2008 Physics

AI24BTECH11003 - Badde Vijaya Sreyas

18) An O^{16} nucleus is spherical and has a charge radius R and a volume $V \equiv \frac{4}{3}\pi R^3$. According to the empirical observations of the charge radii, the volume of the ${}_{54}Xe^{128}$ nucleus, assumed to be spherical, is

a) $8V$ b) $2V$ c) $6.75V$ d) $1.89V$

19) A common emitter transistor amplifier circuit is operated under a fixed bias. In this circuit, the operating point
a) remains fixed with an increase in temperature.
b) moves towards cut-off region with an increase in temperature.
c) moves towards saturation region with a decrease in temperature.
d) moves towards saturation region with an increase in temperature

20) Under normal operating conditions, the gate terminal of an n-channel junction field effect transistor (JFET) and an n-channel metal oxide semiconductor field effect transistor (MOFSET) are
a) both biased with positive potentials
b) both biased with negative potentials
c) biased with positive and negative potentials, respectively
d) biased with negative and positive potentials, respectively

21) The eigenvalues of the matrix $\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$

a) $\frac{1}{2}\left(\sqrt{3} \pm i\right)$ when $\theta = 45°$
b) $\frac{1}{2}\left(\sqrt{3} \pm i\right)$ when $\theta = 30°$
c) ± 1 since the matrix is unitary
d) $\frac{1}{\sqrt{2}}(1 \pm i)$ when $\theta = 30°$

22) If the Fourier transform $F[\delta(x-\alpha)] = \exp(-i2\pi\nu a)$, then $F^{-1}(\cos 2\pi a\nu)$ will correspond to

a) $\delta(x-\alpha) - \delta(x+\alpha)$
b) a constant
c) $\frac{1}{2}[\delta(x-\alpha) + i\delta(x+\alpha)]$
d) $\frac{1}{2}[\delta(x-\alpha) + \delta(x+\alpha)]$

23) If $I = \oint_C dz \ln(z)$, where C is the unit circle taken anticlockwise and $\ln(z)$ is the principal branch of the Logarithmic function, which of the following is correct?

a) $I = 0$ by residue theorem
b) I is not defined since $\ln(z)$ has a branch cut
c) $I \neq 0$
d) $\oint_C dz \ln\left(z^2\right) = 2I$

24) The value of $\int_{-i}^{i} \pi(z+1)\,dz$ is

a) 0 b) $2\pi i$ c) $-2\pi i$ d) $(-1+2i)\pi$

25) Consider the Bessel equation $\nu = 0$, $\frac{d^2y}{dz^2} + \frac{1}{z}\frac{dy}{dz} + y = 0$. Which one of the following statements is correct?

a) Equation has regular singular points at $z = 0$ and $z = \infty$
b) Equation has 2 linearly independent solutions that are entire
c) Equation has an entire solution and a second linearly independent solution singular at $z = 0$.
d) Limit $z \to \infty$, taken along x axis, exists for both the linearly independent solutions.

26) Under a certain rotation of coordinate axes, a rank-1 tensor v_a $(a = 1, 2, 3)$ transforms according to the orthogonal transformation defined by the relations $v_1' = \frac{1}{\sqrt{2}}(v_1 + v_2)$; $v_2' = \frac{1}{\sqrt{2}}(-v_1 + v_2)$; $v_3' = v_3$. Under the same rotation, a rank-2 tensor $T_{a,b}$ would transform such that

a) $T'_{1,1} = T_{1,1}T_{1,2}$
b) $T'_{1,3} = T_{1,3}$
c) $T'_{1,1} = T_{1,1} + 2T_{2,2} - T_{2,1}$
d) $T'_{1,1} = \frac{1}{2}(T_{1,1} + T_{2,2} + T_{1,2} + T_{2,1})$

27) The Lagrangian of a system is given by $L = \frac{1}{2}\dot{q}^2 + q\dot{q} - \frac{1}{2}q^2$. It describes the motion of

a) a harmonic oscillator
b) a damped harmonic oscillator
c) an anharmonic oscillator
d) a system with unbounded motion

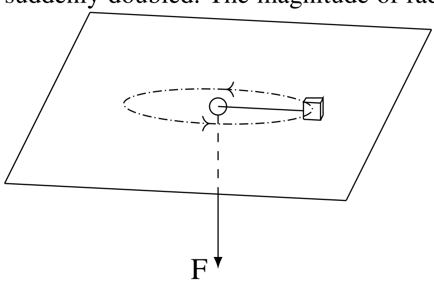
28) The moment of inertia tensor of a rigid body is given by $I = \begin{pmatrix} 8 & 0 & -4 \\ 0 & 4 & 0 \\ -4 & 0 & 8 \end{pmatrix}$. The magnitude of the moment of inertia about an axis $\hat{n} = \left(\frac{1}{2}, \frac{\sqrt{3}}{2}, 0\right)$ is

a) 6 b) 5 c) 2 d) $\frac{8}{3}$

29) A hoop of radius R is pivoted at a point on the circumference. The period of small oscillations in the plane of the hoop is

a) $2\pi\sqrt{\frac{2R}{g}}$ b) $2\pi\sqrt{\frac{R}{4g}}$ c) $2\pi\sqrt{\frac{R}{g}}$ d) $2\pi\sqrt{\frac{9R}{7g}}$

30) A mass m is constrained to move on a horizontal frictionless surface. It is set in circular motion with radius r_0 and angular speed ω_0 by an applied force $\vec{F}$ communicated through an inextensible thread that passes through a hole on the surface as shown in the figure. This force is suddenly doubled. The magnitude of radial velocity of the mass



a) increases till the mass falls into the hole
b) decreases till the mass falls into the hole
c) remains constant
d) becomes zero at a radius r_1 where $0 < r_1 < r_0$

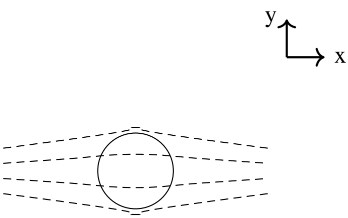
31) For a simple harmonic oscillator the Lagrangian is given by $L = \frac{1}{2}\dot{q}^2 - \frac{1}{2}q^2$. If $A(p,q) = \frac{p+iq}{\sqrt{2}}$ and $H(p,q)$ is the Hamiltonian of the system, the Poisson bracket $\{A(p,q), H(p,q)\}$ is given by

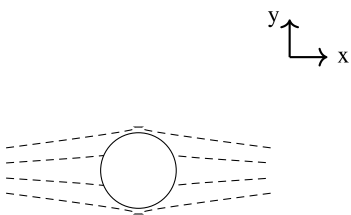
a) $iA(p,q)$ b) $A^*(p,q)$ c) $-iA^*(p,q)$ d) $-iA(p,q)$

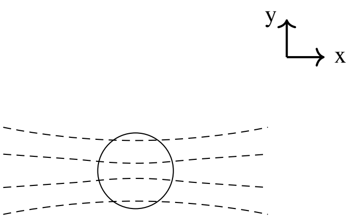
32) A plane electromagnetic wave is given by $E_0\left(\hat{x} + e^{i\delta}\hat{y}\right)\exp\{i(kz - \omega t)\}$. At a given location, the number of times $\hat{E}$ vanishes in one second is

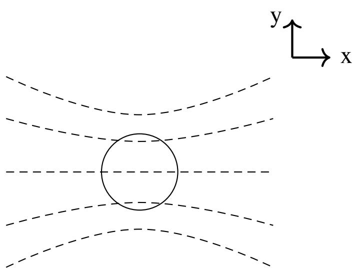
a) An integer near $\frac{\omega}{\pi}$ when $\delta = n\pi$ and zero when $\delta \neq n\pi$, n is integer
b) An integer near $\frac{\omega}{\pi}$ and is independent of δ
c) An integer near $\frac{\omega}{2\pi}$ when $\delta = n\pi$ and zero when $\delta \neq n\pi$, n is integer
d) An integer near $\frac{\omega}{2\pi}$ and is independent of δ

33) A dielectric sphere is placed in a uniform electrical field directed along the positive y-axis. Which of the following represents correct equipotential surfaces?

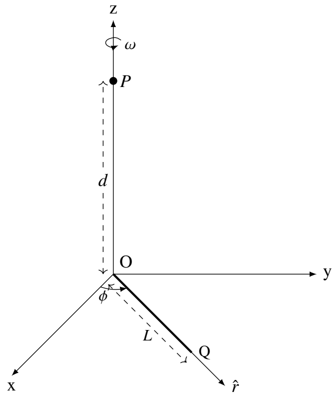
a) 

c) 

b) 

d) 

34) A rod of length L with uniform charge density λ per unit length is in the xy-plane and rotating about z-axis passing through one of its edge with an angular velocity $\vec{\omega}$ as shown in the figure below. $\left(\hat{r}, \hat{\phi}, \hat{z}\right)$ refer to the unit vectors at Q, $\vec{A}$ is the vector potential at a distance d from the origin O along z-axis for $d >> L$ and $\vec{J}$ is the current density due to the motion of the rod. Which of the following statements is correct?



a) $\overrightarrow{J}$ along $\hat{r}$; $\overrightarrow{A}$ along $\hat{z}$; $\left|\overrightarrow{A}\right| \propto \frac{1}{d}$

b) $\overrightarrow{J}$ along $\hat{\phi}$; $\overrightarrow{A}$ along $\hat{\phi}$; $\left|\overrightarrow{A}\right| \propto \frac{1}{d^2}$

c) $\overrightarrow{J}$ along $\hat{r}$; $\overrightarrow{A}$ along $\hat{z}$; $\left|\overrightarrow{A}\right| \propto \frac{1}{d^2}$

d) $\overrightarrow{J}$ along $\hat{\phi}$; $\overrightarrow{A}$ along $\hat{\phi}$; $\left|\overrightarrow{A}\right| \propto \frac{1}{d}$