M.SC. ENTRANCE QUESTION

SUBJECT: PHYSICS

Q1. A unit vector perpendicular to the plane containing $\vec{A} = \hat{\imath} + \hat{\jmath} - 2\hat{k}$ and $\vec{B} = 2\hat{\imath} - \hat{\jmath} + \hat{k}$ *is*

$(A)\ \frac{1}{\sqrt{26}}(-\hat{\imath} + 3\hat{\jmath} - 4\hat{k})$

$(B)\ \frac{1}{\sqrt{19}}(-\hat{\imath} + 3\hat{\jmath} - 3\hat{k})$

$(C)\ \frac{1}{\sqrt{35}}(-\hat{\imath} + 5\hat{\jmath} - 3\hat{k})$

$(D)\ \frac{1}{\sqrt{35}}(-\hat{\imath} - 5\hat{\jmath} - 3\hat{k})$

Ans: *D*

Q2. The real part of an analytic function is $u(x, y) = x^2 - y^2$. The imaginary part of the function is then

$(A)\ x^2 - y^2 - 2xy$

$(B)\ x^2 + y^2$

$(C) x^2 + y^2 + xy$

$(D) 2xy$

Ans: *D*

Q3. The function $e^{\cos x}$ is Taylor expanded about $x = 0$. The coefficient of x^2 is

$(A)\ -\frac{1}{2}$

$(B)\ -\frac{e}{2}$

$(C)\ \frac{e}{2}$

(D) Zero

Ans: *B*

Q4. Let M be a 2x2 matrix. Its trace is 6 and its determinant has value 8. Its eigen values are

(A) 2 and 4

(B) 3 and 3

(C) 2 and 6

$(D) -2$ and -3

Ans: *A*

Q5. The solution $y(x)$of the differential equation $y\frac{dy}{dx}+3x=0, y(1)=0$ is described by

(A) an ellipse

(B) a circle

(C) a parabola

(D) a straight line

Ans: A

Q6.The radial component of acceleration in plane polar coordinate is given by

(A) $\frac{d^2r}{dt^2}$

(B) $\frac{d^2r}{dt^2}-r\left(\frac{d\theta}{dt}\right)^2$

(C) $\frac{d^2r}{dt^2}+r\left(\frac{d\theta}{dt}\right)^2$

(D) $2\frac{d\theta}{dt}\frac{d\theta}{dt}+\frac{d^2\theta}{dt^2}$

Ans: B

Q7. Let (x, y)denote the coordinates in a rectangular cartesian coordinate system C.

Let $(x^{'}, y^{'})$denote the coordinates in another coordinate system $C^{'}$ defined by

$x^{'}=2x+3y$

$y^{'}=-3x+4y$

The area element in $C^{'}$ is

(A) $dx^{'}dy^{'}$

(B) $12dx^{'}dy^{'}$

(C) $\frac{1}{17}dx^{'}dy^{'}$

(D) $x^{'}dx^{'}dy^{'}$

Ans: C

Q8. The function $f(x)=\frac{8x}{x^2+9}$ is continuous everywhere except

(A) $x=0$

(B) $x=\pm 9$

(C) $x=\pm 9i$

(D) $x=\pm 3i$

Ans: D

Q9. If $\phi(x, y, z)$ is a scalar function which satisfies the Laplace equation, the gradient of ϕ is

(A) Solenoidal and irrotational

(B)Solenoidal but not irrotational

(C) Irrotational but not solenoidal and

(D)Neither solenoidal nor irrotational

Ans: A

Q10. The eigen values of $\begin{pmatrix} 3 & i & 0 \\ -i & 3 & 0 \\ 0 & 0 & 6 \end{pmatrix}$ are

(A) 2,4 and 6

(B) $2i, 4i$ and 6

(C) $2i$, 4 and 8

(D) 0,4 and 8

Ans: A

Q11. If the motion of a particle is described by $x = 5\cos(8\pi t)$, $y = 5\sin(8\pi t)$ and $z = 5t$ then the trajectory of the particle is

(A) Circular

(B) Elliptical

(C) Helical

(D) Spiral

Ans: C

Q12. Given $z = x + iy$, the contour integration $\oint_C \frac{dz}{z}$ is equal to (where C is any anticlockwise contour going around the origin

$(A) - \pi i$

(B) $2\pi i$

(C) πi

(D) $\pi/2$

Ans: B

Q13. An integral is defined to be $I = \int_0^\infty \frac{\sin x}{x} dx$, then I is equal to

$(A) - \pi/\cos\sqrt{2}$

$(B)\ \pi/2$

$(C) -\cos\sqrt{2}/\pi$

$(D)\ 2/\pi$

Ans: *B*

Q14. The solution to the nonlinear differential equation $\frac{df}{dx} + \alpha f^2 = 0$ with boundary condition $f(0) = 1$ and α is a constant is given by

$(A) \cos\alpha x$

$(B) \sin\alpha x/\alpha x$

$(C)(\alpha x + 1)^{-1}$

$(D)(\alpha x + 1)^{-2}$

Ans: *C*

Q15. Let $f(x, y) = x^3 - 2y^3$. The curve along which $\nabla^2 f = 0$ is

$(A)\ x = \sqrt{2}\,y$

$(B)\ x = 2y$

$(C)\ x = \sqrt{6}\,y$

$(D) x = -y/2$

Ans: *B*

Q16. A curve is given by $\vec{r}(t) = t\hat{\imath} + t^2\hat{\jmath} + t^3\hat{k}$. The unit vector of the tangent to the curve at $t = 1$ is

$(A)\ \frac{\hat{\imath} + \hat{\jmath} + \hat{k}}{\sqrt{3}}$

$(B)\ \frac{\hat{\imath} + \hat{\jmath} + 2\hat{k}}{\sqrt{6}}$

$(C)\ \frac{\hat{\imath} + 2\hat{\jmath} + 2\hat{k}}{3}$

$(D)\ \frac{\hat{\imath} + 2\hat{\jmath} + 3\hat{k}}{\sqrt{14}}$

Ans: *D*

Q17. In a heat engine based on Carnot engine, heat is added to the working subsance at constant

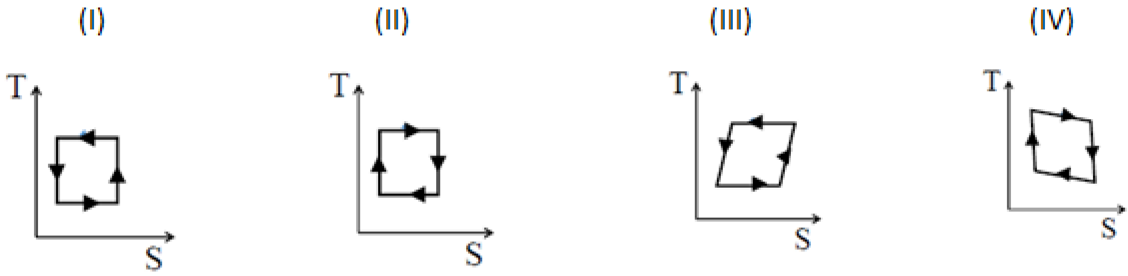
(*A*) Entropy

(*B*) Pressure

(*C*) Temperature

(*D*) Volume

Ans: *C*



Q18. Which one of the figures correctly represents the $T - S$ diagram of a Carnot engine?

(A) II

(B) III

(C) I

(D) IV

Ans: *B*

Q19. Two boxes A and B contain equal number of molecules of the same gas. if the volumes are V_A and V_B and λ_A and λ_B denote respective mean free paths, then

(A) $\lambda_A = \lambda_B$

(B) $\frac{\lambda_A}{V_A} = \frac{\lambda_B}{V_B}$

(C) $\frac{\lambda_A}{V_A^{1/3}} = \frac{\lambda_B}{V_B^{1/3}}$

(D) $\lambda_A V_A = \lambda_B V_B$

Ans: *B*

Q20. The equation of state for one mole of a non − ideal gas is given by $PV = A\left(1 + \frac{B}{V}\right)$, where the coefficient A and B are temperature dependent. if the volume changes from V_1 to V_2 in an isothermal process, the work done by the gas is

(A) $AB\left(\frac{1}{V_1} - \frac{1}{V_2}\right)$

(B) $AB \ln\left(\frac{V_2}{V_1}\right)$

$(C)\ A\ln\left(\frac{V_2}{V_1}\right) + \ AB\left(\frac{1}{V_1} - \frac{1}{V_2}\right)$

$(D)\ A\ln\left(\frac{V_2 - V_1}{V_1}\right) + B$

$Ans:\ C$

Q21.The rms velocity of oxygen molecule is given by at some temperature T. The molecules of another gas have the same rms velocity at temperature $T/16$. The second gas is

(A) Hydrogen

(B) Helium

(C) Nitrogen

(D) Neon

$Ans:\ A$

Q22. Isothermal compressibility is given by

$(A)\ \frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$

$(B)\frac{1}{P}\left(\frac{\partial P}{\partial V}\right)_T$

$(C) - \frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$

$(D) - \frac{1}{P}\left(\frac{\partial P}{\partial V}\right)_T$

$Ans:\ C$

Q23. A blackbody at a temperature of 6000K emits radiation whose intensity spectrum peaks at $600nm$. If the temperature is reduced to 300K, the spectrum will peak at

$(A) 12nm$

$(B) 120\mu m$

$(C) 120\ nm$

$(D) 12\mu m$

$Ans: D$

Q24. An ideal monoatomic gas , initially at $T = 20\ ℃$ expands adiabatically from a volume V_0 to $5V_0$. Then the final temperature is

$(A) - 20$°C

$(B) - 33$ °C

$(C) - 173$°C

$(D) - 113$°C

Ans: *C*

Q25. During free expansion of an ideal gas under adiabatic condition, the internal energy of the gas

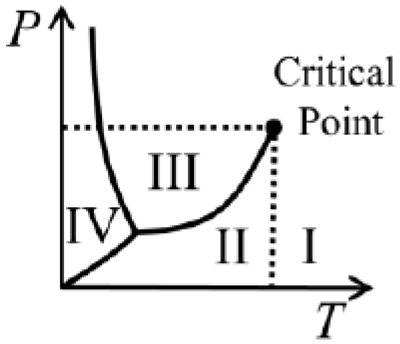
(A)Decreases

(B) Initially decreases and then increases

(C) Increases

(D) Remains constant

Ans: *D*



Q26. In the given phase diagram for a pure substance, region I, II, III, IV respectively represents

(A) Vapour, gas, solid, liquid

(B) Gas, vapor, liquid, solid

(C) Gas, liquid, vapor, solid

(D) Vapor, gas, liquid, solid

Ans: *B*

Q27. A system undergoes a thermodynamic transformation from state S_1 to S_2 via two different paths 1 and 2. The heat absorbed and work done along path 1 are $50J$ and $30J$ respectively. If the heat absorbed along path 2 is $30J$, the work done along path 2 is

(A) *Zero*

(B) $10J$

$(C)$$20J$

$(D)$$30J$

Ans: *B*

Q28. The root mean square(rms)speeds of Hydrogen atoms at $500K, V_H$, and Helium atoms at $2000K, V_{He}$, are related as

(A) $V_H > V_{He}$

(B) $V_H < V_{He}$

$(C)$$V_H = V_{He}$

$(D)$$V_H \gg V_{He}$

Ans: *C*

Q29. For the molecules of an ideal gas the ratio of the most probable speed to average speed to root mean square velocity is given by

(*A*) $\sqrt{2}:\sqrt{\pi/8}:\sqrt{3}$

(*B*) $\sqrt{3}:\sqrt{\pi/8}:\sqrt{2}$

(*C*) $\sqrt{3}:\sqrt{8/\pi}:\sqrt{2}$

(*D*) $\sqrt{2}:\sqrt{8/\pi}:\sqrt{3}$

Ans: *D*

Q30. For a mole of ideal gas at $T = 35$°C, what is the work done for an isothermal expansion from a volume V_0 to $10V_0$?

(*A*) $6 \text{ x } 10^3 J$

(*B*) $3 \text{ x } 10^3 J$

(*C*) $10^3 J$

(*D*) $10^4 J$

Ans: *A*

Q31.Which one of the following is an impossible magnetic field ?

(*A*) $\vec{B} = 3x^2z^2\hat{x} - 2xz^3\hat{z}$

(*B*) $\vec{B} = -2xy\hat{x} + yz^2\hat{y} + \left(2yz - \frac{z^3}{3}\right)\hat{z}$

(*C*) $\vec{B} = (xz + 4y)\hat{x} - yx^3\hat{y} + \left(x^3z - \frac{z^2}{2}\right)\hat{z}$

(*D*) $\vec{B} = -6xz\hat{x} + 3yz^2\hat{y}$

Ans: *D*

Q32. The expression for the magnetic field that induces the electric field

$\vec{E} = K(yz\hat{\imath} + 3z\hat{\jmath} + 4y\hat{k})\cos(\omega t)$ is

(*A*) $-\frac{K}{\omega}(\hat{\imath} + y\hat{\jmath} - z\hat{k})\sin(\omega t)$

(*B*) $-\frac{K}{\omega}(\hat{\imath} + y\hat{\jmath} + z\hat{k})\sin(\omega t)$

(*C*) $-\frac{K}{\omega}(\hat{\imath} - y\hat{\jmath} + z\hat{k})\sin(\omega t)$

(*D*) $-\frac{K}{\omega}(\hat{\imath} + y\hat{\jmath} + z\hat{k})\sin(\omega t)$

Ans: A

Q33. For an electromagnetic wave travelling in free space, given by $\vec{E} = E_m \sin(\omega t - \beta z)\hat{y}$,

the magnetic field will be given by

$(A)\vec{B} = -\frac{E_m\beta}{\omega}\sin(\omega t - \beta z)\hat{x}$

$(B) -\frac{E_m\beta}{\omega}\cos(\omega t - \beta z)\hat{z}$

$(C)\frac{E_m\beta}{\omega}\sin(\omega t - \beta z)\hat{y}$

(D) None of the above

Ans: A

Q34. The electric field of an electromagnetic field is given by

$\vec{E} = (2\hat{k} - 3\hat{j})\text{x}10^{-3}\sin[10^7(x + 2y + 3z - \beta t)]$. The value of β is (c is the speed of light)

$(A)\ \sqrt{14}\ c$

$(B)\sqrt{12}\ c$

$(C)\sqrt{10}\ c$

$(D)\sqrt{7}\ c$

Ans: A

Q35. Three point charges each carrying a charge q are placed on the vertices of an equilateral triangle of side L. The electrostatic potential energy of the configuration is

$(A)\ \frac{1}{4\pi\epsilon_0}\frac{q^2}{L}$

$(B)\frac{2}{4\pi\epsilon_0}\frac{q^2}{L}$

$(C)\frac{3}{4\pi\epsilon_0}\frac{q^2}{L}$

$(D)\frac{1}{\pi\epsilon_0}\frac{q^2}{L}$

Ans: C

$Q36$. For a quantum particle confined inside a cubic box of side L, the grund state energy is given by E_0.

The energy of the first excited state is

$(A)\ 2E_0$

$(B)\ \sqrt{2}\, E_0$

$(C)\ 3E_0$

$(D)\ 6E_0$

$Ans:\ A$

Q37.The maximum number of intensity minima that can be observed in the Fraunhofer diffraction pattern of a single slit (width 10 μm) illuminated by a laser beam(wavelength 0.630 μm will be

(A) 4

(B) 7

(C)12

(D) 14

$Ans:\ A$

Q38.Light of wavelength λ (in free space) propagates through a dispersive medium with refractive index $n(\lambda) = 1.5 + 0.6\lambda$ .The group velocity of a wave travelling inside this medium in units of 10^8 m/s is

(A) 1.5

(B)2.0

(C)3.0

(D) 4.0

$Ans:\ B$

Q39. Arrange the following telescopes, where D is the telescope diameter and λ is the wavelength, in order of decreasing resolving power.

$I.\ \ D = 100m, \quad \lambda = 21cm$

$II.\ \ D = 2m, \quad \lambda = 500nm$

$III.\ \ D = 1m, \quad \lambda = 100nm$

$IV.\ \ D = 2\ m, \quad \lambda = 10mm$

$(A)\ III, II, IV, I$

$(B)\ II, III, I, IV$

$(C)\ IV, III, II, I$

$(D)\ III, II, I, IV$

$Ans:\ B$

Q40. A linearly polarised light falls on a quarter wave plate and the emerging light is found to be elliptically polarised. the angle between the fast axis of the quarter wave plate and the plane of polarisation , can be

$(A)\ 30°$

(B) 45°

(C) 90°

(D) 180°

Ans: A

$Q41$. The plane of polarisation of a plane polarised light rotates by 60° after passing through a wave plate. The pass axis of the wave plate is at an angle α with respect to the plane of polarisation of the incident light. The wave plate and α are

(A) $\lambda/4$, 60°

(B) $\lambda/2$, 30°

(C) $\lambda/2$, 120°

(D) $\lambda/4$, 30°

Ans: C

Q42. An object of density ρ is floating in a liquid with 75% of its volume submerged. The density of the liquid is

(A) $\frac{4}{3}\rho$

(B) $\frac{3}{2}\rho$

(C) $\frac{8}{5}\rho$

(D) 2ρ

Ans: A

Q43. The moment of inertia of a solid sphere (radius R mass M) about the axis which is at a distance of $R/2$ from the centre is

(A) $\frac{3}{20}MR^2$

(B) $\frac{1}{2}MR^2$

(C) $\frac{13}{20}MR^2$

(D) $\frac{9}{10}MR^2$

Ans: C

Q44. Metallic lithium has bcc crystal structure. each unit cell is a cube of side a. the number of atoms per unit volume is

$(A)\frac{1}{a^3}$

$(B)\frac{2}{\sqrt{2}\,a^3}$

$(C)\frac{2}{a^3}$

$(D)\ \frac{4}{a^3}$

$(D)\ 0$

$Ans: B$

$Q45.$ A plane in a cubic lattice makes intercepts of $a, a/2$ and $2a/3$ with the three crystographic axes respectively. the miller indices for this plane are

(A) (2 4 3)

(B)(3 4 2)

(C)(6 3 4)

(D) (1 2 3)

$Ans: C$

Q46.Thermal runway in a transistor biased in the active region is due to

(A) Change in reverse collector saturation current due to rise in temperature.

(B)Breakdown under reverse biasing.

(C) Change in β which increases with temperature.

(D) Base emitter voltage V_{BE} which decreases with rise in temperature.

$Ans: A$

Q47. The Boolean expression $(A+B)(A+\bar{B})(\bar{A}+B)$ is equivalent to

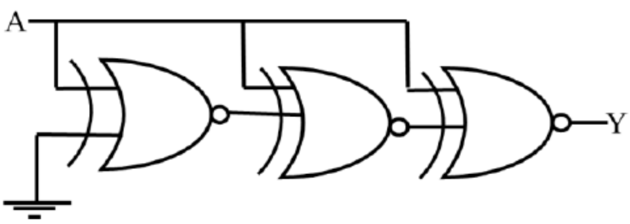
$(A)\ A\bar{B}$

$(B)\ \bar{A}\,B$

$(C)\ \bar{A}\bar{B}$

$(D)\ AB$

$Ans: D$



Q48. For the given circuit , the output Y is

$(A)\ 0$

(B) 1

(C) A

(D) $\bar{A}$

Ans: D

Q49. Let T_g and T_e be the kinetic energies of the electron in the ground and the third excited states of a hydrogen atom, respectively. According to the Bohr model, the ratio T_g/T_e

(A) 3

(B) 4

(C)9

(D)16

Ans: D

Q50. The Hamiltonian of a particle in one dimension is given by $H(x,p) = \frac{p^2}{2m} + \lambda px + \frac{\lambda}{2}x^2$ where m and λ are constant. the corresponding Lagrangian is

(A) $L = \frac{m}{2}(\dot{x})^2 - \lambda mx\dot{x} - \frac{\lambda}{2}x^2$

(B) $L = \frac{m}{2}(\dot{x} - \lambda x)^2 - \lambda mx\dot{x} - \frac{\lambda}{2}x^2$

$(C)$$L = \frac{m}{2}(\dot{x} - \lambda x)^2 - \frac{\lambda}{2}x^2$

$(D)$$L = \frac{m}{2}(\dot{x})^2 - \frac{\lambda}{2}x^2$

Ans: C