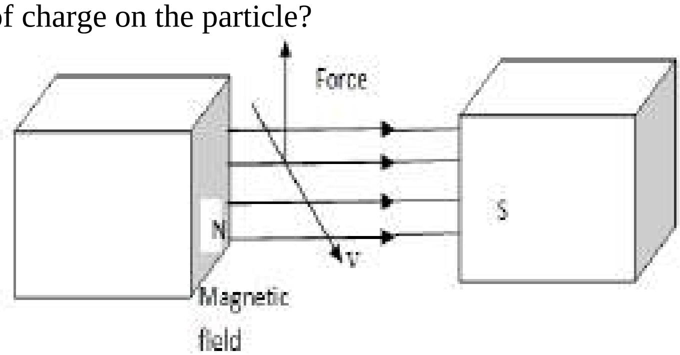
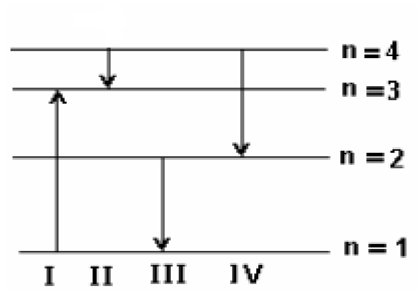
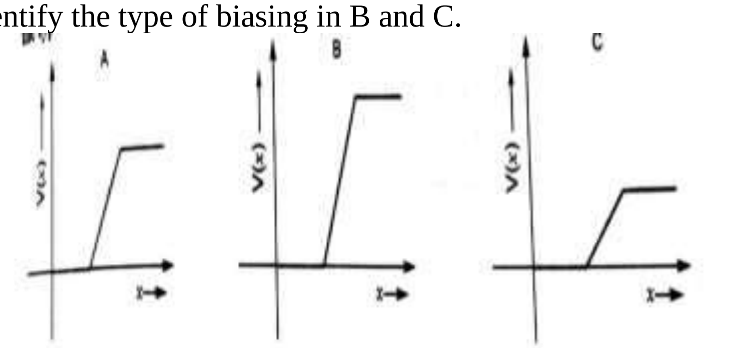
Class: XII Session: 2020-2021
Subject: Physics
Model Question Paper (Theory)

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

General Instructions:

1. All questions are compulsory. There are 33 questions in all.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. Section A contains ten very short answer questions and four assertion reasoning MCQs of 1 mark each, Section B has two case based questions of 4 marks each, Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.
4. There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.

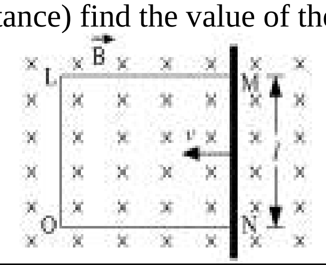
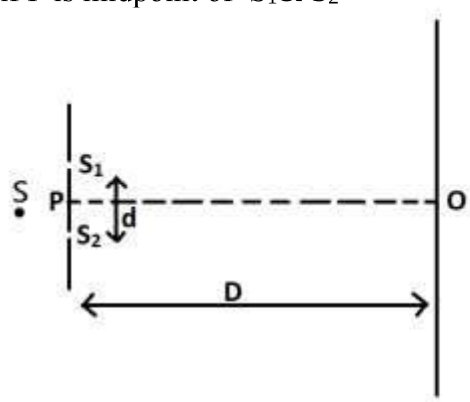
S.NO		MARKS
	Section – A **All questions are compulsory. In case of internal choices, attempt any one of them.**	
1.	What is the angle of dip at the magnetic equator?	
2.	If $\vec{E}$ and $\vec{B}$ represent electric and Magnetic Field vectors of an EM Wave, then what is the direction of propagation of an EM wave? **OR** The energy of the EM waves is of the order of 15 keV. To which part of the spectrum does it belong?	1
3.	A charged particle enters into a uniform magnetic field and experiences an upward force as indicated in the figure. What is the nature of charge on the particle?  	1
4.	If a conductor 0.2m long moves with a velocity of 0.3m/s in a magnetic field of 5T, calculate the emf induced. **OR**	

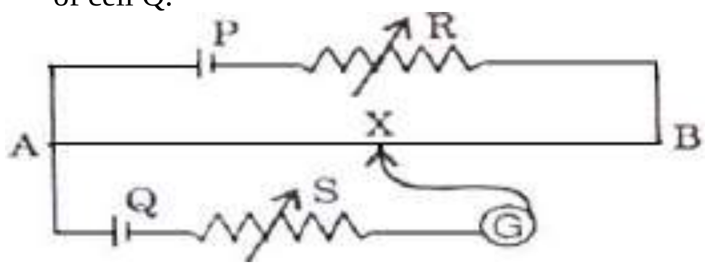
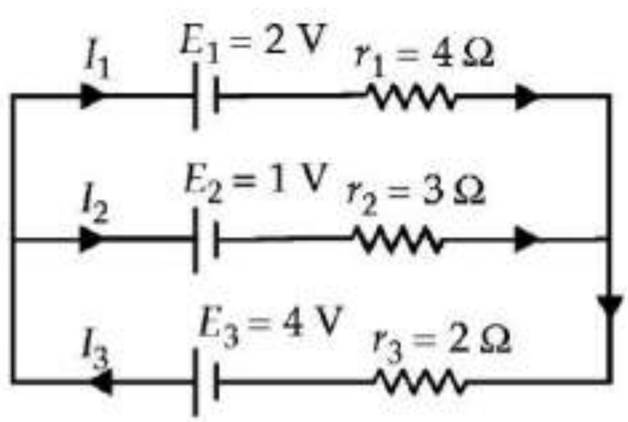
	The instantaneous current in an ac circuit is i =2.0 sin 314t, what is rms value of the current.	
5.	The diagram shows the energy levels for an electron in a certain atom. Which transition shown represents the emission of a photon with the most energy  	1
6.	The work function of a substance is 4.0 eV. What is the longest wavelength of light that can cause photo-electrons emission from this substance (approximately)?	1
7.	The binding energy of deuteron is 2.23 MeV. What is its mass-defect? **OR** Which series of hydrogen spectra exists in visible region?	1
8.	The graph of potential barrier versus width of depletion region for an unbiased **pn** junction is shown below in A. In comparison to A, graphs B and C are obtained after biasing the pn junction in different modes. Identify the type of biasing in B and C.  **OR** In a p- type semiconducting material, the Fermi level is 0.3 eV above the valence band. The concentration of accepter atoms is increased. The new position of Fermi level is likely to be shifted towards which band?	1
9.	When the voltage drop across a p-n junction diode is increased from 0.65V to 0.70V, the change in the diode current is 5mA. What is the dynamic resistance of the diode?	1

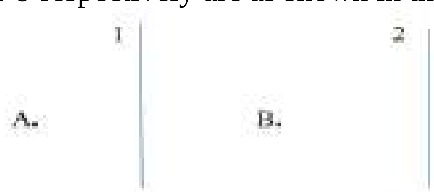
10.	Name one special purpose pn junction diode operated under reverse biased conditions.	1
	For question numbers 11, 12, 13 and 14, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below. **a) Both A and R are true and R is the correct explanation of A** **b) Both A and R are true but R is NOT the correct explanation of A** **c) A is true but R is false** **d) A is false and R is also false**	
11.	**Assertion:** The electrostatic force between the plates of a charged isolated capacitor decreases when dielectric fills whole space between plates. **Reason:** The electric field between the plates of a charged isolated capacitance increases when dielectric fills whole space between plates**.**	1
12.	**Assertion:** two equipotential surfaces cannot cut each other. **Reason:** equipotential surfaces are parallel to each other.	1
13.	**Assertion :** The refractive index of diamond is √6 and that of liquid is √3. If the light travels from diamond to the liquid, it will totally reflected when the angle of incidence is 30°. **Reason** : μ=sinC, where μ is the refractive index of diamond with respect to liquid**.**	1
14.	**Assertion**: A double convex lens (m = 1.5) has focal length 10 cm. When the lens is immersed in water (m = 4/3) its focal length becomes 40 cm. **Reason**: $$\frac{1}{f} = \frac{\mu_l - \mu_m}{\mu_m}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$	1
	Section – B **Questions 15 and 16 are Case Study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.**	
15.	**Transformer** A transformer is a passive electrical device that transfers electrical energy from one electrical circuit to another, or multiple circuits. A varying current in any one coil of the transformer produces a varying magnetic flux in the transformer's core, which induces a varying electromotive force across any other coils wound around the same core. Electrical energy can be transferred between separate coils without a metallic (conductive) connection between the two circuits. Transformers are most commonly used for increasing low AC voltages at high current or decreasing high AC voltages at	4

	low current in electric power applications, and for coupling the stages of signal-processing circuits. Transformers can also be used for isolation, where the voltage in equals the voltage out, with separate coils not electrically bonded to one another. **1.** The core of any transformer is laminated so as to (a) reduce the energy loss due to eddy currents. (b) Make it light weight. (c) Make it robust and strong. (d) Increase the secondary voltage. **2.** A transformer is used to light a 100 W and 110 V lamps from a 220 V mains. If the main current is 0.5 A, the efficiency of the transformer is approximately (a) 30% (b) 50% (c) 90% (d) 10% **3.** A transformer works on the principle of (a) converter. (b) Inverter. (c) Mutual inductance. (d) Self-inductance. **4.** For an ideal-step-down transformer, the quantity which is constant for both the coils is (a) current in the coils (b) voltage across the coils (c) resistance of coils (d) power in the coils **5.** Electrical energy is transmitted over large distances at high alternating voltages. Which of the following statements is not correct? (a) For a given power level, there is a lower current. (b) Lower current implies less power loss. (c) Transmission lines can be made thinner. (d) It is easy to reduce the voltage at the receiving end using step-down transformers.	
16.	**Mirage** an optical phenomenon, especially in the desert or at sea, by which the image of some object appears displaced above, below, or to one side of its true position as a result of spatial variations of the index of refraction of air. **1.** Mirage is a phenomenon due to (a) refraction of light (b) reflection of light	4

	(c) total internal reflection of light (d) diffraction of light. **2.** Critical angle of glass is θ_2 and that of water is θ_2. The critical angle for water and glass surface would be ($\mu_g = 3/2$, $\mu_w = 4/3$). (a) less than θ_2 (b) between θ_1 and θ_2 (c) greater than θ_2 (d) less than θ_1 **3.** If the critical angle for total internal reflection from a medium to vacuum is 30°, the velocity of light in the medium is (a) 3 X 10^8 m/s (b) 1.5 X 10^8 m/s (c) 0.5 X 10^8 m/s (d) 0.2 X 10^8 m/s **4.** Critical angle is a) The angle of refraction in the denser medium corresponding to which the angle of incidence in the rarer medium is 90°. b) The angle of incidence in the denser medium corresponding to which the angle of refraction in the rarer medium is 0°. c) The angle of incidence in the denser medium corresponding to which the angle of refraction in the rarer medium is 90°. d) The angle of incidence in the rarer medium corresponding to which the angle of refraction in the denser medium is 90° **5.** Optical fibre communication uses the principle A. light scattering B. light path reversibility C. Total internal reflection D. least action	
	Section – C **All questions are compulsory. In case of internal choices, attempt anyone.**	
17.	A galvanometer is first converted into a voltmeter of range 0 – 3V and then into a voltmeter of range 0 – 6 V. In which case the resistance would be higher one? Why?	2
18.	If one of the slits in the Young's double slit experiment is painted, so as to allow only half the light intensity to pass than the other, then what will be the effect on the intensity of the maxima and minima in the interference pattern? **OR**	2

	The fringe width in Young's double slit interference pattern is 2.4 x 10^{-4} m when red light of wavelength 6400Å is used. By how much will it change if blue light of wavelength 4000Å is used?	
19.	An electric dipole is held in a uniform electric field. (i) Show that the net force acting on it is zero. (ii) The dipole is aligned parallel to the field. Find the work done in rotating it through the angle of 180^0. **OR** What is an equi-potential surface? Show that the electric field is always directed perpendicular to an equi-potential surface.	2
20.	Draw a circuit diagram to explain the working of a photodiode. Also draw the V-I characteristics of this semiconductor diode.	2
21.	A rectangular conductor LMNO is placed in a uniform magnetic field of 0.5 T. The field is directed perpendicular to the plane of the conductor. When the arm MN of length of 20 cm is moved towards left with a velocity of 10 ms^{-1}, calculate the emf induced in the arm. Given the resistance of the arm to be 5 Ώ (assuming that other arms are of negligible resistance) find the value of the current in the arm. 	2
22.	In the figure given below SS_1- SS_2 = λ/4. Find the position of central maxima from 'O' if P is midpoint of S_1& S_2 	2
23.	Give three differences between p-type and n-type semiconductor. How these are made from intrinsic semiconductors?	2
24.	A bar magnet is held stationery in Magnetic meridian. Another similar magnet is kept parallel to it such that their midpoints lie on their perpendicular bisector. If the second magnet is free to move, what type of Motion will it have? Translatory, rotatory or both? Justify your answer.	2

	OR Where on the earth's surface is the value of angle of dip (i) maximum (ii) minimum?	
25.	A thin converging lens has a focal length 'f' in air. If it is completely immersed in a liquid, briefly explain how the focal length of the lens will vary?	2
	Section –D **All questions are compulsory. In case of internal choices, attempt any one.**	
26.	A long straight wire of a circular cross-section of radius 'a' carries a steady current 'I'. The current is uniformly distributed across the cross-section. Apply Ampere's circuital law to calculate the magnetic field at a point 'r' in the region for (i) $r < a$ and (ii) $r > a$.	3
27.	1. In the potentiometer circuit shown, the balance point is at X. State with reason, where the balance point will be shifted when (i) R is increased, (ii) S is increased, keeping R constant. (iii) Cell P is replaced by another cell whose emf is lower than that of cell Q.  **OR** State Kirchhoff's rules. Use these rules to write the expressions for the currents I_1 , I_2 and I_3 in the circuit diagram shown.  	3
28.	(I) State two important features of Einstein's Photoelectric equation. (II) Radiation of frequency 10^{15} Hz is incident on two photosensitive surface P and Q. there is no photoemission from surface P.	3

	photoemission occurs from surface Q but photoelectrons have zero kinetic energy. Explain this observation and find the value of work function for surface Q. **OR** A beam of monochromatic radiation is incident on a photosensitive surface answer the following questions giving reasons : (i) do the emitted photoelectrons have the same kinetic energy? (ii) does the kinetic energy of the emitted electrons depend on the intensity of incident radiation ? (iii) on what factors does the number of emitted photoelectrons depend?	
29.	The value of ground state energy of hydrogen atom is -13.6 eV : What does the negative sign signify? How much energy is required to take an electron in this atom from the ground state to the first excited state ?	3
30.	Obtain the binding energy of a nitrogen nucleus from the following data m_H=1.007834; m_n=1.00867; m_N=14.03074. Give your answer in MeV.	3
	Section – E **All questions are compulsory. In case of internal choices, attempt any one.**	
31.	(a) Two thin infinite sheets 1 and 2 having surface charge densities + σ and - 2 σ respectively are as shown in the diagram.  Find the electric field at points A and B. (b) A capacitor of capacity C is charged fully by connecting it to a battery of emf E. It is then disconnected from the battery. If the separation between the plates of the capacitor is doubled then how the following parameters will change:- i) Charged stored in the capacitor ii) Field strength between the plates iii) Energy stored by the capacitor **OR** (a) Define electric dipole. Derive an expression for the electric potential on the axial line due to an electric dipole. (b) An electric dipole of length 4cm, when placed with its axis	5

	making an angle of 60° with a uniform electric field, experiences a torque of $4\sqrt{3}$ Nm. Calculate the potential energy of the dipole, if it has a charge of $\pm 8nC$.	
32.	A series LCR circuit is connected to an ac source. Using the phasor diagram, derive the expression for the impedance of the circuit. Plot a graph to show the variation of current with frequency of the source, explaining the nature of its variation and hence calculate impedance at resonance. **OR** **(a)** Define the coefficient of self-inductance. Find the coefficient of self-inductance of a long co axial solenoid. **(b)** A metallic rod of length *l* is rotated at a constant angular speed ω, normal to a uniform magnetic field *B*. Derive an expression for the current induced in the rod, if the resistance of the rod is *R*.	5
33.	(a) Derive lens maker's formula for a given biconvex lens. (b) Double convex lenses are to be manufactured from a glass of refractive index 1.55 with both faces of the same radius of curvature. What is the radius of curvature required if focal length is to be 20 cm? **OR** (a) Draw the ray diagram of image formation by a telescope when final image is formed at infinity. Write the formula for its magnifying power. (b) A small telescope has an objective lens of focal length 144 cm and an eyepiece of focal length of 6 cm. Calculate its magnifying power and separation between both lenses.	5

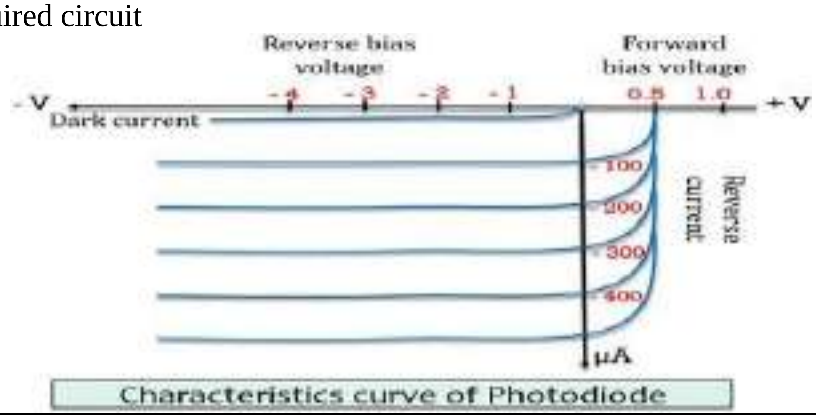
Class –XII

PHYSICS (Theory)

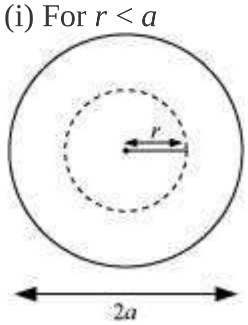
SQP Marking Scheme 2020-21

S.NO.	VALUE POINTS	MARKS
1.	0°	**1**
2.	$\vec{E} \times \vec{B}$ **OR** X-rays	**1** **OR** **1**
3.	**positive**	**1**
4.	**0.3 V** **OR**	**1** **OR**

	1.414 A	**1**
5.	**III**	**1**
6.	310 nm	**1**
7.	0.0024 u **OR** Balmer	**1** OR **1**
8.	**B is reversed biased and C is forward biased** **OR** **Valence band**	**0.5+0.5** **OR** **1**
9.	**10 ohm**	**1**
10.	**photodiode**	**1**
11.	**(d)**	**1**
12.	**(c)**	**1**
13.	**(d)**	**1**
14.	**(a)**	**1**
15.	**1. (a)** **2. (c)** **3. (c)** **4. (d)** **5. (c)** **(any four)**	**1+1+1+1**
16.	**1. (c)** **2. (c)** **3. (b)** **4. (c)** **5. (c)** **(any four)**	**1+1+1+1**
17.	Use $R = V/I_g - G$, $R \alpha V$, show calculation also	**2**
18.	$I_{max}=(\sqrt{2}+1)a$ $I_{min}=(\sqrt{2}--1)a$ **OR** $\beta1/\beta2=\lambda1/\lambda2$ $\beta2=.15mm$ $\Delta\beta=0.09mm$	**1+1**
19.	i) force acting on dipole are equal and opposite therefore net force will be zero ii) $W= -pE(\cos\Theta_2- \cos\Theta_1)$ $=2\ pE$ **OR** The surface which has same potential throughout is called an equipotential surface.	**1+1**

	$Since\ dw = \vec{F}.d\vec{x}$ $dw = (-qoE).d\vec{x}$ (force on the test chage qo $\vec{F}$ = q o $\vec{E}$) Since work done is moving a test charge along an equipotential surface is always zero. $\Rightarrow$ -qo $\vec{E}.\vec{dx} = 0$ $\vec{E}.\vec{dx} = 0$ $\Rightarrow E \perp \vec{d}x$	
20.	Required circuit  Characteristics curve of Photodiode	**1+1**
21.	Let ON be x at some instant. The emf induced in the loop = *e*. $e = -\frac{d\phi}{dt} = -\frac{d(Blx)}{dt} = Bl\left(-\frac{dx}{dt}\right) = Blv = 0.5\times0.2\times10 = 1\text{ V}$ $\therefore$ Current in the arm, $I = \frac{e}{R} = \frac{1}{5} = 0.2\text{ A}$	**2**
22.	For central maxima at a point ‘B’ on screen $SS_1 + S_1B = SS_2 + S_2B$ If OB=y $SS_1 - SS_2 = S_2B - S_1B = dy/D$ $\lambda/4 = dy/D$ $y = D\lambda/4d = OB$	**2**
23.	Any three points Sl No P-type Semi conductor N-type semi conductor 1 P-type semiconductor is formed due N-type semi conductor is formed	**1.5+0.5**

	to the doping of III group elements i.e. Boron, Aluminum, Thallium.	due to doping of Nitrogen, Phosphorus, Arsenic, Antimony, and Bismuth.
2	These are also known as Trivalent semi conductors.	These are also known pentavalent semiconductor.
3	P-type semiconductors are positive type semiconductor it means it deficiency of 1 electron is required.	N-type semiconductor is negative type semi-conductor it means excess of 1 electron is required.
4	In P-type semiconductor majority charge carries are holes and minority charge carries are electrons.	In N-type semiconductor majority charge carries are electrons and minority charge carries are hole.
5	A hole indicates a missing electron. In this no. of holes is more than the no. of electrons.	In N-type semiconductor the no. of holes is less than the no. of free electron.

24.	Translatory, as two equal forces act on two ends, in same direction. **OR** Angle of dip is maximum at poles of earth i e. 90^o and minimum at the equator of the earth. i.e. 0^o	**1+1**
25.	The focal length of the lens in air is given by $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ________________(i) If n' is refractive index of the material of the lens w.r.t. liquid, then focal length of the lens, when placed in liquid is given by $\frac{1}{f'} = (n'-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ________________(ii) From the equations (i) and (ii), we have $\frac{f'}{f} = \frac{(n-1)}{(n'-1)}$ Since $n' < n$, $f' > f$ i.e. focal length of the lens will increase on immersing it in liquid.	**2**
26.	(i) For $r < a$  	**1.5+1.5**

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$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{\text{enclosed}}$

$\frac{I_{\text{enclosed}}}{\pi a^2} = \frac{I}{\pi r^2}$

$I_{\text{encolsed}} = I \frac{r^2}{a^2}$

$\vec{B} \cdot \vec{dl} = Bdl \quad (\because \cos\theta = 1)$

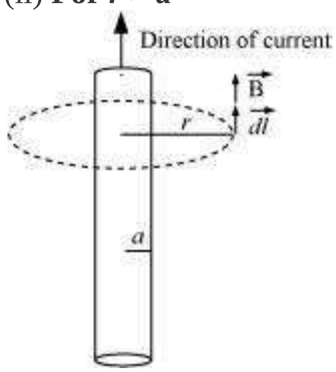
$\therefore \oint Bdl = \mu_0 I \frac{r^2}{a^2}$

$B \oint dl = \mu_0 I \frac{r^2}{a^2}$

$B(2\pi r) = \mu_0 I \frac{r^2}{a^2}$

$B = \frac{\mu_0}{2\pi} \frac{I}{a^2} r$

(ii) **For *r* > *a***



From Ampere's circuital law,

$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{\text{enclosed}}$

$\vec{B} \cdot \vec{dl} = Bdl \cos\theta$

$\theta = 0^\circ$

$\vec{B} \cdot \vec{dl} = Bdl$

$I_{\text{enclosed}} = I$

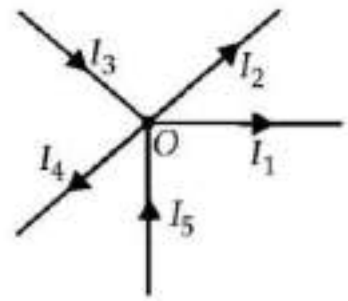
$\oint Bdl = \mu_0 I$

$B \oint dl = \mu_0 I$

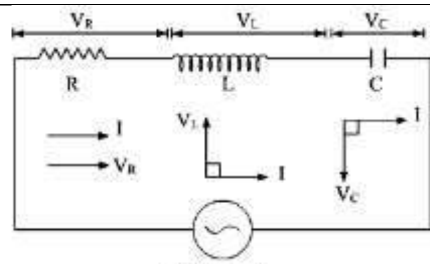
$B(2\pi r) = \mu_0 I$

$B = \frac{\mu_0}{2\pi} \frac{I}{r}$

</td><td></td></tr>
<tr><td>27.</td><td>(i) When R is increased, the potential gradient decreases and $V_{AX} = \phi l_{AX}$
Due to decrease in 'ϕ', the length 'l_{AX}' will increase. Hence the balance point</td><td>1+1+1</td></tr>
</table>

	will shifted towards B. (ii) Balance point is not affected because no current drawn from cell Q at the balance point. (iii) The Balance point is not found on wire because the potential drop across wire is less than the emf of cell Q. **OR** Kirchhoff's first law of electrical network or junction rule states that at any junction of electrical network, sum of incoming currents is equal to the sum of outgoing currents i.e., $I_1 + I_2 + I_4 = I_3 + I_5$  Kirchhoff's second law of electrical network or loop rule states that in any closed loop, the algebraic sum of the applied emf's is equal to the algebraic sum of potential drops across the resistors of the loop i.e., IR To find I_1 , I_2 , I_3 in the given diagram. For loop ABCFA $E_1 + I_1 r_1 - I_2 r_2 - E_2 = 0$ $2 + 4I_1 - 3I_2 - 1 = 0 \Rightarrow 4I_1 - 3I_2 + 1 = 0$ ---------------------- (i) Using loop FCDEF $E_2 + I_2 r_2 + I_3 r_3 - E_3 = 0$ $1 + 3I_2 + 2I_3 - 4 = 0$ $3I_2 + 2I_3 - 3 = 0$ ---------------------- (ii) Also using junction rule $I_3 = I_1 + I_2$ ---------------------- (iii) Using (ii) and (iii) $3I_2 + 2I_1 + 2I_2 - 3 = 0 \Rightarrow 2I_1 + 5I_2 - 3 = 0$ ...(iv) Solving (i) and (iv) i_2=7/ 13 A, i_1=2/13 A i_3= 9/13 A	
28.	(I) Einstein's Photoelectric equation $K_{max} = hv - W_0 = h(v - v_0)$ It indicates the following important features: (a) About threshold frequency K max directly proportional to v. (b) Existence of Threshold frequency for a metal surface, $W_0 = hv_0$ (II)As no photoelectric emission takes place from P, it indicates that the frequency of incident radiation 10^{15}hz is less than the threshold frequency $(v_0)_p$ of metal P. photoemission occurs from Q but kinetic energy of photoelectrons is zero, the frequency of incident radiation 10^{15}hz is just the threshold frequency of cube therefore work function of Q.	**1+2**

	Therefore work function of Q is $W_0 = h\nu_0 = 6.6 \times 10^{-34} \times 10^{15} / 1.6 \times 10^{-19}$ eV = 4.125 eV. **OR** (I) No the different electrons belonging to different energy level in the conduction band they need different energy to come out of the metal surface for the same incident radiation electrons knocked off from different energy levels come out with different energies. (II) No the kinetic energy of photoelectron depends on the energy of each incident Photon and not on the number of photons are intensity of light. (III) Number of photoelectrons emitted depends on the intensity of incident light. larger the intensity of incident radiation larger is the number of incident photons and hence larger is the number of electrons ejected from the metal surface.	
29.	(i) The negative sigh shows that the electron is bound to nucleus by means of electrostatic attraction. (ii) E_1=-13.6eV E_2=-13.622=-3.4 eV Required energy= E_2- E_1 = -3.4-(-13.6)=10.2 eV	**1+2**
30.	Find Δm using Δm= (7x1.00783+7x1.00867-14.003074) U Calculate ΔE_b=Δm x 931.5 MeV	**3**
31.	a) At point A,σ/ 2εo towards plate A At point B, 3σ/ 2εo towards plate B b) Correct answer Correct answer Correct answer OR Correct definition Correct derivation Potential energy = -4J	1 1 1 1 1 1 2 2
32.	Let an alternating Emf E = $E_0 \sin\omega t$ is applied to a series combination of inductor L, capacitor C and resistance R. Since all three of them are connected in series the current through them is same. But the voltage across each element has a different phase relation with current.	



LCR Circuit

The potential difference V_L, V_C and V_R across L, C and R at any instant is given by

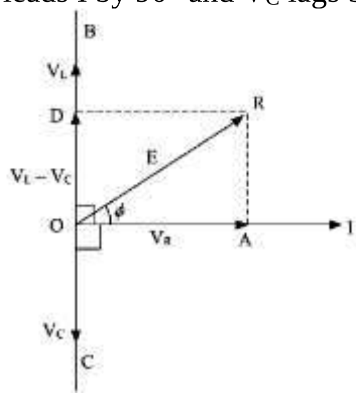
$V_L = IX_L$, $V_C = IX_C$ and $V_R = I_R$

Where I is the current at that instant.

X_L is inductive reactance and

X_C is capacitive reactance.

V_R is in phase with I. V_L leads I by 90° and V_C lags behind I by 90°



In the phases diagram,

V_L and V_C are opposite to each other. If $V_L > V_C$ then resultant $(V_L - V_C)$ is represent by OD. OR represent the resultant of V_R and $(V_L - V_C)$. It is equal to the applied Emf E.

$$E^2 = V_R^2 + (V_L - V_C)^2$$

$$E^2 = I^2 + \left[R^2 + (X_L - X_C)^2\right]$$

$$\text{or } I = \frac{E}{\sqrt{R^2 + (X_2 - X_C)^2}}$$

The term $\sqrt{R^2 + (X_2 - X_C)^2}$ is called impedance Z of the LCR circuit. **2**

1

$$Z = \sqrt{R^2 + (X_2 - X_C)^2} = \sqrt{R^2 + \left(L\omega - \frac{1}{c\omega}\right)^2}$$

Emf leads current by a phase angle ϕ

1+1

$$\tan\phi = \frac{V_L - V_C}{R} = \frac{X_L - X_C}{R} = \frac{L\omega - \frac{1}{c\omega}}{R}$$

Required graph

When resonance takes place

$$\omega L = \frac{1}{\omega c}$$

Impedance of circuit becomes equal to R. Current becomes maximum and is equal to E/R

OR

(a) **2**

Self Inductance of a long air-cored solenoid:

Consider a long air solenoid having 'n' number of turns per unit length. If current in solenoid is I, then magnetic field within the solenoid, $B = \mu_0 nI$ ...(1)

where $\mu_0 = 4\pi \times 10^{-7}$ henry/metre is the permeability of free space.

If A is cross-sectional area of solenoid, then effective flux linked with solenoid of length 'l'; $\Phi = NBA$ where $N = nl$ is the number of turns in length 'l' of solenoid.

$\therefore$ $\Phi = (nl\, BA)$

Substituting the value of B from (1)

$$\Phi = nl\,(\mu_0\, nI)\, A = \mu_0\, n^2\, AlI \quad ...(2)$$

$\therefore$ Self-inductance of air solenoid

$$L = \frac{\Phi}{I} = \mu_0 n^2 Al$$

If N is total number of turns in length l, then

$$n = \frac{N}{l}$$

$\therefore$ Self-inductance $L = \mu_0 \left(\frac{N}{l}\right)^2 Al$

$$= \frac{\mu_0 N^2 A}{l}$$

(b) The given situation can be shown as: **3**

Let θ be the angle traced by the free end of the rod in time t.

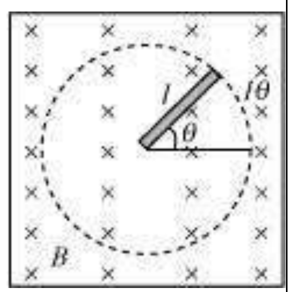
The area swept-out by the rod in time t is given as:

$$A = \pi l^2 \times \left(\frac{\theta}{2\pi}\right) = \frac{l^2\theta}{2} \qquad (1)$$

Since the angle between the area vector and the magnetic field vector is zero, the magnetic flux linked to this area is given as:

$$\phi = B\left(\frac{1}{2}l^2\theta\right)\cos 0^\circ \qquad [\because \text{Flux, } \phi = BA\cos\theta]$$

$$= \frac{1}{2}Bl^2\theta \qquad [\because \cos 0^\circ = 1]$$



According to Faraday's laws of electromagnetic induction, induced *emf* (e) is given as:

$$e = \frac{d\phi}{dt} = \frac{d}{dt}\left(\frac{1}{2}Bl^2\theta\right) = \frac{1}{2}Bl^2\omega \qquad [\because \omega = \frac{d\theta}{dt}]$$

Hence, the current induced in the rod is given as:

$$I = \frac{e}{R} = \frac{\frac{1}{2}Bl^2\omega}{R} = \frac{Bl^2\omega}{2R}$$

33.	Ray Diagram Correct Derivation	1 Marks 2 marks

	Correct solution radius of curvature Or Ray Diagram Formula Correct Solution of Numerical	2 marks 2 marks 1 marks 1+1

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UNIT NAME	**VSA/Assertion-Reason type (1 MARK)**	**Case study based (4 marks)**	**SA1 (2 MARKS)**	**SAII (3 MARKS)**	**LA (5 MARKS)**	**TOTAL**
ELECTROSTATICS	2 (2)		1(2)		1(5)	5(12)
CURRENT ELECTRICITY				1(3)		
MAGNETIC EFFECTS OF CURRENT AND MAGNETISM	2 (2)		2(4)	1(3)		9(21)
ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENT	1 (1)	1(4)	1(2)		1(5)	
ELECTROMAGNETIC WAVES	1 (1)					8(18)
OPTICS	2 (2)	1(4)	3(6)		1(5)	
DUAL NATURE OF MATTER	1 (1)			1(3)		6(12)
ATOMS AND NUCLEI	2 (2)			2(6)		
ELECTRONIC DEVICES	3 (3)		2(4)			5(7)
TOTAL	**14(14)**	**2(8)**	**9(18)**	**5 (15)**	**3(15)**	**33(70)**