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FOR KSET PREPARATION

KSET 2023 Physical Sciences Question Paper

EXAM	YEAR	TYPE
KSET	2023	Question Paper

ಕ್ರಮ ಸಂಖ್ಯೆ

397321

K-SET

ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆ - 2023

ಪತ್ರಿಕೆ – II

ವರ್ಷನ್ ಸಂಕೇತ

A1

ವಿಷಯ: ಭೌತಿಕ ವಿಜ್ಞಾನಗಳು

ವಿಷಯ ಸಂಕೇತ:25

ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ ಸಂಕೇತ	ಅವಧಿ	ಒಟ್ಟು ಪ್ರಶ್ನೆಗಳ ಸಂಖ್ಯೆ	ಗರಿಷ್ಠ ಅಂಕಗಳು	ನಿಮ್ಮ ನೋಂದಣಿ ಸಂಖ್ಯೆಯನ್ನು ನಮೂದಿಸಿ						
PHS202325	ಎರಡು ಘಂಟೆಗಳು	100	200							

ಅಭ್ಯರ್ಥಿಗಳಿಗೆ ಸೂಚನೆಗಳು

ಮಾಡಿ:

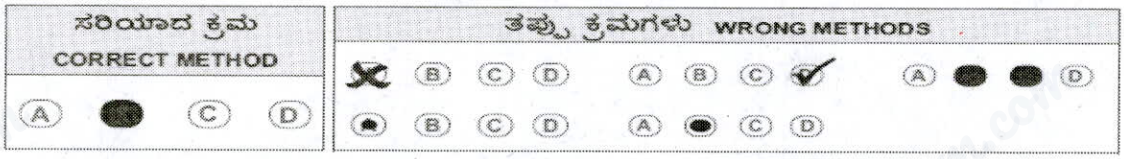
1. ಕೊಠಡಿ ಮೇಲ್ವಿಚಾರಕರು ಈ ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯನ್ನು ನಿಮಗೆ ಎರಡನೇ ಬೆಲ್ ಆದ ನಂತರ ಕೊಡುತ್ತಾರೆ.
2. ನೊಂದಣಿ ಸಂಖ್ಯೆಯನ್ನು ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯಲ್ಲಿ ಬರೆದು ಅದಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ವೃತ್ತಗಳನ್ನು ಸಂಪೂರ್ಣವಾಗಿ ತುಂಬಿದ್ದೀರೆಂದು ಖಾತ್ರಿಪಡಿಸಿಕೊಳ್ಳತಕ್ಕದ್ದು.
3. ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯ ವರ್ಷನ್ ಕೋಡ್ ಅನ್ನು ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯಲ್ಲಿ ಬರೆದು ಅದಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ವೃತ್ತಗಳನ್ನು ಸಂಪೂರ್ಣವಾಗಿ ತುಂಬಬೇಕು.
4. ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯ ವರ್ಷನ್ ಕೋಡ್ ಮತ್ತು ಕ್ರಮ ಸಂಖ್ಯೆಯನ್ನು ನಾಮಿನಲ್ ರೋಲ್‌ನಲ್ಲಿ ತಪ್ಪಿಲ್ಲದೆ ಬರೆಯಬೇಕು.
5. ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯ ಕೆಳಭಾಗದ ನಿಗದಿತ ಜಾಗದಲ್ಲಿ ಕಡ್ಡಾಯವಾಗಿ ಸಹಿ ಮಾಡಬೇಕು.

ಮಾಡಬೇಡಿ:

1. ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯಲ್ಲಿ ಮುದ್ರಿತವಾಗಿರುವ **ಟೈಮಿಂಗ್** & **ಮಾರ್ಕನ್ನು** ತಿದ್ದಬಾರದು / ಹಾಳುಮಾಡಬಾರದು / ಅಳಿಸಬಾರದು.
2. ಮೂರನೇ ಬೆಲ್ ಆಗುವವರೆಗೂ,
   - ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯ ಬಲಭಾಗದಲ್ಲಿರುವ ಸೀಲ್ ಅನ್ನು ತೆಗೆಯಬಾರದು.
   - ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯ ಒಳಗಡೆ ಇರುವ ಪ್ರಶ್ನೆಗಳನ್ನು ನೋಡಲು ಪ್ರಯತ್ನಿಸಬಾರದು ಮತ್ತು ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯಲ್ಲಿ ಉತ್ತರಿಸಲು ಪ್ರಾರಂಭಿಸಬಾರದು.

ಅಭ್ಯರ್ಥಿಗಳಿಗೆ ಮುಖ್ಯ ಸೂಚನೆಗಳು

1. ಪ್ರಶ್ನೆಗಳಲ್ಲಿ ಬಳಸಿರುವ signs and symbols ಗಳನ್ನು, ಬೇರೆ ರೀತಿಯಲ್ಲಿ ಹೇಳದ ಹೊರತು, ನಿಗದಿತ ಪಠ್ಯಪುಸ್ತಕದಲ್ಲಿನ ಅರ್ಥವನ್ನು ಪರಿಗಣಿಸಬೇಕು.
2. ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯಲ್ಲಿ ಒಟ್ಟು **100** ಪ್ರಶ್ನೆಗಳಿದ್ದು, ಪ್ರತಿ ಪ್ರಶ್ನೆಗೂ 4 ಬಹು ಆಯ್ಕೆ ಉತ್ತರಗಳು ಇರುತ್ತವೆ. ಪ್ರತಿ ಪ್ರಶ್ನೆಯ ಕೆಳಗೆ ಕೊಟ್ಟಿರುವ ನಾಲ್ಕು ಬಹು ಆಯ್ಕೆಯ ಉತ್ತರಗಳಲ್ಲಿ ಸರಿಯಾದ ಒಂದು ಉತ್ತರವನ್ನು ಆಯ್ಕೆ ಮಾಡಿ.
3. ಮೂರನೇ ಬೆಲ್ ಆದ ನಂತರ ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯ ಬಲಭಾಗದಲ್ಲಿರುವ ಸೀಲ್ ತೆಗೆದು ಈ ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯಲ್ಲಿ ಯಾವುದೇ ಪುಟಗಳು ಮುದ್ರಿತವಾಗಿಲ್ಲದೇ ಇರುವುದು ಕಂಡು ಬಂದಲ್ಲಿ ಅಥವಾ ಹರಿದು ಹೋಗಿದ್ದಲ್ಲಿ ಅಥವಾ ಯಾವುದೇ ಅಕ್ಷರಗಳು ಬಿಟ್ಟುಹೋಗಿದ್ದಲ್ಲಿ ಎಂಬುದನ್ನು ಖಚಿತಪಡಿಸಿಕೊಂಡು, ಈ ರೀತಿ ಆಗಿದ್ದರೆ ಪ್ರಶ್ನೆಪತ್ರಿಕೆಯನ್ನು ಬದಲಾಯಿಸಿ ಕೊಳ್ಳುವುದು. ನಂತರ ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯಲ್ಲಿ ಉತ್ತರಿಸಲು ಪ್ರಾರಂಭಿಸುವುದು.
4. ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯಲ್ಲಿನ ಪ್ರಶ್ನೆಗೆ ಅನುಗುಣವಾಗಿರುವ ಸರಿ ಉತ್ತರವನ್ನು ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯಲ್ಲಿ ಅದೇ ಕ್ರಮ ಸಂಖ್ಯೆಯ ಮುಂದೆ ನೀಡಿರುವ ಸಂಬಂಧಿಸಿದ ವೃತ್ತವನ್ನು ನೀಲಿ ಅಥವಾ ಕಪ್ಪು ಬಾಲ್ ಪಾಯಿಂಟ್ ಪೆನ್‌ನಿಂದ ಸಂಪೂರ್ಣ ತುಂಬುವುದು.



5. ಈ ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯನ್ನು ಸ್ಕ್ಯಾನ್ ಮಾಡುವ ಸ್ಕ್ಯಾನರ್ ಬಹಳ ಸೂಕ್ಷ್ಮವಾಗಿದ್ದು ಸಣ್ಣ ಗುರುತನ್ನು ಸಹ ದಾಖಲಿಸುತ್ತದೆ. ಆದ್ದರಿಂದ ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯಲ್ಲಿ ಉತ್ತರಿಸುವಾಗ ಎಚ್ಚರಿಕೆ ವಹಿಸಿ.
6. ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯಲ್ಲಿ ಕೊಟ್ಟಿರುವ ಖಾಲಿ ಜಾಗವನ್ನು ರಫ್ ಕೆಲಸಕ್ಕೆ ಉಪಯೋಗಿಸಿ. ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯನ್ನು ಇದಕ್ಕೆ ಉಪಯೋಗಿಸಬೇಡಿ.
7. **ಕೊನೆಯ ಬೆಲ್ ಆದ ನಂತರ ಉತ್ತರಿಸುವುದನ್ನು ನಿಲ್ಲಿಸಿ, ಓ.ಎಂ.ಆರ್. ಉತ್ತರ ಪತ್ರಿಕೆಯನ್ನು ಕೊಠಡಿ ಮೇಲ್ವಿಚಾರಕರಿಗೆ ಯಥಾಸ್ಥಿತಿಯಲ್ಲಿ ನೀಡಿರಿ.**
8. ಕೊಠಡಿ ಮೇಲ್ವಿಚಾರಕರು ಮೇಲ್ಭಾಗದ ಹಾಳೆಯನ್ನು ಪ್ರತ್ಯೇಕಿಸಿ (ಕಚೇರಿ ಪ್ರತಿ) ತಮ್ಮ ವಶದಲ್ಲಿ ಇಟ್ಟುಕೊಂಡು ತಳಬದಿಯ ಯಥಾಪ್ರತಿಯನ್ನು (ಅಭ್ಯರ್ಥಿಯ ಪ್ರತಿ) ಅಭ್ಯರ್ಥಿಗಳಿಗೆ ಕೊಡುತ್ತಾರೆ.
9. ಎಲ್ಲಾ ಪ್ರಶ್ನೆಗಳಿಗೆ ಸಮಾನ ಅಂಕಗಳಿರುತ್ತದೆ. ಋಣಾತ್ಮಕ ಮೌಲ್ಯಮಾಪನವಿರುವುದಿಲ್ಲ.
10. ಯಾವುದೇ ರೀತಿಯ ಮೊಬೈಲ್ ಫೋನ್, ಕ್ಯಾಲ್ಕ್ಯುಲೇಟರ್ ಮತ್ತು ಇತರೆ ರೀತಿಯ ಎಲೆಕ್ಟ್ರಾನಿಕ್/ಕಮ್ಯುನಿಕೇಷನ್ ಸಾಧನಗಳು ಇತ್ಯಾದಿಗಳನ್ನು ಪರೀಕ್ಷಾ ಕೇಂದ್ರದ ಅವರಣದೊಳಗೆ ತರುವುದನ್ನು ನಿಷೇಧಿಸಿದೆ.

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1. The angle between the curves $x^2 + y^2 + z^2 = 9$ and $z = x^2 + y^2 - 3$ at the point (2, 1, 2) is

(A) $\theta = \tan^{-1}\left(\frac{3}{8}\right)$ (B) $\theta = \tan^{-1}\left(\frac{8}{3}\right)$

(C) $\theta = \sin^{-1}\left(\frac{3}{8\sqrt{21}}\right)$ (D) $\theta = \cos^{-1}\left(\frac{8}{3\sqrt{21}}\right)$

2. If vectors $\vec{A}$ and $\vec{B}$ are irrotational, then

(A) $\vec{A} \times \vec{B}$ is irrotational (B) $\vec{A} \times \vec{B}$ is solenoidal

(C) $\vec{A} - \vec{B}$ is solenoidal (D) $\vec{A} + \vec{B}$ is solenoidal

3. If one of the eigenvalues of the matrix $\begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}$ is zero, what is the other eigenvalue ?

(A) 1 (B) -1 (C) 2 (D) -2

4. The degree of the differential equation $\left(\frac{d^3y}{dx^3}\right)^{\frac{3}{7}} = \left[1 + \frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^2\right]^{\frac{2}{3}}$ is

(A) 3 (B) 2 (C) 7 (D) 9

5. The value of $\int_{-1}^{1} x\, P_n(x) \frac{dP_n(x)}{dx}\, dx$ is

(A) 0 (B) 2 (C) $\frac{2n}{2n+1}$ (D) $\frac{2}{2n+1}$

6. The value of a_0 in the Fourier series of t^2 in the interval $-\pi < t < \pi$ is

(A) $\frac{\pi^2}{3}$ (B) $\frac{\pi^2}{4}$ (C) $\frac{\pi^2}{8}$ (D) C

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7. Which of the following function is ***not*** analytic everywhere ?

(A) $e^{\sin z}$ (B) $\log z$ (C) e^{z} (D) $\sin z$

8. The Lagrangian of a particle of mass m is given by $L = \frac{1}{2} m (\dot{x}^2 - \omega^2 x^2) e^{rt}$. The Hamiltonian corresponding to this Lagrangian is

(A) $\frac{p^2}{2m} e^{rt} + \frac{1}{2} m\omega^2 e^{rt}$

(B) $\frac{p^2}{2m} e^{-rt} + \frac{1}{2} m\omega^2 e^{-rt}$

(C) $\frac{p^2}{2m} e^{-rt} + \frac{1}{2} m\omega^2 x^2 e^{rt}$

(D) $\frac{p^2}{2m} e^{rt} + \frac{1}{2} m\omega^2 x^2 e^{-rt}$

9. The Lagrangian of a mechanical system is $L = a\dot{q}^2 + bq^4$; where q is the generalized coordinate and a and b are constants. The equation of motion for this system is

(A) $\dot{q} = \sqrt{\frac{b}{a}}\, q^2$ (B) $\dot{q} = \frac{2b}{a} q^3$

(C) $\ddot{q} = \frac{-2b}{a} q^3$ (D) $\ddot{q} = \frac{2b}{a} q^3$

10. A system with three degrees of freedom is described by the Lagrangian

$$L = \frac{1}{2} m \dot{x}_1^2 + \frac{1}{2} m \dot{x}_2^2 + \frac{1}{2} m \dot{x}_3^2 + \frac{1}{2} k [(x_1 - x_2)^2 + (x_2 - x_3)^2 + (x_3 - x_1)^2].$$

Then the frequencies of small oscillation in terms of $\omega = \sqrt{\frac{k}{m}}$ are :

(A) $0, 3\omega, 3\omega$ (B) $\omega, 2\omega, 3\omega$

(C) $\sqrt{2}\,\omega, \sqrt{2}\,\omega, \sqrt{2}\,\omega$ (D) $0, \sqrt{3}\,\omega, \sqrt{3}\,\omega$

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11. Consider the following statements and identify the correct one :

I. The Hamiltonian of the system is an integral of motion if potential energy does not depend on time.

II. Hamiltonian of the system is equal to the total energy, if the potential energy does not depend on generalized velocity.

III. Law of conservation of energy holds good when potential energy is the function of position only.

(A) I, II and III

(B) I and II only

(C) I and III only

(D) I only

12. A particle of mass m is constrained to move on a curve in the vertical plane by $x = l\,(2\phi + \sin 2\phi)$; $y = l\,(1 - \cos 2\phi)$. There is usual constant gravitational force acting in the vertical y-direction. The Hamiltonian corresponding to the above Lagrangian is given by

(A) $\dfrac{p_\phi^2}{8\,ml^2\cos\phi} + 2\,mgl\,\sin^2\phi$

(B) $\dfrac{p_\phi^2}{8\,ml^2\cos^2\phi} + mgl\,\sin^2\phi$

(C) $\dfrac{p_\phi^2}{32\,ml^2\cos^2\phi} + 2\,mgl\,\sin^2\phi$

(D) $\dfrac{p_\phi^2}{32\,ml^2\cos^2\phi} + mgl\,(1 - \cos^2\phi)$

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13. The Hamiltonian of a particle moving under gravitational force acting along z-direction is given by $H = \frac{1}{2m}\left(p_x^2 + p_y^2 + p_z^2\right) + mgz$. The cyclic coordinates are

(A) x, y, z

(B) x and z only

(C) z only

(D) x and y only

14. A solid cylinder of mass m and radius R rolls down an inclined plane of height h without slipping. Find the speed of its centre of mass when the cylinder reaches the bottom.

(A) $v = \sqrt{\frac{4}{3}gh}$

(B) $v = \sqrt{\frac{2}{3}gh}$

(C) $v = \sqrt{\frac{1}{3}gh}$

(D) $v = \sqrt{\frac{5}{3}gh}$

15. A tetrahedron has four vertices and each vertice is connected to the remaining three vertices by edges of length $\sqrt{2}$ a. A charge Q is located at the centre of the tetrahedron. What is the flux through any one face ?

(A) $\frac{Q}{4\varepsilon_0}$

(B) $\frac{Q}{2a^2\varepsilon_0}$

(C) $\frac{Q}{\sqrt{2}\,a\varepsilon_0}$

(D) $\frac{Q\sqrt{2}}{a\varepsilon_0}$

16. Four equal point charges are kept fixed at four vertices of a square. How many neutral points (i.e. points where the electric field vanishes) will be formed inside the square ?

(A) 1

(B) 4

(C) 5

(D) 7

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17. A circular wire of radius a is in the xy-plane with its centre at the origin. The charge per unit length of the wire is $\lambda = \lambda_0 \cos\theta$, where λ_0 is a constant and the angle θ is measured from the positive x-axis. The electric field at the centre of the circle is

(A) $-\frac{\lambda_0}{4\varepsilon_0 a}\hat{i}$ (B) $\frac{\lambda_0}{4\varepsilon_0 a}\hat{i}$

(C) $-\frac{\lambda_0}{4\varepsilon_0 a}\hat{j}$ (D) $\frac{\lambda_0}{4\pi\varepsilon_0 a}\hat{k}$

18. A charge Q moving with a velocity v along y-axis and a magnetic field B is applied along x-axis, then the resultant Lorentz force on the charge (Q) is along the axis

(A) z (B) $-y$ (C) $-x$ (D) $-z$

19. What current density would produce the vector potential, $\vec{A} = k\hat{\phi}$ (where k is constant) in cylindrical coordinates (s, ϕ, z) ?

(A) $\frac{k}{\mu_0 s^2}\hat{z}$ (B) $\frac{k}{\mu_0 s^2}\hat{\phi}$

(C) $\frac{k}{\mu_0 s^2}\hat{s}$ (D) $-\frac{k}{\mu_0 s^2}\hat{z}$

20. The electric and magnetic field $\vec{E}$ and $\vec{B}$ corresponding to the scalar potential $\phi(z, t) = 0$ and vector potential $\vec{A}(z, t) = tz\hat{i}$ are

(A) $\vec{E} = z\hat{i}$ and $\vec{B} = -t\hat{j}$

(B) $\vec{E} = z\hat{i}$ and $\vec{B} = t\hat{j}$

(C) $\vec{E} = -z\hat{i}$ and $\vec{B} = t\hat{j}$

(D) $\vec{E} = -z\hat{i}$ and $\vec{B} = -t\hat{j}$

21. The light passes from air to glass of refractive index 1·5, the reflection coefficient and transmission coefficient are calculated to be

(A) 0·96 and 0·04 (B) 0·04 and 0·96

(C) 0·76 and 0·24 (D) 0·24 and 0·76

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22. If the de Broglie wavelength of a proton and electron are same then how are their kinetic energies (T_p and T_e) related ?

(A) $T_p = T_e$ (B) $T_p > T_e$ (C) $T_p < T_e$ (D) $\frac{T_p}{T_e} = 1836$

23. Suppose an electron is trapped in a one-dimensional box. What should be the length of the box in units of Compton wavelength so that the zero-point energy is equal to rest mass energy of the electron ?

(A) $0{\cdot}35\ \lambda_c$ (B) $0{\cdot}75\ \lambda_c$ (C) $1{\cdot}35\ \lambda_c$ (D) $1{\cdot}75\ \lambda_c$

24. If $\hat{H}$ is the Hamiltonian of simple harmonic oscillation then $[\hat{u}, \hat{H}]$ is equal to

(A) $\frac{\hbar^2}{m}$ (B) $\frac{\hbar^2}{m}\frac{\partial}{\partial x}$

(C) $\frac{1}{\hbar^2}\frac{\partial}{\partial x}$ (D) $\frac{1}{m\hbar^2}\frac{\partial}{\partial x}$

25. Given two states ψ_1 and ψ_2 of a system described by the Hamiltonian $\hat{H}_1$ with corresponding eigenvalues E_1 and E_2 ($E_1 \neq E_2$). A certain state of the system is represented by $\psi = 2\psi_1 - i\psi_2$. What is the normalization constant if ψ is normalized ?

(A) $\frac{1}{\sqrt{5}}$ (B) $\frac{7}{\sqrt{5}}$ (C) $\frac{1}{\sqrt{4}}$ (D) $\frac{7}{\sqrt{4}}$

26. For a ground state hydrogen atom, the expectation value of potential energy V is

(A) E (B) E/2 (C) $\sqrt{E}$ (D) 2E

27. The value of $[\hat{L}_z, \sin(2\theta)]$ is

(A) $2i\hbar(\sin^2\theta + 1)$

(B) $2i\hbar(\sin^2\theta - \cos^2\theta)$

(C) $2i\hbar(\cos^2\theta + 1)$

(D) $2i\hbar$

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28. A quantum mechanical system has stationary state $|1\rangle$, $|2\rangle$ and $|3\rangle$ corresponding to energy levels, 0 eV, 1 eV and 2 eV respectively. If the system is perturbed by a potential of the form $\hat{V} = \varepsilon|1\rangle\langle 3| + \varepsilon|3\rangle\langle 1|$ in eV, the new ground state, correct to order ε is approximately : (given $0 < \varepsilon << 1$)

(A) $\left(1-\frac{\varepsilon}{2}\right)|1\rangle + \frac{\varepsilon}{2}|3\rangle$

(B) $|1\rangle + \frac{\varepsilon}{2}|2\rangle - \varepsilon|3\rangle$

(C) $|1\rangle + \frac{\varepsilon}{2}|3\rangle$

(D) $|1\rangle - \frac{\varepsilon}{2}|3\rangle$

29. A Carnot engine works between a hot reservoir at temperature T_1 and a cold reservoir at temperature T_2. To increase its efficiency

(A) T_1 and T_2 both should be increased

(B) T_1 and T_2 both should be decreased

(C) T_1 should be increased and T_2 should be decreased

(D) T_1 should be decreased and T_2 should be increased

30. Which of the following thermodynamic relation is used for certain adiabatic changes such as the sudden compression of a liquid or sudden stretching of a rod ?

(A) $\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$

(B) $\left(\frac{\partial S}{\partial T}\right)_P = -\left(\frac{\partial P}{\partial V}\right)_T$

(C) $\left(\frac{\partial S}{\partial T}\right)_P = \left(\frac{\partial P}{\partial V}\right)_T$

(D) $\left(\frac{\partial S}{\partial P}\right)_T = \left(\frac{\partial V}{\partial T}\right)_P$

31. The phase-trajectory of a one-dimensional harmonic oscillator has the shape of

(A) parabola

(B) straight line

(C) circle

(D) ellipse

32. In grand canonical ensemble, the fluctuation is greater if

(A) volume is greater

(B) temperature is smaller

(C) pressure is larger

(D) volume is smaller

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33. The chemical potential μ of a Bose gas at $T = T_c$ is

(A) zero
(B) large and negative
(C) negative and close to zero
(D) positive and close to zero

34. The probability of occupancy of the Fermi-level at a non-zero temperature is

(A) 0% (B) 25% (C) 50% (D) 100%

35. A spherical black body with radius R at the temperature T (K) emits an energy E J/s. Another spherical black body with radius 2R at temperature 2T (K) emits energy equal to

(A) 2 E J/s (B) 16 E J/s (C) 4 E J/s (D) 64 E J/s

36. A silicon diode is in series with a 1·0 kΩ resistor and a 5 V battery. If the anode is connected to the positive battery terminal, the cathode voltage with respect to the negative battery terminal is

(A) 0·7 V (B) 0·3 V (C) 5·7 V (D) 4·3 V

37. A certain JFET data sheet gives $V_{GS\,(OFF)} = -4$ V. The pinch-off voltage, V_P is

(A) + 5 V (B) − 4 V (C) − 5 V (D) + 4 V

38. The gain of a CE-tuned amplifier frequency is

(A) Minimum at resonant frequency
(B) Maximum at resonant frequency
(C) Independent at signal frequency
(D) Zero at signal frequency

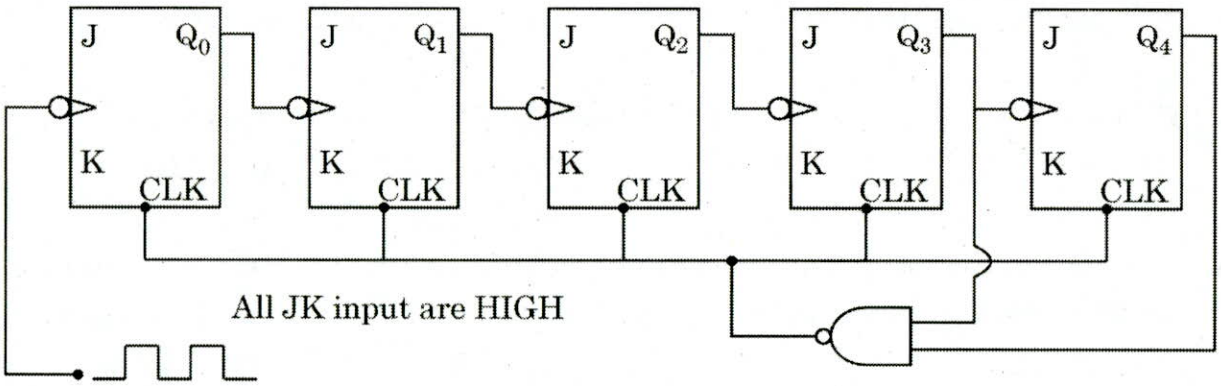
39. The purpose of offset nulling is to

(A) Reduce the gain
(B) Equalize the input signals
(C) Zero the output error voltage
(D) Both (B) and (C)

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40. The mod number of the asynchronous counter shown in figure is



(A) 24 (B) 48

(C) 25 (D) 37

41. The voltage of a circuit is measured by a voltmeter having an input impedance comparable with the output impedance of the circuit thereby causing error in the voltage measurement. This error called

(A) Gross Error

(B) Random Error

(C) Error caused by misuse of instrument

(D) Error caused by loading effect

42. How many comparators are required to build a 5-bit simultaneous A/D converter ?

(A) 11 (B) 21 (C) 31 (D) 41

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43. The Green's function for the differential equation $y'' + 5y' + 6y = \sin x$ is

(A) $2e^{2(t-x)} - 3e^{3(t-x)}$ (B) $e^{2(t-x)} - e^{3(t-x)}$

(C) $2e^{2(t+x)} + 3e^{3(t+x)}$ (D) $e^{2(t+x)} - e^{3(t+x)}$

44. A semi-infinite plate of 10 cm thickness has its faces at 0°C and its base at 100°C. The steady temperature at any point of the plate is given by $\Psi(x) = \sum_{n=1}^{\infty} A_n \rho^{nby} \sin nbx$. Then the values of A_n and b are

(A) $\frac{200}{n\pi}$ and $\frac{\pi}{5}$ (B) $\frac{400}{n\pi}$ and $\frac{\pi}{5}$

(C) $\frac{200}{n\pi}$ and $\frac{\pi}{10}$ (D) $\frac{400}{n\pi}$ and $\frac{\pi}{10}$

45. The first approximation, x_1, up to two decimal places, for the cube root of 13 using Newton-Raphson method with an initial guess of $x_0 = 1{\cdot}5$ will be

(A) 2·93 (B) 2·95

(C) 3·01 (D) 3·12

46. If $g_{\mu\nu} = 0$ for $\mu \neq \nu$, μ, ν and σ are unequal indices, then which of the following vanishes ?

(A) $\Gamma_{\mu\nu,\,\mu}$ (B) $\Gamma_{\mu\nu,\,\nu}$

(C) $\Gamma^{\nu}_{\nu\sigma}$ (D) $\Gamma^{\nu}_{\mu\mu}$

47. The number of irreducible representation of an abelian group is

(A) the order of the group

(B) the highest order of the elements

(C) zero

(D) infinity

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48. The equilibrium points of an anharmonic oscillator governed by $\ddot{x} + \alpha\dot{x} - \omega_0^2 x + \beta x^3 = 0$, where $\alpha > 0$, $\omega_0^2 > 0$ and $\beta > 0$ are

(A) $(0, 0), (\pm \sqrt{\omega_0^2/\beta}, 0)$ (B) $(0, 0), (\pm \sqrt{\omega_0^2/\beta}, 1)$

(C) $(0, -1), (\pm \sqrt{\omega_0^2/\beta}, 0)$ (D) $(0, -1), (\pm \sqrt{\omega_0^2/\beta}, 1)$

49. The Lagrangian of a simple pendulum is given by $L = \frac{1}{2} ml^2 \dot{\theta}^2 - mgl(1 - \cos\theta)$. The Poisson bracket between θ and $\dot{\theta}$ is

(A) 1 (B) $\frac{1}{ml^2}$ (C) $\frac{1}{m}$ (D) $\frac{g}{l}$

50. Suppose (q, p) and (Q, P) are two pairs of canonical variables. The transformation $Q = q^\alpha \cos(\beta p)$, $P = q^\alpha \sin(\beta p)$ is canonical for

(A) $\alpha = 2, \beta = \frac{1}{2}$ (B) $\alpha = 2, \beta = 2$

(C) $\alpha = 1, \beta = 1$ (D) $\alpha = \frac{1}{2}, \beta = 2$

51. The action variable of a linear harmonic oscillator is given by $J = 2\pi E \sqrt{\frac{m}{k}}$, where m, k and E denote mass, force constant and total energy, respectively. The frequency of oscillator is

(A) $\frac{1}{2\pi}\sqrt{\frac{m}{k}}$ (B) $\frac{1}{\pi}\sqrt{\frac{k}{2m}}$

(C) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$ (D) $\frac{1}{\pi}\sqrt{\frac{m}{2k}}$

52. For a dynamical variable, u = u (q, p, t), which of the following expressions is correct ?

(A) $\frac{du}{dt} = \frac{\partial u}{\partial t} - [u, H]$ (B) $\frac{du}{dt} = \frac{\partial u}{\partial t} - [H, u]$

(C) $\frac{du}{dt} = \frac{\partial u}{\partial t} + [u, H]$ (D) $\frac{du}{dt} = -\frac{\partial u}{\partial t} - [u, H]$

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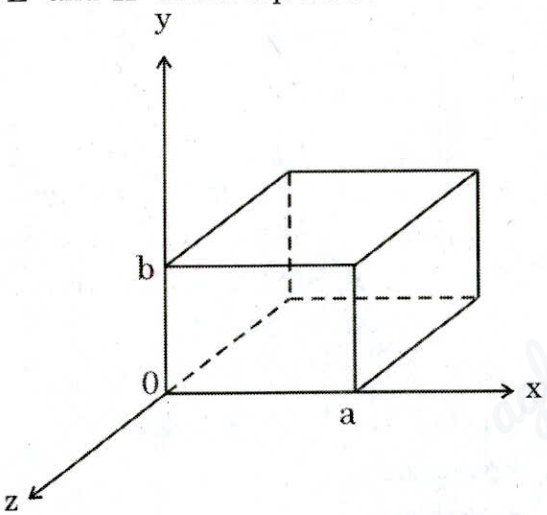
53. Event A happens at point ($x_A = 5$, $y_A = 3$, $z_A = 0$) and at time t_A given by $Ct_A = 15$. Event B occurs at ($x_B = 10$, $y_B = 8$, $z_B = 0$) and $Ct_B = 5$. Both events occur in system S. What is the invariant interval between A and B ?

(A) 25 (B) -125 (C) 50 (D) -50

54. The characteristic impedance of co-axial line is $Z_0 = \frac{1}{2\pi}\sqrt{\frac{\mu}{\varepsilon}}\, ln\left(\frac{b}{a}\right)$. Assume $\mu = \mu_0$ and an air-filled co-axial line has a radius ratio 2. Find its characteristic impedance.

(A) 41·4 Ω (B) 4·14 Ω (C) 20·7 Ω (D) 2·07 Ω

55. A rectangular waveguide is as shown in the figure. Now, what is the boundary condition of $\vec{E}$ and $\vec{H}$ on the top wall ?



(A) $E_z(0, y) = E_y(0, y) = 0$ and $H_x(0, y) = 0$

(B) $E_z(x, b) = E_x(x, b) = 0$ and $H_y(x, b) = 0$

(C) $E_z(a, y) = E_y(a, y) = 0$ and $H_x(a, y) = 0$

(D) $E_z(x, 0) = E_x(x, 0) = 0$ and $H_y(x, 0) = 0$

56. In waveguides, if $E_2 = 0$ then the wave is denoted as

(A) TE waves (B) TM waves (C) TEM waves (D) No propagation

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57. The values of n, l, s, j, m_j for the state $3^2D_{3/2}$ are

(A) $n = 3, l = 2, s = \frac{1}{2}, j = \frac{3}{2}, m_j = \pm\frac{1}{2}, \pm\frac{3}{2}$

(B) $n = 3, l = 2, s = \frac{1}{2}, j = \frac{5}{2}, m_j = \pm\frac{1}{2}, \pm\frac{3}{2}, \pm\frac{5}{2}$

(C) $n = 3, l = 1, s = \frac{1}{2}, j = \frac{1}{2}, m_j = \pm\frac{1}{2}$

(D) $n = 3, l = 1, s = \frac{1}{2}, j = \frac{3}{2}, m_j = \pm\frac{1}{2}, \pm\frac{3}{2}$

58. The condition for the validity of WKB approximation is

($\bar{\lambda}(x)$ – de Broglie wavelength)

(A) $\left|\frac{d\bar{\lambda}(x)}{dx}\right| \simeq 1$ (B) $\left|\frac{d\bar{\lambda}(x)}{dx}\right| \leq 1$ (C) $\left|\frac{d\bar{\lambda}(x)}{dx}\right| << 1$ (D) $\left|\frac{d\bar{\lambda}(x)}{dx}\right| > 1$

59. The scattering of particles by a potential can be analysed by Born approximation. In particular, if the scattered wave is replaced by approximate plane wave, the corresponding Born approximation is known as first Born approximation. Such an approximation is valid for

(A) large incident energies and weak scattering potential

(B) large incident energies and strong scattering potential

(C) small incident energies and weak scattering potential

(D) small incident energies and strong scattering potential

60. If $\bar{\alpha}$ and $\bar{\beta}$ are Dirac matrices, then which of the following is ***not*** correct ?

(A) $\alpha_x = \frac{1}{2}[\alpha_x \alpha_y, \alpha_y]$ (B) $\alpha_x \alpha_y \alpha_z = [\alpha_x \alpha_y \alpha_z \beta, \beta]$

(C) $Tr(\bar{\alpha} \cdot \bar{B})(\bar{\alpha} \cdot \bar{C}) = \bar{B} \cdot \bar{C}$ (D) $\frac{dLx}{dt} = C(\alpha_x p_y - \alpha_y p_z)$

61. The value of $[\hat{L}z, \cos\phi] =$

(ϕ is the azimuthal angle)

(A) $i\hbar \sin\phi$ (B) $i\hbar \cos\phi$ (C) $-i\hbar \sin\phi$ (D) $-i\hbar \cos\phi$

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62. The density and entropy changes suddenly

(A) in first order phase transition

(B) in second order phase transition

(C) both in first order and second order phase transition

(D) neither in first order nor in second order phase transition

63. If μ is the mobility of the system, then diffusion coefficient D is given by

(A) $D = kT\mu$ (B) $D = \sqrt{kT\mu}$ (C) $D = (kT\mu)^{3/2}$ (D) $D = (kT\mu)^2$

64. Diffusion is mainly due to

(A) Temperature gradient (B) Pressure gradient

(C) Concentration gradient (D) Velocity gradient

65. The transition from the non-ferromagnetic state to the ferromagnetic state is a

(A) phase transition of the first order

(B) phase transition of the second order

(C) phase transition of liquid state to gaseous state

(D) phase transition of gaseous state to liquid state

66. In phase modulation, the frequency deviation is

(A) Independent of the modulating signal frequency

(B) Inversely proportional to the modulating signal frequency

(C) Directly proportional to the modulating signal frequency

(D) Inversely proportional to the square root of the modulating frequency

67. $Y = ax^b + c$ in linear form is

(A) $y = bX + c$ (B) $y = cX + b$ (C) $y = aX + b$ (D) $y = aX + c$

68. In a transducer, the experimentally obtained transfer function is different from the theoretical transfer function. The errors resulting from this difference are called

(A) Zero errors (B) Sensitivity errors

(C) Non-conformity errors (D) Dynamic errors

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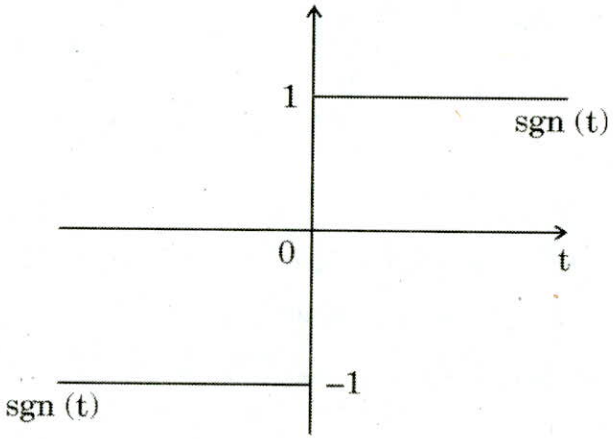
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69. Which one of the following types of noise gains importance at high frequency ?

(A) Shot noise (B) Random noise

(C) Impulse noise (D) Transit-time noise

70. The Fourier transform of the function sgn(t) defined in the figure is



(A) $\frac{-2}{j\omega}$ (B) $\frac{4}{j\omega}$ (C) $\frac{2}{j\omega}$ (D) $\frac{1}{j\omega}+1$

71. The rotational spectrum of $^{79}Br\ ^{19}F$ shows a series of equidistant lines of 0·71433 cm^{-1}. If the molecule is raised from J = 3 to J = 4 level by the absorption of microwaves, then the corresponding spectral line in cm^{-1} is

(A) 2·85733 (B) 1·42866 (C) 5·71464 (D) 4·28598

72. Hot bands in a diatomic molecule with anharmonic oscillations occur when there is a transition from

(A) $n = 0 \rightarrow n = 1$ (B) $n = 1 \rightarrow n = 0$

(C) $n = 0 \rightarrow n = 2$ (D) $n = 1 \rightarrow n = 2$

73. If the fundamental band of H^1Cl^{35} lies at 3·46 micron then the corresponding band of D^2Cl^{37} is

(A) 2·48 micron (B) 4·83 micron (C) 6·76 micron (D) 1·77 micron

74. A hydrogen atom in the ground state absorbed a photon of energy 20 eV. What is the square of the speed of liberated electron in (m^2/s^2) ?

(A) $1{\cdot}42 \times 10^{31}$ (B) $1{\cdot}5 \times 10^{6}$ (C) $2{\cdot}25 \times 10^{12}$ (D) $3{\cdot}77 \times 10^{15}$

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75. The possible terms of a one-electron atom corresponding to n = 3 are

(A) $2S_{1/2}, 2P_{3/2}, 2P_{1/2}$

(B) $2S_{1/2}, 2P_{3/2}, 2P_{1/2}, 2D_{5/2}, 2D_{3/2}$

(C) $3S_1, 3P_0, 3P_2, 3D_1, 3D_3$

(D) $3S_{1/2}, 3P_{3/2}, 3P_{1/2}, 3D_{5/2}, 3D_{3/2}$

76. A diatomic molecule has vibrational states with energies $E_n = \hbar\omega\,(n + \frac{1}{2})$ and rotational states with energies $E_J = BJ(J + 1)$, where n and J are vibrational and rotational quantum numbers respectively. Consider the transitions in which both initial and final states are restricted to $n \leq 2$ and $J \leq 1$ and subject to the selection rules $\Delta n = \pm 1$ and $\Delta J = \pm 1$. Then the largest allowed energy is

(A) $\hbar\omega + 4B$ (B) $\frac{1}{2}\hbar\omega + 2B$ (C) $2\hbar\omega + 4B$ (D) $\hbar\omega + 2B$

77. The Zeeman pattern of lines consists of six equidistant components. The upper state term is $2P_{3/2}$. What is the lower state term ?

(A) $2P_{1/2}$ (B) $2S_{3/2}$ (C) $2S_{1/2}$ (D) $2P_1$

78. In a two-level atom with energy difference of 1 eV, the upper level is populated by twice the number of atoms than that of in the lower level. What is the temperature estimated from Boltzmann factor ?

(A) $-1{\cdot}67 \times 10^4$ K (B) $16{\cdot}7 \times 10^3$ K

(C) $1{\cdot}67 \times 10^3$ K (D) 1670 K

79. The ESR spectrum of an unpaired electron interacting with two equivalent protons shows three lines. What is the ratio of the intensities ?

(A) 1 : 4 : 1 (B) 2 : 1 : 2 (C) 1 : 2 : 1 (D) 3 : 1 : 3

80. An NMR signal for a compound is found to be 180 Hz downward from TMS peak using a spectrometer operating at 60 MHz. What is the chemical shift ?

(A) 6 ppm (B) 1·5 ppm (C) 1·08 ppm (D) 3 ppm

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81. The density of (100) planes in a simple cubic lattice with a = 2·5 Å is

(A) $1{\cdot}6 \times 10^{19}$ per m^2 (B) 16×10^{-19} per m^2

(C) 16×10^{19} per m^2 (D) $1{\cdot}6 \times 10^{-19}$ per cm^3

82. In a powder diffraction pattern recorded from a face-centred cubic sample using X-rays, the first peak appears at 30°. The second peak will appear at

(A) 32·8° (B) 33·7° (C) 34·8° (D) 35·3°

83. The kinetic energy of a free electron at a corner of the first Brillouin zone of a two-dimensional square lattice is larger than that of an electron at the midpoint of a side of the zone by a factor 'b'. The value of 'b' is

(A) $b = \sqrt{2}$ (B) $b = 2$ (C) $b = 4$ (D) $b = 8$

84. The solid phase of an element follows Van der Waals bonding with interatomic potential $V(r) = -\frac{P}{r^6} + \frac{Q}{r^{12}}$, where P and Q are constants. The bond length can be expressed as

(A) $\left(\frac{2Q}{P}\right)^{\frac{1}{6}}$ (B) $\left(\frac{Q}{P}\right)^{\frac{1}{6}}$ (C) $\left(\frac{P}{2Q}\right)^{\frac{1}{6}}$ (D) $\left(\frac{P}{Q}\right)^{\frac{1}{6}}$

85. The Fermi energies of two metals X and Y are 5 eV and 7 eV and their Debye temperatures are 170 K and 340 K respectively. The molar specific heats of these metals at constant volume at low temperature can be written as

$$(C_V)_X = \gamma_X T + A_X T^3$$

$$(C_V)_Y = \gamma_Y T + A_Y T^3$$

where γ and A are constants. Assuming that the thermal effective mass of the electrons in two metals are same, which of the following is correct ?

(A) $\frac{\gamma_X}{\gamma_Y} = \frac{7}{5}, \frac{A_X}{A_Y} = 8$ (B) $\frac{\gamma_X}{\gamma_Y} = \frac{7}{5}, \frac{A_X}{A_Y} = \frac{1}{8}$

(C) $\frac{\gamma_X}{\gamma_Y} = \frac{5}{7}, \frac{A_X}{A_Y} = \frac{1}{8}$ (D) $\frac{\gamma_X}{\gamma_Y} = \frac{5}{7}, \frac{A_X}{A_Y} = 8$

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86. Silicon crystal contains 5×10^{28} atoms per m^3. In an n-type silicon sample, the donor concentration is one atom per $2{\cdot}5 \times 10^7$ silicon atoms. Assuming that the electron effective mass is equal to the true mass, then the temperature (T) at which Fermi level lies at the bottom of the conduction band is

(A) $T = 0{\cdot}56°C$ (B) $T = 5{\cdot}6°C$

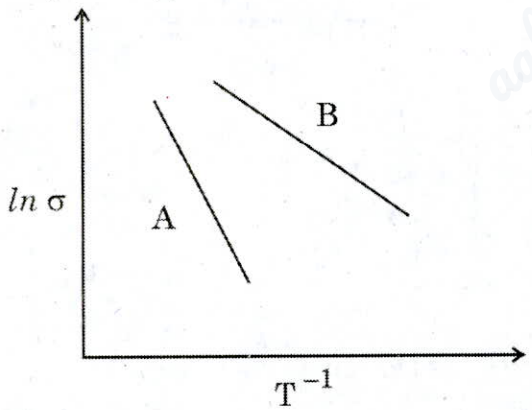
(C) $T = 0{\cdot}56$ K (D) $T = 5{\cdot}6$ K

87. Given the tight binding dispersion relation $E(K) = E_0 + A \sin^2\left(\frac{ka}{2}\right)$, where E_0 and A are constant and 'a' is the lattice parameter. What is the group velocity of an electron at the second Brillouin zone boundary.

(A) 0 (B) $\frac{a}{h}$

(C) $\frac{2a}{h}$ (D) $\frac{a}{2h}$

88. The temperature dependence of the electrical conductivity 'σ' of two intrinsic semi-conductors A and B is shown in the figure. If E_A and E_B are the band gap of A and B respectively, which one of the following is true ?



(A) $E_A > E_B$

(B) $E_A < E_B$

(C) $E_A = E_B$

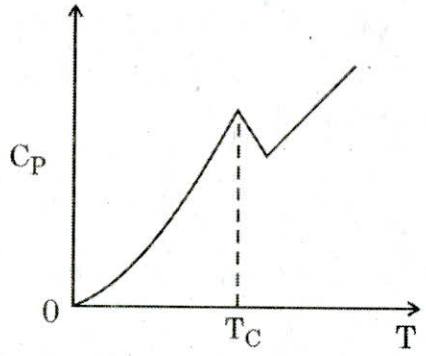
(D) E_A and E_B both depend on temperature

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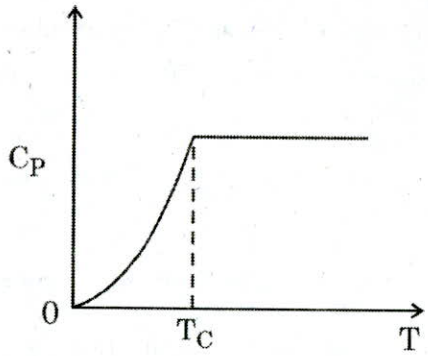
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89. The plot of specific heat versus temperature across the superconductor transition temperature (T_C) is represented by

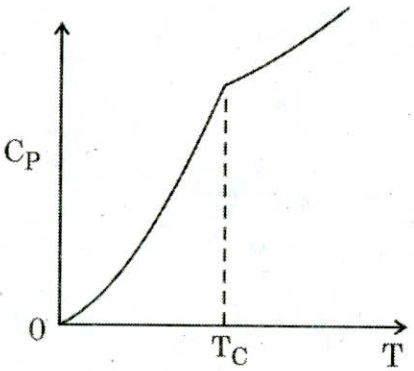
(A)



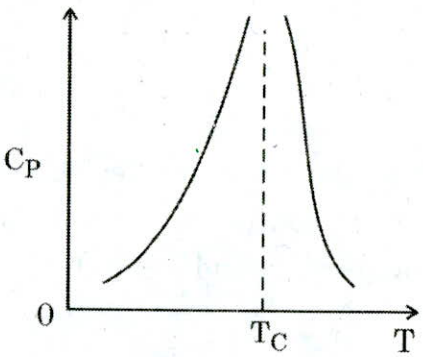
(B)



(C)



(D)



90. The energy required to remove a pair of ions, Na^+ and Cl^-, from NaCl is 2 eV. The number of Schottky imperfections present in the NaCl crystal at 300 K is

(A) $3{\cdot}5 \times 10^6\ cm^{-3}$

(B) $35 \times 10^6\ cm^{-3}$

(C) $0{\cdot}35 \times 10^6\ cm^{-3}$

(D) $3{\cdot}5 \times 10^6\ m^{-3}$

91. The asymmetry term in Weizsacker semi-empirical mass formula is because of

(A) non-spherical shape of the nucleus

(B) non-zero spin of the nucleus

(C) unequal number of protons and neutrons inside the nucleus

(D) odd number of protons inside the nucleus

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92. By using the single particle shell model, the ground state spin of ^{209}Bi (Z = 83) is

(A) $\frac{9}{2}$ (B) $\frac{7}{2}$

(C) $\frac{11}{2}$ (D) $\frac{13}{2}$

93. A sample of carbon from an ancient wooden boat piece gives 5 count/min of carbon due to ^{14}C present in it. If a freshly cut wooden piece gives 16 count/min, what is the age of the boat in years ? (Half life of ^{14}C is 5760 years)

(A) 9,668 (B) 10,608

(C) 11,238 (D) 8,350

94. A particle X decays at rest weakly as follows :

$X \rightarrow \pi^0 + \mu^+ + \nu_\mu$.

What is X ?

(A) π^+ (B) $\bar{z}^+$

(C) K^+ (D) p

95. A ^{16}O (Z = 8) nucleus is spherical and has a charge radius R and a volume $V = \frac{4}{3}\pi R^3$.

According to the empirical observations, the volume of ^{128}Xe (Z = 54) nucleus (assuming spherical shape) is

(A) 2 V (B) 4 V

(C) 8 V (D) 16 V

96. A nucleus has a neutron resonance at 65 eV and no other resonances nearby. For this resonance, Γ_n = 4·2 eV, Γ_γ = 1·3 eV and Γ_α = 2·7 eV and all other partial widths are negligible. What is the cross-section for (n, α) reaction at 70 eV (in barns) ?

(A) 1523 (B) 2523

(C) 523 (D) 23

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97. A neutron and a proton form a bound state, at the same time there is no bound state for two neutrons. This shows

(A) Spin dependence of the nuclear force

(B) Different forces

(C) Energy is different

(D) Charge dependence

98. The electric force between the Earth and Moon can be ignored because

(A) the bodies are electrically neutral

(B) it is much smaller than the gravitational force

(C) of the tidal effect

(D) they are far away

99. A state containing only one strange particle

(A) can decay into a state of zero strangeness

(B) can be created strongly from a state of zero strangeness

(C) can be created by gravitational interaction

(D) cannot exist

100. Consider the fictitious situation where 2^+ and 4^+ levels of ^{18}O have the energies 2 MeV and $6\frac{2}{3}$ MeV respectively. What is the $\frac{\hbar^2}{2g}$ (moment of inertia) in MeV for ^{18}O ?

(A) $\frac{1}{6}$ (B) $\frac{1}{9}$ (C) $\frac{1}{3}$ (D) 1

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COMPETITIVE EXAMINATION-2023

PAPER – II

SUBJECT: PHYSICAL SCIENCES

SUBJECT CODE:25

PAPER CODE	DURATION	TOTAL NO. OF QUESTIONS	MAXIMUM MARKS	MENTION YOUR REGISTER NUMBER
PHS202325	TWO HOURS	100	200	

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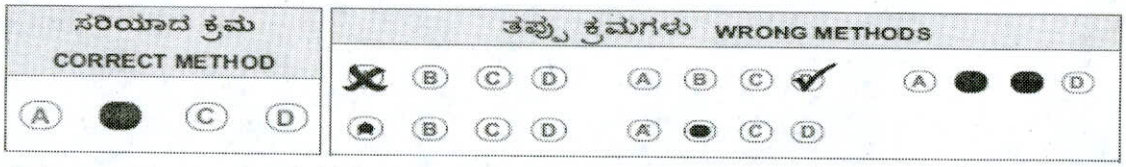
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2. Check whether the Register Number has been entered and shaded in the respective circles on the OMR answer sheet.
3. The version code of this question booklet should be entered on the OMR answer sheet and the respective circles should also be shaded completely.
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4. Completely **darken / shade** the relevant circle with a **blue or black ink ballpoint pen against the question number on the OMR answer sheet.**



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