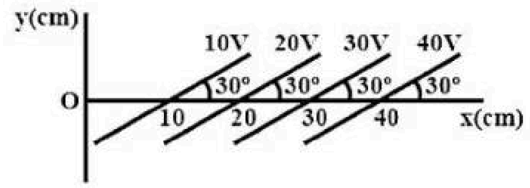
Previous Year Paper

21st May 2023 (Shift 3)

Q1. The magnetic flux(Φ) is:

(a) Scalar quantity and its SI unit is Wb/m^2.
(b) Vector quantity and its SI unit is Tm^2.
(c) Scalar quantity and its SL unit is Tm^2.
(d) Vector quantity and its SI unit is Wb/m^2.

Q2. Some equipotential surfaces are shown. What is the magnitude and direction of electric field?



(a) 200 V/m making an angle of 120° with x-axis
(b) 100 V/m making an angle of 30° with x-axis
(c) 200 V/m making an angle of 300° with x-axis
(d) 100 V/m making an angle of 60° with x-axis

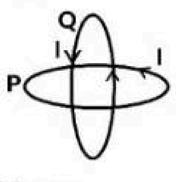
Q3. A ray is incident normally on the face of an triangular prism of refracting angle of 60°. The refractive index of the prism is $\frac{2}{\sqrt{3}}$. The angle of deviation will be:

(a) 60°
(b) 30°
(c) 45°
(d) 90°

Q4. Which of the following pair of nuclides are Isobars?

(a) ${}_1^2H, {}_1^3H$
(b) ${}_1^3H, {}_2^3He$
(c) ${}_{80}^{198}Hg, {}_{79}^{179}Au$
(d) ${}_1^1H, {}_1^3H$

Q5. Two identical circular wires P and Q each of radius R and carrying current I are kept in perpendicular planes such that they have a common centre as shown in figure. Find the magnitude and direction of the net magnetic field at the common centre of the two coils



(a) zero
(b) $\frac{\sqrt{3}}{2}\frac{\mu_0 I}{R}, \beta = 60°$
(c) $\frac{\mu_0 I}{\sqrt{2}R}, \beta = 45°$
(d) $I, \beta = 90°$

Q6. The increased resistance of a wire if its length is doubled and original cross-sectional area is halved will be:

Given R — original resistance of wire)

(a) $\left(\frac{3}{4}\right)R$
(b) $\frac{R}{4}$
(c) 4R
(d) 3R

Q7. Transverse nature of electromagnetic waves are/is evident by:

A. Interference
B. Dispersion
C. Polarisation
D. Diffraction

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

(a) A only
(b) C and D only
(c) A and B only
(d) C only

Q8. Which of the following statements are correct?

A. The relative motion between a magnet and a coil is responsible for induction of electric current in the coil.
B. Magnetic flux is a vector quantity.
C. In a closed coil, the magnitude of emf induced is equal to the time rate of change of magnetic flux.
D. Eddy currents oppose the magnetic braking effect in trains.
E. Lenz's law gives the polarity of the induced emf clearly.

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

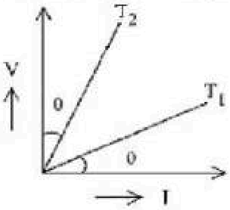
(a) B, C and D only
(b) A, B, D and E only
(c) A, B and D only
(d) A, C and E only

Q9. A molecule of a substance has a permanent electric dipole moment of magnitude 10^{-31} Cm. A mole of this substance is 100% polarised by applying a strong

electrostatic field of magnitude 10^8 Vm^{-1}. The direction of field is suddenly changed by all angle of 60°. Find the heat released by substance in aligning its dipoles along the new direction of the field.
[Take 1 mole $= 6 \times 10^{23}$ molecules]
(a) -9 J
(b) -3 J
(c) 9 J
(d) 3 J

Q10. An electric dipole of dipole moment $\bar{P}$ is rotated in an electric field of magnitude E from the most stable orientation to most unstable orientation. The work done in the process is:
(a) pE
(b) $2pE$
(c) $-2pE$
(d) $-pE$

Q11. V-I graph for a platinum wire at temperatures T_1 and T_2 is shown in the given figure. The temperature difference ($T_2 - T_1$) is proportional to:



(a) $\sin 2\theta$
(b) $\cos 2\theta$
(c) $\tan 2\theta$
(d) $\cot 2\theta$

Q12. Arrange the following EM waves increasing order of their frequency?
A. Ultraviolet rays
B. Gamma rays
C. Radio waves
D. Infrared waves
E. X-rays

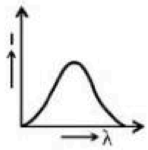
Chose the **correct** answer from the options given below:
(a) C < E < A < D < B
(b) B < E < A < D < C
(c) C < D < A < E < B
(d) B < A < C < D < E

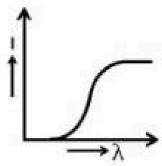
Q13. The amplitude of the magnetic field of a harmonic electromagnetic wave in vacuum is B_0 = 610 nT. The amplitude of the electric field of the wave is:
(a) $5 \times 10^{14} NC^{-1}$
(b) $203 \times 10^{-17} NC^{-1}$
(c) 183 NC^{-1}
(d) 610 NC^{-1}

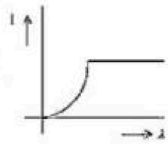
Q14. Which of the following statements are correct:
A. In semiconductor diodes carriers are generated by photo-excitation.
B. When the photo diode is illuminated with light with energy (E) > Energy gap (E_g) of the semiconductor, then electron-hole pairs are generated.
C. Photovoltaic devices convert electricity into optical radiation.
D. Photodiode can be used as a photodetector to detect optical signal
E. Zener diode specification should be taken as per the required output voltage.

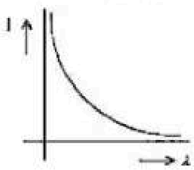
Choose the **correct** answer from the following options given below:
(a) A, B and C only
(b) B, C and E only
(c) A, B, D and E only
(d) A, C and D only

Q15. The anode voltage of a photocell is kept fixed. The wavelength, of light falling on the cathode is gradually changed. The plate currents I of the photocell varies as follows.


(a)


(b)

(c)


(d)


Q16. The kinetic energy of an electron in the ground state of hydrogen atom is 13.6 eV. The potential energy (PE) and total energy (E) of electron in this state is
(a) P.E = -13.6 eV, E = 27.2 eV

(b) P.E = +13.6 eV, E = -27.2 eV
(c) P.E = +27.2 eV, E = -13.6 eV
(d) P.E = -27.2 eV, E = -13.6 eV

Q17. A dentist has a small mirror of focal length 1.6 cm. He observes the cavity in the tooth of a patient by holding the mirror at a distance of 8 mm. from the cavity. The magnification is:
(a) 1
(b) 1.5
(c) 2
(d) 13

Q18. Which of the following frequency would be suitable for the beyond the horizon communication using sky waves?
(a) 1000 GHz
(b) 1 GHz
(c) 10 MHz
(d) 10 kHz

Q19. Match **List - I** with **List - II**

List-I		List-II	
(A)	Impedance of a series RLC circuit at resonance	(I)	Voltage across L & C are 180° out of phase.
(B)	For a series LC circuit	(II)	Current in L & C are 180° out of phase
(C)	For a parallel LC circuit	(III)	Minimum
(D)	Reactance of a capacitor in DC circuit	(IV)	Infinite

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

Q20. In a p-n junction under equilibrium:
(a) Diffusion current dominates
(b) Drift current dominates
(c) No net current flows
(d) Depending upon the semiconductor either diffusion current or drift current dominates.

Q21. Choose the correct statement(s)
A. In photo electric effect, the minimum negative potential to the plate A for which photocurrent is zero is called saturation potential
B. Maximum kinetic energy of photoelectrons is directly proportional to intensity of incident radiation.
C. $K_{max} = eV_0$.
D. Photocurrent becomes zero at stopping potential.
E. For different intensities of light, stopping potential is different.

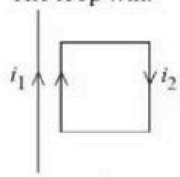
Choose the **correct** answer from the options given below:
(a) C & D on1y
(b) B and E only
(c) D and E only
(d) C, D & E only

Q22. The half-lives of 2 radioactive specimen are $T_1 = 5$ years. and $T_2 = 7.5$ years. The ratio of their disintegration constants and λ_1 and λ_2 is:
(a) $\frac{3}{2}$
(b) $\frac{2}{3}$
(c) 1: 1
(d) 0.693

Q23. The depletion layer has large electrical resistance because:
(a) It contains few ions as charge carriers.
(b) It has few holes as charge carriers.
(c) It has no charge carriers.
(d) It contains few electrons as charge carriers.

Q24. If the frequency of light in a photoelectric experiment is doubled the stopping potential will be:
(a) be doubled
(b) be halved
(c) becomes more than the double
(d) becomes less than the double

Q25. In the situation shown in the figure, the straight wire is fixed but the loop can move under magnetic farce. The loop will:



(a) remains stationary
(b) moves towards the wire
(c) moves away from the wire
(d) rotates about the wire

Q26. An a.c voltage is applied to a resistor of resistance 5Ω and an inductor having inductive reactance of 5Ω connected in series. The phase difference between applied voltage and the current in the circuit is:
(a) $\frac{\pi}{3}$
(b) $\frac{\pi}{4}$
(c) $\frac{\pi}{2}$
(d) Zero

Q27. Which quantity is increased in a step-down transformer?
(a) Power
(b) Current
(c) Frequency
(d) Voltage

Q28. Magnetic susceptibility χ of a given material is -0.5. Identify the magnetic material.
(a) Paramagnetic
(b) Diamagnetic
(c) Ferromagnetic
(d) Diamagnetic and Ferromagnetic both

Q29. If U_E electric field energy density and U_m magnetic field energy density. Then
(a) $\frac{U_E}{U_m} > 1$
(b) $\frac{U_E}{U_m} = 1$
(c) $\frac{U_E}{U_m} < 1$
(d) $\frac{U_E}{U_m}$ is variable

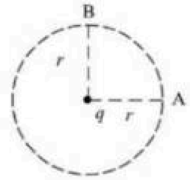
Q30. Match **List - I** with **List - II**

List-I		List-II	
(A)	Electric field outside a uniformly charged thin spherical shell	(I)	Zero
(B)	Electric field inside the uniformly charged thin spherical shell	(II)	$\frac{\lambda}{2\pi\epsilon_0 r}\hat{n}$
(C)	Electric field due to an infinitely long straight uniformly charged wire.	(III)	$\frac{\sigma}{2\epsilon_0}\hat{n}$
(D)	Electric field due to a uniformly charged infinite plane sheet	(IV)	$k\frac{q}{r^2}\hat{r}$

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

Q31. A potential difference of 3 V is applied across a conductor of resistance 1.5 Ω. The number of electrons flowing through it in one second would be:
(Given charge of an electron: $e = 1.6 \times 10^{19}$ C)
(a) 16×10^{19}
(b) 4.5×10^{19}
(c) 1.25×10^{19}
(d) 4.8×10^{19}

Q32. What is the work done in moving a δq charge from A to B?



(a) 0
(b) $\frac{kq\delta q}{r}$
(c) $\frac{kq\delta q}{\sqrt{2}r}$
(d) $\frac{2kq}{r}$

Q33. Which of the following is NOT a property of charges?
(a) Quantisation
(b) Scalar
(c) Additive
(d) affected by frames of reference

Q34. Choose the **correct** statements:
A. Diamagnetic substances have non zero resultant magnetic moment.
B. The magnetisation of a paramagnetic material is inversely proportional to the absolute temperature T.
C. At high enough temperature, a ferromagnet becomes a paramagnet.
D. Magnetic permeability of ferromagnets: $\mu >> 1$
E. Susceptibility of Diamagnetic, $\chi >> 1$
(a) A & C only
(b) A, C & D only
(c) D & E only
(d) B, C & D only

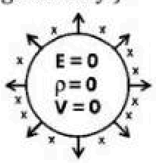
Q35. If charge is moving parallel to uniform magnetic field, its path will be:
(a) straight line
(b) circular
(c) helical
(d) elliptical

Q36. Using the given information, calculate the mass defect of $^{16}_{8}O$ nucleus in MeV/c^2.
mass of electron, $m_e = 0.00055$u
mass of proton, $m_p = 1.00727$u
mass of neutron, $m_n = 1.00866$u
experimental mass of nucleus = 15.99053u
1u = 931.5MeV/c^2 (where u = atomic mass unit)
Choose the correct answer from the options given below:
(a) 150.5 MeV/c^2
(b) 127.5 MeV/c^2
(c) 107.5 MeV/c^2
(d) 680.0 MeV/c^2

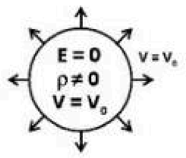
Q37. The capacitance of a capacitor becomes 7/6 times its original value if a dielectric slab of thickness $t = \frac{2}{3}d$ is introduced in between the plates: where d is the separation between the plates. The dielectric constant of the slab is:

(a) $\frac{11}{7}$
(b) $\frac{7}{11}$
(c) $\frac{11}{14}$
(d) $\frac{14}{11}$

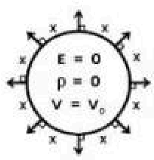
Q38. Which of the following diagram correctly shows the electrostatic properties of a charged conductor. (Given V_o = potential on the surface of conductor; p = Volume charge density.)



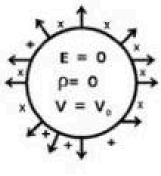
(a)



(b)



(c)



(d)

Q39. A p-n junction diode can be used:

(a) to convert dc voltage into ac voltage
(b) to convert ac voltage into dc voltage
(c) to decrease the amplitude of ac voltage
(d) to decrease the frequency of ac voltage

Q40. A telescope has an objective of focal length 30 cm and an eyepiece of focal length 3.0 cm. It is focused on a scale distant 2.0 m. For seeing with relaxed eye, the separation between the objective and eyepiece would be:

(a) 35.3 cm
(b) 38.3 cm
(c) 37 cm
(d) 30 cm

Q41. The colour of the third band of a colour coded carbon resistor of resistance $2.3 \times 10^2\ \Omega$ would be:

(a) Red
(b) Yellow
(c) Blue
(d) Brown

Q42. Young's double slit experiment is performed using a source of white light.

A. The center fringe will be white.
B. The fringe next to the center fringe will be violet.
C. The fringe next to the center fringe will be red.
D. There will be no completely dark fringe,
E. The center fringe will be of no colour.

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

(a) C, D, E only
(b) A, B, D only
(c) A, C and D only
(d) B, C, D only

Q43. A message signal of peak value 2 V is used to modulate a carrier wave of peak value 10 V. The modulation index of the amplitude modulated wave is:

(a) 0.2
(b) 5
(c) 0.66
(d) 1.5

Q44. When the electron in hydrogen atom jumps from the 2nd orbit to the 1st orbit, the wavelength of the radiation emitted is λ. When the electron jumps from the 3rd orbit to 1st orbit, the wavelength of emitted radiation is :

(a) $\frac{27}{32}\lambda$
(b) $\frac{27}{5}\lambda$
(c) $\frac{4}{5}\lambda$
(d) $\frac{3}{2}\lambda$

Q45. What should be the size of an obstacle to observe diffraction?

(a) has no relation with the wavelength
(b) should be exactly half of the wavelength
(c) should be of the same order as wavelength
(d) should be much larger than the wavelength

Q46. The bottom of a container is a 6 cm thick glass (μ = 1.5) slab. The container contains a thick layer of water (μ_w = 1.33), 4 cm on top of the glass. What is the apparent position of a scratch on the outer surface of the bottom of the glass slab when viewed through the container?

(a) 1 cm
(b) 2 cm
(c) 3.5 cm
(d) 3 cm

Q47. The sensitivity of a potentiometer can be increased by:
(a) Decreasing the length of potentiometer wire only.
(b) Increasing the potential gradient of the potentiometer u•-ire of fixed length.
(c) Decreasing the potential gradient of the potentiometer of fixed length.
(d) Increasing the current in the potentiometer wire circuit.

Q48. A monochromatic visible light consists of
(a) light of a single wavelength with all the colours of spectrum of white light.
(b) light of many wavelengths with a single colour.
(c) light of many wavelengths with all the colours of spectrum of white light
(d) light of a single colour and single wavelength

Q49. Current carrying wire produces:
(a) Electric field only
(b) Magnetic field only
(c) Both Electric and Magnetic field
(d) Electric flux only

Q50. Two lenses of power 3D and —ID are kept in contact. The focal length of the combined lens would be:
(a) 50 cm
(b) 200 cm
(c) 100 cm
(d) 400 cm

SOLUTIONS

S1. Ans. (c)

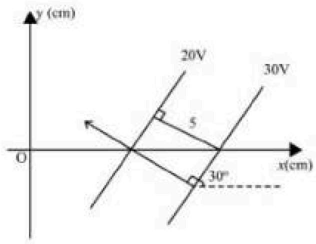
Sol. The Magnetic Flux is a Scalar quantity and Weber (Wb) or Tesla Meter Squared is its SI unit (Tm^2).

S2. Ans. (a)

Sol. Each of the equipotential surfaces are parallel to each other, the perpendicular distance between them is given by $d = 10\sin\ 30 = 5$

Now, the potential gradient between 2 consecutive planes is 10 V So, the electric field is given by, $E = \frac{v}{d} = \frac{10}{5} \times 100 = 200$

Direction of Electric field is from higher potential surface towards the lower potential surface. The electric field is making an angle of 120° with the x axis.



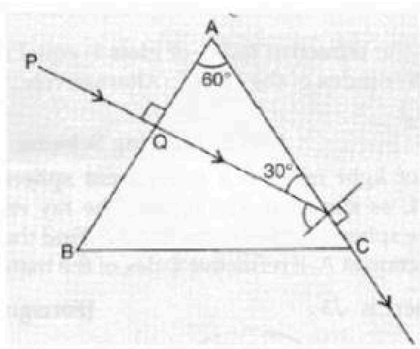
S3. Ans. (b)

Sol. If i_C is the critical angle for the prism/ material,

$$\mu = \frac{1}{\sin\ i_C}$$

$$\therefore\ \sin\ i_C = \frac{1}{\mu} = \frac{\sqrt{3}}{2}$$

$$\Rightarrow\ i_C = 60^\circ$$



Angle of incidence at face AC of the prism = 60°

Hence, refracted ray grazes the surface AC.

⇒ Angle of emergence = 90°

⇒ Angle of deviation = 30°.

S4. Ans. (b)

Sol. Isobars are the atoms of different elements having the same atomic mass but different atomic numbers. ${}^{3}_{1}H, {}^{3}_{2}He$ represents isobars.

S5. Ans. (c)

Sol. P and Q are perpendicular wires (circular)

Current = I, radius = r

B_1 = Magnetic field due to loop P at o

B_2 = Magnetic field due to loop Q at O

Therefore resultant magnetic field, $B = \sqrt{B_1^2 + B_2^2}$

And symmetrical ⇒ $B_1 = B_2$

$\therefore B_1 = \sqrt{2}B = \sqrt{2}\frac{\mu_0 I}{2r}$

$\Rightarrow B_1 = \frac{\mu_0 I}{\sqrt{2r}}$

The net magnetic field is directed at angle of 45° with either of the fields.

S6. Ans. (c)

Sol. ⇒ Length (1) is doubled & Area of cross section (A) is halved

1 becomes 21& A becomes $\frac{A}{2}$

$R = P\frac{L}{A}$

now take $1 = 21, A = \frac{A}{2}$

$R = \frac{P21}{A/2} = 4P\frac{L}{A} \Rightarrow 4R$

Resistance becomes 4 times

S7. Ans. (d)

Sol. The phenomenon in which the vibrations of a wave are restricted in a direction perpendicular to the motion of a wave is known as the polarization of a wave. The waves for which the direction of vibration of the particles in the medium is perpendicular to the direction of motion of the wave is known as transverse waves. This shows that the polarization of waves is possible only for transverse waves. Therefore, the transverse nature of the electromagnetic wave is evident by the phenomenon of polarization.

S8. Ans. (d)

Sol.

A. Electromagnetic induction is a phenomenon in which a changing magnetic field across a wire loop produces an induced emf. When a magnet and a coil move relative to one another, magnetic flux changes, and an electromotive force is generated in the coil.

B. Magnetic flux is the scalar product (dot product) of the magnetic field vector (B) and elementary area vector (dA). Thus, it is a scalar quantity.

C. Faraday's second law of electromagnetic induction states that the magnitude of emf induced in the coil is equal to the rate of change of flux that linkages with the coil. The flux linkage of the coil is the product of the number of turns in the coil and flux associated with the coil

D. The working of magnetic braking of trains is based on eddy current

E. Lenz's law states that the polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it.

S9. Ans. (d)

Sol. Dipole moment of each molecule $= 10^{-30}$ cm.
As 1 mole of the substance contains 6×10^{23} molecules Total dipole moment of all the molecules
$p = 6 \times 10^{23} \times 10^{-30}\text{Cm} = 6 \times 10^{-7}\text{Cm}$
Initial potential energy $U_i = -pE\cos\theta = -6 \times 10^{-7} \times 10^{7} \cos 0^\circ = -6\text{ J}$
Final potential energy $U_f = -6 \times 10^{-6} \times 10^{6} \times \cos 60^\circ = -3\text{ J}$
Work done $= -($ Change in potential energy $)$
$= -[(-3) - (-6)] = 3\text{ J}$

S10. Ans. (b)

Sol. Equation for work done in rotating dipole from angle 'X_1' to angle 'X_2'
Work done = P * E ($\cos X_1 - \cos X_2$)
Here, $\cos X_1 = \cos 0 = 1$ (stable)
$\cos X_2 = \cos 180 = -1$ (unstable)
So,
Work done = P * E (1--1)
= 2PE

S11. Ans. (d)

Sol. Slope of V - I graph
Ohm's Law states that V = IR
From the graph
Slope of V - I graph will be resistance
So, $\frac{V_1}{I_1} = \tan\theta = R_1$
& $\frac{V_2}{I_2} = \tan(90-\theta) = \cot\theta = R_2$
Calculation of $T_2 - T_1$
Temperature dependence of resistance is given by:
$R_1 = R_0(1 + \alpha T_1)$
$R_2 = R_0(1 + \alpha T_2)$
Subtracting above equations, we get
$R_2 - R_1 = \alpha(T_2 - T_1)$
$\therefore T_2 - T_1$ is proportional to $R_2 - R_1$
$\Rightarrow T_2 - T_1 \propto (\cot\theta - \tan\theta) = \frac{\cos\theta}{\sin\theta} - \frac{\sin\theta}{\cos\theta} = \frac{\cos^2\theta - \sin^2\theta}{\sin\theta\cos\theta}$
$T_2 - T_1 \propto \frac{2\cos 2\theta}{\sin 2\theta} = 2\cot 2\theta$
Hence, $T_2 - T_1 \propto \cot 2\theta$

S12. Ans. (c)

Sol. The frequency is the inverse of wavelength. Radio waves < Infrared waves < Ultraviolet rays < X-rays < Gamma rays

S13. Ans. (c)

Sol. It is given that the amplitude of the magnetic field part of a harmonic electromagnetic wave in vacuum is $BO = 610\text{nT}$.
The formula of the amplitude of electric field of the electromagnetic wave is, E = C B O
Substitute the values in above expression.
$E = 3 \times 10^{8} \times 610 \times 10^{-9} = 183\text{ N/C}$

S14. Ans. (c)

Sol. Photovoltaic devices which convert optical radiation into electricity (solar cells).

S15. Ans. (d)

Sol. As the wavelength λ of the incident light falling on cathode is gradually increased, there will be a value of λ above which the photoelectric emission will stop. I.e., the photoelectric emission will stop. i.e, the photoelectric current will become zero. As λ is decreased, the energy of the incident photons increases (E=hc/λ). Due to it, a greater number of photons will be successful in ejecting the electrons from the surface of cathode. As a result of it, the photoelectric current increases, i.e., $I \propto 1/\lambda$

S16. Ans. (d)

Sol. The ground state energy of the hydrogen atom is −13.6 eV.
This is the total energy of the hydrogen atom. Kinetic Energy is given as the negative of the total energy.
Therefore,
Kinetic Energy=−E =13.6 eV
Potential energy is given by the negative of two times of kinetic energy. Therefore,
Potential Energy=−2×(13.6) =−27.2 eV
Thus, the kinetic energy is 13.6 eV and the potential energy is −27.2 eV.

S17. Ans. (c)

Sol. Concave mirror is used by dentist such that $† = -16$ mm and $u = -8$ mm
Using the formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$
$\Rightarrow \frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-16} - \left(\frac{1}{-8}\right)$
$\Rightarrow \frac{1}{v} = \frac{-1}{16} + \frac{1}{8} = \frac{-1+2}{16}$
$\Rightarrow \frac{1}{v} = \frac{1}{16} \Rightarrow v = 16\text{ mm}$
So, $m = -\frac{v}{u} = -\frac{16}{(-8)} = 2$

S18. Ans. (c)

Sol. signal waves of 10 frequencies MHz easily get reflected from the ionosphere and hence for beyond – the – horizon communication signal waves such frequencies are suitable.

S19. Ans. (a)

Sol.

List-I		List-II	
(A)	Impedance of a series RLC circuit at resonance	(I)	Minimum
(B)	For a series LC circuit	(II)	Voltage across L & C are 180° out of phase.
(C)	For a parallel LC circuit	(III)	Current in L & C are 180° out of phase

(D)	Reactance of a capacitor in DC circuit	(IV)	Infinite

S20. Ans. (c)

Sol. At equilibrium in a p–n junction, the forward diffusion current in the depletion region is balanced with a reverse drift current, so that the net current is zero.

S21. Ans. (a)

Sol.
A. The negative potential of the collector plate at which the photoelectric current becomes zero is called stopping potential or cut - off potential.
B. The maximum kinetic energy of photoelectrons is directly proportional to wave number or frequency of the incident radiation. Also, the maximum kinetic energy of photoelectrons is directly proportional to wavelength
E. Changing the intensity of incident radiation does not affect the stopping potential. As the intensity increases, the number of photoelectrons ejected increases. However, the maximum velocity attained by them remains independent of the intensity of the radiation.

S22. Ans. (a)

Sol. We know that decay constant $\lambda = \frac{\log_e 2}{T}$

Here for two different specimens, we can write,

$\lambda_1 = \frac{\log_e 2}{T_1}$ *and* $\lambda_2 = \frac{\log_e 2}{T_2}$

$\frac{\lambda_1}{\lambda_2} = \frac{\log_e 2}{T_1} \times \frac{T_2}{\log_e 2}$

$\frac{\lambda_1}{\lambda_2} = \frac{T_2}{T_1} = \frac{7.5}{5} = \frac{3}{2}$

S23. Ans. (c)

Sol. The electrical resistance if depletion layer is large because there is no charge carriers because Depletion layer consist of mainly stationary ions. The free electrons of the metal conductor are charge carriers.

S24. Ans. (c)

Sol. The energy equation is given as,

$eV_o = hv - W$

$V_o = \frac{hv}{e} - \frac{W}{e}$

When the frequency is doubled,

$V_o' = \frac{2hv}{e} - \frac{W}{e}$

$V_o' = 2\left(\frac{hv}{e} - \frac{W}{e}\right) + \frac{W}{e}$

$V_0' = 2V_0 + \frac{W}{e}$

$V_0' > 2V_0$

Thus, the stopping potential will become more than doubled.

S25. Ans. (b)

Sol. Force between two parallel current carrying conductors is attractive, if they carry current in same direction and repulsive, if they carry current in opposite direction. So,the branch AD is attracted to the long wire, while the branch BC is repelled by it. Since the force is inversely proportional to the distance between the two wires, the force of attraction is more than the force of repulsion. Hence there is a net force attracting the loop towards the wire and the loop will move towards the wire

S26. Ans. (b)

Sol. $\phi = \tan^{-1}\left(\frac{X_L}{R}\right) = \tan^{-1}\left(\frac{5}{5}\right) = \tan^{-1}(1) = \frac{\pi}{4} rad$

S27. Ans. (b)

Sol. If step-down transformer, voltage decreases corresponding current increases.

S28. Ans. (b)

Sol. For diamagnetic material, $\chi<0$ It is diamagnetic material.

S29. Ans. (b)

Sol. Average energy density of magnetic field, $U_m = \frac{m_o^2}{2\mu_0}, m_0$ is maximum value of magnetic field.

Average energy density of electric field, Average energy density of electric field,

$U_E = \frac{\varepsilon_0 \epsilon_0^2}{2}$

now, $\epsilon_o = Cm_o, C^2 = \frac{1}{\mu_o \epsilon_o}$

$\mu_E = \frac{\epsilon_o}{2} \times C^2 m_0^2$

$= \frac{\epsilon_o}{2} \times \frac{1}{\mu_o \epsilon_o} \times m_0^2 = \frac{m_0^2}{2\mu_o} = \mu_m$

$U_E = U_m$

since energy density of electric & magnetic field is same, energy associated with equal volume will be equal.

$\frac{U_E}{U_m} = 1$

S30. Ans. (a)

Sol.

List-I		List-II	
(A)	Electric field outside a uniformly charged thin spherical shell	(I)	$k\frac{q}{r^2}\hat{r}$
(B)	Electric field inside the uniformly charged thin spherical shell	(II)	Zero
(C)	Electric field due to an infinitely long straight uniformly charged wire.	(III)	$\frac{\lambda}{2\pi \in r}\hat{n}$
(D)	Electric field due to a uniformly charged infinite plane sheet	(IV)	$\frac{\sigma}{2 \in_0}\hat{n}$

S31. Ans. (c)

Sol. Here, $V = 3$ volt, $R = 1.5\Omega$,

$e = 1.6 \times 10^{-19} C, t = 1s.$

Now, $I = \frac{V}{R} = \frac{3}{1.5} = 2A$ and $I = \frac{Q}{t} = \frac{ne}{t}$

or $n = I\frac{t}{e} = 2 \times \frac{1}{1.6} \times 10^{-19} = 1.25 \times 10^{19}$

S32. Ans. (a)

Sol. W = 0 ∵ Electrostatic force is conservative force and work done by conservative force depends only upon the initial and final position. Since, final position = initial position, hence work done is zero.

S33. Ans. (d)

Sol. The basic properties of electric charge are:
Charges are additive in nature.
Charge is a conserved quantity.
Quantization of charge.

S34. Ans. (d)

Sol. A. In the absence of an external magnetic field, the net magnetic moment of diamagnetic substance is zero
E. Susceptibility of Diamagnetic, $\chi < 0$

S35. Ans. (a)

Sol. If a charged particle's velocity is completely parallel to the magnetic field, the magnetic field will exert no force on the particle and thus the velocity will remain constant. A particle with constant velocity will move along a straight line

S36. Ans. (b)

Sol. Oxygen $^{16}_{8}O$ has 8 protons and 8 neutrons.
mass of electron, $m_e = 0.00055u$
mass of proton, $m_p = 1.00727u$
mass of neutron, $m_n = 1.00866u$
experimental mass of nucleus $= 15.99053u$
$1u = 931.5 MeV/c^2$
Mass defect, $\Delta M = 8\, m_p + 8\, m_n - M_N$
$\therefore \Delta M = 8(1.0078) + 8(1.0087) - 15.99053$
$= 0.137u$

$=0.137 \times 931.5 = 127.5$ MeV/c2

S37. Ans. (d)

Sol.

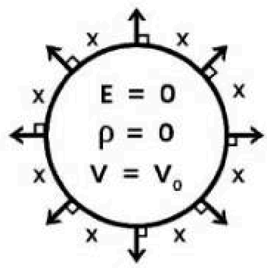
$$C_0 = \frac{\epsilon_0 A}{d} \ldots\ldots\ldots (1)$$
$$C = \frac{7}{6} C_0 \ldots\ldots\ldots (2)$$
$$C = \frac{\epsilon_0 A}{d - t\left(1 - \frac{1}{K}\right)} = \frac{\epsilon_0 A/d}{1 - \frac{t}{d}\left(1 - \frac{1}{K}\right)}$$
$$\frac{C_0}{1 - \frac{2}{3}\left(1 - \frac{1}{K}\right)} = \frac{3KC_0}{2+K} \ldots\ldots\ldots (3)$$

Dividing (1) and (3)

$$\Rightarrow \frac{C}{C_0} = \frac{3K}{K+2} = \frac{7}{6}$$
$$\Rightarrow K = \frac{14}{11}$$

S38. Ans. (c)

Sol. The potential inside the conductor is the same as the potential at the surface. Since the surface of the solid conductor is an equipotential surface hence the electric field will be perpendicular or in other words normal to the perfectly solid conductor surface.



S39. Ans. (b)

Sol. The main application of p-n junction diode is in rectification circuits. These circuits are used to describe the conversion of a.c signals to d.c in power supplies.

S40. Ans. (b)

Sol. For seeing with relaxed eye, the final image should be formed at infinity.
For this, the image formed by the objective should fall at the focus of the eyepiece.
Let v_0 be the distance of the image formed by the objective.
Then, from the lens formula,

$$\frac{1}{v_0} - \frac{1}{u_0} = \frac{1}{f_0}$$

Here $u_0 = -2.0$ m $= -200$ cm, $f_0 = 30$ cm

$$\Rightarrow \frac{1}{V_0} - \frac{1}{-200} = \frac{1}{30}$$
$$\Rightarrow \frac{1}{V_0} = \frac{1}{30} - \frac{1}{200} = \frac{20-3}{600} = \frac{17}{600}$$
$$\Rightarrow V_0 = \frac{600}{17} = 35.3 \text{ cm}$$

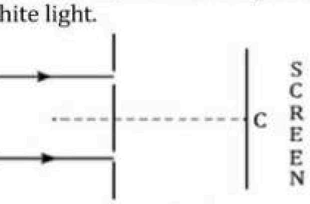
$\therefore$ distance between the objective and the eyepiece,
$d = v_0 + f_e = 35.3 + 3.0 = 38.3$ cm

S41. Ans. (d)

Sol. Resistance of resistor $= 2.3 \times 10^2 \Omega = 23 \times 10^2 \Omega$ Therefore, the colour of third band of a colour coded resistor will be related to number 1, i.e., brown.

S42. Ans. (b)

Sol. Young's double slit experiment is performed using a source of white light.



Bright white fringe is formed at the centre of the screen. Fringe closest to either side of centre of the screen is red. Fringe closest to either side of centre of the screen is violet. After few fringes, no clear fringe pattern is seen.

S43. Ans. (a)

Sol. The modulation index is the ratio of modulating signal voltage to the carrier wave peak voltage.

That is, $m = \frac{V_m}{V_c}$

$$= \frac{2\text{ V}}{10\text{ V}} = 0.2$$

S44. Ans. (a)

We have, $n_1 = 3 n_2 = 1$

$\therefore \frac{1}{\lambda'} = R\left(\frac{1}{1^2} - \frac{1}{3^2}\right)$

$\Rightarrow \lambda' = \frac{9}{8R} = \frac{9}{8} \times \frac{3\lambda}{4} = \frac{27}{32}\lambda$

S45. Ans. (c)

Sol. The diffraction effect will also increase as the wavelength increases. Thus it is important that the size of the obstruction is proportional to the wavelength of the source for greater diffraction. Therefore, the size of the obstacle should be of the order of wavelength.

S46. Ans. (d)

Sol. We know that

$D = t\left[1 - \frac{1}{u}\right] + t_w\left[1 - \frac{1}{u_w}\right]$

$\because t = 6, t_w = 4,$

$u = 1.5, u_w = 1.33$

$\therefore d = 6\left[1 - \frac{1}{1.5}\right] + 4\left[1 - \frac{1}{1.33}\right]$

$= 6[0.33] + 4[0.25]$

$= 1.98 + 1$

$= 2.98$ cm

S47. Ans. (c)

Sol. Sensitivity of potentiometer means the smallest potential difference it can measure. It can be increased by reducing the potential gradient. The same is possible by increasing the length of the potentiometer.

S48. Ans. (d)

Sol. A monochromatic light has a single frequency, single colour and a single wavelength.

S49. Ans. (b)

Sol. Wavelength of photon emitted $\frac{1}{\lambda} = R\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$ ($\because Z =$ 1) Transaction from second orbit to first orbit :

We have, $n_1 = 2 n_2 = 1$

$\therefore \frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) \Rightarrow R = \frac{4}{3\lambda}$

Transaction from third orbit to first orbit:

Sol. A current-carrying wire generates a magnetic field as a result of the moving charges inside the conductor. A current-carrying conductor is a neutral species under electromagnetism's rules until an external charge or electric field is added to it.

S50. Ans. (a)

Sol. When two or more lenses are kept in contact with each other, the resultant power of the combined l equal to the algebraic sum of the individual powers.

$P = P_1 + P_2 + ..$

Formula Used:

$P = \frac{1}{f}$

$P = P_1 + P_2 + ..$

Complete step by step answer:

When the 2 lenses are kept in contact together, the resultant power,

$P = P_1 + P_2$

Substituting, we get -

$P = 3D + (-1D)$

$P = 3 - 1 = 2D$

Power is defined at the inverse of the focal length, $P = \frac{1}{f}$

Hence, the focal length is given by, $f = \frac{1}{P}$ Substituting the value of P, we get -

$f = \frac{1}{2}$

$f = 0.5$ m

$f = 50$ cm

For a convex lens, the focal length is positive and for a concave lens, the focal length is negative. Since, the focal length is +50cm, the combination lens is of convex nature.