$  and frequency  $50\text{Hz}$  is applied. Find the voltage across the capacitor and the phase angle between the applied emf and the current. [4]  
 Ans:  $6.37 \times 10^{-3}\text{A}$ ,  $10.2\text{V}$ ,  $57.9^\circ$
54. **2075 GIE Q.No. 9c** An ac source of  $220\text{V}$ ,  $50\text{Hz}$  is connected to series circuit containing a resistor  $R$  and inductor  $L$  and a capacitor  $C$ . If  $R = 200\ \Omega$ ,  $L = 0.5\text{H}$  and  $C = 10\ \mu\text{F}$ , calculate, (i) the current in the circuit, (ii) the phase angle and (iii) the power consumed in the circuit. [4]  
 Ans: (i)  $0.856\text{A}$  (ii)  $-38.9^\circ$  (iii)  $146.56\text{Watt}$
55. **2074 Supp Q.No. 9c** An iron cored coil of inductance  $2\text{H}$  and resistance  $50\ \Omega$  is connected in series with a resistor of  $950\ \Omega$ . A  $220\text{V}$ ,  $50\text{Hz}$  ac supply is connected across the arrangement. Find the current flowing in the circuit and the voltage across the coil. [4]  
 Ans:  $0.186\text{A}$ ,  $116.87\text{V}$
56. **2074 Set A Q.No. 9c** A coil of inductance  $0.1\text{H}$  and negligible resistance is in series with a resistance  $40\Omega$ . A supply voltage of  $50\text{v}$  (rms) is connected to them. If the voltage across  $L$  is equal to that across  $R$ , calculate the voltage across the inductor and frequency of the supply. [4]  
 Ans:  $63.7\text{Hz}$ ,  $35.35\text{V}$
57. **2073 Supp Q.No. 9c** **2053 Q.No. 11** An iron cored coil of inductance  $3\text{H}$  and  $50\Omega$  resistance is placed in series with a resistor of  $550\Omega$  and a  $100\text{v}$ ,  $50\text{Hz}$  ac supply is connected across the arrangements. Find the current flowing in the coil and voltage across the coil. [4]  
 Ans:  $0.09\text{A}$ ,  $84.8\text{V}$
58. **2073 Set C Q.No. 9b** L-C-R alternating current series circuit of  $L = 1\text{H}$ ,  $C = 1\ \mu\text{F}$  and  $R = 100\Omega$  are connected in series with a source of frequency  $50\text{Hz}$ . What is the phase shift between current and voltage? [4]  
 Ans:  $88^\circ$
59. **2072 Set C Q.No. 9c** A coil having inductance and resistance is connected to an oscillator giving a fixed sinusoidal output voltage of  $5\text{V}$  rms. With the oscillator set at a frequency of  $50\text{Hz}$ , the rms current in the coil is  $1\text{A}$  and at a frequency of  $100\text{Hz}$ , the rms current is  $0.625\text{A}$ . Determine the inductance of the coil. [4]  
 Ans:  $0.0114\text{H}$
60. **2071 Set C Q.No. 9c** A circuit consists of a capacitor of  $2\ \mu\text{F}$  and a resistor of  $1000\Omega$ . An alternating emf of  $12\text{V}$  (rms) and frequency  $50\text{Hz}$  is applied. Find the current flowing, the voltage across capacitor and the phase angle between the applied emf and current. [4]  
 Ans:  $6.38 \times 10^{-3}\text{A}$ ,  $10.2\text{V}$ ,  $57.9^\circ$
61. **2070 Supp. Set A Q.No. 9 b** A.C. mains of  $200\text{volts}$  and  $50\text{Hz}$  is joined to a circuit containing an inductance of  $100\text{mH}$  and a resistance of  $20\Omega$  in series. Calculate the power consumed. [4]  
 Ans:  $576.3\text{watt}$
62. **2070 Supp. Set B Q.No. 9 c** An iron cored coil of  $2\text{H}$  and  $50\ \Omega$  resistance placed in series with a resistor of  $450\ \Omega$  and  $200\text{v}$ ,  $50\text{Hz}$  a.c. supply is connected across the arrangement, find  
 i. the current flowing the coil,  
 ii. its phase angle relative to the voltage supply  
 iii. the voltage across the coil. [4]  
 Ans: (i)  $0.25\text{A}$  (ii)  $156.5\text{V}$  (iii)  $54.3^\circ$
63. **2070 Set C Q.No. 9 c** A  $50\text{V}$  a.c. supply is connected to a resistor having resistance  $50\Omega$ , in series with a solenoid whose inductance is  $0.25\text{H}$ . The potential difference between the ends of the resistor is  $25\text{V}$ . Find the resistance of the wire of the solenoid. Take frequency of the ac source is  $50\text{Hz}$ . [4]  
 Ans:  $11.89\ \Omega$
64. **2069 Set B Old Q.No. 9b** Alternating voltage in an ac circuit is represented by  $V = 100\sqrt{2} \sin(100\pi t)$  volts. Find its roots mean square value and the frequency. [4]  
 Ans:  $100\text{V}$ ,  $50\text{Hz}$
65. **2068 Can. Q.No. 9c** A  $100\text{V}$ ,  $50\text{Hz}$  AC source is connected to an LCR circuit containing  $L = 8.1\text{mH}$ ,  $C = 12.5\ \mu\text{F}$  and  $R = 10\ \Omega$  all connected in series. Find the potential difference across the resistor. [4]  
 Ans:  $3.9\text{V}$
66. **2068 Old Can. Q.No. 7b** An alternating voltage  $10\text{v}$  (rms) and  $4\text{KHz}$  frequency is applied to a resistor of resistance  $5\Omega$  in series with a capacitor of capacitance  $10\ \mu\text{F}$ . Calculate the r.m.s. potential differences across the resistor and the capacitor. [3]  
 Ans:  $7.8\text{V}$ ,  $6.2\text{V}$
67. **2068 Q.No. 9 c** A circuit consists of an inductor of  $200\ \mu\text{H}$  and resistance of  $10\Omega$  in series with a variable capacitor and a  $0.10\text{V}$  (r.m.s.),  $1.0\text{MHz}$  supply. Calculate (i) the capacitance to give resonance (ii) the quality factor of the circuit at resonance. [4]  
 Ans:  $1.267 \times 10^{-10}\text{F}$ ,  $126$
68. **2068 Old Q.No. 7 b** A  $50\text{V}$ ,  $50\text{Hz}$ , a.c. supply is connected to a resistor, of resistance  $40\Omega$ , in series with a solenoid whose inductance is  $0.20\text{H}$ . The p.d. between the ends of the resistor is found to be  $20\text{V}$ . What is the resistance of the wire of the solenoid? (Assume  $\pi^2 = 10$ ) [3]  
 Ans:  $38\ \Omega$
69. **2067 Sup Q.No. 9c** An iron cored coil of inductance  $2\text{H}$  and of resistance  $50\Omega$  is connected in series with a resistor of  $950\Omega$ , and a  $220\text{V}$ ,  $50\text{Hz}$  ac supply. Find the current flowing in the circuit and the voltage across the coil. [4]  
 Ans:  $0.186\text{A}$ ,  $116.87\text{V}$
70. **2066 Supp Q.No. 7b** A coil of inductance  $L$  and negligible resistance is in series with a resistance  $R$ . A supply voltage of  $40\text{V}$  (rms) is connected to them. If a voltage across  $L$  is equal to that across  $R$ , calculate the voltage across  $R$  and the frequency of the supply? [3]  
 Ans:  $28.3\text{V}$ ,  $63.7\text{Hz}$

71. **2064 Q.No. 7 b** A 50V, 50 Hz, ac supply is connected to a resistor of resistance  $40\Omega$  in series with a solenoid having inductance 200 mH with same resistance. The potential difference across the ends of the  $40\Omega$  resistor is found to be 20V. Find the resistance of the wire of the solenoid. [4]  
**Ans: 37.79  $\Omega$**
72. **2063 Q.No. 7 b** An inductor, a resistor and a capacitor are connected in series across an a.c. circuit. A voltmeter reads 60 v when connected across the inductor, 16V across the resistor and 30 V across the capacitor:  
 i. What will the voltmeter read when placed across the series circuit?  
 ii. What is the power factor of the circuit? [4]  
**Ans: 34V, 0.47**
73. **2062 Q.No. 7 b** In a series LCR circuit,  $R = 25\Omega$ ,  $L = 30\text{mH}$  and  $C = 10\mu\text{F}$  and these elements are connected to 240 ac (rms) 50 Hz source. Calculate the current in the circuit and voltmeter reading across a capacitor. [4]  
**Ans: 0.774 A and 246.37 V**
74. **2059 Q.No. 7 b** The maximum capacitance of a variable capacitor is 33 pF. What should be the self-inductance to be connected to this capacitor for the natural frequency of the LC circuit to be 810 KHz. Corresponding to A.m. broadcast band of Radio Nepal? [4]  
**Ans:  $1.17 \times 10^{-3}$  H**
75. **2057 Q.No. 7 b** A circuit consists of a capacitor of 10  $\mu\text{F}$  and a resistor of  $1000\Omega$ . An alternating emf of 12V (rms) and frequency 50Hz is applied. Calculate the current flowing and voltage across the capacitor. [4]  
**Ans: 0.0114 A, 3.63 V**
76. **2054 Q.No. 11** A constant A.C. supply is connected to a series circuit consisting of a resistance of  $300\Omega$  in series with a capacitance 6.67 MF, the frequency of the supply being  $3000/2\pi$  Hz. It is desired to reduce the current in the circuit to half its value. Show how this could be done by placing an additional resistance. [4]  
**Ans: 306.1  $\Omega$**

### UNIT-3 MODERN PHYSICS

#### 1. ELECTRONS AND PHOTONS

##### FORMULAE

- Motion of electron in uniform electric field:
  - The charge of an electron,  $e = 1.6 \times 10^{-19}$  C, negative nature and its mass,  $m_e = 9.1 \times 10^{-31}$  kg.  
 Speed of light,  $C = 3 \times 10^8$  m/sec  
 Planck's constant,  $h = 6.62 \times 10^{-34}$  Js
  - Its specific charge  $\left(\frac{e}{m}\right) = 1.76 \times 10^{11}$  C / kg.
  - Its path in electric field is parabolic in nature, and the equation of path,  $y = \left(\frac{eV}{2mdu^2}\right) x^2$ .
  - Acceleration produced is,  $a = \frac{F}{m} = \frac{eE}{m}$ .
- Motion of electron in uniform magnetic field:
  - Force experienced by an electron moving in a magnetic field.  $F = Bev \sin\theta$
  - The radius of circular path,  $r = \frac{mv}{Be} = \frac{p}{Be} = \frac{\sqrt{2mE_k}}{Be}$

- The time period of revolution,  $T = \frac{2\pi m}{Be}$
  - The frequency of revolution,  $f = \frac{1}{T} = \frac{Be}{2\pi m}$
  - The angular frequency,  $\omega = 2\pi f = \frac{Be}{m}$
  - The radius of a circle in helical path,  $r = \frac{mv \sin \theta}{Be}$
  - The pitch of helical path,  
 $= v \cos \theta \times T = \frac{2\pi mv \cos \theta}{Be} = \frac{2\pi r}{\tan \theta}$
- The speed of electron in cross field,  $v = \frac{E}{B}$
  - Millikan's oil drop experiment:
    - Radius of oil drop,  $r = \sqrt{\frac{9\eta v_1}{2(\rho - \sigma)g}}$
    - The charge of electron is determined from,  
 $q = \frac{6\pi\eta d}{V} \sqrt{\frac{9\eta v_1}{2(\rho - \sigma)g}} (v_1 + v_2)$  and  $q = ne$
  - Photons:
    - Energy of a photon,  $E = hf = \frac{hc}{\lambda}$
    - It has zero rest mass,  $m_0 = m\sqrt{1 - \frac{v^2}{c^2}}$ , for  $v = c$ ,  $m_0 = 0$
    - From Einstein's mass-energy equivalence,  
 $E = hf = \frac{hc}{\lambda} = mc^2$   
 So,  $m = \frac{hf}{c^2} = \frac{h}{c\lambda}$
    - Momentum of photon,  $p = mv = mc = \frac{E}{c} = \frac{h}{\lambda}$
    - Work function ( $\phi_0$ ) =  $hf_0 = \frac{hc}{\lambda_0}$
    - Einstein's photoelectric equation,  $hf = \phi_0 + E_k$  and  
 $(E_k = \frac{1}{2} mv_{\max}^2)$
    - Stopping potential ( $V_s$ ),  $eV_s = hf - \phi_0 = \frac{1}{2} mv_{\max}^2$

#### Short Answer Questions [2 Marks]

- 2076 GIE Set A Q.No. 2a** Beams of protons and electrons with the same initial K.E. enter normally into an electric field. Which one will deflect more and why? [2]
- 2076 GIE Set A Q.No. 2c** Can photoelectric effect be explained on the basis of wave theory of light? Justify your answer. [2]
- 2076 GIE Set B Q.No. 2a** Why does the electric discharge take place at reduced pressure? Explain. [2]
- 2076 Set B Q.No. 2a** Why discharge does not take place at very low pressure? [2]
- 2075 GIE Q.No. 2a** **2071 Supp. Q.No. 2a** Explain why electric discharge through a gas takes place at low pressure. [2]
- 2075 GIE Q.No. 2b** If the wavelength of electromagnetic radiation is doubled, what will happen to the energy of the photons? [2]
- 2075 Set A Q.No. 2a** **2068 Can. Q.No. 2a** Gases insulators at ordinary pressure and start conducting at low pressure. Why? [2]

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## Long Answer Questions [4 Marks]

- 2075 Set A Q.No. 2c 2070 Supp. Set B Q.No. 2 b What happens to the kinetic energy of photo electrons when intensity of light is doubled? [2]
- 2075 Set B Q.No. 2a Why is a magnetic field used to deflect electron beam but not an electric field in a T.V. picture tube? [2]
- 2074 Supp Q.No. 2a Gases become conducting at low pressure. Why? [2]
- 2074 Set A Q.No. 2b 2071 Set C Q.No. 2 a 2069 Set A Q.No. 2a The value of  $e/m$  is constant for cathode rays but not for positive rays, why? [2]
- 2073 Supp Q.No. 2a 2069 Supp Set B Q.No. 2 a An electron and a proton move with the same speed in a uniform magnetic field of equal magnitude. Compare the radii of their circular paths. [2]
- 2072 Supp Q.No. 2b Human skin is relatively insensitive to visible light, but ultra violet radiation can cause severe burns. Does this have anything to do with photon energies? Explain. [2]
- 2072 Set C Q.No. 2a If we go on increasing the wavelength of light incident on a metal surface, what changes take place in the number of electrons and energy of the electrons? [2]
- 2072 Set E Q.No. 2a Beams of electrons and protons having the same initial K.E. enter normally into an electric field, which beam will be more curved? Justify. [2]
- 2071 Set D Q.No. 2 a A gas at lower pressure conducts electricity but the same gas at higher pressure does not. Explain. [2]
- 2070 Supp. Set A Q.No. 2 b Gases at normal pressure are insulators; how do they become conducting at low pressure? [2]
- 2070 Set C Q.No. 2 a A charged particle is fired into a cubical region of space where there is uniform magnetic field. Outside this region, there is no magnetic field. Is it possible that the particle will remain inside the cubical region? Explain. [2]
- 2070 Set D Q.No. 2 a A charged particle moves through a region of space with constant velocity. If the external magnetic field is zero in this region, can we conclude that the external field in the region is also zero? Explain. [2]
- 2069 Set A Q.No. 2e What is the threshold frequency for photoelectric emission? Does it depend on the intensity of light? [2]
- 2069 Set B Q.No. 2f Write down expressions for acceleration of a moving charge  $Q$  in parallel and perpendicular magnetic fields. [2]
- 2068 Q.No. 2 a What property of the cathode rays indicates that they consist of electrons? [2]
- 2067 Q.No. 2a What is the importance of Millikan's oil drop experiment? [2]
- 2067 Sup Q.No. 2a Why does electric discharge take place at low pressure and high potential difference? [2]
- 2065 Q.No. 2 f Compare the specific charge of an electron with that of a proton. [2]
- 2060 Q.No. 1 g Cathode rays can not be regarded as electromagnetic waves. Why? [2]
- 2056 Q.No. 12 c What is meant by stopping potential? [2]
- 2054 Q.No. 12 d Explain why photoelectric effect can not be observed with all wavelengths of light. [2]
- 2053 Q.No. 12 e What is threshold frequency? [2]
- 2077 Set D Q.No. 2b Describe J.J. Thomson's experiment for measuring the specific charge ( $e/m$ ) of an electron. [4]
- 2076 GIE Set A Q.No. 6a Discuss the motion of electrons in an electric field and obtain the expression of vertical deflection when it leaves the electric field. [4]
- 2076 GIE Set B Q.No. 6a Discuss the motion of electrons in a magnetic field and show that time period is independent of electron velocity. [4]
- 2076 Set B Q.No. 6a What is quantization of charge? Describe the theory of Millikan's oil drop experiment to determine the number of charges on an oil drop. [4]
- 2076 Set C Q.No. 6a What are cathode rays? How are they produced? Mention the properties of cathode rays. [4]
- 2076 Set C Q.No. 6c What is photoelectric effect? Discuss Einstein's photoelectric equation. Write some applications of photoelectric effect. [4]
- 2075 GIE Q.No. 6b Describe Millikan's experiment to determine the value of Planck's constant. Explain how Einstein's photoelectric equation is verified from this experiment. [4]
- 2075 Set A Q.No. 6b Discuss J.J Thomson's experiment to determine the specific charge of an electron. [4]
- 2075 Set B Q.No. 6a 2074 Set B Q.No. 6a 2071 Set D Q.No. 6 a 2069 Set A Q.No. 6a 2068 Can. Q.No. 6a Describe the theory of Milikan's oil drop experiment to determine the charge of an electron. [4]
- 2074 Supp Q.No. 6b What is photoelectric effect? Explain the effect of increase of (i) frequency (ii) intensity of the incident radiation on photoelectrons emitted by a phototube. [4]
- 2074 Set A Q.No. 6b 2072 Set D Q.No. 6a Discuss photoelectric effect and derive Einstein's photoelectric equation. What is stopping potential? [4]
- 2073 Supp Q.No. 6a 2070 Supp. Set B Q.No. 6 a 2054 Q.No. 15 Describe an experiment to determine the specific charge of an electron. [4]
- 2073 Set C Q.No. 6a Explain photoelectric effect to write Einstein's photoelectric equation. Describe Millikan's laboratory method to determine Planck's constant. [4]
- 2073 Set D Q.No. 6d Describe the laboratory method to determine the specific charge of an electron by J.J. Thomson's method. [4]
- 2072 Supp Q.No. 6b Describe an experiment to determine the ratio of the charge to mass ( $e/m$ ) for an electron. Show how the result is derived from the observations. [4]
- 2072 Set C Q.No. 6a Describe with necessary theory Thomson's method to determine specific charge of an electron. [4]
- 2072 Set E Q.No. 6d 2067 Q.No. 6a Explain Millikan's experiment for the verification of Einstein's photoelectric equation. [4]
- 2071 Supp. Q.No. 6a Verify quantization of charge using Millikan's oil drop experiment. [4]

48. **2071 Set C Q.No. 6a** Discuss the motion of an electron in a uniform magnetic field and show that if a free electron moves at right angle to a magnetic field, the path is a circle and the time period of revolution is independent of the speed of the electron. [4]
49. **2070 Supp. Set A Q.No. 6a** Discuss the trajectory of a charged particle when it is moving in a uniform magnetic field and hence discuss how the specific charge of the particle is obtained. [4]
50. **2070 Supp. Set A Q.No. 6 d** What is work function of a metal? Does it depend on the intensity of incident light? Discuss Einstein's photoelectric equation. [4]
51. **2069 Supp Set B Q.No. 6 a** Describe J.J. Thomson's experiment with necessary theory behind the determination of specific charge of electron. [4]
52. **2069 Supp Set B Q.No. 6 d** Explain photoelectric effect and present the necessary theory to determine the value of Planck's constant. [4]
53. **2069 Set A Old Q.No. 8a** What is photoelectric effect? Derive Einstein's photoelectric equation. Define various terms used in it. [3]
54. **2069 Set B Q.No. 6a** Describe Millikan's oil drop experiment with necessary theory. Estimate the specific charge of an electron from it. [4]
55. **2068 Q.No. 6 a** Describe the phenomenon of electrical discharge through gases. [4]
56. **2068 Old Q.No. 9** What are cathode rays? How are they produced? Mention two of their important properties. [4]
57. **2067 Old Q.No. 8a** Describe J.J. Thomson's experiment to determine the specific charge of an electron. [4]
58. **2067 Sup Q.No. 6a** What is photoelectric effect? Discuss Einstein's Photoelectric equation. Does the work function of a metal depend on intensity of light? [1+2+1]
59. **2066 Supp Q.No. 9 OR** Describe with necessary theory to determine the ratio of charges to mass ( $e/m$ ) of an electron by J.J. Thomson method. [4]
60. **2065 Q.No. 9 a OR** Describe an experimental method to determine the specific charge of an electron. [2+2]
61. **2064 Q.No. 9** What is specific charge of an electron? Describe and give necessary theory of J.J. Thomson's method to determine the specific charge of an electron. [1+3]
62. **2063 Q.No. 8 a OR** Describe the theory of Millikan's oil drop experiment to determine the number of charge on oil drop. [4]
63. **2063 Q.No. 9 OR** Show that electron motion in magnetic field is circular. Prove that frequency and time period are independent with the velocity of electron. [4]
64. **2060 Q.No. 8 a** Write down Einstein's photoelectric equation and describe an experiment to verify it. [1+3]
65. **2057 Q.No. 8 a** What are cathode rays? State their six properties. [4]
66. **2056 Q.No. 13** Explain the phenomena of discharge of electricity through gases at low pressure. [4]
67. **2055 Q.No. 13** Discuss the physical principles involved in Millikan's experiment for the determination of the charge of an electron. [4]
68. **2052 Q.No. 15** Describe with necessary theory, Millikan's oil drop experiment to determine the value of the charge associated with an electron.
- Numerical Problems [4 Marks]**
69. **2076 GIE Set B Q.No. 10a** Find the change in stopping potential when the wavelength of a radiation is decreased from 400 nm to 300 nm on the same metallic surface. Planck's constant =  $6.62 \times 10^{-34}$  Js and velocity of light =  $3 \times 10^8$  m/s. [4]  
Ans: 1.034 V
70. **2076 Set B Q.No. 10a** **2069 Set B Q.No. 10c** An ion for which the charge per unit mass is  $4.40 \times 10^7$  C/kg has a velocity of  $3.52 \times 10^5$  m/s and moves in a circular orbit in a magnetic field of flux density 0.4 T. What will be the radius of this orbit? [4]  
Ans: 0.02 m
71. **2075 GIE Q.No. 10a** **2068 Can. Q.No. 10a** **2060 Q.No. 8b OR** Two plane metal plates 4 cm long are held horizontally 3 cm apart in a vacuum, one being vertically above the other. The upper plate is at a potential of 300 V and the lower plate is earthed. Electrons having a velocity  $10^7$  m/s are injected horizontally midway between the plates and in a direction parallel to 4 cm edge. Calculate the vertical deflection of the electron beam as it emerges from the plates. ( $e/m$  for the electron =  $1.8 \times 10^{11}$  Ckg $^{-1}$ ) [4]  
Ans:  $1.44 \times 10^{-4}$  m
72. **2075 Set A Q.No. 10b** A clean nickel surface of work function 5.1 eV is exposed to light of wavelength 235 nm. What is the maximum speed of the photoelectrons emitted from its surface? [4]  
Ans:  $2.91 \times 10^{-20}$  J,  $2.52 \times 10^5$  m/sec
73. **2075 Set A Q.No. 10c** An electron moving with a speed of  $10^7$  m/s is passed into a magnetic field of intensity 0.1 T normally. What is the radius of the path of the electron inside the field? If the strength of the magnetic field is doubled, what is the radius of the new path? ( $e/m = 1.8 \times 10^{11}$  C/kg) [4]  
Ans:  $5.6 \times 10^{-4}$  m,  $2.78 \times 10^{-4}$  m
74. **2075 Set B Q.No. 10a** Sodium has a work function of 2 eV. Calculate the maximum energy and speed of the emitted electrons when sodium is illuminated by a radiation of 150 nm. What is the threshold frequency of radiation for which electrons are emitted from sodium surface? [4]  
Ans:  $1.004 \times 10^{-18}$  J,  $1.483 \times 10^6$  m/sec,  $4.8 \times 10^{14}$  Hz
75. **2074 Supp Q.No. 10a** Calculate the potential difference to be maintained between two horizontal conducting plates separated by a distance of 10 mm so that a small charged oil drop of mass  $1.31 \times 10^{-14}$  kg will remain in equilibrium. Charge in the oil drop is  $6.4 \times 10^{-19}$  C. [4]  
Ans: 2046.87 V
76. **2074 Set A Q.No. 10a** An electron moves in a circular path of radius 20 cm in a uniform magnetic field of  $2 \times 10^{-3}$  T. Find the speed of the electron and period of revolution. Mass of electron =  $9.1 \times 10^{-31}$  kg. [4]  
Ans:  $7.02 \times 10^7$  m/sec and  $5.6 \times 10^{-7}$  sec
77. **2074 Set B Q.No. 10a** Radiations of wavelength 5400 Å fall on a metal whose work function is 1.9 eV. Find the energy of the photoelectrons emitted and their stopping potential. Planck's constant =  $6.62 \times 10^{-34}$  Js. [4]  
Ans: 0.4 eV

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- 2073 Supp Q.No. 10a** **2068 Q.No. 10 b** **2066 Supp Q.No. 8b**  
**2053 Q.No. 14** Light of frequency  $5 \times 10^{14}$  Hz liberates electrons with energy  $2.3 \times 10^{-19}$  J from a certain metallic surface. What is the wavelength of ultraviolet light which liberates electrons of energy  $8.93 \times 10^{-19}$  J from the same surface? (Given  $h = 6.62 \times 10^{-34}$  Js,  $c = 3 \times 10^8$  m/s) [4]  
 Ans:  $2 \times 10^{-7}$  m
- 2073 Set C Q.No. 10b** An electron having 500 eV energy enters at right angle to a uniform magnetic field of  $10^{-4}$  Tesla. If its specific charge is  $1.75 \times 10^{11}$  Ckg $^{-1}$ , calculate the radius of its circular orbit. [4]  
 Ans: 0.75 m
- 2073 Set D Q.No. 10a** 400 nm wavelength of light falls on a photo sensitive material of work function 2.3 eV. Compute the maximum energy of photoelectrons. [4]  
 Ans: 0.803 eV
- 2072 Supp Q.No. 10b** Sodium has a work function of 2 eV. Calculate the maximum energy and speed of the emitted electrons when sodium is illuminated by radiation of wavelength 150 nm. (Given mass of electron =  $9.1 \times 10^{-31}$  Kg) [4]  
 Ans:  $1.48 \times 10^6$  m/sec. and  $9.96 \times 10^{-5}$  J
- 2072 Set C Q.No. 10a** The work function for the surface of aluminium is 4.2 eV. How much potential difference will be required to stop the emission of maximum energy electrons emitted by light of wavelength 2000 Å? (Planck's constant,  $h = 6.6 \times 10^{-34}$  Js) [4]  
 Ans: 2 V
- 2072 Set D Q.No. 10a** In a Millikan's oil drop experiment, a drop is observed to fall with a terminal speed 1.4 mm/s in the absence of electric field. When a vertical electric field of  $4.9 \times 10^5$  V/m is applied, the droplet is observed to continue to move downward at a lower terminal speed 1.21 mm/s. Calculate the charge on the drop. (Density of oil =  $750$  kg/m $^3$ , viscosity of air =  $1.81 \times 10^{-5}$  kg/ms, density of air =  $1.29$  kg/m $^3$ ) [4]  
 Ans:  $5.16 \times 10^{-19}$  C
- 2072 Set E Q.No. 10b** A beam of electrons, moving with velocity of  $10^7$  m/s, enters midway between two horizontal parallel plates in the direction parallel to the plates which are 5 cm long and 2 cm apart and have a p.d. of V volts between them. Calculate V if the beam is deflected so that it just grazes the edge of the plate. (Assume  $e/m = 1.76 \times 10^{11}$  c/kg). [4]  
 Ans: 90.9 V
- 2071 Set C Q.No. 10 a** Light of wavelength  $5 \times 10^{-7}$  m falls on a sensitive metal plate with photo electric work function 1.90 eV. Find kinetic energy of the photoelectrons emitted and stopping potential. (given  $h = 6.62 \times 10^{-34}$  Js) [4]  
 Ans:  $E_k = 0.58$  eV;  $V_s = 0.58$  V
- 2071 Set D Q.No. 10a** Ultraviolet light of wavelength  $3.6 \times 10^{-7}$  m is made to fall on a smooth surface of potassium. Determine maximum energy of emitted photo electrons and stopping potential. [4]  
 Ans: 1.5eV, 1.5V
- 2071 Set D Q.No. 10 c** An electron is accelerated through a potential difference of 2000 V and then it enters a uniform magnetic field of 0.02 Tesla in a direction perpendicular to it. Find the radius of the path of the electron in the magnetic field. Mass of an electron is  $9.1 \times 10^{-31}$  kg, charge of an electron is  $1.6 \times 10^{-19}$  C. [4]  
 Ans:  $7.5 \times 10^{-4}$  m
- 2070 Supp. Set A Q.No. 10 a** Calculate the radius of a water drop which would just remain suspended in an electric field of 300 V/cm and charged with one electron. [4]  
 Ans:  $4.9 \times 10^{-7}$  m
- 2070 Supp. Set B Q.No. 10 a** Electrons with maximum kinetic energy of 3 eV are ejected from a metal surface by ultra-violet radiation of wavelength  $1.5 \times 10^{-7}$  m. Determine work function, threshold wavelength and the stopping potential for the metal (Planck's constant,  $h = 6.62 \times 10^{-34}$  Js) [4]  
 Ans: 5.275 eV.,  $2.35 \times 10^{-7}$  m, 3V
- 2070 Set C Q.No. 10 a** An electron beam after being accelerated from rest through a potential difference of 5 KV in vacuum is allowed to impinge normally on a fixed surface. If the incident current is  $50 \mu$  A, Determine the force exerted on the surface assuming that it brings the electrons to rest. Take mass of electron is  $9.1 \times 10^{-31}$  Kg. [4]  
 Ans:  $1.2 \times 10^{-8}$  N
- 2070 Set C Q.No. 10 b** The photoelectric threshold wavelength of a tungsten surface is 272 nm. Calculate the maximum velocity of the electrons ejected from this tungsten surface by ultraviolet radiation of frequency  $1.45 \times 10^{15}$  Hz. ( $h = 6.62 \times 10^{-34}$  Js,  $c = 3 \times 10^8$  m/s,  $m_e = 9.1 \times 10^{-31}$  kg) [4]  
 Ans:  $7.1 \times 10^6$  m/sec
- 2070 Set D Q.No. 10 a** A beam of electrons, moving with a velocity of  $10^7$  m/s, enters midway between two horizontal parallel plates in a directions parallel to the plates. Each plate is 5 cm long. These plates are kept 2 cm apart and a potential difference of 90 V is applied between them. Calculate the velocity of the electron- beam with which it just grazes the edge of the positive plate. ( $e/m = 1.8 \times 10^{11}$  c/kg) [4]  
 Ans:  $10^7$  m/sec,  $22^\circ$
- 2070 Set D Q.No. 10 b** When ultraviolet light with a wavelength of 400 nm falls on a certain metal surface, the maximum kinetic energy of the emitted electrons is 1.10 eV. What is the maximum kinetic energy of the photoelectrons when light of wavelength 300 nm falls on the same surface? [4]  
 Ans: 2.137 eV
- 2069 Supp Set B Q.No. 10a** **2067 Sup Q.No. 10a** In a Millikan apparatus the horizontal plates are 1.5 cm apart. With the electric field switched off an oil drop is observed to fall with the steady velocity  $2.5 \times 10^{-2}$  cms $^{-1}$ . When the field is switched on the upper plate being positive, the drop just remains stationary when the potential difference between the plates is 1500 V. Calculate the radius of the drop and the number of electronic charges neglecting air density. (Given: density of oil =  $900$  kgm $^{-3}$  and viscosity of air =  $1.8 \times 10^{-5}$  Nsm $^{-2}$ ) [4]  
 Ans:  $1.5 \times 10^{-6}$  m, 8
- 2069 Set A Q.No. 10a** An electron is accelerated through a potential difference of 2KV and then it enters a uniform magnetic field of 0.02T, in a direction perpendicular to it. Find the radius of the path of the electron in the magnetic field. (mass of electron =  $9.1 \times 10^{-31}$  kg) [4]  
 Ans:  $7.5 \times 10^{-4}$  m
- 2069 Set A Old Q.No. 8bOR** In a Thomson experiment, voltage across the plates is 50V and the distance between them is 3 cm. The magnetic field applied to make the beam undeflected is  $10^{-4}$ T. What is the velocity of the electron passing between the plates? [4]  
 Ans:  $1.6 \times 10^7$  m/s

97. **2068 Can. Q.No. 10c** What will be the change in the stopping potential for photoelectrons emitted from a source if the wavelength of incident light is reduced from 400 nm to 360 nm? [4]  
 Ans: 0.34V
98. **2068 Old Can. Q.No. 8b** A beam of electrons, moving with a velocity of  $10^6$  m/s enters midway between two horizontal parallel plates in a direction parallel to the plates. Each plate is 4cm long. These plates are kept 2cm apart and a potential difference  $V$  is applied between them. Calculate  $V$  if the beam is deflected so that it just grazes the edge of positive plate. (Given  $e/m$  for the electron is  $1.8 \times 10^{11} \text{ C kg}^{-1}$ ). [4]  
 Ans: 1.38 V
99. **2068 Old Can. Q.No. 8b OR** The maximum energy of photoelectrons emitted from a metal plate is 1.2 eV. If the threshold wavelength is  $2.48 \times 10^{-9} \text{ m}$ , calculate the wavelength of incident light. (Given Planck's constant is  $6.62 \times 10^{-34} \text{ J.s}$ ). [4]  
 Ans:  $2.47 \times 10^{-9} \text{ m}$
100. **2068 Q.No. 10 a** An electron having 450 eV of energy moves at right angles to a uniform magnetic field of flux density  $1.50 \times 10^{-3} \text{ T}$ . Find the radius of its circular orbit. [Given: specific charge of the electron =  $1.76 \times 10^{11} \text{ C/kg}$ ] [4]  
 Ans: 0.048m
101. **2068 Old Q.No. 8 b** Light of wavelength 6000 Å falls on a photosensitive plate of work function 1.9 eV. Find the speed of the photoelectrons emitted. ( $h = 6.62 \times 10^{-34} \text{ J.s}$  and  $m_e = 9.1 \times 10^{-31} \text{ kg}$ ) [4]  
 Ans:  $2.44 \times 10^5 \text{ m/sec}$
102. **2067 Q.No. 10a** A beam of electrons is under potential difference of  $1.36 \times 10^4 \text{ V}$  applied across two parallel plates 4 cm apart and a magnetic field  $2 \times 10^{-3} \text{ T}$  at right angles to each other. If two fields produce no deflection in the electronic beam, calculate (i) The velocity of electrons (ii) the radius of the orbit in which the beam will move, if the electric field is made zero. [Given; mass of electron =  $9.1 \times 10^{-31} \text{ kg}$ ]. [4]  
 Ans:  $1.7 \times 10^8 \text{ m/sec}$ , 0.48m
103. **2066 Q.No. 8 b Or** In Millikan-type apparatus, the horizontal plates are 1.5 cm apart. With the electric field switched off an oil drop is observed to fall with the steady velocity  $2.5 \times 10^{-2} \text{ cm/s}$ . When the electric field is switched on the upper plate being positive, the drop just remains stationary when the p.d. between plates is 1500V. (a) Calculate the radius of the drop (b) How many electronic charges does it carry? [4]  
 Ans: (a)  $1.5 \times 10^{-6} \text{ m}$  (b) 8
104. **2064 Q.No. 8 b** **2063 Q.No. 8 b** **2056 Q.No. 15** When a light of frequency  $5.4 \times 10^{14} \text{ Hz}$  is incident on a metal surface, the maximum energy of the electrons emitted is  $1.2 \times 10^{-19} \text{ J}$ . If the same surface is illuminated with light of frequency  $6.6 \times 10^{14} \text{ Hz}$ , the maximum energy of the electrons is  $2 \times 10^{-19} \text{ J}$ . Find the value of Planck's constant. [4]  
 Ans:  $6.67 \times 10^{-34} \text{ J.s}$
105. **2061 Q.No. 8 b** A beam of proton is accelerated from rest through a potential difference of 2000V and then enters a uniform magnetic field which is perpendicular to the direction of the proton beam. If the flux density is 0.2T, calculate the radius of the path which the beam describes. (proton mass =  $1.7 \times 10^{-27} \text{ kg}$ , Electronic charge =  $-1.6 \times 10^{-19} \text{ C}$ ) [4]  
 Ans: 0.03m

106. **2059 Q.No. 8 b** A UV light of 400 nm strikes a cesium surface of work function 1.9 eV. Find the velocity of electrons emitted from the cesium surface  $m_e = 9.1 \times 10^{-31} \text{ kg}$ ,  $c = 3 \times 10^8 \text{ m/s}$ ,  $h = 6.62 \times 10^{-34} \text{ J.s}$ .  
 Ans:  $6.5 \times 10^5 \text{ m/s}$
107. **2058 Q.No. 8 b OR** Calculate the p.d. in volt necessary to be maintained between two horizontal conducting plates, one 1 mm above the other, so that a small oil drop of mass  $1.31 \times 10^{-14} \text{ kg}$  with two electrons attached to it remains in equilibrium. ( $g = 9.8 \text{ ms}^{-2}$ , charge of electron =  $-1.6 \times 10^{-19} \text{ C}$ ).  
 Ans: 2005.94V
108. **2057 Q.No. 8 b** The photoelectric work function of potassium is 2eV and the surface is illuminated with radiation of wavelength 350 nm. What potential difference have to be applied between a potassium surface and the collecting electrode in order just to prevent collection of electrons? What would be the kinetic energy of the electrons?  
 Ans: 1.5 V,  $2.4 \times 10^{-19} \text{ J}$
109. **2056 Q.No. 16 OR** Find the electric field required to keep a water drop of radius  $10^{-5} \text{ cm}$  just suspended in vacuum when charged with one electron. (electronic charge =  $-1.6 \times 10^{-19} \text{ C}$ , [density of water =  $1000 \text{ kg/m}^3$ ])  
 Ans: 257V
110. **2055 Q.No. 15 OR** The maximum kinetic energy of the electrons emitted from a metallic surface is  $1.6 \times 10^{-19} \text{ J}$  when the frequency of the radiation is  $7.5 \times 10^{14} \text{ Hz}$ . Calculate the minimum frequency of the radiation for which electrons will be emitted. Assume that  $h = 6.6 \times 10^{-34} \text{ J.s}$ .  
 Ans:  $5 \times 10^{14} \text{ Hz}$
111. **2054 Q.No. 14** A beam of proton is accelerated from rest through a p.d. of 2000V and then enters a uniform magnetic field which is perpendicular to the direction of the proton beam. If the flux density is 0.4T, calculate the radius of the path which the beam describes. (Proton mass =  $1.7 \times 10^{-27} \text{ kg}$ , electronic charge =  $-1.6 \times 10^{-19} \text{ C}$ ).  
 Ans:  $162.9 \times 10^{-2} \text{ m}$
112. **2053 Q.No. 16** An oil drop of mass  $3.25 \times 10^{-15} \text{ kg}$  falls vertically with uniform velocity, through the air between vertical parallel plates which are 2cm apart. When a p.d. of 1000V is applied to the plates the drop moves to the positively charged plate being inclined at  $45^\circ$  to the vertical. Calculate the charge on the drop.  
 Ans:  $6.37 \times 10^{-16} \text{ C}$

## 2. SOLIDS AND SEMICONDUCTOR DEVICES

### Short Answer Questions [2 Marks]

- 2076 GIE Set A Q.No. 2b** What is doping? Write its importance in semiconductor.
- 2076 GIE Set B Q.No. 2b** Explain why the electrical conductivity of a pure semiconductor increases on heating.
- 2076 Set B Q.No. 2b** **2052 Q.No. 12 f** What do you mean by hole in a semiconductor?
- 2076 Set C Q.No. 2b** **2068 Old Q.No. 1 f** Why is the emitter region of a transistor doped heavily?
- 2075 GIE Q.No. 2c** **2071 Set D Q.No. 2d** What is nanotechnology? Explain.
- 2075 Set A Q.No. 2d** A semiconductor has electrons and holes as charge carriers. Do conductors also have the holes as charge carriers? Justify.

- 2075 Set B Q.No. 2b In a transistor, emitter-base junction is always forward biased. Why? [2]
- 2074 Set A Q.No. 2c The output of two-input AND gate is fed to a NOT gate. Give its logic symbol and write down its truth table. Identify the new logic gate formed. [2]
- 2074 Set B Q.No. 2a Draw a circuit diagram for p-n junction diode in forward bias. Sketch the voltage versus current graph for it. [2]
- 2073 Supp Q.No. 2b 2070 Set C Q.No. 2 c What is a logic gate? Give logic symbol and truth table for an OR gate. [2]
- 2073 Set C Q.No. 2b How does the conductivity of semiconductor vary with temperature? Explain. [2]
- 2073 Set D Q.No. 2a Explain how the conductivity of a semiconductor varies with temperature? [2]
- 2072 Supp Q.No. 2c Explain the essential characteristics for an element to serve as (i) a donor impurity (ii) an acceptor impurity in a semiconductor. [2]
- 2072 Set C Q.No. 2b What are logic gates? Give a truth table for a two input NOR gate. [2]
- 2072 Set D Q.No. 2a The output of two-input AND gate is fed to a NOT gate. Draw the logic circuit of the combination of gates. Write down its truth table. [2]
- 2072 Set E Q.No. 2b What is meant by a charge carrier hole in a semi conductor? Can it be created in a conductor? [2]
- 2071 Supp. Q.No. 2b When examining a circuit diagram, how is it possible to tell whether a transistor is PNP or NPN? [2]
- 2071 Set C Q.No. 2 b Draw a circuit diagram for a p-n junction diode in forward bias. Sketch the voltage-current graph for the same. [2]
- 2071 Set C Q.No. 2 d What is truth table? Write down the truth table for a two-input NAND gate. [2]
- 2070 Supp. Set A Q.No. 2 e Based on the band theory of solids, how would you distinguish between conductors and semi conductors? [2]
- 2070 Supp. Set B Q.No. 2 d 2067 Sup Q.No. 2b An n-type semiconductor has a large number of free electrons at room temperature, yet it is said to be electrical neutral. Why? [2]
- 2070 Set D Q.No. 2 c 2067 Sup Q.No. 2c What is a logic gate? Give logic symbol and truth table for a two-input AND gate. [2]
- 2069 Supp Set B Q.No. 2 d What is doping? Discuss its significance in semiconductor studies. [2]
- 2069 Set A Q.No. 2b A p-type semiconductor has a large number of holes but still it is electrically neutral. Explain. [2]
- 2069 Set A Old Q.No. 2f Explain how the conductivity of a semiconductor changes with presence of impurity. [2]
- 2069 Set B Q.No. 2d What is a logic gate? Draw the truth table for an AND gate. [2]
- 2068 Can. Q.No. 2c How does the suitable impurity increase the conductivity of a semiconductor? [2]
- 2068 Q.No. 2 b Would there be any advantage to adding n-type or p-type impurities to copper? Why or why not? [2]
- 2067 Q.No. 2b A student asserts that Si and Ge became good conductors at very high temperatures and good insulators at very low temperature. Do you agree? Explain your reasoning. [2]
- 2065 Q.No. 1f How is p-type semiconductor formed? Explain. [2]
- 2063 Q.No. 1f Give the circuit symbol and truth table of NAND gate. [2]
- 2062 Q.No. 1f What do you mean by biasing a transistor? [2]
- 2062 Q.No. 2 g When P and N type materials are interfaced, these exists a depletion layer at the interface. Explain. [2]
- 2059 Q.No. 1f What factors determine whether a material is a semiconductor or an insulator? [2]
- 2058 Q.No. 1f A p-n diode conducts electricity when forward biased and does not conduct when reserve biased. Explain. [2]
- 2057 Q.No. 2 f The base region of a transistor is made very thin as compared with emitter and collector regions, why? [2]
- 2056 Q.No. 12 b How the conductivity of a semiconductor changes with the presence of impurities? [2]
- 2055 Q.No. 12 a How is it possible to rectify an AC? [2]
- 2055 Q.No. 12 d When examining a circuit diagram, how is it possible to tell whether a transistor is a n-p-n or p-n-p? [2]
- 2054 Q.No. 12 e Why may the addition of small quantities of suitable impurities to an intrinsic semiconductor result in a considerable decrease in its resistivity? [2]
- Long Answer Questions [4 Marks]**
- 2076 GIE Set A Q.No. 6b What is a rectifier? Describe the working of a half wave rectifier. [4]
- 2076 GIE Set B Q.No. 6b What is Zener breakdown? Describe the Zener diode as a voltage regulator. [4]
- 2076 Set B Q.No. 6b What is P-N junction diode? Discuss its applications as full wave rectifier. [4]
- 2076 Set C Q.No. 6b 2071 Set D Q.No. 6 d Distinguish between intrinsic and extrinsic semiconductors. Explain the formation of potential barrier and depletion region in a PN junction. [4]
- 2075 GIE Q.No. 6a 2068 Can. Q.No. 6b What is transistor? Discuss the input and output characteristics of a transistor in common emitter configuration. [4]
- 2075 Set A Q.No. 6c What is the difference between a zener diode and a common diode? Discuss the function of Zener diode as a voltage regulator. [4]
- 2075 Set B Q.No. 6b What are avalanche effect and Zener effect? How can a Zener diode be used as a voltage regulator? [4]
- 2074 Supp Q.No. 6a Distinguish between intrinsic and extrinsic semiconductors. Explain the information of potential barrier and depletion region in a p-n junction. [4]
- 2074 Set A Q.No. 6a What is zener diode? Explain its use as a voltage regulator. [4]
- 2074 Set B Q.No. 6b What is rectification? With the help of a circuit diagram, explain full wave rectification by using junction diodes. [4]
- 2073 Supp Q.No. 6b Explain the characteristic of a diode and discuss its application as a half wave rectifier. [4]
- 2073 Set C Q.No. 6b How are intrinsic and extrinsic semiconductors conceptualized? Explain the biasing characteristics of a junction diode. [4]

53. **2073 Set D Q.No. 6c** What is a rectifier? Describe the working principle of a full wave rectifier. [4]
54. **2072 Supp Q.No. 6c** Describe the common emitter configuration in a n-p-n transistor. Draw and explain input, output and transfer characteristics. [4]
55. **2072 Set C Q.No. 6b** What is an extrinsic semiconductor? Explain the formation of potential barrier and depletion region in a p-n junction. [4]
56. **2072 Set D Q.No. 6b** Explain the use of a p-n junction diode as a rectifier. Draw the circuit diagram of a full wave rectifier using diodes and explain its working. [4]
57. **2072 Set E Q.No. 6a** What is rectification? How can you construct a full wave rectifier using two semiconductor diodes? Explain their working. [4]
58. **2071 Supp. Q.No. 6b** What is a semiconductor diode? Explain the working of a full wave rectifier. [4]
59. **2071 Set C Q.No. 6 d** What is p-n junction? Describe forward biased and reverse biased condition of p-n junction. [4]
60. **2070 Supp. Set A Q.No 6 c** **2070 Supp. Set B Q.No. 6 d** **2067 Q.No. 6b** **2067 Sup Q.No. 6b** **2066 Q.No. 8 a** What is a rectifier? Explain how two diodes can be used full wave rectifier. [4]
61. **2070 Set C Q.No. 6 a** What is Zener breakdown? Describe how a Zener diode can be used as a voltage regulator? [4]
62. **2070 Set D Q.No. 6 a** What is a p-n a junction diode? Explain the characteristics of it in the forward and reversed biased condition. [4]
63. **2069 Supp Set B Q.No. 6 c** What is rectifier? Describe the working of a full wave rectifiers. [4]
64. **2069 Set A Q.No. 6b** Explain with neat diagram, the working mechanism of a full wave rectifier using junction diodes. How the output changes when a filter circuit is used? [4]
65. **2069 Set A Old Q.No. 9** What is n-p-n transistor? Describe briefly a circuit of n-p-n transistor amplifier in its common emitter configuration. [1+3]
66. **2069 Set B Q.No. 6b** What is a Zenor diode? Explain how it regulates the constant voltage in the electronic circuit. [4]
67. **2068 Old Can. Q.No. 8a** What is a p-n junction diode? With the help of a circuit diagram, explain the working of a junction diode as a full- wave rectifier. [1+3]
68. **2068 Q.No. 6 b** What are Logic gates? Describe, with truth tables, three basis gates: OR, AND and NOT. [4]
69. **2067 Old Q.No. 9 OR** What do you mean by rectifier? Describe the working of full wave rectifier using semiconductor diodes. [1+3]
70. **2066 Supp Q.No. 8a** What are N-type and P-type semiconductors? Discuss how the semiconductor diodes are used as a full-wave rectifier. [2+2]
71. **2065 Q.No. 9 a** What do you understand by Zener diode? How can this be used as voltage regulator? [2+2]
72. **2061 Q.No. 9** What is a junction diode? Explain its working as a half wave rectifier. [1+3]
73. **2060 Q.No. 9 OR** How is an NPN transistor formed? Discuss the input and output characteristics of the transistor in CE configuration. [1+3]

74. **2059 Q.No. 9 a** What are N-type and P-type semiconductors? Describe with a neat diagram the working mechanism of full wave rectifier for a junction diode.
75. **2056 Q.No. 14 OR** Explain the action of a diode valve as full wave rectifier.
76. **2055 Q.No. 13 OR** Explain the characteristics of a diode and discuss its application as a full wave rectifier.
77. **2054 Q.No. 15 OR** What is a junction diode? Explain wave rectification produced by a filter circuit.
78. **2053 Q.No. 15 OR** What is a junction diode? Discuss applications as full wave rectifier.

### 3. QUANTIZATION OF ENERGY

#### FORMULAE

- Bohr's theory:
  - Mathematical form of basic postulates
    - $\frac{mv^2}{r} = \frac{1}{4\pi\epsilon_0} \frac{Ze^2}{r^2}$       b.  $mvr = \frac{nh}{2\pi}$
    - $\Delta E = hf = E_1 - E_2$
  - Radius of orbit of hydrogen like atom,  $r_n = \frac{\epsilon_0 n^2 h^2}{\pi m Ze^2}$   
 $\therefore r_n \propto n^2$
  - Velocity of electron in an orbit,  $v_n = \frac{Ze^2}{2\epsilon_0 nh}$ ,  $v_n \propto \frac{1}{n}$   
 As,  $r_n \propto n^2$ ,  $v_n \propto \frac{1}{\sqrt{r_n}}$
  - Energy of electron in an orbit of hydrogen like atom,  
 $E = \frac{me^4 Z^2}{8\epsilon_0^2 n^2 h^2} = -13.6 \frac{Z^2}{n^2} \text{ eV}$
  - Rydberg constant,  $R = \frac{me^4}{8\epsilon_0^2 n^2 ch^3} = 1.097 \times 10^7 \text{ m}^{-1}$ .
  - The wavelength of radiation that is emitted in electron transition,  $\frac{1}{\lambda} = RZ^2 \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$
- Dual nature of radiation:
  - de Broglie wavelength,  $\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mE_k}} = \frac{h}{\sqrt{3mk_e}}$
- Heisenberg's uncertainty principle:
  - Position momentum uncertainty,  $\Delta x \times \Delta p \geq \frac{h}{2\pi}$
  - Energy time uncertainty,  $\Delta E \times \Delta t \geq \frac{h}{2\pi}$
  - Angular momentum and angular displacement uncertainty,  $\Delta L \times \Delta \theta \geq \frac{h}{2\pi}$
- X-Rays:
  - The minimum value of wavelength of X-rays is,  $\lambda = \frac{hc}{eV}$   
 i.e.  $\lambda \propto \frac{1}{V}$
  - The energy of electron is  $\frac{1}{2} mv_{\text{max}}^2 = eV$ .
  - Bragg's law of X-rays difference,  $2d \sin \theta = n\lambda$ , where  $n = 1, 2, 3, \dots$
- Some constants; electric charge,  $e = 1.16 \times 10^{-19} \text{ C}$ ,  
 Mass of electron,  $m_e = 9.1 \times 10^{-31} \text{ kg}$ ,  
 Speed of light,  $c = 3 \times 10^8 \text{ m/s}$   
 Planck's constant,  $h = 6.62 \times 10^{-34} \text{ Js}$

### Short Answer Questions. [2 Marks]

1. **2076 GIE Set A Q.No. 2d** A proton and an electron have the same de-Broglie wavelength. Which one has greater K.E.? Explain. [2]
2. **2076 GIE Set B Q.No. 2c** Justify that production of X-ray is the inverse phenomenon of photoelectric effect. [2]
3. **2076 GIE Set B Q.No. 2f** Why cannot we observe matter waves in our daily life? [2]
4. **2076 Set B Q.No. 2c** **2054 Q.No. 12 b** Which has more energy- a proton in the infrared or photon in the ultraviolet? Given reasons. [2]
5. **2076 Set C Q.No. 2a** **2074 Set B Q.No. 2b** **2073 Supp Q.No. 2c** **2068 Can. Q.No. 2b** **2068 Old Can. Q.No. 1f** An electron and a proton have the same kinetic energy. Which one of them has the longer wavelength? [2]
6. **2075 Set A Q.No. 2b** A photon and an electron have got the same de-Broglie wavelength. Which one has greater total energy? Explain. [2]
7. **2073 Set C Q.No. 2a** The accelerating voltage of a proton is increased to twice. How will its de Broglie wavelength change? Explain. [2]
8. **2073 Set C Q.No. 2d** Can X-ray diffraction experiment be performed by an ordinary grating? Why? [2]
9. **2073 Set D Q.No. 2f** Explain the difference between stimulated and spontaneous emissions of radiation. [2]
10. **2072 Supp Q.No. 2f** If a proton and an electron have the same speed, which has the longer de Broglie wavelength? Explain. [2]
11. **2072 Set C Q.No. 2c** Even if a hydrogen atom contains an electron, its spectrum consists of a large number of lines. Explain how. [2]
12. **2072 Set D Q.No. 2b** What is optical pumping in the production of laser? [2]
13. **2072 Set E Q.No. 2d** Production of X-ray is the inverse phenomenon of photoelectric effect. Justify it. [2]
14. **2072 Set E Q.No. 2f** "The total energy of an electron of an atom in an orbit is negative". What does this negative energy indicate? [2]
15. **2071 Supp. Q.No. 2c** An electron and proton are accelerated through the same potential, which one has higher De-Broglie's wavelength? Justify your answer. [2]
16. **2071 Set C Q.No. 2 c** An electron and a proton have same kinetic energy, which of the two has greater de-Broglie wavelength? Justify your answer. [2]
17. **2071 Set D Q.No. 2 b** A proton and an electron have same de-Broglie wavelengths, which of the two has greater kinetic energy? Justify your answer. [2]
18. **2071 Set D Q.No. 2c** **2060 Q.No. 2f** Distinguish between stimulated emission and spontaneous emission. [2]
19. **2070 Supp. Set A Q.No. 2 a** If a proton and an electron have the same kinetic energy which has the longer de Broglie wavelength? [2]
20. **2070 Supp. Set A Q.No. 2c** Why is the gravitational force not taken into consideration while evaluating the energy of an electron in an atom? [2]
21. **2070 Supp. Set B Q.No. 2 c** Can X-rays be produced from gases? Explain. [2]
22. **2070 Set C Q.No. 2 b** A proton and an electron have the same speed. Which has longer wavelength? [2]
23. **2070 Set D Q.No. 2 b** The wave nature of particles is not observable in daily life. Why? [2]
24. **2069 Supp Set B Q.No. 2 b** Draw schematic diagram to show the difference between spontaneous and stimulated emissions of radiation. [2]
25. **2069 Supp Set B Q.No. 2 c** Can Bragg's law of x-ray diffraction be verified with yellow light of wavelength 600 nm? Explain. [2]
26. **2069 Set A Q.No. 2c** A stone is dropped from the top of a building. How does its de Broglie wavelength change? [2]
27. **2069 Set A Old Q.No. 1e** What do you mean by ionization energy and ionization potential? [2]
28. **2069 Set A Old Q.No. 2h** What is laser? On what principle it works? [2]
29. **2069 Set B Q.No. 2c** Compare the wavelengths of an electron with that of a proton if their kinetic energies are equal. Mass of a proton is nearly equal to 1840 times the mass of an electron. [2]
30. **2068 Can. Q.No. 2d** Define population inversion and optical pumping. [2]
31. **2068 Q.No. 2 f** When x-rays are produced only about 10% of the initial input energy appears as x-ray energy. Explain what has happened to the other 90% of the energy. [2]
32. **2068 Old Q.No. 1 g** What are the differences between X-rays and the ordinary ray of light? [2]
33. **2067 Q.No. 2c** What are the differences between matter wave and electromagnetic wave? [2]
34. **2067 Old Q.No. 1f** **2066 Supp Q.No. 2f** Why is the production of x-rays called inverse of photoelectric effect? [2]
35. **2066 Q.No. 1f** The phenomenon of x-rays production is also called an inverse of photoelectric effect. Why? [2]
36. **2066 Q.No. 2 f** If matter has a wave nature, why is this not observable in our daily experiences? [2]
37. **2062 Q.No. 2 f** What do you mean by matter waves? [2]
38. **2061 Q.No. 1 g** Production of x-rays is the reverse phenomenon of photoelectric effect. Justify this statement. [2]
39. **2058 Q.No. 1 g** Can aluminum be used as a target in X-ray tube? [2]
40. **2056 Q.No. 12 a** Why a glowing gas, such as that in a neon tube, gives only certain wavelengths of light? [2]
41. **2056 Q.No. 12 d** Differentiate between stimulated and spontaneous emission of radiations. [2]
42. **2056 Q.No. 12 e** What do you mean by uncertainty principle? [2]
43. **2055 Q.No. 12 f** Point out the importance of a de Broglie wave. [2]
44. **2054 Q.No. 12 a** What do you meant by De Broglie waves? [2]
45. **2053 Q.No. 12 a** An electron is in the third excited state. How many different photon-wave lengths are possible? [2]
46. **2052 Q.No. 12 c** In the production of X-ray, how will you control the penetrating power of X-rays? [2]

47. **2052 Q.No. 12 a** How Paschen series is originated in Hydrogen spectra? [2]
48. **2052 Q.No. 15 b** Differentiate between excitation potential and ionization potential. [2]

**Long Answer Questions [4 Marks]**

49. **2076 GIE Set A Q.No. 6c** What is laser? Describe the working of He-Ne laser. [4]
50. **2076 GIE Set B Q.No. 6c** State and explain Bragg's law. [4]
51. **2075 Set A Q.No. 6a** Stating the Bohr's postulates, deduce an expression for the total energy of an electron in  $n^{\text{th}}$  orbit of hydrogen atom. [4]
52. **2075 Set B Q.No. 6c** Describe Coolidge tube for the production of X-rays. How do you control (i) the intensity (ii) the penetrating power of the emitted X-rays? [4]
53. **2074 Set B Q.No. 6c** State Bohr's postulates. Using these postulates obtain an expression for the total energy of an electron in the  $n^{\text{th}}$  orbit of hydrogen atom. [4]
54. **2073 Supp Q.No. 6c** **2063 Q.No. 9** What are Bohr's postulates? Derive an expression for the total energy of electron in  $n^{\text{th}}$  orbit of H-atom. [4]
55. **2073 Set C Q.No. 6d** Explain the working principle of a gas laser. How is population inversion achieved for lasing action? [4]
56. **2073 Set D Q.No. 6a** Write down the postulates of Bohr's hydrogen atom. Hence derive expression for energy of the third electron orbit. [4]
57. **2072 Set D Q.No. 6c** State Bohr's postulates of hydrogen atom and use them to calculate the radius of  $n^{\text{th}}$  orbit of the hydrogen atom. [4]
58. **2072 Set E Q.No. 6b** Explain the working of He-Ne laser. [4]
59. **2071 Supp. Q.No. 6d** Derive Bragg's equation and explain how this equation is used to determine the crystal plane spacing. [4]
60. **2071 Set C Q.No. 6 b** What are x-rays? Describe the modern Coolidge tube method to produce x-rays. [4]
61. **2071 Set D Q.No. 6 b** State Bohr's postulates of hydrogen atom. Use these postulates to derive an expression for the radius of the  $n^{\text{th}}$  orbit of the hydrogen atom. [4]
62. **2070 Supp. Set B Q.No. 6 b** State Bohr's postulates of atomic structure. Use the postulates to determine the total energy of an electron in  $n^{\text{th}}$  orbit of hydrogen atom. [4]
63. **2070 Set C Q.No. 6 b** State Bohr's postulates and hence derive expression for the radius of  $n^{\text{th}}$  orbit of hydrogen atom. [4]
64. **2070 Set D Q.No. 6 b** Describe the construction and working of a Helium-Neon laser. [4]
65. **2069 Set A Q.No. 6d** Describe the construction and working principle of He-Ne laser. Write some important uses of laser. [4]
66. **2069 Set B Q.No. 6d** Describe the construction and working principle of He-Ne laser. Also write its important uses. [4]
67. **2068 Old Can. Q.No. 9 OR** Starting from Bohr's postulates, obtain an expression for the energy of the electron in  $n^{\text{th}}$  orbit of the hydrogen atom. [4]
68. **2068 Q.No. 6 d** Describe the modern method of productions of x-rays. Discuss crystal diffraction. [4]
69. **2068 Old Q.No. 8 a** On the basis of Bohr's theory of hydrogen atom, derive an expression for the energy of electron in the  $n^{\text{th}}$  orbit of a hydrogen atom.
70. **2067 Q.No. 6d** **2066 Q.No. 9 OR** Obtain an expression for the energy of electron in  $n^{\text{th}}$  orbit of hydrogen atom.
71. **2067 Old Q.No. 8a OR** What do you mean by laser? Describe the He-Ne laser. [1+3]
72. **2067 Old Q.No. 9** Explain Bragg's law of diffraction of x-rays. [1+3]
73. **2067 Sup Q.No. 6c** What is laser? Describe the construction and working principle of He-Ne laser. [1+3]
74. **2066 Q.No. 9** Derive Bragg's law. [1+3]
75. **2065 Q.No. 8 a** Write down the postulates of Bohr's model of hydrogen atom and obtain expression for the energy of the  $n^{\text{th}}$  orbit of electron. [1+3]
76. **2062 Q.No. 8 a** X-ray diffraction has been very useful in determining the structure of a crystalline substance. Use this concept to determine the distance between two planes. [1+3]
77. **2062 Q.No. 8 a OR** Explain how Bohr modified the Rutherford model of an atom to explain the emission of radiation from atoms: (only quantitative discussion required). [1+3]
78. **2059 Q.No. 8 a** What are Bohr's postulates? Derive the formula for the radius of the third Bohr's orbit. [1+3]
79. **2058 Q.No. 9** Derive Bragg's law and explain how is this used to determine the crystal plane spacing. [1+3]
80. **2057 Q.No. 9** Derive an expression for the energy of an electron in a hydrogen atom. [1+3]
81. **2055 Q.No. 14** What are the X-rays? Confirm with experiment the wave nature of X-rays. [1+3]
82. **2053 Q.No. 15** What are Bohr's postulates of hydrogen atom? Derive an expression for the radius of Bohr's orbit. [1+3]
83. **2052 Q.No. 15 a OR** State and explain uncertainty principle. [1+3]

**Numerical Problems [4 Marks]**

84. **2076 GIE Set A Q.No. 10a** An  $\alpha$ -particle of mass  $6.64 \times 10^{-27}$  kg is emitted in radioactive decay of  ${}_{92}\text{U}^{238}$  with a energy of 4.1 MeV. What is its de-Broglie wavelength? (Planck's constant =  $6.62 \times 10^{-34}$  Js)
- Ans:  $7 \times 10^{-16}$  m
85. **2076 GIE Set A Q.No. 10b** Electrons in an x-ray tube are accelerated by a p.d. of 10 KV. If an electron produces a photon on impact with the target, what is the minimum wavelength of resulting x-rays? What is the velocity with which the electron hit the target? Mass of the electron =  $9.1 \times 10^{-31}$  kg.
- Ans:  $1.24 \times 10^{-10}$  m,  $5.93 \times 10^7$  m/sec
86. **2076 GIE Set B Q.No. 10b** An electron is confined within a region of width  $1.0 \times 10^{-10}$  m. (a) Estimate the minimum uncertainty in x - component of electron's momentum (b) if the electron has momentum with magnitude equal to the uncertainty found in part (a) what is its K.E.? Mass of electron =  $9.1 \times 10^{-31}$  kg.
- Ans:  $1.05 \times 10^{-24}$  kg m/sec,  $3.81 \times 10^{-18}$  J
87. **2076 Set B Q.No. 10b** **2066 Supp Q.No. 8b Or** **2058 Q.No. 9** Obtain the de Broglie wavelength of neutron of kinetic energy 150 eV. (mass of neutron =  $1.675 \times 10^{-27}$  kg. Planck's constant =  $6.6 \times 10^{-34}$  Js.  $1\text{eV} = 1.6 \times 10^{-19}$  J.)
- Ans:  $2.33 \times 10^{-10}$  m

88. **2076 Set C** operated at the target at electrons is incident elec

89. **2075 GIE C** which has 200 V. Ta Plank's con

90. **2075 Set F** What is the absorbing

91. **2074 Supp** that has b 20 kV. Ma =  $6.62 \times 1$

92. **2074 Sup** member wavelength second m

93. **2074 Set** electron v difference Planck's c

94. **2073 Set** electron h

95. **2072 Su** electroma undergoe J and -5.

96. **2072 Set** works at energy o is gener the cur electrons charge o

97. **2072 Set** rock salt  $14^\circ$  to th increas voltage Planck c

98. **2071 Su** differen 0.5mA. second, kinetic e ray emit light c =

88. **2076 Set C Q.No. 10a** **2069 Set A Q.No. 10b** An x-ray tube, operated at a dc potential difference of 10kv, produces heat at the target at the rate of 720 watt. Assuming 0.5% of the incident electrons is converted into x-radiation, calculate the number of electrons striking per second at the target and velocity of the incident electrons. (given,  $e/m = 1.8 \times 10^{11} \text{ Ckg}^{-1}$ ) [4]  
 Ans:  $0.072 \text{ A}$ ,  $6 \times 10^7 \text{ m/sec}$
89. **2075 GIE Q.No. 10b** Calculate the wavelength of an electron which has been accelerated through a potential difference of 200 V. Take mass of the electron as  $9.1 \times 10^{-31} \text{ kg}$  and Planck's constant as  $6.6 \times 10^{-34} \text{ Js}$ . [4]  
 Ans:  $8.6 \times 10^{-11} \text{ m}$
90. **2075 Set B Q.No. 10b** A hydrogen atom is in ground state. What is the quantum number to which it will be excited absorbing a photon of energy 12.75 eV? [4]  
 Ans: 4
91. **2074 Supp Q.No. 10b** Determine the wavelength of a proton that has been accelerated through a potential differences of 20 kV. Mass of proton =  $1.67 \times 10^{-27} \text{ kg}$  and Planck constant =  $6.62 \times 10^{-34} \text{ Js}$ . [4]  
 Ans:  $2.02 \times 10^{-13} \text{ m}$
92. **2074 Supp Q.No. 10c** **2073 Set C Q.No. 10c** The first member of Balmer series of hydrogen atom has a wavelength of 6563 Å. Calculate the wavelength of its second member. [4]  
 Ans: 4861.48 Å
93. **2074 Set A Q.No. 10b** Calculate de Broglie wavelength of an electron which has been accelerated through a potential difference of 200V. Given-mass of electron =  $9.1 \times 10^{-31} \text{ kg}$  and Planck's constant,  $h = 6.6 \times 10^{-34} \text{ Js}$ . [4]  
 Ans:  $8.7 \times 10^{-11} \text{ m}$
94. **2073 Set D Q.No. 10c** Calculate the de Broglie wavelength of electron having kinetic energy of 400 eV. [4]  
 Ans:  $6.13 \times 10^{-11} \text{ m}$
95. **2072 Supp Q.No. 10a** Calculate the wave length of electromagnetic radiation emitted by a hydrogen atom which undergoes a transition between energy levels of  $-1.36 \times 10^{-19} \text{ J}$  and  $-5.45 \times 10^{-19} \text{ J}$ . (Given plank constant =  $6.6 \times 10^{-34} \text{ Js}$ ). [4]  
 Ans:  $4.84 \times 10^{-7} \text{ m}$
96. **2072 Set C Q.No. 10b** **2072 Set D Q.No. 10b** A X-ray tube works at a dc potential difference of 50 kV. Only 0.4% of the energy of the cathode rays is converted into x-rays and heat is generated in the target at the rate of 600 watt. Estimate the current passed into the tube and the velocity of the electrons striking the target. (Mass of electron =  $9 \times 10^{-31} \text{ kg}$ , charge of electron =  $1.6 \times 10^{-19} \text{ C}$ ) [4]  
 Ans: 0.012 A,  $1.3 \times 10^8 \text{ m/sec}$
97. **2072 Set E Q.No. 10a** An X-ray spectrometer has a crystal of rock salt for which atomic spacing is 2.82 Å set at an angle of  $14^\circ$  to the beam coming from a tube operated at a constantly increasing voltage. An intense first line appears when the voltage across the tube is 9045 V. Calculate the value of Planck constant. [4]  
 Ans:  $6.58 \times 10^{-34} \text{ Js}$
98. **2071 Supp. Q.No. 10a** An x-ray tube works at a dc potential difference of 50KV and the current through the tube is 0.5mA. Find (i) the number of electrons hitting the target per second, (ii) the energy falling on the target per second as the kinetic energy of electrons, (iii) the cut off wavelength of x-ray emitted. (The charge of electron =  $1.6 \times 10^{-19} \text{ C}$ , velocity of light  $c = 3 \times 10^8 \text{ m/s}$ , Planck's constant =  $6.62 \times 10^{-34} \text{ Js}$ ). [4]  
 Ans: (i)  $3.125 \times 10^{15} \text{ number/sec}$ . (ii) 25 Watt. (iii)  $2.48 \times 10^{-11} \text{ m}$
99. **2071 Supp. Q.No. 10c** Determine the energy that must be given to a hydrogen atom so that it can emit second line of Balmer series. (Rydberg's constant  $R = 1.097 \times 10^7 \text{ m}^{-1}$ ) [4]  
 Ans: 2.55 eV.
100. **2070 Supp. Set A Q.No. 10 c** Find the wavelength of the radiation emitted from a hydrogen atom when an electron jumps from 4<sup>th</sup> orbit to the second orbit. (given  $E_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$ ,  $h = 6.62 \times 10^{-34} \text{ Js}$ ,  $m_e = 9.1 \times 10^{-31} \text{ kg}$ ) (where the symbols have their usual meanings.) [4]  
 Ans:  $4.89 \times 10^{-7} \text{ m}$
101. **2070 Supp. Set B Q.No. 2 a** A cricket ball is moving with a speed of 120 km/hr. What would be its de-Broglie wavelength if its mass is 400gms. [2]  
 Ans:  $4.96 \times 10^{-35} \text{ m}$ .
102. **2070 Supp. Set B Q.No. 10 b** X-rays are incident on the zinc sulphide crystal of crystal spacing  $3.08 \times 10^{-8} \text{ cm}$  such that first order reflection takes place at glancing angle  $12^\circ$ . Calculate the wavelength of X-rays and glancing angle for second order maximum. [4]  
 Ans:  $1.28 \times 10^{-10} \text{ m}$ .
103. **2069 Supp Set B Q.No. 10 b** **2067 Sup Q.No. 10b** Find the wavelength of radiation emitted from hydrogen atom when an electron jumps from third orbit to second orbit. (Given:  $\epsilon_0 = 8.854 \times 10^{-12} \text{ N}^{-1} \text{ m}^{-2}$ ,  $h = 6.62 \times 10^{-34} \text{ Js}$  and mass of electron,  $m_e = 9.1 \times 10^{-31} \text{ kg}$ .) [4]  
 Ans:  $6.6 \times 10^{-7} \text{ m}$
104. **2069 Set A Old Q.No. 8b** **2052 Q.No. 16 OR** X-ray beam of wavelength 2.9Å (Å) is diffracted from the plane of cubic crystal. The first order diffraction is obtained at an angle of  $35^\circ$ . Calculate the spacing between the planes. [4]  
 Ans:  $5 \times 10^{-10} \text{ m}$
105. **2069 Set B Q.No. 10b** X-rays are incident on the zinc sulphide crystal. It's crystal spacing is  $3.08 \times 10^{-8} \text{ cm}$  and the first order reflection takes place at a glancing angle of  $12^\circ$ . Calculate the wavelength of incident X-rays. [4]  
 Ans:  $1.28 \times 10^{-10} \text{ m}$
106. **2067 Q.No. 10b** An x-ray tube operated at a d.c. potential difference of 40 KV, produces heat at the rate of 720 w assuming 0.5% of the energy of the incident electrons converted into x-radiation. Calculate (i) number of electrons per second striking the target. (ii) the velocity of the incident electrons. [Given  $e/m = 1.8 \times 10^{11} \text{ C/kg}$ ]. [4]  
 Ans:  $1.13 \times 10^{17}$ ,  $1.18 \times 10^8 \text{ m/sec}$
107. **2065 Q.No. 8 b** X-rays of wavelength 0.36 Å are diffracted by a Bragg's crystal spectograph at a glancing angle of  $(4.8)^\circ$ . Find the spacing of the atomic planes in the crystal. [4]  
 Ans:  $2.15 \times 10^{-10} \text{ m}$
108. **2062 Q.No. 8 b** If an electron position can be measured to an accuracy of  $10^{-9} \text{ m}$ . How accurately can its velocity be measured? ( $m_e = 9.1 \times 10^{-31} \text{ kg}$ ) [4]  
 Ans:  $1.16 \times 10^5 \text{ ms}^{-1}$
109. **2061 Q.No. 8 b OR** Obtain the De Broglie wave length of the electron having the kinetic energy of 3600v. (mass of electron =  $9.1 \times 10^{-31} \text{ kg}$ , Electronic charge =  $1.6 \times 10^{-19} \text{ C}$ , Plank's constant =  $6.6 \times 10^{-34} \text{ m}$ ) [4]  
 Ans:  $2.04 \times 10^{-11} \text{ m}$
110. **2060 Q.No. 8 b** Calculate energy in electron volts of a quantum of x-radiation of wavelength 0.15nm. Take  $e = 1.6 \times 10^{-19} \text{ C}$ ,  $h = 6.5 \times 10^{-34} \text{ Js}$ ,  $c = 3 \times 10^8 \text{ ms}^{-1}$ . [4]  
 Ans: 8125 eV

111. **2055 Q.No. 15** An electron of energy 20eV comes into collision with a hydrogen atom in its ground state. The atom is excited into a higher state and the electron is scattered with reduced velocity. The atom subsequently returns to its ground state with the emission of photon of wavelength  $1.216 \times 10^{-7} \text{m}$ . Determine the velocity of the scattered electron. (mass of electron =  $9.1 \times 10^{-31} \text{kg}$ ). [4]

Ans:  $1.86 \times 10^8 \text{ms}^{-1}$ 

112. **2054 Q.No. 16** Calculate the wavelength of the first line of the Balmer series, if the wavelength of the second line of this series is  $4.86 \times 10^{-7} \text{m}$ . [4]

Ans:  $6.56 \times 10^{-7} \text{m}$ 

#### 4. NUCLEAR PHYSICS

##### FORMULAE

- The radius (R) of nucleus,  $R = R_0 A^{1/3}$ , where  $R_0 = 1.2 \times 10^{-15} \text{m}$
- Volume (V) of nucleus,  $V = \frac{4}{3} \pi R_0^3 A$
- Einstein's mass energy relation,  $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$
- Mass defect ( $\Delta m$ ),  $(Zm_p + (A - Z)m_n) - M$ .
- Packing fraction =  $\frac{\Delta m}{A}$
- Binding energy (BE) =  $\Delta m \times 931 \text{ MeV}$ , [ $\therefore 1 \text{ amu} = 931 \text{ MeV}$ ]
- Binding energy per nucleon =  $\frac{\text{B.E.}}{A}$
- Equation for nuclear reaction is,  ${}_Z X^A + a = {}_Z Y^A + b + Q$ , where Q is energy released or observed.
- Example of nuclear fission,  ${}_{92}\text{U}^{235} + {}_0\text{n}^1 \rightarrow {}_{92}\text{U}^{236} \rightarrow {}_{56}\text{B}^{141} + {}_{36}\text{Kr}^{92} + 3 {}_0\text{n}^1 + Q$ ,  $Q = 200 \text{ MeV}$
- Example of nuclear fusion,  ${}_1\text{H}^2 + {}_1\text{H}^2 \rightarrow {}_2\text{He}^4 + Q$ ,  $Q = 24 \text{ MeV}$

##### Short Answer Questions [2 Marks]

- 2076 Set C Q.No. 2c** Neutron is considered the most effective bombarding particle in a nuclear reaction. Why? [2]
- 2075 Set A Q.No. 2e** A nucleus consists of positively charged protons and electrically neutral neutrons in a small volume. How can this be possible as the like charges repel each other? [2]
- 2075 Set B Q.No. 2d** All nuclei have nearly the same density. Why? [2]
- 2074 Supp Q.No. 2b** **2066 Q.No. 1g** The nuclear density is almost constant for all nuclei. Why? [2]
- 2074 Set A Q.No. 2a** **2070 Set C Q.No. 2 d** Why is neutron considered the most effective bombarding particle in a nuclear reaction? [2]
- 2074 Set B Q.No. 2c** According to properties of charges, like charges repel each other. Then, how do the protons in a nucleus stay together? [2]
- 2073 Supp Q.No. 1d** **2067 Q.No. 2d** Why is the mass of a nucleus slightly less than the mass of constituent nucleons? [2]
- 2073 Set C Q.No. 2c** Define atomic mass unit (amu). Hence convert the mass of a neutron, (1840 me), into amu where me is the mass of 'an electron'. [2]

- 2073 Set D Q.No. 2b** Diameter of  $\text{Al}^{27}$  nucleus is  $D$ . How can one express the diameter of  $\text{Cu}^{64}$  in terms of  $D$ ? Explain. [2]
- 2072 Supp Q.No. 2d** By what factor must the mass number of a nucleus increase to double its volume? Explain. [2]
- 2072 Set D Q.No. 2c** All the nuclei have nearly the same density. Justify. [2]
- 2071 Supp. Q.No. 2d** What is the significance of binding energy per nucleon? [2]
- 2070 Set D Q.No. 2 d** Does a nucleus contain electrons? Explain. [2]
- 2069 Supp Set B Q.No. 2 e** What does the energy balance (Q-value) of a nuclear reaction signify? Explain. [2]
- 2070 Supp. Set B Q.No. 2 e** Find the value of 1 amu in terms of MeV. [2]
- 2068 Old Can. Q.No. 1g** Why are the neutrons used to initiate fission reaction? [2]
- 2067 Old Q.No. 2f** Why does a mountain of uranium not explode as a bomb? [2]
- 2066 Supp Q.No. 1f** Write difference between nuclear fission and fusion. [2]
- 2065 Q.No. 1 g** Explain the significance of Einstein's mass energy equivalence relation. [2]
- 2065 Q.No. 2 g** Define atomic mass unit and convert it into MeV. [2]
- 2061 Q.No. 1 f** Define mass defect and packing fraction of a nucleus. [2]
- 2059 Q.No. 2 f** Distinguish between isotopes and isobar? [2]
- 2056 Q.No. 12 f** Explain why the mass of a nucleus is always less than the combined masses of its constituent particles. [2]
- 2055 Q.No. 12 b** Explain binding energy in terms of packing fraction. [2]
- 2055 Q.No. 12 c** Point out the difference between nuclear fission and fusion. [2]
- 2053 Q.No. 12 b** What is meant by chain reaction? [2]
- 2052 Q.No. 12 d** Distinguish between fission and fusion reaction. [2]

##### Long Answer Questions [4 Marks]

- 2075 GIE Q.No. 6c** Define binding energy and binding energy per nucleon. How does binding energy per nucleon vary with mass number? What is its significance? [4]
- 2075 Set A Q.No. 6d** Differentiate between nuclear fission and fusion. Explain the production of energy in the Sun. [4]
- 2074 Supp Q.No. 6c** Discuss fission and fusion reaction with one example of each. In which reaction is the energy released greater? [4]
- 2074 Set A Q.No. 6c** Define mass defect and binding energy of a nucleus. Draw a graph showing the variation of binding energy per nucleon and atomic number of the elements. Also, interpret the graph. [4]
- 2073 Set C Q.No. 6c** Write down the representative nuclear fission and fusion reactions. Explain, how the energy release in the case of four protons fused into doubly ionized helium can be estimated? [4]

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33. **2072 Set C** nucleol.  
 34. **2071 Supp.** binding energy relation between number. Expl  
 35. **2071 Set C** binding energy its significance  
 36. **2070 Set C** example of greater?  
 37. **2070 Set D** sources of the  
 38. **2069 Set A** nuclear fission fusion reaction  
 39. **2068 Q.No.** released from  
 40. **2067 Sup C** fusion and any of these value of a n  
 41. **2063 Q.No.** released in  
 42. **2062 Q.No.** representat  
 43. **2061 Q.No.** fission with  
 44. **2058 Q.No.** released in  
 45. **2057 Q.No.** fission with  
 46. **2056 Q.No.** nuclear rea  
 47. **2052 Q.No.** relation with  
**Numerical Pr**  
 48. **2076 GIE** nucleon of Given mass 1.008665 a 930 MeV).  
 49. **2076 GIE** correspond reactor. E MeV. Avog  
 50. **2076 Set** binding energy is 55.934 u 1.00867u  
 51. **2076 Set** nucleon of Given: mass of n

33. **2072 Set C Q.No. 6c** Discuss four important properties of nuclei. [4]
34. **2071 Supp. Q.No. 6c** What are meant by mass defect and binding energy per nucleon? Draw a graph showing the relation between binding energy per nucleon and atomic number. Explain its significances. [4]
35. **2071 Set C Q.No. 6c** Define binding energy. How does binding energy per nucleon vary with mass number? What is its significance? [4]
36. **2070 Set C Q.No. 6c** Discuss fission and fusion with an example of each. In which reaction is the energy released greater? [4]
37. **2070 Set D Q.No. 6d** What is nuclear fusion? Discuss the sources of the energy released during fusion. [4]
38. **2069 Set A Q.No. 6c** How does nuclear fusion differ from nuclear fission? How is the energy released estimated in the fusion reaction? [4]
39. **2068 Q.No. 6c** What is nuclear fission? Compare the energy released from nuclear fission with that of fusion. [4]
40. **2067 Sup Q.No. 6d** Write down the schemes for nuclear fusion and nuclear fission. How can the release energy in any of these reactions estimated? What do you mean by Q-value of a nuclear reaction? [1+2+1]
41. **2063 Q.No. 8a** What is nuclear fission? How energy is released in nuclear fission reaction? [4]
42. **2062 Q.No. 2h** What is nuclear fusion? Write a representative equation of fusion reaction? [4]
43. **2061 Q.No. 9 OR** Distinguish between nuclear fusion and fission with examples. [4]
44. **2058 Q.No. 8a** What do you mean by fission? How energy is released in fission of uranium nucleus? [4]
45. **2057 Q.No. 9 OR** Distinguish between nuclear fusion and fission with examples. [4]
46. **2056 Q.No. 14** What is nuclear fission? Give an example of nuclear reaction. [4]
47. **2052 Q.No. 13** State and explain Einstein's mass energy relation with example. [4]

### Numerical Problems [4 Marks]

48. **2076 GIE Set A Q.No. 10c** Find mass defect and B.E. per nucleon of  ${}_{26}\text{Fe}^{56}$ . [4]  
Given mass of proton = 1.007825 amu, mass of neutron = 1.008665 amu, mass of  ${}_{26}\text{Fe}^{56}$  = 55.934939 amu. (1 amu = 930 MeV).  
**Ans: 8.78 MeV/nuclear**
49. **2076 GIE Set B Q.No. 10c** Find the power production corresponding to 2g of  ${}_{92}\text{U}^{235}$  consumed per day in a nuclear reactor. Energy released per fission of  $\text{U}^{235}$  is about 200 MeV. Avogadro number =  $6.023 \times 10^{23}$ /mol. [4]  
**Ans:  $1.9 \times 10^6$  Watt**
50. **2076 Set B Q.No. 10c** **2070 Set D Q.No. 10c** Calculate the binding energy per nucleon of  ${}_{26}\text{Fe}^{56}$ . Atomic mass of  ${}_{26}\text{Fe}^{56}$  is 55.9349u and that of  ${}^1\text{H}^1$  is 1.00783u. Mass of  $n^1 = 1.00867\text{u}$  and  $1\text{u} = 931\text{MeV}$ . [4]  
**Ans: 8.78 MeV/nuclear**
51. **2076 Set C Q.No. 10b** Calculate the binding energy per nucleon of calcium nucleus ( ${}_{20}\text{Ca}^{40}$ ). [4]  
Given: mass of  ${}_{20}\text{Ca}^{40} = 39.962589\text{u}$   
mass of neutron,  $m_n = 1.008665\text{u}$

mass of proton,  $m_p = 1.007825\text{u}$   
 $1\text{u} = 931\text{MeV}$

- Ans: 8.54 MeV/nuclear**
52. **2075 Set A Q.No. 10a** A city requires  $10^7$  watts of electrical power on the average. If this is to be supplied by a nuclear reactor of efficiency 20%. Using  ${}_{92}\text{U}^{235}$  as the fuel source, calculate the amount of fuel required per day (Energy released per fission  ${}_{92}\text{U}^{235} = 200\text{MeV}$ ). [4]  
**Ans: 0.0527 kg**
53. **2075 Set B Q.No. 10c** **2067 Q.No. 10c** A nucleus of  ${}_{92}\text{U}^{238}$  disintegrates according to  
 ${}_{92}\text{U}^{238} \rightarrow {}_{90}\text{Th}^{234} + 2\text{He}^4$ . [4]  
Calculate:  
i. the total energy released in the disintegration process.  
ii. the k.e. of the  $\alpha$  particle, the nucleus at rest before disintegration.  
[Mass of  ${}_{92}\text{U}^{238} = 3.859 \times 10^{-25}\text{kg}$   
Mass of  ${}_{90}\text{Th}^{234} = 3.787 \times 10^{-25}\text{kg}$   
Mass of  $2\text{He}^4 = 6.648 \times 10^{-27}\text{kg}$ ]  
**Ans: 4.236 MeV, 4.16 MeV**
54. **2074 Set B Q.No. 10b** The mass of  ${}_{17}\text{Cl}^{35}$  is 34.9800 amu. Calculate its binding energy and binding energy per nucleon. Mass of one proton = 1.007825 amu and mass of one neutron = 1.00865 amu. [4]  
**Ans: 287.66 MeV and 8.2 MeV**
55. **2073 Supp Q.No. 10b** **2072 Set D Q.No. 10c** **2070 Supp. Set A Q.No. 10b** **2068 Can. Q.No. 10b** The energy liberated in the fission of single uranium  ${}_{92}\text{U}^{235}$  atom is  $3.2 \times 10^{-11}\text{J}$ . Calculate the power production corresponding to the fission of 1g of uranium per day. Assume Avogadro constant as  $6.02 \times 10^{23}\text{mole}^{-1}$ . [4]  
**Ans:  $9.5 \times 10^6$  watt**
56. **2073 Set D Q.No. 10b** What will be the amount of energy released in the fusion of three alpha particles into a  $\text{C}^{12}$  nucleus if mass of  $\text{He}^4$  and  $\text{C}^{12}$  nuclei are respectively 4.00263 amu and 12 amu. [4]  
**Ans: 7.35 MeV**
57. **2072 Supp Q.No. 10c** The mass of the nucleus of the isotope Lithium ( $\text{Li}7$ ) is 7.014351 u. Find its binding energy and binding energy per nucleon. (Given mass of proton = 1.007275 u, mass of neutron = 1.008665 u) [4]  
**Ans: 39.22 Mev and 5.60 Mev/ Nucleon**
58. **2072 Set E Q.No. 10c**  ${}_{28}\text{Ni}^{62}$  may be described as the most strongly bound nucleus because it has the highest B.E. per nucleon. Its neutral atomic mass is 61.928349 amu. Find its mass defect, its total binding energy and binding energy per nucleon. Given, mass of neutron = 1.008665 amu; mass of proton = 1.007825 amu; 1 amu = 931.5 MeV. [4]  
**Ans: MD = 0.585361 amu; TBE = 545.26 MeV; BE = 8.8 Mev Per nucleon**
59. **2071 Set C Q.No. 10c** The energy released by fission of one  $\text{U}^{235}$  atom is 200 MeV. Calculate the energy released in KWh, when one gram of uranium undergoes fission. [4]  
**Ans:  $4.96 \times 10^8$  watt**
60. **2071 Set D Q.No. 10b** Calculate the binding energy per nucleon for a helium nucleus. Given that mass of helium nucleus = 4.001509 amu, mass of proton = 1.007277 amu and mass of neutron = 1.008666 amu. [4]  
**Ans: 7.07 MeV/nucleo**

61. **2070 Supp. Set B Q.No. 10 c** The most common isotope of uranium  ${}^{238}_{92}\text{U}$ , has atomic mass 238.050783u. Calculate the (a) mass defect, (b) binding energy, (c) Binding energy per nucleon (Mass of proton = 1.007825u, mass of neutron = 1.008665u) [4]  
Ans: (a) 1.9342u (b) 1800.75 MeV (c) 7.566 MeV/nucleon
62. **2069 Set B Q.No. 10a** Estimate the binding energy per nucleon of  ${}^7_3\text{Li}$ . Mass of  ${}^7_3\text{Li}$ , a proton and a neutron are respectively 7.01435 amu, 1.00728 amu and 1.00867 amu. [4]  
Ans: 5.6 MeV/nucleon
63. **2068 Old Q.No. 8 b OR** Assuming that about 200 MeV energy is released per fission of  ${}_{92}\text{U}^{235}$  nuclei, what would be the mass of  $\text{U}^{235}$  consumed per day in the fission reactor of power 1MW approximately? [4]  
Ans: 1.05 gm
64. **2064 Q.No. 8 b OR** The energy liberated in the fission of a single uranium - 235 atom is  $3.2 \times 10^{-11}$  J. Calculate the power production corresponding to the fission of 1.5 kg. of uranium per day. [4]  
Ans:  $1.42 \times 10^9$  W
65. **2054 Q.No. 16 OR** The energy liberated in the fission of a single uranium - 235 atom is  $3.2 \times 10^{-11}$  J. Calculate the power production corresponding to the fission of 1 kg. of uranium per day. [4]  
(Avogadro constant =  $6.0 \times 10^{23}$  mole $^{-1}$ ) Ans:  $9.4 \times 10^8$  W
66. **2052 Q.No. 14** Calculate the Q-value of the reaction and mention the type of reaction (endothermic or exothermic)  
 $2\text{He}^4 = 4.00377$  amu       $8\text{O}^{17} = 17.00450$  amu  
 $7\text{N}^{14} = 14.00783$  amu       $1\text{H}^1 = 1.00814$  amu [4]  
Ans: 0.96824 Mev
67. **2052 Q.No. 16** Calculate the speed of particle if the mass of it is equal to 5 times its rest mass. [4]  
Ans:  $2.94 \times 10^8$  m/s

## 5. RADIOACTIVITY

### FORMULAE

- The activity of a radioactive nucleus,  $dN/dt = -\lambda N$ , where  $N = N_0 e^{-\lambda t}$ , Where  $N_0$  is the number of undecayed nuclei at time  $t = 0$ .
- The half-life  $T_{1/2}$  and the decay constant  $\lambda$  are related by the equation,  $T_{1/2} = 0.693/\lambda$ .
- The relation of mean life and decay constant is  $T_m = \frac{1}{\lambda}$

### Short Answer Questions [2 Marks]

- 2077 Set D Q.No. 1c** How does a daughter nucleus differ from its parent nucleus when it emits a  $\beta$  particle? [2]
- 2076 Set B Q.No. 2d** All the radioactive series terminate at lead as their final product. Why? [2]
- 2076 Set C Q.No. 2d** How does a daughter nucleus differ from its parent nucleus when it emits an  $\alpha$ -particle? [2]
- 2075 GIE Q.No. 2d** How does a daughter nucleus differ from its parent nucleus when it emits  
i. an  $\alpha$  particle      ii.  $\gamma$ -rays [2]

- 2074 Supp Q.No. 2c** What change takes place in the nucleus when  
i. an  $\alpha$  particle is emitted.  
ii. a  $\gamma$ -ray is emitted.
  - 2074 Set A Q.No. 2d** How does a daughter nucleus differ from its parent nucleus when it emits (i) an  $\alpha$ -particle and (ii) a  $\beta$ -particle?
  - 2074 Set B Q.No. 2d** If a radioactive nucleus has a half life of one year, will it be completely decayed at the end of two years? Explain.
  - 2073 Set D Q.No. 2d** Characteristic features of X-rays and  $\gamma$ -rays are similar in many aspects. Write two important features that explain the differences between these rays.
  - 2072 Set C Q.No. 2e** A nucleus contains no electrons, yet it ejects them. Explain.
  - 2072 Set D Q.No. 2d** How do the mass number and atomic number of a radioactive element change in an  $\alpha$ -decay?
  - 2071 Supp. Q.No. 2e** There are no electrons inside the nucleus, but they are emitted from an unstable nucleus. Why?
  - 2070 Supp. Set A Q.No. 2 d** How are half life and average life of a radioactive substance related?
  - 2069 Set A Q.No. 2d** Beta particles penetrate through matter easily than that of alpha-particle of the same energy. Why?
  - 2069 Set A Old Q.No. 2d** **2052 Q.No. 12 a** What do you mean by curie?
  - 2069 Set B Q.No. 2b** Write down the decay schemes separately for alpha and beta decays from a nucleus  ${}^A_Z\text{X}$ .
  - 2068 Q.No. 2 d** Heavy unstable nuclei usually decay by emitting an  $\alpha$  or  $\beta$  particle. Why do they not usually emit a single proton or neutron?
  - 2068 Old Q.No. 1 h** Explain the term "decay constant".
  - 2064 Q.No. 2 g** How do you get emission of  $\beta$ -particles from the nucleus, although there are no electron within it?
  - 2060 Q.No. 2 g** What is the result if an  $\alpha$ -particle is emitted from a nucleus? Give an example.
  - 2058 Q.No. 2 f** Can a single nucleus at a time emit  $\alpha$ -particle,  $\beta$ -particle and gamma ray?
  - 2057 Q.No. 1 f** How do  $\beta$ -particles differ from electrons?
  - 2054 Q.No. 12 c** **2053 Q.No. 12 d** Explain the term artificial radio isotopes.
  - 2053 Q.No. 13** What are beta and gamma rays? State three properties each.
  - 2052 Q.No. 12 b** How will you identify  $\alpha$ ,  $\beta$  and  $\lambda$  radiation by simple experiment?
- ### Long Answer Questions [4 Marks]
- 2076 GIE Set A Q.No. 6d** State radioactive disintegration law and obtain the expression between half life and decay constant.
  - 2076 GIE Set B Q.No. 6d** Describe radioactive disintegration law. Obtain the relation between half life and decay constant.
  - 2076 Set B Q.No. 6c** List out the laws of radioactive disintegration. Deduce the expression  $N = N_0 e^{-\lambda t}$  where symbols have their usual meaning.

28. **2075 Set B Q** State the la relation betw

29. **2074 Supp** disintegratio substance?

30. **2073 Set D** hence defin one Curie?

31. **2072 Supp** disintegratio equation fi constant.

32. **2072 Set** activity? De

33. **2071 Set** disintegrati substance?

34. **2070 Supp** radioactive where the estimate th

35. **2070 Supp** Deduce at has elaps radioactiv

36. **2070 Set** derive the

37. **2069 Supp** natural an radioactiv and half l

38. **2068 Ca** disintegra decay co

39. **2068 Old** Define a substance

40. **2067 Q.** relations active el

41. **2065 Q.** a radioa radioact

42. **2064 Q.** show th substan relation substan

43. **2060 Q** decay period.

44. **2054 Q** Derive

### Numerical Problems [4 Marks]

28. **2075 Set B Q.No. 6d** **2073 Supp Q.No. 6d** **2072 Set D Q.No. 6d** State the laws of radioactive disintegration. Derive the relation between half life and decay constant. [4]
29. **2074 Supp Q.No. 6d** State the laws of radioactive disintegration. What is half life period of a radioactive substance? Derive an expression for it. [4]
30. **2073 Set D Q.No. 6b** Deduce the law of radioactivity and hence define half life of a radioactive sample. How much is one Curie? [4]
31. **2072 Supp Q.No. 6d** State the laws of radioactive disintegration. Derive disintegration equation. Using the equation find a relation between the half life and decay constant. [4]
32. **2072 Set E Q.No. 6c** What are different units of radio activity? Describe "carbon dating". [4]
33. **2071 Set D Q.No. 6 c** State the laws of radioactive disintegration. What is half life period of a radioactive substance? Derive an expression for it. [4]
34. **2070 Supp. Set A Q.No. 6 b** Define decay constant for a radioactive substance and deduce the expression  $N=N_0 e^{-\lambda t}$ , where the symbols have their usual meanings. How can we estimate the age of some fossils using such equation? [4]
35. **2070 Supp. Set B Q.No. 6 c** Discuss radioactive decay law. Deduce an expression for the number of atoms after a time 't' has elapsed and hence write an expression for half life of the radioactive substance. [4]
36. **2070 Set D Q.No. 6 c** State the laws of radioactivity and derive the decay equation. [4]
37. **2069 Supp Set B Q.No. 6 b** Explain the difference between natural and artificial radioactivity and obtain the decay law of radioactivity. Also find a relation between the decay constant and half life of a radioactive isotope. [4]
38. **2068 Can. Q.No. 6c** Write down laws of radioactive disintegration and establish a relation between half life and decay constant. [4]
39. **2068 Old Can. Q.No. 9** **2066 Supp Q.No. 9** **2061 Q.No. 8a** Define half- life and decay constant of a radioactive substance. Establish a relation between them. [2+2]
40. **2067 Q.No. 6c** Derive the decay equation and establish the relationship between decay constant and half life of radioactive element. [4]
41. **2065 Q.No. 8 a OR** What do you understand by the activity of a radioactive material? Write its unit. Also derive the law of radioactive disintegration. [1+3]
42. **2064 Q.No. 9 OR** State laws of radioactive disintegration and show that the number of atoms of a given radioactive substance decreases exponentially with time. Also, derive a relation between decay constant and half life of a radioactive substance. [2+2]
43. **2060 Q.No. 9** What is radioactivity? Obtain its exponential decay law and hence derive an expression for half life period. [1+2+1]
44. **2054 Q.No. 13** State the law of radioactive disintegration. Derive a relation between half-life and decay constant. [4]
45. **2077 Set D Q.No. 3b** A radioactive element has a half life of 2500 years. In how many years will its mass decay by 90% of its initial mass? [4]  
Ans: 8297 years
46. **2076 Set C Q.No: 10c** **2075 GIE Q.No. 10c** Find the half life of  $^{238}\text{U}$ , if 1 gm of it emits  $1.24 \times 10^4$   $\alpha$ -particles per-second Avogadro's number =  $6.025 \times 10^{23}$ . [4]  
Ans:  $4.5 \times 10^9$  years
47. **2074 Set A Q.No. 10c** The isotope Ra-226 undergoes  $\alpha$  decay with a half life of 1620 years. What is the activity of 1 g of Ra-226? Avogadro number =  $6.023 \times 10^{23}$ /mole. [4]  
Ans:  $3.6 \times 10^{10}$  dis/sec
48. **2074 Set B Q.No. 10c** Calculate the mass in grams of a radioactive sample Pb-214 having an activity of  $3.7 \times 10^4$  decays / s and a half life of 26.8 minutes. Avogadro number =  $6.02 \times 10^{23}$  /mole. [4]  
Ans:  $3.05 \times 10^{-17}$  kg
49. **2073 Supp Q.No. 10c** **2056 Q.No. 16** A radioactive source has decayed to one tenth of one percent of its initial activity in one hundred days. What is its half life period? [4]  
Ans: 10 days
50. **2073 Set C Q.No. 10a** Half life of  $\text{Ra}^{226}$  is 1620 years. Estimate its mass when its activity is 0.5 Curie. [4]  
Ans:  $0.51 \times 10^{-3}$  kg
51. **2072 Set C Q.No. 10c** After a certain lapse of time, the fraction of radioactive polonium undecayed is found to be 12.5% of the initial quantity. What is the duration of this time lapse if half life of polonium is 139 days. [4]  
Ans: 417.2 day
52. **2071 Supp. Q.No. 10b** If 15% of the radioactive material decays in 5 days, what would be the percentage of amount of original material left after 25 days? [4]  
Ans: 44%
53. **2071 Set C Q.No. 10 b** The mass of the radium is 226. It is observed that  $3.67 \times 10^{10}$   $\alpha$ -particles are emitted per second from 1g of radium. Calculate the half life of radium. (Avogadro number =  $6.023 \times 10^{23}$  mole) [4]  
Ans: 1586 years
54. **2070 Set C Q.No. 10 c** Measurements on certain isotope show that the decay rate decreases from 8318 decays/min. to 3091 decays/min. in 4 days. What is the half life of this isotope? [4]  
Ans: 2.8 days
55. **2069 Supp Set B Q.No. 10 c** At a certain instant a piece of radioactive material contains  $10^{12}$  atoms. The half life of the material is 40 days. Calculate the number of disintegrations in first one second. [4]  
Ans:  $2 \times 10^5$  dis/sec
56. **2069 Set A Q.No. 10c** Find the half life of  $^{238}\text{U}$ , if one gram of it emits  $1.24 \times 10^4$   $\alpha$ - particles per second. (Avogadro's number =  $6.023 \times 10^{23}$ ) [4]  
Ans:  $1.4 \times 10^{17}$  sec
57. **2068 Q.No. 10 c** At a certain instant, a piece of radio active material contains  $10^{12}$  atoms. The half-life of the material is 30 days. Calculate the number of disintegrations in the first second. [4]  
Ans:  $2.7 \times 10^5$  s

58. **2067 Old Q.No. 8b** If the half life period of a radioactive substance is 2 days, after how many days will  $\frac{1}{64}$  th part of the substance be left behind? [4]  
Ans: 12 days
59. **2067 Sup Q.No. 10c** The initial number of atoms in a radioactive element is  $6 \times 10^{20}$  and its half life is 10 hours. Calculate the number of atoms which have decayed in 30 hours and the amount of energy liberated if the energy liberated per atom decay is  $4 \times 10^{-13}$  J. [4]  
Ans:  $5.25 \times 10^{20}$  atoms,  $2.1 \times 10^8$  J
60. **2066 Q.No. 8 b** A small volume of a solution which contains a radioactive isotope of sodium had an activity of 12000 disintegrations per minute when it was injected into the blood stream of a patient. After 30 hours the activity of  $1 \text{ cm}^3$  of the blood was found to be 0.5 disintegration per minute. If the half life of the sodium isotope is 15 hours, estimate the volume of the blood in the patient. [4]  
Ans:  $6000 \text{ cm}^3$
61. **2063 Q.No. 8 b OR** A sample of Ra-226 has half life of 1620 years. What is the mass of the sample which undergoes 20000 disintegrations per second? (Avogadro's no. =  $6.02 \times 10^{23} \text{ mol}^{-1}$ ) [4]  
Ans:  $5.44 \times 10^{-10} \text{ kg}$ .
62. **2062 Q.No. 8 b OR** The isotope  $^{14}\text{C}$  has a half life 5700 yrs. If the sample contains  $1 \times 10^{22}$  carbon 14 nuclei. What is the activity of the sample? [4]  
Ans:  $4 \times 10^{10}$  disintegrations/second
63. **2059 Q.No. 8 b OR** The unstable isotope of potassium - 40 has a half life of  $2.4 \times 10^8$  yrs. How many decays occur per second in a sample containing  $2 \times 10^{-6}$  gm of potassium - 40? [4]  
Ans: 2.76 dis/S
64. **2057 Q.No. 8 b OR** A radioactive source which has the half life of 130 days, contains initially  $1 \times 10^{20}$  radioactive atoms, and the energy released per disintegration is  $8 \times 10^{-13}$  J, calculate the activity of the source after 260 days have elapsed and total energy released during this period. [4]  
Ans:  $1.54 \times 10^{12}$  dis/S,  $6 \times 10^7$  J
65. **2055 Q.No. 16** If 4g of radio active material of half life period of 10 years disintegrates, find out mean life of the given sample. [4]  
Ans: 14.43 years
66. **2053 Q.No. 16 OR** At certain instant a piece of radio active material contained  $10^{12}$  atoms. The half life of the material is 15 days. Calculate the rate of decay after 30 days have elapsed. [4]  
Ans:  $1.15 \times 10^{10}$  dis/S

## 6. NUCLEAR ENERGY AND OTHER SOURCES OF ENERGY

### Short Answer Questions [2 Marks]

- 2076 GIE Set A Q.No. 2e** What do you mean by degradation of energy? Explain. [2]
- 2076 GIE Set B Q.No. 2e** How is biomass used as fuel? [2]
- 2076 Set B Q.No. 2e** What do you mean by greenhouse effect? Write its effects. [2]

- 2076 Set C Q.No. 2e** What is acid rain? Write its any two effects. [2]
- 2075 GIE Q.No. 2e** **2072 Set D Q.No. 2f** **2071 Set D Q.No. 2f** **2070 Set C Q.No. 2 e** **2068 Can. Q.No. 2f** What is acid rain? Explain. [2]
- 2075 Set A Q.No. 2f** **2068 Q.No. 2 e** If energy is conserved, why is there an energy crisis? [2]
- 2075 Set B Q.No. 2c** Define acid rain and write it's adverse effects. [2]
- 2074 Supp Q.No. 2e** What do you mean by degradation of energy? Explain. [2]
- 2074 Supp Q.No. 2f** Explain how acid rain is formed. [2]
- 2074 Set A Q.No. 2f** **2074 Set B Q.No. 2f** What is energy crisis? Explain. [2]
- 2073 Supp Q.No. 2e** **2067 Old Q.No. 1h** **2065 Q.No. 1h** What do you mean by energy crisis? [2]
- 2072 Supp Q.No. 2e** Which type of renewable energy is most useful to our country? Give reasons. [2]
- 2072 Set C Q.No. 2f** What do you mean by global warming? [2]
- 2071 Set C Q.No. 2 e** Write the meaning of conservation of energy and degradation of energy. [2]
- 2071 Set C Q.No. 2 f** **2070 Set D Q.No. 2 e** What is global warming? Explain. [2]
- 2069 Set A Old Q.No. 1g** Name some of major air pollutants. [2]
- 2069 Set B Q.No. 2e** What is global warming? Give two examples of its effect. [2]
- 2068 Old Can. Q.No. 1h** State the two main effects on the earth due to ozone depletion? [2]
- 2068 Old Can. Q.No. 2h** What are the main energy sources in Nepal? [2]
- 2068 Old Q.No. 2 g** Explain what are solar flares. [2]
- 2068 Old Q.No. 2 h** Mention the major sources of Noise Pollution. [2]
- 2067 Q.No. 2f** What is global warming? [2]
- 2066 Supp Q.No. 2h** What do you mean by radiation hazard? [2]
- 2065 Q.No. 2 h** **2064 Q.No. 2 h** What do you understand by green house effect? [2]
- 2063 Q.No. 1 h** What is radiation hazard? [2]
- 2063 Q.No. 2 e** Which bomb is more explosive, hydrogen bomb or atom bomb? [2]
- 2063 Q.No. 2 f** What is the source of energy of sun? [2]
- 2062 Q.No. 1 h** What is Ozone depletion? [2]
- 2062 Q.No. 10 OR** Discuss energy crisis in a modern society. [2]
- 2060 Q.No. 2 h** What is water pollution? [2]
- 2059 Q.No. 1 h** What is noise pollution? [2]
- 2059 Q.No. 2 h** Why is solar energy more preferable than fossil-fuel energy? Explain. [2]
- 2058 Q.No. 1 h** What is ozone-hole? [2]
- 2057 Q.No. 1 g** What are renewable sources of energy? [2]

### Long Answer Questions [4 Marks]

- 2076 Set B Q.No. 6d** What are sources of energy? Discuss global energy consumption pattern and demands. [4]

2076 Set C Q. Discuss the demands.

2075 GIE Q.No. Nepal? Suggest the future.

2074 Set A Q. source of energy consumption.

2074 Set B Q. effects, sources.

2072 Supp. implications of (i) fossil fuels.

2072 Set C. renewable energy. Describe the source of energy to.

2070 Set C. Discuss the brief account demands.

2068 Old C. adverse effects measures to.

2068 Old Q. What safety avoid it?

2068 Old C. energy for the develop.

2067 Old C. development.

2067 Old. causes and impacts of physics in.

2064 Q.No. effects and the develop.

2063 Q.No. development.

2063 Q.No. being used of ozone.

2062 Q.No. What steps atmospheric.

2061 Q.No. its effects.

36. **2076 Set C Q.No. 6d** What are the major energy sources? Discuss the global energy consumption pattern and demands. [4]
37. **2076 GIE Q.No. 6d** What are the major energy sources in Nepal? Suggest some measures to reduce energy crisis in the future. [4]
38. **2074 Set A Q.No. 6d** Explain renewable and non-renewable source of energy with examples. Give an account of the energy consumption scenario in Nepal. [4]
39. **2074 Set B Q.No. 6d** What is green house effect? Discuss its effects, sources and the controlling measures. [4]
40. **2072 Supp Q.No. 6a** What are the environmental implications of the following energy sources:  
(i) fossil fuels and (ii) nuclear fuels? [4]
41. **2072 Set C Q.No. 6d** What are renewable and non-renewable sources of energy? Write with examples. Describe the necessity of conservation of natural resources of energy to reduce energy crisis in the future. [4]
42. **2070 Set C Q.No. 6 d** What are the major energy sources? Discuss the global energy consumption pattern. [4]
43. **2068 Can. Q.No. 6d** What are major energy sources? Give a brief account on the global energy consumption pattern and demands. [4]
44. **2068 Old Can. Q.No. 10** What is air pollution? Discuss the adverse effects of it on the human beings. Write some measures to control it. [4]
45. **2068 Old Q.No. 10** What do you mean by radiation hazard? What safety measures may be taken into account in order to avoid it? [4]
46. **2068 Old Q.No. 10 OR** Discuss, in brief, the importance of energy for the development of a country. [4]
47. **2068 Old Can. Q.No. 10 OR** Discuss the role of physics in the development of a nation. [4]
48. **2067 Old Q.No. 10** Discuss the importance of physics for the development of nation. [4]
49. **2067 Old Q.No. 10 OR** What is ozone hole? Mention the causes and effects of depletion of ozone layer. [1+3 = 4]
50. **2066 Supp Q.No. 10** What is ozone hole? Discuss the impacts of ozone depletion on living beings. [4]
51. **2066 Supp Q.No. 10 Or** Write an essay on the role of physics in the development of nation. [4]
52. **2064 Q.No. 10** What is water pollution? Discuss its adverse effects and give some measures to control it. [4]
53. **2064 Q.No. 10 OR** Write an essay on the role of physics in the development of a developing country like Nepal. [4]
54. **2063 Q.No. 10** What are the roles of physics in the development of nation? [4]
55. **2063 Q.No. 10 OR** Describe the present sources of energy being used in our country. [4]
56. **2062 Q.No. 10** What is an ozone layer? Describe the effects of ozone depletion on the plants and animal life on earth. What steps should we take to avoid ozone depletion in our atmosphere? [4]
57. **2061 Q.No. 10** What are the causes of air pollution? Mention its effects and ways to minimize it. [4]
58. **2061 Q.No. 10 OR** Write an essay on major sources of energy in Nepal. [4]
59. **2060 Q.No. 10** Give a brief account on "Energy sources of Nepal". [4]
60. **2060 Q.No. 10 OR** What is air pollution? Discuss major sources of air pollution and suggest some ways of controlling it. [1+2+1]
61. **2059 Q.No. 10** What do you mean by ozone-hole? What various agents are responsible for ozone layer depletion in the stratosphere? What measures should we take to stop the depletion of ozone layer? [1+2+1 = 4]
62. **2059 Q.No. 10 OR** What is renewable source of energy? Nepal is rich in hydro power next to Brazil. Comment on it. [1+3]
63. **2058 Q.No. 10** What is water pollution? What degree of water pollution do you think exists in Kathmandu valley? [4]
64. **2058 Q.No. 10 OR** What do you mean by radiation hazard? What are its safety measures? [4]
65. **2057 Q.No. 10** What is the role of physics in the development of a nation? [4]
66. **2057 Q.No. 10 OR** What is ozone hole? Discuss the impacts of ozone depletion on living things. [4]

## 7. PARTICLE PHYSICS AND COSMOLOGY

### Short Answer Questions [2 Marks]

- 2076 GIE Set A Q.No. 2f** Write quark combination of proton and neutron. [2]
- 2076 GIE Set B Q.No. 2d** What do you mean by elementary particles and antiparticles? [2]
- 2076 Set B Q.No. 2f** **2072 Supp Q.No. 2a** **2070 Supp. Set B Q.No. 2 f** Does the universe have a centre? Explain. [2]
- 2076 Set C Q.No. 2f** **2074 Supp Q.No. 2d** **2072 Set C Q.No. 2d** Write the quark composition of proton and neutron. [2]
- 2075 GIE Q.No. 2f** **2074 Set A Q.No. 2e** **2072 Set D Q.No. 2e** **2071 Set D Q.No. 2 e** State Hubble's law and write the significance of Hubble's constant. [2]
- 2075 Set B Q.No. 2e** Distinguish between leptons and quarks. [2]
- 2075 Set B Q.No. 2f** Give two evidences to show that the universe is expanding. [2]
- 2074 Set B Q.No. 2e** State Hubble's law. What do you mean by dark matter? [2]
- 2073 Supp Q.No. 2f** What are the similarities and differences between a neutrino and a photon? [2]
- 2073 Set C Q.No. 2f** What class of quark combination one can expect in the combination of one quark and a lepton. Explain with example. [2]
- 2073 Set C Q.No. 2e** **2073 Set D Q.No. 2e** State and explain Hubble's law. [2]
- 2073 Set D Q.No. 2c** How many types of quark you know? Name them with their electronic charges. [2]
- 2072 Set E Q.No. 2c** **2066 Q.No. 1h** **2064 Q.No. 1 f** **2061 Q.No. 2 h** **2060 Q.No. 1 h** What are cosmic rays? [2]
- 2072 Set E Q.No. 2e** **2070 Set D Q.No. 2 f** Show that proton contains three quarks: up, up and down. [2]

15. **2071 Supp. Q.No. 2f** What are quarks? Write their names with charge they contained. [2]
16. **2070 Supp. Set A Q.No. 2 f** What are the similarities and differences between quarks and leptons? [2]
17. **2070 Set C Q.No. 2 f** **2069 Set B Q.No. 2a** Explain the significance of Hubble's constant. [2]
18. **2069 Supp Set B Q.No. 2 f** Show that the dimension of Planck's constant is the same as that of angular momentum. [2]
19. **2069 Set A Q.No. 2f** What are the quark combination of proton and neutron. [2]
20. **2068 Can. Q.No. 2e** **2066 Supp Q.No. 2g** Write the quark combination of proton and neutron. [2]
21. **2068 Old Can. Q.No. 2g** What are quarks? Write quark combination of a proton. [2]
22. **2068 Q.No. 2 c** What are the similarities and differences between a neutrino and a photon? [2]
23. **2067 Q.No. 2e** Write down the quark combination for proton and antineutron. [2]
24. **2067 Old Q.No. 2d** What is red shift? [2]
25. **2067 Old Q.No. 2g** **2057 Q.No. 2 g** What particles do the  $u \bar{u} d$  combination produce? [2]
26. **2067 Old Q.No. 2h** What are asteroids? [2]
27. **2067 Sup Q.No. 2d** A particle consisting up, up and down quarks is a proton. Justify? [2]
28. **2066 Q.No. 2 g** What are mesons? Write the names of two mesons. [2]
29. **2066 Q.No. 2 h** **2066 Supp Q.No. 1g** **2063 Q.No. 1 g** What is a black hole? [2]
30. **2063 Q.No. 2 g** Give two examples of the pairs of particle-antiparticle system. [2]
31. **2061 Q.No. 1 h** What is a black hole? [2]
32. **2061 Q.No. 2 g** What is the quark combination of a proton? [2]
33. **2059 Q.No. 1 g** What quarks combination will give a neutron? [2]
34. **2059 Q.No. 2 g** How do you know that the universe is expanding? Give reasons. [2]

**Long Answer Questions [4 Marks]**

35. **2069 Set B Q.No. 6c** Name the quarks you know. Also present the quark combinations of baryon and meson groups of particles. [4]
36. **2068 Old Q.No. 9 OR** Give an account of simple classification of elementary particles with examples. [4]
37. **2066 Q.No. 10 OR** Describe the death of a star. [4]
38. **2062 Q.No. 9** What are fundamental particles? How are they classified? Write the properties of quarks and lepton. [4]
39. **2062 Q.No. 9 OR** Explain how Universe expands. Explain the Hubble's law. [4]
40. **2059 Q.No. 9 a OR** Name the different types of galaxies you know? Describe milky way galaxy in brief. [4]
41. **2058 Q.No. 9 OR** Give a classification of elementary particles with example. [4]

**YEARWISE QUESTIONS****2077 (Set D)****Group 'A'**

1. **Answer, in brief, any three questions.** [3×2=6]
- Draw a Wheatstone bridge circuit and mention the balance condition for it.
  - What is Curie temperature?
  - How does a daughter nucleus differ from its parent nucleus when it emits a  $\beta$  particle?
  - What is quality of sound?
  - Can sound waves be polarized? Explain.

**Group 'B'**

2. **Answer any three questions.** [3×4=12]
- Define thermoelectric effect. How does the emf of a thermocouple vary with the temperature of hot junction?
  - Describe J.J. Thomson's experiment for measuring the specific charge ( $e/m$ ) of an electron.
  - Prove, with necessary diagrams, that both types of harmonics odd and even can be obtained in an organ pipe open at both ends. What is end correction of a pipe?

- State and explain Huygen's construction and use it to verify laws of refraction.

**Group 'C'**

3. **Answer any three numerical questions.** [3×4=12]
- A coil of inductance 0.5 H and negligible resistance is in series with a resistance of 40  $\Omega$ . A supply voltage of 40 V (rms) is connected across them. If the voltage across the coil is equal to that across resistor, calculate the voltage across each component and frequency of the supply.
  - A radioactive element has a half life of 2500 years. In how many years will its mass decay by 90% of its initial mass?
  - At what temperature, the velocity of sound in air is increased by 60% to that at 27°C?
  - In a Newton's rings experiment, the diameter of 15<sup>th</sup> ring was found as 0.594 cm and that of 5<sup>th</sup> ring was 0.332 cm. Calculate the radius of curvature of the plano-convex lens if the wavelength of light used is 5890Å.