The West Bengal Central School Service Commission

2nd SLST 2025

PHYSICS

[CLASSES : XI - XII]

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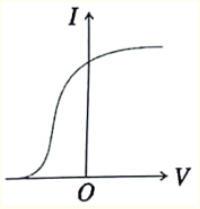
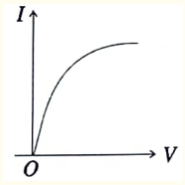
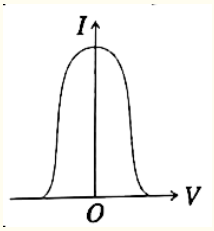
1. Which one of the following graphs in the figure shows the variation of incident photoelectric current (I) with the voltage (V) for a constant intensity between the electrodes in a photoelectric cell?



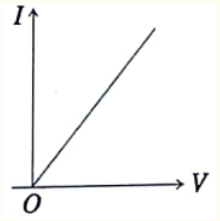
(a)



(b)



(c)



(d)

(A) (a)

(B) (b)

(C) (c)

(D) (d)

2. The fundamental frequency of an organ pipe of length 15 cm, closed at one end is equal to the second overtone of an organ pipe open at both ends. The length of the organ pipe with both ends open is

(A) 105 cm

(B) 90 cm

(C) 60 cm

(D) 75 cm

3. Three mass points m_1, m_2, m_3 are located at the vertices of an equilateral triangle of length a. What is the moment of inertia of the system about an axis passing through m_1 and centroid of the triangle?

(A) $I = \frac{a^2}{2}(m_2 + m_3)$

(B) $I = \frac{a^2}{4}(m_2 + m_3)$

(C) $I = (m_2 + m_3)$

(D) None of the above

4. The period of oscillation of a simple pendulum of length ℓ suspended from roof of a car running down a frictionless inclined plane of inclination θ is given by

(A) $2\pi\sqrt{\frac{\ell}{g}}$

(B) $2\pi\sqrt{\frac{\ell}{g\sin\theta}}$

(C) $2\pi\sqrt{\frac{\ell}{g\cos\theta}}$

(D) $2\pi\sqrt{\frac{\ell}{g\tan\theta}}$

5. If three simple harmonic travelling waves of same amplitude A and differing consecutively by $\frac{2\pi}{3}$ phase difference are superposed, then the resultant amplitude of the superposed wave is

(A) A

(B) 0

(C) $3A$

(D) $2A$

6. The electric field associated with a plane electromagnetic wave is given by $\vec{E} = E_0 \sin(kz - \omega t)\hat{j}$. The magnetic field corresponding to the $\vec{E}$ field is given by

*[where c is the velocity of light in vacuum]

(A) $\vec{B} = \frac{E_0}{c}\sin(kz - \omega t)\hat{i}$

(B) $\vec{B} = \frac{E_0}{c}\cos(kz - \omega t)\hat{i}$

(C) $\vec{B} = -\frac{E_0}{c}\sin(kz - \omega t)\hat{i}$

(D) $\vec{B} = \frac{E_0}{c}\sin(kz - \omega t)\hat{k}$

7. $\hat{\alpha}$ and $\hat{\beta}$ are two non-orthogonal unit vectors in a two dimensional vector space. A vector orthogonal to $\hat{\alpha}$ is

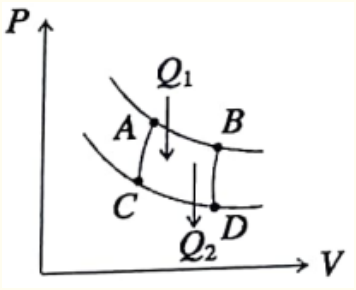
(A) $\hat{\beta} + (\hat{\alpha}\cdot\hat{\beta})\hat{\alpha}$

(B) $-\hat{\alpha} + (\hat{\alpha}\cdot\hat{\beta})\hat{\alpha}$

(C) $\hat{\beta}$

(D) $\hat{\beta} - (\hat{\alpha}\cdot\hat{\beta})\hat{\alpha}$

8. In *P–V* diagram, AB and CD are two isothermals at temperature T_1 and T_2 respectively ($T_1 > T_2$). AC and BD are two reversible adiabatics. In this Carnot cycle, which of the following statements is incorrect?



(A) $\frac{Q_1}{T_1} = \frac{Q_2}{T_2}$

(B) The entropy of the source decreases.

(C) The entropy of the system increases.

(D) Work done by the system, $W = Q_1 - Q_2$.

9. In a conservative force field $\vec{F}(r)$, the total work done on a particle to complete a circle of radius R is

(A) $2\pi R\left|\vec{F}(R)\right|$

(B) $\pi R^2 \left|\vec{F}(R)\right| / 2R$

(C) zero

(D) $2R\left|\vec{F}(R)\right|$

10. Which of the following distribution applies to indistinguishable particles with integer spin?

(A) Maxwell-Boltzmann Distribution

(B) Fermi-Dirac Distribution

(C) Bose-Einstein Distribution

(D) Gaussian Distribution

11. Which of the following commutation relations is non-zero?

(A) $[\hat{x}, \hat{p}_x]$

(B) $[\hat{y}, \hat{p}_x]$

(C) $[\hat{z}, \hat{p}_y]$

(D) $[\hat{x}, \hat{p}_z]$

12. A muon is moving with a velocity of 0·98 c where c is the velocity of light in vacuum. Its measured life-time in laboratory is 7·8 μs. The muon's life-time in its own rest frame is

(A) 7·8 μs

(B) 3·9 μs

(C) 1·195 μs

(D) 1.55 μs

13. A wave disturbance in a medium is described by

$y(x, t) = 2\cos\left(40\pi t + \frac{\pi}{2}\right)\cos(5\pi x)$

where x and y are in meter and t is in second. The distance between the node and nearest antinode is

(A) 1

(B) 0·1

(C) 0·2

(D) 0·25

14. Ratio of terminal velocities of two balls of same material with radii in 1 : 2 ratio falling under gravity through same liquid is

(A) 1 : 1

(B) 1 : 4

(C) 1 : 8

(D) 1 : 16

15. A zone plate with circular aperture of diameter 2 mm is illuminated by a plane light wave. The most intense spot on the axis is at a distance of 200 cm from the centre of the aperture. The wavelength of light is

(A) 5×10^{-5} cm

(B) 6×10^{-5} cm

(C) 4×10^{-5} cm

(D) 2×10^{-5} cm

16. What is the dimension of constant $\frac{a}{b}$ in van der Waal gas equation $\left(P + \frac{a}{V^2}\right)(V - b) = RT$?

(A) ML^2T^{-2}

(B) ML^5T^{-2}

(C) L^3

(D) MLT^{-1}

17. Consider a Ramsden eye-piece of two convex lenses each of focal length f and separated by a distance $\frac{3}{2}f$. In this case

(A) only chromatic aberration is minimized.

(B) only spherical aberration is minimized.

(C) both chromatic and spherical aberrations are minimized.

(D) None of chromatic and spherical aberrations is minimized.

18. The root mean square velocities of ^{4}He and ^{16}O at same temperature are respectively in the ratio of approximately

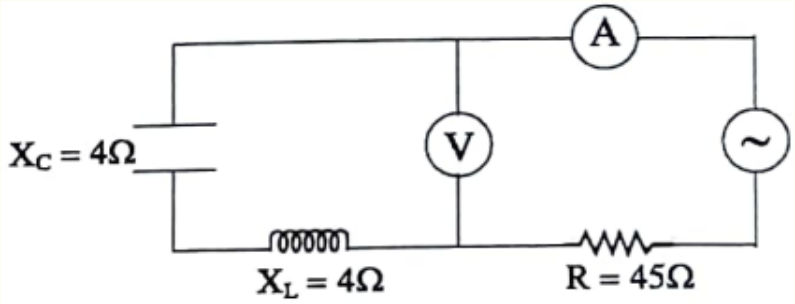
(A) 1 : 2

(B) 2 : 1

(C) 1 : 4

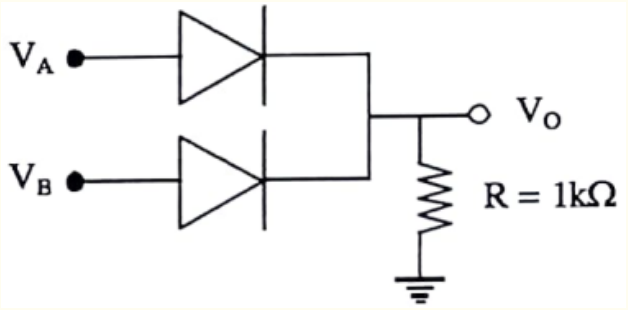
(D) 4 : 1

19. What will be the readings in the voltmeter and ammeter of the circuit shown in figure below?



(A) 2 Volt, 2 A
(B) 2 Volt, 0 A
(C) 0 Volt, 2 A
(D) 0 Volt, 0 A

20. If V_A and V_B are the input voltage (either 5 V or 0 V) and V_o is the output voltage of the following circuit, then the circuit represents



(A) NOT gate
(B) AND gate
(C) NAND gate
(D) OR gate

21. If the vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ represent the sides of a triangle BC, CA and AB respectively, then

(A) $\vec{a}\cdot\vec{b} = \vec{b}\cdot\vec{c} = \vec{c}\cdot\vec{a}$

(B) $\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a} = 0$

(C) $\vec{a}\times\vec{b} = \vec{b}\times\vec{c} = \vec{c}\times\vec{a}$

(D) $\vec{a}\times\vec{b} + \vec{b}\times\vec{c} + \vec{c}\times\vec{a} = 0$

22. A charged particle in a uniform magnetic field $\vec{B} = B_0\hat{k}$ (where B_0 is constant) starts to move from the origin with velocity $\vec{v} = \left(3\hat{i} + 2\hat{k}\right)$ m/sec. The trajectory of the charged particle will be

(A) Helical path

(B) Straight line

(C) Circular

(D) Parabolic

23. A parallel plate capacitor has a capacitance of C. A slab of dielectric constant K of half the area of plate and same thickness as the gap between parallel plates is inserted. The capacitance becomes—

(A) KC

(B) $(K+1)C$

(C) $\left(\frac{K+1}{2}\right)C$

(D) Remain same

24. A particle with restoring force (having natural frequency ω_0) proportional to displacement and viscous force proportional to velocity is subjected to a force $F\sin\omega t$. If amplitude is maximum for $\omega = \omega_1$ and energy of particle is maximum $\omega = \omega_2$, then

(A) $\omega_1 = \omega_0, \omega_2 = \omega_0$

(B) $\omega_1 = \omega_0, \omega_2 \neq \omega_0$

(C) $\boldsymbol{\omega_1 \neq \omega_0, \omega_2 = \omega_0}$

(D) $\omega_1 \neq \omega_0, \omega_2 \neq \omega_0$

25. The pressure of air inside a soap bubble of radius r is p above atmospheric pressure. The surface tension of the soap solution is

(A) rp

(B) $rp/2$

(C) $2rp$

(D) $rp/4$

26. Two point charges are situated as $+q$ at (0, 0, 0) and $-q$ at (a, 0, 0). The equipotential surface $\phi = 0$ is a

(A) *Y–Z* plane

(B) *X–Z* plane

(C) *X–Y* plane

(D) spherical

27. The pressure of a gas is changed from 1.01×10^5 Pa to $1{\cdot}165 \times 10^5$ Pa and change in volume is 10% keeping temperature constant. Find the bulk modulus of the gas.

(A) $0{\cdot}1 \times 10^5$ Pa

(B) 2×10^4 Pa

(C) $1{\cdot}55 \times 10^5$ Pa

(D) 10^5 Pa

28. A Carnot engine takes 3×10^6 cal of heat from a reservoir at 627ºC and rejects it to a sink at 27ºC. Find the work done by the engine.

[Given: Mechanical equivalent of heat = 4·2 J/cal]

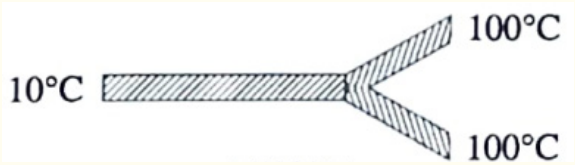
(A) $8{\cdot}4 \times 10^6$ J

(B) 10 J

(C) 2·4 J

(D) None of the above

29. Three identical rods are joined as shown in figure below. The left and right ends are kept at 10°C and 100°C respectively. The temperature of the junction of three rods at equilibrium will be



(A) 30ºC

(B) 45ºC

(C) 60ºC

(D) 70ºC

30. Two tortional pendulums are identical in all respects except that one having length ℓ while the other 4ℓ. The time period of oscillation for the first is T_1 while for the second is T_2. Then $T_1 : T_2$ is given by

(A) 1 : 1

(B) 1 : 2

(C) 1 : 4

(D) 1 : 16

31. Consider the following truth table with A, B input and Y output:

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

This represents which logic gate?

(A) XNOR gate

(B) NAND gate

(C) OR gate

(D) XOR gate

32. If an object is moving under gravitational potential in a parabolic path, then its total energy E (K·E· + P·E·) is

(A) E > 0

(B) E = 0

(C) E < 0

(D) None of the above

33. A monochromatic circularly polarized light is incident normally on a quarter wave plate. The emerging light will be

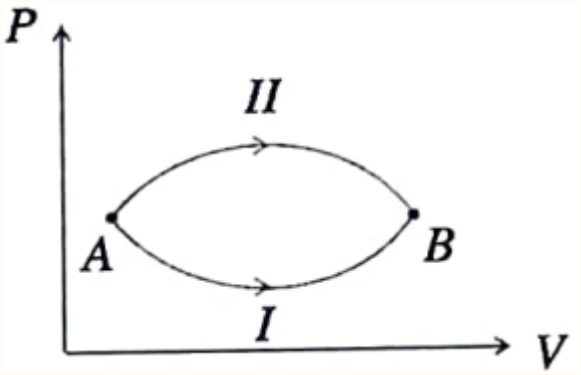
(A) unpolarized

(B) plane polarized

(C) circularly polarized

(D) elliptically polarized

34. A gaseous system goes from point A to point B via two processes I and II as shown in the figure. If Δu_1 and Δu_2 are the changes in internal energies in the processes I and II respectively, then



(A) $\Delta u_1 = \Delta u_2$

(B) $\Delta u_1 > \Delta u_2$

(C) $\Delta u_1 < \Delta u_2$

(D) Relation between Δu_1 and Δu_2 cannot be determined

35. Two different Young's double slit experimental set-ups having equal amplitude and wavelength of light, one with coherent and the other with incoherent sources are performed. The ratio of the intensity of light in the first case to that in second case is

(A) 1 : 1

(B) 2 : 1

(C) 4 : 1

(D) 1 : 0

36. Gravitational force inside a closed shell vanishes. It is a consequence of

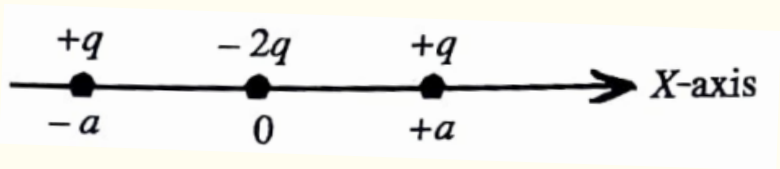
(A) thickness of shell.

(B) $\frac{1}{r^2}$ behaviour of gravitational force.

(C) vacuum inside.

(D) deviation from $\frac{1}{r^2}$ law.

37. Consider the following charge distribution on the X-axis. The electric potential at a far away point r ($r >> a$) varies with r as



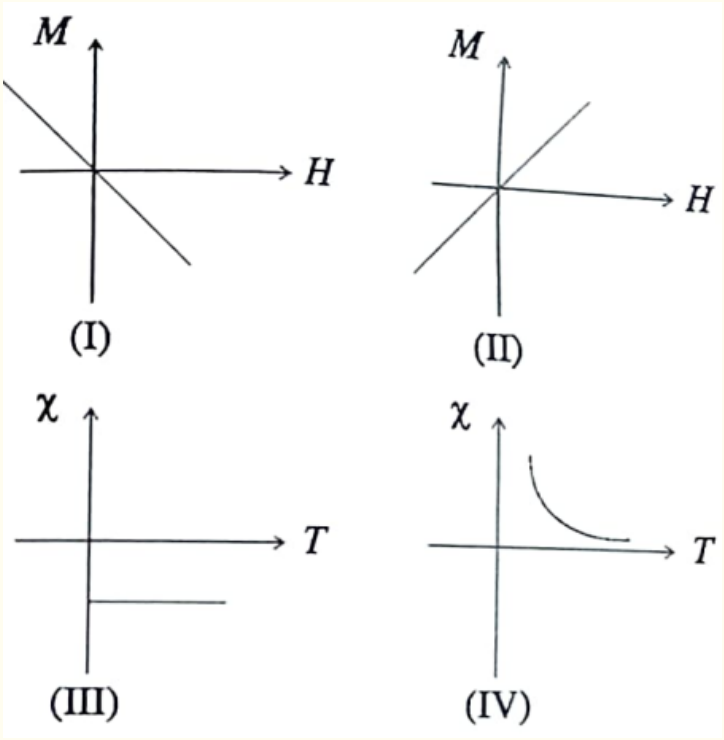
(A) $\frac{1}{r}$

(B) $1/r^2$

(C) $1/r^3$

(D) $1/r^4$

38. Following plots show Magnetization (M) vs. Magnetic field (H) and Magnetic susceptibility (χ) vs. Temperature (T). Which of the following combinations represent the diamagnetic material?



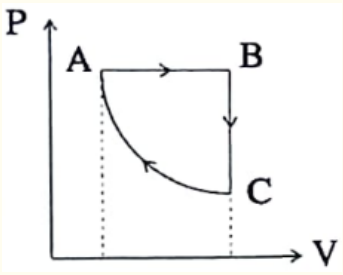
(A) (I) and (IV)

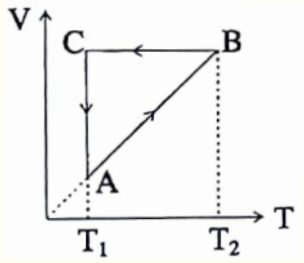
(B) (II) and (III)

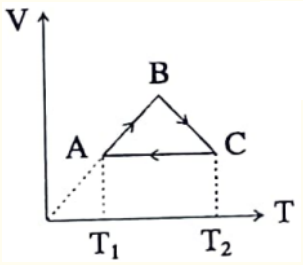
(C) (II) and (IV)

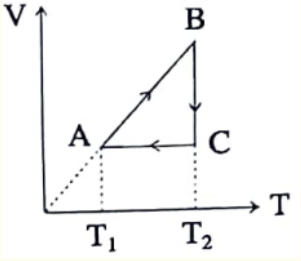
(D) (I) amd (III)

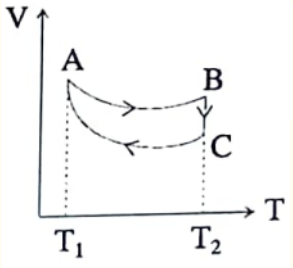
39. Consider a P–V diagram for an ideal gas as shown below where path AC is an isothermal. Corresponding V–T diagram of the process will be



(A) 

(B) 

(C) 

(D) 

40. For a transistor connected in *CE* mode, the voltage drop across the collector is 2 volt and β is 50. Find the base current, if R_c is $2k\Omega$.

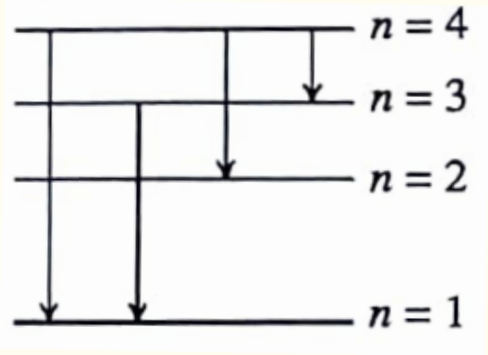
(A) 20 *mA*

(B) 20 μ*A*

(C) 10 μ*A*

(D) 10 m*A*

41. Energy level diagram of hydrogen atom is shown below. Find out the transition which results in the emission of photon of wavelength 496 nm. [Ground state energy of an electron in hydrogen atom is –13·6 eV and *n* is the principal quantum number]



(A) $n = 4$ to $n = 2$

(B) $n = 4$ to $n = 1$

(C) $n = 3$ to $n = 1$

(D) $n = 4$ to $n = 3$

42. When a plane polarized light is passed through an isotropic substance of high refractive index, the plane of polarization is rotated by an angle θ when the substance is placed in a strong magnetic field. If the length travelled by the light through the substance be doubled and also the magnetic field is doubled, then the angle of rotation θ of the plane of polarized light will be

(A) θ

(B) 2θ

(C) 4θ

(D) 0

43. A long wire with a small current element of length 1 cm is placed at the origin and carries a steady current of 10 A along the *X*-axis. Find out the magnitude of the magnetic field due to the element on the *Y*-axis at a distance 0.5 m from it.

(A) $10^{-7}\ T$

(B) $4 \times 10^{-8}\ T$

(C) $10^{+7}\ T$

(D) $4 \times 10^{+8}\ T$

44. A convex lens of focal length f produces m times magnified virtual image of an object. The object distance is

(A) $\frac{(m+1)f}{m}$

(B) $\frac{(m-1)f}{m}$

(C) $\frac{mf}{m+1}$

(D) $\frac{mf}{m-1}$

45. An ideal gas is taken from initial state (P_1, V_1) to (P_2, V_2) in three different paths — isothermal, adiabatic and isobaric. The work W done by the gas is

(A) $W_{isobaric} > W_{isothermal} > W_{adiabatic}$

(B) $W_{isobaric} > W_{adiabatic} > W_{isothermal}$

(C) $W_{isothermal} > W_{isobaric} > W_{adiabatic}$

(D) $W_{adiabatic} > W_{isothermal} > W_{isobaric}$

46. The ratio of the magnetic field produced by a magnetic dipole for end-on position and broad side-on position is

(A) 1 : 1

(B) 1 : 2

(C) 2 : 1

(D) 1 : 8

47. An insulator has an optical absorption which occurs for all wavelengths shorter than 1800Å. Find the width of the forbidden energy band for this insulator.

[Given: $h = 6{\cdot}6 \times 10^{-34}$ Js]

(A) $1{\cdot}1 \times 10^{-18}$ J

(B) 5×10^{-18} J

(C) 5×10^{-20} J

(D) 1 J

48. Consider a Lagrangian $L=\frac{\dot{x}^2}{2x}-V(x)$ where $x, \dot{x}$ and p-are generalised position, velocity and momentum respectively. The corresponding Hamiltonian is

(A) $H=\frac{1}{2}x^2p^2+V(x)$

(B) $H=\frac{\dot{x}^2}{x}+V(x)$

(C) $H=\frac{1}{2}xp^2+V(x)$

(D) $H=\frac{\dot{x}^2}{p}+V(x)$

49. Two particles of identical masses m and identical speeds v collide at right angle and fuses. The velocity of fused mass $2m$ and kinetic energy loss respectively are

(A) v, zero

(B) $\frac{v}{2}, \frac{3}{4}mv^2$

(C) $\frac{v}{\sqrt{2}}, \frac{mv^2}{2}$

(D) $\sqrt{2}v, mv^2$

50. When sound wave passes from one medium to the other, the quantity that remains unchanged is

(A) speed

(B) frequency

(C) wavelength

(D) amplitude

51. An ideal gas is found to obey a hypothetical law $PV^{1/2}$ = constant. The gas is initially at temperature T and volume V. When it expands to a volume $4V$, the temperature becomes

(A) $T/4$

(B) $T/2$

(C) $\sqrt{2}T$

(D) $2T$

52. The ratio of velocity of electron in its first Bohr orbit to the speed of light c in vacuum is $\left[K = \frac{1}{4\pi\varepsilon_0}\right]$

(A) $\frac{Ke^2}{\hbar c}$

(B) $\frac{Ke}{\hbar c}$

(C) $\frac{Ke\hbar}{c}$

(D) $\frac{Ke^2\hbar}{c}$

53. The displacement of a travelling wave is given by $y(x,t) = A \exp\left(\frac{2abxt - a^2x^2 - b^2t^2}{c^2}\right)$ where A, a, b and c are positive constants of appropriate dimensions. The speed of the wave is

(A) $\frac{b}{a}$

(B) $\frac{2b}{a}$

(C) $\frac{cb}{a}$

(D) $\frac{b}{2a}$

54. The magnitude of the magnetic dipole moment associated with a square shaped loop carrying a steady current I is m. If the loop is changed to a circular loop with the same current I passing through it, the magnetic dipole moment am becomes $\frac{\alpha m}{\pi}$. The value of α is

(A) 2

(B) 1

(C) 4

(D) $\frac{1}{2}$

55. One mole of monoatomic ideal gas is mixed with one mole of diatomic ideal gas. The molar specific heat of the mixture at constant volume is

(A) R

(B) $2R$

(C) $3R$

(D) $4R$

56. Lagrangian for a system is $L=\frac{1}{2}m\left(\dot{x}_1^2+\dot{x}_2^2+\dot{x}_3^2\right)+k(t)\,x_1^2$ where x_i is generalised position and k(t) is a time dependent constant. (p is generalised momentum)

(A) Total energy and p_1 are constants of motion.

(B) Only total energy is constant of motion.

(C) p_1, p_2, p_3 are constants of motion.

(D) p_2 and p_3 are constants of motion.

57. In the decay given below, identify the particle X:

$$n \rightarrow p + e^- + X$$

(A) $\bar{\nu}_e$

(B) ν_e

(C) ν_μ

(D) e^+

58. $\begin{pmatrix} 0 & 1 & 2 \\ -1 & 0 & 3 \\ -2 & -3 & 0 \end{pmatrix}$ — For this matrix

(A) all eigenvalues are real.

(B) eigenvalues are zero or purely imaginary.

(C) eigenvalues are both real and imaginary.

(D) all eigenvalues are zero.

59. Calculate the momentum of a photon associated with a radiation of frequency 5×10^{13}Hz.

[Given: $h = 6{\cdot}6 \times 10^{-34}$ Jsec and $c = 3 \times 10^{8}$ m/sec]

(A) 5×10^{-29} kg m/sec

(B) 20×10^{-25} kg m/sec

(C) 1×10^{-30} kg m/sec

(D) 11×10^{-29} kg m/sec

60. A convex lens A of focal length f_1 and a concave lens B of focal length f_2 are kept along same axis with a distance d between them. If a parallel monochromatic beam falling on A leaves B as parallel beam, then d is

(A) $f_1 + f_2$

(B) $f_1 - f_2$

(C) $f_2 - f_1$

(D) $\dfrac{f_1 f_2}{f_1 + f_2}$
