Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCE P2
(CHEMISTRY)

COMMON TEST

JUNE 2017

NATIONAL SENIOR CERTIFICATE

GRADE 11

MARKS: 100

TIME: 2 Hours

This question paper consists of 9 pages, 2 data pages and graph paper.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
2. Number the answers correctly according to the numbering system used in this question paper.
3. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
4. You may use a non-programmable calculator.
5. You may use appropriate mathematical instruments.
6. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEET.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum to TWO decimal places.
9. Give brief motivations, discussions, et cetera where required.
10. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions.
Each question has only ONE correct answer. Write down only the letter (A – D) next to the question number (1.1 – 1.7) in the answer book, for example 1.8 D.

1.1 The shape of the SF_6 molecule is

A Pyramidal

B Octahedral

C Tetrahedral

D Trigonal Bipyramid (2)

1.2 Aquatic animals obtain their oxygen that is dissolved in water. The type of intermolecular forces that are found between water and dissolved oxygen is called

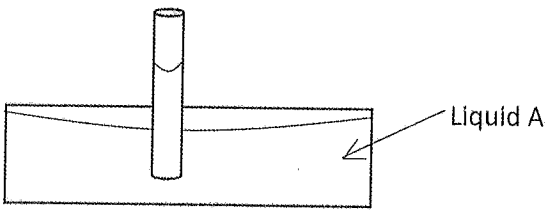
A Hydrogen bonds

B Dispersion forces

C Ion-induced dipole forces

D Dipole-induced dipole forces (2)

1.3 A thin tube, opened at both ends is placed in liquid A as shown in the sketch below. It is observed that liquid A rises in the tube.



The reason for this observation is

A Liquid A has no surface tension.

B Liquid A has high surface tension.

C The adhesive forces are less than the intermolecular forces.

D The adhesive forces are greater than intermolecular forces. (2)

1.4 The behaviour of a real gas is approximately the same as that of an ideal gas under the following conditions of temperature and pressure:

	Temperature	Pressure
A.	Low	Low
B.	Moderate	High
C.	Low	High
D.	Moderate	Low

(2)

1.5 A cubic container is filled with a gas which exerts pressure ***p***. What will the pressure exerted by the same amount of this gas be if the gas is placed in a cubic container whose side is half of that of the original container?

A ⅛ ***p***

B ¼ ***p***

C 4***p***

D 8***p***

(2)

1.6 The number of hydrogen atoms in 1 mole of NH_4OH is

A 5

B 6.022×10^{23}

C $4 \times 6.022 \times 10^{23}$

D $5 \times 6.022 \times 10^{23}$

(2)

1.7 A solution of HCℓ has a concentration **C**. A learner pours 25 cm^3 of this solution into a 100 cm^3 volumetric flask and adds water to make a 100 cm^3 solution.

The final concentration of the new solution is:

A ¼ **C**

B ¾ **C**

C 0,01 **C**

D 4 **C**

(2)

[14]

QUESTION 2

2.1 Given the table below answer the questions that follow:

Bond	Bond energy ($k \cdot J \cdot mol^{-1}$)	Bond Length (pm)
O – H	463	96
N – H	389	100.8
C – C	348	154

2.1.1 Define bond length. (2)

2.1.2 From the data provided, what is the relationship between bond length and bond energy? (2)

2.1.3 Calculate the energy required to break all the bonds in one mole of NH_3. (2)

2.2 Hydrogen and carbon atoms react to form methane.

2.2.1 Name the type of bond between the hydrogen and carbon atoms. (1)

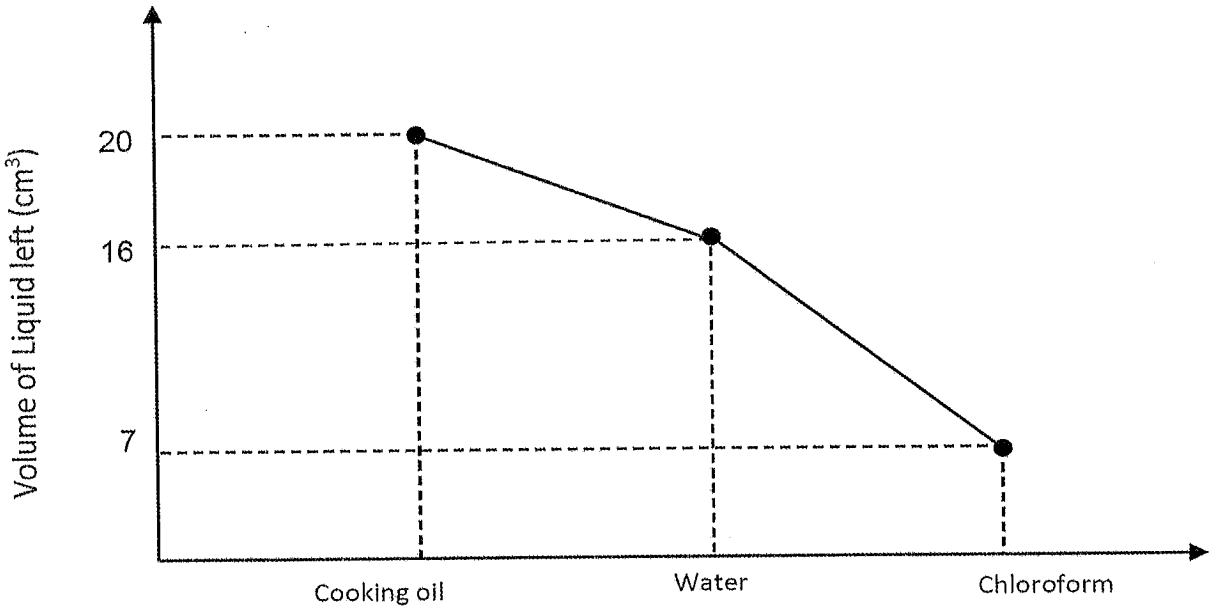
2.2.2 Draw the Lewis Structure for CH_4. (2)

2.2.3 Calculate the difference in electronegativity between carbon and hydrogen atoms. (1)

2.2.4 Is CH_4 a POLAR or a NON-POLAR molecule? Explain. (2)
[12]

QUESTION 3

Learners conduct an experiment to measure the rate of evaporation of three liquids under the same conditions. The learners placed 20 cm^3 of cooking oil, 20 cm^3 of water and 20 cm^3 of chloroform in separate beakers. All three beakers were left exposed for 5 hours. The experiment was repeated 5 times under identical conditions. The average results obtained are shown in the graph below.



3.1 Define vapour pressure. (2)

3.2 Write down an investigative question for this experiment. (2)

3.3 Name a controlled variable. (1)

3.4 Which substance has the lowest vapour pressure?
Give a reason for your answer. (2)

3.5 Calculate the rate of evaporation of chloroform in $cm^3.hour^{-1}$. (2)

3.6 Is the experiment a fair test? Give a reason for your answer. (2)

3.7 Chloroform and water are both solvents, but their evaporation rates differ.
Explain this observation. (3)

[14]

QUESTION 4

A learner investigates the relationship between volume and pressure of an enclosed DIATOMIC gas at room temperature. The following results were recorded by the learner.

Pressure (p) (kPa)	Volume (v) (cm^3)	$\frac{1}{v}$ (cm^{-3})
100	50	0.02
150	33	0.03
200	25	0.04
250	20	0.05

4.1 Name the law being investigated. (1)

4.2 Draw a graph of pressure vs $\frac{1}{v}$ on the attached GRAPH PAPER. (4)

4.3 What conclusion could be drawn from the graph in question 4.2? (2)

4.4 Name ONE factor that must be kept constant in this investigation. (1)

4.5 Assume that there is a deviation in the graph at pressures greater than 250 kPa. On the same set of axes show how the graph of pressure vs 1/v will appear at pressures higher than 250 kPa. (1)

4.6 Fully explain the reason for the deviation in question 4.5. (2)
[11]

QUESTION 5

A gas cylinder containing deodorant (perfume) has a warning that it should not be exposed to excessive heat, as exposure to heat may lead to an explosion. The cylinder can withstand a maximum pressure of 120 kPa.

5.1 Name the law that is described in the above statement. (1)

5.2 The container is stable at 25°C and 101.3 kPa. Determine the minimum temperature that could lead to the cylinder exploding. (4)

5.3 Will this cylinder explode at 100 °C and 101,3 kPa?
Write down only YES or NO. (1)

5.4 Explain your answer to question 5.3. (2)
[8]

QUESTION 6

Samples of impure oxalic acid crystals ($H_2C_2O_4 \cdot 2H_2O$) are obtained from the technician of a laboratory. The samples are placed in small packets of 0.350 g each. These samples are used to prepare standard solutions of oxalic acid.

6.1 Define a standard solution. (2)

6.2 One packet of impure $H_2C_2O_4 \cdot 2H_2O$ was used to prepare a 250 cm^3 solution. After analysis, the concentration of the prepared solution was found to be 0.01 $mol \cdot dm^{-3}$.

Determine mass of $H_2C_2O_4 \cdot 2H_2O$ in the sample. (4)

6.3 Calculate the mass of the impurities in each sample. (2)

6.4. What is the percentage purity of the used sample? (3)

[11]

QUESTION 7

Pure $CaCO_3$ powder was dropped into a test tube containing a 0,12 $mol.dm^{-3}$ $HC\ell$ solution of unknown volume. The following reaction took place:

$$CaCO_{3(s)} + 2HC\ell_{(aq)} \rightarrow CaC\ell_{2(aq)} + CO_{2(g)} + H_2O_{(\ell)}$$

Upon completion of the reaction, it was found that:

- 1,146 dm^3 of CO_2 was produced at STP.
- 110 cm^3 of $HC\ell$, with a concentration of 0,09 $mol \cdot dm^{-3}$ remained in the beaker.

7.1 Explain what is meant by an excess reactant. (2)

7.2 Identify the excess reactant in the above reaction. (1)

7.3 Calculate the number of moles of CO_2 produced. (3)

7.4 Calculate the initial mass of $HC\ell_{(aq)}$ that was present in the test tube. (6)

7.5 5,68 g of $CaCO_3$ was added in the reaction vessel to start the reaction.

7.5.1 Calculate the theoretical yield of CO_2 in grams. (4)

7.5.2 Calculate the percentage yield of CO_2. (3)

[19]

QUESTION 8

7,5340 g of pure ethylene glycol was analysed and was found to contain 2,9164 g of carbon, 0,7291 g of hydrogen, and 3,8885 g of oxygen

8.1 Explain what is meant by the **empirical formula** of a compound. (2)

8.2. Determine the empirical formula of ethylene glycol. (6)

8.3 If the molar mass of ethylene glycol is 62 $g \cdot mol^{-1}$, what is its molecular formula? (3)

[11]

TOTAL: 100 MARKS

PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 2 (CHEMIE)

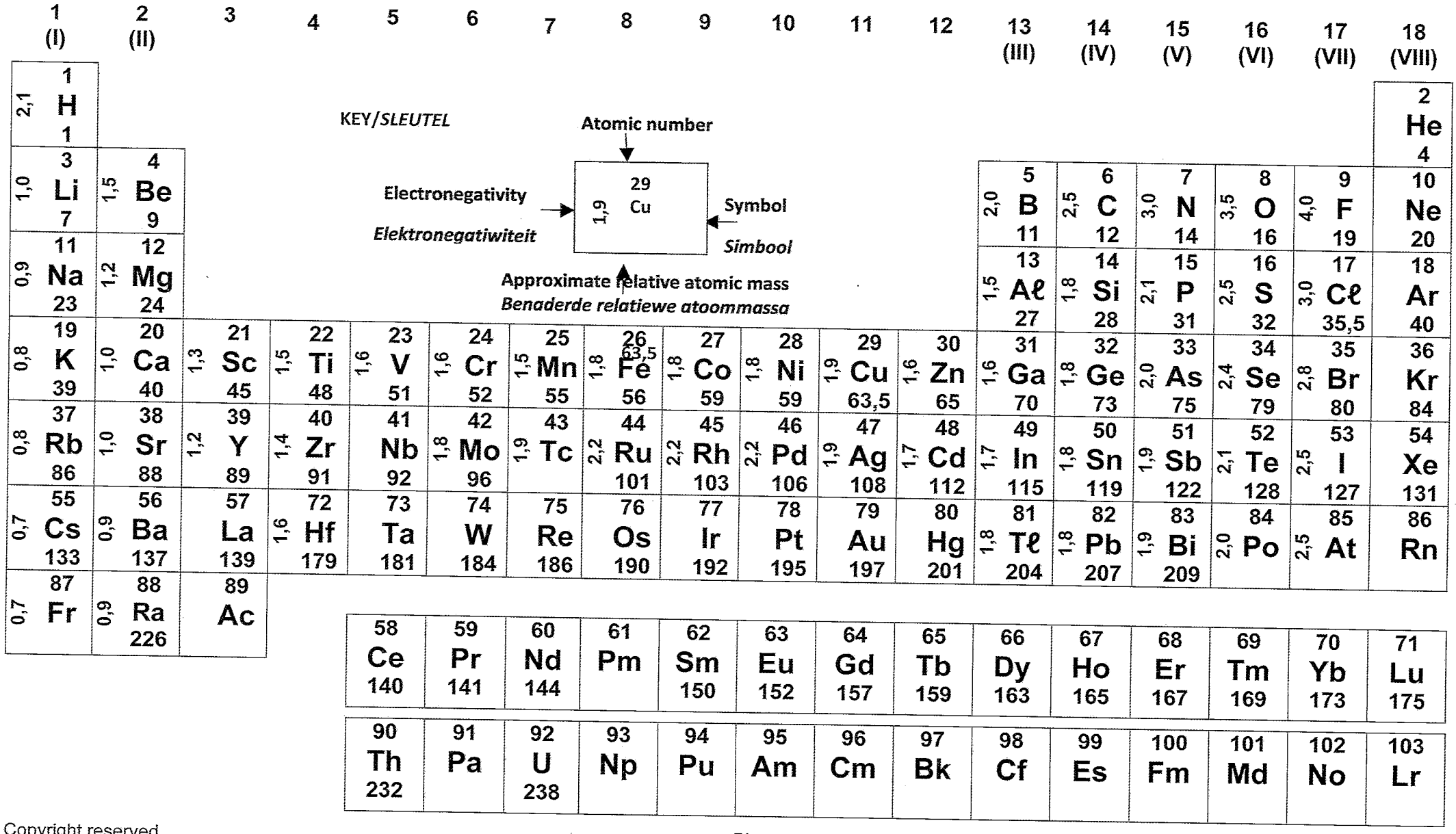
TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Molêre gaskonstante Molar gas constant	R	8.31 $J \cdot K^{-1} \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Avogadro's Constant	N of/or N_A	6.022×10^{-23} mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

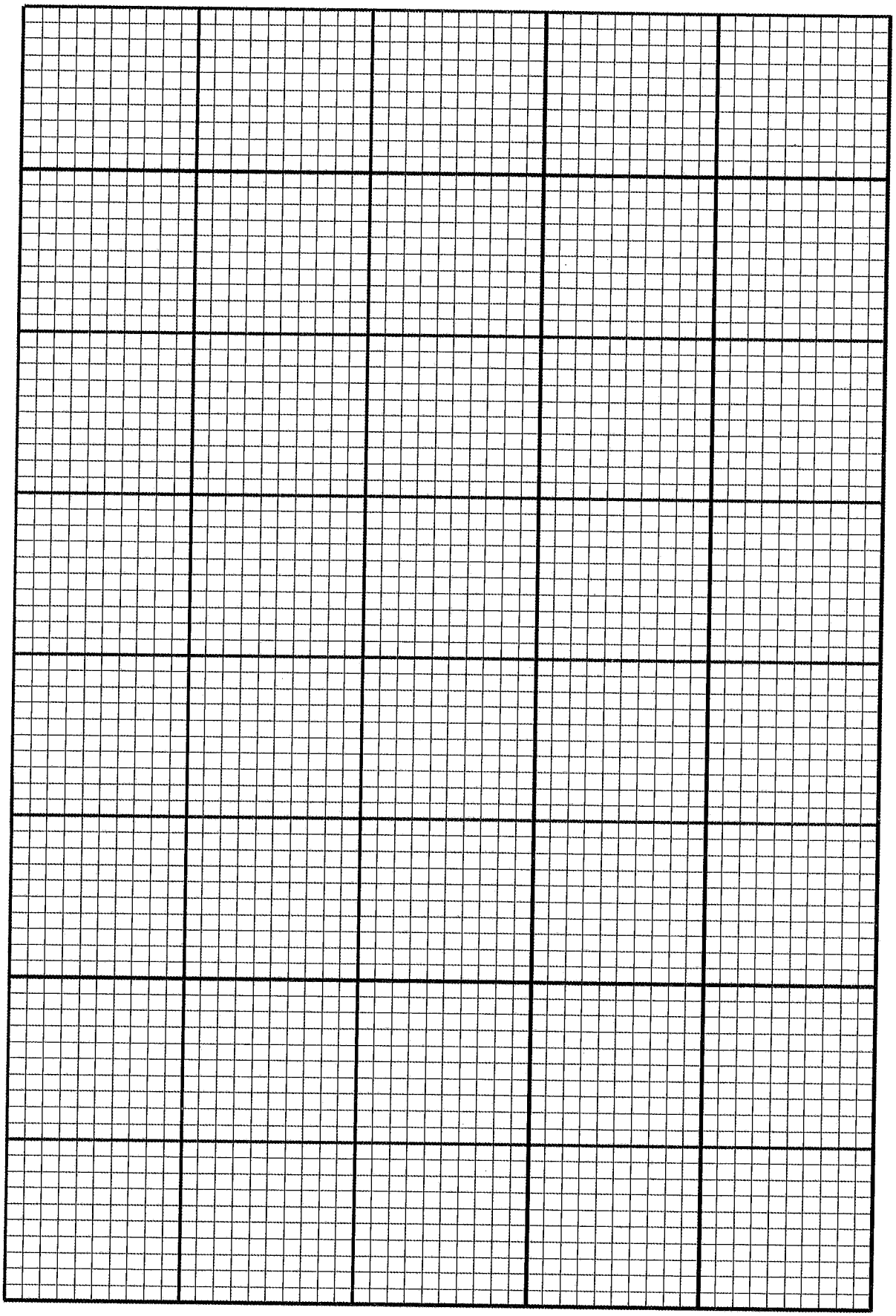
$n = \frac{m}{M}$	$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $pV = nRT$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS



NAME:

TEAR – OFF SHEET



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N.B. This marking guideline consists of 8 pages.

QUESTION 1

1.1 B ✓✓ (2)

1.2 D ✓✓ (2)

1.3 D ✓✓ (2)

1.4 D ✓✓ (2)

1.5 D ✓✓ (2)

1.6 D ✓✓ (2)

1.7 A ✓✓ (2)

[14]

QUESTION 2

2.1.1 Bond length is the average distance between the nuclei of two bonded atoms✓✓ (2)

2.1.2 as the bond length increases, the bond energy decreases ✓✓ (2 or 0)

or

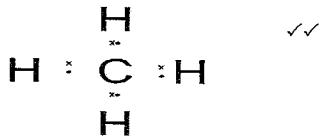
as the bond length decreases the bond energy increases ✓✓

2.1.3 $\Delta H = 3\times (N - H)$
$= 3\times 389$✓
$= 1\ 167 kJ\cdot mol^{-1}$✓ (2)

2.2

2.2.1 Covalent bond✓ (1)

2.2.2 (2)



✓✓

2.2.3 $\Delta EN = 2.5 - 2.1 = 0.40$ ✓ (1)

2.2.4. Non-polar ✓, C – H bonds are polar but the molecule is symmetrical✓ (2)

OR CH_4 is tetrahedral in shape.

[12]

QUESTION 3

3.1 Vapour pressure is the pressure exerted by the vapour at equilibrium with its liquid in a closed system✓✓ (2 or 0)

3.2 How does the nature of a liquid affect the rate of evaporation? ✓✓ (2)

OR

What is the relationship between different types of liquids and the rate of evaporation of these liquids? ✓✓

(one mark for identifying the two variables, and one mark for framing it into a question).

3.3 Volume ✓ or Temperature or Atmospheric pressure. (1)

3.4 Cooking oil✓, it does not change into vapour easily✓ (2)

3.5

$$\text{rate} = \frac{\Delta V}{\Delta t} \quad ✓$$
$$= \frac{7-20}{5} \quad (2)$$
$$= -2{,}6\ \text{cm}^3\ \text{hr}^{-1} \quad ✓$$

3.6 yes ✓, only one variable was changed✓ (2)

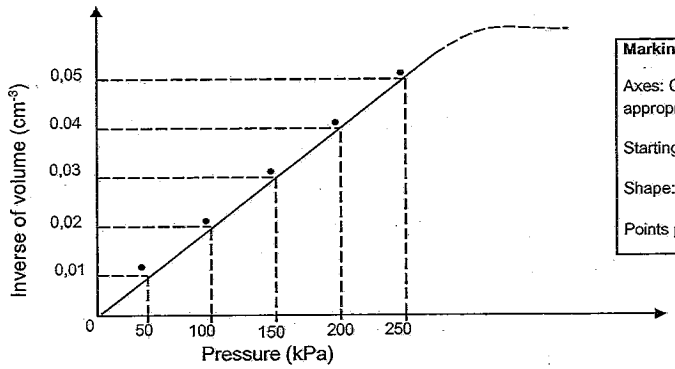
3.7 Water is held by strong hydrogen bonds✓ while chloroform has weak dipole-dipole forces / van der Waal forces✓.
Therefore, water requires more energy to vapourize than chloroform. ✓ (3)

[14]

QUESTION 4

4.1 Boyle's law✓ (1)

4.2 Figure 1: Graph of pressure vs inverse of volume (4)



Marking Guide
- Axes: Correctly labelled, appropriate scale✓
- Starting from origin ✓
- Shape: Straight line✓
- Points plotted correctly ✓

4.3 Pressure is inversely proportional to the volume.✓✓ (2)

OR

The inverse of volume is directly proportional to pressure. ✓✓

4.4. Temperature✓ / Quantity of gas or number of moles of gas OR mass of gas. (1)

4.5 on the Graph sheet✓ (1)

4.6 At high pressures, the volume of the gas is reduced.
Increasing the pressure further does not result in a decrease in the volume, ✓
as predicted by Boyle's Law, because the space occupied by the particles themselves cannot be ignored. ✓ (2)

[11]

QUESTION 5

5.1 Gay-Lussac's law✓ (1)

5.2 (4)

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}\checkmark$$

$$\frac{101.3\times10^3\checkmark}{298} = \frac{120\times10^3}{T}\checkmark$$

$T = 353.01\ K$ ✓

5.3 Yes ✓ (1)

5.4 The temperature (273+100) 373K ✓ is greater than the minimum temperature, hence the cylinder would explode (2)

[8]

QUESTION 6

6.1 A standard solution is a solution whose concentration is known precisely.✓✓ (2 or 0)

6.2

$$c = \frac{m}{MV}\ \checkmark$$

$$0.01\ \checkmark \frac{m}{126 \times 0{,}250}\ \checkmark$$

$m = 0{,}315g$ ✓ (4)

6.3 mass of impurities = 0.350 – 0.315✓ = 0.035 g✓ (2)

6.4

$$\%purity = \frac{mass\ of\ pure\ substance}{mass\ of\ impure\ substance}\ \checkmark$$

$$= \frac{0{,}315}{0{,}350} \times 100\%\ \checkmark$$

$= 90\%$ ✓ (3)

[11]

QUESTION 7

7.1 Excess reactant is that reactant that is left after the reaction is complete✓✓.

OR

That reactant whose initial amount is greater than the amount that reacts. ✓✓ (2 or 0)

7.2 HCℓ (1)

7.3

$$n = \frac{V}{Vm}$$

$$\frac{1{,}46}{22{,}4}\ \checkmark$$

$= 0{,}0512$ mol ✓ (3)

7.4 Ratio: HCl : CO_2
2 : 1

2 x✓ 0,0512 = 0,102 mol of HCl reacted.

No of mol of HCℓ in excess = C x V✓

= 0,09 x 0,110✓

= 0,010 mol.

Initial moles of HCℓ = moles that reacted + excess moles

= 0,102 + 0,010✓

= 0,112 mol

Initial mass of HCℓ = n×M

= 0.112 × 36.5 ✓

= 4,088 g✓ (6)

7.5.1

$$n = \frac{m}{M}$$
$$= \frac{5.68}{100}$$
$$= 0.0568 \text{ mol} \quad ✓$$

Ratio $CaCO_3$: CO_2
1 : 1
: 0.0568 mol (theoretical) ✓
m = n×M
= 0.0568×44 ✓
= 2.4992 g ✓ (4)

7.5.2

$$\%\text{yield} = \frac{\text{actual}}{\text{theoretical}} \times 100\% \quad ✓$$
$$= \frac{2.25}{2.4992} \times 100\% \quad ✓$$
$$= 90.03\% \quad ✓$$

(3)
[19]

QUESTION 8

8.1 An empirical formula is the simplest atomic ratio of a molecule✓✓ (2)

8.2 **Option 1** (6)

	C	H	O
Mass (g)	2,9164	0.7291	3,8885
Molar mass ($g.mol^{-1}$)	12	1 ✓	16
$n = \frac{m}{M}$ (mol)	0,24303 ✓	0.7291✓	0,24303 ✓
Ratio	1	3 ✓	1

Empirical formula is CH_3O✓

OPTION 2

	C	H	O	
Percentage (%)	38.7097	9.6774	51.6129	
Mass (g)	38.7097	9.6774	51.6129	
Molar mass ($g.mol^{-1}$)	12	1	16	✓
$n = \frac{m}{M}$ (mol)	3.2258 ✓	9.6774✓	3.2258✓	
Ratio	1	3	1	✓

Empirical formula is CH_3O✓

8.3 $M_{\text{Molecular formula}}$ = integer ×$M_{\text{empirical formula}}$ (3)
62 = integer × (12+16+3×1) ✓
Therefore: integer = 2✓
Molecular formula = $C_2H_6O_2$ ✓

[11]

TOTAL MARKS: [100]