UNIVERSITY OF JOHANNESBURG
EXAM 2014

COURSE: ENGINEERING — **TIME: 3 HOURS**
QUESTION PAPER: SCIENCE OF MATERIALS 2B — **FULL MARKS: 90**
EXAMINERS: 1. Prof. RF LAUBSCHER
2. Me. N JANSE VAN RENSBURG

This paper consists of 4 pages

ALL QUESTIONS MUST BE ANSWERED
NON PROGRAMABLE CALCULATORS MAY BE USED

1.

Illustrate diagrammatically the global materials cycle for a steel spade?

(5)

2.

Briefly describe the following:

- Fick's first law
- Extrinsic semiconductivity
- Dispersed phase
- Matthiessen's rule
- Structural composite

(15)

3.

Sketch $(0\bar{2}0)$ and $[0\,\bar{1}\,\bar{1}]$ in a cubic unit cell?
Calculate the appropriate linear packing fraction and planar packing fraction for the direction and plane as sketched above for a body centered cubic crystal structure?

(8)

4.

What is the difference between engineering stress and strain and true stress and strain? Derive expressions for true stress and strain so that $\sigma_{true} = f(\sigma_{eng}, \varepsilon_{eng})$ and $\varepsilon_{true} = f(\varepsilon_{eng})$.

(6)

2/...

COURSE: ENGINEERING
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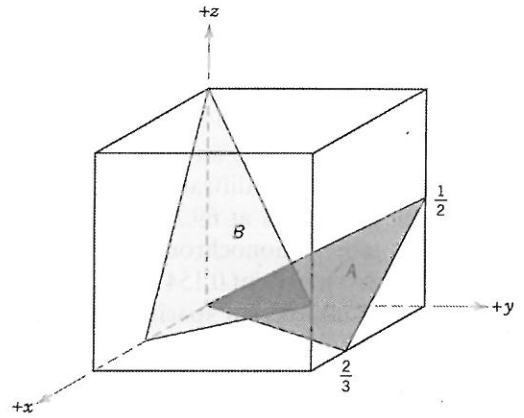
5.

Determine the Miller indices for the planes in the following unit cell:

(6)



6.

The diffusion coefficient for copper in aluminum at 400 and 500 K is 5.0×10^{-14} and 5.5×10^{-13} m^2/s, respectively. Determine the approximate time at 400 K that will produce the same result (in terms of concentration at a specific point) as a 10 hour heat treatment at 500 K.

(6)

$$\frac{C_x - C_0}{C_s - C_0} = 1 - erf\left(\frac{x}{2\sqrt{Dt}}\right)$$

Tabulation of Error Function Values

z	$erf(z)$	z	$erf(z)$	z	$erf(z)$
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

3/...

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7.

Briefly introduce and describe the three most important mechanisms of strengthening in metals. Can any of these be reversed? If so, briefly describe how?

(12)

8.

Calculate the composition in weight and atomic percent of an alloy that contains 150 g of chromium, 70 g of nickel and 1.2 kg of iron. The atomic weights are as follows: Cr: 52 g/mol, Ni: 58.7g/mol and Fe: 55.85g/mol. $N_A = 6.023 \times 10^{23}$.

(6)

9.

Briefly describe the different manufacturing techniques utilized to manufacture metallic products.

(10)

10.

Sketch the basic units (mers) of the following polymers.

a. polyethylene
b. polyvinyl chloride
c. polytetrafluoroethylene
d. polypropylene
e. polystyrene

(5)

11.

Name and briefly explain the aim of the different polymer additives?

(10)

12.

Resistance is an electrical material property. Discuss this statement?

(4)

Total (93)

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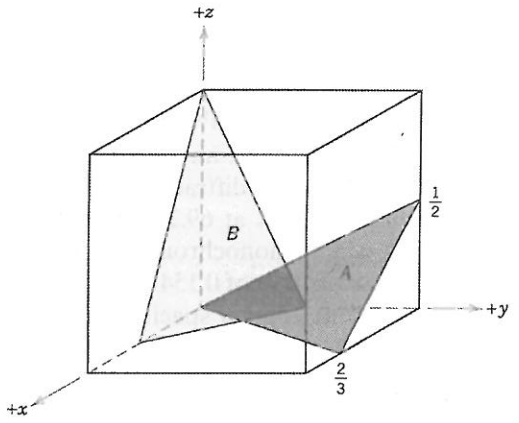

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