

- (1) (a) Which brackets you use to represent crystallographic plane, equivalent planes, direction and equivalent directions? (2)
 (b) Show the possible sharing of tetrahedra by two silicate units. (1.5)
 (c) What do I , 2 and $/a$ denote in the space group $I2/a$? (1.5)
 (d) Graphically show the evolution of the space group 32 . (2)
 (e) Draw space group Pc with a parallelogram and motif 'R' as the motif in a monoclinic system. Write the symmetry operation in terms of x , y , z axes. (2)
 (f) What is the point group symmetry of a human body? (1)

Note: Use only Hermann-Mauguin notation for answering Q 1(c-f)

- (2) Fill in the blanks. Explain the terms wherever necessary. (5 × 1)

- (a) Reflection on the Ewald sphere is observed if -----.
 (b) If the incidence angle of an X-ray of wavelength 1.54 \AA is 45° , the scattering vector is -----.
 (c) In the real diffraction experiment with a crystal at the center of the Ewald sphere, the scattering vector $|K| = (2/\lambda)$ -----, where λ is the X-ray wavelength.
 (d) The information contained in the first and fourth Brillouin zones is the same because -----
 (e) In the plot of $\{P[(\sin \alpha)/\alpha] + \cos \alpha\}$ versus αa for electron in a periodic field of a crystal, if the potential barrier is very large, the electron behaves like -----.

- (3) (a) Using the energy expression of bound electron calculate and show first three allowed levels. (2)
 (b) Show free electron bands between wave vector $0 - \pi/a$ and calculate energy of the electron when $n = -2$ at $k_x = \pi/a$. (2)
 (c) Show by diagram the evolution of first two Brillouin zones from (i) extended zone scheme and (ii) reciprocal lattice vectors. (1+2)
 (d) Calculate the energy and show the overlapping of allowed energy bands when electron travels simultaneously at 15° and 60° to the k_x axis inside the first Brillouin zone. (2)
 (e) Draw the plot of $y = Px^2$, where P is a constant. (1)

- (4) Explain the synthesis procedure to for monodispersed semiconductor nanoparticles by taking CdSe as example----- (4)
 (5) Explain the phenomena ((a) carrier multiplication and (b) blinking in Q-dots ----- (4)
 (6) How do you create a chemical pattern of thiol molecules on gold surface. Please explain with diagram each step starting from creating PDMS stamp from the master pattern----- (4)
 (7) Explain in brief the principles of (a) Atomic force (b) scanning tunneling microscopes ----- (4)
 (8) Explain the mechanism of microwave heating and give 2 advantages over----- (3)
 (9) Explain the reason for the observation of hysteresis loop for larger ferromagnetic materials and the absence of same in the case of small nanoparticles----- (4)
 (10) The SAMs of long chain thiols are tilted to 30° in case of gold substrate whereas for silver substrate the tilt angle is very less. Explain----- (2)