GATE-2015-PH

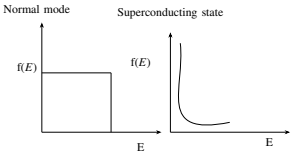
EE24BTECH11017-D.KARTHIK

40) The band gap of an intrinsic semiconductor is $E_g = 0.72eV$ and $m_h^* = 6m_e^*$. At $300K$, the Fermi level with respect to the valence band (in eV) is at _____ (upto three decimal places) $k_B = 1.38x10^{-23}JK^{-1}$

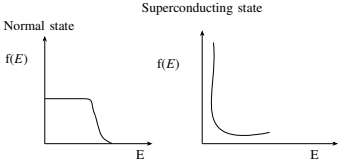
41) The number of permitted transitions from $^2P_{3/2} \rightarrow {}^2S_{1/2}$ in the presence of a weak magnetic field is _____

42) Which one of the following represents the electron occupancy for a superconductor in its normal and superconducting states? **diagrams**

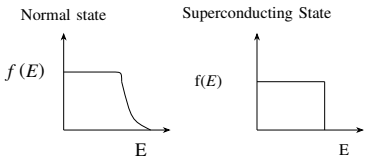
a)



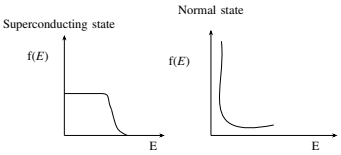
b)



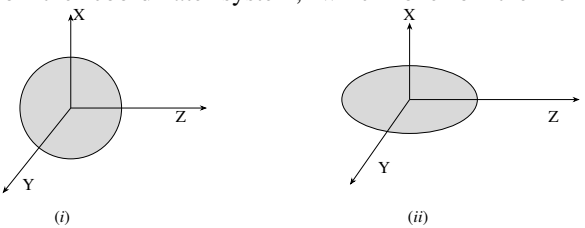
c)



d)



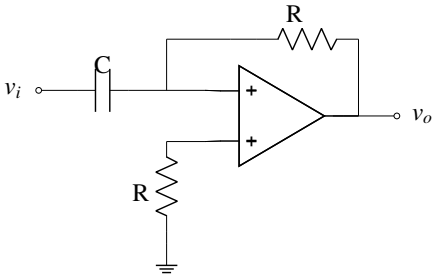
43) A charge $-q$ is distributed uniformly over a sphere, with a positive charge q at its center in (i). Also in (ii), a charge $-q$ is distributed uniformly over an ellipsoid with a positive charge q at its center. With respect to the origin of the coordinate system, which one of the following statements is correct?

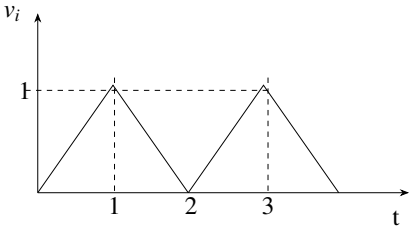


(i) (ii)

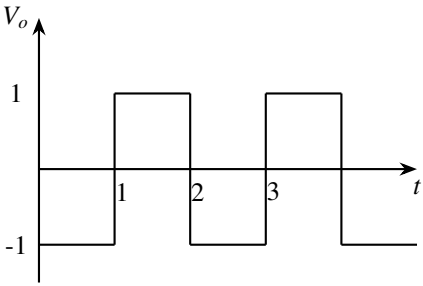
a) The dipole moment is zero in both (i) and (ii)
b) The dipole moment is non-zero in (i) but zero in (ii)
c) The dipole moment is zero in (i) but non-zero in (ii)
d) The dipole moment is non-zero in both (i) and (ii)

44) Consider the circuit shown in the figure, where $RC = 1$. For an input signal V_1 shown below, choose the correct V_o from the options:

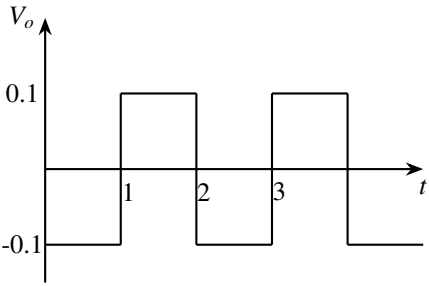




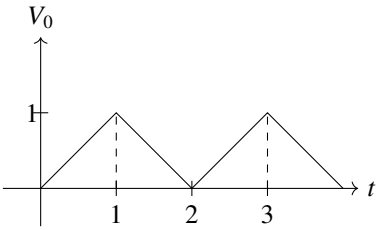
a)



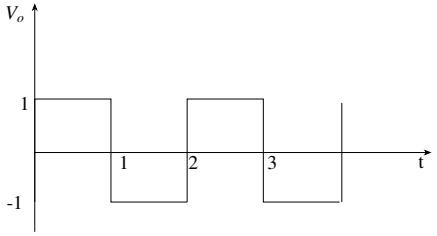
c)



b)



d)



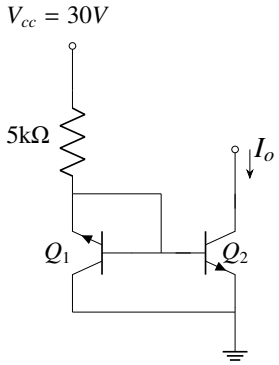
45) A long solenoid is embedded in a conducting medium and is insulated from the medium. If the current through the solenoid is increased at a constant rate, the induced current in the medium as a function of the radial distance r from the axis of the solenoid is proportional to

a) r^2 inside the solenoid and $\frac{1}{r}$ outside
b) r inside the solenoid and $\frac{1}{r^2}$ outside
c) r^2 inside the solenoid and $\frac{1}{r^2}$ outside
d) r inside the solenoid and $\frac{1}{r}$ outside

46) In the simple current source in the figure, Q_1 and Q_2 are identical transistors with current gain $\beta = 100$ and $V_{BE} = 0.7V$

47) Match the phrases in Group I and Group II and identify the correct option.

a) (P-i), (Q-ii), (R-iii), (S-iv)
b) (P-ii), (Q-i), (R-iv), (S-iii)
c) (P-iii), (Q-iv), (R-i), (S-ii)
d) (P-iii), (Q-i), (R-iv), (S-ii)



The cuurent I_0 (in mA) is _____ (upto two decimal places)

Group I	**Group II**
(P) Electron spin resonance (ESR)	(i) radio frequency
(Q) Nuclear magnetic resonance (NMR)	(ii) visible range frequency
(R) Transition between vibrational states of a molecule	(iii) microwave frequency
(S) Electronic transition	(iv) far-infrared range Â

48) Consider the motion of the Sun with respect to the rotation of the Earth about its axis. If $\overrightarrow{F_c}$ and $\overrightarrow{F}_{\mathbf{Co}}$ denote the centrifugal and the Coriolis forces, respectively, acting on the Sun, then

a) $\overrightarrow{F_c}$ is radially outward and $\overrightarrow{F}_{\mathbf{Co}} = \overrightarrow{F_c}$
b) $\overrightarrow{F_c}$ is radially inward and $\overrightarrow{F}_{\mathbf{Co}} = -\mathbf{2}\overrightarrow{F_c}$
c) $\overrightarrow{F_c}$ is radially outward and $\overrightarrow{F}_{\mathbf{Co}} = -\mathbf{2}\overrightarrow{F_c}$
d) $\overrightarrow{F_c}$ is radially outward and $\overrightarrow{F}_{\mathbf{Co}} = \mathbf{2}\overrightarrow{F_c}$

49) In a rigid-rotator of mass M, if the energy of the first excited state is $1meV$, then the fourth excited state energy (in meV) is _____

50) A plane wave $(\hat{x} + i\hat{y})\,\mathbf{E}_0 \exp[i(kz - \omega t)]$ after passing through an optical element emerges a $\omega t)]$, where k and ω are the wavevector and the angular frequency,respectively. The optica

a) quarter wave plate
b) half wave plate
c) polarizer
d) Faraday rotator

51) The Lagrangian for a particle of mass m at a position $\overrightarrow{r}$ moving with a velocity $\overrightarrow{v}$ is given by $L = \frac{m}{2}\overrightarrow{v}^{\mathbf{2}} + C\overrightarrow{r}.\overrightarrow{v} - \mathbf{V}(\mathbf{r})$, where $V(r)$is a potential and C is a constant. If $\overrightarrow{p}_{\mathbf{c}}$ is the canonical momentum, then its Hamiltonian is given by

a) $\frac{1}{2m}\left(\overrightarrow{p}_{\mathbf{c}} + C\overrightarrow{r}\right)^2 + V(r)$
b) $\frac{1}{2m}\left(\overrightarrow{p}_{\mathbf{c}} - C\overrightarrow{r}\right)^2 + V(r)$
c) $\frac{p_c^2}{2m} + V(r)$
d) $\frac{1}{2m}p_c^2 + C^2r^2 + V(r)$

52) The Hamiltonian for a system of two particles of masses m_1 and m_2 at $\vec{r}_1$ and $\vec{r}_2$ having velocities $\vec{v}_1$ and $\vec{v}_2$ is given by $H = \frac{1}{2}m_1 v_1^2 + \frac{1}{2}m_2 v_2^2 + \frac{C}{(\vec{r}_1 - \vec{r}_2)^2}\hat{z}.\left(\vec{r}_1 \times \vec{r}_2\right)$,where C is a constant. Which one of the following statements is correct?

a) The total energy and total momentum are conserved
b) Only the total energy is conserved
c) Only the total energy and the $z-$component of the total angular momentum are conserved
d) The total energy and total angular momentum are conserved