Previous Years Paper

9th June 2023 (Shift 3)

Q1. In an LCR circuit, which of the following expression has the dimension of frequency:
(a) $\sqrt{\frac{L}{C}}$
(b) $\frac{C}{R}$
(c) $\frac{1}{\sqrt{RC}}$
(d) $\frac{1}{\sqrt{LC}}$

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

	LIST – I		LIST – II
(A)	$[M^0\ L^{-2}\ T^0\ A^1]$	(I)	Conductance
(B)	$[M^{-1}\ L^{-2}\ T^3\ A^2]$	(II)	Electrical conductivity
(C)	$[M\ L^3\ T^{-3}\ A^{-2}]$	(III)	Current density
(D)	$[M^{-1}\ L^{-3}\ T^{+3}\ A^{+2}]$	(IV)	Specific resistance

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

Q3. What is the force between two small charged spheres having charges of 4×10^{-7}C and 6×10^{-7}C placed 60 cm apart in air?
(a) $3 \times 10^{-3} N$
(b) $4 \times 10^{-3} N$
(c) $6 \times 10^{-3} N$
(d) $9 \times 10^{-3} N$

Q4. Which of the following scientists has not contributed significantly to photoelectric effect?
(a) Wilhelm Hallwacks
(b) Philipp Lenard
(c) Albert Einstein
(d) C.J. Davission

Q5. Two spheres of silver of same radii, one solid and the other hollow are charged to the same potential, then:
(a) solid sphere will have more charge
(b) hollow sphere will have more charge
(c) both spheres will have same charge
(d) solid sphere will have charge inside as well as on the surface

Q6. The resistivity of a potentiometer wire is $10^{-7}\ \Omega\, m$ and its cross-section area is $10^{-6}\ m^2$. When a current of 0.1 A follows through the wire, its potential gradient is:
(a) 10^{-1} V/m
(b) 10^{-2} V/m
(c) 10^{-4} V/m
(d) 10 V/m

Q7. The two coherent monochromatic light beams of intensities I and 4I are superposed. The maximum and minimum possible intensities in the resulting beams are:
(a) 5 I and I
(b) 9 I and I
(c) 5 I and 3 I
(d) 9 I and 3 I

Q8. The shortest wavelength present in the Lyman series of spectral lines is:
(Given Rydberg constant $R = 1.097 \times 10^7\ m^{-1}$)
(a) 9.1×10^{-8} m
(b) 1.2×10^{-7} m
(c) 8.2×10^{7} m
(d) 9.1×10^{8} m

Q9. Sodium has a work function of 2 eV. Calculate the maximum energy and speed of the emitted electrons, when sodium is illuminated by radiation of wavelength 150 nm:
(a) 7.5×10^{-19} J and 3.2×10^3 m/s
(b) 13.2×10^{-19} J and 1.5×10^6 m/s
(c) 7×10^{-15} J and 1.2×10^4 m/s
(d) 3.5×10^{-19} J and 2.4×10^6 m/s

Q10. The metre bridge wire is made of alloys such as nichrome because they have:
(a) high temperature coefficient of resistance and high resistivity
(b) low temperature coefficient of resistance and low resistivity
(c) low temperature coefficient of resistance and high resistivity
(d) high temperature coefficient of resistance and low resistivity

Q11. Match **List – I** with **List – II.**

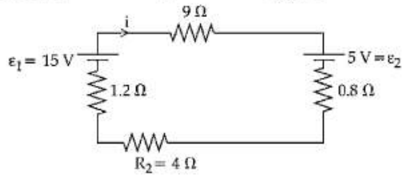
	LIST – I		LIST – II
(A)	Purely resistive AC circuit	(I)	No power dissipation
(B)	Purely inductive or capacitive AC circuit	(II)	Power is dissipated only in Resistor
(C)	LCR series AC circuit	(III)	Maximum power dissipation
(D)	Power dissipated at resonance in LCR series circuit	(IV)	Power is dissipated in L and C

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

Q12. What will be the minimum length of antenna required to transmit a radio signal of frequency 10 MHz?
(a) 30 m

(b) 15 m
(c) 7.5 m
(d) 60 m

Q13. The current flow in the circuit of two battery with internal resistance and two external resistance as shown in figure will be



(a) 1.5 A
(b) 0.67 A
(c) 0.9 A
(d) 1.0 A

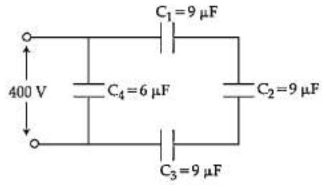
Q14. A very long solenoid has 800 turns per unit length. A current of 1.6 A flows through it. Then the magnetic induction in the middle of the solenoid on its axis is approximately:
(a) 16×10^{-4} T
(b) 8×10^{-4} T
(c) 32×10^{-4} T
(d) 4×10^{-4} T

Q15. The critical angle of a medium for a specific wavelength, if the medium has relative permittivity 3 and relative permeability $\frac{4}{3}$ for this wavelength, will be:
(a) 15°
(b) 30°
(c) 45°
(d) 60°

Q16. An insulating rod of length L carries charge q distributed uniformly on it. The rod is pivoted at one end and is rotated at a frequency f about a fixed perpendicular axis. Then the magnetic dipole moment of the system is:
(a) $\pi q f L^2$
(b) $\frac{1}{3}\pi q f L^2$
(c) qfL
(d) qfL^2

Q17. The wave length of Red light in the visible region is about 760 nm the energy of photon in that case will be:
(a) 2.43 eV
(b) 3.18 eV
(c) 1.64 eV
(d) 2.68 eV

Q18. A network of three capacitors each 9 μF connected in series and the fourth capacitor of 6 μF is supplied 400 V as shown in figure. The ratio of charge on the capacitor C_1 to the capacitor C_4 is:



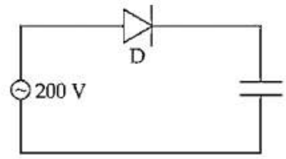
(a) 1 : 3
(b) 1 : 4
(c) 4 : 1
(d) 1 : 2

Q19. After how many half-lives a radioactive substance will decay to 6.25% of its original value:
(a) One half life
(b) Two half lives
(c) Three half lives
(d) Four half lives

Q20. A 20-watt, 50 V lamp is to be connected to AC mains of 250 V, 50 Hz. Calculate the value of series capacitor to run the lamp.
(a) 1.4 μF
(b) 2.1 μF
(c) 3.5 μF
(d) 4.9 μF

Q21. Charge on a conducting metal sphere is present:
(a) on the surface of the sphere
(b) inside the sphere
(c) outside the sphere
(d) both inside and outside the sphere

Q22. An a.c. source of 200 V is connected through a diode 'D' to a capacitor as shown in figure. Find the maximum potential difference across the capacitor:



(a) 100 V
(b) 200 V
(c) 283 V
(d) 310 V

Q23. The electrical conductivity of a semiconductor increases when electromagnetic radiation of wavelength shorter than 2480 nm is incident on it. The band gap for the semiconductor is:
(a) 0.5 eV
(b) 0.7 eV
(c) 0.9 eV
(d) 1.1 eV

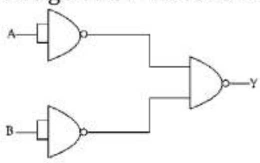
Q24. Energy gap between valence band and conduction band of a semiconductor is approximately:
(a) zero
(b) 4 eV
(c) 1 eV
(d) 10 eV

Q25. Match **List – I** with **List - II**

	LIST – I (Type of EM Wave)		LIST – II (Application)
(A)	Microwaves	(I)	Cellular phones
(B)	Radio waves	(II)	Greenhouse effect
(C)	Infrared waves	(III)	Eye surgery
(D)	Ultraviolet rays	(IV)	Ovens

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

Q26. The given combination represents the following gate:



(a) OR
(b) XOR
(c) NAND
(d) NOR

Q27. Heavy water and _______ is one of the substances used as moderator in reactors.
(a) Sea water
(b) Titanium
(c) Graphite
(d) Cobalt

Q28. Diameter of the objective lens of a telescope is 250 cm. For light of wavelength 600 nm, coming from a distant object, the limit of resolution of the telescope is close to:
(a) 1.5×10^{-7} rad
(b) 2×10^{-7} rad
(c) 3×10^{-7} rad
(d) 4.5×10^{-7} rad

Q29. A source emits sound of frequency 600 Hz inside water. The frequency heard in air (velocity of sound in water is 1500 m/s and velocity of sound in air is 300 m/s) will be:
(a) 300 Hz
(b) 600 Hz
(c) 900 Hz
(d) 1200 Hz

Q30. An electron enters a crossed electrical and magnetic field region with a speed of 100 m s^{-1} along + x-axis and passes undeviated. The strength of magnetic field is 5.0 T and it acts along + z-axis. Give the electrical field in vector notations indicating its magnitude as well as direction:
(a) $(500\text{ V m}^{-1})\hat{j}$
(b) $-(500\text{ V m}^{-1})\hat{k}$
(c) $(100\text{ V m}^{-1})\hat{j}$
(d) $-(100\text{ V m}^{-1})\hat{k}$

Q31. An AC current is given by $I = i_1\cos\omega t + i_2\sin\omega t$
The rms current is given by:
(a) $\frac{1}{\sqrt{2}}(i_1 + i_2)$
(b) $\frac{1}{\sqrt{2}}(i_1 + i_2)^2$
(c) $\frac{1}{\sqrt{2}}(i_1^2 + i_2^2)^{\frac{1}{2}}$
(d) $\frac{1}{2}(i_1^2 + i_2^2)^{\frac{1}{2}}$

Q32. Frequencies in the UHF range normally propagate by means of:
(a) Ground waves
(b) Sky waves
(c) Surface waves
(d) Space waves

Q33. Which of the following is **not** an EM wave?
(a) X-rays
(b) Gamma rays
(c) Microwaves
(d) Cathode rays

Q34. The least distance of distinct vision of a person is 50 cm. He wants to read a book placed at 25 cm.
The focal length of the spectacles would be:
(a) + 25 cm
(b) – 25 cm
(c) + 50 cm
(d) – 50 cm

Q35. The current flowing through a wire as a function fo time is given as: $I = 3t^2 + 2t + 5$The charge flowing through any cross-section of the wire in first 2 s is:
(a) 5 C
(b) 17 C
(c) 16 C
(d) 22 C

Q36. When a ray of light enters a glass slab from air:
(a) its wavelength decreases
(b) its wavelength increases
(c) its frequency increases
(d) neither its wavelength nor its frequency changes

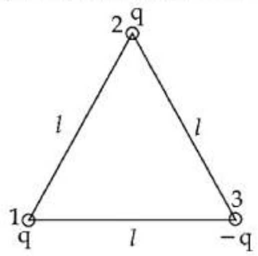
Q37. Light of two different frequencies whose photons have energies 1 eV and 2.5 eV respectively, illuminate a metal of work function 0.5 eV. The ratio of the maximum KE of the emitted electrons will be:
(a) 1 : 5
(b) 1 : 4
(c) 1 : 2
(d) 1 : 1

Q38. The capacities of two capacitors are C_1 and C_2 and their respective potentials are V_1 and V_2. If they are connected with a wire, then the loss of energy is given by:
(a) $\frac{C_1C_2(V_1+V_2)}{2(C_1+C_2)}$
(b) $\frac{C_1C_2(V_1-V_2)}{2(C_1+C_2)}$
(c) $\frac{C_1C_2(V_1-V_2)^2}{2(C_1+C_2)}$
(d) $\frac{(C_1+C_2)(V_1-V_2)}{C_1C_2}$

Q39. We can reduce eddy currents in the core of transformer by:
(a) increasing the number of turns in the secondary coil
(b) taking laminated core
(c) making step down transformer
(d) using a weak AC at high potential

Q40. A piece of copper and another of germanium are cooled from room temperature to 100 K. The resistance of:
(a) copper increases and germanium decreases
(b) copper decreases and germanium increases
(c) each of them increases
(d) each of them decreases

Q41. Three charges q, −q, q placed at the vertices of an equilateral triangle as shown in figure. What is the magnitude of force on charge placed at position 3 due to the presence of other two charges?



(a) $\frac{1}{2\pi\varepsilon_0}\frac{q^2}{l}$
(b) $\frac{\sqrt{3}}{4\pi\varepsilon_0}\frac{q^2}{l^2}$
(c) $\frac{\sqrt{5}}{8\pi\varepsilon_0}\frac{q}{\sqrt{l}}$
(d) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{\sqrt{l}}$

Q42. Which of the following radiations will have maximum penetration power?
(a) X-rays
(b) α-rays
(c) β-rays
(d) γ -rays

Q43. A hot wire voltmeter measures the voltage across the inductor, the capacitor and the resistor as 150 V, 100 V and 50 V across a series, LCR circuit. If resistance is 100 Ω, the current in the circuit is:
(a) 1.5 A
(b) 1 A
(c) 0.5 A
(d) 0.7 A

Q44. Speed of Electromagnetic wave is **Not** the same:
(a) in all media
(b) for all intensities in vacuum
(c) for all frequencies in vacuum
(d) for all wavelengths in vacuum

Q45. What uniform magnetic field applied perpendicular to a beam of electrons moving at 1.3×10^6 m/s, is required to make the electrons travels in a circular arc of radius 0.35 m?
(a) 2.1×10^{-5} G
(b) 6×10^{-5} T
(c) 2.1×10^{-5} T
(d) 6×10^{-5} G

Q46. In a double slit experiment, the distance between slits is increased 10 times whereas their distance from screen is halved, then what is the fringe width?
(a) it remains same
(b) become $\frac{1}{10}$
(c) become $\frac{1}{20}$
(d) become $\frac{1}{90}$

Q47. A tiny spherical oil drop of mass 8 mg is kept suspended by applying a potential difference of 100 V between two metallic plates kept separated by a distance 1 cm. The number of electrons on the oil drop are: (Take $g = 10\text{ms}^{-2}$)
(a) 5×10^{10}
(b) 5×10^{8}
(c) 5×10^{12}
(d) 5×10^{13}

Q48. A strong magnetic field is applied on a stationary electron:
(a) The electron moves in the direction of the field
(b) The electron moves in an opposite direction
(c) The electron remains stationary
(d) The electron starts spinning

Q49. The focal length of the objective of a microscope if f_o and that of the eye piece if f_e. The aperture of objective is d_o and that of eye piece is d_e. Which of the following relation is **correct?**
(a) $f_o > f_e, d_o > d_e$
(b) $f_o < f_e, d_o < d_e$
(c) $f_o > f_e, d_o < d_e$
(d) $f_o < f_e, d_o > d_e$

Q50. Time period of oscillation of a bar magnet in a uniform magnetic field is T_o. The magnet is cut into 3 equal parts transverse to its length. The new time period of oscillation of one part will be:
(a) T_o
(b) $\frac{T_o}{2}$
(c) $\frac{T_o}{3}$
(d) $\frac{T_o}{4}$

SOLUTIONS

S1. **Ans. (d)**

Sol. For RC circuits, time constant is, $\tau = \text{RC}$ has unit of time,

so, $\frac{1}{\text{RC}}$ has a unit of frequency,

similar for LC oscillations, $\tau = \sqrt{\text{LC}}$

for RL circuit, $\tau = \frac{L}{R}$

so,

$\frac{1}{\text{RC}}, \frac{\text{R}}{\text{L}}$ and $\frac{1}{\sqrt{\text{LC}}}$ has units of frequency.

S2. **Ans. (c)**

Sol.

	LIST – I		LIST – II
(A)	$[\text{M}^0\,\text{L}^{-2}\,\text{T}^0\,\text{A}^1]$	(III)	Current density
(B)	$[\text{M}^{-1}\,\text{L}^{-2}\,\text{T}^3\,\text{A}^2]$	(I)	Conductance
(C)	$[M\,\text{L}^3\,\text{T}^{-3}\,\text{A}^{-2}]$	(IV)	Specific resistance
(D)	$[\text{M}^{-1}\,\text{L}^{-3}\,\text{T}^{+3}\,\text{A}^{+2}]$	(II)	Electrical conductivity

S3. **Ans. (c)**

Sol. Charge on the first sphere, $q_1 = 4 \times 10^{-7}\text{C}$

Charge on the second sphere, $q_2 = 6 \times 10^{-7}\text{C}$

Distance between the spheres, $r = 60 \text{ cm} = 0.6 \text{ m}$

$$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$$

Were, ε_0 = Permittivity of free space

$$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{ N m}^2\text{C}^{-2}$$

$$F = \frac{9 \times 10^9 \times 4 \times 10^{-7} \times 6 \times 10^{-7}}{(0.6)^2} = 6 \times 10^{-3} \text{ N}$$

Hence, force between the two small charged spheres is 6×10^{-3} N. The charges are of same nature. Hence, force between them will be repulsive.

S4. **Ans. (d)**

Sol. C.J. Davission does not contributed significantly to photoelectric effect

S.5. **Ans. (c)**

Sol. Both the spheres will hold the same amount of charge. It is because, the two spheres pass equal capacitance. The capacitance of a sphere depends only on its radius. It does not matter whether the sphere is hollow or solid

S6. **Ans. (b)**

Sol. Potential gradient of a wire equal to potential fall per unit length. Potential gradient = Potential fall per unit length = Current × Resistance per unit length $= i = \frac{R}{l}$

But $R = \frac{\rho l}{A} \Rightarrow \frac{R}{l} = \frac{\rho}{A}$

$\therefore$ Potential gradient $= i \times \frac{\rho}{A}$

Here, $\rho = 10^{-7}\Omega - m, i = 0.1A \times A = 10^{-6}m^2$

Hence, potential gradient

$$= 0.1 \times \frac{10^{-7}}{10^{-6}} = \frac{0.1}{10} = 0.01 = 10^{-2}V/m$$

S7. **Ans. (b)**

Sol The intensity of light waves depends on the amplitude of the wave in this manner.

$$I \propto A^2$$

When two light waves converge, we cannot add the intensity of the light waves.

We need to find the amplitude of the waves and then calculate the resultant amplitude of the new superimposed wave.

Let's assume the amplitude of the wave that has intensity L, is A.

As intensity depends on the square of the amplitude, we can write

$$I = kA^2$$

Hence, for the other light wave amplitude can be given by.

$$4I = k(2A)^2$$

If the two light waves converge in-phase, the amplitudes can be added.

Hence, the resultant amplitude will be $= (A + 2A) = 3A$.

So, the intensity will be,

$$I' = k(3A)^2 = 9kA^2 = 9I$$

When the two light waves converge out-of-phase, the amplitude will be,

$$(2\,\text{A} - \text{A}) = \text{A}$$

Hence, the intensity of the resultant light will be,

$$I^n = k(A)^2 = kA^2 = I$$

So, the maximum intensity will be 9I and the minimum intensity will be I.

S8. **Ans. (a)**

Sol. Rydberg's formula is:

$$\frac{1}{\lambda} = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

For hydrogen, $Z = 1$ and for Lyman series, $n_1 = 1$ and $n_2 = \infty$ (for shortest wavelength)

On substituting values, we get-

$$\frac{1}{\lambda} = 109678 \times (1)^2 \times \left[\frac{1}{(1)^2} - \frac{1}{(\infty)^2}\right]$$

$$\frac{1}{\lambda} = 109678 \text{ cm}^{-1}$$

$$\text{or } \lambda = \frac{1}{109678} \text{ cm}^{-1}$$

$$= 9.117 \times 10^{-6} \text{ cm}$$

$$= 911.7 \times 10^{-8} \text{ cm} = 9.1 \times 10^{-8} \text{ m}$$

S9. Ans. (b)

Sol. Work Function $(\Phi) = 2.0\text{eV}$

Wavelength $(\lambda) = 150 \text{ nm} = 150 \times 10^{-19}\text{m}$

First, let's calculate the maximum energy of the emitted electrons:

Energy of incident photons = (Planck's Constant * Speed of Light)/ Wavelength

$= (6.62607015 \times 10^{-34} \times 2.998 \times 10^{8} \text{ m/s})/(150 \times 10^{-9})\text{m})$
$= 8.82 \times 10^{-19}\text{J}$

Maximum Energy = Energy of incident photons - Work Function

$= 8.82 \times 10^{-19}\text{J} - 2.0\text{eV}^{*}(1.6 \times 10^{-19}\text{J/eV})$
$= 8.82 \times 10^{-19}\text{ J} - 3.2 \times 10^{-19}\text{ J}$
$= 13.2 \times 10^{-19}\text{ J}$

Now, let's calculate the maximum speed of the emitted electrons. We can us the formula:

Maximum Speed = sqrt (2 * Maximum Energy / Electron Mass)

Electron Mass $= 9.10938356 \times 10^{-31}\text{kg}$

Maximum Speed $= \sqrt{(2 \times 5.62 \times 10^{-19}/9.10938356 \times 10^{-31})}$
$= 1.5 \times 10^{6} \text{ m/s}$

S10. Ans. (c)

Sol. Generally alloys magainin/ constantan/ nichrome/ eureka are used in Meter Bridge, because these materials have low temperature coefficient of resistivity.

S11. Ans. (d)

Sol.

	LIST – I		LIST – II
(A)	Purely resistive AC circuit	(III)	Maximum power dissipation
(B)	Purely inductive or capacitive AC circuit	(I)	No power dissipation
(C)	LCR series AC circuit	(II)	Power is dissipated only in Resistor
(D)	Power dissipated at resonance in LCR series circuit	(III)	Maximum power dissipation

S12. Ans. (c)

Sol. Here, $v = 10\text{MHz} = 10^{7}\text{ Hz}$

$$\lambda = \frac{c}{v} = \frac{3 \times 10^{8}}{10^{7}} = 30 \text{ m}$$

Minimum length of antenna $= \frac{\lambda}{4} = \frac{30}{3} = 7.5 \text{ m}.$

S13. Ans. (b)

Sol. Since the batteries are connected in reverse polarities, the net potential applied to the circuit = $15 \text{ V} - 5 \text{ V} = 10 \text{ V}$

The net resistance in the circuit $= r_1 + r_2 + r_3 + r_4 = 9\Omega + 0.8\Omega + 4\Omega + 1.2\Omega = 15\Omega$

Hence, the current in the circuit $= \frac{10 \text{ V}}{15\Omega} = 0.66 \text{ A}$

S14. Ans. (a)

Sol. The magnetic induction at the middle point of the solenoid on its axis is given as,

$$B = \mu_0 nI$$
$$= 4\pi \times 10^{-7} \times 800 \times 1.6$$
$$= 16.084 \times 10^{-4} \text{ T}$$

Thus, the magnetic induction is 16.084×10^{-4} T.

S15. Ans. (b)

Sol. It is given that the

Relative permittivity of the medium, $\epsilon_r = 3$

The relative permeability of the medium, $\mu = \frac{4}{3}$

The refractive index of the medium

$$\mu_2 = \frac{c}{v}$$

Substituting the values of $c = \frac{1}{\sqrt{v_0 \epsilon 0}}$ and the $v = \frac{1}{\sqrt{\mu \epsilon r}}$ in the above formula,

critical angle of free space

$$\mu_2 = \frac{\frac{1}{\sqrt{v_b \in_0}}}{\frac{1}{\sqrt{\mu \in_r}}}$$

By simplifying the above equation, and also using the formula of The relative permittivity and The relative permeability of the medium in it, we get

$$\mu_2 = \sqrt{\mu_r \epsilon_r}$$
$$\mu_2 = \sqrt{3 \times \frac{4}{3}}$$
$$\mu_2 = 2$$

Using the formula (4).

$$\mu_2 \sin\ \theta_i = \mu_1 \sin\ \theta_r$$

The critical angle $\theta_r = 90°$, so

$$\mu_2 \sin\ \theta_i = \mu_1 \sin\ 90°$$
$$\mu_2 \sin\ \theta_i = 2 \times \frac{1}{2}$$

Substituting the value of the angles and the refractive index of the medium

$$2\sin\ \theta_i = 1$$
$$\sin\ \theta_i = \frac{1}{2}$$

Hence the value of the critical angle of the medium is 30°.

S16. **Ans. (b)**

Sol. Consider a small element dl at a distance I from the pivot.

Charge on element = $dq = \frac{q}{l} dl$

The rod sweeps a circle of radius I

Charge dq rotating at frequency f will give rise to current $= di = dq \times f = \frac{df}{l} dl$

Magnetic moment of this element dl is

$$dM = diA = \frac{a_f}{l} dl(\pi l^2)$$

$$M = \int dM = f\frac{q}{1}\pi \int_0^1 \Big|^2 dl = f\frac{a}{1}\pi\frac{l^3}{3} = f\left(\frac{q}{1}\right)\pi\frac{13}{3}$$

$$M = \frac{fql^2\pi}{3}$$

S17. **Ans. (c)**

Sol.

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

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{760 \times 10^{-9}}$$

$$= 2.61 \times 10^{-19}\,\text{J}$$

in ev $\frac{2.61 \times 10^{-19}}{1.6 \times 10^{-19}}$

$= 1.64\text{eV}$

S18. **Ans. (d)**

Sol.

S19. **Ans. (d)**

Sol.

$$A_{(g)} \rightarrow B_{(g)}\ k = 2.3 \times 10^{-3}\ s^{-1}$$

Here, unit of Rate constant (k) is $\mathbf{s^{-1}}$. Therefore, it's a first order reaction

Units of Rate constant in zero, first and second order reactions.

Reaction	Unit of Rate constant (k)
Zero order reaction	$molL^{-1}\ s^{-1}$
First order reaction	s^{-1}
Second order reaction	$mol^{-1}\ L\ s^{-1}$

For a first order reaction, we can write

$$N = \frac{N_0}{2^n}$$

Were

- N_0 = Initial amount of substance
- **N** = Amount of substance after **n** half lives
- **n** = Number of half lives

$$6.25\% = \frac{100\%}{2^n}$$

$$2^n = \frac{100\%}{6.25\%}$$

$$2^n = 16$$

$$2^n = 2^4 = 4$$

S20. **Ans. (d)**

Sol. Here, $p = 20$ watt, $V = 50$ volt

$E_v = 260\ \text{V}, C = ?, v = 50\ \text{Hz}$

$$I = \frac{P}{V} = \frac{20}{50} = 0.4\ \text{A}$$

$$R = \frac{V}{I} = \frac{50}{0.4} = 125\text{ohm}$$

$$Z = \frac{E_v}{I_v} = \frac{E_v}{I} = \frac{250}{0.4} = 625\text{ohm}$$

$$X_C = \sqrt{Z^2 - R^2} = \sqrt{625^2 - 125^2} = 250\sqrt{6}$$

$$\text{As } X_C = \frac{1}{\omega C} = \frac{1}{2\pi v C} = 250\sqrt{6}$$

$$\therefore C = \frac{1}{2\pi v \times 250\sqrt{6}}$$

$$= \frac{1}{2 \times 3.14 \times 50 \times 250\sqrt{6}}\ \text{farad}$$

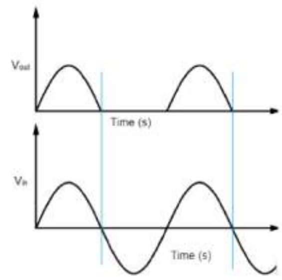
$$C = 0.052 \times 10^{-4}\text{F} = 5.2\mu\text{F}$$

S21. **Ans. (a)**

Sol. The charge on a conducting metal sphere is present on the surface of the sphere

S22. **Ans. (c)**

Sol. In half wave rectification, the diode will work as an open circuit for the negative half cycle. The positive half cycle will get reproduced as it is past the diode as it will work just as a closed circuit in case of a positive half cycle. Therefore, the output waveform is in the form of fluctuating dc and just consists of positive half cycles.



Now, as the current enters the capacitor with this waveform, it begins to charge till waveform reaches it's peak. As the current starts to go down, the capacitor begins discharging and maintains the same peak potential difference until the next peak. Therefore, the potential difference that the capacitor has across it is simply the peak value of the input waveform i.e.,

$$V_m = V_{rms}\sqrt{2}$$

$$\Rightarrow V_m = 200\sqrt{2} = 282.84\ \text{V}.$$

S23. Ans. (a)

Sol. Band gap, $E_g = \frac{hc}{\lambda} = \frac{(6.63\times10^{-34})(3\times10^{8})}{2480\times10^{-9}\times1.6\times10^{-19}} eV = 0.5 eV$

S24. Ans. (c)

Sol. In the semiconductor, as the temperature increases the valence electron gain enough energy to jump from valence band to the conduction band. Thus , the band gap in semiconductor is approximately 1eV.

S25. Ans. (b)

Sol.

	LIST – I (Type of EM Wave)	LIST – II (Application)	
(A)	Microwaves	(IV)	Ovens
(B)	Radio waves	(I)	Cellular phones
(C)	Infrared waves	(II)	Greenhouse effect
(D)	Ultraviolet rays	(III)	Eye surgery

S26. Ans. (a)

Sol. The given combination performs the function of an OR gate.

As per the combination,

$$Y = \overline{\overline{(A \cdot A)} \cdot \overline{(B \cdot B)}}$$
$$Y = \overline{\bar{A} \cdot \bar{B}}$$

By de-morgan's law,

$Y = A + B$, which is the representation of OR gate.

S27. Ans. (c)

Sol. The substance used as moderator and coolant, in nuclear reactors is Heavy water. Heavy water: It is also known as deuterium oxide

S28. Ans. (c)

Sol.

$$\text{Limit of resolution } = \frac{1.22\lambda}{d}$$
$$= \frac{1.22 \times 600 \times 10^{-9}}{250 \times 10^{-2}}$$
$$= 2.9 \times 10^{-7} \text{rad}$$

S29. Ans. (b)

Sol. Frequency of the a particular wave remains constant in all medium, but its velocity as well as wavelength vary with medium. Thus the source emits sound of frequency of 600 H z inside water and in air also.

S30. Ans. (a)

Sol. The fact that the fields are uniform, with the feature that the charge moves in a straight line, implies the speed is constant (if it were not, then the magnetic force would vary while the electric force could not - causing it to deviate from straight-line motion). This is then the situation leading to $v = \frac{E}{B}$, and we find

$$|\vec{E}| = v|\vec{B}| = 500 \text{ V/m}$$

Its direction (so that $\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$ vanishes) is downward, or $-\hat{j}$, in the "page" coordinates.

In unit-vector notation, $\vec{E} = -(500 \text{ V/m})\hat{j}$.

S31. Ans. (c)

Sol.

$$I = I_1 \cos \omega t + I_2 \sin \omega t$$
$$I = \sqrt{I_1^2 + I_2^2 + I_1 I_2 \cos 90\circ}$$
$$I = \sqrt{I_1^2 + I_2^2}$$
$$I_{rms} = \frac{I}{\sqrt{2}}$$
$$I_{rms} = \frac{\sqrt{I_1^2 + I_2^2}}{\sqrt{2}}$$
$$= \sqrt{\frac{I_1^2 + I_2^2}{2}}$$

S32. Ans. (d)

Sol. Ultra-High Frequency (UHF) range normally propagate by means of Space waves

S33. Ans. (d)

Sol. Cathode rays are not electromagnetic wave because they do not have electric and magnetic components perpendicular to each other

S34. Ans. (c)

Sol. For a normal person, the least distance of distinct vision is 25 cm. But in this problem, the least distance of distinct vision is 50 cm.

We have $1/f = 1/v - 1/u$

Here v $= -50$ cm

$$u = -25 \text{ cm}$$
$$1/f = -1/50 - (-1/25)$$
$$1/f = 1/50$$

Focal length = **50 cm**

Hence focal length should be +50 cm i.e. convex lens should be used.

S35. Ans. (d)

Sol. Current through the wire

We know that,

$$I = \frac{dq}{dt}$$
$$\Rightarrow dq = Idt \ldots\ldots 1 \ (1)$$

Integrating the equation (1) with proper limits

Time interval: t = os to t = 2 s

$$\int dq = \int_0^2 I dt$$
$$I = 3t^2 + 2t + 5$$
$$\Rightarrow q = \int_0^2 (3t^2 + 2t + 5)dt = [t^3 + t^2 + 5t]_0^2$$

$$= (8 + 4 + 10) = 22C$$

S36. Ans. (a)

Sol. On entering a glass slab the velocity decreases. $v = v\lambda$

Frequency is inherent property of a wave and does not change. So the wavelength decreses which results in reduction in velocity on entering a glass slab from air.

S37. Ans. (b)

Sol. For maximum speed of the photo electrons

$\frac{1}{2}\text{mv}^2 = \text{E}_{\text{photon}} - \phi$ where $\phi = 0.5\text{eV}$ is the work function of the metal.

Energy of photon $\text{E}_1 = 1\text{eV}$

$$\therefore \frac{1}{2}\text{mv}_1^2 = 1 - 0.5$$

We get $\frac{1}{2}\text{mv}_1^2 = 0.5\text{eV}$

Energy of photon $\text{E}_2 = 2.5\text{eV}$

$$\therefore \frac{1}{2}\text{mv}_2^2 = 2.5 - 0.5$$

We get $\frac{1}{2}\text{mv}_2^2 = 2\text{eV}$

Ratio of maximum speeds $\frac{\text{v}_1^2}{\text{v}_2^2} = \frac{0.5}{2} = \frac{1}{4}$

S38. Ans. (c)

Sol. Initial energy $(E_i) = \frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2$

Let V be the common potential after connection

By law of conservation of charge total initial charge = total final charge

$$q_1 + q_2 = q_1' + q_2'$$

$$C_1V_1 + C_2V_2 = C_1V + C_2V$$

$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

Final energy $(E_f) = \frac{1}{2}(C_1 + C_2)V^2$

$$= \frac{1}{2}(C_1 + C_2)\left[\frac{C_1V_1 + C_2V_3^2}{C_1 + C_2}\right.\ 2$$

$\Rightarrow$ Energy loss $= E_i - E_f$

$$= \frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2 - \frac{1}{2}(C_1 + C_2)\left[\frac{C_1V_1 + C_2V_2^2}{C_1 + C_2}\right]^2$$
$$= \frac{C_1C_2(V_1 - V_2)^2}{2(C_1 + C_2)}$$

Thus, energy loss of capacitors is $\frac{C_1C_2(V_1-V_2)^2}{2(C_1+C_2)}$

S39. Ans. (b)

Sol. Eddy currents can be reduced by channelizing the current paths in a conductor. To do that, the core is formed by combining several insulated or laminated metal plates.

S40. Ans. (b)

Sol. the resistance of a conductor increases with increase in temperature whereas that of semiconductor decreases with increase in temperature. Copper is a very good conductor and germanium is a semiconductor. Thus, resistance of copper decreases but that of germanium increases when they are cooled from room temperature to 100 K

S41. Ans. (c)

Sol.

S42. Ans. (d)

Sol. Gamma rays have the shortest wavelengths of all electromagnetic radiation, has the greatest penetrating power.

S43. Ans. (c)

Sol.

S44. Ans. (a)

Sol. The speed of electromagnetic wave in a region is same for all intensities but different for different frequencies.

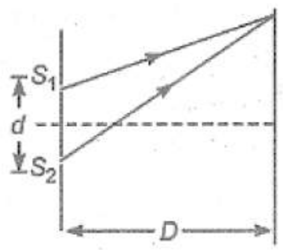
S45. Ans. (c)

Sol. From $r = \frac{mv}{qB}$ we find

$$B = \frac{m_e v}{er}$$
$$= \frac{(9.11 \times 10^{-31}\ \text{kg})(1.30 \times 10^6\ \text{m/s})}{(1.60 \times 10^{-19}\text{C})(0.350\ \text{m})}$$
$$= 2.11 \times 10^{-5}\ \text{T}$$

S46. Ans. (c)

Sol.



Let λ be wavelength of monochromatic light, d the distance between coherent sources, and D the distance between screen and source, then fringe width is

$$\beta = \frac{\text{D}\lambda}{\text{d}}$$

Given, $\text{d}_1 = \text{d}, \text{D}_1 = \text{D}, \text{d}_2 = 1\text{od}, \text{D}_2 = \frac{\text{D}}{2}$

$$\therefore \beta_2 = \frac{\frac{\text{D}_2}{2}\lambda}{1\text{od}} = \frac{\text{D}\lambda}{2\text{Od}}$$
$$\Rightarrow \beta_2 = \frac{\text{W}}{2\text{O}}$$

S47. Ans. (a)

Sol. $V = 100\ V$

$$E = \frac{V}{d} = \frac{100}{1 \times 10^{-2}} = 10000$$

$$mg = qE$$

$$q = \frac{mg}{E}$$

$$ne = q = \frac{mg}{E}$$

$$n = \frac{mg}{eE}$$

$$n = 5 \times 10^{12}$$

S48. Ans. (c)

Sol. A strong magnetic field is applied on a stationary electron. Then the electron remains stationary because magnetic force act on moving charge.

S49. Ans. (b)

Sol . The focal length of the objective of a microscope if f_o and that of the eye piece if f_e. The aperture of objective is d_o and that of eye piece is d_e. s the magnifying power of compound microscope is inversely proportional to the focal length of the objective lens. Hence, smaller is the focal length, higher is the magnifying power. Therefore, focal length of objective lens is less than the focal length of eyepiece lens.

$$f_o < f_e, d_o < d_e$$

S50. Ans. (c)

Sol. Initially the time period of magnet $= T_0 = 2\pi\sqrt{\frac{1}{MB}}$

where I is the moment of inertia of the bar magnet M is the magnetic moment of the bar magnet When the magnet is cut in three equal parts, the magnetic moment of each bar becomes $\frac{M}{3} = M'$.

Also the new moment of inertia becomes $I' = \frac{I}{3^3} = \frac{I}{27}$

Hence, the new time period becomes $T' = 2\pi\sqrt{\frac{I'}{M'B}} = \frac{T_0}{3}$