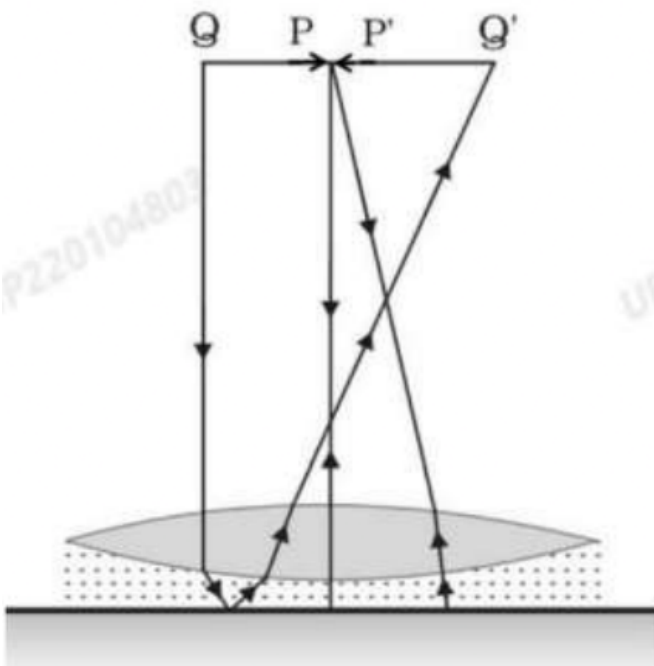




General Instructions

- (i) The examination will be conducted in Computer-Based Test (CBT) mode.
- (ii) Each question carries +5 marks for correct answer and -1 mark for wrong answer.
- (iii) The total number of questions are 50.
- (iv) Duration of the exam is 1 hour (60 minutes).

1. The figure below shows an equiconvex lens ($n = 1.5$) placed in contact with a thin liquid layer resting on a plane mirror. A small needle, with its tip positioned on the principal axis of the lens, is moved along the axis until its inverted image coincides with the needle tip itself. When the liquid is present, the distance between the needle and the lens is found to be 50 cm. The experiment is then repeated after removing the liquid, and the distance is observed to be 35 cm. The refractive index of the liquid is



- (A) 1.33
- (B) 1.30
- (C) 1.50
- (D) 1.41

2. Match List-I with List-II (Symbols have their usual meanings).

List-I	List-II
(A) Magnetic field due to an infinitely long straight conductor	(I) $BIl \sin \theta$
(B) Magnetic field due to a circular coil at the center	(II) $BIA \sin \theta$
(C) Force on a current carrying conductor in a magnetic field	(III) $\frac{\mu_0 I}{2\pi r}$
(D) Torque on a current loop in a magnetic field	(IV) $\frac{\mu_0 I}{2r}$

Choose the correct answer from the options given below:

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

3. According to Bohr's model of the hydrogen atom,

- (A) the radius of the orbit of an electron is directly proportional to n .
- (B) the speed of the orbiting electron is directly proportional to $\frac{1}{n}$.
- (C) the total energy of the electron is directly proportional to $\frac{1}{n^2}$.
- (D) the radius of the orbit of an electron is directly proportional to n^2 .

Choose the correct answer from the options given below:

- (A) (A), (B) and (C) only
- (B) (B), (C) and (D) only
- (C) (A), (C) and (D) only
- (D) (C) and (D) only

4. An alternating current is given by the equation

$$i = i_1 \sin \omega t + i_2 \cos \omega t$$

The i_{rms} will be:

(A)

$$\frac{1}{\sqrt{2}}(i_1 + i_2)$$

(B)

$$\frac{1}{\sqrt{2}}(i_1^2 + i_2^2)$$

(C)

$$\frac{1}{\sqrt{2}}(i_1 + i_2)^2$$

(D)

$$\frac{1}{\sqrt{2}}(i_1^2 + i_2^2)^{1/2}$$

5. A horizontal wire of length 10 cm and mass 0.3 g carries a current of 5 A. The magnitude of the magnetic field which can keep the wire in suspension is

$$(g = 10 \text{ m s}^{-2})$$

(A) $3 \times 10^{-3} \text{ T}$

(B) $6 \times 10^{-3} \text{ T}$

(C) $3 \times 10^{-4} \text{ T}$

(D) $6 \times 10^{-4} \text{ T}$

6. Arrange the following in increasing order of focal length of a given lens.

(A) f_V – focal length for violet colour

(B) f_B – focal length for blue colour

(C) f_Y – focal length for yellow colour

(D) f_R – focal length for red colour

Choose the correct answer from the options given below:

(A) (A), (B), (C), (D)

(B) (A), (B), (D), (C)

(C) (C), (D), (B), (A)

(D) (D), (C), (B), (A)

7. Light is incident on an interface between water (refractive index = 1.33) and glass (refractive index = 1.5). For total internal reflection, light should be travelling from

(i_c is the critical angle)

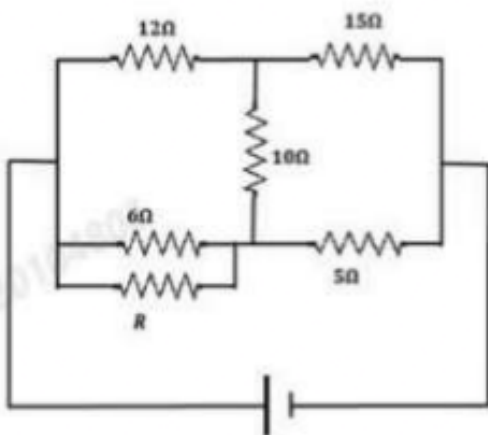
(A) Water to glass with an angle of incidence $i > i_c$

(B) Glass to water with an angle of incidence $i > i_c$

(C) Water to glass with an angle of incidence $i < i_c$

(D) Glass to water with an angle of incidence $i < i_c$

8. The value of R in the given circuit, so that there is no current flow in the 10Ω resistor, will be



(A) 2Ω

(B) 4Ω

(C) 8Ω

(D) 12Ω

9. A charge q coulomb is circulating in an orbit of radius r metres making n revolutions per second. The magnetic field (in N/A m) produced at the centre of the circle is

(A)

$$\frac{2nq}{nr} \times 10^{-7}$$

(B)

$$\frac{2nq}{r} \times 10^{-7}$$

(C)

$$\frac{2\pi nq}{r} \times 10^{-7}$$

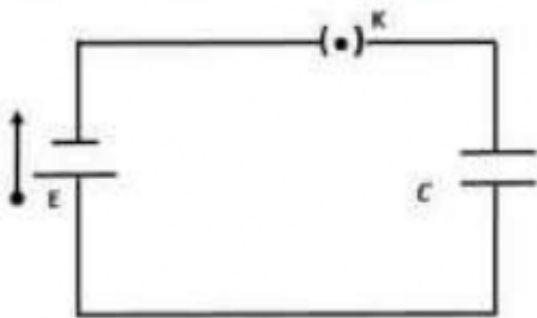
(D)

$$\frac{2\pi rn}{q} \times 10^{-7}$$

10. A parallel plate capacitor (C) is connected to a battery as shown in the figure. Consider two cases:

Case-I: Key k is kept closed and plates of the capacitor are moved apart using an insulating handle.

Case-II: Initially key k is closed for a long time and then opened. Now, the plates of the capacitor are moved apart using an insulating handle.



Identify the correct statements among the following:

- (A) In Case-I, Q remains same but C changes.
- (B) In Case-II, V remains same but C changes.
- (C) In Case-I, V remains same and hence Q changes.
- (D) In Case-II, Q remains same and hence V changes.

Choose the correct answer from the options given below:

- (A) (A) and (B) only

- (B) (C) and (D) only
- (C) (B) and (C) only
- (D) (A) and (D) only

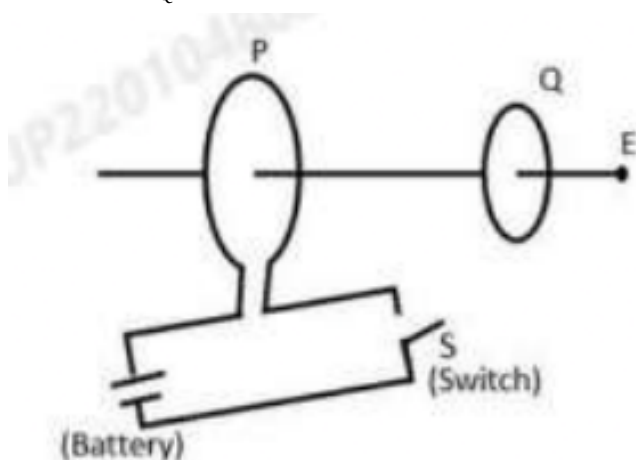
11. The ratio of maximum wavelength to minimum wavelength in Balmer series is

- (A) $\frac{4}{3}$
- (B) $\frac{3}{4}$
- (C) $\frac{9}{5}$
- (D) $\frac{5}{9}$

12. When a magnet is inserted into a coil, the induced e.m.f. in the coil does not depend on

- (A) the number of turns in the coil.
- (B) the resistance of the coil.
- (C) the magnetic moment of the magnet.
- (D) the speed of the magnet.

13. As shown in the figure, P and Q are two coaxial conducting loops separated by some distance. When the switch S is closed, a clockwise current I_p flows in P (as seen by E) and an induced current I_{Q1} flows in Q . The switch remains closed for a long time. When S is opened, a current I_{Q2} flows in Q . Then the directions of I_{Q1} and I_{Q2} (as seen by E) are



- (A) Clockwise and anti-clockwise, respectively
- (B) Both clockwise

- (C) Both anti-clockwise
 (D) Anti-clockwise and clockwise, respectively

14. Match List-I with List-II in the context of Young's Double Slit Experiment.

List-I	List-II
(A) Fringe width	(I) path difference = $\frac{(2n+1)\lambda}{2}$; $n = 0, 1, 2, \dots$
(B) Condition for bright fringe in interference	(II) path difference = $n\lambda$; $n = 1, 2, 3, \dots$
(C) Condition for dark fringe in interference	(III) $\frac{\lambda D}{d}$
(D) Condition for central maximum	(IV) path difference = 0

Choose the correct answer from the options given below:

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

15. In a Young's double slit experiment using monochromatic light of wavelength λ , the intensity of light at a point on the screen is I_0 , where the path difference between two interfering waves is λ . The path difference between the interfering waves at a point on the screen where the intensity is $\frac{I_0}{4}$ will be

- (A) $\frac{\lambda}{4}$
 (B) $\frac{\lambda}{3}$
 (C) $\frac{3\lambda}{2}$
 (D) 2λ

16. Arrange the following media (characterised by their relative dielectric permittivities (ϵ_r) and relative magnetic permeabilities (μ_r)) according to the velocity of an electromagnetic wave propagating in them in ascending order.

- (A) $\epsilon_r = 4, \mu_r = 400$

- (B) $\epsilon_r = 3, \mu_r = 300$
- (C) $\epsilon_r = 4, \mu_r = 250$
- (D) $\epsilon_r = 5, \mu_r = 150$

Choose the correct answer from the options given below:

- (A) (A), (C), (B), (D)
- (B) (C), (A), (B), (D)
- (C) (B), (A), (C), (D)
- (D) (A), (B), (C), (D)

17. Taking Bohr's radius as $r_0 = 53 \text{ pm}$, the ground state radius of Li^{2+} ion, on the basis of Bohr's model, will be about

- (A) 53 pm
- (B) 27 pm
- (C) 18 pm
- (D) 13 pm

18. A deuteron and an alpha particle with the same kinetic energy move in circular paths under the effect of the same magnetic field. The ratio of the radii ($r_d : r_\alpha$) of their trajectories is

- (A) 1 : 1
- (B) 1 : $\sqrt{2}$
- (C) $\sqrt{2} : 1$
- (D) 2 : 1

19. A metal at very low temperature has magnetic permeability $\mu = 0$. It is a perfect

- (A) Paramagnet
- (B) Diamagnet
- (C) Soft ferromagnet
- (D) Hard ferromagnet

20. The radius of curvature of the curved surface of a plano-convex lens is 20 cm. If the refractive index of the material of the lens is 1.5, it will

- (A) Act as a convex lens only for the objects that lie on its curved side.
 - (B) Act as a concave lens for the objects that lie on its curved side.
 - (C) Act as a convex lens irrespective of the side on which the object lies.
 - (D) Act as a concave lens irrespective of the side on which the object lies.
-

21. A proton accelerated through a potential difference V has a de-Broglie wavelength λ . On doubling the potential difference, the de-Broglie wavelength of the proton

- (A) Remains unchanged
 - (B) Becomes double
 - (C) Becomes 4 times
 - (D) Decreases by a factor of $\frac{1}{\sqrt{2}}$
-

22. Arrange the following in the correct order as the angle of incidence in a denser medium is gradually increased.

- (A) The refracted ray bends away from the normal.
- (B) The refracted ray grazes along the surface of separation.
- (C) The light is totally reflected back into the denser medium.
- (D) The ray passes undeviated when incident normally.

Choose the correct answer from the options given below:

- (A) (A), (D), (B), (C)
 - (B) (D), (B), (A), (C)
 - (C) (D), (A), (B), (C)
 - (D) (A), (C), (B), (D)
-

23. The source of electromagnetic waves can be

- (A) A charge moving with a constant velocity.
- (B) An accelerated charge.
- (C) A charge at rest.

(D) A charge moving parallel to a magnetic field.

24. The kinetic energy of an electron in the ground level in hydrogen atom is K units. The values of potential energy and total energy, respectively, are

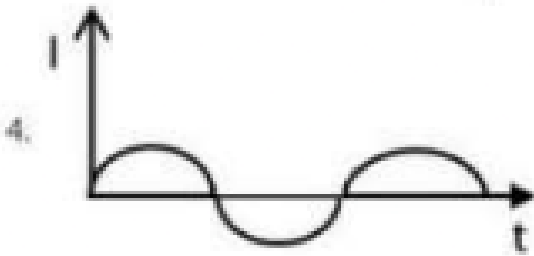
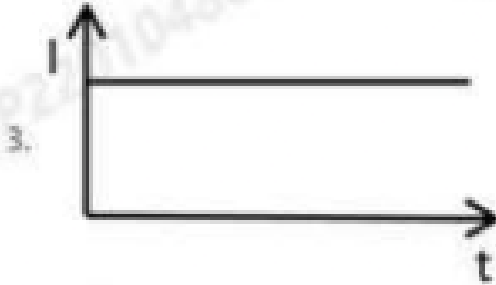
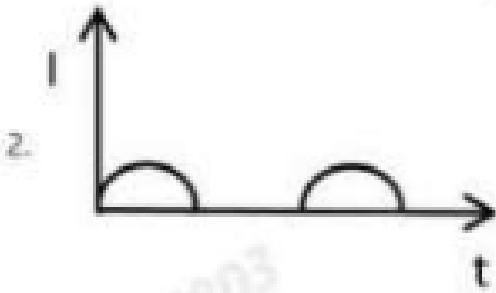
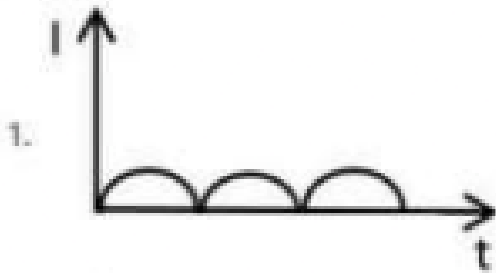
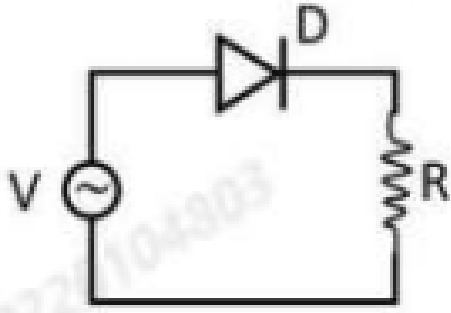
(A) $-2K, -K$

(B) $+2K, -K$

(C) $-K, +2K$

(D) $+K, +2K$

25. A p-n junction diode (D) shown in the figure below can act as a rectifier. An alternating current source (V) is connected in the circuit. The current (I) in the resistor (R) can be shown by which graph?



- (A) Graph 1
- (B) Graph 2
- (C) Graph 3
- (D) Graph 4

26. The oscillating electric and magnetic field vectors of an electromagnetic wave are in

- (A) The same direction and in phase
 - (B) The same direction but have a phase difference of 90°
 - (C) Mutually perpendicular directions and are in phase
 - (D) Mutually perpendicular directions with a phase difference of 90°
-

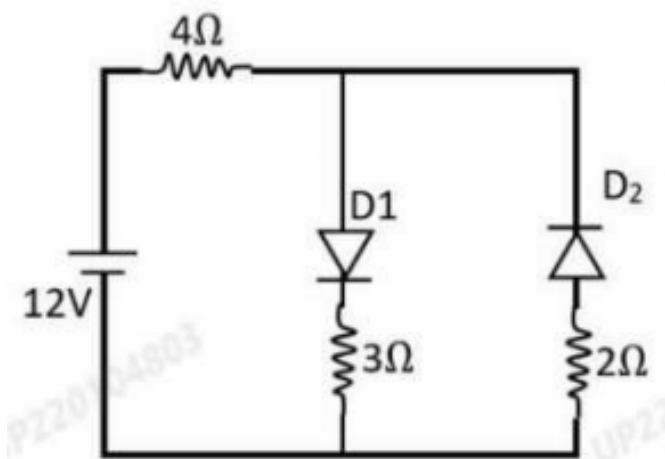
27. For a cell or a battery, the emf is

- (A) equal to the potential difference between its terminals when terminals are not connected externally
- (B) less than the potential difference between its terminals when the cell/battery is being discharged
- (C) always greater than the potential difference between its terminals
- (D) less than the potential difference between its terminals when the cell/battery is being charged

Choose the correct answer from the options given below:

- (A) (A) and (D) only
 - (B) (A) and (C) only
 - (C) (C) only
 - (D) (A), (B) and (C) only
-

28. The circuit has two oppositely connected ideal diodes in parallel. The current flowing in the circuit will be



- (A) 2 A
- (B) 1.71 A
- (C) 2.31 A

(D) 1.33 A

29. When a forward bias is applied to a p-n junction diode, then

- (A) majority carrier current becomes zero.
- (B) potential barrier is raised.
- (C) width of the depletion layer reduces.
- (D) junction resistance increases.

Choose the correct answer from the options given below:

- (A) (A) and (C) only
 - (B) (C) only
 - (C) (B), (C) and (D) only
 - (D) (B) and (C) only
-

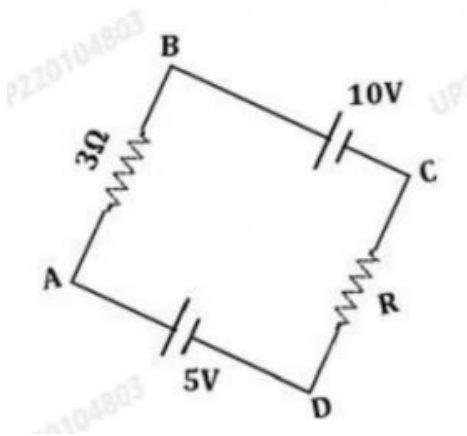
30. An electron beam has an aperture 2 mm^2 . A total of 6.0×10^{15} electrons pass through any perpendicular cross-sectional area per second. The current density of the beam is

- (A) $19.2 \times 10^{-10} \text{ A m}^{-2}$
 - (B) $9.6 \times 10^{-4} \text{ A m}^{-2}$
 - (C) $9.6 \times 10^2 \text{ A m}^{-2}$
 - (D) $4.8 \times 10^2 \text{ A m}^{-2}$
-

31. A parallel plate capacitor is formed by two plates each of area $30\pi \text{ cm}^2$ separated by 1 mm. A material of dielectric strength $3.6 \times 10^7 \text{ V m}^{-1}$ is filled between the plates. If the maximum charge that can be stored in the capacitor without causing any dielectric breakdown is $7 \times 10^{-6} \text{ C}$, the value of dielectric constant of the material is

- (A) 1.66
 - (B) 1.75
 - (C) 2.25
 - (D) 2.33
-

32. In the given network, if $V_A - V_C = 8 \text{ V}$, the value of R is



- (A) $3\ \Omega$
- (B) $2.5\ \Omega$
- (C) $4.5\ \Omega$
- (D) $2\ \Omega$

33. Two small insulating spheres are rubbed against each other and placed 1 cm apart. If they attract each other with a force $F = 0.1\ \text{N}$, the number of electrons that were transferred from one sphere to another during rubbing are nearly

- (A) 5×10^{11}
- (B) 2×10^{11}
- (C) 2×10^{10}
- (D) 1×10^{12}

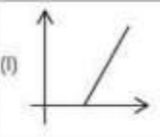
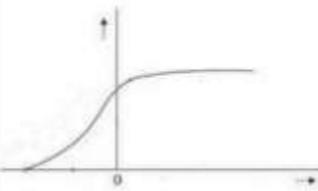
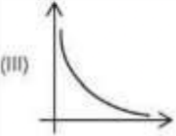
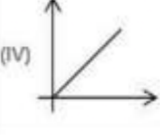
34. Identify the correct statements with regard to the application of Gauss's law in electrostatics.

- (A) Gauss's law is true only for spherical closed surfaces.
- (B) The Gaussian surface should not pass through any discrete charges.
- (C) The total electric flux through any closed surface is zero, if no charge is enclosed by the surface.
- (D) The charge in the vicinity of the surface must be zero.

Choose the correct answer from the options given below:

- (A) (B) only
- (B) (A) and (D) only
- (C) (B) and (C) only
- (D) (A) and (C) only

35. Match List-I with List-II.

List-I	List-II
(A) Variation of photoelectric current (Y-axis) with intensity (X-axis) of incident radiation.	(I) 
(B) Variation of stopping potential (Y-axis) with frequency (X-axis) of incident radiation.	(II) 
(C) Variation of photoelectric current (Y-axis) with anode potential (X-axis).	(III) 
(D) Variation of de-Broglie wavelength (Y-axis) with its particle momentum (X-axis).	(IV) 

Choose the correct answer from the options given below:

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

36. Equipotential surfaces

- (A) are closer in regions of large electric fields compared to regions of lower electric fields.
- (B) are closer in regions of lower electric fields compared to regions of large electric fields.
- (C) will always be concentric spherical surfaces.
- (D) will always be equally spaced.

37. Nuclear forces are

- (A) Strong, short range and charge independent.
- (B) Attractive, long range and charge independent.

(C) Strong, attractive and charge dependent.

(D) Strong, short range and repulsive.

38. Five cells, each of emf (E) and internal resistance (r), are connected in series. If out of these five cells, one of the cells is connected with opposite polarity, the equivalent emf and internal resistance of the combination, respectively, will be

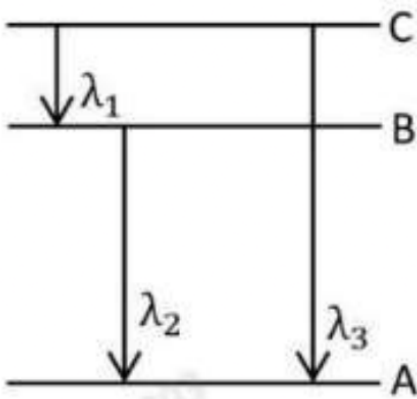
(A) $5E, 5r$

(B) $4E, 4r$

(C) $3E, 5r$

(D) $3E, 3r$

39. Energy levels A, B, C of a certain atom correspond to increasing values of energy ($E_A < E_B < E_C$). If λ_1, λ_2 and λ_3 are the wavelengths of radiations corresponding to the transitions $C \rightarrow B, B \rightarrow A$ and $C \rightarrow A$ respectively, the relation between these wavelengths can be written as



(A)

$$\lambda_3 = \lambda_1 + \lambda_2$$

(B)

$$\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$

(C)

$$\lambda_1 + \lambda_2 + \lambda_3 = 0$$

(D)

$$\lambda_1^2 + \lambda_2^2 = \lambda_3^2$$

40. A magnetic dipole aligned parallel to a uniform magnetic field requires a work of W to rotate it through 60° . The torque exerted by the field on the dipole in this new position is

- (A) $2W$
(B) W
(C) $\sqrt{3}W$
(D) $\frac{\sqrt{3}}{2}W$
-

41. An electron is found to repel another electron at a distance of 1 cm with a force $F = 2.3 \times 10^{-24}$ N. Two protons placed at a distance of 5 cm will

- (A) repel each other with a force $F = 2.3 \times 10^{-24}$ N
(B) attract each other with a force $F = 2.3 \times 10^{-24}$ N
(C) repel each other with a force $F = 9.2 \times 10^{-26}$ N
(D) attract each other with a force $F = 4.6 \times 10^{-25}$ N
-

42. Match List-I with List-II

List-I (Physical quantity)	List-II (Dimensions)
(A) Mutual inductance	(I) $[ML^2T^{-3}A^{-1}]$
(B) Magnetic flux	(II) $[M^0T^0L^2A]$
(C) EMF	(III) $ML^2T^{-2}A^{-1}$
(D) Magnetic moment	(IV) $ML^2T^{-2}A^{-2}$

where

$$(I) [ML^2T^{-3}A^{-1}]$$

$$(II) [M^0L^2A]$$

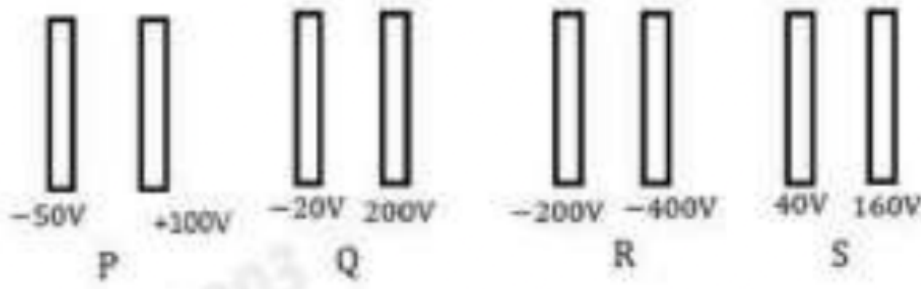
$$(III) [ML^2T^{-2}A^{-1}]$$

$$(IV) [ML^2T^{-2}A^{-2}]$$

Choose the correct answer from the options given below:

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

43. Figures show four pairs of parallel plates P, Q, R and S with the same separation and the electric potential of each plate. The electric field between the plates is uniform and perpendicular to the plates. Arrange the plates in descending order of the magnitude of the electric field between the plates.



- (A) P
- (B) Q
- (C) R
- (D) S

Choose the correct answer from the options given below:

- (A) (B), (C), (D), (A)
- (B) (A), (C), (B), (D)
- (C) (B), (C), (A), (D)
- (D) (C), (D), (A), (B)

44. Arrange the following steps in the chronological order, when a charged particle enters perpendicularly into a uniform magnetic field.

- (A) The charged particle starts moving in a circular path.

(B) Net work done by the field is zero.

(C) The speed of the charged particle remains constant but its direction changes.

(D) A force acts perpendicular to both the velocity of the charged particle and the magnetic field.

Choose the correct answer from the options given below:

(A) (D), (A), (C), (B)

(B) (A), (C), (D), (B)

(C) (C), (A), (D), (B)

(D) (A), (C), (B), (D)

45. In a full wave rectifier circuit operating with 50 Hz mains frequency, the fundamental frequency in the ripple at the output would be

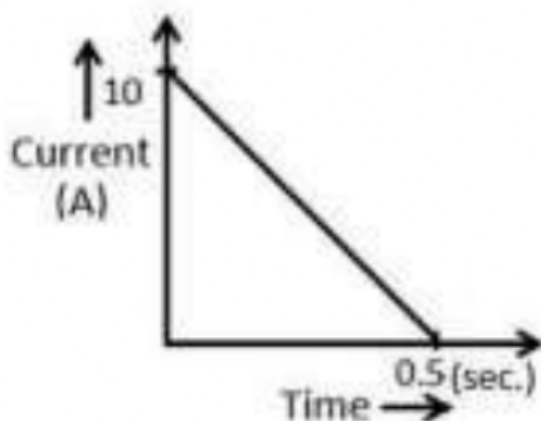
(A) 25 Hz

(B) 50 Hz

(C) 75 Hz

(D) 100 Hz

46. In a coil of resistance $100\ \Omega$, a current is induced by changing the magnetic flux through it. The current versus time variation is as shown. The magnitude of change in flux through the coil is



(A) 250 Wb

(B) 275 Wb

(C) 20 Wb

(D) 225 Wb

47. The surface of a certain metal is first illuminated with light of wavelength $\lambda_1 = 350 \text{ nm}$, and then by light of wavelength $\lambda_2 = 540 \text{ nm}$. It is found that the maximum speed of the photoelectrons in the two cases differ by a factor of 2. The work function of the metal (in eV) is close to

$$\left(\text{Energy of photon} = \frac{1240}{\lambda(\text{nm})} \text{ eV} \right)$$

- (A) 2.58
- (B) 1.88
- (C) 3.22
- (D) 1.48

48. Match List-I with List-II

List-I	List-II
(Wave)	(Wavelength)
(A) Microwaves	(I) 100 m
(B) Gamma Rays	(II) 10^{-15} m
(C) A. M. Radio waves	(III) 10^{-10} m
(D) X-Rays	(IV) 10^{-3} m

where

(I) 100 m

(II) 10^{-15} m

(III) 10^{-10} m

(IV) 10^{-3} m

Choose the correct answer from the options given below:

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

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

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

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

49. The velocity of an electromagnetic wave in a medium with $\epsilon_r = 2$ and $\mu_r = 18$ is

(A) $1.5 \times 10^8 \text{ m s}^{-1}$

(B) $2 \times 10^8 \text{ m s}^{-1}$

(C) $0.5 \times 10^8 \text{ m s}^{-1}$

(D) $0.25 \times 10^8 \text{ m s}^{-1}$

50. A circular wire loop of radius R is placed in the x - y plane centered at the origin. A square loop of side a ($a \ll R$) of single turn is placed with its plane parallel to the x - y plane and at a distance $z = \sqrt{3}R$. The mutual inductance between the loops is

(A)

$$\frac{\mu_0 a^2}{4R}$$

(B)

$$\frac{\mu_0 R}{8a^2}$$

(C)

$$\frac{\mu_0 R}{4a}$$

(D)

$$\frac{\mu_0 a^2}{16R}$$
