MSE 170 A Midterm 10/27/2008 100pts. Total
Exam is closed book, closed notes, no collaborations with neighbors.

(One sheet of letter-size paper is allowed)

Instructions:

1. *Write your name and student ID on the top of the page.*
2. *Read the questions carefully.*
3. *Read the questions carefully, again.*
4. *Make sure you are answering the right questions.*
5. *Write legibly.*
6. *Show work as needed to justify answers.*
7. *After you are done, hand in your work and as once a wise man said: " Do a little dance, ……."*

Point Distribution (total=100)

Problem 1	*15*
Problem 2	*25*
Problem 3	*10*
Problem 4	*10*
Problem 5	*25*
Problem 6	*15*

Problem 1 (15 points): Bonding and interatomic forces

a. Referring to the periodic Table on page 11, determine what is the predominant type of bonding for BN (Boron Nitride), CsCl (Cesium Chloride), and solid Co. Why? (6)

b. Briefly describe the main differences between ionic, covalent, and metallic bonding (draw sketches and a few words)(5).

c. Explain why H_2O is liquid at room temperature (draw a cartoon of the molecules)(4).

Problem 2 (25 points): Crystal structures

a. What is a unit cell? (2)

b. Draw a unit cell for an FCC structure (3).

b. Determine the atomic packing factor for a FCC structure (make sure you draw the appropriate sketches and explain your answers) (10)

c. Draw a Sodium Chloride structure, and determine the type of unit cell and the coordination number for both cation and anion (5).

d. Determine the Miller indices for the planes in the unit cell shown in Figure 1(5).

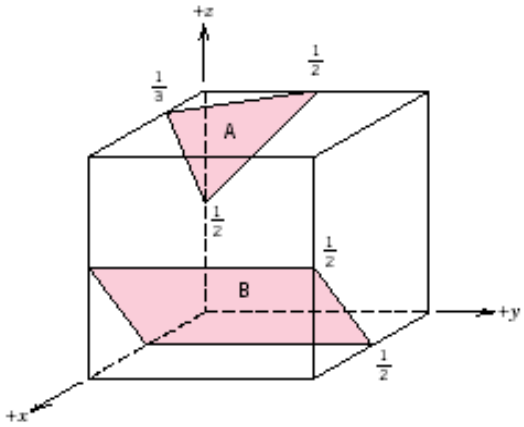
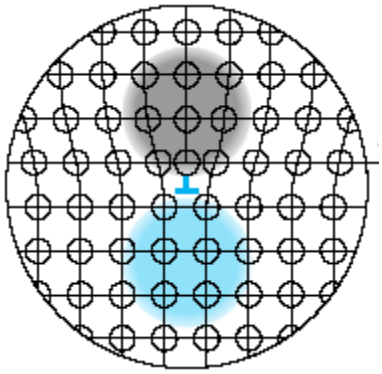


Figure 1

Problem 3 (10 points): Defects

a. List at least 3 types of defects that are present in solids. Which defect plays a major role in influencing plastic deformation of materials? (4)

b. Indicate the type the dislocation below, and label the dislocation line and slip plane. Indicate the type of stress above and below the slip plane. (6)



Problem 4 (10 points) Diffusion

a. Given Fick's first law of diffusion $J = -D\frac{dC}{dx}$ define all the quantities present in the equation and state which assumption was made to derive it (6).

b. Qualitatively describe the dependence of D on temperature and explain how this dependence relates to Q_d (diffusion activation energy) (4).

Problem 5 (25 points) Mechanical Properties

From the stress-strain plot for brass (a Cu-Zn alloy) shown in the Figure 2:

a. Estimate the modulus of elasticity and yield strength (put labels on graph)(8).

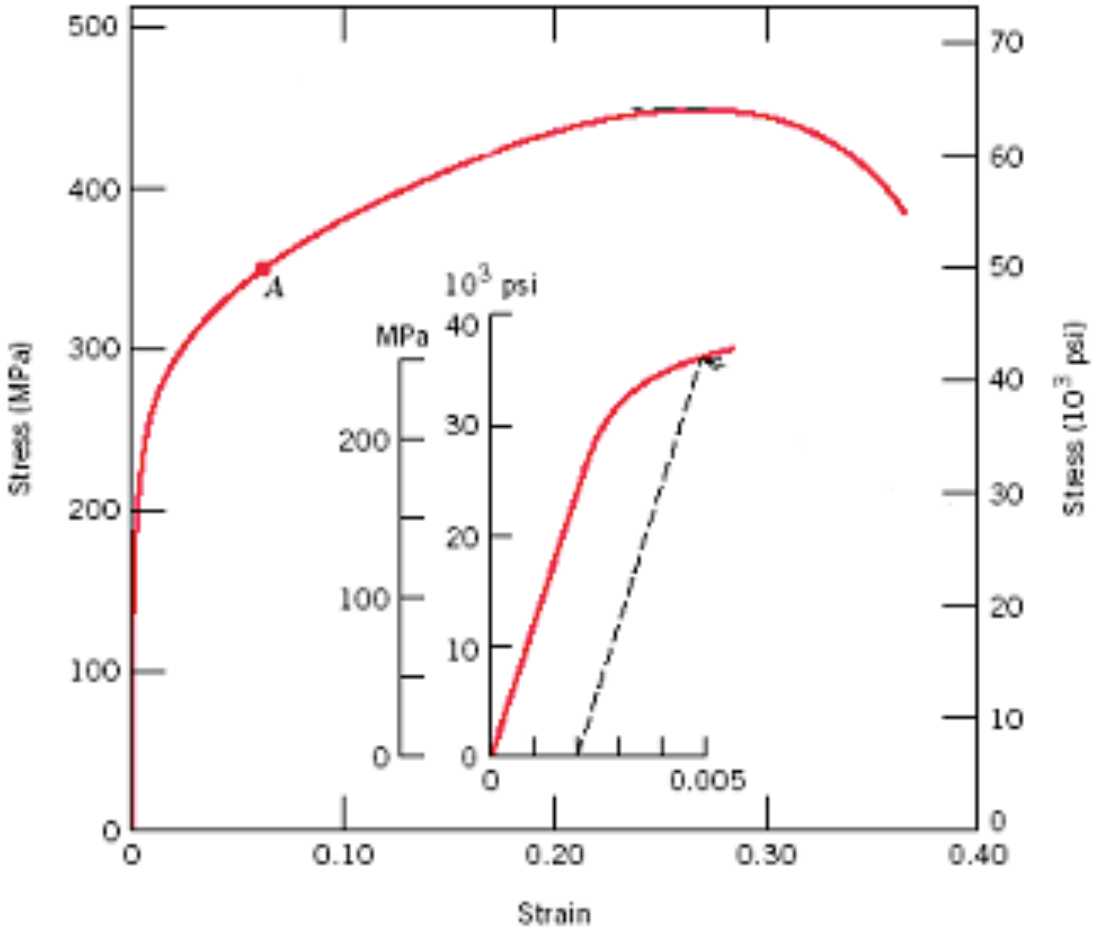


Figure 2. The stress-strain behavior for the brass specimen

b. Estimate the strain when a tensile load 100 MPa is applied on a cylindrical specimen. Is it elastic, plastic or both (explain)(5)?

c. Label tensile strength, resilience, toughness, and ductility on the figure and briefly explain their physical meaning (12).

Problem 6 (15 points). Plastic deformation and fracture

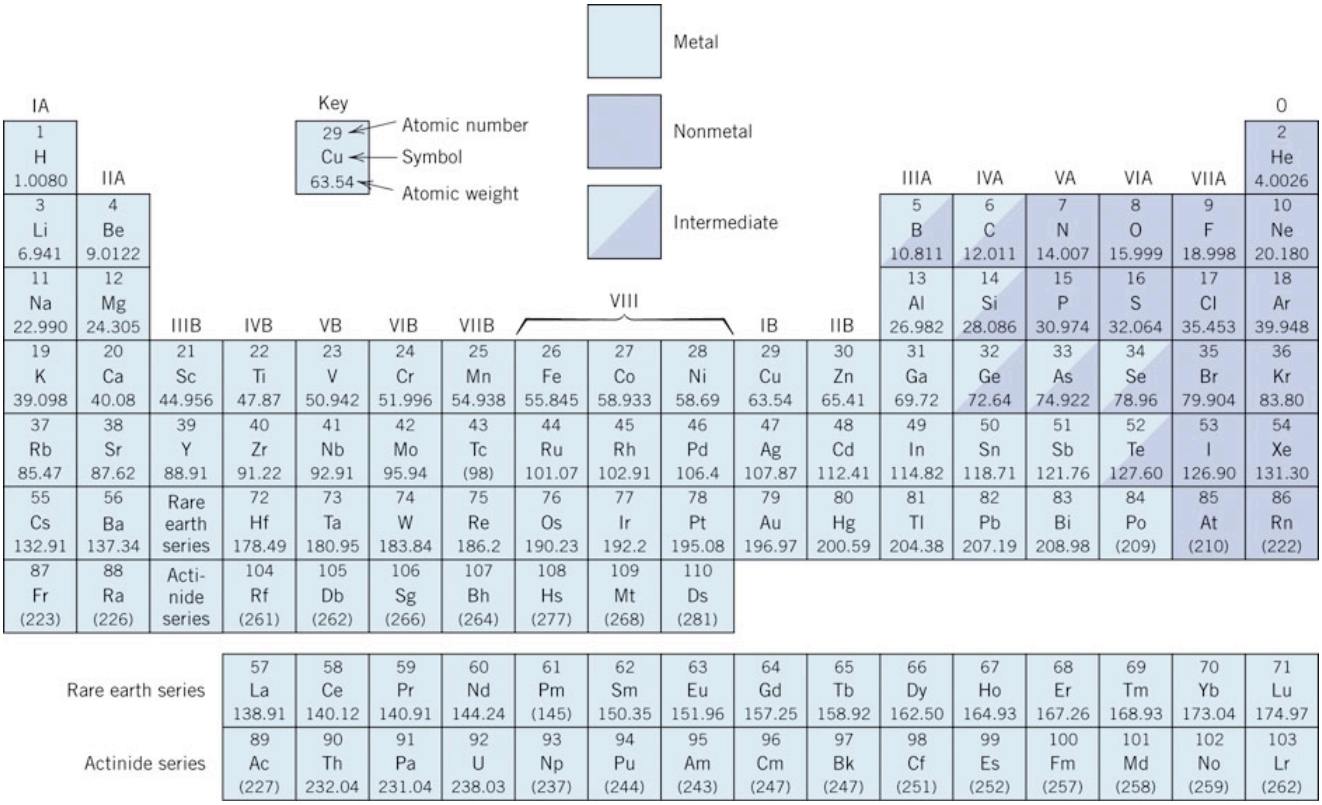
a. Complete the following sentence (2):

Virtually all strengthening techniques rely on this simple principle:

b. List three strategies to reduce dislocation motion and explain their mechanisms (you may draw sketches if you find it helpful)(9)

c. List the types of fracture modes (draw sketches for a sample exposed to a tensile stress) (2) For safety reasons, is one type more desirable than the other(s) (2)?

Periodic Table



IA							VIII										0
1 H 1.0080	IIA										IIIA	IVA	VA	VIA	VIIA	2 He 4.0026
3 Li 6.941	4 Be 9.0122										5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305	IIIB	IVB	VB	VIB	VIIB				IB	IIB	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.87	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.69	29 Cu 63.54	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.34	Rare earth series	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.2	76 Os 190.23	77 Ir 192.2	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.19	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	Acti-nide series	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (281)								

Rare earth series	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinide series	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Electronegativity

IA							VIII										0
H 2.1	IIA										IIIA	IVA	VA	VIA	VIIA	He –
Li 1.0	Be 1.5										B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne –
Na 0.9	Mg 1.2	IIIB	IVB	VB	VIB	VIIB				IB	IIB	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	Ar –
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.8	Ni 1.8	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	Kr –
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	Xe –
Cs 0.7	Ba 0.9	La–Lu 1.1–1.2	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.8	Bi 1.9	Po 2.0	At 2.2	Rn –
Fr 0.7	Ra 0.9	Ac–No 1.1–1.7															