Kzn education

Department:
Education
KWAZULU-NATAL

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES NOVEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of **16** pages including **3** data sheets and **1** answer sheet.

INSTRUCTIONS AND INFORMATION

1. Write your name and class (e.g. 10A) in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 7 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, etc. where required.
12. Write neatly and legibly.

QUESTION 1 MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E. Each question has only ONE correct answer.

1.1 Two forces 5 N and 7 N respectively act simultaneously on an object. Which of the following CANNOT be the magnitude of the resultant for these forces?

A 12 N

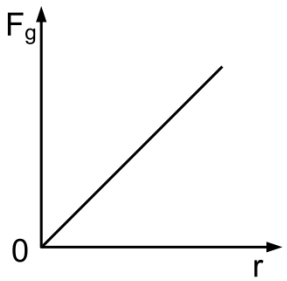
B 2 N

C 13 N

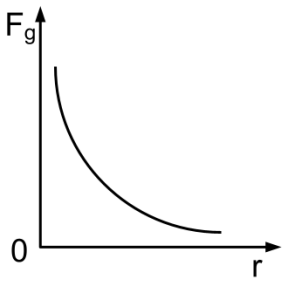
D 9 N (2)

1.2 Which of the following graphs best illustrates the relationship between the gravitational force (F_g) and the distance (r) between the centres of two particles?

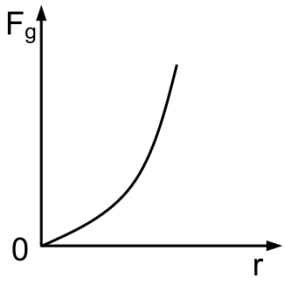
A



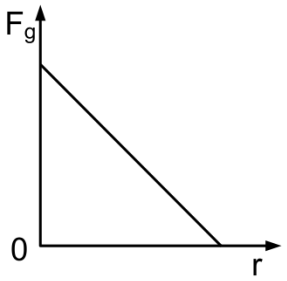
B



C



D



(2)

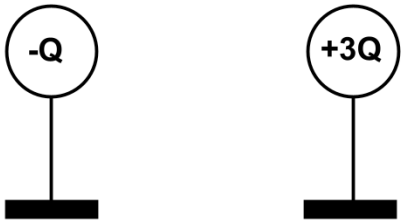
1.3 Planet X has the same radius but half the mass as Earth. An astronaut has mass **m** and weight **W** on Earth.

Which ONE of the following combinations of MASS OF THE ASTRONAUT and WEIGHT OF THE ASTRONAUT is correct when the astronaut stands on Planet X?

	MASS OF THE ASTRONAUT	WEIGHT OF THE ASTRONAUT
A	**m**	**W**
B	**m**	½ **W**
C	½ **m**	½ **W**
D	½ **m**	**W**

(2)

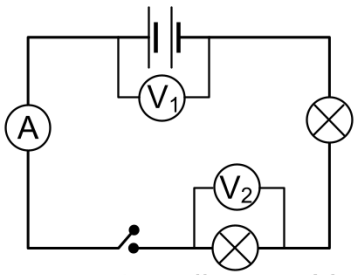
1.4 Two identical metal spheres are placed on INSULATED stands as shown in the diagram below. They carry charges of -Q and +3Q respectively and exert a force F on each other.



The spheres are allowed to touch and they are then returned to their original positions. What is the magnitude of the new electrostatic force that they exert on each other, in terms of F?

A 2 F
B F
C ½ F
D ⅓ F (2)

1.5 The potential difference of the battery in the circuit below is 12 V. The internal resistance of the battery is negligible and the two light bulbs are identical. Two voltmeters, V_1 and V_2, are connected in the circuit, as shown in the diagram.



When the switch is closed, the correct readings on V_1 and V_2 will be as follows:

	V_1 (V)	V_2 (V)
A	12	12
B	0	12
C	12	6
D	0	6

(2)

1.6 1 mol of helium gas and 1 mol of oxygen gas are stored in separate containers at STP.
Which one of the following statements about both gases is true? Helium gas will …

A Occupy a greater volume at STP than oxygen gas.
B Occupy a smaller volume at STP than oxygen gas.
C Occupy the same volume at STP as oxygen gas.
D Have the same mass at STP than oxygen gas. (2)

1.7 Which one of the following molecules is non-polar with polar bonds?

A HCℓ
B H_2O
C $C\ell_2$
D BF_3 (2)

1.8 Which of the following statements about strong acids is/are TRUE?

(I) Strong acids are always very concentrated acids.
(II) Strong acids ionise almost completely in water.
(III) The conjugate base of a strong acid is a weak base.

A (I) and (II)
B (I) and (III)
C (II) and (III)
D (II) only (2)

1.9 A gas of volume V is at a certain temperature and pressure in a gas syringe. If the pressure on the gas is halved and the temperature is kept constant, then the volume that the gas will occupy is …

A V
B 2V
C 4V
D ½V (2)

1.10 Consider the reaction below:

$$\mathbf{2Fe^{3+} + 2H_2O + SO_2 \rightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+}$$

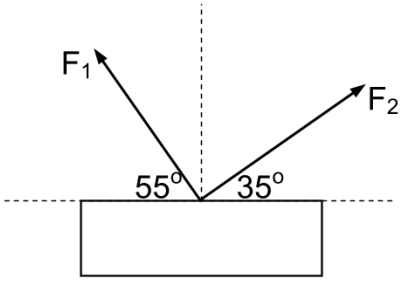
The oxidation half-reaction for this reaction is:

A $2Fe^{2+} \rightarrow 2Fe^{3+} + 2e^-$
B $SO_2 + 2H_2O \rightarrow SO_4^{2-} + 4H^+ + 2e^-$
C $Fe^{3+} + e^- \rightarrow Fe^{2+}$
D $SO_4^{2-} + 4H^+ + 2e^- \rightarrow SO_2 + 2H_2O$ (2)

[20]

QUESTION 2 (Start on a new page)

Two forces F_1 and F_2 of magnitude 35 N and 50 N respectively act at the same point on a box suspended above the ground. F_1 makes an angle of 55° with the horizontal, while F_2 makes an angle of 35° with the horizontal, as shown in the diagram below.



The box is stationary above the ground, and all the forces acting on the block are in the same plane.

2.1 Define the term *equilibrant*. (2)

2.2 Draw a closed vector diagram (triangle of forces) for the above system, showing at least two angles. (4)

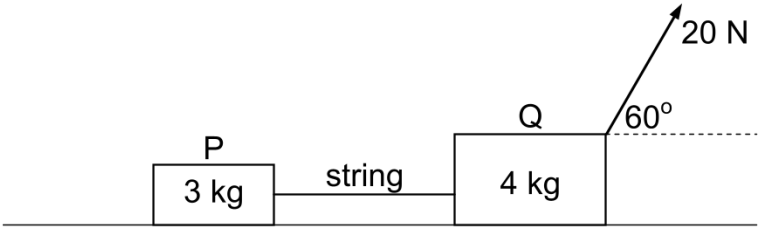
2.3 Calculate the mass of the block. (4)

2.4 What will be the net force acting on the box if force F_2 is removed? (2)

[12]

QUESTION 3 (Start on a new page)

A toy train Q of mass 4 kg is connected to a toy wagon P of mass 3 kg by a light, inextensible string. A force of 20 N is applied on P at an angle of 60° to the horizontal as shown in the diagram below.



P and Q move horizontally on a straight track. A constant kinetic frictional force of 2N acts on P, while a constant kinetic frictional force of 3 N acts on Q.

3.1 Define the term *kinetic frictional force.* (2)

3.2 Draw a free body diagram showing all the forces acting on Q. (5)

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

3.4 By applying Newton's Second Law to P and Q separately, calculate the magnitude of the acceleration of the system. (5)

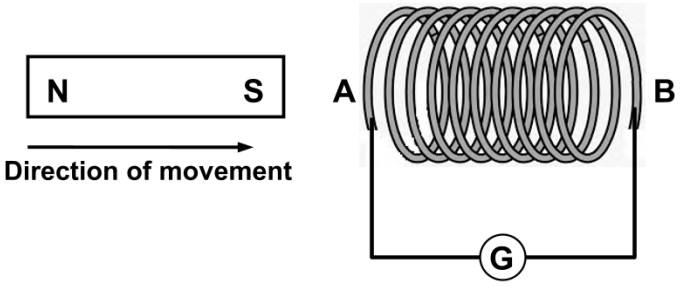
3.5 Hence calculate the tension in the string. (2)

[16]

QUESTION 4 (Start on a new page)

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

4.2 The SOUTH Pole of a magnet is inserted on the LEFT-HAND side of solenoid (as shown)



4.2.1 What is the polarity (NORTH POLE or SOUTH POLE) of the left hand side of the solenoid (A) as the bar magnet approaches? (1)

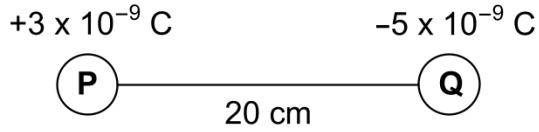
4.2.2 In which direction does the induced current flow in the coil?

Write down A to B or B to A (2)

[5]

QUESTION 5 (Start on a new page)

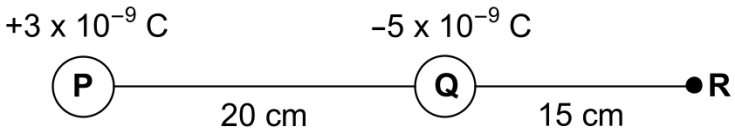
Two spheres P and Q carrying charges of $+3 \times 10^{-9}$ C and -5×10^{-9} C respectively, are placed 20 cm apart, as shown in the diagram below.



5.1 State *Coulomb's Law* in words. (2)

5.2 Calculate the magnitude of the electrostatic force that the two spheres exert on each other. (4)

R is a point 15 cm to the right of charge Q, on the line joining the centres of P and Q.



5.3 Calculate the magnitude of the net electric field at R. (5)

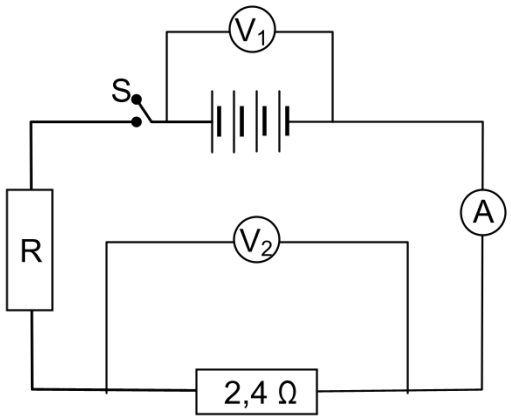
[11]

QUESTION 6 (Start on a new page)

6.1 An investigation is conducted to verify the relationship between potential difference and current in an electric circuit.

Four cells, each with an emf of 1,5 V, are connected in series with an ammeter, switch S and a combination of a resistor R and a 2,4Ω resistor as shown in the diagram below.

Voltmeters V_1 and V_2 are connected across the battery and the 2,4Ω resistor respectively. The internal resistance of the battery is negligible.



6.1.1 NAME and STATE the law being investigated. (3)

6.1.2 Name a variable that must be controlled in this investigation. (1)

6.1.3 The switch is now closed and five resistors (R_1 to R_5), each with a different resistance, replace R one at a time. The voltmeter and ammeter readings are recorded for each replacement of R.

The results obtained are shown below.

Resistors at R	Reading on V_2 (V)	Reading on A (A)
R_1	1,2	0,5
R_2	1,4	0,6
R_3	1,9	0,8
R_4	2,4	1,0
R_5	2,9	1,2

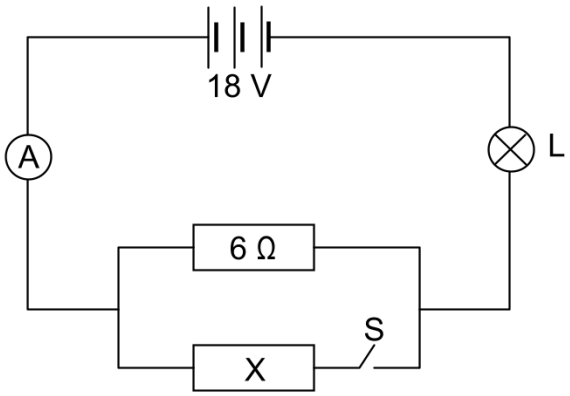
Take the independent variable to be the reading on V_2.

Sketch a graph of V versus I for the above results on the answer sheet provided on page 16 of this question paper.

NB: YOU MUST DETACH THE GRAPH AND SUBMIT THIS PAGE WITH YOUR ANSWER BOOKLET. WRITE YOUR NAMES AND GRADE ON THE ANSWER SHEET. (4)

6.1.4 What quantity does the gradient of the graph represent? (2)

6.2 In the circuit below, the battery has an emf of 18 V, and has negligible internal resistance. It is connected to an ammeter, light bulb L, a 6Ω resistor, a switch S, and a resistor X of unknown resistance, as shown in the diagram below.



Switch S is OPEN and the ammeter reads 2 A.

Calculate the

6.2.1 Potential difference across the 6 Ω resistor (3)

6.2.2 Resistance of light bulb L (4)

The switch is now CLOSED and the ammeter reads 3 A.

6.2.3 How does the brightness of light bulb L change?

Choose from GLOWS BRIGHTER, GLOWS DIMMER or STAYS THE SAME. (1)

6.2.4 Calculate the resistance of resistor X. (6)

[24]

QUESTION 7 (Start on a new page)

Ammonia reacts with water to produce ammonium ions and hydroxide ions according to the following reaction:

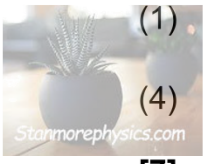
$$NH_3\ (aq) + H_2O\ (\ell) \rightarrow NH_4^+\ (aq) + OH^-\ (aq)$$

7.1 Define a covalent bond. (2)

7.2 The ammonia molecule gains a hydrogen ion from the water molecule to form the ammonium ion.

7.2.1 Name the type of bond between the ammonia molecule and the hydrogen ion. (1)

7.2.2 Using Lewis notation, write an equation to show the formation of the ammonium ion. (4)



[7]

QUESTION 8 (Start on a new page)

8.1 Define boiling point. (2)

8.2 The boiling points of the first four hydrides (molecules with hydrogen) of group seven elements are shown in the table below:

Hydride	Boiling Point (°C)
HF	19,7
HCℓ	–84,8
HBr	–66,4
HI	–35,6

8.2.1 Describe the trend in the boiling points from HCℓ to HI. (1)

8.2.2 Explain the trend identified in QUESTION 8.2.1 (3)

8.2.3 By referring to the strengths of intermolecular forces, explain why the boiling point of HF is higher than the boiling point of HCℓ. (4)

[10]

QUESTION 9 (Start on a new page)

A researcher investigates the relationship between the pressure (p) and the volume (V) of carbon tetrachloride gas ($CC\ell_4$) at a temperature of 200 °C. The researcher varies the pressure, and records the volume of the $CC\ell_4$ to obtain the following results:

Result	P(kPa)	V(cm^3)
A	15	160
B	20	120
C	25	96
D	30	88
E	35	68,6

9.1 What is the name of the law under investigation? (1)

9.2 Write a suitable investigative question for this investigation. (2)

9.3 Give a reason why the investigation must be conducted at a high temperature. (1)

9.4 For the results obtained, the first volume reading (A) is correct, while one of the remaining volume readings is incorrect.

9.9.1 For which result is the volume reading INCORRECT?

Choose from B, C, D or E. (1)

9.9.2 By means of a calculation, determine what the correct volume reading should be for the result identified in QUESTION 9.9.1. (3)

[8]

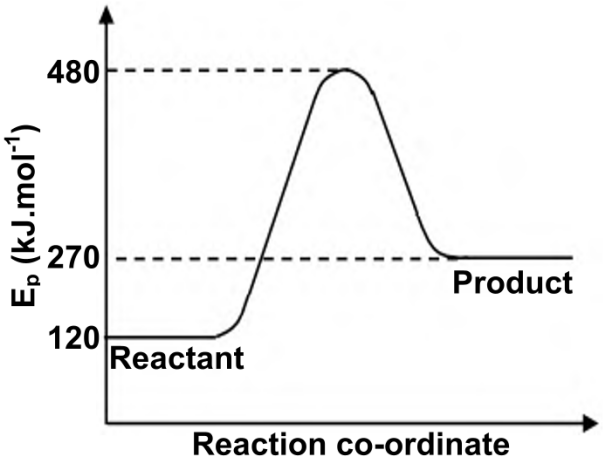
QUESTION 10 (Start on a new page)

Magnetite is a type of magnetised rock that occurs naturally and is found in the beaks of homing pigeons and some other birds. The magnetite allows these birds to navigate using Earth's magnetic field.

Magnetite can be formed according to the following unbalanced chemical reaction.

$$\mathbf{Fe\,(s) + H_2O\,(\ell) \rightarrow Magnetite + H_2\,(g)}$$

10.1 The energy diagram for the above reaction is given below.



10.1.1 What is the activation energy for the forward reaction? (1)

10.1.2 Calculate the heat of reaction (ΔH) for the reverse reaction. (1)

10.1.3 A catalyst is added to the reaction mixture.

How does this affect the heat of reaction for the forward reaction?

Choose from **INCREASES, DECREASES** or **REMAINS THE SAME** (1)

10.2 Magnetite consists of **72,41%** iron and **27,59%** oxygen.

Determine the empirical formula of magnetite. (5)

[8]

QUESTION 11 (Start on a new page)

11.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

11.2 Consider the following acid-base reactions:

I) $H_2SO_4 + H_2O \rightleftharpoons HSO_4^- + H_3O^+$
II) $HSO_4 + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$

11.2.1 Identify one conjugate acid-base pair in reaction (II) above. (2)

11.2.2 Identify one substance in the above reactions that is an ampholyte. (1)

11.3 Magnesium carbonate ($MgCO_3$) is one of the active ingredients found in antacid medication used to treat indigestion and acid reflux. $MgCO_3$ reacts with HCℓ according to the following balanced equation:

$$\mathbf{MgCO_3\,(s) + 2HC\ell\,(aq) \rightarrow MgC\ell_2\,(aq) + H_2O\,(\ell) + CO_2\,(g)}$$

The mass of the magnesium carbonate found in each antacid tablet is 0,15 g.

Calculate the volume of CO_2 gas formed when ONE such antacid tablet reacts with excess HCℓ at STP. (5)

11.4 A solution of magnesium hydroxide $Mg(OH)_2$ is prepared by dissolving 8g solid $Mg(OH)_2$ in water to make 250 cm^3 of the solution.
Assume that the $Mg(OH)_2$ dissolves completely.

This solution reacts COMPLETELY with a sample of **impure** ammonium chloride, $NH_4C\ell$(s), according to the following balanced equation:

$$\mathbf{Mg(OH)_2\,(aq) + 2NH_4C\ell\,(s) \rightarrow MgC\ell_2\,(aq) + H_2O\,(\ell) + 2NH_3\,(aq)}$$

The percentage purity of the $NH_4C\ell$ sample is 90,95%.

11.4.1 Calculate the concentration of the $Mg(OH)_2$ solution. (3)

11.4.2 Calculate the mass of the **impure** $NH_4C\ell$ in the sample. (6)

[19]

QUESTION 12 (Start on a new page)

12.1 Define oxidation in terms of electron transfer. (2)

12.2 The reaction between dichromate ions ($Cr_2O_7^{2-}$) and iron (II) ions (Fe^{2+}) in an acidic medium is given below.

$$\mathbf{Cr_2O_7^{2-}\,(aq) + Fe^{2+}\,(aq) + H^+\,(aq) \rightarrow Cr^{3+}\,(aq) + Fe^{3+}\,(aq) + H_2O\,(\ell)}$$

12.2.1 Write down the oxidation number of CHROMIUM in $Cr_2O_7^{2-}$. (1)

12.2.2 Write down the FORMULA of the substance that undergoes oxidation. Explain the answer in terms of oxidation numbers. (2)

12.2.3 Write down the reduction half-reaction. (2)

12.2.4 Balance the above chemical equation using the appropriate half reactions. (3)

[10]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES
GRADE 11 PHYSICS

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9,8\ m\cdot s^{-2}$
Gravitational constant	G	$6,67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
Radius of Earth	R_E	$6,38 \times 10^{6}\ m$
Coulomb's constant	k	$9,0 \times 10^{9}\ N\cdot m^2\cdot C^{-2}$
Speed of light in a vacuum	c	$3,0 \times 10^{8}\ m\cdot s^{-1}$
Charge on electron	e	$-1,6 \times 10^{-19}\ C$
Electron mass	m_e	$9,11 \times 10^{-31}\ kg$
Mass of Earth	M	$5,98 \times 10^{24}\ kg$

TABLE 2: FORMULAE

MOTION	FORCE	ELECTROSTATICS	ELECTROMAGNETISM
$v_f = v_i + a\Delta t$	$F_{net} = ma$	$n = \frac{Q}{e}$	$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$
$v_f^2 = v_i^2 + 2a\Delta x$	$w = mg$	$F = \frac{kQ_1Q_2}{r^2}\ (k = 9,0\times10^9\ N\cdot m^2\cdot C^{-2})$	$\Phi = BA\cos\theta$
$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$	$F = \frac{Gm_1m_2}{r^2}$	$E = \frac{F}{q}$	
$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$	$\mu_s = \frac{f_{s(max)}}{N}$	$E = \frac{kQ}{r^2}\ (k = 9,0\times10^9\ N\cdot m^2\cdot C^{-2})$	
	$\mu_k = \frac{f_k}{N}$		

ELECTRIC CIRCUITS			
$I = \frac{Q}{\Delta t}$	$R = \frac{V}{I}$	$R = R_1 + R_2 + R_3 + \ldots$	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$
$W = Vq$	$W = VI\Delta t$	$W = I^2R\Delta t$	$W = \frac{V^2\Delta t}{R}$
$P = \frac{W}{\Delta t}$	$P = VI$	$P = I^2R$	$P = \frac{V^2}{R}$

DATA FOR PHYSICAL SCIENCES
GRADE 11 – CHEMISTRY

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
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

TABLE 2: FORMULAE

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

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 **H** 1																	**He** 4
1,0 **Li** 7	1,5 **Be** 9											2,0 **B** 11	2,5 **C** 12	3,0 **N** 14	3,5 **O** 16	4,0 **F** 19	**Ne** 20
0,9 **Na** 23	1,2 **Mg** 24											1,5 **Aℓ** 27	1,8 **Si** 28	2,1 **P** 31	2,5 **S** 32	3,0 **Cℓ** 35,5	**Ar** 40
0,8 **K** 39	1,0 **Ca** 40	1,3 **Sc** 45	1,5 **Ti** 48	1,6 **V** 51	1,6 **Cr** 52	1,5 **Mn** 55	1,8 **Fe** 56	1,8 **Co** 59	1,8 **Ni** 59	1,9 **Cu** 63,5	1,6 **Zn** 65	1,6 **Ga** 70	1,8 **Ge** 73	2,0 **As** 75	2,4 **Se** 79	2,8 **Br** 80	**Kr** 84
0,8 **Rb** 86	1,0 **Sr** 88	1,2 **Y** 89	1,4 **Zr** 91	**Nb** 92	1,8 **Mo** 96	1,9 **Tc**	2,2 **Ru** 101	2,2 **Rh** 103	2,2 **Pd** 106	1,9 **Ag** 108	1,7 **Cd** 112	1,7 **In** 115	1,8 **Sn** 119	1,9 **Sb** 122	2,1 **Te** 128	2,5 **I** 127	**Xe** 131
0,7 **Cs** 133	0,9 **Ba** 137	**La** 139	1,6 **Hf** 179	**Ta** 181	**W** 184	**Re** 186	**Os** 190	**Ir** 192	**Pt** 195	**Au** 197	**Hg** 201	1,8 **Tℓ** 204	1,8 **Pb** 207	1,9 **Bi** 209	2,0 **Po**	2,5 **At**	**Rn**
0,7 **Fr**	0,9 **Ra** 226	**Ac**															

Ce 140	**Pr** 141	**Nd** 144	**Pm**	**Sm** 150	**Eu** 152	**Gd** 157	**Tb** 159	**Dy** 163	**Ho** 165	**Er** 167	**Tm** 169	**Yb** 173	**Lu** 175
Th 232	**Pa**	**U** 238	**Np**	**Pu**	**Am**	**Cm**	**Bk**	**Cf**	**Es**	**Fm**	**Md**	**No**	**Lr**

KEY: Atomic number (29) · Electronegativity (1,9) · Symbol (Cu) · Approximate relative atomic mass (63,5)

TABLE 4A: STANDARD REDUCTION POTENTIALS

Half-reactions			E^{θ} (V)
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$Na^+ + e^-$	⇌	Na	– 2,71
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Cs^+ + e^-$	⇌	Cs	- 2,92
$K^+ + e^-$	⇌	K	– 2,93
$Li^+ + e^-$	⇌	Li	– 3,05

Increasing oxidising ability ↑

Increasing reducing ability ↓

TABLE 4B: STANDARD REDUCTION POTENTIALS

Half-reactions			E^{θ} (V)
$Li^+ + e^-$	⇌	Li	– 3,05
$K^+ + e^-$	⇌	K	– 2,93
$Cs^+ + e^-$	⇌	Cs	- 2,92
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Na^+ + e^-$	⇌	Na	– 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87

Increasing oxidising ability ↓

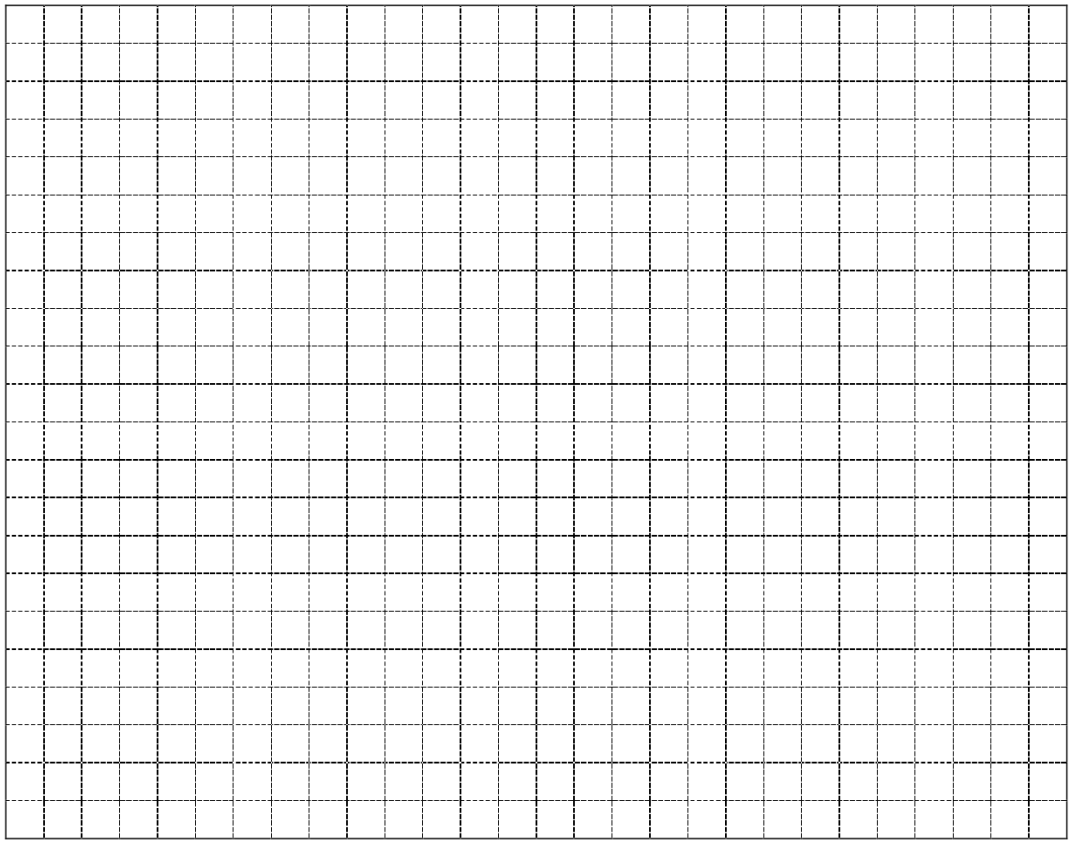
Increasing reducing ability ↑

NAME: _____ **GRADE:** 11___

Detach this page and submit it with your answer booklet.

Question 6

Answer Question 6.1.3 on the graph page provided below



Kzn education

Department:
Education
KWAZULU-NATAL

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES
NOVEMBER 2022

MARKS: 150

TIME: 3 hours

MARKING GUIDELINE

This MARKING GUIDELINE consists of **8** pages.

QUESTION 1

1.1 C ✓✓ (2)

1.2 B ✓✓ (2)

1.3 B ✓✓ (2)

1.4 D ✓✓ (2)

1.5 C ✓✓ (2)

1.6 C ✓✓ (2)

1.7 D ✓✓ (2)

1.8 C ✓✓ (2)

1.9 B ✓✓ (2)

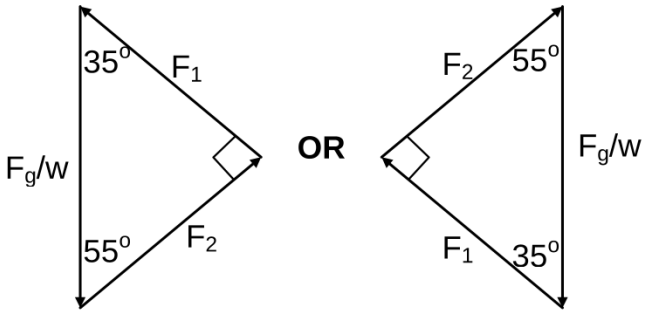
1.10 B ✓✓ (2)

[14]

QUESTION 2

2.1 A force that balances all other forces acting on an object and brings about equilibrium. ✓✓ (2)

2.2



Marking Criteria
- ✓ F_g/w (Label and arrow)
- ✓ F_1 (Label and arrow)
- ✓ F_2 (Label and arrow)
- ✓ Any two angles

(4)

2.3 **Mark according to learner answer:**

Learner uses F_1

$$F_g = mg$$
$$\frac{F_g}{\sin 90^o} = \frac{F_1}{\sin 55^o} \checkmark$$
$$m(9,8) = \frac{35 \sin 90^o \checkmark}{\sin 55^o \checkmark}$$
$$m = 4,36 \text{ kg} \checkmark$$

Learner uses F_2

$$F_g = mg$$
$$\frac{F_g}{\sin 90^o} = \frac{F_2}{\sin 35^o} \checkmark$$
$$m(9,8) = \frac{50 \sin 90^o \checkmark}{\sin 35^o \checkmark}$$
$$m = 8,895 \text{ kg} \checkmark$$

Learner uses Theorem of Phythagoras

$$F_g = mg$$
$$F_g = \sqrt{F_1^2 + F_2^2} \checkmark$$
$$m(9,8) = \sqrt{35^2 \checkmark + 50^2} \checkmark$$
$$m = 6,23 \text{ kg} \checkmark$$

(4)

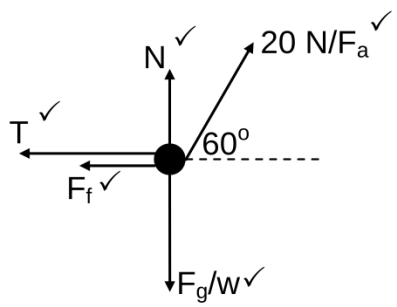
2.4 $F_{net} = F_g - F_1 = m(9,8) - 35$ ✓
$F_{net} = (4,36)(9,8) - 35 =$ 7,73N down✓
OR $F_{net} = (8,895)(9,8) - 35 =$ 52,171N down✓
OR $F_{net} = (6,23)(9,8) - 35 =$ 20,05N down✓ (2)

[12]

QUESTION 3

3.1 The force that opposes the motion of a moving object relative to a surface. ✓✓ (2)

3.2



(5)

3.3 When a resultant/net force acts on an object, the object will accelerate in the direction of the force at an acceleration directly proportional to the force and inversely proportional to the mass of the object. ✓✓ (2)

3.4

For toy train Q

$F_{net} = ma$ ✓

$F_X - f - T = ma$ ✓

$(20\cos 60^o) - 3 - T = 4a$

$T = 7 - 4a$ (1)

For toy wagon P

$F_{net} = ma$

$T - f = ma$ ✓

$T - 2 = 3a$

$T = 2 + 3a$ (2)

(1) = (2) ✓

$7 - 4a = 2 + 3a$

$7a = 5$ ✓

$a = 0{,}71\,m.s^{-2}$

(5)

3.5

$T = 2 + 3a$

$= 7 + 3(0{,}71)$ ✓

$= 4{,}13\,N$ ✓

OR

$T = 7 - 4a$

$= 7 - 4(0{,}71)$ ✓

$= 4{,}16\,N$ ✓

(2)

[16]

QUESTION 4

4.1 The magnitude of the induced emf across the ends of a conductor is directly proportional to the rate of change in the magnetic flux linkage with the conductor. ✓✓ (2)

4.2 4.2.1 South Pole ✓ (1)

4.2.2 B to A ✓ (1)

[4]

QUESTION 5

5.1 The magnitude of the electrostatic force exerted by two point charges on each other is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them. ✓✓ (2)

OR

The magnitude of the electrostatic force exerted by two charges on each other is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between their centres. ✓✓ (2)

5.2
$$F = k\frac{Q_1Q_2}{r^2} \checkmark$$
$$= (9 \times 10^9)\frac{(3 \times 10^{-9})(5 \times 10^{-9})}{(0,2)^2} \checkmark \checkmark$$
$$= 3,375\ N \checkmark \quad (3,38\ N)$$
(4)

5.3
$$E_{PR} = \frac{kq}{r^2} \checkmark = \frac{(9\times10^9)(3\times10^{-9})}{(0,35)^2} \checkmark = 2,204\times10^2\ N.C^{-1}$$
$$E_{QR} = \frac{kq}{r^2} = \frac{(9\times10^9)(5\times10^{-9})}{(0,15)^2} \checkmark = 2,000\times10^3\ N.C^{-1}$$
$$E_{net} = E_{QR} - E_{PR} = 2,00\times10^3 - 2,204\times10^2 \checkmark = 7,780\times10^3\ N.C^{-1} \checkmark$$
(5)

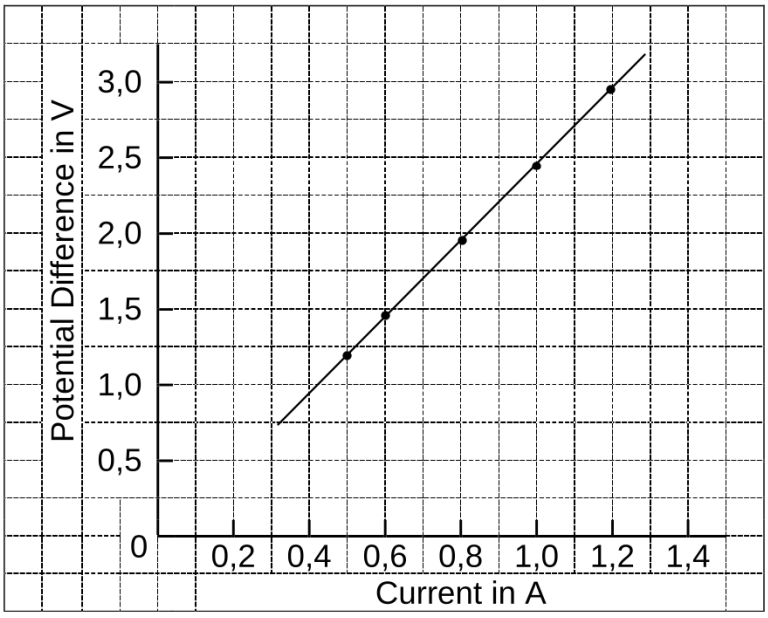
[11]

QUESTION 6

6.1 6.1.1 Ohm's Law ✓✓ (2)

6.1.2 Current ✓ (Temperature) (1)

6.1.3



Marking Criteria
- ✓ Label x-axis
- ✓ Label y-axis
- ✓✓ 3 points plotted correctly
- ✓ 2 points plotted correctly

(4)

6.1.4 Resistance ✓✓ (2)

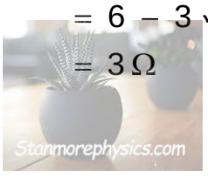
6.2 6.2.1 $V_{6\Omega} = IR$ ✓
$= (2)$✓(6) ✓
$= 12\ V$✓ (4)

6.2.2 $V_{L_1} = 18 - 12$ ✓ $= 6\ V$
$V_{L_1} = IR$
6✓$= (2)$✓(R)
$R = 3\ \Omega$ ✓ (4)

6.2.3 $V = IR$ ✓
$18 = (3)R$ ✓
$R = 6\ \Omega$

$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{X}$ ✓
$\frac{1}{3} = \frac{1}{6} + \frac{1}{X}$ ✓
$X = 6\ \Omega$ ✓

$R_p = R_T - R_{L_1}$
$= 6 - 3$ ✓
$= 3\ \Omega$



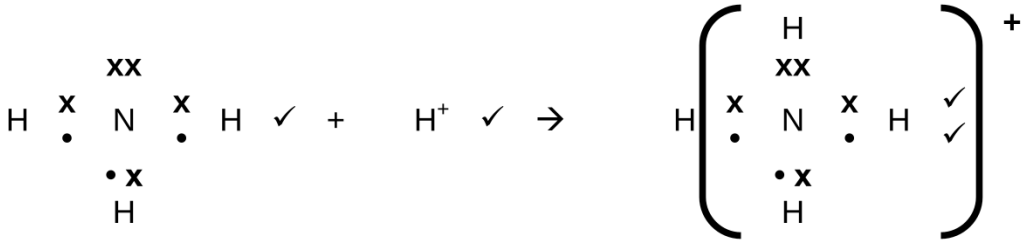
(6)
[23]

QUESTION 7

7.1 The sharing of electrons between two atoms to form a molecule.✓✓ (2)

7.2 7.2.1 Dative covalent bond ✓ (Co-ordinate covalent bond) (1)

7.2.2



(4)
[7]

QUESTION 8

8.1 The temperature at which the vapour pressure of a substance is equal to the atmospheric (external) pressure. ✓✓ (2/0) (2)

8.2 8.2.1 The boiling points increase. ✓ (1)

8.2.2 There is an increase molecular mass from HCℓ to HI. ✓
An increase in molecular mass increases the strength of the intermolecular forces. ✓
More energy is required to disrupt/break the intermolecular forces resulting in a higher boiling point. ✓ (3)

8.2.3 HCℓ contain dipole forces, ✓ while HF has hydrogen bonding.✓
Hydrogen bonds are stronger than dipole forces ✓
Therefore more energy is required to disrupt/break the intermolecular forces in HF than in HCℓ resulting in HF having a higher boiling point. ✓ (4)
[10]

QUESTION 9

9.1 Boyle's law ✓ (1)

9.2 What is the relationship between the pressure of an enclosed gas and the volume it occupies when temperature is kept constant? ✓✓ (2)

9.3 So that condensation of the gas does not occur. ✓ (1)

9.4 9.4.1 D ✓ (1)

9.4.2 $p_1V_1 = p_2V_2$ ✓
$(15)(160) = 30V_2$ ✓
$V_2 = 80\ cm^3$ ✓
(3)
[8]

QUESTION 10

10.1 10.1.1 360 $kJ.mol^{-1}$ ✓ (1)

10.1.2 $\Delta H = H_p - H_r$
$= 120 - 270$
$= -150\ kJ.mol^{-1}$ ✓ (1)

10.1.3 Remains the same ✓ (1)

10.2 Assume we have 100g of sample.

Element	%	m	$n = \frac{m}{M}$	Mole Ratio	Ratio
Fe	72, 41	72,41g	1,29 ✓	1 ÷1,29 ✓	3 x3 ✓
O	27, 59	27,59g	1,72 ✓	1,33	4

Empirical Formula: Fe_3O_4 ✓ (5)
[8]

QUESTION 11

11.1 An acid is a proton/H^+ ion donor. ✓✓ (2)

11.2 11.2.1 HSO_3^- ; H_2SO_3 ✓✓ OR

H_2O ; OH^- ✓✓ (2)

11.2.2 HSO_3^- ✓ or H_2O ✓ (1)

11.3 $n_{MgCO3} : n_{CO_2} = 1 : 1$ ✓

$$n_{MgCO_3} = \frac{m}{M}$$
$$= \frac{0,15}{84} \checkmark$$
$$= 0,00179 \text{ mol}$$

$n_{CO_2} = 0,00179$ mol

$$n_{CO_2} = \frac{V}{V_m} \checkmark$$
$$0,00179 = \frac{V}{22,4} \checkmark$$
$$= 0,04 \text{ dm}^3$$ (5)

11.4 11.4.1 $c = \frac{m}{MV}$ ✓

$$= \frac{8}{(58)(0,25)} \checkmark$$
$$= 0,552 \text{ mol.dm}^{-3} \checkmark$$ (3)

11.4.2 $Mg(OH)_2(aq) : 2NH_4C\ell$ ✓

1 : 2

$$n_{Mg(OH)_2} = \frac{m}{M} = \frac{8}{58} \checkmark = 0,14 \text{ mol}$$

$$n_{NH_4C\ell} = 2 \times 0,14 \checkmark = 0,18 \text{ mol}$$

$$m_{NH_4C\ell} = nM = 0,18 \times 53,5 \checkmark = 9,63 \text{ g}$$

$$\%\text{Purity} = \frac{\text{Pure mass} \times 100}{\text{Impure mass}}$$
$$90,95 = \frac{9,63 \times 100}{\text{Impure mass}} \checkmark$$
$$\text{Impure mass} = 10,59 \text{ g} \checkmark$$ (6)

[19]

QUESTION 12

12.1 A loss of electrons. ✓✓ / An increase in oxidation number. ✓✓ (2)

12.2 12.2.1 Cr^{6+} (+6) ✓ (1)

12.2.2 Fe^{2+}, ✓ the oxidation number increases from +2 to +3 ✓ (2)

12.2.3 $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ ✓✓ (2)

12.2.4 $6Fe^{2+} \rightarrow 6Fe^{3+} + 6e^-$ ✓(for correct equation) ✓(for x 6)

$Cr_2O_7^{2-} + 14H^+ + 6e- \rightarrow 2Cr^{3+} + 7H_2O$

$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 7H_2O + 6Fe^{3+}$ ✓ (3)

[11]

TOTAL: 150