Previous Year Paper

30/ 05/ 2023 (Shift-1)

Q1. Resolving power of a telescope can be increased by increasing:
(a) Wavelength of light incident at telescope
(b) Diameter of eye piece
(c) Focal length of eyepiece
(d) Diameter of Objective lens

Q2. Which of the following is the correct equation for the law of radioactive decay? Symbols have their usual meaning.
(1) $N(t) = N_o e^{-t/\lambda}$
(2) $N(t) = N_o e^{-\lambda t}$
(3) $N(t) = N_o e^{-\lambda/t}$
(4) $N(t) = N_o e^{-2\lambda t}$

Q3. Match List - I with List - II.

List - I	List - II
(A) Contracting of Eye ball	(I) Myopia
(B) Controls the shape of eye lens	(II) Cornea
(C) Elongation of eye ball	(III) Ciliary Muscle
(D) Control the light entering in eyes	(IV) Hypemetropia

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

Q4. What is the mathematical expression for potential gradient?
(a) $\frac{dv}{rdr}$
(b) $-\frac{dE}{dr}$
(c) $-\frac{dV}{dr}$
(d) $-\frac{dV}{dA}$

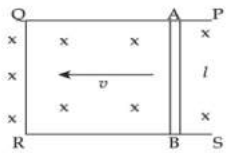
Q5. Two electrons are moving with different kinetic energies. If 1st electron is moving with kinetic energy k and the 2nd electron with kinetic energy $4k$, the ratio of their de Broglie wavelengths will be respectively:
(a) 1: 2
(b) 1: 4
(c) 2: 1
(d) 4: 1

Q6. The distance estimation for which ray optics is good approximation for an aperture of 3 mm and wavelength 300 nm would be:
(a) 40 m
(b) 30 m
(c) 20 m
(d) 10 m

Q7. The current flowing through the two bulbs marked as 60 W, 240 V each when connected in series with 240 V source is:
(a) 0.125 A
(b) 0.25 A
(c) 4 A
(d) 2 A

Q8. In equation $P = Ec^{-1}$, where P is momentum, E is energy and c is the speed of light. In which of the following options, this equation is valid:
(a) for an electron only
(b) for a photon but not for an electron
(c) for an electron as well as for a photon
(d) neither for an electron nor for a photon

Q9. Let a rod AB of length l having resistance r is moving perpendicular to a magnetic field B with constant velocity v. If the ends of the rod is connected to a wire PQRS of negligible resistance, then current passing through the wire will be: (see fig.)

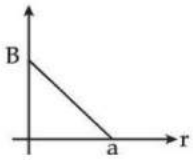


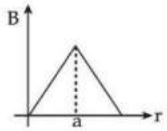
(a) $\frac{Blv}{2r}$
(b) $\frac{Blv}{r}$
(c) $\frac{Blv}{4}$

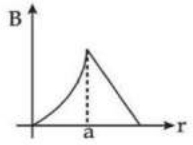
(d) $\frac{3Blv}{4r}$

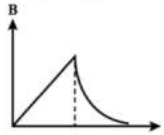
Q10. Let i_E, i_C and i_B represent the emitter current, collector current and the base current respectively in a transistor. Choose the correct statement from the following.
(a) i_C is slightly greater than i_E
(b) i_B is much greater than i_E
(c) i_C is equal to i_B
(d) i_E is equal to the sum of i_C and i_B

Q11. A long straight wire of circular cross section with radius ' a ' carries steady current ' I ' which is uniformly distributed across the cross-section. The magnetic field in the region $r < a$ and $r > a$ is represented by:

(a) 

(b) 

(c) 

(*d*) 

Q12. Match List - I with List - II.

List - I	List - II
(A) The current lags behind the emf by $\pi/4$ in phase	(I) A.C. circuit containing only an inductor
(B) The e.m.f. lags behind the current by $\pi/4$ in phase	(II) A.C. circuit with resistance and inductances in series
(C) The current lags behind the e.m.f. in phase by $\frac{\pi}{2}$	(III) A.C. circuit containing only as capacitor
(D) The e.m.f. lags behind the current in phase by $\frac{\pi}{2}$	(IV) A.C. circuit with resistance and capacitor in series

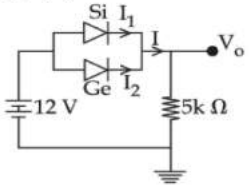
Choose the correct answer from the options given below:
(a) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)
(b) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)
(c) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
(d) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)

Q13. Match List - I with List - II.

List - I	List - II
(A) Low Mass number nuclei	(I) Medium penetrating power
(B) Electron microscope	(II) Nuclear reactor
(C) Beta decay	(III) Diffracted electron
(D) $^{235}_{92}U$	(IV) Fusion

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

Q14. What is the value of V_o if the silicon diode starts conducting at $0.7\ V$ while the Germanium start conducting at $0.3\ V$?



(a) $11\ V$
(b) $12\ V$
(c) $11.7\ V$
(d) $11.3\ V$

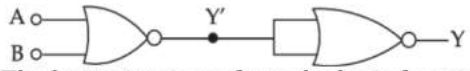
Q15. A cube of side ' a ' has a charge Q at each of its vertices, what is the potential due to this charge array at the centre of the cube?
(a) $\frac{2Q}{\sqrt{3}\pi\epsilon_0 a}$
(b) $\frac{4Q}{\sqrt{3}\pi\epsilon_0 a}$
(c) $\frac{Q}{2\sqrt{3}\pi\epsilon_0 a}$
(d) $\frac{8Q}{\sqrt{3}\pi\epsilon_0 a^2}$

Q16. What will be the time by light to travel $2\ cm$ thickness of glass of refractive index 1.5?
(a) $2 \times 10^{-10}\ s$
(b) $2.5 \times 10^{-10}\ s$
(c) $2.25 \times 10^{10}\ s$
(d) $10^{-10}\ s$

Q17. Choose the correct relation between drift velocity (v_d) and current density (J) from the following:

(a) $v_d = \text{Jne}$
(b) $v_d = \frac{J}{ne}$
(c) $v_d = \frac{J}{neA}$
(d) $v_d = \frac{J}{ne^2 A}$

Q18.



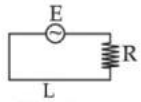
The logic circuit perform the logic function of:
(a) AND
(b) NAND
(c) OR
(d) NOR

Q19. In Ampere-circuital law, the missing term is:
(a) $i = \varepsilon_o \frac{dt}{d\phi_E}$
(b) $i = \varepsilon_o \frac{d\phi_E}{dt}$
(c) $i = \frac{1}{\varepsilon_o} \frac{dt}{d\phi_E}$
(d) $i = \frac{1}{\varepsilon_o} \frac{d\phi_E}{dt}$

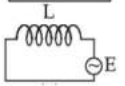
Q20 Which of the following causes electric conduction in a semiconductor?
(a) Holes only
(b) Electrons only
(c) Both electrons and holes
(d) Neither holes nor electrons

Q21. Three circuits are shown below in which same alternating current is flowing. What will be the effect on currents in three cases respectively if frequency of alternating emf be increased?

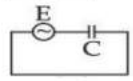
(i)



(ii)



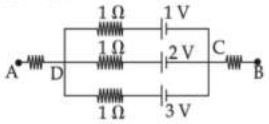
(iii)



(a) Decrease; decrease; increase
(b) No effect; decrease; increase
(c) Increase; increase; decrease
(d) No effect; decrease; decrease

Q22. Four lenses of focal length $\pm 5\ cm$ and $\pm 200\ cm$ are available for making a telescope. To produce the largest magnification for making a telescope with the help of these lenses, the focal length of eye piece should be:
(a) $+200\ cm$
(b) $-5\ cm$
(c) $-200\ cm$
(d) $+5\ cm$

Q23. In the circuit shown below, the potential difference between A and B is:



(a) $6\ V$
(b) $3\ V$
(c) $2\ V$
(d) $1\ V$

Q24. In a Young double slit experiment, if one of the slits is covered with a black paper then:
(a) Fringe width of central maxima decreases
(b) Intensity of the central maxima increases
(c) Width of maxima decreases
(d) Diffraction pattern is observed on the screen

Q25. A 300 turns rectangular coil of length 20 cm and breadth 12 cm is carrying a current of 12 A, when placed in a magnetic field of 6 T. The plane of the coil is making an angle of 60° with the magnetic field. What is the torque acting on the coil?
(a) 518.4 $N\ m$
(b) 259.2 $N\ m$
(c) 447.8 $N\ m$
(d) 366.6 $N\ m$

Q26. In a hydrogen atom an electron makes a transition from $n_1 \rightarrow n_2$, where n_1 and n_2 are the principal quantum numbers of these two states. Assuming Bohr's model to be valid, if the time period of electron in the initial state is eight times of that in the final state, the possible values of n_1 and n_2 are:
(a) $n_1 = 8, n_2 = 4$
(b) $n_1 = 4, n_2 = 8$
(c) $n_1 = 8, n_2 = 2$
(d) $n_1 = 2, n_2 = 8$

Q27. A parallel plate capacitor with air between the plates has a capacitance of $6pF$. What will be the capacitance if the distance between the plates is reduced to half and the space between them is filled with a substance of dielectric constant 5?
(a) $30pF$
(b) $60pF$
(c) $15pF$
(d) $120pF$

Q28. The wavelength of light from the spectral emission line of sodium is 662 nm. The kinetic energy at which an electron would have same de-Broglie wavelength would be: ($h = 6.62 \times 10^{-34}\ J - s$, $m_e = 9 \times 10^{-31}\ kg$)
(a) $5.5 \times 10^{-25}\ J$

(b) $5.5 \times 10^{-24}\ J$
(c) $18 \times 10^{-23}\ J$
(d) $4.5 \times 10^{-22}\ J$

Q29. A e.m.f. $e_s = 50sin\ 314t$ is applied across a pure capacitor of $637\mu F$. The instantaneous current I is:
(a) $10cos\ 314tA$
(b) $50cos\ 314tA$
(c) $20cos\ 314tA$
(d) $20sin\ 314tA$

Q30. An alpha-particle moves with a speed of $(5 \times 10^5\hat{\imath})ms^{-1}$. It enters a region where there is a magnetic field of magnitude $4\ T$, directed at an angle of 45° to the X-axis and lying in XY plane. The magnitude of magnetic force on alpha particle is:
(a) $1.6 \times 10^{-14}\ N$
(b) $3.2 \times 10^{-13}\ N$
(c) $4.5 \times 10^{-13}\ N$
(d) $1.6 \times 10^{-13}\ N$

Q31. Calculate the Ratio of Range of Transmitting antenna of height $64\ m$ to the receiving antenna of height $16\ m$:
(a) 4: 1
(b) 1: 4
(c) 2: 1
(d) 1: 2

Q32. The resistance of a potentiometer wire of length $4\ m$ is 10Ω. A resistance box and $2\ V$ accumulator are connected in series with it. What resistance should be introduced in the box to have a potential drop of $1\mu V/mm$ of the potentiometer wire?
(a) 799.9Ω
(b) 790Ω
(c) 9.995Ω
(d) 4990Ω

Q33 What is the unit of electric flux in terms of the base units of SI?
(a) $kg^{-1}\ m^3\ s^{-3}\ A^{-1}$
(b) $kgm^3\ s^3\ A^{-1}$
(c) $kgm^3\ s^{-3}\ A^1$
(d) $kgm^3\ s^{-3}\ A^{-1}$

Q34. Match List - I with List - II.

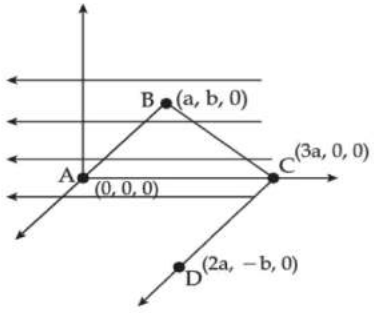
List - I	**List - II**
(A) Resistive Circuit	(I) No power dissipation
(B) Purely inductive or capacitive circuit	(II) Maximum power dissipation because $X_L = X_C$
(C) LCR series circuit	(III) Power dissipated only in resistor
(D) Power dissipated at resonance in LCR circuit	(IV) Maximum power dissipation

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

Q35. A capacitor charged from a $50\ V$ d.c. supply is found to have charge of $10\mu C$. The capacitance of the capacitor would be:
(a) $0.1\mu F$
(b) $0.2\mu F$
(c) $0.3\mu F$
(d) $0.4\mu F$

Q36. In terms of Bohr radius a_o the radius of 2nd Bohr orbit of Hydrogen is:
(a) $4a_0$
(b) $8a_o$
(c) $\sqrt{2}a_0$
(d) $2a_o$

Q37. A point charge q moves from point A to point D along the path $ABCD$ (as shown) in a uniform electric field E pointing parallel to negative direction of X-axis. The co-ordinates of A, B, C, D are $(0,0,0), (a, b, 0), (3a, 0, 0)$ and $(2a, -b, 0)$ respectively. The work done by the field in the above process is given by expression:



(a) qEa
(b) $\sqrt{2}qEa$

(c) $-qEa$
(d) - 2aqE

Q38. A radioactive nucleus decays as given below:
${}^{A}_{Z}P \rightarrow {}^{A}_{Z+1}Q \rightarrow {}^{A-4}_{Z-1}R^{*} \rightarrow {}^{A-4}_{Z-1}R$
Which particles are emitted in the sequence?
(a) α, β, γ
(b) β, γ, α
(c) γ, α, β
(d) β, α, γ

Q39. An electron moves around the nucleus in a hydrogen atom of radius 0.05 nm with a velocity of $2 \times 10^{6}\ m\ s^{-1}$. The magnetic field produced at the center of nucleus is:
(a) 0.128
(b) 6.4 T
(c) 128 T
(d) 12.8

Q40. Match List - I with List - II.

List – I	List - II
(A) Electric Field	(I) $[LTA]$
(B) Electric Flux	(II) $[L^2]$
(C) Electric Dipole Moment	(III) $[ML^3\ T^{-3}\ A^{-1}]$
(D) Area Vector Element	(IV) $[MLT^{-3}\ A^{-1}]$

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

Q41. In an experiment, a student in the laboratory measures the terminal potential difference (V) of a cell (emf E and internal resistance r) as a function of current I flowing through it and plot a graph taking V on y-axis and I on x-axis. What is the slope of the graph between V and I?
(a) r^2
(b) $-r^2$
(c) r
(d) $-r$
Compare it with standard equation of the line:
$y = mx + c$
$\Rightarrow y = c + mx$
Since graph of student is V vs I $\therefore$ V is y and I is x
Therefore, $(-r)$ is slope

Q42. A plane electromagnetic wave of frequency $30MHz$ travels in free space along the x-direction. At a particular point in space and time $\vec{E} = 6.3\hat{j}\ V/m$. The $\vec{B}$ at this point would be:
(a) $2.1 \times 10^{-8}\hat{k}\ T$
(b) $2.1 \times 10^{-6}\hat{j}\ T$
(c) $1.6 \times 10^{-8}\hat{i}\ T$
(d) $2.6 \times 10^{-8}\hat{j}\ T$

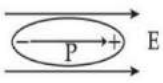
Q43. Match List - I with List - II.

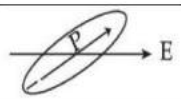
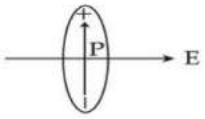
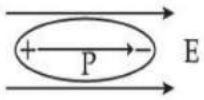
List – I	List - II
(A) 1 T	(I) Vs
(B) 1H	(II) 1 $m^2\ A$
(C) JT^{-1}	(III) Wb/m^2
(D) 1 Wb	(IV) Wb/A

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

Q44. Which of the following statements are correct?
(A) When light rays undergo two internal reflections inside a raindrop, a secondary rainbow is formed.
(B) The angle between the emergent ray and angle of prism is called the angle of deviation.
(C) Light undergoes successive total internal reflections as it moves through an optical fiber.
(D) A telescope provides angular magnification of distant objects.
(E) A simple magnifier is a diverging lens of small focal length.
Choose the correct answer from the options given below:
(a) (A), (B) and (E) only
(b) (A), (C) and (D) only
(c) (B), (C), (D) and (E) only
(d) (A), (B), (C) and (D) only

Q45. Match List - I with List - II.

List – I	List - II
A. 	(I) $U = pE$
B.	(II) $U = -\vec{p} \cdot \vec{E}$

	
C. 	(III) $U = -pE$
D. 	(IV) $U = 0$

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

Q46. Which of the following is not a significant characteristic of a pulse?
(a) Pulse amplitude
(b) Pulse width
(c) Pulse position
(d) Pulse duration modulation

Q47. An object is placed before a convex lens and its real image is obtained. Now if half of the surface is covered with paper. The result will be:
(a) No image will be formed
(b) Half image will be formed
(c) Image will be same as before
(d) Full image will be formed with less brightness

Q48. A car has a fresh storage battery of e.m.f. 15 V and internal resistance $4 \times 10^{-2}\Omega$. If the starter motor draws a current of 85 A, what is the terminal voltage of the battery when the starter is on?
(a) 3.4 V
(b) 11.6 V
(c) 12 V
(d) 12.5 V

Q49. A bar magnet of magnetic moment $3\,J/T$ lies aligned with the directions of a uniform magnetic field of 0.2 T. The amount of work, required so as to align its magnetic moment opposite to the field direction is:
(a) 1.2 J
(b) 0.6 J
(c) zero
(d) $-0.6\,J$

Q50. Match List - I with List - II.

List - I	**List - II**
(A) $\oint_S \vec{B} \cdot \overrightarrow{ds} = 0$	(I) magnetic field lines
(B) Directional properly of freely suspended magnet	(II) circulating ions
(C) Never intersect each other	(III) torque on magnetic dipole
(D) Magnetic field of earth	(IV) monopoles in magnetism do not exist

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

SOLUTIONS

S1. Ans. (d)

Sol. resolving power of telescope can be increased by increasing the diameter of objective lens of telescope

S2. Ans. (b)

Sol. Radioactive Decay law states that the number of nuclei undergoing decay per unit time is directly proportional to the total number of nuclei present in the sample at that instant of time.

$\boldsymbol{N(t) = N_o e^{-\lambda t}}$

Here, N_o represent the number of nuclei present at t = 0

S3. Ans. (b)

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

S.4. Ans. (c)

Sol. the mathematical expression for potential gradient is $-\frac{dV}{dr}$

S5. Ans. (c)

Sol. Here we have, $E_1 : E_2 = 1:4$

$$\lambda_1 = \frac{h}{\sqrt{2mE_1}}$$

$$\lambda_2 = \frac{h}{\sqrt{2mE_2}}$$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{E_2}{E_1}} = \sqrt{\frac{4}{1}} = \frac{2}{1}$$

S6. Ans. (b)

Sol. Here we have

Aperture (a) $= 3\ mm = 3 \times 10^{-3}\ m$

Wavelength $(\lambda) = 300\ nm = 300 \times 10^{-9}\ m$

Fresnel distance $(Z) = \frac{a^2}{\lambda} = \frac{(3\times10^{-3})^2}{300\times10^{-9}} = 30\ m$

Thus $\boldsymbol{30m}$ ray optics is good approximation. Hence option 2 is correct.

S7. Ans. (a)

Sol. Current is same

$$I = \frac{V}{R_1+R_2}$$

$$= \frac{240}{\frac{(240)^2}{P_1}+\frac{(240)^2}{P_2}}$$

$$= \frac{1}{240} \times \frac{P_1P_2}{P_1+P_2}$$

$$= \frac{60\times60}{120} \times \frac{1}{240}$$

$$= 0.125A$$

S8. Ans. (b)

Sol. The energy equation E=pc is valid only for the particle which has zero rest mass. So, it is valid for a photon but not for an electron.

S9. Ans. (b)

S10. Ans. (d)

Sol. The highlighted parts could not be edited, as the meaning could not be understood. Also, please check the last line for logical accuracy. Only one option is given as correct, while the solution gives two correct options.

We know that in the transistor base is slightly doped, therefore when the majority carriers due to forward biasing of emitter base junction, feel the repulsive force from the battery and pass over to the base region. This gives the emitter current i_E.

As the base is thin and lightly doped, only few majority carriers of the emitter are neutralized at the base. This gives the base current. Hence, base current (i_B) is low.

The remaining majority carriers of the emitter pass to the collector and give collector current i_C.

Thus, we get the relation given below:

$$i_E = i_B + i_C$$

S11. Ans. (d)

Sol. From Ampere's circuital law

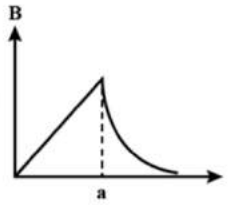
$$B = \frac{\mu_0 I}{2\pi R^2} \cdot r \text{ if } r < R$$

$$\Rightarrow B_{\text{inside}} \propto r$$

$$B = \frac{\mu_0 I}{2\pi r} \text{ if } r \geq R$$

$$\Rightarrow B_{\text{outside}} \propto \frac{1}{r}$$

Hence, magnetic field B with distance r from the axis of the cable is given as



S12. Ans. (b)

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

S13. Ans. (a)

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

S14. Ans. (c)

Sol. Consider the case when Ge and Si diodes are connected as show in the given figure.

Equivalent voltage drops across the combination Ge and Si diode $= 0.3\ V$

$\Rightarrow$ Current $i = \frac{12-0.3}{5k\Omega} = 2.34mA$

$\therefore$ Output voltage $V_0 = Ri = 5k\Omega \times 2.34\ mA = 11.7\ V$

S15. Ans. (b)

Sol. Diagonal of the cube face, $d = \sqrt{(b^2 + b^2)} = b\sqrt{2}$

Diagonal of cube $l = \sqrt{(d^2 + b^2)} = b\sqrt{3}$

Distance between center of cube and vertices, $r = \frac{1}{2} = \frac{b\sqrt{3}}{2}$

Potential, $v = \frac{8q}{4\pi\epsilon_0 r} = \frac{4q}{\sqrt{3}\pi\epsilon_0 b}$ (8 due to presence of 8 charges at the vertices)

S16. Ans. (d)

Sol. Given, refractive index of glass

We know,

$\mu = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}} = \frac{c}{v}$

$\Rightarrow v = \frac{c}{\mu_g}$

$\Rightarrow v = \frac{3\times10^8}{1.5} = 2 \times 10^8\ ms^{-1}$

Thickness of the slab, $d = 2\ cm = 0.02\ m$

Time taken by a ray of light to travel through the glass slab is given as

$t = \frac{d}{v} = \frac{0.02}{2\times10^8} = 10^{-10}$ seconds

S17. Ans. (b)

Sol. Current flowing in a conductor is given by $I = \text{Anev}_d$

Current density$J = \frac{I}{A}$

$J = nev_d$

$\boldsymbol{v_d = \frac{J}{ne}}$

S18. Ans. (c)

Sol. The logic circuit perform the logic function of OR gate.

S19. Ans. (b)

Sol. Ampere-circuital law, the missing term is $\boldsymbol{i = \varepsilon_o \frac{d\phi_E}{dt}}$

S20. Ans. (c)

Sol. A semiconductor has two types of charge carriers i.e., holes and electrons. The conductivity of a semiconductor is sum of conductivities of holes and electrons i.e., $\sigma = en_1(\mu_h + \mu_e)$. where, $n_i =$ intrinsic concentration $\mu_h =$ mobility of holes $\mu_e =$ mobility of electrons Therefore, electrical conduction in a semiconductor is due to holes and electrons both.

S21. Ans. (b)

Sol. In circuit (i), there will be no effect on the current flowing. This is because, R is not affected by frequency.

In circuit (ii), current will decrease as inductive reactance $X_L = \omega L = 2\pi vL$ will increase with increasing frequency.

In circuit (iii), current will increases as capacitive reactance $X_C = \frac{1}{\omega C} = \frac{1}{2\pi vC}$ will decrease on increasing the frequency.

S22. Ans. (d)

Sol. Magnifying power of telescope M = f_0/f_e to produce largest magnifications $f_0 > f_e$ and f_0 and f_e both should be positive convex lens. Therefore f_e =+5 cm.

S23. Ans. (c)

Sol. Potential difference across AB will be equal to battery equivalent across CD.

$$V_{AB} = V_{CD} = \frac{\frac{E_1}{r_1}+\frac{E_2}{r_2}+\frac{E_3}{r_3}}{\frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{r_3}} = \frac{\frac{1}{1}+\frac{2}{1}+\frac{3}{1}}{\frac{1}{1}+\frac{1}{1}+\frac{1}{1}} = \frac{6}{3}$$

$$V_{AB} = 2\ V$$

S24. Ans. (d)

Sol. When one slit is closed completely instead of an interference pattern a diffraction pattern is observed. Central bright fringes and Other bright fringes will be observed.

S25. Ans. (b)

Sol. Here, $n = 300, l = 20\ cm = 0 \cdot 20\ m,$

$b = 12\ cm = 0 \cdot 12\ m$

$B = 6T, A = l \times b = 0 \cdot 20 \times 0 \cdot 12 = 0 \cdot 024\ m^2$

$I = 12A.$

Angle between $\vec{B}$ and normal on the plane of the coil

$\theta = 90° - 60° = 30°$

Torque, $\tau = nIBAsin\ \theta$

$= 300 \times 12 \times 6 \times 0 \cdot 024 \times sin\ 30° = \mathbf{259.2}Nm$

S26. Ans. (a)

Sol. Here, $Z = 1$. We can derive the expression for the time period of electron in n^{th} orbit as

$$T_n = \frac{1}{f_n} \propto n^3$$

Hence

$\frac{T_1}{T_2} = \frac{n_1^3}{n_2^3}$. As $T_1 = 8T_2$, therefore we get

$8 = \left(\frac{n_1}{n_2}\right)^3 \Rightarrow n_1 = 2n_2$

Thus, the possible values of n_1 and n_2 are $n_1 = 2, n_2 = 1; n_1 = 4, n_2 = 2; n_1 = 6, n_2 = 3;$ $n_1 = 8, n_2 = 4$ and so on.

S27. Ans. (b)

Sol. Let the initial distance between the plates be d.

Let A be the area of each plate.

Capacitance of the parallel plate capacitor is given by:

$$C_i = \frac{A\epsilon_0}{d}$$

Capacitance after inserting dielectric

Let k be the dielectric constant.

$$C_f = \frac{kA\,\epsilon_0}{d'}$$

As the distance between plates is reduced to half, new distance is $d = \frac{d}{2}$

$\therefore C_f = \frac{2kA\epsilon_0}{d} = 2kC_i = 2 \times 5 \times 6pF = 6opF$

S28. Ans. (a)

Sol. $h = 6.62 \times 10^{-34}\, J - s$

$m_e = 9 \times 10^{-31}\, kg$

$\lambda = 662 \times 10^{-9}\, m$

$K = \frac{mv^2}{2} \ldots . eq(1);$

m is the mass of the electron.

We have de Broglie wavelength as,

$\lambda = \frac{h}{mv} \Rightarrow v = \frac{h}{m\lambda} \ldots . . eq(2)$

From (1) and (2), we get $K = \frac{h^2}{2\lambda^2 m_e} = \frac{(6.62\times10^{-34})^2}{2\times(662\times10^{-9})^2\times9\times10^{-31}} = 5.55 \times 10^{-25} J$

S29. Ans. (a)

Sol. $E = 50sin\,(314t)$

we have $\omega = 314 \Rightarrow 2(\pi)f = 100\pi \Rightarrow f = 50\ Hz$

Capacitive reactance:

$(X_c) = \frac{1}{\omega C} = \frac{1}{314\times637\times10^{-6}} = 5\Omega$

since there is pure capacitor in the circuit, so current leads emf by $(\phi) = (\pi)/2$

$i - i_0 sin\,(\omega t + \phi 0 = i_0 sin\,[314t + (\pi)/(2)]$

$= \frac{E_0}{X_C} cos\,(314t) = \frac{50}{5} cos\,(314t) = 10cos\,(314t)$

S30. Ans. (c)

Sol. The speed of alpha-particle,

$v = (5 \times 10^5 \hat{\imath}) ms^{-1}$

Magnetic field, $B = 4.0$ Tesla

Angle $\theta = 45°$

Charge on proton, $q = 2 \times 1.6 \times 10^{-19} C$

When the proton enters in magnitude field, it experiences Lorentz force

$F = q(v \times B)$

$|F| = qvBsin\ \theta$

$F = 2 \times 1.6 \times 10^{-19} \times 5 \times 10^6 \times 4 \times sin\ 45°$

$= 4.52 \times 10^{-13}\ N$

S31. Ans. (c)

Sol. $H_R = 16\ m$ and $H_T = 64\ m$

Ratio of covering Range $= \frac{\sqrt{2RH_T}}{\sqrt{2RH_R}} = \frac{\sqrt{2R64}}{\sqrt{2R16}} = \frac{\sqrt{64}}{\sqrt{16}} = \frac{\sqrt{64}}{\sqrt{16}} = \frac{8}{4} = \frac{2}{1}$

S32. Ans. (d)

Sol. $R = 10\Omega, L = 4\ m, E = 2\ V,$

$K = 1\mu V/mm = 1 \times \frac{10^{-6}\ V}{10^{-3}\ m} = 10^{-3}\ V/m$

$K = \frac{V}{L} = \frac{ER}{(R+R_B)L}$

where R_B is the resistance in the box.

$\therefore 10^{-3} = \frac{2\times10}{(10+R_B)4}$

$\therefore 10 + R_B = \frac{5}{10^{-3}}$

$\therefore 10 + R_B = 5 \times 10^3$

$\therefore R_B = 5000 - 10$

$\therefore R_B = 4990\Omega$

S33. Ans. (d)

Sol. the SI base unit of electric flux is volt-meters (Vm) which is also equal to newton-metres squared per coulomb (Nm^2C^{-1}). Besides, the base units of electric flux are $kg \cdot m^3 \cdot s^{-3} \cdot A^{-1}$.

S34. Ans. (b)

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

S35. Ans. (b)

Sol. As $C = \frac{q}{V} = \frac{10\times10^{-6}}{50} = 0.2\mu F$

S36. Ans. (a)

Sol. As $r \propto n^2$, therefore, radius of $2nd$ Bohr's orbit = $4a_0$.

S37. Ans. (d)

Sol. - 2aqE

S38. Ans. (d)

Sol.

α - decay

$Z^{P^A} \xrightarrow{\alpha} Z - 2^{P^{A-4}}$

β - decay

$Z^{P^A} \xrightarrow{\beta} Z + 1^{P^A}$

γ - decay consists of electromagnetic radiations.

Now, the given decay series.

$Z^{P^A} \xrightarrow{\beta} Z + 1^{Q^A} \xrightarrow{\alpha} Z - 1^{R^{A-4}} \xrightarrow{\gamma} Z - 1^{R^{A-4}}$

$\therefore$ The correct sequence.

β, α, γ

S39. Ans. (d)

Sol. $r = 0 \cdot 05\text{nm} = 5 \times 10^{-11}\ m$

$v = 2 \times 10^6\ m/s$

$I = \frac{e}{T} = \frac{e}{2\pi r/v} = \frac{ev}{2\pi r}$

$= \frac{1 \cdot 6 \times 10^{-19} \times 2 \times 10^6}{2 \times 3 \cdot 14 \times 5 \times 10^{-11}} = 1.019 \times 10^{-4}$

$B = \frac{\mu_0 I}{2r} = \frac{4\pi \times 10^{-7} \times 0.01019}{2 \times 5 \times 10^{-11}} = 12.79T$

S40. Ans. (a)

S41. Ans. (d)

Sol. the slope and intercept of the graph between V and I Solution:

The general equation of EMF in cell:

$V = E - ir$

$\Rightarrow V = E + i(-r)$

S42. Ans. (a)

Sol. frequency $= 30MHz$

Electric field $\varepsilon = \frac{6v}{m} f$ (along + y axis)

Now we know that

$c = \frac{\varepsilon_0}{B_0}$

$c =$ speed of EM wave $= 3 \times 10^8\ m/s$

$\varepsilon_0 =$ peak value of electric field

$B_0 =$ peak value of magnetic field

$c = \frac{\varepsilon}{B}$

B = magnetic field

$3 \times 10^8 = \frac{6}{B}$

$B = \frac{6}{3 \times 10^8}$ $B = 2.1 \times 10^{-8}$ Tesla

Now we have to find direction of magnetic field

We know that wave propagates in the direction perpendicular to oscillating electric field and magnetic field.

$c = \vec{\varepsilon} \times \vec{B}$ (Only for direction)

$c =$ along x axis

$\varepsilon =$ along y axis

So B should be along z axis

$B = 2.1 \times 10^{-8} \hat{k}\ T$

S43. Ans. (d)

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

S44. Ans. (b)

Sol. When the light rays undergo two internal reflections in a water drop, a secondary rainbow is formed. Observer can see a rainbow when his front is towards the Sun. Light is made to undergo total internal reflection successive times as the ray of light moves through the optical fiber. An astronomical telescope has an angular magnification of magnitude 5 for distant objects.

S45. Ans. (b)

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

S46. Ans. (d)

Sol. the significant characteristics of a pulse are pulse amplitude, pulse duration or pulse width, and pulse position (denoting the time of rise or fall of the pulse amplitude).

S47. Ans. (d)

Sol. if half of the convex lens is covered with a black sheet of paper, the lens will produce a complete image of the object. However, the intensity of the image will be less and the image formed will be less bright as compared to the one formed by a complete convex lens

S48. Ans. (b)

Sol. The relationship between the terminal voltage and emf is given as

$V = \varepsilon - Ir$

$V = 15 - (85 \times 0.04)$

$V = 11.6V$

S49. Ans. (a)

Sol. Magnetic moment, $M = 3\ J\ T^{-1}$

Magnetic field strength, $B = 0.2\ T$

Initial angle between the axis and the magnetic field, $\theta_1 = 0°$

Final angle between the axis and the magnetic field, $\theta_2 = 180°$

The work required to make the magnetic moment opposite to the direction of magnetic field is given as:

$$
\begin{aligned}
W &= -MB(cos\ \theta_2 - cos\ \theta_1) \\
&= -3 \times 0.2(cos\ 180 - cos\ 0°) \\
&= -0.6(-1 - 1) \\
&= 1.2\ J
\end{aligned}
$$

S50. **Ans. (b)**

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