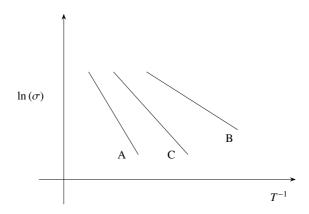
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EE24BTECH11036 - Krishna Patil

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) $E_1 \le E_0, E_2 \le E_0, E_1 \ge E_2$
- b) $E_1 \ge E_0, E_2 \le E_0, E_1 \ge E_2$
- c) $E_1 \le E_0, E_2 \ge E_0, E_1 \le E_2$
- d) $E_1 \ge E_0, E_2 \ge E_0, E_1 \ge E_2$

29) The wave function for a particle is give real constants. In which one of the follow	In by the form $e^{(i\alpha x + \beta t)}$, where α and β are ving potentials $V(x)$, the particle is moving?
a) $V(x) \propto \alpha x^2$	c) $V(x) = 0$
b) $V(x) \propto e^{(-\alpha x)}$	d) $V(x) \propto \sin \alpha x$

30) Consider a volume integral

$$I = \int_{V} v^{2} \left(\frac{1}{r}\right) dV$$

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 (C) a residue equal to -2 at z = 1
 - (B) an essential singularity at z = 1 (D) a branch point at z = 1
- 32) The minimum number of basic logic gates required to realize the Boolean expression $B \cdot (A + B) + A \cdot (\overline{B} + A)$ 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) $\frac{3}{4}k\hbar^{2^2}$
- 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) $\dot{x} = \frac{p_x}{p_x}, \dot{p}_x = m\omega_0^2 x, \dot{y} = \frac{p_y}{m}, \dot{p}_y = m\omega_0^2 y$ 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° 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 2θ , 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