UNIVERSITY OF JOHANNESBURG

SCHOOL OF MINES

ENGINEERING METALLURGY

NATIONAL DIPLOMA: ENGINEERING METALLURGY

SUBJECT:	PHYSICAL METALLURGY 1
CODE:	PMY 11-1
EXAMINER:	TS TSHEPHE
MODERATOR:	Dr D NYEMBWE
DATE	: SUMMER EXAMINATION 2017 20 NOVEMBER 2017
DURATION	: (SESSION 2) 12:30 - 15:30

INSTRUCTIONS:

1. Answer all questions.
2. Calculators are permitted

QUESTION 1

1.1. Explain the difference between the terms materials science and materials engineering? (4)

1.2. Classify engineering materials into five groups and state at least two examples for each group (10)

QUESTION 2

2.1. Explain the relationship between the binding energy and mechanical properties i.e. modulus of elasticity, melting point and yield strength. (6)

2.2. State if the following statements are true or false

(a) Materials with high binding energy have high strength and high melting temperature (2)

(b) Metals have lower binding energy due to electronegativities of atoms are similar (2)

(c) Ionically bonded materials have large binding energy (2)

(d) The energy required to create or break the bond is known as the binding energy (2)

2.3. The density of potassium, which has the BCC structure, is 0.855 g/ cm^3, the atomic weight of potassium is 39.09 g/ mol. Calculate

(a) The lattice parameter; (5)

(b) The atomic radius of potassium. (5)

QUESTION 3

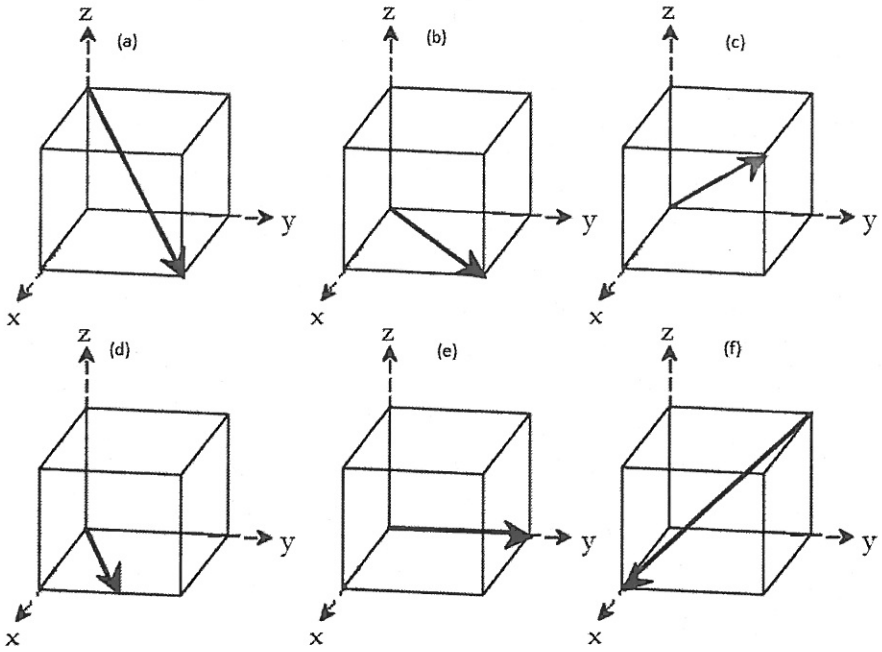
3.1. With a simple illustration of a diagram, determine the relationship between atomic radius and lattice parameters:

(a) Simple cubic (SC) (3)

(b) Body centered cubic (BCC) and (3)

(c) Face centered cubic (FCC) (3)

3.2. Name the following directions (Figure a-f) (12)



QUESTION 4

4.1. Define the following terms:

(a) Nucleation (2)

(b) Critical radius (2)

(c) Undercooling (2)

4.2. Calculate the size of the critical radius and the number of atoms in the critical nucleus when solid copper forms by homogeneous nucleation.
Assume that the lattice parameter of the solid FCC copper is 0.3615 nm
(10)

4.3. Sketch the cooling curve for a pure metal that has not been well inoculated and explain all segments of the curve (10)

QUESTION 5

5.1. Explain the five most important three-phase reactions in binary phase diagrams using equations and sketches (15)

5.2. Draw and fully label the Lead-tin phase diagram (15)

TOTAL: **[115]**

TABLE 9-1 ■ *Values for freezing temperature, latent heat of fusion, surface energy, and maximum undercooling for selected materials*

	Freezing Temperature (T_m)	Heat of Fusion (ΔH_f)	Solid-Liquid Interfacial Energy (σ_{sl})	Typical Undercooling for Homogeneous Nucleation (ΔT)
Metal	(°C)	(J/cm^3)	(J/cm^2)	(°C)
Ga	30	488	56×10^{-7}	76
Bi	271	543	54×10^{-7}	90
Pb	327	237	33×10^{-7}	80
Ag	962	965	126×10^{-7}	250
Cu	1085	1628	177×10^{-7}	236
Ni	1453	2756	255×10^{-7}	480
Fe	1538	1737	204×10^{-7}	420
NaCl	801			169
CsCl	645			152
H_2O	0			40

$$r^* = \frac{2\sigma_{sl}T_m}{\Delta H_f \Delta T}$$