UNIVERSITY OF JOHANNESBURG

SCHOOL OF MINES

ENGINEERING METALLURGY

NATIONAL DIPLOMA: ENGINEERING AND EXTRATIVE METALLURGY

SUBJECT:		PHYSICAL METALLURGY I
CODE:		PMY 11-1
DATE	:	SUMMER SSA EXAMINATION 2017 10 JANUARY 2017
DURATION	:	(SESSION 3) 15:00 - 18:00
EXAMINER:		TS TSHEPHE
MODERATOR:		Dr. K NYEMBWE

INSTRUCTIONS:

1. This paper consist of 3 pages
2. Answer all questions.
3. Calculators are permitted

QUESTION 1

1.1. There are five different classes of materials in material science. List the five classes and give two examples each (10)

1.2. Explain the materials design and selection process (6)

QUESTION 2

2.1. Sketch tensile stress strain curves for the following materials:

(a) Metal (2)

(b) Thermoplastic materials (2)

(c) Elastomer (2)

(d) Ceramics, glasses and concrete (2)

2.2. List five properties that can be obtained from tensile tests and explain each property (15)

2.3. Explain the difference between hot and cold working (10)

2.4. Sketch a cooling curve for a pure metal and label the different regions (12)

QUESTION 3

3.1. Suppose that liquid iron is undercooled until homogeneous nucleation occurs. Calculate

(a) the critical radius of the nucleus required; and (3)

(b) the number of iron atoms in the nucleus. (7)

Assume that the lattice parameter of the solid BCC iron is 2.92 Å.

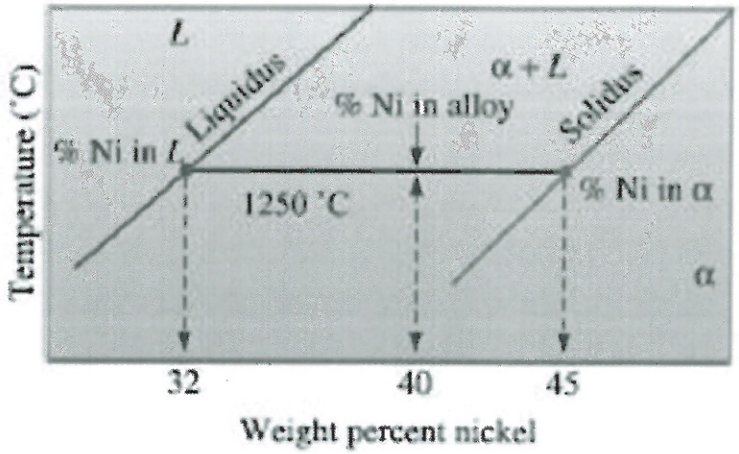
QUESTION 4

4.1. Explain the most important three-phase reactions in binary phase diagrams using equations and sketches (10)

4.2. Draw and fully label the Fe-Fe_3C phase diagram (15)

QUESTION 5

5.1. Calculate the amount of α and L at 1250 °C in the Cu-40 % Ni shown diagram below, using the lever rule (5)



TOTAL: **[101]**

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

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