

科目：材料科學[2921]

1. (a) Write down the electron configuration for each of the following elements, (40%) using only their atomic numbers: Li ($Z=3$), Al ($Z=13$), Ti ($Z=22$), Ni ($Z=28$), Cu ($Z=29$)
- (b) Which of the following materials has the lowest free energy and why? (i) Fe, (ii) Fe^{3+} , and (iii) Fe_2O_3
- (c) Consider atoms to be hard spheres in contact and calculate for body-centered-cubic packing, the following
- (i) the volume of the cubic unit cell in terms of an atom diameter D
- (ii) the number of atoms per unit cell
- (iii) the density in terms of number of atoms/ D^3
- (d) A piece of metal (bcc) is exposed to an x-ray radiation with a wavelength of $\lambda=0.154$ nm and a diffraction peak is observed at $2\theta=44.7^\circ$ from the $\{110\}$ plane, what is the lattice constant of the metal?
2. (a) A plastic material is stressed under a high stress of 1100 psi at 20°C for 40 (30%) days. When the stress is reduced to 700 psi at the constant strain, what is (i) the relaxation time constant, and (ii) the applied stress at the same temperature (20°C) for 60 days?
- (b) If it takes 0.5 h to soften a metallic alloy to 172 MPa at 230°C and 100 h at 190°C to reach the same strength, what is the activation energy for the process in kilojoules per mole? Given: gas constant, $R=8.314$ J/mol-deg
- (c) Consider a unit slip dislocation with a Burgers vector $\frac{a}{2}[\bar{1}10]$ on a (111) plane in a face-centered-cubic crystal, (i) what is the direction of the dislocation line, and (ii) how does the dislocation line ($\frac{a}{2}[\bar{1}10]$) split into two partial dislocations?
3. Explain the following definitions
- (30%)(a) Dendrite: (f) Carbon nanotube:
- (b) Martensite: (g) Etch pit:
- (c) Phase rule: (h) Eutectoid reaction:
- (d) p -type semiconductor: (i) Transistor:
- (e) Fermi level: (j) Curie temperature: