**Class: XII**
**SESSION : 2022-2023**
**CBSE SAMPLE QUESTION PAPER (THEORY)**
**SUBJECT: PHYSICS**

**Maximum Marks**: 70 Marks **Time Allowed**: 3 hours.

**General Instructions:**

(1) There are 35 questions in all. All questions are compulsory
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
(3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
(4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

**SECTION A**

| Q. NO. | | MARKS |
|---|---|---|
| 1 | **According to Coulomb's law, which is the correct relation for the following figure?**<br><br><br>(i) $q_1 q_2 > 0$<br>(ii) $q_1 q_2 < 0$<br>(iii) $q_1 q_2 = 0$<br>(iv) $1 > q_1/q_2 > 0$ | 1 |
| 2 | **The electric potential on the axis of an electric dipole at a distance 'r from it's centre is V. Then the potential at a point at the same distance on its equatorial line will be**<br>(i) 2V<br>(ii) -V<br>(iii) V/2<br>(iv) Zero | 1 |

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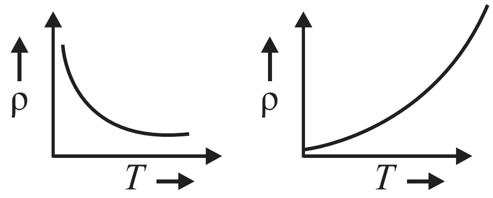
| 3 | **The temperature (T) dependence of resistivity of materials A and material B is represented by fig (i) and fig (ii) respectively. Identify material A and material B.**<br><br><br>fig. (i) fig. (ii)<br>(i) material A is copper and material B is germanium<br>(ii) material A is germanium and material B is copper<br>(iii) material A is nichrome and material B is germanium<br>(iv) material A is copper and material B is nichrome | 1 |
| 4 | **Two concentric and coplanar circular loops P and Q have their radii in the ratio 2:3. Loop Q carries a current 9 A in the anticlockwise direction. For the magnetic field to be zero at the common centre, loop P must carry**<br>(i) 3A in clockwise direction<br>(ii) 9A in clockwise direction<br>(iii) 6 A in anti-clockwise direction<br>(iv) 6 A in the clockwise direction. | 1 |
| 5 | **A long straight wire of circular cross section of radius a carries a steady current I. The current is uniformly distributed across its cross section. The ratio of the magnitudes of magnetic field at a point distant a/2 above the surface of wire to that at a point distant a/2 below its surface is**<br>(i) 4 :1<br>(ii) 1:1<br>(iii) 4: 3<br>(iv) 3 :4 | 1 |
| 6 | **If the magnetizing field on a ferromagnetic material is increased, its permeability**<br>(i) decreases<br>(ii) increases<br>(iii) remains unchanged<br>(iv) first decreases and then increases | 1 |

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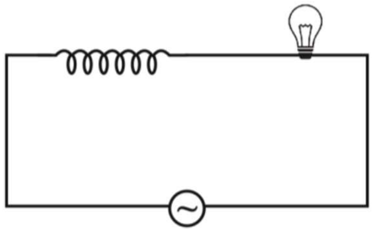
|---|---|---|
| 7 | **An iron cored coil is connected in series with an electric bulb with an AC source as shown in figure. When iron piece is taken out of the coil, the brightness of the bulb will**<br><br>**(i)** decrease<br>(ii) increase<br>(iii) remain unaffected<br>(iv) fluctuate | 1 |
| 8 | **Which of the following statement is NOT true about the properties of electromagnetic waves?**<br>(I) These waves do not require any material medium for their propagation<br>(ii) Both electric and magnetic field vectors attain the maxima and minima at the same time<br>(iii) The energy in electromagnetic wave is divided equally between electric and magnetic fields<br>(iv) Both electric and magnetic field vectors are parallel to each other | 1 |
| 9 | A rectangular, a square, a circular and an elliptical loop, all in the ($x$-$y$) plane, are moving out of a uniform magnetic field with a constant velocity $\vec{v} = v\hat{i}$.The magnetic field is directed along the negative $z$-axis direction. The induced emf, during the passage of these loops, out of the field region, will not remain constant for<br>(i) any of the four loops<br>(ii) the circular and elliptical loops<br>(iii) the rectangular, circular and elliptical loops<br>(iv) only the elliptical loops | 1 |

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| 10 | **In a Young's double slit experiment, the path difference at a certain point on the screen between two interfering waves is $\frac{1}{8}$th of the wavelength. The ratio of intensity at this point to that at the centre of a bright fringe is close to**<br>(i) 0.80<br>(ii) 0.74<br>(iii) 0.94<br>(iv) 0.85 | 1 |
| 11 | **The work function for a metal surface is 4.14 eV. The threshold wavelength for this metal surface is:**<br>(i) 4125 Å<br>(ii) 2062.5 Å<br>(iii) 3000 Å<br>(iv) 6000 Å | 1 |
| 12 | **The radius of the innermost electron orbit of a hydrogen atom is $5.3\times10^{-11}$ m. The radius of the n =3 orbit is**<br>(i) 1.01 x $10^{-10}$m<br>(ii) 1.59 X $10^{-10}$m<br>(iii) 2.12 x $10^{-10}$m<br>(iv) 4.77 X $10^{-10}$m | 1 |
| 13 | **Which of the following statements about nuclear forces is not true?**<br>**(i)** The nuclear force between two nucleons falls rapidly to zero as their distance is more than a few femtometres.<br>**(ii)** The nuclear force is much weaker than the Coulomb force.<br>**(iii)** The force is attractive for distances larger than 0.8 fm and repulsive if they are separated by distances less than 0.8 fm.<br>**(iv)** The nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same. | 1 |
| 14 | **If the reading of the voltmeter $V_1$ is 40 V, then the reading of voltmeter $V_2$ is** | 1 |

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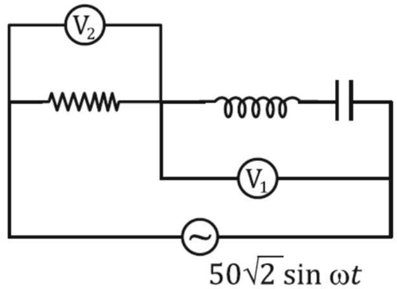
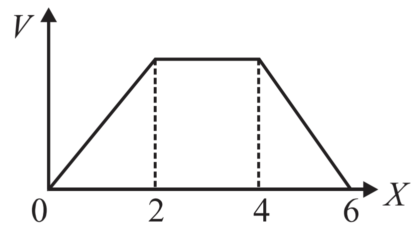
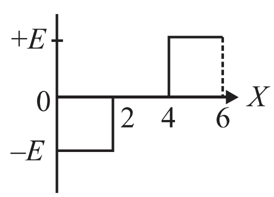
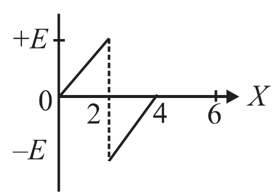
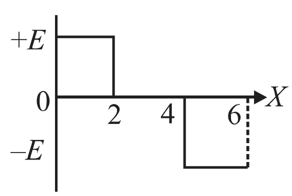
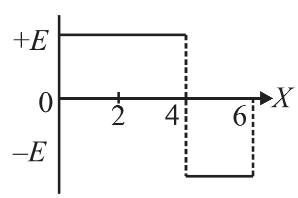
| | <br><br>(i) 30 V (ii) 58 V (iii) 29 V (iv) 15 V | |
| 15 | **The electric potential V as a function of distance X is shown in the figure.**<br><br><br>**The graph of the magnitude of electric field intensity E as a function of X is**<br>**(i)** <br>**(ii)** <br>**(iii)** <br>**(iv)**  | 1 |
| 16 | **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**<br>**a) Both A and R are true and R is the correct explanation of A**<br>**b) Both A and R are true and R is NOT the correct explanation of A** | 1 |

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|---|---|---|
| | **c) A is true but R is false**<br>**d) A is false and R is also false**<br><br>**ASSERTION(A):**<br>The electrical conductivity of a semiconductor increases on doping.<br>**REASON:**<br>Doping always increases the number of electrons in the semiconductor. | |
| 17 | **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**<br>**a) Both A and R are true and R is the correct explanation of A**<br>**b) Both A and R are true and R is NOT the correct explanation of A**<br>**c) A is true but R is false**<br>**d) A is false and R is also false**<br><br>**ASSERTION:**<br>In an interference pattern observed in Young's double slit experiment, if the separation (d) between coherent sources as well as the distance (D) of the screen from the coherent sources both are reduced to $1/3^{rd}$, then new fringe width remains the same.<br>**REASON:**<br>Fringe width is proportional to (d/D). | 1 |
| 18 | **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.**<br>**a) Both A and R are true and R is the correct explanation of A**<br>**b Both A and R are true and R is NOT the correct explanation of A**<br>**c) A is true but R is false**<br>**d) A is false and R is also false**<br>**Assertion(A)** :<br>The photoelectrons produced by a monochromatic light beam incident on a metal surface have a spread in their kinetic energies.<br>**Reason(R)** : | 1 |

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| | The energy of electrons emitted from inside the metal surface, is lost in collision with the other atoms in the metal. | |

**SECTION B**

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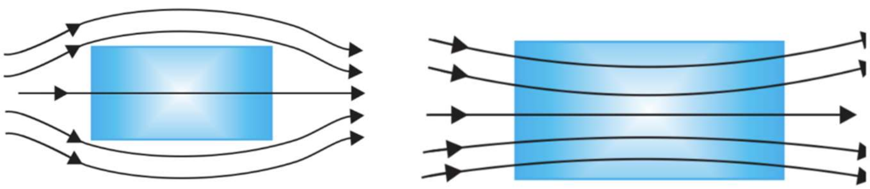
| 19 | Electromagnetic waves with wavelength<br>(i) $\lambda_1$ is suitable for radar systems used in aircraft navigation.<br>(ii) $\lambda_2$ is used to kill germs in water purifiers.<br>(iii) $\lambda_3$ is used to improve visibility in runways during fog and mist conditions.<br>Identify and name the part of the electromagnetic spectrum to which these radiations belong.Also arrange these wavelengths in ascending order of their magnitude. | 2 |
| 20 | A uniform magnetic field gets modified as shown in figure when two specimens A and B are placed in it.<br><br>(a) (b)<br>(i)Identify the specimen A and B.<br>(ii) How is the magnetic susceptibility of specimen A different from that of specimen B? | 2 |
| 21 | What is the nuclear radius of $^{125}Fe$ ,if that of $^{27}$ Al is 3.6 fermi?.<br>**OR**<br>The short wavelength limit for the Lyman series of the hydrogen spectrum is 913.4 $\mathbf{A^0}$. Calculate the short wavelength limit for the Balmer series of the hydrogen spectrum. | 2 |
| 22 | A biconvex lens made of a transparent material of refractive index 1.25 is immersed in water of refractive index 1.33. Will the lens behave as a converging or a diverging lens? Justify your answer. | 2 |

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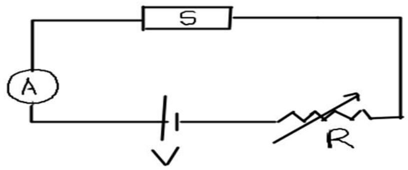
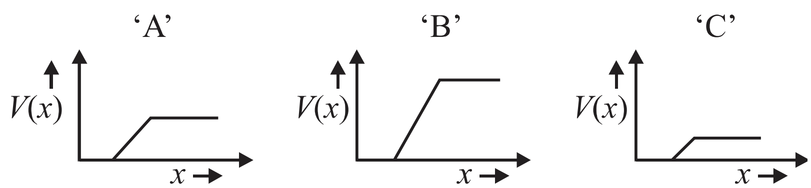
| 23 | The figure shows a piece of pure semiconductor S in series with a variable resistor R and a source of constant voltage V. Should the value of R be increased or decreased to keep the reading of the ammeter constant, when semiconductor S is heated? Justify your answer<br><br>**OR**<br>The graph of potential barrier versus width of depletion region for an unbiased diode is shown in graph A. In comparison to A ,graphs B and C are obtained after biasing the diode in different ways .Identify the type of biasing in B and C and justify your answer.<br> | 2 |
| 24 | A narrow slit is illuminated by a parallel beam of monochromatic light of wavelength λ equal to 6000 Å and the angular width of the central maximum in the resulting diffraction pattern is measured. When the slit is next illuminated by light of wavelength λ', the angular width decreases by 30%. Calculate the value of the wavelength λ'. | 2 |
| 25 | Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude $17.7 \times 10^{-22}$ C/m$^2$. What is electric field intensity E:<br>(a) in the outer region of the first plate, and<br>(b) between the plates? | |

## SECTION C

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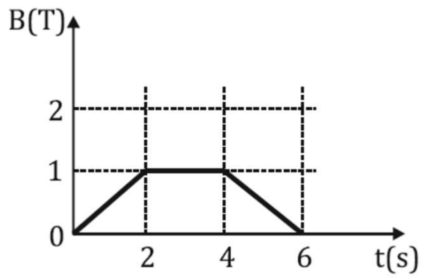
| 26 | Two long straight parallel conductors carrying currents $I_1$ and $I_2$ are separated by a distance d. If the currents are flowing in the same direction, show how the magnetic field produced by one exerts an attractive force on the other. Obtain the expression for this force and hence define 1 ampere. | 3 |
| 27. | The magnetic field through a circular loop of wire, 12cm in radius and 8.5Ω resistance, changes with time as shown in the figure. The magnetic field is perpendicular to the plane of the loop. Calculate the current induced in the loop and plot a graph showing induced current as a function of time.   | 3 |
| 28 | An a.c. source generating a voltage $\varepsilon = \varepsilon_0 \sin \omega t$ is connected to a capacitor of capacitance C. Find the expression for the current I flowing through it. Plot a graph of ε and I versus ωt to show that the current is ahead of the voltage by π/2.<br>**OR**<br>An ac voltage $V = V_0 \sin \omega t$ is applied across a pure inductor of inductance *L*. Find an expression for the current *i*, flowing in the circuit and show mathematically that the current flowing through it lags behind the applied voltage by a phase angle of $\frac{\pi}{2}$. Also draw graphs of *V* and *i* versus ωt for the circuit. | 3 |
| 29 | Radiation of frequency $10^{15}$ Hz is incident on three photosensitive surfaces A, B and C. Following observations are recorded:<br>**Surface A**: no photoemission occurs<br>**Surface B**: photoemission occurs but the photoelectrons have zero kinetic energy. | 3 |

| | | |
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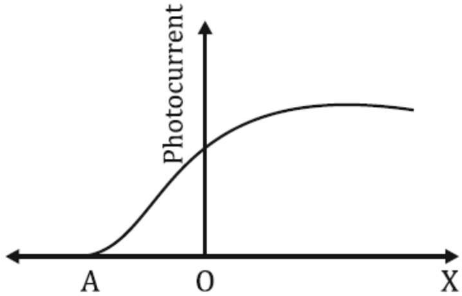
| | **Surface C**: photo emission occurs and photoelectrons have some kinetic energy.<br>Using Einstein's photo-electric equation, explain the three observations.<br>**OR**<br>**The graph shows the variation of photocurrent for a photosensitive metal**<br><br>(a)What does X and A on the horizontal axis represent?<br>(b)Draw this graph for three different values of frequencies of incident radiation $\upsilon_1$, $\upsilon_2$ and $\upsilon_3$ ($\upsilon_3$>$\upsilon_2$>$\upsilon_1$) for the same intensity.<br>(c) Draw this graph for three different values of intensities of incident radiation $I_1$, $I_2$ and $I_3$ ($I_3$> $I_2$>$I_1$) having the same frequency. | |
| 30 | The ground state energy of hydrogen atom is -13.6 eV. The photon emitted during the transition of electron from n=3 to n=1 state, is incident on a photosensitive material of unknown work function .The photoelectrons are emitted from the material with the maximum kinetic energy of 9eV.Calculate the threshold wavelength of the material used. | 3 |

**SECTION D**

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| 31 | (a)Draw equipotential surfaces for (i)an electric dipole and (ii) two identical positive charges placed near each other.<br>(b) In a parallel plate capacitor with air between the plates, each plate has an area of 6 x $10^{-3}m^2$ and the separation between the plates is 3 mm.<br>(i) Calculate the capacitance of the capacitor.<br>(ii) If the capacitor is connected to 100V supply, what would be the the charge on each plate?<br>(iii) How would charge on the plate be affected if a 3 mm thick mica sheet of k=6 is inserted between the plates while the voltage supply remains connected ?. | 5 |

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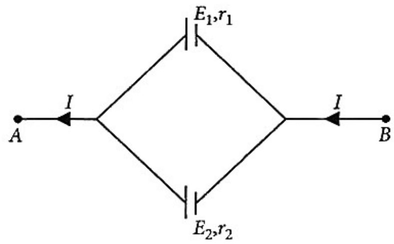
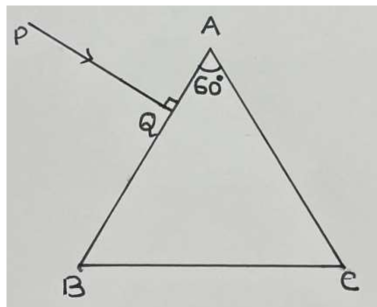
| | **OR**<br>(a)Three charges –q, Q and –q are placed at equal distances on a straight line. If the potential energy of the system of these charges is zero, then what is the ratio Q:q?<br>(b)(i) Obtain the expression for the electric field intensity due to a uniformly charged spherical shell of radius R at a point distant r from the centre of the shell outside it.<br>(ii) Draw a graph showing the variation of electric field intensity E with r, for r > R and r < R. | |
| 32 | (a) Explain the term drift velocity of electrons in a conductor .Hence obtain the expression for the current through a conductor in terms of drift velocity.<br>(b) Two cells of emfs $E_1$ and $E_2$ and internal resistances $r_1$ and $r_2$ respectively are connected in parallel as shown in the figure.<br>Deduce the expression for the<br>(i) equivalent emf of the combination<br>(ii) equivalent internal resistance of the combination<br>(iii) potential difference between the points *A* and *B*.<br><br><br>**OR**<br>(a) State the two Kirchhoff's rules used in the analysis of electric circuits and explain them.<br>(b) Derive the equation of the balanced state in a Wheatstone bridge using Kirchhoff's laws. | 5 |
| 33 | a) Draw the graph showing intensity distribution of fringes with phase angle due to diffraction through a single slit. What is the width of the central maximum in comparison to that of a secondary maximum?<br>b) A ray PQ is incident normally on the face AB of a | 5 |

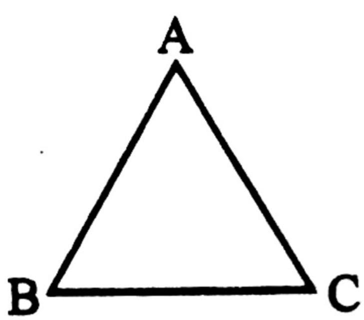
triangular prism of refracting angle $60^0$ as shown in figure. The prism is made of a transparent material of refractive index $\frac{2}{\sqrt{3}}$. Trace the path of the ray as it passes through the prism. Calculate the angle of emergence and the angle of deviation.




**OR**

a) Write two points of difference between an interference pattern and a diffraction pattern.

b) (i) A ray of light incident on face AB of an equilateral glass prism, shows minimum deviation of 30°. Calculate the speed of light through the prism.




(ii) Find the angle of incidence at face AB so that the emergent ray grazes along the face AC.

**SECTION E**

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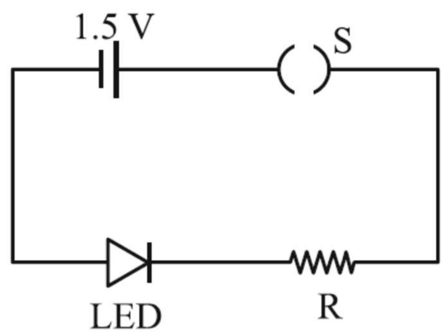
| 34 | **Case Study :**<br>***Read the following paragraph and answer the questions.***<br>A number of optical devices and instruments have been designed and developed such as periscope, binoculars, microscopes and telescopes utilising the reflecting and refracting properties of mirrors, lenses and prisms. Most of them are in common use. Our knowledge about the formation of images by the mirrors and lenses is the basic requirement for understanding the working of these devices.<br>(i) Why the image formed at infinity is often considered most suitable for viewing. Explain<br>(ii) In modern microscopes multicomponent lenses are used for both the objective and the eyepiece. Why?<br>(iii) Write two points of difference between a compound microscope and an astronomical telescope<br>**OR**<br>(iii) Write two distinct advantages of a reflecting type telescope over a refracting type telescope. |
| 35 | **Case study: Light emitting diode.**<br>**Read the following paragraph and answer the questions**<br>**LED** is a heavily doped P-N junction which under forward bias emits spontaneous radiation. When it is forward biased, due to recombination of holes and electrons at the junction, energy is released in the form of photons. In the case of Si and Ge diode, the energy released in recombination lies in the infrared region. LEDs that can emit red, yellow, orange, green and blue light are commercially available. The semiconductor used for fabrication of visible LEDs must at least have a band gap of 1.8 eV. The compound semiconductor Gallium Arsenide – Phosphide is used for making LEDs of different colours. |

LEDs of different kinds

**(i)**. Why are LEDs made of compound semiconductor and not of elemental semiconductors?

**(ii)** What should be the order of bandgap of an LED, if it is required to emit light in the visible range?

**(iii)** A student connects the blue coloured LED as shown in the figure. The LED did not glow when switch S is closed. Explain why ?




**OR**

(iii) Draw V-I characteristic of a p-n junction diode in

(i) forward bias and (ii) reverse bias

**Class: XII**
**SESSION : 2022-2023**
**MARKING SCHEME**
**CBSE SAMPLE QUESTION PAPER (THEORY)**
**SUBJECT: PHYSICS**

| Q.no | | Marks |
|---|---|---|
| | SECTION A | |
| 1 | (ii) $q_1q_2<0$ | 1 |
| 2 | (iv) zero | 1 |
| 3 | (ii) material A is germanium and material B is copper | 1 |
| 4 | (iv) 6A in the clockwise direction | 1 |
| 5 | (iii) 4:3 | 1 |
| 6 | (i) decreases | 1 |
| 7 | (ii) increase | 1 |
| 8 | (iv) Both electric and magnetic field vectors are parallel to each other. | 1 |
| 9 | (ii) the circular and elliptical loops | 1 |
| 10 | (iv) 0.85 | 1 |
| 11 | (iii) 3000 Å | 1 |
| 12 | (iv) $4.77 \times 10^{-10}$m | 1 |
| 13 | (ii) The nuclear force is much weaker than the Coulomb force . | 1 |
| 14 | (i) 30 V | 1 |
| 15 | (i) | 1 |
| 16 | c) A is true but R is false | 1 |
| 17 | c) A is true but R is false | 1 |
| 18 | a) Both A and R are true and R is the correct explanation of A | 1 |
| | SECTION B | |
| 19 | $\lambda_1$ -Microwave<br>$\lambda_2$ - ultraviolet<br>$\lambda_3$- infrared<br>Ascending order - $\lambda_2<\lambda_3<\lambda_1$ | ½<br>½<br>½<br>½ |
| 20 | A - diamagnetic<br>B- paramagnetic<br>The magnetic susceptibility of A is small negative<br>and that of B is small positive. | ½<br>½<br>½<br>½ |
| 21 | From the relation $R = R_0A^{1/3}$, where $R_0$ is a constant and A is the mass number of a nucleus<br>$R_{Fe}/R_{Al} = (A_{Fe}/A_{Al})^{1/3}$<br>$= (125/27)^{1/3}$<br>$R_{Fe} = 5/3\ R_{Al}$<br>$=5/3 \times 3.6$<br>$= 6$ fermi<br>**OR**<br>Given short wavelength limit of Lyman series | ½<br><br><br>½<br><br>½<br>½ |

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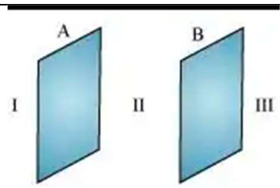
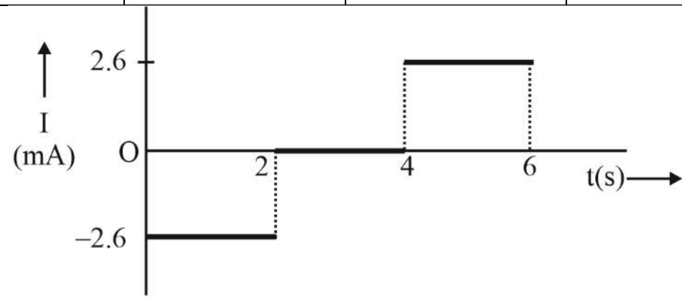
| | $$\frac{1}{\lambda_L} = R\left(\frac{1}{1^2} - \frac{1}{\infty}\right)$$ $$\frac{1}{913.4\ Å} = R\left(\frac{1}{1^2} - \frac{1}{\infty}\right)$$ | ½ |
| | $\lambda_L = \frac{1}{R} = 913.4$ Å | ½ |
| | For the short wavelength limit of Balmer series<br>$n_1=2,\ \ n_2 = \infty$ $$\frac{1}{\lambda_B} = R\left(\frac{1}{2^2} - \frac{1}{\infty}\right)$$ | ½ |
| | $\lambda_B = \frac{4}{R} = 4$ x 913.4 Å<br>= 3653.6 Å | ½ |
| **22** | $$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$ | ½ |
| | $$\frac{1}{f} = \left(\frac{\mu_m}{\mu_w} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$ $$\frac{\mu_m}{\mu_w} = \frac{1.25}{1.33}$$ | ½ |
| | $$\frac{\mu_m}{\mu_w} = 0.98$$ | ½ |
| | The value of $(\mu - 1)$ is negative and 'f' will be negative. So it will behave like diverging lens. | ½ |
| **23** | To keep the reading of ammeter constant value of R should be **increased** | 1 |
| | as with the increase in temperature of a semiconductor, its resistance **decreases** and current tends to increase. | 1 |
| | **OR** | |
| | B - reverse biased | ½ |
| | In the case of reverse biased diode the potential barrier becomes higher as the battery further raises the potential of the n side. | ½ |
| | C -forward biased | ½ |
| | Due to forward bias connection the potential of P side is raised and hence the height of the potential barrier decreases. | ½ |
| **24** | Angular width $2\varphi = 2\lambda/d$ | ½ |
| | Given $\lambda = 6000$ Å<br>In Case of new $\lambda$ (assumed $\lambda'$ here), | ½ |
| | angular width decreases by 30%<br>New angular width = 0.70 $(2\ \varphi)$ | ½ |
| | $2\ \lambda'/d = 0.70$ X $(2\ \lambda/d)$<br>$\therefore\lambda' = 4200$ Å | ½ |

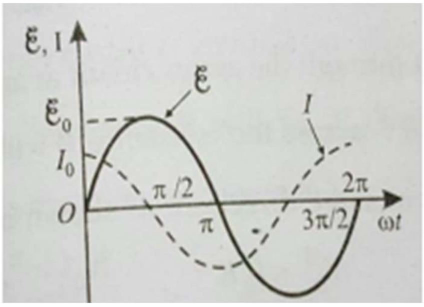
| | | |
|---|---|---|
| **25** | <br><br>Surface charge density of plate A = $+17.7 \times 10^{-22}$ C/m$^2$<br><br>Surface charge density of plate B = $-17.7 \times 10^{-22}$ C/m$^2$<br><br>(a) In the outer region of plate I, electric field intensity E is zero.<br>(b)Electric field intensity E in between the plates is given by relation<br>$$E = \frac{\sigma}{\epsilon_0}$$<br>Where,<br>$\epsilon_0$ = Permittivity of free space = 8.85 x$10^{-12}$ N$^{-1}$ C$^2$ m$^{-2}$<br>$$\therefore E = \frac{17.7\ x\ 10^{-22}}{8.85\ x\ 10^{-1}}$$<br>Therefore, electric field between the plates is 2.0 x $10^{-10}$ N/C | ½<br>½<br><br>½<br><br>½ |
| | SECTION C | |
| **26** | Diagram<br>Derivation<br>The ampere is the value of that steady current which, when maintained in each of the two very long, straight, parallel conductors of negligible cross-section, and placed one metre apart in vacuum, would exert on each of these conductors a force equal to $2 \times 10^{-7}$newtons per metre of length. | ½<br>1 ½<br><br>1 |
| **27** | Area of the circular loop = $\pi r^2$<br>$= 3.14 \times (0.12)^2\ \text{m}^2 = 4.5 \times 10^{-2}\ \text{m}^2$<br>$E = -\frac{d\varphi}{dt} = -\frac{d}{dt}(\text{BA}) = -\text{A}\,\frac{dB}{dt} = -\text{A}\,.\,\frac{B_2-B_1}{t_2-t_1}$<br>For $0 < t < 2$s<br>$E_1 = -4.5 \times 10^{-2} \times \left\{\frac{1-0}{2-0}\right\} = -2.25 \times 10^{-2}$ V<br>$\therefore \quad I_1 = \frac{E_1}{R} = \frac{-2.25 \times 10^{-2}}{8.5}$ A $= -2.6 \times 10^{-3}$ A $= -2.6$ mA<br>For $2\text{s} < t < 4\text{s}$,<br>$E_2 = -4.5 \times 10^{-2} \times \left\{\frac{1-1}{4-2}\right\} = 0$<br>$\therefore \quad I_2 = \frac{E_2}{R} = 0$<br>For $4\text{s} < t < 6\text{s}$,<br>$I_3 = -\frac{4.5 \times 10^{-2}}{8.5} \times \left\{\frac{0-1}{6-4}\right\}$A = 2.6 mA | <br>½<br><br>½<br><br>½<br><br>½ |

| | 0<t<2s | 2<t<4s | 4<t<6s |
|---|---|---|---|
| E(V) | -0.023 | 0 | +0.023 |
| I(mA) | -2.6 | 0 | +2.6 |




1

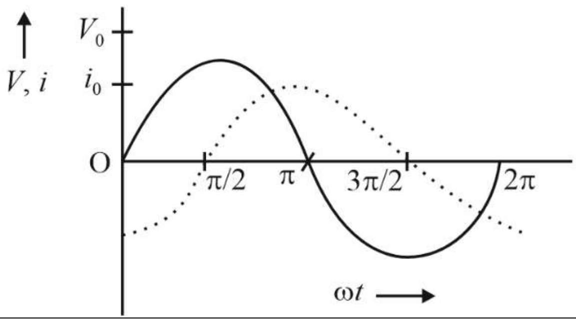
**28** Derivation — 2




1

**OR**

Derivation — 2




1

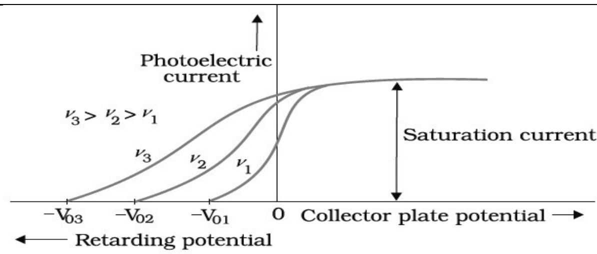
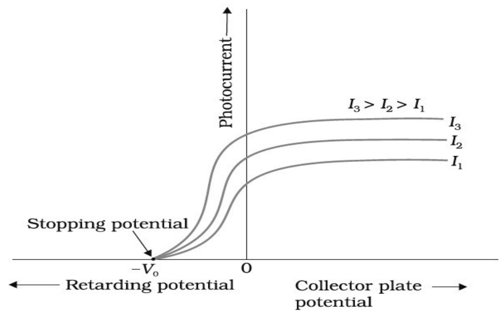
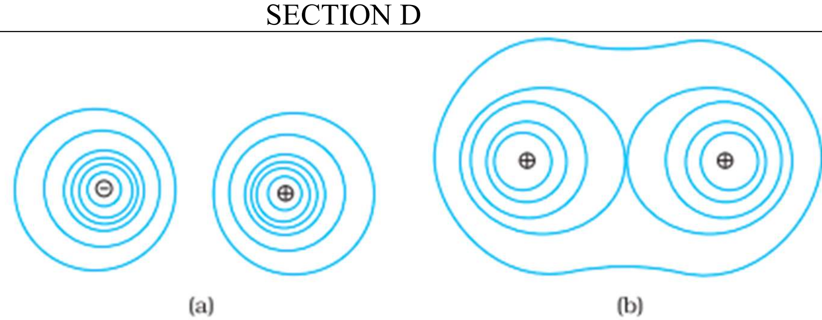
**29** From the observations made (parts A and B) on the basis of Einstein's photoelectric equation, we can draw following conclusions:

1. For surface A, the threshold frequency is more than $10^{15}$ HZ, hence no photoemission is possible. — 1
2. For surface B the threshold frequency is equal to the frequency of given radiation. Thus, photo-emission takes place but kinetic energy of photoelectrons is zero. — 1
3. For surface C, the threshold frequency is less than $10^{15}$ Hz. So photoemission occurs and photoelectrons have some kinetic energy — 1

**OR**

**a)** A - cut off or stopping potential — ½

X - anode potential — ½

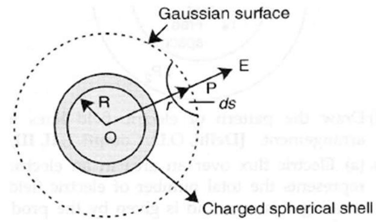
| | | |
|---|---|---|
| b) | <br><br>**FIGURE** Variation of photoelectric current with collector plate potential for different frequencies of incident radiation. | 1 |
| c) | <br><br>**FIGURE** Variation of photocurrent with collector plate potential for different intensity of incident radiation. | 1 |
| **30** | For a transition from n=3 to n =1 state, the energy of the emitted photon,<br>$h\nu = E_2 - E_1 = 13.6\left[\frac{1}{1^2} - \frac{1}{3^2}\right]$ eV = 12.1 eV.<br>From Einstein's photoelectric equation,<br>$h\nu = K_{max} + W_0$<br>$\therefore W_0 = h\nu - K_{max} = 12.1 - 9 = 3.1\ eV$<br>Threshold wavelength,<br>$\lambda_{th} = \frac{hc}{W_0} = \frac{6.62x10^{-34}x3x10^8}{3.1x1.6x10^{-19}} = 4x10^{-7}$ m | 1<br>½<br>½<br>1 |
| | SECTION D | |
| **31(a)** | <br><br>**FIGURE 2.11** Some equipotential surfaces for (a) a dipole, (b) two identical positive charges. | 1 + 1 |
| **(b)** | Here, A =6 x $10^{-3}$ $m^2$, d =3mm=3x$10^{-3}$m<br>(i) Capacitance, C=$\epsilon_0$A/d = (8.85x$10^{-12}$ x 6x$10^{-3}$/3x$10^{-3}$) = 17.7x$10^{-12}$ F<br>(ii) Charge, Q = CV =17.7 x$10^{-12}$x100=17.7x$10^{-10}$C<br>(iii) New charge Q'= KQ=6x17.7 x$10^{-10}$ =1.062 x $10^{-8}$ C | 1<br>1<br>1 |
| **(a)** | **OR**<br>Diagram | 1/2 |

$$\frac{K(-q)Q}{x} + \frac{kQ(-q)}{x} + \frac{k(-q)(-q)}{2x} = 0$$ 1

$$\frac{-2kqQ}{x} + \frac{kq^2}{2x} = 0 \text{ or } \frac{kq^2}{2x} = \frac{2kqQ}{x}$$

$$q = 4Q \quad \text{or} \quad \frac{Q}{q} = \frac{1}{4}$$ ½

**(b)** Electric field due to a uniformly charged thin spherical shell:




½

**(i)** When point P lies outside the spherical shell: Suppose that we have calculate field at the point P at a distance r (r>R) from its centre. Draw Gaussian surface through point P so as to enclose the charged spherical shell. Gaussian surface is a spherical surface of radius r and centre O.

Let $\vec{E}$ be the electric field at point P, then the electric flux through area element of area $\overrightarrow{ds}$ is given by

$$d\varphi = \vec{E}.\overrightarrow{ds}$$ ½

Since $\overrightarrow{ds}$ is also along normal to the surface

$$d\varphi = E\ dS$$

∴ Total electric flux through the Gaussian surface is given by

$$\varphi = \oint E ds = E \oint ds$$

$$\text{Now, } \oint ds = 4\pi r^2 \quad ...(i)$$

$$= Ex4\pi r^2$$

Since the charge enclosed by the Gaussian surface is q, according to the Gauss's theorem,

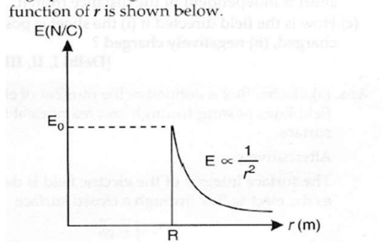
$$\varphi = \frac{q}{\epsilon_0} ........(ii)$$ ½

From equation (i) and (ii) we obtain

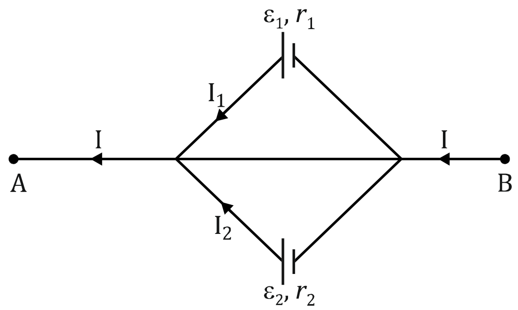
$$E \text{ x } 4\pi r^2 = \frac{q}{\epsilon_0}$$

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{r^2} \quad (\text{for } r>R)$$ ½

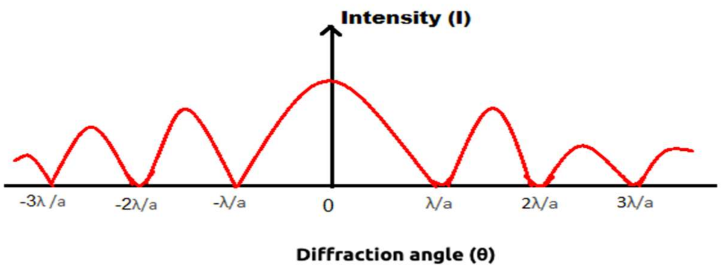
(ii) A graph showing the variation of electric field as a function of $r$ is shown below.




1

| | | |
|---|---|---|
| **32(a)** | Drift velocity: It is the average velocity acquired by the free electrons superimposed over the random motion in the direction opposite to electric field and along the length of the metallic conductor.<br>Derivation $I = ne A V_d$ | ½<br><br><br>1½ |
| **(b)** | Here, $I = I_1 + I_2$ ...(*i*)<br>Let $V$ = Potential difference between A and B.<br>For cell $\varepsilon_1$<br>Then, $V = \varepsilon_1 - I_1 r_1 \Rightarrow I_1 = \frac{\varepsilon_1 - V}{r_1}$<br><br><br>Similarly, for cell $\varepsilon_2$ $I_2 = \frac{\varepsilon_2 - V}{r_2}$<br>Putting these values in equation (*i*)<br>$I = \frac{\varepsilon_1 - V}{r_1} + \frac{\varepsilon_2 - V}{r_2}$<br>or $I = \left(\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}\right) - V\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$<br>or $V = \left(\frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}\right) - I\left(\frac{r_1 r_2}{r_1 + r_2}\right)$ ...(*ii*)<br>Comparing the above equation with the equivalent circuit of emf '$\varepsilon_{eq}$' and internal resistance '$r_{eq}$' then,<br>$V = \varepsilon_{eq} - I r_{eq}$ ...(*iii*)<br>Then<br>(*i*) $\varepsilon_{eq} = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}$ (*ii*) $r_{eq} = \frac{r_1 r_2}{r_1 + r_2}$<br>(*iii*) The potential difference between A and B<br>$V = \varepsilon_{eq} - I r_{eq}$ | <br><br><br><br><br><br>3 |
| | **OR** | |
| **(a)** | Junction rule: At any junction, the sum of the currents entering the junction is equal to the sum of currents leaving the junction<br><br>Loop rule: The algebraic sum of changes in potential around any closed loop involving resistors and cells in the loop is zero | 1<br><br><br>1 |
| **(b)** | Derivation | 3 |

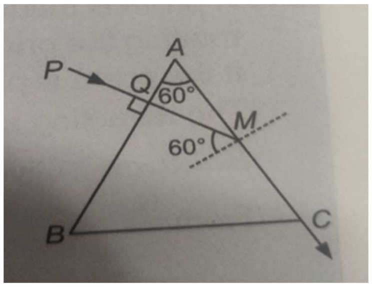
**33(a)**




1

Width of central maximum is twice that of any secondary maximum 1

**(b)**




1

Given : ∠A = $60^0$, ∠i=$0^0$

At M : Sin C = $\frac{1}{\mu} = \frac{\sqrt{3}}{2}$= sin $60^0$

∴ C = $60^0$ 1

So the ray PM after refraction from the face AC grazes along AC.

∴ ∠ e=$90^0$

From ∠i +∠e=∠A + ∠ $\delta$

Or $0^0 + 90^0 = 60^0 + \angle\delta$

∴ $\delta = 90^0 - 60^0 = 30^0$ 1

**OR**

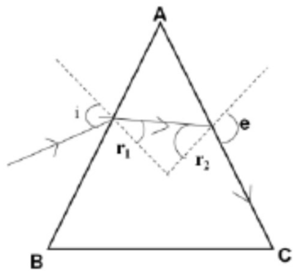
**(a)** (i) The interference pattern has a number of equally spaced bright and dark bands. The diffraction pattern has a central bright maximum which is twice as wide as the other maxima. The intensity falls as we go to successive maxima away from the centre, on either side. 1

(ii) We calculate the interference pattern by superposing two waves originating from the two narrow slits. The diffraction pattern is a superposition of a continuous family of waves originating from each point on a single slit. 1

**(b)**

**(i)** $$\mu = \frac{sin\left(\frac{A+\delta_m}{2}\right)}{sin\left(\frac{A}{2}\right)} = \frac{sin\left(\frac{60+30}{2}\right)}{sin\left(\frac{60^o}{2}\right)} = \sqrt{2}$$ 1½

Also $\mu = \frac{c}{\upsilon} \Rightarrow \upsilon = \frac{3\times10^8}{\sqrt{2}} m/s$

| | | |
|---|---|---|
| | **(ii)** At face AC, let the angle of incidence be $r_2$. For grazing ray, $e = 90^o$ $\Rightarrow \mu = \frac{1}{\sin r_2} \Rightarrow r_2 = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45^o$ Let angle of refraction at face AB be $r_1$. Now $r_1 + r_2 = A$ $\therefore\ r_1 = A - r_2 = 60^o - 45^o = 15^o$ Let angle of incidence at this face be $i$ $\mu = \frac{\sin i}{\sin r_1} \Rightarrow \sqrt{2} = \frac{\sin i}{\sin 15^o}$ $\therefore i = \sin^{-1}\left(\sqrt{2}\,.\,\sin 15^o\right) = 21.5^0$   | 1½ |
| | SECTION E | |
| **34(i)** | When the image is formed at infinity, we can see it with minimum strain in the ciliary muscles of the eye. | 1 |
| **(ii)** | The multi-component lenses are used for both objective and the eyepiece to improve image quality by minimising various optical aberrations in lenses. | 1 |
| **(iii)** | (a)The compound microscope is used to observe minute nearby objects whereas the telescope is used to observe distant objects. | 1 |
| | (b) In compound microscope the focal length of the objective is lesser than that of the eyepiece whereas in telescope the focal length of the objective is larger than that of the eyepiece. | 1 |
| | **OR** | |
| **(iii)** | (a) The image formed by reflecting type telescope is brighter than that formed by refracting telescope. | 1 |
| | (b) The image formed by the reflecting type telescope is more magnified than that formed by the refracting type telescope. | 1 |
| **35(i)** | LEDs are made up of compound semiconductors and not by the elemental conductor because the band gap in the elemental conductor has a value that can detect the light of a wavelength which lies in the infrared (IR) region. | 1 |
| **(ii)** | 1.8 eV to 3 eV | 1 |
| **(iii)** | LED is reversed biased that is why it is not glowing. | 2 |
| | **OR** | |
| | V-I Characteristic curves of pn junction diode in forward biasing and reverse biasing. | 1+ 1 |