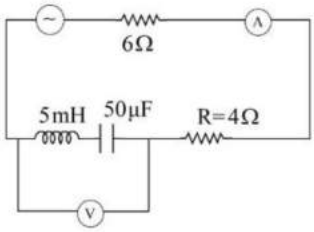
Previous Year Paper

25th May 2023 (Shift 3)

Q1. In the shown ac source gives a Voltage V=20 cos 2000t. Neglecting source resistance, the voltmeter and Ammeter reading will be.



(a) 0 v, 1.4 A
(b) 1.68 V, 0.47 A
(c) 0 V, 14A
(d) 5.6 V, 1.4a

Q2. If the forward voltage in a p-n junction diode is increased, the width of the depletion region
(a) Increases
(b) Decreases
(c) No change
(d) Fluctuates

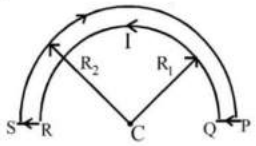
Q3. The work function for Aluminium surface is 4.2 eV. Find the threshold wavelength for the photoelectric emission.
(a) 2959 A°
(b) 4200 A°
(c) 4736 A°
(d) 5890 A°

Q4. The half-life period of a radioactive element 'X' is same as the mean life of another radioactive element Y. Initially both of them have the same no. of atoms, then:
A. X and Y have the same decay rate initially.
B. X and Y decay at the same rate always.
C. Y will decay at a faster rate than X.
D. X will decay at a faster rate than Y.

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

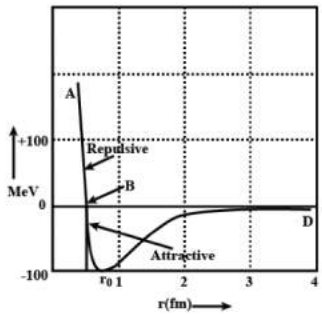
Q5. A Convex minor produces the magnification 1/3 and 1/4 when the object is placed at the points P and Q in front of the mirror.
(a) P is far from the mirror as compared to Q.
(b) Q is far from the mirror as compared to P
(c) P and Q both are coinciding
(d) Convex mirror produces the magnification always greater than l.

Q6. The wire loop PQRSP formed by joining two semicircular wires of radii R_1 & R_2 carries a current I as shown in the fig. The magnitude of magnetic field at the centre 'C' is

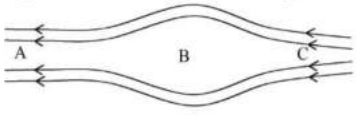


(a) $\frac{\mu_0 I}{2}\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$
(b) $\frac{\mu_0 I}{4}\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$
(c) $\frac{\mu_0 I}{2}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$
(d) $\frac{\mu_0 I}{4}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

Q7. When we draw the variation of the potential energy of a pair of nucleons with their separations, then
(a) the force is attractive when separation between them is greater than 0.8 fm
(b) the force is repulsive when separation between them is greater than O.S fm
(c) the force is attractive when separation between them is less than 0.8 fm
(d) the force is independent of their separation.



Q8. A Neutron is moving with a velocity of V in non-uniform magnetic field as shown in figure.



Velocity $\vec{v}$ of neutron would be

(a) Maximum at B

(b) Same at A, B and C

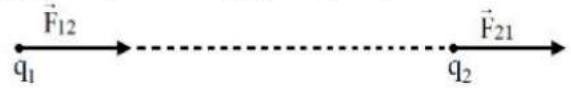
(c) Minimum at A and C

(d) Maximum at A and C

Q9. Which of the following option is correct by using Coulomb's law.

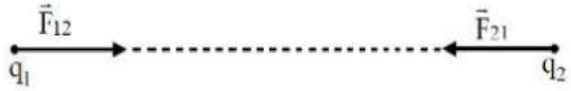
(a) (if the product of q_1q_2 is positive)

(b) (if the product of q_1q_2 is negative)



(c) (if the product of q_1q_2 is positive)

(d) (if the product of q_1q_2 negative)



Q10. A heater boils x amount of water in time t_1 and another heater boils the same water in time t_2 having resistances R_1 and R_2 respectively. The ratio $\frac{t_1}{t_2}$ will be:

(a) $\left(\frac{R_1}{R_2}\right)^2$

(b) $\left(\frac{R_2}{R_1}\right)^2$

(c) $\frac{R_2}{R_1}$

(d) $\frac{R_1}{R_2}$

Q11. Which of the following statements are correct?

A. A Equi Convex lens of $f = 20$ cm is cut as the  focal length of each part is 10 cm.

B. A Equi Convex lens of $f = 20$ cm is cut as  the focal length of each part is 20 cm.

C. If an Equi Convex lens of refractive index μ_1 is placed in a liquid of $(\mu 2)$ such that $(\mu_1 > \mu 2)$. It will not change it's nature.

D. A Convex lens of $f = 20$ cm is cut as  the focal length of each part is 40 cm.

(a) A, B only

(b) A, B, c only

(c) B, C Only

(d) B, C, D Only

Q12. Which of the following statements are collect about transformers?

A. Transformers cannot be used to step up DC.

B. The frequency of output across the secondary is always equal to the frequency of input across the primary.

C. The output power of a transformer may be increased to a value which is more than the input power.

D. Transformation ratio is equal to turns ratio.

E. In a step-up transformer, secondary current is less than primary current.

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

(a) A, B, C

(b) B, C, D

(c) C, D, A

(d) A, B, D, E

Q13. A Potentiometer wire of length L and a resistance r are connected in series with a battery of emf E_0 and a resistance $r_{(a)}$ An unknown emf E is balanced at a length l of the potentiometer wire. The emf E will be:

(a) $\frac{LE_0r}{(r+r_1)l}$

(b) $\frac{E_0r}{lr_1}$

(c) $\frac{E_0r}{(r+r_1)} \cdot \frac{l}{L}$

(d) $\frac{E_0l}{L}$

Q14. A capacitor of 25μF is connected in series with d.c Voltage of 5V. The value of current in the circuit will be:

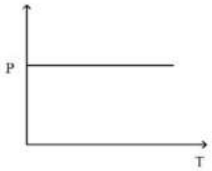
(a) 2×10^5 A

(b) 5A

(c) 5×10^6 A

(d) Zero

Q15. The graph between resistivity and temperature given below can be for the material



(a) Copper

(b) Nichrome

(c) Manganin

(d) Semiconductors

Q16. Which phenomena proves the particle nature of photon?

(a) Interference

(b) diffraction
(c) polarisation
(d) Photo electric effect

Q17. Peak voltage of a modulating signal is 2 V. The carrier wave is represented by $C(t) = 4\sin(8\pi t)$V. The modulation index of modulated singnal is:
(a) 0.5
(b) 1.0
(c) 4.0
(d) 8.0

Q18. The waves used by artificial satellite for communication purposes are
(a) Ground waves
(b) Microwaves
(c) F. M. radio waves
(d) A. M. radio waves

Q19. The time taken by light to travel normally through a glass plate of thickness 1 mm would be:
(Take refractive index of glass = 1.5)
(a) $0.1 \times 10^{-13}s$
(b) $12 \times 10^{-5}s$
(c) $5 \times 10^{-12}s$
(d) $1.5 \times 10^{-5}s$

Q20. A slab of material of dielectric constant k has the same area as the plates of a parallel plate capacitor, but has a thickness $\frac{3d}{4}$. Where d is the distance between plates of capaciptor. The ratio of the capacitance with dielectric inside it to its capacitance without the dielectric is:
(a) $\frac{3k}{(k+4)}$
(b) $\frac{4k}{(k+3)}$
(c) $\frac{5k}{(k+2)}$
(d) $\frac{k}{(k+3)}$

Q21. Monochromatic light of frequency $6x10^{14}$ Hz is produced by a laser source. The energy of photon of light is:
(a) $3.98x\ 10^{-19}$ J
(b) $39.8x\ 10^{-19}$ J
(c) $1.12x\ 10^{-20}$ J
(d) $2.24x\ 10^{-20}$J

Q22. A semiconductor device is connected in series circuit with a battery and resistance. A current is found to pass through the circuit. If the polarity of the battery is reversed, the current chops at almost zero. The device may be
(a) A p-type semiconductor
(b) An Intrinsic semiconductor
(c) An- n-type semiconductor
(d) a p-n Junction

Q23. Two identical thin metal plates are given charges q_1 and q_2 ($q_2 < q_1$) respectively. If they are now brought close together to form a parallel plate capacitor with a capacitance 'C' then the potential difference between the plates is:
(a) $\frac{q_1+q_2}{2C}$
(b) $\frac{q_1}{2Cq_2}$
(c) $\frac{q_1-q_2}{2C}$
(d) $\frac{q_2}{C(q_1+q_2)}$

Q24. the shape of a wavefront when light emerging out of a convex lens when a parallel beam of light incident over it is,
(a) Parabolic
(b) Plane
(c) Cylindrical
(d) Spherical

Q25. Arrange the following m Increasing number of quantum number when coming from excited energy state
A. Lyman Series
B. Balmer Series
C. Paschen Series
D Brackett Series
E. Pfund Series

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

Q26. A short solenoid of radius a and n_1 number of turns per unit length and length L is kept coaxially inside a very long solenoid of radius b and n_2 number of turns per unit length. What is the mutual inductance of the system.
(a) $\mu_0\pi b^2 n_1 n_2 L$
(b) $\mu_0\pi a^2 n_1 n_2 L^2$
(c) $\mu_0\pi a^2 n_1 n_2 L$
(d) $\mu_0\pi b^2 n_1 n_2 L^2$

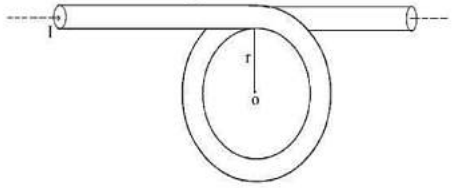
Q27. Which of the following statements are correct?
A. The saturation current is constant with collector plate potential for different frequencies of incident radiation.

B. The saturation current is different with collector plate potential for different frequencies of incident radiation.
C. The saturation current is different with collector plate potential for different intensity of incident radiation.
D. The saturation current is constant with collector plate potential for different intensity of incident radiation.
E. Below threshold frequency no photo electrons are emitted.

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

Q28. For insulators and semiconductors, the resistance decreases with increase in temperature because
(a) number density decreases
(b) number density of charge carriers increases
(c) Resistivity does not depend upon the temperature
(d) Resistivity does not depend upon the number density of Charge carriers

Q29. A long wire carrying current I is bent in the form of a circle as shown in the figure.



The $\vec{B}$ at point O is:
(a) $\frac{\mu_0}{4\pi} = \frac{2I}{r}(1 - \pi)$ perpendicularly outward
(b) $\frac{\mu_0}{4\pi} = \frac{2\pi I}{r}$ perpendicularly inward
(c) $\frac{\mu_0}{4\pi} = \frac{2I}{r}(1 + \pi)$ perpendicularly outward
(d) $\frac{\mu_0}{4\pi} = \frac{2I}{r}(1 + \pi)$ perpendicularly inward

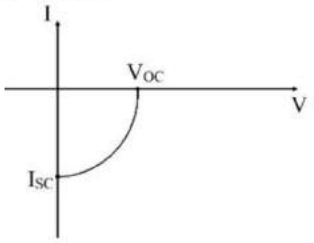
Q30. A bubble in glass slab (μ = 1.5) when viewed from one side appears at 5 cm and 2 cm from otherside, then the thickness of the glass slab is:
(a) 2.5 cm
(b) 7.5 cm
(c) 10.5 cm
(d) 17.5 cm

Q31. Match **List - I** with **List - II**

	List-I		**List-II**
(A)	Rod rotated with angular velocity ω in a uniform magnetic field	(I)	$e = e_0 \sin \omega t$
(B)	Coil is rotated with angular velocity in a uniform magnetic field.	(II)	$E = B/v$
(C)	Rod is moved with linear velocity v in uniform magnetic field	(III)	Constant
(D)	When a rectangular coil is moved in a magnetic field induced emf is	(IV)	$e = \frac{B\omega l^2}{2}$

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

Q32. I-V characteristics of solar cell is drawn in the fourth quadrant. The reason is



(a) Solar cells does not draw current and supplies the same to the load.
(b) Solar cell draws the current and does not supply.
(c) Solar cell does not supply the current.
(d) Solar cell only store the light energy.

Q33. A parallel plate capacitor whose capacitance C is 13.0 pF is charged by a battery to a potential difference V = 13.0 V between its plates. What is the potential energy of the capacitor?
(a) 1.098 nJ
(b) 2197 pF
(c) 1.98 pJ
(d) 2.197 nJ

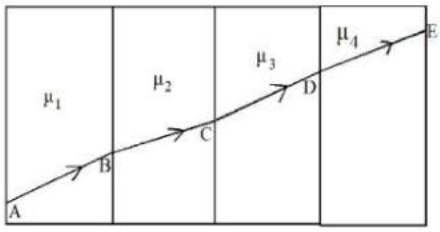
Q34. The wavelength of radiation emitted, when He^+ makes a transition from the state n = 3 to the state n = 2 will be:
(Take Rydberg constant R - 1.097×10^7 m^{-1})
(a) 1.641 nm
(b) 164.1 nm
(c) 16.41 um
(d) 1641 nm

Q35. An electric dipole of dipole moment 5×10^{-6} Cm is placed in a uniform electric field of 10^{-2} N/C making an angle of 30° with the direction of the field. The torque exerted by the electric field on the dipole is:
(a) 1×10^{-8} Nm
(b) 1.5×10^{-8} Nm
(c) 2.5×10^{-8} Nm
(d) 5×10^{-8} Nm

Q36. Choose the **wrong** statement:
(a). Potential difference across the terminals of the cell in a closed circuit is less than its emf.
(b) Internal resistance of the cell decreases with decrease in temperature of electrolyte.
(c) Terminal potential difference versus current graph for a cell is a straight line with a negative slope.
(d) Terminal potential difference when cell is being charged V=E+Ir.

Q37. A dielectric material placed in uniform electric field, which of the following option is NOT CORRECT:
(a) The free movement of charges in a dielectric is not possible
(b) The free movement of charges in a dielectric is possible
(c) The external field induces dipole moment by stretching molecules of dielectrics
(d) The external field induces dipole moment by re-orienting molecules of dielectrics

Q38. A ray of light passes through four transparent media with refractive index μ_1, μ_2, μ_3 and μ_4 shown in figure. The surfaces of all media are parallel. If BC and DE are parallel, we must have



(a) $\mu_1 = \mu_4$
(b) $\mu_2 = \mu_3$
(c) $\mu_2 = \mu_4$
(d) $\mu_1 = \mu_2$

Q39. Four materials A, B, C and D have the magnetic susceptibilities x_{mA}, x_{mB}, x_{mC} and x_{mD} respectively. which are related as $x_{mD} < x_{mC} < x_{mB} < x_{mA}$. Which material can be magnetised with maximum ease?
(a) B
(b) C
(c) A
(d) D

Q40. Which of the following statements are correct?
A. The angle at minimum deviation of a prism is greater for violet light than that for red light.
B. The purpose of microscopes and telescopes is to increase the visual angle.
C. For the diffraction to take place the size of aperture or of the obstacle should be comparable to the wavelength of light.
D. The light scattered in the direction of the incident light is always plane polarised.
E. The source and its virtual image can behave as a coherent sources.

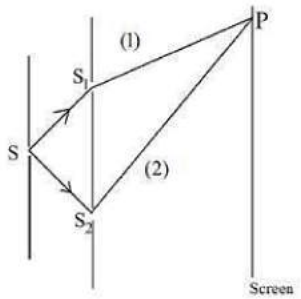
Choose the **correct** answer from the options given below:
(a) A, B, and C only
(b) A, B, C, D only
(c) A, B, C, E Only
(d) B, C, D, E Only

Q41. Light of uniform intensity shines perpendicularly on a totally absorbing surface, fully illuminating the surface. If the area of the surface is decreased, what is the effect on radiation pressure?
(a) Increases
(b) Decreases
(c) Remains the same
(d) Cannot be said

Q42. The intensity of a plane monochromatic wave is 1380 Wm^{-2} What is the amplitude of electric field in this wave? (Take speed of light $3 \times 10^8\ ms^{-1}$; $\omega_0 = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2}$)
(a) 102 N C^{-1}
(b) 10.2 N C^{-1}
(c) 1020 N C^{-1}
(d) 10200 N C^{-1}

Q43. In free space, all components of the complete electromagnetic spectrum have the same
(a) energy
(b) velocity
(c) frequency
(d) intensity

Q44. The intensity of light due to (see figure) interference of two waves (1) and (2) which have path difference of λ is: (where I_0 = Intensity of each wave)

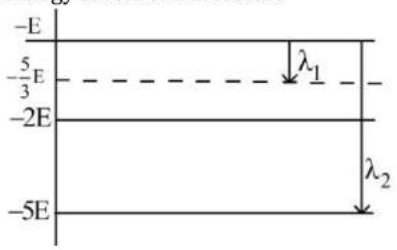


(a) Zero
(b) I_0
(c) $2I_0$
(d) $4I_0$

Q45. The induced e.m.f in a coil rotating in a uniform magnetic field will increases if
A. Total number of turns in the coil decreases
B. Magnetic field increases
C. Speed of rotation of coil decreases
D. Area of the coil increases

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

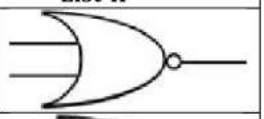
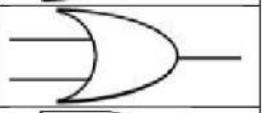
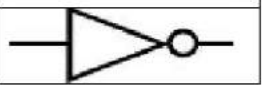
Q46. What is the ratio of wavelength in the given figure of energy levels of a molecule



(a) 5:1
(b) 1:4
(c) 2:3
(d) 6:1

Q47. A bulb and a capacitor are connected in series to an a.c. source. A dielectric slab is now introduced between the plates of the capacitor. The intensity of the bulb will be:
(a) Zero
(b) Increases
(c) Decreases
(d) Remain same

Q48. Match **List - I** with **List - II**

List-I		List-II	
(A)	NAND Gat4e	(I)	
(B)	NOR Gate	(II)	
(C)	NOT Gate	(III)	
(D)	OR Gate	(IV)	

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

Q49. The magnitude of electric force exerted by a proton on an electron in a hydrogen atom is, (Given distance of separation between charges, 1Å)
(a) 2.3×10^{-10}N
(b) 2.3×10^{-8}N
(c) 2.3×10^{-9}N
(d) 2.3×10^{-7}N

Q50. Displacement current $(i_d) = \frac{\omega_0 d\phi_E}{dt}$.
Where symbols have their usual meanings.
Which of the following options gives correct equation for displacement current?
(a) $i_d = \omega_0 \frac{d(BA)}{dt}$
(b) $i_d = A\omega_0 \frac{dE}{dt}$
(c) $i_d = qA\omega_0 \frac{dE}{dt}$
(d) $i_d = \frac{A\omega_0}{q} \frac{dE}{dt}$

SOLUTIONS

S1. Ans. (a)

Sol. Here we have, $X_L = \omega L = 2000 \times 5 \times 10^{-3}\Omega = 10\Omega$

$X_C = \frac{1}{\omega C} = \frac{1}{2000\times50\times10^{-6}}\Omega = 10\Omega$ $X_L = X_C$.

Hence this is a case of resonance.

$\Rightarrow i = \frac{V}{R} = \frac{(20/\sqrt{2})}{10} = 1.4$ A

Voltmeter reading $= 1.4 \times 0$ volt $= 0$ V

S2. Ans. (b)

Sol. If the forward voltage in a diode is increased to the break down voltage of the depletion region, then the width of the depletion region decreases.

S3. Ans. (a)

Sol.

$e = 1.6 \times 10^{-19}$C

$c = 3 \times 10^8$ m/s

$\phi = 4.2$eV $= 4.2 \times 1.6 \times 10^{-19} = 6.72 \times 10^{-19}$ J

$h = 6.63 \times 10^{-34}$ J. s

Threshold wavelength

$$= \lambda_o = \frac{hc}{\phi} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{6.72 \times 10^{-19}}$$

$$= 2.959 \times 10^{-7} \text{ m} = 2959 \text{ A}^\circ$$

S4. Ans. (c)

Sol. Rate of decay $= \frac{dN}{dt} = -\lambda N$, N is the original number of atoms and λ is the decay constant.

The negative sign indicates the decay/reduction in atoms with time.

Half life $= t_{\frac{1}{2}} = \frac{\ln 2}{\lambda} = \frac{0.693}{\lambda}$

Mean life $= \tau = \frac{1}{\lambda}$

It is given that the half life period of x is the same as the mean life of y.

$$\left(t_{\frac{1}{2}}\right)_x = \tau_y$$

$$\Rightarrow \frac{0.693}{\lambda_x} = \frac{1}{\lambda_y}$$

$$\Rightarrow \lambda_x = 0.693 \times \lambda_y$$

$$\therefore \lambda_y > \lambda_x$$

Initial number of atoms i.e., N is the same for both radioactive materials x and y.

Higher the decay constant, faster the decay.

∴ Radioactive element y will decay faster.

S5. Ans. (b)

S6. Ans. (d)

Sol. Magnetic field at the centre of a coil $B_c = \frac{\mu_0 IN}{2r}$ where N is the number of turn.

For semi-circular coil N = 0.5

So, magnetic field at C due to semicircular coil of radius R_1, $B_1 = \frac{\mu_0 I(0.5)}{2R_1} = \frac{\mu_0 I}{4R_1}$ out of plane of paper

So, magnetic field at C due to semicircular coil of radius R_2, $B_2 = \frac{\mu_0 I(0.5)}{2R_2} = \frac{\mu_0 I}{4R_2}$ into the plane of paper

Magnetic field at C due to section SR and PQ is zero.

So net magnetic field at $CB_{net} = B_1 - B_2 = \frac{\mu_0 I}{4}\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

S7. Ans. (a)

Sol. (i) The potential energy is minimum at a distance r_0 of about 0.8fm.

(ii) Nuclear force is attractive for distance larger than r_0.

(iii) Nuclear force is repulsive if two are separated by distance less than r_0.

S8. Ans. (b)

Sol. Magnetic force $\overrightarrow{F_m} = q(\vec{v} \times \vec{B})$

The particle being uncharged, $q = 0$.

So, magnetic force on the particle, $\overrightarrow{F_m} = \vec{o}$

Since there is no external force acting on the particle, its velocity $\vec{v}$ will be same at all points.

S9. Ans. (d)

Sol. According to Coulomb's law, $\vec{F}_{12} = -\vec{F}_{21}$

There is a force of attraction and the charge must be unlike charge. and we know that $F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$

For attractive force, $q_1 q_2 < 0$

$q_1 = +$

$q_2 = -$

$q_1 q_2 < o$

(d) $\frac{R_1}{R_2}$

S10. Ans. (d)

Sol. Let $R_1 R_2$ be the resistance of two heaters and time t_1 and another heater boils the same water in time t_2. if V is the voltage applied to heated then

$H = \frac{V^2}{R_1} t_1 = \frac{V^2}{R_2} t_2$

or $\frac{t_1}{R_1} = \frac{t_2}{R_2}$

$\Rightarrow \frac{R_1}{R_2} = \frac{t_1}{t_2}$

S11. Ans. (d)

Sol. The focal length of equiconvex lens is 20 cm

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

for equiconvex lens $R_1 = -R_2 = R$ thus,

$$\frac{1}{20} = (\mu - 1)\left(\frac{1}{R} + \frac{1}{R}\right)$$

$$\Rightarrow R = 40(\mu - 1)$$

when lens is cut into two equal parts perpendicular to optical axis then,

$$R_1 = \infty,\ R_2 = R$$

thus

$$\frac{1}{f'} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f'} = (\mu - 1)\left(\frac{1}{R}\right)$$

by putting value of R we get,

$$\frac{1}{f'} = (\mu - 1)\left(\frac{1}{40(\mu - 1)}\right)$$

$\Rightarrow f' = 40$ cm

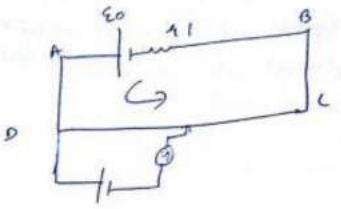
new focal length of each part is 40 cm, becomes double

S12. Ans. (d)

Sol. the output power in a step-up transformer is equal to the input power.

S13. Ans. (c)

Sol.



Current in ABCD

$$I = \frac{V}{R_{eq}} = \frac{V}{r + r_1}$$

potential difference across potentiometr $= Ir$

$$= \frac{Vr}{(r + r_1)}$$

Potential gradient $= \frac{V}{L} = \frac{Vr}{(r+r_1)} \times \frac{1}{L} = k$

we know that EMF $= kl$

l = balancing length

$$\text{EMF} = \left(\frac{Vr}{r + r_1}\right)\frac{l}{L} = \left(\frac{Er}{r + r_1}\right)\frac{l}{L}$$

S14. Ans. (d)

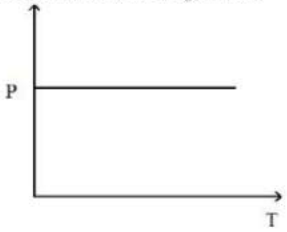
Sol. For a DC supply of 5 V, the frequency is zero, i.e., f = 0 Hz.

For a DC supply of 5 V, under steady-state, i.e., at $t \to \infty$, the capacitor will act as an open circuit because it will offer infinite resistance.

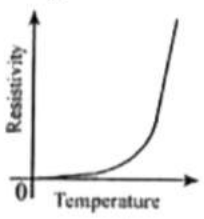
$\therefore$ The steady-state current will be 0 A.

S15. Ans. (c)

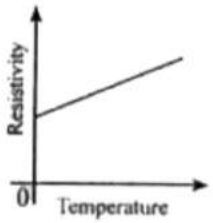
Sol. The graph between resistivity and temperature for the material Manganin is



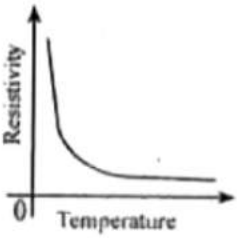
For Copper



For Nichrome,



For Semiconductors



S16. Ans. (d)

Sol. (a) Interference is a phenomenon in which two waves of same frequency superpose to give resultant intensity different from sum of their separate intensity. So, it cannot exhibit particle's nature of light.

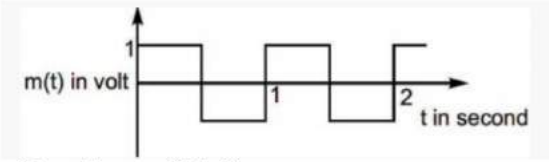
(b) Diffraction is a phenomenon in which light bends at sharp ends of an obstacle or a hole. So, it also cannot exhibit particle's nature of light.

(c) Polarisation of light is a property owing to which a light ray after emerging through a crystal (a special kind like tourmaline) have vibrations in a plane perpendicular to its direction of propagation. So, it also can not explain particle's nature of light.

(d) Photoelectric effect states that light travels in the form of bundles or packets of energy, called photons. This effect is explained on the basis of quantum nature of light. So, it clearly explains the particles' nature of light

S17. Ans. (a)

Sol.



$y(t) = [A_c + m(t)]c(t)$

where,

A_C is the amplitude of carrier wave.

The modulated waveform $y(t)$ as shown in fig.

Modulation index, $\mu = \frac{M}{A} = 0.5$

S18. Ans. (b)

Sol. Microwaves are mostly used for satellite communication, as microwaves can pass straight through the atmosphere and connect antennas on earth to satellite in earth's orbit.

S19. Ans. (c)

Sol. We know that

$$v = c/\mu$$

$$v = \frac{3 \times 10^8}{1.5} = 2 \times 10^8 \text{ m/s}$$

$$\text{Time} = T = \frac{d}{v} = \frac{10^{-3}}{2 \times 10^8}$$

$$T = 0.5 \times 10^{-11} \text{sec}$$

$$T = 5 \times 10^{-12} \text{sec}$$

S20. Ans. (b)

Sol.

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

$$C' = \frac{A\epsilon_0}{d - t + \frac{t}{k}}$$

Put $t = \frac{3d}{4}$;

$$C' = \frac{4k}{3+k} \cdot \frac{A\epsilon_0}{d}$$

$$C' = \frac{4k}{3+k} \cdot C$$

S21. Ans. (a)

Sol.

$$E = hv$$

$$= 6.63 \times 10^{-34} \times 6.0 \times 10^{14}$$

$$= 3.98 \times 10^{-19} \text{ J}$$

S22. Ans. (d)

Sol. A p-n junction is a device in which current flows through the junction when it is forward biased whereas when reverse biased, it conducts a very small current (almost zero) untill the output voltage equals the breakdown voltage. Moreover, current through the intrinsic as well as extrinsic semiconductor does not depend on the polarity of the battery.

S23. Ans. (c)

Sol. Electric field between plates given by,

$$E = \frac{q_1 - q_2}{2A\varepsilon_0}$$

(Here, $q_1 > q_2$)

Then, the potential difference will be

$V = Ed = \frac{q_1 - q_2}{2A\varepsilon_0} d = \frac{q_1 - q_2}{2C} \left(\because C = \frac{\varepsilon_0 A}{d}\right)$

S24. Ans. (b)

Sol. Corresponding to a beam of parallel rays of light the wavefronts, are planes parallel to one another.

S25. Ans. (c)

Sol.

n_1	n_2	Name	Converge toward
1	$2 \to \infty$	Lyman series	91 nm
2	$3 \to \infty$	Balmer series	365 nm
3	$4 \to \infty$	Paschen series	821 nm
4	$5 \to \infty$	Brackett series	1459 nm
5	$6 \to \infty$	Pfund series	2280 nm
6	$7 \to \infty$	Humphreys series	3283 nm

S26. Ans. (c)

Sol. Let L be the length of each solenoid S_1 and S_2 having radius a and b respectively.

n_1 and n_2 be the number of turns per unit length of S_1 and S_2.

And I be the current through solenoid S_2

Magnetic field in $S_2 = B_2 = \mu_0 n_2 I$

Magnetic flux linked with each turn of $S_1 = B_2 \times$ area of each turn $= B_1 \pi a^2$

Total magnetic flux linked with $S_1 = B_2 \pi a^2 n_1 L$

$$\therefore \phi_1 = (\mu_0 n_2 I)\pi a^2 n_2 L = \mu_0 n_1 n_2 \pi a^2 IL$$

But magnetic flux linked with S_1 is due to I

$$\therefore \phi_1 \propto I \text{ or } \phi_1 = MI$$

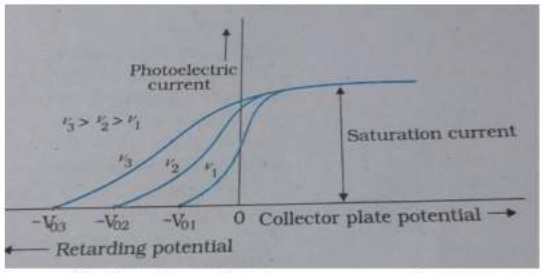
Where M is the mutual inductance of S_2 and S_1

$$\therefore MI = \mu_0 n_1 n_2 \pi a^2 IL$$

$$\therefore M = \mu_0 n_1 n_2 \pi a^2 L$$

S27. Ans. (c)

Sol.



Since all the three-frequency curve have same saturation current, this must imply same intensity for all three as photoelectric current depends on intensity of radiation. Intensity equals I=nhv/AT (where A and T is constant), thus intensity depends on both number of photons(n) and frequency of radiation(v). Since intensity is constant, this should mean a inverse proportionality relation between number of photon and frequency, As frequency increases number of photon decreases to maintain same intensity. But as the number of photons decreases, number of photoelectrons decreases resulting in a decreases in photoelectric current Thus concluding that different frequencies should not have same saturation current

A metal exhibits photoelectric effect that when a light of certain frequency, greater than the threshold frequency of metal surface, falls on the metal then the surface starts to emit electrons from its surface known as photo-electrons. If frequency of light is less than the threshold frequency, no emission of photo electrons takes place.

S28. Ans. (b)

Sol. In semiconductor, the density of charge carriers (electron holes) is very small, so its resistance is high. When temperature increases the charge carriers (density) increases which increases the conductivity. As temperature of semiconductor

increases, the speed of free electrons increases which decreases the relaxation time. As the density of charge carrier is small so there is small effect on decrease of relaxation time.

S29. Ans. (d)

Sol.

$$\frac{\mu_0 l}{2\pi}(\pi + 1)$$

Magnetic field at point O due to straight wire AB is

$$B_1 = \frac{\mu_0}{4\pi i}\frac{2\mathrm{I}}{r} = \frac{\mu_0 l}{2\pi r}$$

Both these fields are normal to the plane of the loop and directed into the page. Therefore, net field at point O is

$$B = B_1 + B_2 = \frac{\mu_0 l}{2\pi r} + \frac{\mu_0 l}{2r} = \frac{\mu_0 l}{2\pi r}(1 + \pi)$$

S30. Ans. (c)

Sol. Total apparent depth,

$$y = y_1 + y_2 = 5 + 2 = 7 \text{ cm.}$$

If x is real depth

= thickness of slab, then as

$$\mu = \frac{\text{real depth}}{\text{apparent depth}} = \frac{x}{y}$$

or, $x = \mu y = 1.5 \times 7 = 10.5$ cm.

S31. Ans. (c)

Sol.

List-I		List-II	
(A)	Rod rotated with angular velocity ω in a uniform magnetic field	(IV)	$e = \frac{B\omega l^2}{2}$
(B)	Coil is rotated with angular velocity in a uniform magnetic field.	(I)	$e = e_0 \sin \omega t$
(C)	Rod is moved with linear velocity v in uniform magnetic field	(II)	$\mathrm{E} = \mathrm{B}/v$
(D)	When a rectangular coil is moved in a magnetic field induced emf is	(III)	Constant

S32. Ans. (a)

Sol. The solar cell does not need current for its operation; it gives current to the load. Also the EMF generated by the cells is positive As, the current is negative and the EMF generated is positive, that is why we have a graph in the fourth quadrant and the graph appears in the fourth quadrant. Without illumination, a solar cell has similar I-V characteristics like a large diode. When the light is incident on the cell, the I-V curve goes in the fourth quadrant since the cell begins to produce power. The P part of the P-N junction behaves as a positive electrode and the N side of the PN junction acts as a negative terminal of the electrode. Therefore, it can be said that the flow of current from the positive side when external source resistance is connected. Therefore, a solar cell does not withdraw current but it supplies to the load

S33. Ans. (a)

Sol. Capacitance, $C = 13pF$

Potential difference, $V = 13$ V

the initial energy stored in the capacitor Initial energy stored in the capacitor,

$$U_i = (1/2)cv^2$$
$$U_i = (1/2) \times 13 \times (13)^2 pJ$$
$$U_i = 1098pJ = 1.098 \text{ nJ}$$

S34. Ans. (b)

Sol.

$$\frac{1}{d} = R^2\left(\frac{1}{n^2} - \frac{1}{m^2}\right)$$
$$= 1.09 \times 10^7 \times 2^2\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$
$$= 1.09 \times 10^7 \times 4\left(\frac{1}{4} - \frac{1}{9}\right)$$
$$d = 0.605 \times 10^7$$
$$d = 1.65 \times 10^7 \text{ m}$$
$$= 165 \text{ nm}$$

S35. Ans. (c)

Sol.

Here, $p = 5 \times 10^{-6}$ C.m,

$E = 10^{-2} N/C, \theta = 30°$

$\tau = pE\sin\theta$

$= (5 \times 10^{-6})10^{-2}\sin 30°$

$= 2.5 \times 10^{-8}$ N.m

S36. Ans. (b)

Sol. In the presence of electrolyte, internal resistance, R_i is inversely proportional to temperature T. It is because, as we increase the temperature, more electrolyte dissociates and resistance decreases.

S37. Ans. (b)

Sol. Then dielectrics are placed in an electric field, practically no current flows in them because, unlike metals, they have no loosely bound, or free, electrons that may drift through the material. Instead, electric polarization occurs.

S38. Ans. (c)

Sol. Here, incident ray BC is parallel to emergent ray DE

$$\therefore \theta_2 = \theta_4$$

Since, incident ray BC is parallel to emergent ray DE, so we can use

$\mu\sin\theta$ = constant

So, for first and last media,

$\mu_2\sin\theta_2 = \mu_4\sin\theta_4$

$\Rightarrow \mu_2 = \mu_4 (\because \theta_2 = \theta_4)$

S39. Ans. (c)

Sol. Materials that can be magnetized, which are also the ones that are strongly attracted to a magnet, are called ferromagnetic (or ferrimagnetic) substances. Magnetic susceptibility is very high and positive and depends on the applied field.

S40. Ans. (c)

Sol. Linearly polarized light can be obtained by scattering. This is possible because when the light is scattered by the air molecules, the incident light and the scattered light are perpendicular to each other

S41. Ans. (c)

Sol. Light of uniform intensity shines perpendicularly on a totally absorbing surface, fully illuminating the surface. If the area of the surface is decreased, the radiation pressure stays.

S42. Ans. (c)

Sol.

$$\text{Intensity of wave } = \frac{1}{2}\epsilon_0 E_0^2 C$$

$$\epsilon_0 = 8.85 \times 10^{-12}; E_0 = ?; C = 3 \times 10^8, I = 1380 \text{ W/m}^2$$

$$1380 = 1/2 \times 8.85 \times 10^{-12} \times E_0^2 \times 3 \times 10^8$$

$$\Rightarrow E_0^2 = \frac{2 \times 1380}{8.85 \times 3 \times 10^{-4}} = 103.95 \times 10^4$$

$$\Rightarrow E_0 = 10.195 \times 10^2 = 1020\text{N C}^{-1}$$

S43. Ans. (b)

Sol. All components of the electromagnetic spectrum in vacuum have the same velocity

S44. Ans. (d)

Sol. we know that,

$$I = I_0 \cos^2 \frac{\phi}{2}$$

If path difference $= \lambda$

$$\Rightarrow \Delta\phi = \frac{2\pi}{\lambda} \times \Delta x$$

$$\Rightarrow \Delta\phi = \frac{2\pi}{\lambda} \times \lambda = 2\pi$$

Also, $I = 4I_0 \cos^2 \frac{\Delta\phi}{2} = 4I_0 \cos^2 2\pi = 4I_0$

S45. Ans. (b)

Sol. The magnitude of induced emf increases with the increase in the number of turns in closed coil. The induced emf in a coil change when the speed (acceleration) of the coil in a magnetic field is increased. This is because the induced emf is directly proportional to the rate of change of flux linkage.

S46. Ans. (d)

Sol.

$$E = \frac{hc}{\lambda}$$

$$\Rightarrow \lambda = \frac{hc}{E}$$

$$\Rightarrow \lambda \propto \frac{1}{E}$$

Energy of photon of wavelength λ_2 $\triangle E_2 = -E - (-5E)$

$= 4\text{E}$

Energy of photon of wavelength $\lambda_1 \Delta E_1 = -E - (-\frac{5}{3}E)$

$$= \frac{2}{3}E$$

$$\therefore \frac{\lambda_1}{\lambda_2} = \frac{\Delta E_2}{\Delta E_1} = \frac{(4\text{E})}{\frac{2}{3}E} = \frac{4 \times 3E}{2E}$$

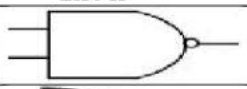
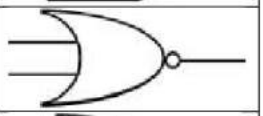
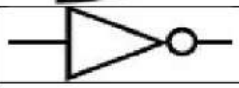
$$r = \frac{\lambda_1}{\lambda_2} = \frac{6}{1}$$

S47. Ans. (b)

Sol. As the dielectric slab is introduced between the plates of the capacitor, its capacitance will increase. Hence, the potential drop across the capacitor will decrease (V = Q/C). As a result, the potential drop across the bulb will increase (since both are connected in series). So, it brightness will increase.

S48. Ans. (d)

Sol.

List-I		List-II	
(A)	NAND Gat4e	(III)	
(B)	NOR Gate	(I)	
(C)	NOT Gate	(II)	
(D)	OR Gate	(IV)	

S49. Ans. (d)

Sol. Charge on electron, $q_1 = 1.6 \times 10^{-19}\text{C}$

Charge on proton, $q_2 = 1.6 \times 10^{-19}\text{C}$

Distance between charges, $r = 1\text{Å} = 1 \times 10^{-10}$ m

The electrostatic force between charges is $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$

$$= \frac{9 \times 10^9 \times (1.6 \times 10^{-19})^2}{(1 \times 10^{-10})^2}$$

$$= \frac{9 \times 10^9 \times 2.56 \times 10^{-38}}{1 \times 10^{-21}}$$

$$= 2.304 \times 10^{-7} \text{ N}$$

S50. Ans. (b)

Sol. Displacement current $(i_d) = \frac{\omega_0 d\phi_E}{dt}$

Where symbols have their usual meanings

$$i_d = A\omega_0 \frac{dE}{dt}$$