NOVEMBER 2020 180 MIN

PHYSICAL SCIENCES EXAMINATION

CO, JA, MH TOTAL = 150

GRADE 11

Instructions

- The question paper consists of 13 questions.
- Answer all the questions.
- Answer section A on the answer sheet provided AND section B and C on folio sheets.
- A non-programmable calculator may be used.
- Number the answers correctly according to the numbering system.
- Round off to two (2) decimal places where necessary.
- A formula sheet and a table of standard reduction potentials have been provided at the end of the question paper.
- A periodic table has been provided on the back of the answer sheet.

SECTION A

- Answer on the answer sheet -

QUESTION 1: Multiple choice

Four possible options are provided as answers to the following questions. Each question has only 1 correct answer. Choose the correct answer and write the letter (A – D) next to the relevant question number (1.1 – 1.10) on the answer sheet.

1.1 A 10 N and 17 N force act on an object. Which ONE of the following CANNOT be the resultant?

A. 25 N

B. 19 N

C. 7 N

D. 5 N

1.2 Which ONE of the following statements correctly describes Newton's third law of motion?

Forces occur in pairs that are

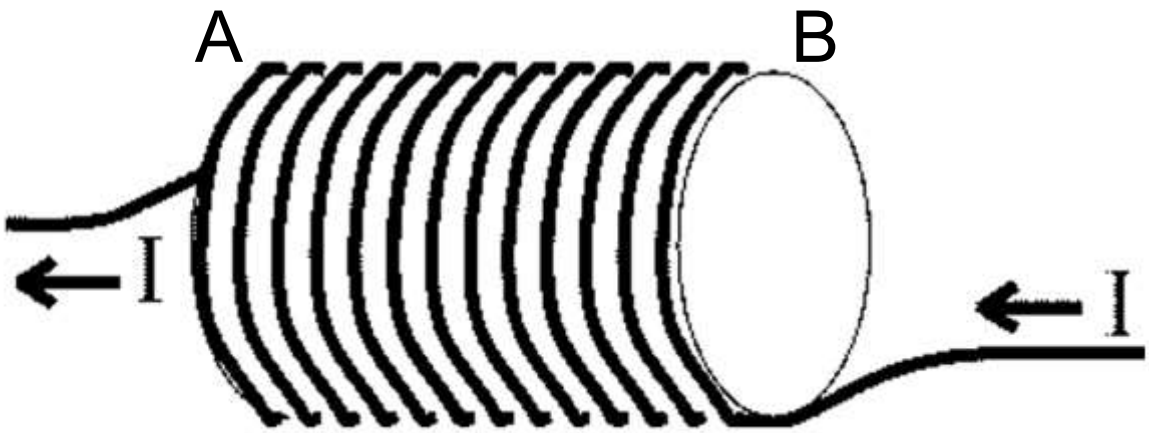
A. …equal in direction and opposite in magnitude.

B. …equal in magnitude and opposite in direction.

C. …opposite in magnitude and opposite in direction.

D. …equal in magnitude and equal in direction.

1.3 Consider the following current-carrying solenoid



The induced magnetic field will

A. …have a north pole at A and a south pole at B.

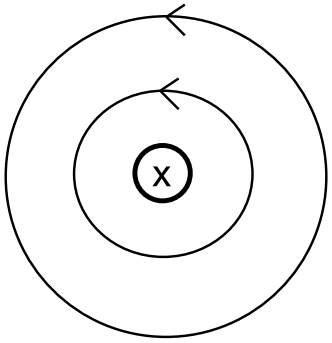
B. …have a south pole at A and a north pole at B.

C. …have a north pole at both A and B.

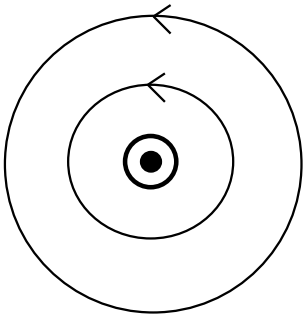
D. …not exist in the case of a solenoid.

1.4 Which ONE of the following diagrams CORRECTLY depicts the magnetic field around a current-carrying conductor?

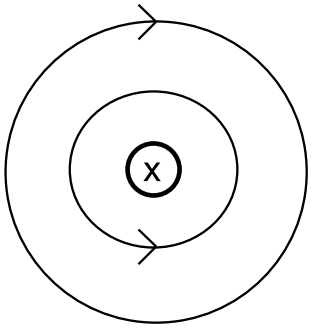
A.



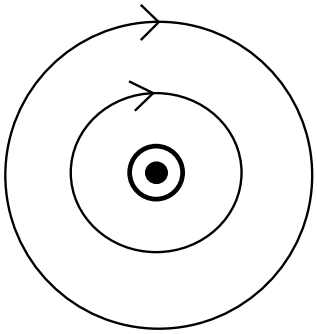
B.



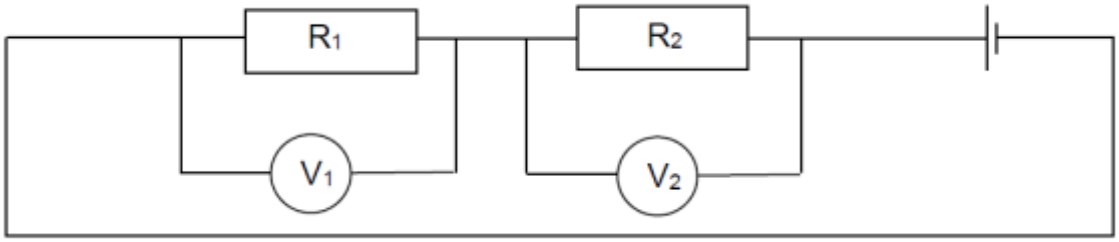
C.



D.



1.5 In the circuit diagram below, the resistance of resistor R_1 is TWICE the resistance of resistor R_2. The two resistors are connected in series and identical high-resistance voltmeters are connected across each resistor. The readings on the voltmeters are V_1 and V_2 respectively.



Which ONE of the following statements concerning the voltmeter readings is CORRECT?

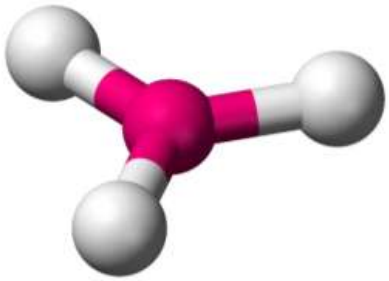
A. $V_1 = 2V_2$

B. $V_1 = ½V_2$

C. $V_1 = ¼V_2$

D. $2V_1 = V_2$

1.6 Which ONE of the following options corresponds to the molecular shape shown in the diagram below?



	Name of Shape	Bond Angle	Example
A	Trigonal planer	All 120˚	NH_3
B	Trigonal planer	All 120˚	BF_3
C	Trigonal pyramidal	All 120˚	NH_3
D	Trigonal pyramidal	All 107˚	BF_3

1.7 The type of intermolecular forces present between O_2 molecules are…

A. …double bonds.
B. …dipole-dipole forces.
C. …hydrogen bonds.
D. …London forces.

1.8 Which ONE of the following substances cannot act as an ampholyte?

A. H_2O
B. HNO_3
C. HCO_3^-
D. HSO_4^-

1.9 Which ONE of the following balanced equations represents a redox reaction?

A. $H^+ (aq) + OH^- (aq) \rightarrow H_2O (\ell)$
B. $Mg (s) + CuSO_4 (aq) \rightarrow Cu (s) + MgSO_4 (aq)$
C. $2\ NaCl (aq) + Pb(NO_3)_2 (aq) \rightarrow 2\ NaNO_3 (aq) + PbCl_2 (s)$
D. $H_2SO_4 (aq) + Ba(NO_3)_2 (aq) \rightarrow BaSO_4 (s) + 2\ HNO_3 (aq)$

1.10 A chemical reaction that occurs under controlled conditions, has an energy indicator $\Delta H > 0$. What does this mean?

A. Energy is released and absorbed and the final product has a higher energy than reactants' initial energy.

B. Energy is absorbed and the final product energy is less than the initial reactants' energy.

C. Energy is absorbed and the initial reactants' energy is lower than the final products' energy

D. Energy is released and the initial reactant's energy is lower than the final products' energy.

TOTAL SECTION A [20]

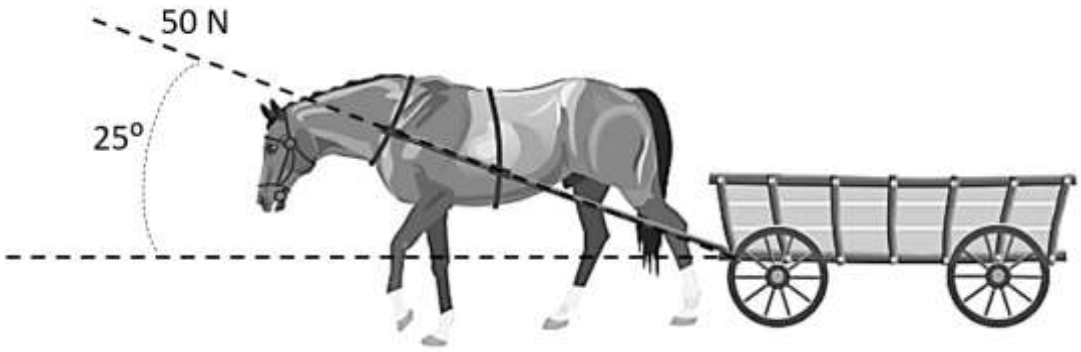
SECTION B - PHYSICS

-Answer on folio paper-

QUESTION 2:

2.1 Define the term *vector*. (2)

2.2 A farm horse is pulling a cart to the left, with a force of 50 N at an angle of 25° as shown in the picture below. The cart experiences friction of 8,5 N.



https://www.vectorstock.com/royalty-free-vectors/horse-pulling-a-cart-vectors

2.2.1 Draw a free body diagram showing all the forces acting on the cart. (4)

2.2.2 Calculate the horizontal **resultant** force vector that acts on the cart. (3)

[9]

QUESTION 3:

A passenger in a motor car notices that the extra mask hanging from the rearview mirror, swings forward when the car stops at the traffic lights.

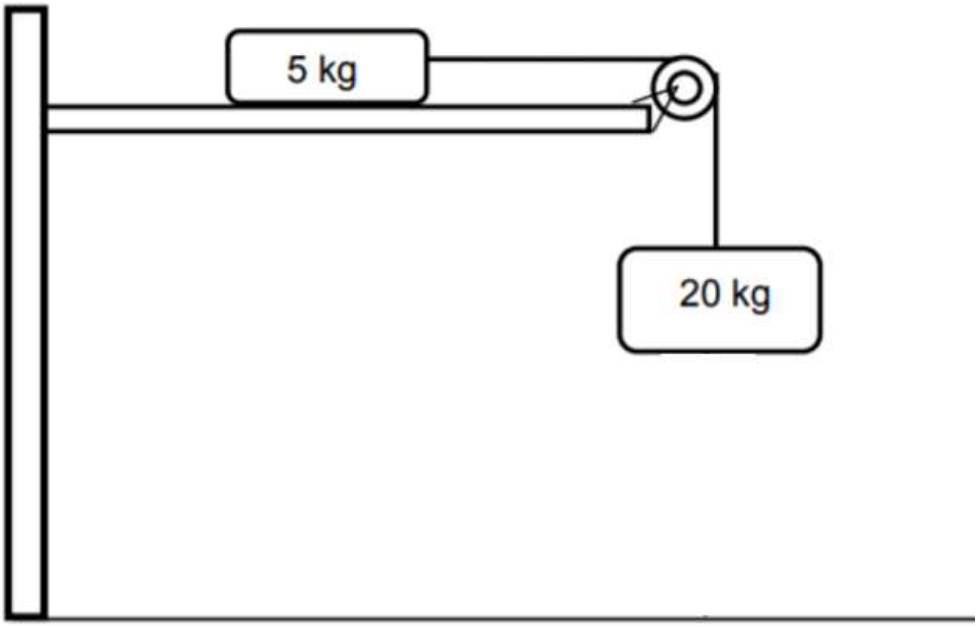
3.1 State *Newton's First Law of Motion* in words. (2)

3.2 Explain the observation using Newton's First Law of Motion. (3)

[5]

QUESTION 4:

A 5 kg mass and a 20 kg mass are connected by a light inextensible string which passes over a light frictionless pulley. The 5 kg mass is on a horizontal surface, while the 20 kg mass hangs vertically downwards, as shown below. The diagram is not drawn to scale.



When the 5 kg mass is released, the two masses begin to move. The coefficient of kinetic friction, μ_k, between the 5 kg mass and the horizontal surface is 0,3. Ignore the effects of air resistance.

4.1 State *Newton's Second Law of Motion* in words. (2)

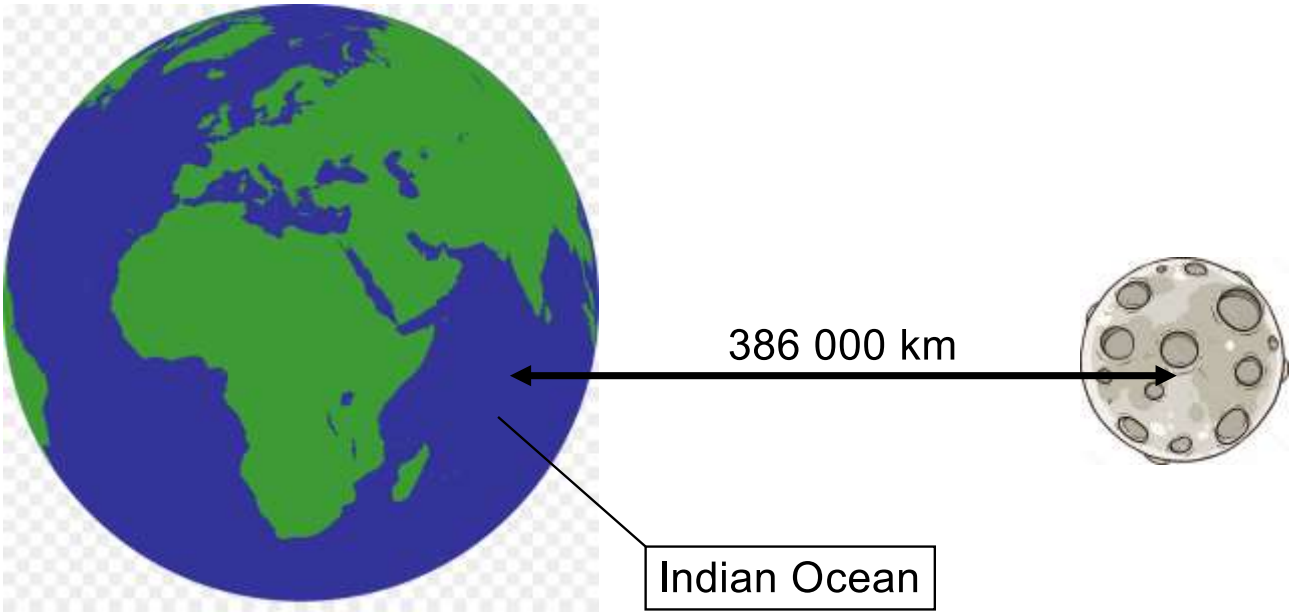
4.2 Draw a free-body diagram of all the forces acting on the 5 kg mass. (4)

4.3 Calculate the magnitude of the acceleration of the 5 kg mass. (6)

[12]

QUESTION 5:

The sea tides are partly caused by the gravitational pull of the moon on the Earth's oceans. At 06:00 on a particular day, the Indian Ocean is facing the moon. The Indian Ocean is 386 000 km away from the center of the moon as shown in the diagram below. The mass of the moon is $7{,}35 \times 10^{22}$ kg.



5.1 State *Newton's Universal Law of Gravitation* in words. (2)

5.2 If mass of water in the Indian Ocean is approximately $2{,}84 \times 10^{17}$ kg, calculate the magnitude of the gravitational force of the moon on the Indian Ocean. (4)

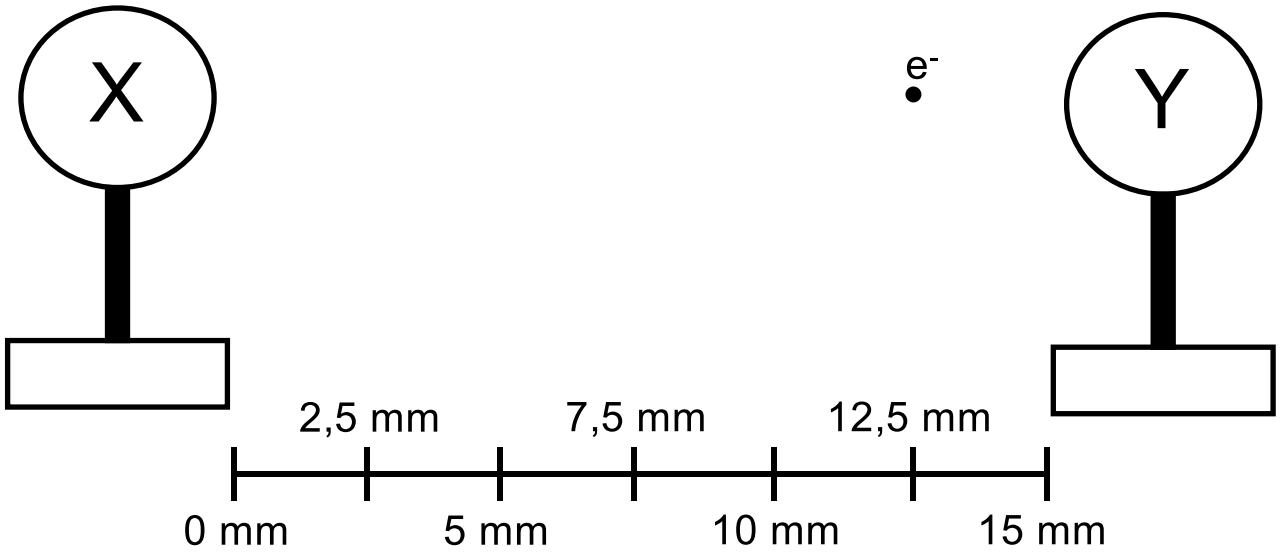
5.3 The Indian Ocean forms the coastline of the Kwa-Zulu Natal (KZN) province of South Africa. At 06:00, will the water level on the coast be at its HIGHEST level (i.e. high tide) or at its LOWEST level (i.e. low tide)? (1)

5.4 At 18:00, 12 hours later, the Earth has rotated such that the Indian Ocean is now facing away from the moon. Will the gravitational force of the moon on the Indian Ocean at 18:00 be GREATER THAN, LESS THAN or EQUAL TO the gravitational force of the moon on the Indian Ocean at 06:00?
Give a reason for your answer. (2)

[9]

QUESTION 6:

Two charged spheres X and Y, with charges 8 μC and 2 μC respectively, are placed on insulated stands 15 mm apart as shown in the diagram below.



6.1 State *Coulomb's Law of Electrostatics* in words. (2)

6.2 An electron is placed 12,5 mm to the right of X.

6.2.1 Calculate the **net electrostatic force** experienced by the electron. (5)

6.2.2 At which point between X and Y will the electron experience no net force? (2)

[9]

QUESTION 7:

7.1 State *Faraday's Law of Electromagnetic Induction* in words. (2)

7.2 A circular loop of wire, consisting of a single coil, is rotated inside a magnetic field.

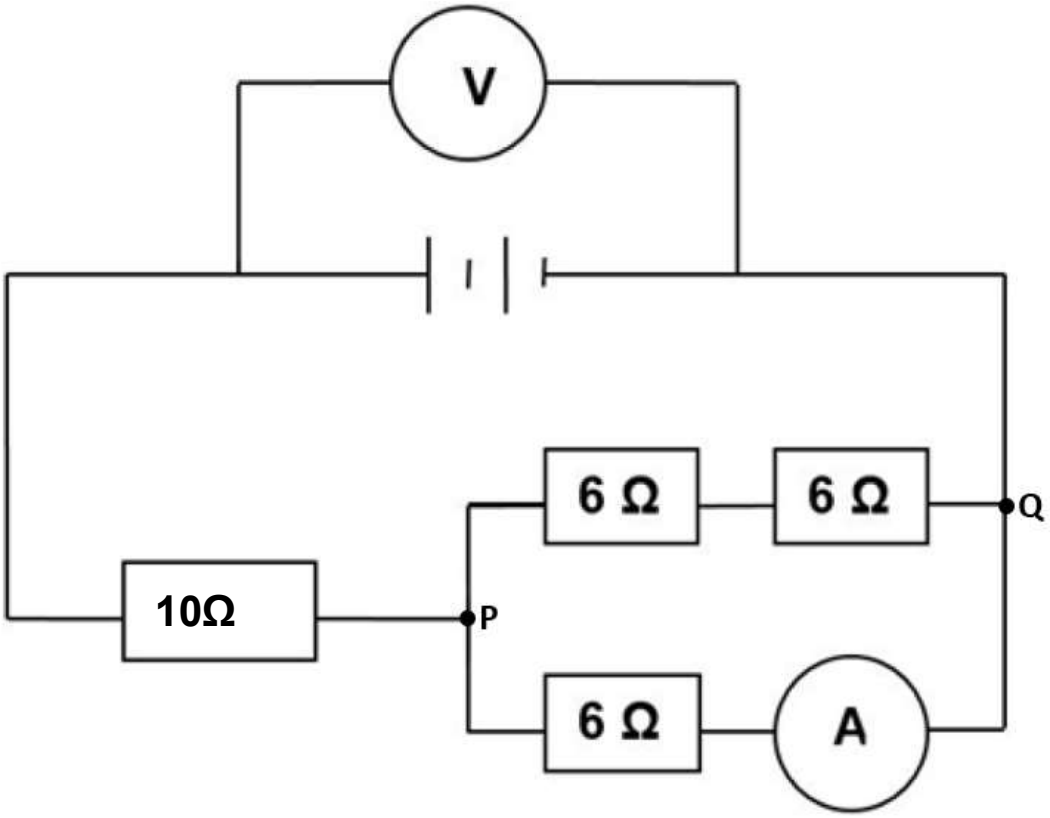
7.2.1 Describe two ways the magnetic flux through the circular loop of wire can be increased at any given part of its rotation. (2)

7.2.2 Without repeating any answers from question 7.2.1, describe two ways the emf induced in the wire can be increased. (2)

[6]

QUESTION 8:

In the circuit below, the resistance of the battery, ammeter and connecting wires can be ignored.



The power dissipated in the 10 Ω resistor is 0,45 W.

8.1 Define the term *power.* (2)

8.2 Calculate the current strength through the ammeter A. (4)

8.3 Calculate the amount of charge that passes through the 10 Ω resistor in 1 minute and 40 seconds. (2)

8.4 Calculate the reading on voltmeter V. (6)

8.5 If a connecting wire is connected in the circuit between points P and Q, how will the ammeter reading be influenced? Only write INCREASE, DECREASE or REMAIN THE SAME. (1)

[15]

TOTAL SECTION B [65]

SECTION C - CHEMISTRY

-Answer on folio paper-

QUESTION 9:

9.1 Draw Lewis structures for the following molecules:

9.1.1 H_2O (2)

9.1.2 HCN (2)

9.2.1 Define the term *bonding pair.* (2)

9.2.2 Give the number of bonding pairs in an H_2O molecule. (1)

9.3 Which bond, H-O (in H_2O) or H-C (in HCN), is more polar?
Give a reason for your answer. (2)

9.4 Give the shape of the hydrogen cyanide molecule. (1)

9.5 Is HCN a polar or a non-polar molecule? **Give a reason** for your answer. (2)

[12]

QUESTION 10:

10.1 Write down the NAME of the most important intermolecular force in each of the following cases:

10.1.1 between He atoms (1)

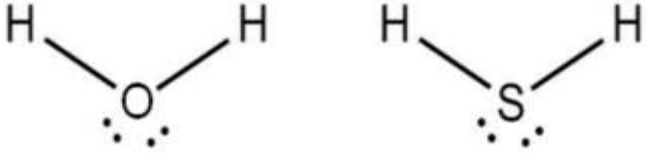
10.1.2 between the molecules of CCl_4 and HCl (1)

10.1.3 in an aqueous solution of NaCl (1)

10.2 A learner has two bottles of clear solutions, but has lost the labels of the bottles. She knows the one bottle contains NH_3 and the other BF_3. Using iodine crystals, she was able to tell which bottle contained which substance. Using *intermolecular forces* and *solubility*, explain how she was able to tell them apart.

You must identify the different types of intermolecular forces in your answer. (5)

10.3



H_2O and H_2S are both angular, polar molecules, but H_2O has a boiling point of 100˚C while H_2S boils at -60˚C.

Explain the difference in boiling points by referring to the intermolecular forces in each substance.

(4)
[12]

QUESTION 11:

11. The following balanced reaction occurs in a big stainless steel tank, as part of the Fertiliser industry:

$$N_2\,(g) + 3\,H_2\,(g) \rightarrow 2\,NH_3\,(g)$$

11.1 Define the term *limiting reactant.* (2)

11.2 If 200 dm^3 of N_2 react with 60 g of H_2 at 300ºC, it is found that some of the reactant gases are left over when the reaction is completed. Determine the TOTAL volume of gas left in the tank at the end of this reaction. Show all calculations. (The molar gas volume at 300ºC is 50 dm^3). (8)

11.3 Calculate the % yield of this reaction if it was found that 140 dm^3 of NH_3 was formed. (2)

11.4 A catalyst is now added to the reaction. Define what a *catalyst* is. (2)

11.5 It was found that the steel tank gets extremely hot when this reaction takes place. Draw a rough labeled **Potential energy** vs **Course of reaction** graph to show the energy changes in this reaction for the uncatalysed AND the catalysed reactions. Draw the catalyst graph with a dotted line. Show the energy labels and reactants and products' positions on the graph. (3)

11.6 Calculate the change in heat of this reaction if the following **total** energies are known:

Activation energy = 90 kJ Energy released = 130 kJ (2)

[19]

QUESTION 12:

Zinc oxide, ZnO, is insoluble in water and can be harmful to the environment. Nitric acid can be used to neutralise zinc oxide. The **incomplete** equation for the reaction is:

$$ZnO\ (s)\ +\ 2\ HNO_3\ (aq)\ \rightarrow\ salt\ X\ (aq)\ +\ H_2O\ (\ell)$$

12.1 What is a *base* in terms of Arrhenius' definition? (2)

12.2 Give the FORMULA for salt X. (1)

12.3 Identify any ONE conjugate acid-base pair according to the Lowry-Brønsted definition. (2)

12.4 Name this type of acid-base reaction. (1)

Nitric acid ionizes in water according to the following formula:

$$HNO_3\ +\ H_2O\ \rightarrow\ H_3O^+\ +\ NO_3^-$$

12.5 Define the term *monoprotic acid.* (2)

12.6 Identify the type of bond responsible for the formation of the hydronium ion (H_3O^+) in the above equation. (1)

12.7 A drop of methyl orange is added to the reaction flask. What is the colour of the solution in the flask? (1)

12.8 An excess amount of a soluble base is now added to the flask and the contents are stirred. What is the final colour of the solution in the flask? (1)

[11]

QUESTION 13:

The **unbalanced** equations for two redox reactions, in which SO_2 is involved, are shown below:

Reaction 1: $SO_2(g) + H_2S(g) \rightarrow S(s) + H_2O(\ell)$

Reaction 2: $SO_2(g) + MnO_4^-(aq) \rightarrow SO_4^{2-}(aq) + Mn^{2+}(aq)$

13.1 Define *oxidation* in terms of electron transfer. (2)

13.2 In which reaction, Reaction 1 or Reaction 2, does SO_2 act as an oxidising agent? **Give a reason** for your answer. (2)

13.3 Is Mn in Reaction 2 OXIDISED or REDUCED? **Give a reason** for your answer. (2)

13.4 Use the Table of Standard Reduction Potentials and write down the balanced net ionic equation for Reaction 1. Show the half-reactions and how you arrived at the final equation. (4)

13.5 Which is the stronger REDUCING AGENT: Mn or S? (1)

[11]

TOTAL SECTION C [65]

Formula Sheet

Physical Constants:

Name	Symbol	Value
PHYSICS		
Acceleration due to gravity	g	9,8 $m.s^{-2}$
Gravitational constant	G	$6,67 \times 10^{-11}$ $N.m^2.kg^{-2}$
Radius of Earth	R_E	$6,38 \times 10^6$ m
Coulomb's constant	k	$9,0 \times 10^9$ $N.m^2.C^{-2}$
Speed of light in a vacuum	c	$3,0 \times 10^8$ $m.s^{-1}$
Charge on electron	e	$-1,6 \times 10^{-19}$ C
Electron mass	m_e	$9,11 \times 10^{-31}$ kg
Mass of Earth	M	$5,98 \times 10^{24}$ kg
CHEMISTRY		
Avogadro's constant	N_A	$6,02 \times 10^{23}$ mol^{-1}
Molar gas constant	R	8,31 $J.K^{-1}.mol^{-1}$
Standard pressure	p^θ	$1,013 \times 10^5$ Pa
Molar gas volume at STP	V_m	22,4 $dm^3.mol^{-1}$
Standard temperature	T^θ	273 K

Formulae:

MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$v_f^2 = v_i^2 + 2a\Delta x$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE

$F_{net} = ma$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$\mu_s = \frac{f_{s(max)}}{N}$
$\mu_k = \frac{f_k}{N}$	

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{F}{q}$
$E = \frac{kQ}{r^2}$	$n = \frac{Q}{e}$

ELECTRIC CIRCUITS

$I = \frac{Q}{\Delta t}$	$R = \frac{V}{I}$

$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \cdots$	$R = r_1 + r_2 + r_3 + \cdots$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

CHEMISTRY

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$	$pV = nRT$
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$n = \frac{V}{V_m}$	$c = \frac{n}{V}$ or $c = \frac{m}{MV}$