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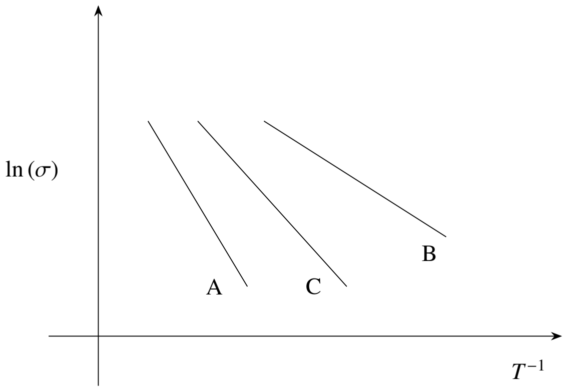
EE24BTECH11036 - Krishna Patil

27) The temperature dependence of the electrical conductivity (σ) of three intrinsic semiconductors A ,B and C is shown in the figure. Let E_a,E_b and E_c be the bandgaps



of A,B and C respectively . Which one of the following relations are correct ?

a) $E_c > E_a > E_b$
b) $E_b > E_c > E_a$
c) $E_a > E_b > E_c$
d) $E_a > E_c > E_b$

28) Following trial waveforms

$$\phi_1 = e^{Z'(r_1+r_2)}$$

and

$$\phi_2 = e^{Z'(r_1+r_2)}\left(1 + g\left|\overrightarrow{r_1} - \overrightarrow{r_2}\right|\right)$$

are used to get a variational estimate of the ground state energy of helium atom. Z' and g are variational parameters , $\overrightarrow{r_1}$ and $\overrightarrow{r_2}$ are position vectors of the electrons. Let E_0 be the exact ground state energy of helium atom. E_1 and E_2 are the variational estimates of the ground state energy of the helium atom corresponding to ϕ_1 and ϕ_2 respectively .Which one of the following options is true ?

a) $E_1 \leq E_0, E_2 \leq E_0, E_1 \geq E_2$
b) $E_1 \geq E_0, E_2 \leq E_0, E_1 \geq E_2$
c) $E_1 \leq E_0, E_2 \geq E_0, E_1 \leq E_2$
d) $E_1 \geq E_0, E_2 \geq E_0, E_1 \geq E_2$

29) The wave function for a particle is given by the form $e^{(i\alpha x+\beta t)}$, where α and β are real constants. In which one of the following potentials $V(x)$, the particle is moving?

a) $V(x) \propto \alpha x^2$
b) $V(x) \propto e^{(-\alpha x)}$
c) $V(x) = 0$
d) $V(x) \propto \sin \alpha x$

30) Consider a volume integral

$$I = \int_V \nabla^2 \left(\frac{1}{r}\right) dV$$

over a volume V, where $r = \sqrt{x^2 + y^2 + z^2}$. Which of the following statements is/are correct?

a) $I = -4\pi$, if $r = 0$ is inside the volume V
b) Integrand vanishes for $r \neq 0$
c) $I = 0$, if $r = 0$ is not inside the volume V
d) Integrand diverges as $r \to \infty$

31) The complex function $e^{-\frac{2}{z-1}}$ has

(A) a simple pole at $z = 1$
(B) an essential singularity at $z = 1$
(C) a residue equal to -2 at $z = 1$
(D) a branch point at $z = 1$

32) The minimum number of basic logic gates required to realize the Boolean expression $B \cdot (A + B) + A \cdot \left(\overline{B} + A\right)$ is ____________ (in integer).

33) The vapor pressure (P) of solid ammonia is given by $\ln(p) = 23.03 - \frac{3754}{T}$,while that of liquid ammonia is given by $\ln(p) = 29.49 - \frac{3063}{T}$,where T is the temperature in K.The temperature of the triple point of ammonia is ____________ K (rounded off to two decimal places).

34) The electric field in a region depends only on x and y coordinates as

$$E = k\frac{x\hat{x}+y\hat{y}}{x^2+y^2}$$

where k is a constant. The flux of E through the surface of a sphere of radius R with its center at the origin is $n\pi kR$, where the value of n is ______ (in integer).

35) The Hamiltonian of a system of N particles in volume V at temperature T is

$$H = \sum_{i=1}^{2N} a_i q_i^2 + \sum_{i=1}^{2N} b_i p_i^2$$

where a_i and b_i are positive constants. The ensemble average of the Hamiltonian is $\alpha N k_B T$, where k_B is the Boltzmann constant. The value of α is ______ (in integer).

36) Binding energy and rest mass energy of a two-nucleon bound state are denoted by B and mc^2, respectively, where c is the speed of light. The minimum energy of a photon required to dissociate the bound state is

a) B
b) $B\left(1+\frac{B}{2mc^2}\right)$
c) $B\left(1-\frac{B}{2mc^2}\right)$
d) $B-mc^2$

37) The spin-orbit interaction in a hydrogen-like atom is given by the Hamiltonian

$$H' = -k\overrightarrow{L}\cdot\overrightarrow{S}$$

where k is a real constant. The splitting between levels $^2p_{\frac{3}{2}}$ and $^2p_{\frac{1}{2}}$ due to this interaction is:

a) $\frac{1}{2}k\hbar^2$
b) $\frac{3}{2}k\hbar^2$
c) $\frac{3}{4}k\hbar^{22}$
d) $2k\hbar^2$

38) Consider the Lagrangian $L = m\dot{x}\dot{y} - m\omega_0^2 xy$. If p_x and p_y denote the generalized momenta conjugate to x and y, respectively, then the canonical equations of motion are:

a) $\dot{x}=\frac{p_x}{m}, \dot{p}_x=-m\omega_0^2 x, \dot{y}=\frac{p_y}{m}, \dot{p}_y=-m\omega_0^2 y$
b) $\dot{x}=\frac{p_x}{m}, \dot{p}_x=m\omega_0^2 x, \dot{y}=\frac{p_y}{m}, \dot{p}_y=m\omega_0^2 y$
c) $\dot{x}=\frac{p_y}{m}, \dot{p}_x=-m\omega_0^2 y, \dot{y}=\frac{p_x}{m}, \dot{p}_y=-m\omega_0^2 x$
d) $\dot{x}=\frac{p_y}{m}, \dot{p}_x=m\omega_0^2 y, \dot{y}=\frac{p_x}{m}, \dot{p}_y=m\omega_0^2 x$

39) The X-ray diffraction pattern of a monoatomic cubic crystal with rigid spherical atoms of radius $1.56A^\circ$ shows several Bragg reflections of which the reflection appearing at the lowest 2θ value is from (111) plane .If the wavelength of X-ray used is $0.78A^\circ$,the Bragg angle ($in 2\theta$, rounding off to one decimal place) corresponding to this reflection and the crystal structure ,respectively,are

a) 21.6° and Body centered cubic
b) 17.6° and face centered cubic
c) 10.8° and Body centered cubic
d) 8.8° and face centered cubic