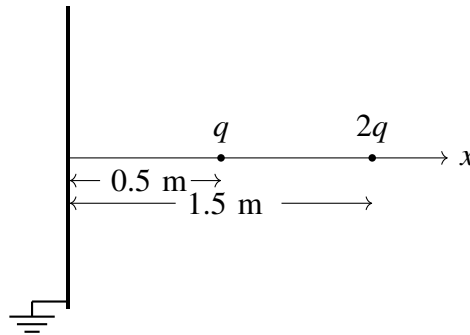


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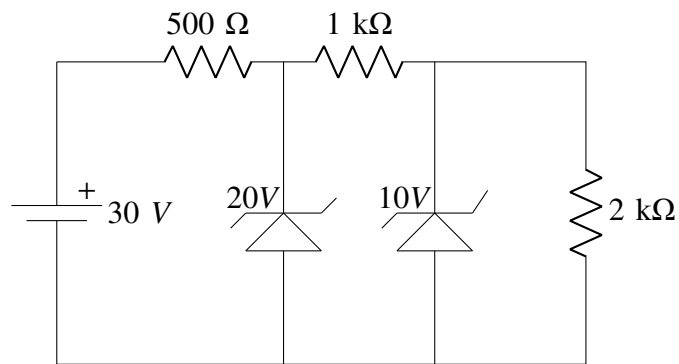
AI24BTECH11020 - Rishika

- 14) If L_x, L_y and L_z are respectively the x, y and z components of angular momentum operator L , the commutator $[L_x L_y, L_z]$ is equal to
- $i\hbar(L_x^2 + L_y^2)$
 - $2i\hbar L_z$
 - $i\hbar(L_x^2 - L_y^2)$
 - 0
- 15) The normalized ground state wavefunction of a hydrogen atom is given by $\psi(r) = \frac{1}{\sqrt{4\pi}} \frac{2}{a^{3/2}} e^{-\frac{r}{a}}$, where a is the Bohr radius and r is the distance of the electron from the nucleus, located at the origin. The expectation value $\langle \frac{1}{r^2} \rangle$ is
- $\frac{8\pi}{a^2}$
 - $\frac{4\pi}{a^2}$
 - $\frac{4}{a^2}$
 - $\frac{2}{a^2}$
- 16) Two charges q and $2q$ are placed along the x -axis in front of a grounded, infinite conducting plane, as shown in the figure. They are located respectively at a distance of $0.5m$ and $1.5m$ from the plane. The force acting on the charge q is



- $\frac{1}{4\pi\epsilon} \frac{7q^2}{2}$
 - $\frac{1}{4\pi\epsilon} 2q^2$
 - $\frac{1}{4\pi\epsilon} q^2$
 - $\frac{1}{4\pi\epsilon} \frac{q^2}{2}$
- 17) A uniform surface current is flowing in the positive y -direction over an infinite sheet lying in $x - y$ plane. The direction of the magnetic field is
- along \hat{i} for $z > 0$ and along $-\hat{i}$ for $z < 0$
 - along \hat{k} for $z > 0$ and along $-\hat{k}$ for $z < 0$
 - along $-\hat{i}$ for $z > 0$ and along \hat{i} for $z < 0$
 - along $-\hat{k}$ for $z > 0$ and along \hat{k} for $z < 0$
- 18) A magnetic dipole of dipole moment m is placed in a non-uniform magnetic field B . If the position vector of the dipole is r , the torque acting on the dipole about the origin is
- $r \times (m \times B)$
 - $r \times \nabla(m \cdot B)$

- c) $m \times B$
 d) $m \times B + r \times \nabla(m \cdot B)$
- 19) Which of the following expressions for a vector potential A DOES NOT represent a uniform magnetic field of magnitude B_0 along the z -direction ?
- a) $A = (0, B_0 x, 0)$
 b) $A = (-B_0 y, 0, 0)$
 c) $A = \left(\frac{B_0 x}{2}, \frac{B_0 y}{2}, 0\right)$
 d) $A = \left(-\frac{B_0 y}{2}, \frac{B_0 x}{2}, 0\right)$
- 20) A neutron passing through a detector is detected because of
- a) the ionization it produces
 b) the scintillation light it produces
 c) the electron - hole pairs it produces
 d) the secondary particles produced in a nuclear reaction in the detector medium
- 21) An atom with one outer electron having orbital angular momentum l is placed in a weak magnetic field. The number of energy levels into which the higher total angular momentum state splits, is
- a) $2l + 2$
 b) $2l + 1$
 c) $2l$
 d) $2l - 1$
- 22) For a multi-electron atom, l, L and S specify the one-electron orbital angular momentum, total orbital angular momentum and total spin angular momentum, respectively. The selection rules for electric dipole transition between the two electronic energy levels, specified by l, L and S are
- a) $\Delta L = 0, \pm 1; \Delta S = 0; \Delta l = 0, \pm 1$
 b) $\Delta L = 0, \pm 1; \Delta S = 0; \Delta l = \pm 1$
 c) $\Delta L = 0, \pm 1; \Delta S = \pm 1; \Delta l = 0, \pm 1$
 d) $\Delta L = 0, \pm 1; \Delta S = \pm 1; \Delta l = \pm 1$
- 23) For a three-dimensional crystal having N primitive unit cells with a basis of p atoms, the number of optical branches is
- a) 3
 b) $3p$
 c) $3p - 3$
 d) $3N - 3p$
- 24) For an intrinsic semiconductor, m_e^* and m_h^* are respectively the effective masses of electrons and holes near the corresponding band edges. At a finite temperature, the position of the Fermi level
- a) depends on m_e^* but not on m_h^*
 b) depends on m_h^* but not on m_e^*
 c) depends on both m_e^* and m_h^*
 d) depends neither on m_e^* nor on m_h^*
- 25) In the following circuit, the voltage across and the current through the $2K\Omega$ resistance are



- a) 20V, 10mA
- b) 20V, 5mA
- c) 10V, 10mA
- d) 10V, 5mA

I. Q.26 TO Q.55 CARRY TWO MARKS EACH.

26) The unit vector normal to the surface $x^2 + y^2 - z = 1$ at the point $\mathbf{P}(1, 1, 1)$ is

- a) $\frac{\hat{i} + \hat{j} - \hat{k}}{\sqrt{3}}$
- b) $\frac{2\hat{i} + \hat{j} - \hat{k}}{\sqrt{6}}$
- c) $\frac{\hat{i} + 2\hat{j} - \hat{k}}{\sqrt{6}}$
- d) $\frac{2\hat{i} + 2\hat{j} - \hat{k}}{3}$