

國立臺灣科技大學
113學年度碩士班招生
試題

系所組別：0350機械工程系碩士班戊組

科目：材料原理

<<503501>>



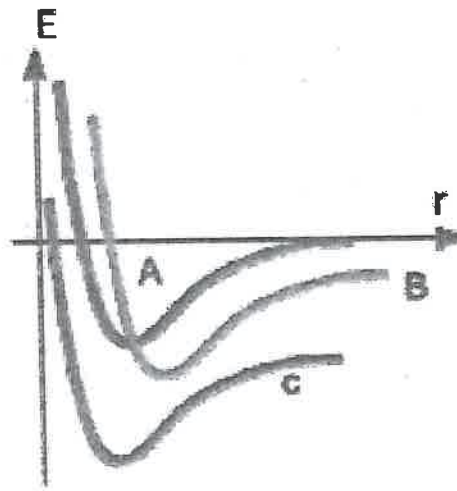
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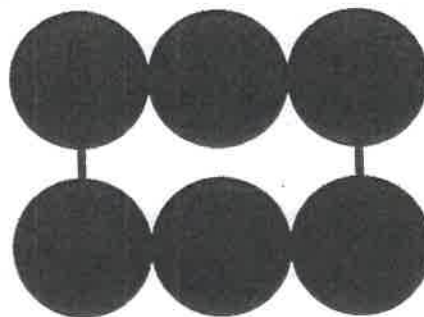
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(總分為 100 分；所有試題務必於答案卷內頁依序作答，否則不予計分)

1. (15%) According to the graph below, three different materials (A, B, and C) is present: E is defined as potential energy and r is defined as interatomic distance
- (a) (5%) Which material has the highest equilibrium distance between atoms? _____
- (b) (5%) Which material has the lowest melting point? _____
- (c) (5%) Which material has the highest bonding energy? _____



2. (5%) If the atomic radius of Pb is 0.175nm (FCC), calculate the volume of its unit cell in cubic meters.
3. (10%) The drawing below shows the arrangements of atoms on the { _____ } of a _____ metal. (5% each)



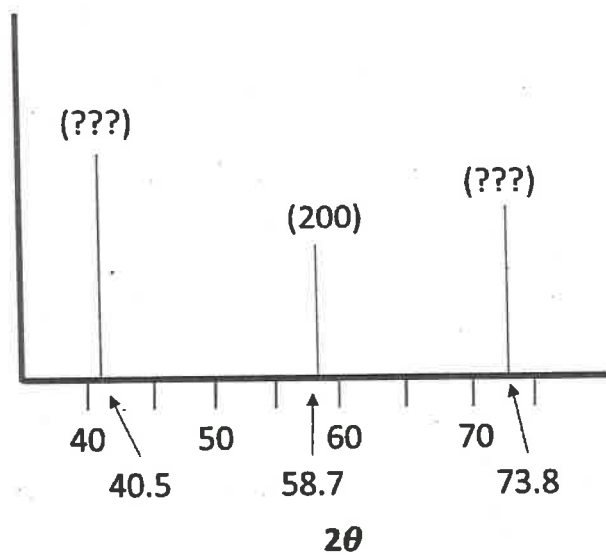
4. (20%) The figure below represents an x-ray diffraction pattern for a pure cubic metal collected using x-ray radiation of wavelength $\lambda = 0.154 \text{ nm}$.

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- (a) (10%) Determine the metal's crystal structure and provide the Miller's indices for the peaks at 40.5° and 73.8° two theta. Be sure to show your work.
- (b) (10%) Using the table below, determine the metal represented in the diffraction pattern above. Use a calculation to support how you made your choice.

Metal	Crystal Structure	Atomic radius (nm)
Molybdenum	BCC	0.136
Iron	BCC	0.124
Niobium	BCC	0.143
Aluminum	FCC	0.143
Nickel	FCC	0.125
Lead	FCC	0.175

5. (10%) When performing a hardness test, the spacing between the indentations should be 3 to 5 times of the indentation diameter. Why?
6. (12%) The following figure presents three lines (A, B and C) about the relationship between Y vs. X for metals.
- (a) (4%) When X is grain size and Y is yield strength, which line is more reasonable and why?
- (b) (4%) When X is amount of solute atoms in a solid solution and Y is thermal conductivity, which line is more reasonable and why?

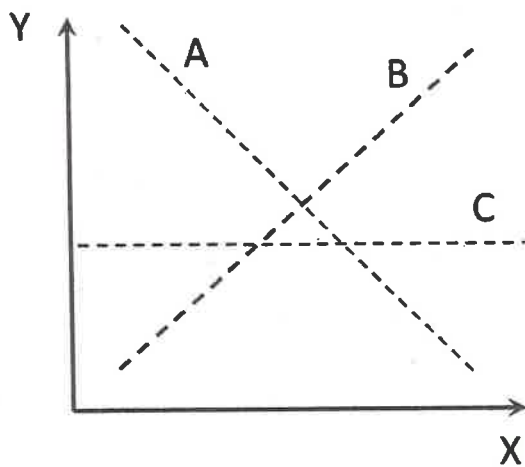


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(c) (4%) When X is amount of solute atoms in a solid solution and Y is thermal conductivity, which line is more reasonable and why?

7. (8%) Explain why ruby is red in color.
8. (12%) Three types of three-phase invariant reactions can be found at 727 °C, 1147 °C and 1493 °C in a Fe-C phase diagram. Phases in a Fe-C system are L (liquid), α , γ , δ and Fe_3C . Please describe these reactions by giving the names of the reactions and their equations as well as sketching a brief phase diagram characteristic. An example has been given in the table. (1% for each of name of reaction, 1% for each of equation, and 2% for each of phase diagram characteristic, 12% total)

Temperature (°C)	Name of reaction	Equation	Phase diagram characteristic
-	Monotectic	$L_1 \rightarrow \alpha + L_2$	
1493			
1147			
727			



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9. (8%) Which of the following diffusion systems has a higher magnitude of the diffusion coefficient? Please justify your answer.
- C in Fe at 900 °C
C in Fe at 1000 °C
- (Below 912 °C, BCC iron exists. Between 912 and 1394 °C, FCC iron exists. The atomic radius of C and Fe are 0.071 nm, and 0.124 nm, respectively.)

