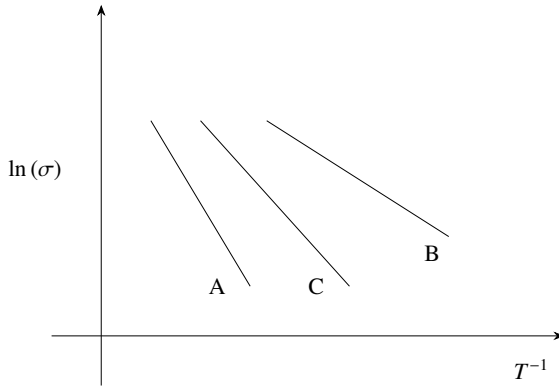


- 27) The temperature dependence of the electrical conductivity (σ) of three intrinsic semiconductors A, B and C is shown in the figure. Let E_a, E_b and E_c be the bandgaps



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

$$\phi_2 = e^{Z'(r_1+r_2)} \left(1 + g \left| \vec{r}_1 - \vec{r}_2 \right| \right)$$

are used to get a variational estimate of the ground state energy of helium atom. Z' and g are variational parameters, \vec{r}_1 and \vec{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) $E_1 \geq E_0, E_2 \geq E_0, E_1 \geq E_2$

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

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

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) $\frac{1}{5}k\hbar^2$
- b) $\frac{3}{2}k\hbar^2$
- c) $\frac{3}{4}k\hbar^2$
- 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) $\dot{x} = \frac{p_x}{m}, \dot{p}_x = m\omega_0^2 x, \dot{y} = \frac{p_y}{m}, \dot{p}_y = m\omega_0^2 y$
- 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 1.56\AA 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 0.78\AA , 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