Topic	Marks	U/B

Question 1

- Ceramics are covalently bound systems, meaning they are brittle and insulating. Metals are metallic bound giving free electrons for conduction of heat and electricity and making them malleable. — 4 — B
- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$ notice the 3d state fills — 2 — B
- 5% — 2 — B
- Graph — 5 — B
- it's a ductile material it shows a large amount of extension before fracture — 1 — B
- Engineering stress uses the Area at the beginning of the force pull, real stress corrects for changes in area — 2 — B

Numerical

- 1.89.4kN, — 2 — B
- 115.2 mm — 2 — B

Question 2

- U=Z1Z2Q^2 / 4(pi) e r. Where Z1 and Z2 are the number of lost or gained electrons (-1*1) and r is the separation — 2 — b
- 4 — b

$$\mu^{i} = -\frac{e^2}{4\pi\varepsilon_0 r}\left[6 - \frac{12}{\sqrt{2}} + \frac{8}{\sqrt{3}} - \frac{6}{2} + \cdots\right]$$
$$= -\frac{e^2}{4\pi\varepsilon_0 r}\left[6 - 8.485 + 4.619 - 3.000 + \cdots\right]$$

=1.675, this is not the given value because we have not included all the terms due to the NACL bond being above KT to about 60nm out, also we have not included secondary interactions.

- U=a/r^12-b/r^6. The 6 comes from free dipole dipole interactions (AKA Van Der Waals) The 12 is a hard sphere (Pauli exclusion principle limit) the 12 is actually just a fast rising function — 6 — b
- 4 — b

$$u = \frac{b}{r^n} - \frac{a}{r^m}$$

$$\frac{du}{dr} = \left(\frac{b}{r^n} - \frac{a}{r^m}\right)' = \left(\frac{b}{r^n}\right)' - \left(\frac{a}{r^m}\right)' = (br^{-n})' - (ar^{-m})' = -nbr^{-n-1} + mar^{-m-1}$$

$$\frac{du}{dr} = 0$$
$$-nbr^{-n-1} + mar^{-m-1} = 0$$
$$nbr^{-n-1} = mar^{-m-1}$$
$$\frac{nb}{ma} = \frac{r^{-m-1}}{r^{-n-1}}$$

$$\frac{nb}{ma} = r^{-m-1} \cdot r^{n+1}$$
$$\frac{nb}{ma} = r^{-m-1+n+1}$$
$$\frac{nb}{ma} = r^{n-m}$$
$$r^{n-m} = \frac{nb}{ma}$$

n, m are positive integer numaers,

so we can take the $(n-m)^{\text{th}}$root:

$$r = \sqrt[n-m]{\frac{nb}{ma}} \quad \text{or} \quad r = \left(\frac{nb}{ma}\right)^{\frac{1}{n-m}}$$

This is done for any value of m and n the answer will sub in 6 and 12

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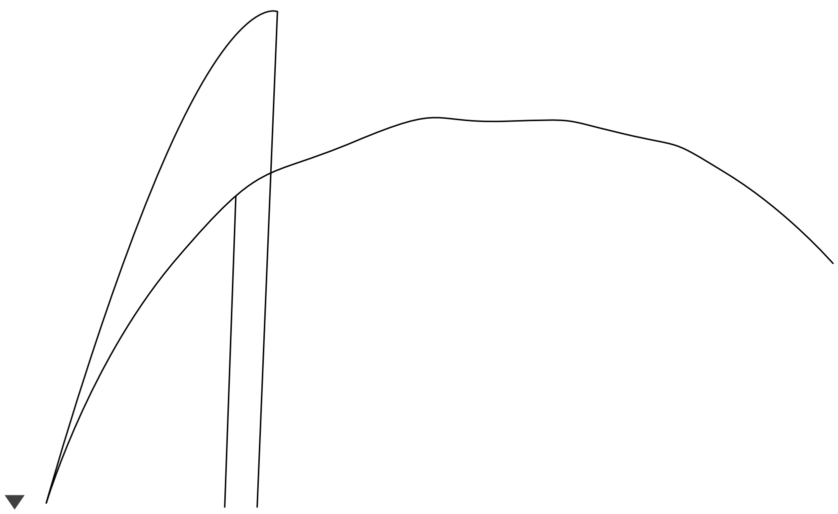
• Take the lenard jones and differentiate it to get force (DU/DR), then differentiate it gain to get change in force as a function of displacement which is the Young's Moduls. Then set the radius to be the value derived above	4	b
▼ Question 3		
• Material B will experience the greatest percent area reduction since it has the highest strain at fracture, and, therefore is most ductile	4	B
• Material D is the strongest because it has the highest yield and tensile strengths.	2	B
• Material E is the stiffest because it has the highest elastic modulus.	2	B
• 5600 N (calculate the required elongation (Strain) in Z from the Poisson ratio. The use this in hooks law to get strs, then from the stress calculate the force.	4	B
• 16%	2	B
▼ 5600 /(2*pi*(10.7/2)^2	2	B
	4	B



- The resilience is the area under the gap up to the plastic limit (not fracture)

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▼ Question 4		
▼ A		
• Draw the diagram of water moving through a surface A1 at height H1. Then moving on to A2 at H2.	6	B
• The total energy of the first section is Kinetic + potential = 1/2 (DM)*V^2+DM*g*H1. Same for the second area.		
• Then E1-E2 = the work done by the system		
• Which is Force X distance = Presure * area * velocity * time		
• work done on system is P1* DM/ density		
• work done by system = P2*Dm/density		

Topic	Marks	U/B
• $W_{on} - W_{out} = \frac{p_1 \bullet \Delta m}{\rho} - \frac{p_2 \bullet \Delta m}{\rho}$		
• $E_2 - E_1 = \Delta m \bullet \left[\frac{1}{2} (v_2^2 - v_1^2) + g(y_2 - y_1) \right]$		
• $P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2$		
• The top of the wing has a large are on one side and a smaller area on the other. This means that the water flows faster across that surface than the other. From BE asuming that the height is the same we can see that a difference in velocity	B	U
• $\frac{\delta C}{\delta t} = D \frac{1}{r^2} \frac{\delta}{\delta r} \left(r^2 \frac{\delta C}{\delta r} \right)$	2	B
• Steady state so D2C =0		
• so		
$0 = \frac{1}{r^2} \frac{\delta}{\delta r} \left(r^2 \frac{\delta C}{\delta r} \right)$		
• at r=a concentration =0 (absorber)		
• $C_{(r)} = C_0 \left(1 - \frac{a}{r} \right)$		

Topic	Marks	U/B
• We know the relation between Flux is J=-D(dc/dr) (flux equation)		
• so		
$$J_{(r)} = -DC_0\left(\frac{a}{r^2}\right)$$		
• The adsorption rate is -J(a) as its towards the sphere and dependent on are we Have		
• I=4(pi)Da(Co)		
▼ Question 5		
• An alloy is a blend of materials where one is a metal. A compound is a chemically bonded mixture of elements. Alloys alter the properties of a material by structural (changes in the lattice) alteration. Compounds provide new materials normally with little relationship (in properties) to the original elements. (AlO3)	4	B/U
• The first liquid forms at the temperature at which a vertical line at this composition intersects the alpha-(alpha + *L*) phase boundary—i.e., about 1350 degrees C.	2	B/U
• The composition of this liquid phase corresponds to the intersection with the ([illegible] + *L*)-*L* phase boundary, of a tie line constructed across the alpha + *L* phase region at 1350 deg C—i.e., 59 wt% Ni;	2	B/U
• Complete melting of the alloy occurs at the intersection of this same vertical line at 70 wt% Ni with the (alpha + *L*)-*L* phase boundary—i.e., about 1380 deg C	4	B/U
• The composition of the last solid remaining prior to complete melting corresponds to the intersection with alpha-(alpha + *L*) phase boundary, of the tie line constructed across the alpha + *L* phase region at 1380 degC—i.e., about 78 wt% Ni.	4	B/U
• It is *not possible* to have a Cu-Ni alloy, which at equilibrium, consists of a liquid phase of composition 20 wt% Ni-80 wt% Cu and an alpha phase of composition 37 wt% Ni-63 wt% Cu. From Figure 10.3*a*, a single tie line does not exist within the alpha + *L* region that intersects the phase boundaries at the given compositions. At 20 wt% Ni, the *L*-(alpha + *L*) phase boundary is at about 1200 deg C, whereas at 37 wt% Ni the (*L* + alpha)-alpha phase boundary is at about 1225 deg C	4	U
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