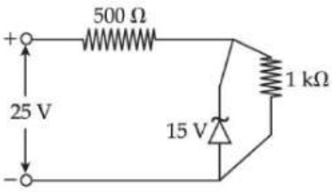
Previous Year Paper

22nd May 2023 (Shift 3)

Q1. A Zener diode is used in a voltage regulator circuit as shown below. Its breakdown voltage is 15 V. What is the current flowing through the Zener diode?



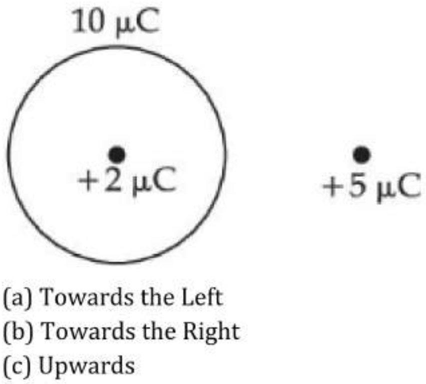
(a) 5 mA
(b) 10 mA
(c) 15 mA according
(d) 20 mA

Q2. Match **List - I** with **List - II**

List-I		List-II	
(A)	Microwave	(I)	Radar System for Aircraft Navigation
(B)	UV Rays	(II)	To study crystal structure
(C)	X-Rays	(III)	Radioactive decay of Nucleus
(D)	Gamma-Rays	(IV)	Lasik eye surgery

Choose the **correct** answer from the options given below:
(a) (A)-(I), (B)-(IV), (C)-(II), (D)-(III)
(b) (A)-(II), (B)-(IV), (C)-(III), (D)-(I)
(c) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)
(d) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

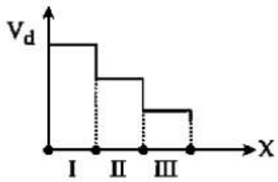
Q3. A thin metallic spherical shell contains a charge $+10\ \mu C$ on it. A point charge $+2\ \mu C$ is placed at the centre of the shell and another charge $+5\ \mu C$ is placed outside it as shown. The force on the charge $+2\ \mu C$ at the centre is:



(a) Towards the Left
(b) Towards the Right
(c) Upwards
(d) zero

Q4. Energy of a photon corresponding to a wavelength of 600 nm is 2.08 eV. The energy of a photon of wavelength 400 nm will be:
(a) -1.39 eV
(b) 3.12 eV
(c) 4.68 eV
(d) 0.92 eV

Q5. Figure shows drift speed V_d of conduction electrons in a copper wire versus position (X) for the three sections. Then,

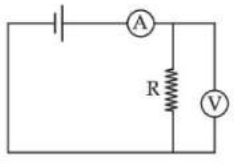


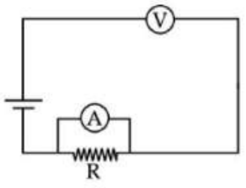
(A) Radius of III > Radius of II > Radius of I
(B) Electric Field in III > Electric Field in II > Electric Field in I
(C) Radius of wire is same in all sections
(D) Conductivity is same in all sections

Choose the **correct** answer from the options given below:
(a) (D) only
(b) (B) and (D) only
(c) (A) and (D) only
(d) (B) and (C) only

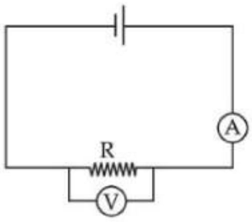
Q6. A square shaped wire loop of side L is carrying a current I. What is the magnetic field at the point of intersection of diagonals of the square wire loop?
(a) $\frac{\mu_0 I}{\pi L\sqrt{2}}$
(b) $\frac{2\sqrt{2}\,\mu_0 I}{\pi L}$
(c) $\frac{2\mu_0 I}{\pi L}$
(d) $\frac{\sqrt{2}\,\mu_0 I}{\pi L}$

Q7. Which of the following circuits cannot be used to measure the resistance of resistor R?

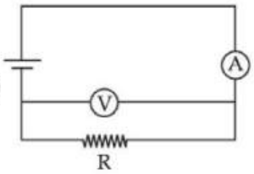
(a) 

(b) 

(c)



(d)



Q8. Which of the following change is observed when light travels from air to glass?

(a) speed of light only
(b) frequency of light only
(c) wavelength of light only
(d) wavelength and speed of light only

Q9. The same current is flowing in two AC circuits. The first circuit contains a pure inductor and the second, a capacitor. If the frequency of the AC is increased, then the current will.

(a) increase in the first but decrease in the second
(b) increase in both
(c) decrease in both
(d) decrease in the first and increase in the second

Q10. Which of the following is an example of nuclear fusion?

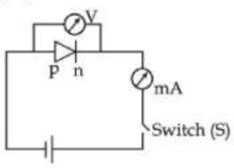
(a) Formation of ${}^{144}_{56}$Ba and ${}^{89}_{36}$Kr from ${}^{235}_{92}$U
(b) Formation of ${}^{235}_{94}$Pu from ${}^{235}_{92}$U
(c) Formation of ${}^{4}_{2}$He from ${}^{2}_{1}$H
(d) Formation of water from hydrogen and oxygen

Q11. The temp at which the resistance of a conductor becomes 30% more than that of its resistance at 47°C will be:
(Given the value of temperature coefficient of resistance of the conductor is $2 \times 10^{-4} K^{-1}$.)

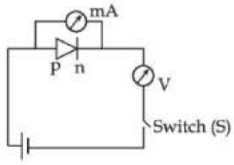
(a) 1847 K
(b) 1820 K
(c) 1547 K
(d) 1500 K

Q12. Choose the correct experimental circuit arrangement for studying V-I characteristics a p-n junction diode in forward bias:

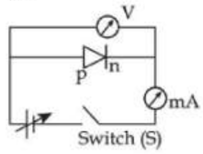
(a)



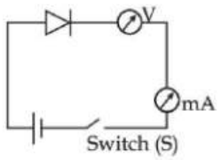
(b)



(c)



(d)



Q13. If the 8th bright band of wavelength λ_1 coincides with 9th bright brand of wavelength λ_2 in a Young's double slits experiment, then the possible wavelength of two lights is:

(a) $\lambda_1 = 450\ nm, \lambda_2 = 400\ nm$
(b) $\lambda_1 = 400\ nm, \lambda_2 = 450\ nm$
(c) $\lambda_1 = 425\ nm, \lambda_2 = 450\ nm$
(d) $\lambda_1 = 400\ nm, \lambda_2 = 425\ nm$

Q14. A ray of light passes through an equilateral glass prism in such a manner that the angle of incidence is equal to the angle of emergence and each of these angles is equal to $\left(\frac{3}{4}\right)^{th}$ of the angle of prism.
The angle of deviation is:

(a) 45°
(b) 70°
(c) 39°
(d) 30°

Q15. A transformer has an efficiency of 80%. It works at 3 kW and 120 V. If the secondary voltage is 240 V, what will be the secondary current?

(a) 2.5 A
(b) 12.5 A
(c) 25 A
(d) 10 A

Q16. During the p-n junction formation, when an electron diffuses from n $n \to p$, it leaves behind an:

(a) ionised acceptor on n-side
(b) ionised donor on n-side
(c) ionised donor on p-side
(d) ionised donor on n-side and p-side both

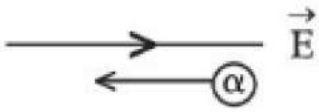
Q17. A particle moves three times as fast as an electron. The ratio of the de Broglie wavelength of the particle to that of the electron is 1.813×10^{-4}. The mass of the particle is:

(a) $1.67 \times 10^{-27}\ kg$
(b) $1.675 \times 10^{-31}\ kg$
(c) $1.675 \times 10^{-29}\ kg$
(d) 1.675×10^{-30} kg

Q18. The half-life of a radioactive substance is 10 days. How many days will it take to disintegrate 3/4 of its initial value?
(a) 5 days
(b) 10 days
(c) 20 days
(d) 15 days

Q19. The magnitude of a magnetic force on a current carrying conductor is given by:
(a) $q\frac{dV}{dx}$
(b) q vB sinθ
(c) ilB sinθ
(d) q(E+VB sinθ)

Q20. In the figure, an α-particle moves a distance l in a uniform electric field $\vec{E}$ as shown. Does the Electric Field do a positive or a negative work on the α-particle? Does the electric potential energy of the α-particle increase or decrease?



(a) Negative, increases
(b) Positive, decreases
(c) Negative, decreases
(d) Positive, increases

Q21. Two coherent light beams of intensities I and 4 I are superimposed. The maximum and minimum possible intensities in the resulting pattern are:
(a) 5 I and 3 I
(b) 5 I and I
(c) 9 I and I
(d) 9 I and 3 I

Q22. Eight identical spherical drops, each having a potential of 9 V are combined together to form a single large drop. The potential of this large drop will be:
(a) 4.5 V
(b) 18 V
(c) 36 V
(d) 72 V

Q23. Match **List - I** with **List - II**

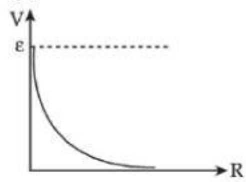
List-I		**List-II**	
(A)	Minimum magnetic moment associated with orbital motion of electron in 1st orbit is	(I)	greater than one
(B)	Paramagnetic materials have relative permeability	(II)	Meissner's effect
(C)	Magnetic moment per unit volume of the material is called	(III)	Bohr Magneton
(D)	Perfect diamagnetism of superconductors	(IV)	Intensity of magnetisation

Choose the **correct** answer from the options given below:
(a) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)
(b) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
(c) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)
(d) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

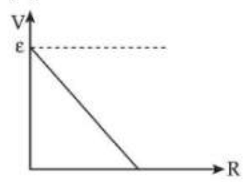
Q24. Under the influence of a uniform magnetic field, a charged particle moves with a constant speed v in a circle of radius r. The time period of the revolution of the particle:
(a) depends on v and not on r
(b) is independent of both v and r
(c) depends on r and not on v
(d) depends on both v and r

Q25. A uniformly charged conducting sphere of radius 1.3 m has a surface charge density of 70 μC m^{-2}.
What is the total electric flux leaving the surface of the sphere?
(a) $5.9 \times 10^{8}\ N\ m^2\ C^{-1}$
(b) $1.7 \times 10^{-8}\ N\ m^2\ C^{-1}$
(c) $1.7 \times 10^{8}\ N\ m^2\ C^{-1}$
(a) $6.4 \times 10^{-8}\ N\ m^2\ C^{-1}$

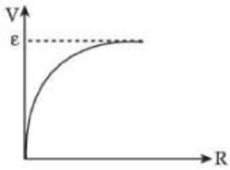
Q26. Cell having an emf E and internal resistance r is connected across a variable external resistance R. As the resistance R is increased, the plot of potential difference V across R is given by:
(a)



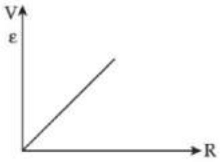
(b)



(c)



(d)



Q27. What is the approximate earth's dipole moment, if the earth's magnetic field at the Equator is approximately 0.5 G and diameter is 15.0×10^6m?

(a) 5.9×10^8 Am^2

(b) 6.5×10^{30} Am^2

(c) 2.1×10^{23} Am^2

(d) 1.05×10^{23} Am^2

Q28. When a capacitor is subjected to a D.C. source it takes small time internal to get fully charged up. During this small-time interval there is no passage of charge through dielectric, yet we use a term - displacement current. This term is used because:

(a) There is a slow motion of charge from one plate to another

(b) There is a continues change of electric field between plates and hence electric flux

(c) The electric charge from battery stops moving

(d) There is temporary breakdown of dielectric

Q29. A 25 μF capacitor, a 0.10 H inductor and a 25 Ω resistor is connected in series with an ac source of emf $\varepsilon = 310 \sin 314$ t. What is the frequency of AC source?

(a) 314 Hz

(b) 100 Hz

(c) 50 Hz

(d) 310 Hz

Q30. Match **List - I** with **List - II**

List-I		**List-II**	
(A)	Range	(I)	Range of frequencies over which communication system works
(B)	Band width	(II)	The largest distance between transmitter and receiver
(C)	Attenuation	(III)	A device that has input in electrical form or provides Output in electrical form
(D)	Transducer	(IV)	Loss of strength of a signal during propagation

Choose the **correct** answer from the options given below:

(a) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(b) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(c) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(d) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

Q31. In an AC generator when the plane of the armature is perpendicular to the magnetic field, what will the magnitude of the magnetic flux passing through the coil and the emf induced in the coil be?

(a) Both the magnetic flux and the induced emf are maximum

(b) Both the magnetic flux and the induced emf are zero

(c) The magnetic flux is zero and the induced emf is maximum

(d) The magnetic flux is maximum and the induced emf is zero

Q32. A carrier wave of peak voltage 14 V is used to transmit a message. What should be the peak voltage of the modulating signal in order to have a modulation index of 70%?

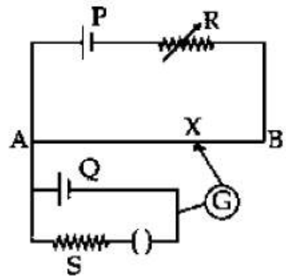
(a) 20.0 V

(b) 2.0 V

(c) 9.8 V

(d) 4.2 V

Q33. In the potentiometer circuit the balance point is at X. The balance point will be shifted right towards B when:



(A) Resistance R is increased keeping all other parameters constant

(B) Resistance S is increased keeping all other parameters constant

(C) Cell P is replaced by another cell whose emf is lower than Q

(D) The polarity of Q is reversed

Choose the **correct** answer from the options given below:

(a) (A) only

(b) (B) and (D) only

(c) (A), (B) only

(d) (B) and (C) only

Q34. Kirchhoff's First Law, $\sum I = 0$ at a junction deal with conservation of:

(a) Charge

(b) Energy

(c) Momentum

(d) Angular Momentum

Q35. According to Einstein's photoelectric equation, the plot of the Kinetic Energy of the emitted photoelectrons from a metal versus the frequency of the incident radiation gives a straight line whose slope:

(a) depends on the nature of the metal used

(b) depends on the intensity of the radiation

(c) depends both on the intensity of the radiation and the metal used

(d) is the same for all metals and independent of the intensity of the radiation

Q36. Which of the following spectral series is found in the visible region of the hydrogen spectrum?

(a) Lyman

(b) Balmer

(c) Paschen

(d) Pfund

Q37. If a match box of size 5 cm × 4 cm × 1 cm is filled with nuclear matter, what will be its expected mass? The density of the nuclear matter is approximately 2.3×10^{17} kg m^{-3}.

(a) 4.6×10^{12} mg

(b) 4.6×10^{12} μg

(c) 4.6×10^{12} g

(d) 4.6×10^{12} kg

Q38. The force between two electric charges is expressed by the equation:

$F = \frac{k\, q_1\, q_2}{r^2}$

Which of the following is a correct statement?

(a) The equation applies to point charges

(b) k is Boltzmann's constant

(c) r is the radius of the spheres on which the two charges are placed

(d) The equation can only be applied to uniform

Q39. Electrostatics deals with the study of forces, fields and potential arising from static charges. Which of the following statements are correct?

(A) Electrostatic force is a conservative force

(B) Charge is quantized because only integral number of electrons can be transferred from one body to the other

(C) In a uniform electric field E, an electric dipole experiences a torque and a net force F.

(D) The electric field lines start from positive charges and end at negative charges. If there is a single charge, these may start or end at infinity.

(E) If the uniform surface charge density of an infinite plane sheet is positive, the electric field is directed away from the plate.

Choose the **correct** answer from the options given below:

(a) (B), (C) and (E) only

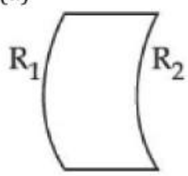
(b) (A), (C) and (D) only

(c) (A), (B), (D) and (E) only

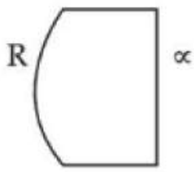
(d) (A), (B) and (C) only

Q40. Which of the following spherical lenses does not exhibit dispersion? The radii of curvature of the surfaces of the lenses are given in diagrams.

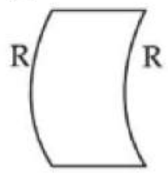
(a)



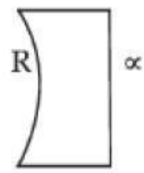
(b)



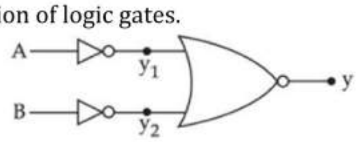
(c)



(d)



Q41. Choose the logic gate represented by the following combination of logic gates.



(a) NOR

(b) NAND

(c) AND

(d) OR

Q42. A plane electromagnetic wave of frequency 50 MHz travels in free space along the x-direction. At a particular point in space and time $\vec{E} = 9.3\,\hat{j}\,V\,m^{-1}$. What is $\vec{B}$ at this point?

(a) $(3.1 \times 10^{-8}\hat{k})$T

(b) $(3.1 \times 10^{-8}\hat{\imath})$T

(c) $(3.1 \times 10^{8}\hat{k})$T

(d) $(3.1 \times 10^{-8}\hat{j})$T

Q43. In Bohr's atomic model, the radius of the first orbit isr_0. The radius of the third orbit will be:

(a) 3 r_0

(b) 9 r_0

(c) r_0

(d) $r_{0/3}$

Q44. Which of the following statement is NOT true, when two capacitors charged to different potential are connected in parallel by a conducting wire?

(a) Some energy is lost

(b) The charge lost by one is equal to the charge gained by the other

(c) Both the capacitors acquire a common potential

(d) The potential lost by one is equal to the potential gained by the other

Q45. A magnet suspended freely at the Equator will set itself ___________ to the surface of Earth, while one suspended at pole will stand ___________.

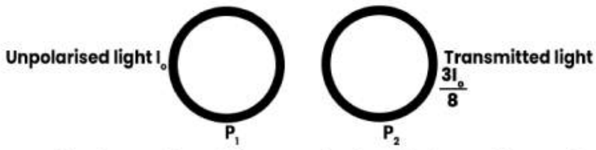
(a) vertical, parallel

(b) parallel, parallel

(c) parallel, vertical

(d) vertical, vertical

Q46. P_1 and P_2 are two polaroids



The intensity of the unpolarised is Io and intensity of the transmitted height is $\frac{3Io}{8}$. The angle bet-ween axis of P_1 and P_2 is:

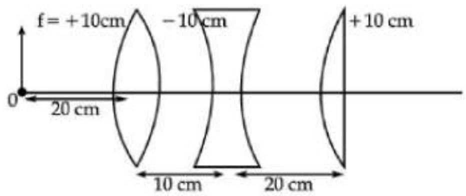
(a) 30°

(b) 90°

(c) 45°

(d) 60°

Q47. What would be the position of image formed by the lens combination given in the figure below?



(a) 10 cm to the right of third lens

(b) 7 cm to the right of third lens

(c) 7 cm to the left of third lens

(d) at ∞ to right of third lens

Q48. Two coils of self-inductances L_1 and L_2 are kept close to each other so that the effective flux in one is completely linked with the other. What is the mutual inductance M between them?

(a) L_1L_2

(b) $L_1L_2^{-1}$

(c) $(L_1L_2)^2$

(d) $(L_1L_2)^{1/2}$

Q49. The objective of a reflecting telescope is a:

(a) Convex lens

(b) Concave mirror

(c) Concave lens

(d) Prism

Q50. A boat is moving due east in a region where the Earth's magnetic field is 5.0×10^{-5} NA$^{-1}m^{-1}$ due north and horizontal. The boat carries a vertical aerial 2 m long. If the speed of the boats is 1.5 ms^{-1}, the magnitude of the induced emf is:

(a) 0.50 mV

(b) 0.15 mV

(c) 1.00 mV

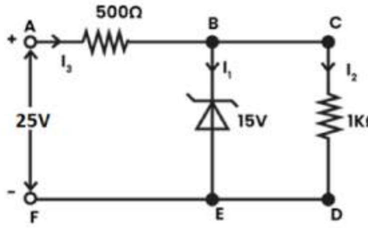
(d) 0.75 mV

SOLUTIONS

S1. Ans. (a)

Sol. Current passes in reverse direction in a Zener diode when the Zener voltage is reached. Here the Zener voltage is given as 15 V.

After redrawing the circuit diagram to note the potentials and the current through different segments we get,



Here we have grounded the point F and all the points F, E and D have voltage is equal to O, since all of them are connected to each other through a wire.

Point A has potential of 25 V, B has potential of 15 V and C again has potential of $15V$ (again because points B and C are connected through a wire).

The current through the resistance 500Ω is

$I_3 = \frac{V_A - V_B}{R} = \frac{25-15}{500}$

$= \frac{1}{50} = 0.02$ A

The current through the 1kΩ resistance will be

$I_2 = \frac{V_C - V_D}{R} = \frac{15-0}{1000}$

$= 0.015$ A

According to the junction rule at B :

$I_3 = I_1 + I_2$

Hence, $I_1 = I_3 - I_2$

$= 0.005$ A $= 5$ mA

S2. Ans. (b)

Sol.

List-I		List-II	
(A)	Microwave	(II)	Radar System for Aircraft Navigation
(B)	UV Rays	(IV)	Lasik eye surgery
(C)	X-Rays	(III)	Radioactive decay of Nucleus
(D)	Gamma-Rays	(I)	To study crystal structure

S3. Ans. (d)

Sol. **Let us consider,** A thin metallic spherical shell contains a charge Q=+10 μC on its surface. A point charge q_1 =+2 μC is placed at the centre of the shell and another charge q_2=+5 μC is placed outside the shell. All the three charges are positive. Then, the force on charge q_1=+2 μC is

Due to Electrostatic shielding, the metallic spherical shell acts as a shield and do not allow the electric field due to outside charges to penetrate through it. Hence, electric field inside shell due to Q and q 1 is zero. Therefore, no force will act on charge q.

S4. Ans. (c)

Sol. here we have, $\lambda_1 = 6\text{nm} = 6000\ \text{A}^\circ \text{E}_1 = 2.08\ \text{eV} = 3.33 \times 10^{-19}\ \text{J}\ and\ \lambda_2 = 4\text{nm} = 4000\ \text{A}^\circ$

Energy of the photon $E = \frac{hc}{\lambda}$

$\Rightarrow \frac{E_2}{E_1} = \frac{\lambda_1}{\lambda_2}$

$\therefore \frac{E_2}{3.2\times10^{-19}} = \frac{6000}{4000}$

$E_2 = \frac{6}{4} \times 3.2 \times 10^{-19}$

We get $E_2 = 4.8 \times 10^{-19}$ J

S5. Ans. (c)

Sol. The rank of the three sections according to the radius is Radius of III > Radius of II > Radius of I

The rank of the three sections according to the magnitude of the electric field is $E_I > E_{II} > E_{III}$.

The rank of the three sections according to the conductivity is $\sigma_I = \sigma_{II} = \sigma_{III}$

S6. Ans. (b)

Sol. The side length of the square loop, AB = L

$\therefore \text{BC} = \frac{L}{2}$

From geometry, we get ∠BOC = 45°

$\therefore$ In $\triangle OCB \Rightarrow \frac{BC}{x} = \tan 45^\circ$

$\Rightarrow \frac{\frac{L}{2}}{x} = 1$

$\Rightarrow x = \frac{L}{2}$

Magnetic field at O due to AB,

$I_0' = \frac{\mu_0 I_2}{4\pi x}[\sin\theta_1 + \sin\theta_2]$

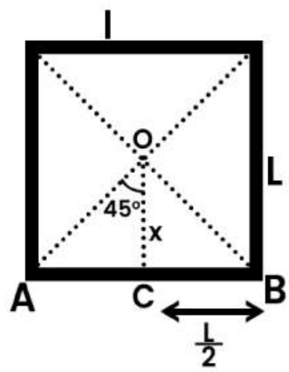
where, $\theta_1 = \theta_2 = 45^\circ$

$\Rightarrow I_0' = \frac{\mu_0 I}{4\pi L/2}[\sin 45^\circ + \sin 45^\circ]$

$\Rightarrow I_0' = \frac{\mu_0 2I}{4\pi L}\left[\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\right]$

$\Rightarrow I_0' = \frac{\mu_0 I}{\pi L\sqrt{2}}$

$\Rightarrow$ Net magnetic field at point O due to four such wires, $I_0 = 4I_0' = \frac{\mu_0 2\sqrt{2} I}{\pi L}$



S7. Ans. (b)

Sol. In order to measure the resistance in the circuit, we need to know the voltage V and the current I in the circuit, this way we can calculate the resistance using the formula:

R=V/I

In order to calculate the current, we can use an amperemeter that must be in series with the circuit, this way it will not affect the circuit.

And in order to calculate the voltage, we can use a voltmeter that must be in parallel with the resistance, this way it will not affect the circuit.

S8. **Ans. (d)**

Sol. Whenever light waves travel from air medium to glass medium, wavelength and velocity get affected.

S9. **Ans. (d)**

Sol. Let the frequency of AC be v.

$\therefore \mathrm{w} = 2\pi \mathrm{v}$

Reactance (or resistance) of the capacitor, $X_c = \frac{1}{wC}$ Reactance (or resistance) of the inductor, $X_L = wL$ Current in the circuit, $I = \frac{V}{X}$ where X is the reactance of the circuit ⇒ When the frequency of the AC is increased, then the X_c will decrease whereas X_L will get increased. Hence for the same input AC voltage, current in the inductor circuit will decrease and that in capacitor circuit will increase.

S10. **Ans. (c)**

Sol. **The** example of nuclear fusion is Formation of $^{4}_{2}He$ from $^{2}_{1}H$

S11. **Ans. (b)**

Sol. Here we have, $R_{27} = R, R_T = R + \frac{30}{100}R = 1.3R, T_1 = 47 + 273 = 320\text{k}, \alpha = 2 \times 10^{-4} K^{-1}$

From relation.

$R_T = R_{27}[1 + \alpha(T_2 - 320)]$

$\Rightarrow 1.3R = R[1 + 2 \times 10^{-4}(T_2 - 320)]$

$\Rightarrow 1 + 2.0 \times 10^{-4}(T_2 - 320) = 1.3$

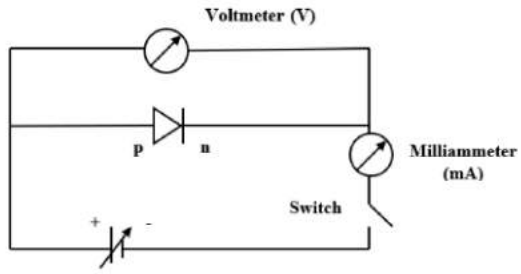
or $2.0 \times 10^{-4}(T_2 - 320) = 0.3$

$T_2 - 320 = \frac{0.3}{2.0 \times 10^{-4}}$

$T_2 = 1500 + 320 = 1820k$

S12. **Ans. (c)**

Sol. There are three possible biasing conditions for a p-n junction diode and these are: 1) Zero bias: In this biasing condition, no external voltage potential is applied to the diode. 2) Forward bias: In this biasing condition, a negative voltage is applied to the N-type material and a positive voltage is applied to the P-type material, Due to this type of biasing, the width of the p-n junction diode decreases. 3) Reverse bias: In this biasing condition, a positive voltage is applied to the N-type material and a negative voltage is applied to the P-type material, Due to this type of biasing, the width of the p-n junction diode increases. The circuit arrangement for studying V-I characteristics of a p-n junction diode in forward bias is given below.



S13. **Ans. (a)**

Sol. Position of nth bright fringe from central maximum is $\frac{n\lambda D}{d}$.

$\therefore \frac{8\lambda_1 D}{d} = \frac{9\lambda_2 D}{d}$

$\frac{\lambda_1}{\lambda_2} = \frac{9}{8}$

so, it must be 400 nm and 450 nm

S14. **Ans. (d)**

Sol. Let the angle of incidence of light at prism. $i = x$

So, Angle of emergence, $e = x$

Angle of prism, $A = \frac{4}{3}x$

Since prism is equilateral $\Rightarrow 3A = 180^\circ \Rightarrow x = 45^\circ$

From prism formula:

Angle of deviation, $\delta = i + e - A = 45 + 45 - 60 = 30^\circ$

S15. **Ans. (d)**

Sol. Efficiency, $\eta = 80\%$ Input power, $P_{\text{in}} = 3\text{ kW} = 3000\text{ W}$ Input voltage, $V_{\text{in}} = 120\text{ V}$ Output voltage, $V_{\text{out}} = 240\text{ V}$ Current, $I = \frac{P}{V}$ Where P is the power and V is the voltage. And Efficiency, $\eta = \frac{P_{\text{out}}}{P_{\text{in}}}$ Since,

$I_p = \frac{P_{\text{in}}}{V_{\text{in}}}$

Where I_p is the primary current

$\Rightarrow I_p = \frac{3000}{120}$

$\Rightarrow I_p = 25\text{ A}$

We have.

$\eta = \frac{P_{\text{out}}}{P_{\text{in}}}$

$\Rightarrow 80\% = \frac{P_{\text{out}}}{3000}$

$\Rightarrow 80\% = \frac{V_{\text{out}} I_s}{3000}$

Where I_s is the secondary current

$$\Rightarrow \frac{80}{100} = \frac{240 I_s}{3000}$$

$$\Rightarrow I_s = 10\text{ A}$$

S16. **Ans. (b)**

Sol. Electron Diffuses from n→p This diffusion leaves an ionized donor (or a positive charge) on the n-side. This donor is bonded to the surrounding atoms and is immobile. As more and more electrons start diffusing to the p-side, a layer of positive charge (or positive space-charge region) in the n-side of the junction is formed.

S17. **Ans. (a)**

Sol. $v = 3v_e, \lambda = \lambda_e \times 1.813 \times 10^{-4}, m_e = 9.11 \times 10^{-31}$ kg

Using $\lambda = h/p$

$h = \lambda p = \lambda mv$

As h is constant

$\therefore \lambda \mathrm{mv} = \lambda_{\mathrm{e}} \mathrm{m_e v_e}$

$\mathrm{m} = m_e \times \frac{\lambda_e v_e}{\lambda v}$

$\mathrm{m} = 9.11 \times 10^{-31} \times \frac{1}{1.813 \times 10^{-4} \times 3}$

$\mathrm{m} = 1.67 \times 10^{-27}$ kg

S18. Ans. (c)

Sol.

$$\text{Mass left } = -\frac{3}{4} = \frac{1}{4}$$

$$\mathrm{N} = \mathrm{N_0} \mathrm{e}^{-\lambda t}$$

$$\mathrm{N} = \frac{\mathrm{N_0}}{4}$$

$$\frac{1}{4} = \mathrm{e}^{-\lambda t}$$

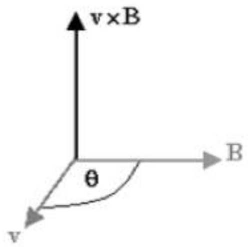
$$2 \ln\ 2 = \lambda t$$

$$t = 2 \frac{2 \ln\ 2}{\lambda}$$

$$t = 2 \times 10 = 20 \text{ days}$$

S19. Ans. (c)

Sol. The magnitude of the Lorentz force F is F = qvB sinθ, where θ is the smallest angle between the directions of the vectors v and B.



S20. Ans. (a)

S21. Ans. (c)

Sol. Given intensities of the beams are $I_1 = 1, I_2 = 41$

Maximum intensity

$I_{\max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = (\sqrt{1} + \sqrt{41})^2 = 91$

Minimum intensity

$I_{\min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2 = (\sqrt{1} - \sqrt{41})^2 = 1$

S22. Ans. (c)

Sol. Here, $C \propto r$ or $C = kr$ Charge on each small drop, $q = CV = (kr \times 9)C$

Let R be radius of large drop As volume of 8 small drops, $\therefore \frac{4}{3}\pi R^3 = 8 \times \frac{4}{3}\pi r^3$ or $R = 2r$. Capacitance of large drop, $C = kR = 2\mathrm{kr}$ Potential of large drop

$V' = \frac{q'}{C'} = \frac{8q}{C'} = \frac{8 \times kr \times 9}{2kr} = 36$ V

S23. Ans. (d)

Sol.

List-I		List-II	
(A)	Minimum magnetic moment associated with orbital motion of electron in 1st orbit is	(III)	Bohr Magneton
(B)	Paramagnetic materials have relative permeability	(I)	greater than one
(C)	Magnetic moment per unit volume of the material is called	(IV)	Intensity of magnetisation
(D)	Perfect diamagnetism of superconductors	(II)	Meissner's effect

S24. Ans. (b)

Sol. When a particle moves in a magnetic field of intensity B pointing downwards into the page and particle is moving with a speed of v on the plane of paper: F = qvB (Force of charged particle in a magnetic field)

And we know that $\mathrm{F} = \frac{\mathrm{mv}^2}{\mathrm{r}}$ (r is the radius of motion and m is mass of particle) $\Rightarrow \mathrm{qvB} = \frac{\mathrm{mv}^2}{\mathrm{r}} \Rightarrow \mathrm{r} = \frac{\mathrm{mv}}{\mathrm{Bq}}$

Now as we know that $\omega = \frac{\mathrm{v}}{\mathrm{r}} \Rightarrow \omega = \frac{\mathrm{Bq}}{\mathrm{m}}$

Time period, $\mathrm{T} = \frac{2\pi}{\omega} \Rightarrow \mathrm{T} = \frac{2\pi \mathrm{m}}{\mathrm{Bq}}$

And this shows that it is independent of both radius and velocity.

S25. Ans. (c)

Sol. $\mathrm{r} = 1.3$ m

Surface charge density, $\sigma = 70\ \mu\mathrm{C/m^2} = 70 \times 10^{-6} \mathrm{C/m^2}$ Total charge on surface of sphere, Q = Charge density × Surface area

$= \sigma \times 4\pi r^2$

$= 70 \times 10^{-6} \times 4 \times 3.14 \times (1.3)^2$

$= 1.48 \times 10^{-3}$C

Therefore, the charge on the sphere is 1.447×10^{-3}C.

$\phi_{\text{total}} = \frac{\mathrm{Q}}{\epsilon_0}$

$\epsilon_0 = 8.854 \times 10^{-12}\ \mathrm{N^{-1} C^2\ m^{-2}}$

$\mathrm{Q} = 1.48 \times 10^{-3}$C

$\phi_{\text{total}} = \frac{1.48 \times 10^{-3}}{8.854 \times 106-12}$

$= 1.7 \times 10^8\ \mathrm{NC^{-1}\ m^2}$

S26. Ans. (c)

Sol. Current in the circuit $I = \frac{\varepsilon}{R+r}$ Potential difference across R,

$V = IR = \left(\frac{\varepsilon}{R+r}\right) = \frac{\varepsilon}{\left(1+\frac{r}{R}\right)}$

When $R = 0, V = 0$ or $R = \infty, V = \varepsilon$

S27. Ans. (c)

Sol. The equatorial magnetic field is:

$\mathrm{B} = \frac{\mu_0 \mathrm{m}}{4\pi \mathrm{r}^3}$

Here we have

$B = 0.5G = 0.5 \times 10^{-4}$ T

diameter of earth, d= 15.0×10^6m

Radius of earth $r = \frac{d}{2} = \frac{15.0\times10^6}{2} = 7.5 \times 10^6$ m

$\therefore m = \frac{B}{\frac{\mu_0}{4\pi}} r^3 = \frac{0.5\times10^{-4}}{10^{-7}} \times (7.5 \times 10^6)^3 = 500 \times 4.22 \times 10^{23} = 2.11 \times 10^{23}$ A m^2

S28. Ans. (b)

Sol. Whenever a capacitor is subjected to a D.C. source it takes small time internal to get fully charged up. During this small-time interval there is no passage of charge through dielectric, yet we use a term - displacement current. This term is used because there is a continues change of electric field between plates and hence electric flux

S29. Ans. (c)

Sol. There we have,: $C = 25\mu F = 25 \times 10^{-6}$ F, $L = 0.10H$, $R = 25\Omega$, $e = 310\sin(314t)$[volt] Comparing $\varepsilon = 310\sin(314t)$ with $\varepsilon = \varepsilon_0 \sin(2\pi f t)$, we get, the frequency of the alternating emf as

$f = \frac{314}{2\pi} = \frac{314}{2(3.14)} = 50$ Hz

S30. Ans. (b)

Sol.

List-I		List-II	
(A)	Range	(II)	The largest distance between transmitter and receiver
(B)	Band width	(I)	Range of frequencies over which communication system works
(C)	Attenuation	(IV)	Loss of strength of a signal during propagation
(D)	Transducer	(III)	A device that has input in electrical form or provides Output in electrical form

S31. Ans. (d)

Sol. In an A.C. generator, when the plane of the armature is perpendicular to the magnetic field. both the flux linked and induced emf in the coil are zero.

S32. Ans. (c)

Sol. Modulation Index $= \frac{V_m}{V_c}$ V_m = Modulating Signal Voltage V_c = Carrier Signal Voltage

$0.7 = \frac{V_m}{14}$

$V_m = 9.8$ V

S33. Ans. (c)

Sol. (i) If resistance R is increased, the balance point shifts towards B, because when R is increased current flowing in the circuit will decrease and the potential drop per unit length also decrease, so balance length will increase. (ii) If S is increased, there is no effect on the null point. As at balance condition, no current is drawn from cell Q.

S34. Ans. (a)

Sol. Kirchhoff's first law i.e. junction rule is centered on the law of conservation of charge.

S35. Ans. (d)

Sol. According to Einstein's photoelectric equation,

$h\nu = h\nu_0 + \frac{1}{2} m v_{max}{}^2$

or $\frac{1}{2} m v_{max}{}^2 = h\nu - h\nu_0$

The equation of a straight line in intercept form is given by

$y = mx + c$ ... (ii)

Comparing the equations (i) and (ii), we get

$m = h$

Therefore, slope of the plot is equal to Planck's constant. Hence, the plot is same for all metals and independent of the intensity of the radiation.

S36. Ans. (b)

Sol. All of the wavelengths in the Balmer series are in the visible region of the electromagnetic spectrum (400 nm to 740 nm). The presence of Hydrogen is detected in astronomy by using the H-Alpha line of the Balmer series; it is also a component of the solar spectrum.

S37. Ans. (d)

Sol. mass = Volume ×nuclear density

$= V \times d$

V volume $= 5 \times 4 \times 1\ cm^3 = 2 \times 10^{-5}\ m^3$

density of Nucleons $= d \approx 2.3 \times 10^{17}\ g/m^3$

mass $= V \times d$

$= 2 \times 10^{-5} \times 2.3 \times 10^{17}$

$= 4.6 \times 10^{12}$kg

S38. Ans. (a)

Sol. Coulomb's Law $F = \frac{k q_1 q_2}{r^2}$

is an equation that represents the attractive or repulsive electric force (F) of two-point charges (q). The force is proportional to the square of the distance (r) between charges. The proportionality constant that relates force to charge and distance is given the letter k, or k, and is known as Coulomb's constant.

S39. Ans. (b)

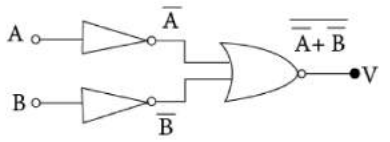
Sol. Work done by the electrostatic force is independent of the path followed by it, and it depends only on the initial and final positions. For example, work done in moving a unit positive charge in a closed loop of an electric field is zero. So, electrostatic force is a conservative force. In a uniform electric field E, an electric dipole experiences a torque and a net force F. The electric field lines start from positive charges and end at negative charges. If there is a single charge, these may start or end at infinity.

S40. Ans. (c)

Sol. A lens for which the radii of curvature for both the inner and outer surface are same, does not exhibit dispersion.

S41. Ans. (c)

Sol. This is a case of AND gate. Input and output are shown below $\therefore y = \overline{\overline{A} + \overline{B}} = \overline{\overline{A}} \cdot \overline{\overline{B}} = AB$(since $\overline{\overline{A} + \overline{B}} = \overline{\overline{A}} \cdot \overline{\overline{B}}$)



S42. Ans. (a)

Sol. From electromagnetic theory,

$|\vec{B}| = \frac{|\vec{E}|}{c}$

$\Rightarrow |\vec{B}| = \frac{9.3}{3\times10^8} = 3.1 \times 10^{-8}$ T

and $\hat{E} \times \hat{B} = \hat{c}$

$\Rightarrow \hat{j} \times \hat{B} = \hat{\imath}$

$\therefore \hat{B} = \hat{k}$

$\Rightarrow \vec{B} = 3.1 \times 10^{-8}\hat{k}T$

S43. Ans. (b)

Sol. The radius of the nth orbit of an electron is given by $r_n = r_0 \frac{n^2}{Z}$

Were, r_n - Radius of the nth Orbit r_0 - Radius of the first Orbit Z - Atomic number n - Number of orbits

For the hydrogen atom, the atomic number $Z = 1$

$\Rightarrow r_n = r_0 n^2$

So, for the third orbit $n = 3$

Thus, the radius of the third orbit $r_3 = r_0 \times 3^2 = 9r_0$

The radius of the third orbit is calculated as $9r_0$.

S44. Ans. (d)

Sol. Potential lost by one is equal to potential gained by the other the potential will be lost, when the battery gets disconnected. But, the poter the capacitor will be independent of the potential of the other.

Charge lost by one is equal to charge gained by the other To conserve charge takes place, thus, the charge lost by one will be equal to charge gained by the other. There will be some loss of energy. After connecting the capacitors, these acquire a common potential.

S45. Ans. (c)

Sol. At the North pole and the South pole, a bar magnet will point vertically because the magnetic north pole and the south pole are near the geographical South pole and North pole, respectively. Since the attraction is the strongest at the poles of a magnet, the bar magnet will stand vertically at the poles.

S46. Ans. (a)

Sol. Intensity of light passing through a single polaroid is halved when unpolarized light is incident on it.

Hence, $I_1 = \frac{I_0}{2}$

$I_2 = \frac{3I_0}{8}$

Now, angle between P_1 and P_2 is ϕ

By Malus' Law,

$I_2 = I_1 \cos^2(\phi)$

$\frac{3I_0}{8} = \frac{I_0}{2}\cos^2(\phi)$

$\frac{3I_0\times2}{8\times I_0} = \cos^2(\phi)$

$\frac{3}{4} = \cos^2(\phi)$

After taking square root of both side we get,

$\sqrt{\frac{3}{4}} = \cos(\phi)$

$\cos(\phi) = \frac{\sqrt{3}}{2}$

We know, $\cos(30°) = \frac{\sqrt{3}}{2}$

S47. Ans. (a)

Sol. For first lens

$f_1 = +10$ cm

$u_1 = -20$ cm

Using lens formula

$\frac{1}{v_1} - \frac{1}{u_1} = \frac{1}{f_1}$

$\frac{1}{v_1} = \frac{1}{f_1} + \frac{1}{u_1} = \frac{1}{10} - \frac{1}{20}$

$v_1 = +20$ cm

For the first lens image is formed at a distance of 20 cm from the right of it. This image behaves as object for second lens.

For second lens

$f_2 = -10$ cm

$u_2 = 20 - 10 = +10$ cm

$\frac{1}{v_2} = \frac{1}{f_2} + \frac{1}{u_2}$

$\frac{1}{v_2} = \frac{-1}{10} + \frac{1}{10}$

$v_2 = \infty$

Real image is formed by the second lens at infinite distance. This image will act as an object for third lens.

For third lens

$f_3 = +10cm$

$u_3 = \infty$

$\frac{1}{v_3} = \frac{1}{f_3} + \frac{1}{u_3}$

$\frac{1}{v_3} = \frac{1}{10} + \frac{1}{\infty}$

$v_3 = +10$ cm

So, the final image is formed at distance of 10 cm to the right of third lens.

S48. Ans. (d)

Sol. We know that, $M = -\frac{e_2}{di_1/dt} = -\frac{e_1}{di_2/dt}$ Also, $e_1 = -L_1\frac{di_1}{dt}$ and $e_2 = -L_2\frac{di_2}{dt}$

$\Rightarrow M^2 = \frac{e_1 e_2}{\left(\frac{di_1}{dt}\right)\left(\frac{di_2}{dt}\right)} = L_1 L_2$

$\Rightarrow M = \sqrt{L_1 L_2}$

S49. Ans. (b)

Sol. In reflecting type telescope, the object used is concave mirror.

S50. Ans. (b)

Sol.

$e = BlV$

$= 5 \times 10^{-5} \times 2 \times 1.5$

$= 15 \times 10^{-5}$ V

$= 0.15$mV