UNIVERSITY EXAMINATIONS

UNIVERSITEITSEKSAMENS

UNISA university of south africa

SMI181Q (480840) October/November 2017

SCIENCE: MINING I

Duration : 2 Hours 100 Marks

EXAMINERS :
FIRST : DR LL NOTO
SECOND : PROF BM MOTHUDI

MEMO

Use of a non-programmable pocket calculator is permissible.

Closed book examination.

This examination question paper remains the property of the University of South Africa and may not be removed from the examination venue.

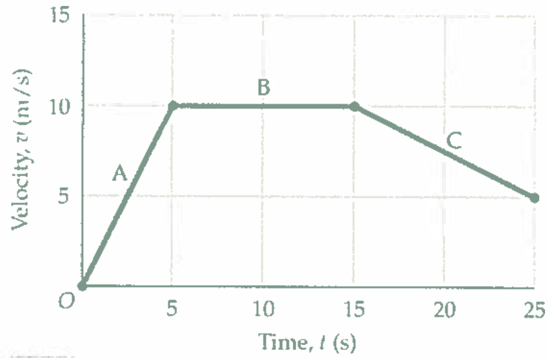
- This examination paper consists of thirteen **(13) pages**.
- The paper consists of two sections; **Section A** (30%) and **Section B (70%).**
- **Answer Section A (Multiple choice) on the examination mark reading sheet.**
- **Answer Section B (Written solutions) in the examination answer book.**
- Show all steps in carrying out the calculations.
- The mark allocation for each question is indicated in square brackets to the right.
- The information given at the end of Section B may be used without proof.

Open Rubric

Open Rubric

Section B: Written Solution (70 marks)

1. A motorcycle moves according to the velocity-versus-time graph shown in the figure below.



Find the average acceleration of the motorcycle during each of the following segments of the motorcycle:

a) A (2)
b) B (2)
c) C (2)
[6]

2

(a) $a_{av} = \frac{\Delta v}{\Delta t} = \frac{10 m/s}{5.0 s} = 2 m/s^2$

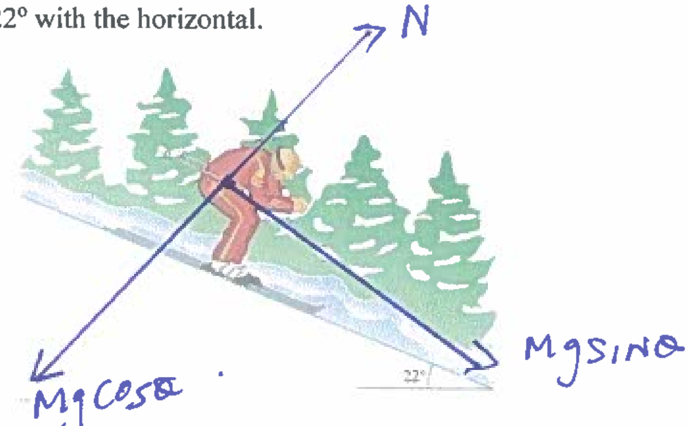
2

(b) $a_{av} = \frac{\Delta V}{\Delta t} = \frac{0 \ m/s}{10 s} = 0.0 \ m/s^2$

(c) $a_v = \frac{\Delta V}{\Delta t} = \frac{-5.0 m/s}{10 m/s} = -0.50 \ m/s^2$

2

2. A 65 kg skier speeds down a trail, as shown in the figure. The surface is smooth and inclined at an angle of 22° with the horizontal.

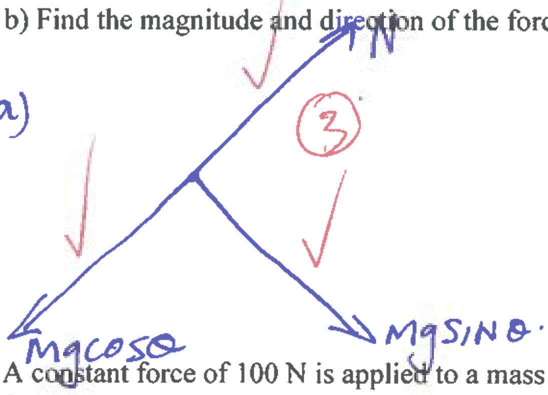


a) Draw the free body diagram of the forces on the skier. (3)

b) Find the magnitude and direction of the force acting on the skier. (3)

[6]

(a)



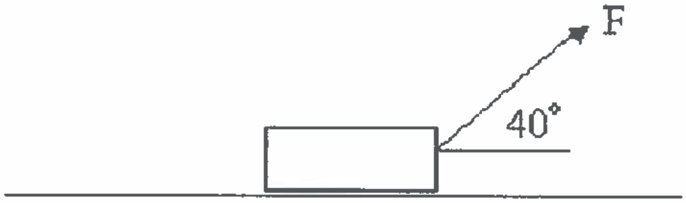
(b) $\sum F_x = Mg\sin\theta$

$= (65kg)(9.81)(\sin 2\ldots$

$= 238{,}86\ N$

3

3. A constant force of 100 N is applied to a mass of 40.0 kg as shown in the figure. The force causes a displacement of 20.0 m to this mass along the + x-axis.



Calculate work done. (Neglect friction). [3]

$W = F \times d = F_x \times d$

$F_x = F\cos\theta = (100)(\cos 40°)$

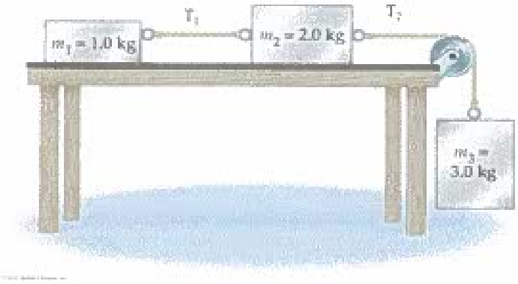
$= 76.60\ N$

$\therefore W = F_x \times d = (76.60\ N)(20m)$

$= 1532\ J$

3

4. Three masses ($m_1 = 1.0$ kg , $m_2 = 2.0$ kg and $m_3 = 3.0$ kg) are connected on the table as shown in the figure. Assume the table is frictionless and the masses move freely.



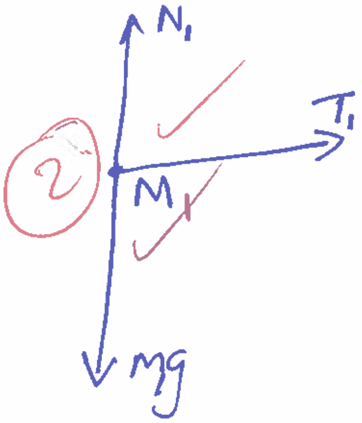
a. Show the free body diagrams for m_1 , m_2 and m_3. (7)

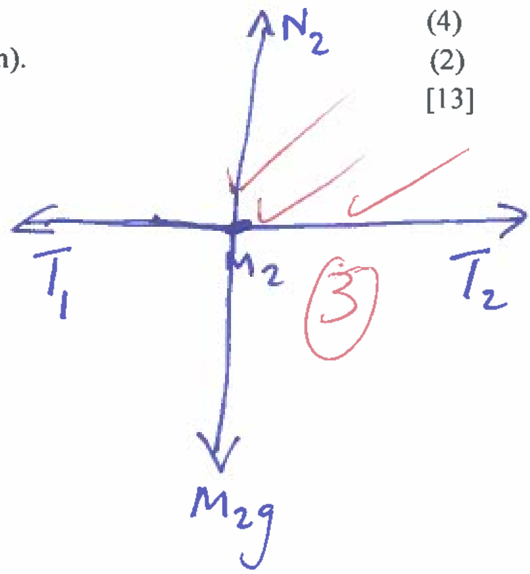
b. Deteremine tension T_1 and T_2 (4)

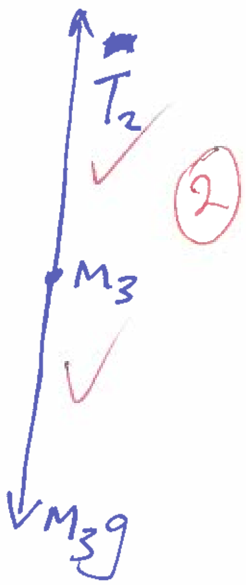
c. Calculate the acceleration of the masses (system). (2)

[13]

(a)







$\sum F_x = T_1 = M_1 a$ (1).

(c)

$\sum F_x = T_2 - T_1 = M_2 a$ (2)

$M_3 g - T_2 = M_3 a$ (3)

$\sum F_y = M_3 g - T_2$

Substitute eq (1) and (3) into eq (2).

$T_2 - T_1 = M_2 a$ (2).

$(-M_3 a + M_3 g) - (M_1 a) = M_2 a$ (2)

$-M_3 a + M_3 g - M_1 a = M_2 a$

$M_3 g = a(M_1 + M_2 + M_3)$

$M_3 g = a(1.0 + 2.0 + 3.0)$

$(3\,kg)(9.81) = a(6\,kg)$

$\therefore a = \left(\frac{3\,kg}{6\,kg}\right)(9.81\,m/s^2)$

$= 4.9\,m/s^2$

2

(b)

eq (1) $T_1 = M_1 a$

$= (1)(4.9) = 4.9\,N$

2

eq (2)

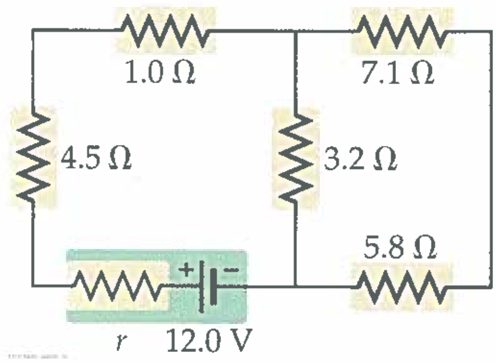
$T_2 - T_1 = M_2 a$

$T_2 = (2)(9.81) + 4.9$

$= 24.52\,N$

2

5. The circuit shown in the figure below includes a battery with a finite internal resistance, $r = 0.50\ \Omega$.



a. Calculate the total resistance of the circuit. (3)

b. Find the current the flowing through the $7.1\ \Omega$ and the $3.2\ \Omega$ resistors (4)

c. Determine the current that flows through the battery. (2)

[9]

(a) $R_{eq,(series)} = 7.1\Omega + 5.8\Omega = 12.9\Omega$

$$\frac{1}{R_{eq,\parallel}(\text{Parallel})} = \frac{1}{3.2\Omega} + \frac{1}{12.9\Omega}$$

$$\therefore R_{eq}(\text{Parallel}) = \frac{41.28}{16.10} = 2.56\Omega$$

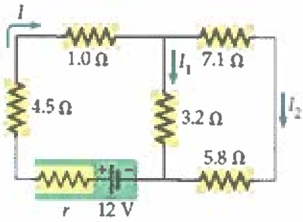
3

$$R_{eq}(\text{series}) = r + 4.5\Omega + 1.0\Omega + 2.56\Omega$$

$$= (0.5)\Omega + 4.5\Omega + 1.0\Omega + 2.56\Omega$$

$$= 8.56\Omega$$

51. **Picture the Problem:** Five resistors are connected to a battery that has an internal resistance, as indicated in the circuit diagram at the right.



Strategy: We must first find the equivalent resistance of the entire circuit and then apply Ohm's Law to determine the current I that is drawn from the battery. To accomplish this we note that the 7.1-Ω and 5.8-Ω resistors are connected in series, and their 12.9-Ω equivalent resistance is connected in parallel with the 3.2-Ω resistor. The combination of those three resistors is connected in series with r and the 4.5-Ω and 1.0-Ω resistors. Once the current I is known, the voltage drop across r and the 4.5-Ω and 1.0-Ω resistors can be found, and the remaining potential difference across the 3.2-Ω resistor and 12.9-Ω combination can be used together with Ohm's Law to find the two branch currents I_1 and I_2. The current I is the current through the battery (see the diagram) and can be used to find the potential drop across the internal resistance r and hence the potential across the terminals of the battery by using Ohm's Law.

Solution: 1. (a) Find R_{eq} by applying equations 12-7 and 12-10 as appropriate:

$$R_{eq} = 0.50\ \Omega + 4.5\ \Omega + 1.0\ \Omega + \left(\frac{1}{3.2\ \Omega} + \frac{1}{7.1\ \Omega + 5.8\ \Omega}\right)^{-1} = \underline{\underline{8.6\ \Omega}}$$

2. Apply Ohm's Law to find I: 5.a

$$I = \frac{V}{R_{eq}} = \frac{12.0\ \text{V}}{8.6\ \Omega} = 1.4\ \text{A}$$

5.b

3. Determine ΔV across r and the 4.5-Ω and 1.0-Ω resistors, and therefore ΔV across the 3.2-Ω resistor:

$$\Delta V_{3.2\Omega} = \mathcal{E} - I(r + 4.5\ \Omega + 1.0\ \Omega)$$
$$= 12.0\ \text{V} - (1.4\ \text{A})(0.50\Omega + 4.5\Omega + 1.0\Omega) = \underline{\underline{3.6\ \text{V}}}$$

2

4. The 3.6 V potential difference drives current through the 3.2-Ω and 7.1-Ω resistors:

$$I_1 = \frac{\Delta V_{3.2\Omega}}{R} = \frac{3.6\ \text{V}}{3.2\ \Omega} = \boxed{1.1\ \text{A}} = I_{3.2\,\Omega}$$

$$I_2 = \frac{\Delta V_{3.2\Omega}}{R} = \frac{3.6\ \text{V}}{7.1 + 5.8\ \Omega} = \boxed{0.29\ \text{A}} = I_{7.1\,\Omega}$$

2

5.c

5. (b) The current I was found in step 2: $I = \boxed{1.4\ \text{A}}$

6. (c) Use I to find $\Delta V_{\text{battery}}$:

$$V_{\text{battery}} = \mathcal{E} - Ir = 12.0\ \text{V} - (1.4\ \text{A})(0.50\ \Omega) = \boxed{11.3\ \text{V}}$$

2

Insight: Kirchoff's Rules could also be applied to two circuit loops in this problem to find I_1 and I_2, but the solution is no simpler than the one presented here.

6. A person 1.7 m tall stands 0.66 m from a reflecting globe in a garden,

a. If the diameter of the globe is 18 cm, calculate the focal length. (2)
b. Where is the image of the person, relative to the surface of the globe? (3)
c. How large is the person's image? (3)
d. Is the image real or virtual (please explain)? (2)

[10]

Soln:

6. A person 1.7 m tall stands 0.66 m from a reflecting globe in a garden,

a. If the diameter of the globe is 18 cm, calculate the focal length. (2)
b. Where is the image of the person, relative to the surface of the globe? (3)
c. How large is the person's image? (3)
d. Is the image real or virtual (please explain)? (2)

[10]

(a) $f = -\frac{1}{2}R$ ✓ NB $R = \frac{D}{2} = \frac{18cm}{2} = 9cm$

$= -\frac{1}{2}(9cm) = -4.5cm$ ✓

$= -0.045m$ ✓ 2

6.
(b) $\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$ ✓ 1

$d_i = \left(\frac{1}{f} - \frac{1}{d_o}\right)^{-1} = \left(\frac{1}{-0.045m} - \frac{1}{0.66m}\right)^{-1}$ ✓ 3

$= -0{,}042\,m$ ✓ (Behind the surface of the globe) ✓

6.
(c) $M = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$ ✓

$\therefore h_i = -\frac{d_i}{d_o}h_o = -\frac{-0.042m}{0.66m}(1.7\,m)$ ✓ 3

$= \cancel{0.11cm} = 0.11M$ ✓

6.
(d) d_i is negative $(-0.042\,M) \rightarrow$ Virtual ✓ ✓ 2
The image is formed behind the mirror (Virtual)

7. Calculate the pH of a solution whose $[H^+(aq)] = 4.48\times10^{-9}$ mol dm^{-3} .

Ans:

$[H^+] = 4.48 \times10^{-9} mol/dm^3$

$pH = -\log[4.48 \times10^{-9}]$

$pH = -[-8.35] = 8.35$

4

8. What volume of a 0.10 M NaOH solution is needed to provide 0.50 mol of NaOH?

Ans:

Given: 0.50 mol NaOH
0.10 M NaOH
Find: vol soln

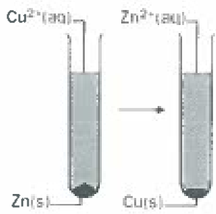
Use M as a conversion factor

$$\text{Vol soln} = 0.50\ \cancel{\text{mol NaOH}} \times \frac{1\ \text{L soln}}{0.10\ \cancel{\text{mol NaOH}}}$$

$$= 5.0\ \text{L solution}$$

5

9. When solid zinc is added to blue (II) sulphate solution, the solution gradually becomes paler and red-brown (copper) is deposited at the bottom of the test tube as shown in the figure below.



In this reaction, zinc metal supplies two electrons to the copper ions and copper is precipitated. The two half reactions are:

$$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$$
$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$

a. Which half-reaction represents reduction?

Ans:

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ 1

b. Which half-reaction represents oxidation?

Ans:

$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ 1

c. Write the overall redox equation for the reaction.
(2)
Ans:

$Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$ 2

d. The sulphate ions are not included in the redox reaction. Explain.
Ans:

The sulphate ions remain the same throughout the reaction they do not take part in the redox reaction. The sulphate ions are spectator ions. 2

10. Calculate the number of molecules of methane in $0.50\ m^3$ of the gas at a pressure of 2.0×10^2 kPa and a temperature of exactly 300 K.

Ans:
$PV = nRT$

$V = 0.50\ cm^3 = 0.0005L$

$P = 2.0 \times 10^2 kPa = 1.97atm$

$$n = \frac{PV}{RT} = \left(\frac{1.974atm \times 0.0005L}{0.082L \bullet \frac{atm}{mol \bullet K} \times 300K} \right)$$

$$n = \frac{9.87 \times 10^{-4}}{24.6} = 4.012 \times 10^{-4} \text{ moles}$$

4

$$\text{number of molecules} = \text{number of moles} \times \frac{\text{avogadro's number}}{1mole} = 4.012 \times 10^{-4} \text{ moles} \times \frac{6.022 \times 10^{23}}{1mole} = 2.416 \times 10^{19}$$

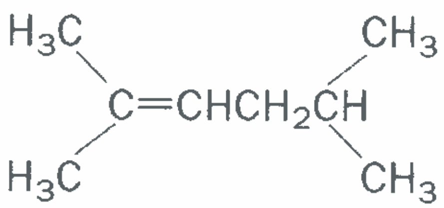
11. Name the following compounds:

a.

$CH_3CH{=}CHCH_2CH_3$

Ans: pent-2-ene 2

b.



Ans:
2,5-dimethylhex-2-ene 2