1. **Rank** and **explain** the magnitudes of the <u>diffusion coefficients from greatest to least</u> for the following systems: (1) N in Fe at 700°C (2) Cr in Fe at 700°C (3) N in Fe at 900°C (4) Cr in Fe at 900°C. (3, 7%) (*Note: Both Fe and Cr have the BCC crystal structure, and the atomic radii for Fe, Cr, and N are 0.124, 0.125, and 0.065 nm, respectively*)

2. **Identify** the defect in below figure (2%*5)
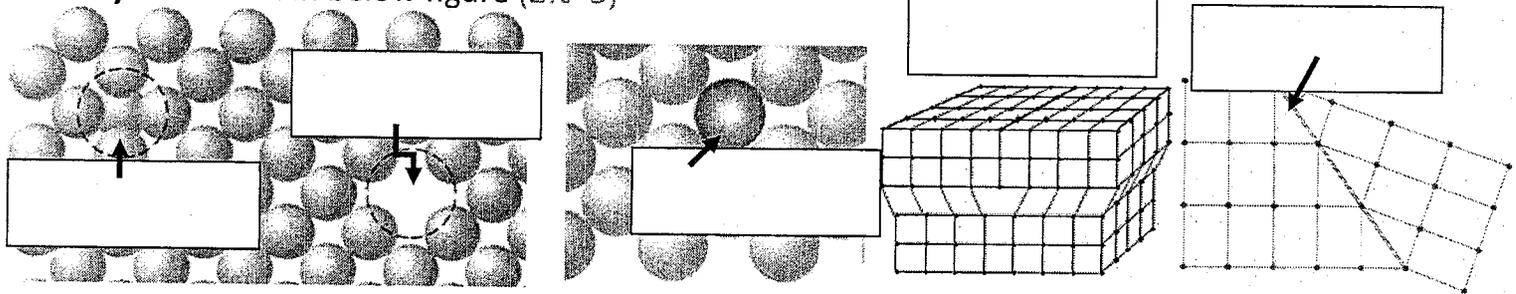
3. Is it possible to have a poly(methyl methacrylate) <u>homopolymer</u> with the following molecular weight data and a degree of polymerization of 530? Why or why not? (10%)
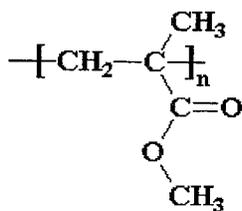
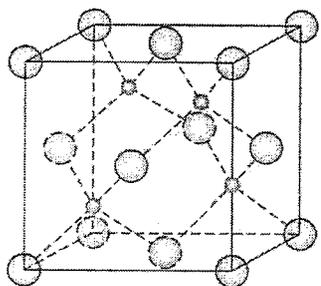| Molecular Weight Range (g/mol)	w_i	x_i
8,000–20,000	0.02	0.05
20,000–32,000	0.08	0.15
32,000–44,000	0.17	0.21
44,000–56,000	0.29	0.28
56,000–68,000	0.23	0.18
68,000–80,000	0.16	0.10
80,000–92,000	0.05	0.03

(*Note: Degree of polymerization (DP)= M_n /m, M_n is the number-average molecular weight and m is the molecular weight of the monomer unit*)
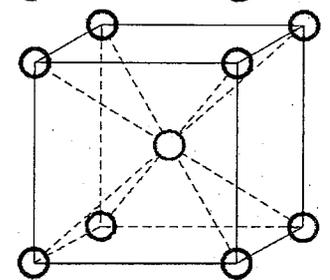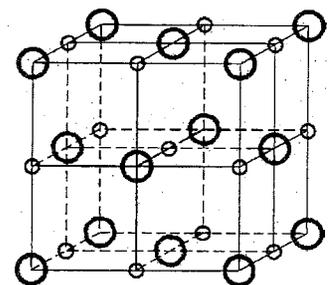
4. Match (2*4%)
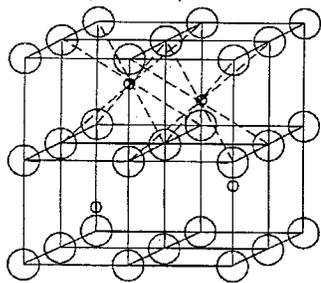
Cesium chloride

Zinc blende/ sphalerite

Rock salt

Fluorite

5. Identify the two crystal structure: Body-Centered Cubic (BCC) and Face-Centered Cubic (FCC). (*r:* radius of sphere and *a:* length of cube side) (2%*6)

Crystal Structure	Atom/ unit cell	The relation between r and a	Coordination number
BCC	(1)	(2)	(3)
FCC	(4)	(5)	(6)

6. On a tensile engineering stress – engineering strain plot of a ductile metal, indicate the following mechanical properties: (1) Yield strength, (2) Tensile strength, (3) Modulus of elasticity (5% × 3)

7. Briefly explain why HCP metals are typically more brittle than FCC and BCC metals. (8%)

8. Define the following terms: (1) strain hardening, (2) fracture toughness, and (3) heterogeneous nucleation. (5% × 3)

9. What is the driving force for grain growth of a polycrystalline material? (6%)

10. Plot a phase-transformation rate versus temperature curve. (6%)