

UNIVERSITY EXAMINATIONS



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SMI181Q
SECOND PAPER

(469906)

May/June 2017

SCIENCE: MINING I

Duration : 2 Hours

100 Marks

EXAMINERS :

FIRST : PROF BM MOTHUDI
SECOND : DR SJ MOLOI

Use of a non-programmable pocket calculator is permissible.

Closed book examination.

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- **MEMO**

Section A: Multiple Choice Questions (30 marks)

1. A block of mass M slides down a frictionless plane inclined at an angle θ with the horizontal. The normal reaction force exerted by the plane on the block is
 1. Mg .
 2. $Mg \sin \theta$.
 3. $Mg \cos \theta$.
 4. $Mg \tan \theta$.
 5. zero, since the plane is frictionless.

2. A proton, moving north, enters a magnetic field of certain strength. Because of this field the proton curves downward. What is the direction of the magnetic field?
 1. downward
 2. upward
 3. towards the east
 4. towards the west
 5. towards the north

3. A car battery is rated at $80 \text{ A} \cdot \text{h}$. An ampere-hour is a unit of
 1. power.
 2. energy.
 3. current.
 4. charge.
 5. force.

4. A proton, moving north, enters a magnetic field of certain strength. Because of this field the proton curves downward. What is the direction of the magnetic field?
 1. downward
 2. upward
 3. towards the east
 4. towards the west
 5. towards the north

5. An object is placed in front of a convex mirror at a distance larger than twice the focal length of the mirror. The image will appear
 1. in front of the mirror.
 2. inverted and reduced.
 3. inverted and enlarged.
 4. upright and reduced.
 5. upright and enlarged.

6. An object is placed 21 cm from a concave lens of focal length 25 cm. What is the magnification?

- 0.54
 - 0.54
 - 0.32
 - 0.22
 - 0.22
7. A beam of white light goes through dispersion in a prism. The color that bends the most is
- violet.
 - yellow.
 - red.
 - orange.
 - green.
8. Complete the following chemical reaction and indicate the products.
- $$\text{HCl}(aq) + \text{NH}_4\text{OH}(aq) \rightarrow$$
- NH_4Cl and O_2
 - NH_4Cl and H_2O
 - NH_4Cl and H_2O_2
 - NH_3 , Cl_2 , and H_2O
 - NH_3 , HCl , and H_2O
9. What is the term for a substance that causes the oxidation of another substance in a redox reaction?
- anode
 - cathode
 - oxidizing agent
 - reducing agent
 - none of the above
10. A reaction between strong acid and strong base produces
- a salt and water.
 - a base and an acid.
 - a metallic oxide and water.
 - a non-metallic oxide and water.
 - water only

Section B: Written Solution (70 marks)

1. A car is traveling at 30.0 m/s when the driver suddenly applies the brakes, giving the car a constant deceleration. The car comes to a stop in a distance of 120.0 m.

Determine the deceleration of the car?

[5]

Soln:

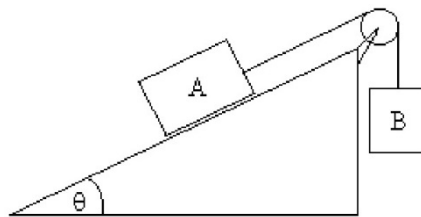
$$v^2 = u^2 + 2as$$

$$(0) = (30)^2 + 2(a)(120)$$

$$a = -\frac{(900)}{2(120)}$$

$$a = -3.75 \text{ m/s}^2$$

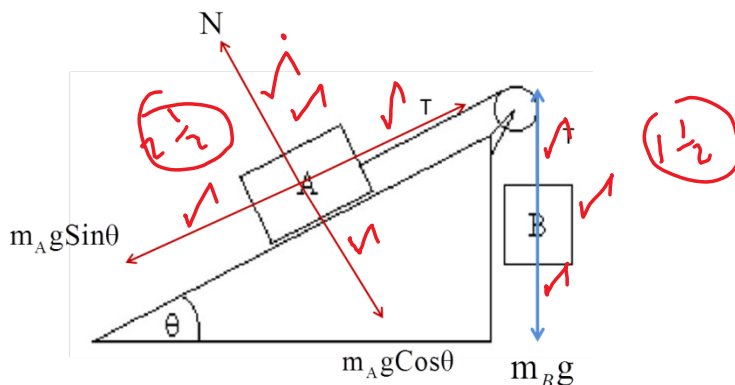
2. Two masses are connected by a string which goes over an ideal pulley as shown in figure below. Block A has a mass of 3.0 kg and can slide along a smooth plane inclined 30° to the horizontal. (Note: the system is in equilibrium)



- i. Draw free body diagrams for block A and B. (4)
 ii. Determine the mass of block B (the system is in equilibrium). (4)
 [8]

Soln:

i.



ii.

$$T = m_B g \dots \dots \dots \text{(eq 1)}$$

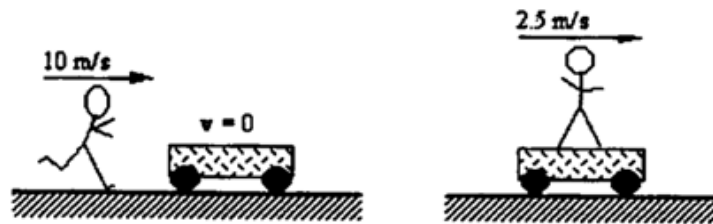
$$m_A g \sin \theta = T \dots \dots \dots \text{eq 2}$$

$$\therefore m_B g = m_A g \sin \theta$$

$$m_B = (3.0) \sin 30^\circ$$

$$m_B = (3.0) \times (0.5) = 1.5 \text{ kg}$$

3. A 50.0 kg boy runs at a speed of 10.0 m/s and jumps onto a cart as shown in the figure. The cart is initially at rest.



If the speed of the cart with the boy on it is 2.5 m/s, determine the mass of the cart.

[7]

Soln:

The handwritten solution shows the following steps:

- Diagram of the initial state: A boy of mass m moves with velocity $U_0 = 10.0 \text{ m/s}$ towards a cart of mass M at rest ($v = 0$).
- Diagram of the final state: The boy and cart move together with velocity $U = 2.50 \text{ m/s}$.
- Conservation of momentum: $\Delta p = 0$, $p_i = p_f$
- Equation: $mU_0 + M \cdot 0 = (m+M)U$
- Equation: $mU_0 = (m+M)U$
- Equation: $mU_0 - mU = MU$
- Equation: $M = \frac{m(U_0 - U)}{U}$
- Calculation: $= \frac{50 \text{ kg} (10 - 2.50) \text{ m/s}}{2.50 \text{ m/s}}$
- Final answer: $= 150 \text{ kg}$

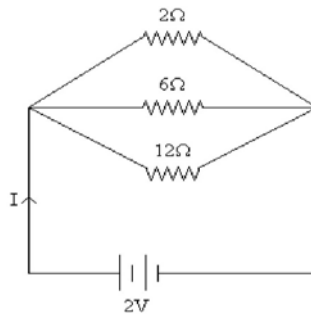
A circled '7' is written next to the equations, indicating the number of marks for this part.

4. How long does it take for a rotating disc to speed up from 15.0 to 33.3 rad/s if it has an angular acceleration of 3.45 rad/s²? [5]

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{\omega_f - \omega_i}{\Delta t}$$

$$t = \frac{\omega_f - \omega_i}{\alpha} = \frac{33.3 - 15}{3.45} = \frac{18.3}{3.45} = 5.304 \text{ s}$$

5. Three resistors of values 2 Ω, 6 Ω and 12 Ω are connected across a 2.0-V DC voltage source as shown in the figure.



- i. Calculate the equivalent resistance of the circuit (3)

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{2} + \frac{1}{6} + \frac{1}{12}$$

$$\frac{1}{R_{eq}} = \frac{(6)(12) + (3)(12) + (2)(6)}{(2)(6)(12)} = \frac{108}{144}$$

$$R_{eq} = \frac{144}{108} = 1.33\Omega$$

- ii. Determine the current flowing through the 12 Ω resistor. (3)

$$I_{(12\Omega)} = \frac{V}{R} = \frac{2.0}{12} = 0.167\text{A}$$

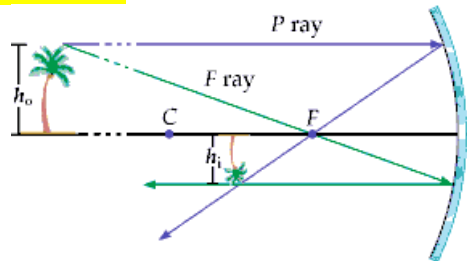
- iii. Determine the total current *I* of the circuit? (3)

$$I = \frac{V}{R} = \frac{2}{1.33} = 1.5\Omega$$

6. You view a nearby tree in a concave mirror. The inverted image of the tree is 3.8 cm high and is located 7.0 cm in front of the mirror. If the tree is 200 cm from the mirror, calculate its height. [5]

Soln

$$h_o = -\frac{d_o h_i}{d_i} = -\frac{200 \text{ m} (-3.8 \text{ cm})}{7.0 \text{ cm}} = \boxed{12 \text{ m}}$$



7. Determine the critical angle for light traveling from crown glass ($n = 1.52$) into water ($n = 1.33$)? [5]

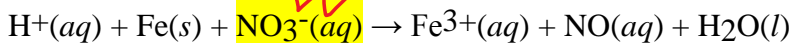
Soln;

$$\sin \theta_c = \frac{n_2}{n_1} = \frac{1.33}{1.52} = 0.875 \dots n_1 = 1.52, n_2 = 1.33$$

$$\theta_c = \sin^{-1}(0.875) = 61^\circ$$

8. Which substance is reduced in the following redox reaction? [3]
 $\text{H}^+(\text{aq}) + \text{Fe}(\text{s}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{Fe}^{3+}(\text{aq}) + \text{NO}(\text{aq}) + \text{H}_2\text{O}(\text{l})$

Soln:

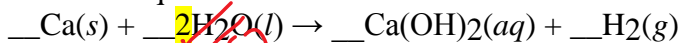


Reduced substance: NO_3^-

9. How many moles of calcium metal react to yield 0.500 mol of hydrogen gas? [8]
 $\text{Ca}(\text{s}) + __ \text{H}_2\text{O}(\text{l}) \rightarrow __ \text{Ca}(\text{OH})_2(\text{aq}) + __ \text{H}_2(\text{g})$

Soln:

Balanced equation



$$0.500 \text{ mol H}_2 \text{ gas} * (1 \text{ mole Ca} / 1 \text{ mol H}_2 \text{ gas}) = 0.500 \text{ mol H}_2 \text{ gas.}$$

10. Calculate the concentration for the reaction of 0.25 mole of Sodium Hydroxide (NaOH) and water (H_2O) solution of 250 cm^3 . [8]

Soln:

Concentration = number of moles/volume

$$C = n/v = 0.25 \text{ moles NaOH} / 0.250 \text{ L} = 1.0 \text{ moles/L} = 1.0 \text{ M}$$

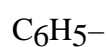
Or

$$C = n/v = 0.25 \text{ mole} / 0.25 \text{ dm}^3 = 1 \text{ mole/dm}^3$$

Or

$$\frac{0.25 \text{ moles NaOH}}{250 \text{ cm}^3} = 1.0 \times 10^{-3} \text{ mol / cm}^3$$

11. Name of the following aryl group:



[2]

Soln: Phenyl

12. Calculate the molar mass of mercury (I) nitrate, $\text{Hg}_2(\text{NO}_3)_2$?

[5]

Soln:

$$\begin{aligned} \text{Molar Mass of the compound} &= 2(200.59) + 2(14.007 + 3(15.999)) \\ &= 401.18 + 2(62.004) \\ &= 525.188 \text{ g/mol} \end{aligned}$$

Total marks

[100]

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