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AI24BTECH11011 - Himani Gourishetty

1) The ordinary differential equation
$$\left(1-x^2\right)y''-xy'+9y=0$$
has a regular singularity at
   a) -1
   b) 0
   c) +1
   d) no finite value of x
2) For a bipolar junction transistor, which of the following statements are true?
   a) Doping concentration of emitter region is more than that in collector and base region
   b) Only electrons participate in current conduction
   c) The current gain β depends on temperature
   d) Collector current is less than the emitter current
3) Potassium metal has electron concentration of $1.4\times10^{28}\ m^{-3}$ and the corresponding density of states at Fermi level is $6.2\times10^{46}\ Joule^{-1}m^{-3}$. If the Pauli paramagnetic susceptibility of Potassium is $n\times10^{-k}$ in standard scientific form, then the value of k (an integer) is ________
$\left(\text{Magnetic moment of electron is } 9.3\times10^{-24}JouleT^{-1};\ \text{permeability of free space is } 4\pi\times10^{-7}TmA^{-1}\right)$
4) A power supply has internal resistance R_S and open load voltage $V_S=5V$. When a load resistance R_L is connected the power supply, a voltage drop of $V_L=4V$ is measured across the load. The value of $\frac{R_L}{R_S}$ is ________ (Round off to the nearest integer)
5) Electric field is measured along the axis of a uniformly charged disc of radius 25 cm. At a distance d from the centre, the field differs by 10% from that of a infinite plane having same charge density. The value of d is _____ cm. (Round off to one decimal place)
6) In a solid, a Raman line observed at $300cm^{-1}$ has intensity of Stokes line four times that of the anti-Stokes line. The temperature of the sample is _____K. (Round of to nearest integer) $\left(1cm^{-1}\equiv1.44K\right)$
7) An electromagnetic pulse has pulse width of $10^{-3}s$. The uncertainty in the momentum of the correspoding photo is of the order of $10^{-N}kgms^{-1}$, where N is an integer. The value of N is ______________
$\left(\text{speed of light}=3\times10^{8}ms^{-1}, h=6.6\times10^{-}34Js\right)$
8) The wavefunction of a particle in a one-dimensional infinite well of size 2a at a certain time is $\varphi(x)=\frac{1}{\sqrt{6a}}[\sqrt{2}sin\left(\frac{\pi x}{a}\right)+\sqrt{3}cos\left(\frac{\pi x}{2a}\right)+cos\left(\frac{3\pi x}{2a}\right)]$. Probability of finding the particle in $n=2$ state at that time is _____% (Round off to the nearest integer)
9) A spectrometer is used to detect plasma oscillations in a sample. The spectrometer can work in the range of $3\times10^{12}rads^{-1}$ to $30\times10^{12}rads^{-1}$. The minimum carrier concentration that can be detected by using this spectrometer is $n\times10^{21}m^{-3}$. The value of n is ________ (Round off to two decimal places)
$\left(\text{Charge of an electron }=-1.6\times10^{-1}C, \text{mass of an electron }=9.1\times10^{-31}kg \text{ and } \epsilon_0=8.85\times10^{-12}C^2N^{-1}m^{-2}\right)$
10) Consider a non-interacting gas of spin 1 particles, each with magnetic moment μ, placed in a weak magnetic field B, such that $\frac{\mu B}{k_BT}<<1$. The average magnetic moment of a particle is
   a) $\frac{2\mu}{3}\left(\frac{\mu B}{k_BT}\right)$
   b) $\frac{\mu}{2}\left(\frac{\mu B}{k_BT}\right)$
   c) $\frac{\mu}{3}\left(\frac{\mu B}{k_BT}\right)$

d) $\frac{3\mu}{4}\left(\frac{\mu B}{k_B T}\right)$

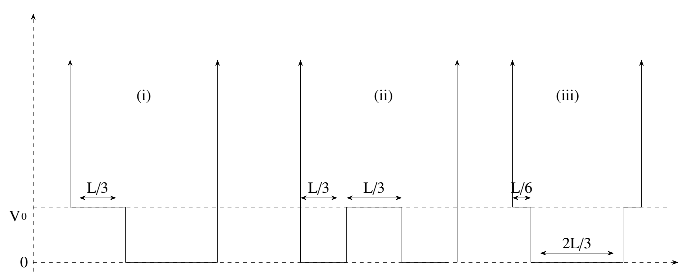
11) Water at 300 K can be brought to 320 K using one of the following processes.
Process 1: Water is brought in equilibrium with a reservoir at 320 K directly.
Process 2: Water is first brought in equilibrium with a reservoir at 310 K and then with the reservoir at 320 K.
Process 3: Water is first brought in equilibrium with a reservoir at 350 K and then with the reservoir at 320 K.
The corresponding changes in the entropy of the universe for these processes are ΔS_1, ΔS_2, ΔS_3 respectively. Then

a) $\Delta S_2 > \Delta S_1 > \Delta S_3$
b) $\Delta S_3 > \Delta S_1 > \Delta S_2$
c) $\Delta S_3 > \Delta S_2 > \Delta S_1$
d) $\Delta S_1 > \Delta S_2 > \Delta S_3$

12) A student sets up Young's double slit experiment with electrons of momentum p incident normally on the slits with width w separated by distance d. In order to observe interference fringes on a screen at a distance D from the slits, which of the following conditions should be satisfied?

a) $\frac{h}{p} > \frac{Dw}{d}$
b) $\frac{h}{p} > \frac{dw}{D}$
c) $\frac{h}{p} > \frac{d^2}{D}$
d) $\frac{h}{p} > \frac{d^2}{\sqrt{Dw}}$

13) Consider a particle in three different boxes of width L. The potential inside the boxes vary as shown in figures (i), (ii) and (iii) with $V_0 << \frac{h^2\pi^2}{2mL^2}$. The corresponding ground-state energies of the particle are E_1, E_2 and E_3, respectively. Then



a) $E_2 > E_1 > E_3$
b) $E_3 > E_1 > E_2$
c) $E_2 > E_3 > E_1$
d) $E_3 > E_2 > E_1$