education

Department:
Education
PROVINCE OF KWAZULU-NATAL

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES P2 (CHEMISTRY)

COMMON TEST

JUNE 2019

MARKS: 100

TIME : 2 Hours

This question paper consists of 9 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK**.
2. Answer **ALL** the questions in the answer book.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. Number the answers correctly according to the numbering system used in this question paper.
6. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
7. Give brief motivations, discussions, et cetera where required.
8. Show the formulae and substitutions in ALL calculations.
9. Round off answers to a minimum of TWO decimal places

QUESTION 1: MULTIPLE- CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A - D) next to the question number (1.1 – 1.7) in the ANSWER BOOK. Eg 1.8 A

1.1 The shape of the OF_2 molecule is :

A Trigonal pyramidal
B Linear
C Bent
D Tetrahedral (2)

1.2 Which statement BEST explains the formation of the dative bond between ammonia (NH_3) and the hydrogen ion (H^+)?

A Both NH_3 and H^+ are polar
B The NH_3 molecule has a lone pair of electrons and the H^+ ion has an empty orbital.
C H^+ ion is regarded as a proton and is attracted to the electrons on the nitrogen atom of the NH_3 molecule.
D The electronegativity of the nitrogen atom is greater than the electronegativity of hydrogen. (2)

1.3 Which ONE of the following statements concerning ideal gases is **INCORRECT?**

A Ideal gases do not exert pressure
B Ideal gas molecules do not occupy a volume
C The collision between ideal gas molecules is elastic
D There are no intermolecular forces between ideal gas molecules. (2)

1.4 Which ONE of the following statements regarding the effect of intermolecular forces and some physical properties is INCORRECT?

A The stronger the intermolecular force, the slower the rate of evaporation.
B The weaker the intermolecular force, the lower the boiling point.
C The stronger the intermolecular force, the higher the surface tension.
D The stronger the intermolecular force, the lower the melting point.. (2)

1.5 2,50 mol of SO_2 and 1 mol of O_2 are sealed in a 1 dm^3 flask and allowed to react completely at STP according to the following balanced equation.

$$2\ SO_2\ (g) + O_2\ (g) \rightarrow 2\ SO_3\ (g)$$

The TOTAL number of moles of gas in the flask at the END of the reaction is:

A 2
B 3,50
C 2,50
D 0,50 (2)

1.6 The gas law that expresses the relationship between pressure and temperature of a gas is known as:

A Charle's Law
B Gay- Lussac Law
C Boyle's Law
D Avogadro's Law (2)

1.7 The type of intermolecular force involved when CO_2 is added to water is :

A Dipole- induced dipole forces
B London forces
C Covalent bonds
D Ion – induced dipole forces (2)

TOTAL : SECTION A [14]

QUESTION 2

Consider the substances in the table below. Select the correct answer for each of the questions that follow. Write down only the LETTER that corresponds to your choice

	SUBSTANCE		SUBSTANCE
A.	HCN	F	H_2O
B	$MgCl_2$	G	CCl_4
C	I_2	H	CO_2
D	NH_4^+	I	C_2H_2
E	Cl_2	J	H_2S

2.1 Identify

2.1.1 TWO molecules that have triple bonds. (2)

2.1.2 TWO substances that when mixed together will result in ion-dipole forces of attraction. (2)

2.1.3 A non-polar LIQUID at room temperature (1)

2.1.4 A MOLECULE having a tetrahedral shape. (1)

2.1.5 A SOLID that is insoluble in water. (1)

2.1.6 A GAS at room temperature with pure covalent bonds between its atoms. (1)

2.2 Compounds F (H_2O) and J (H_2S) are hydrides of group 6 elements. H_2O has a lower molar mass than H_2S, but a higher boiling point than H_2S.

Explain fully why H_2O has a higher boiling point than H_2S, by referring to the types and strengths of the intermolecular forces in each and the energy involved. (4)

2.3 Draw the Lewis structure for compound G (CH_4) (2)

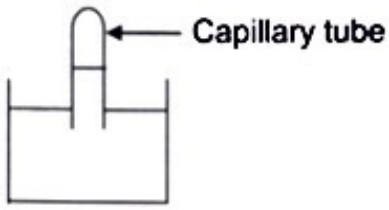
2.4 Compound H (CO_2) has polar covalent bonds in the molecule.

2.4.1 Is the compound CO_2 polar or non-polar? Explain fully. (3)

2.4.2 Name the type of intermolecular forces found in this compound. (1)
[18]

QUESTION 3

Grade 11 learners investigated the effect of intermolecular force on capillarity. They pour 100ml each of **water; glycerine and nail polish remover** in separate beakers. A capillary tube is inserted into each liquid and after a while, the level of liquid in the capillary tube is measured.



They recorded their results in a table as follows:

Liquid	Height (mm)
Water	19
Glycerine	5
Nail polish remover	26

3.1 State the dependent variable in the above investigation. (1)

3.2 Which liquid displayed the greatest degree of capillarity? (1)

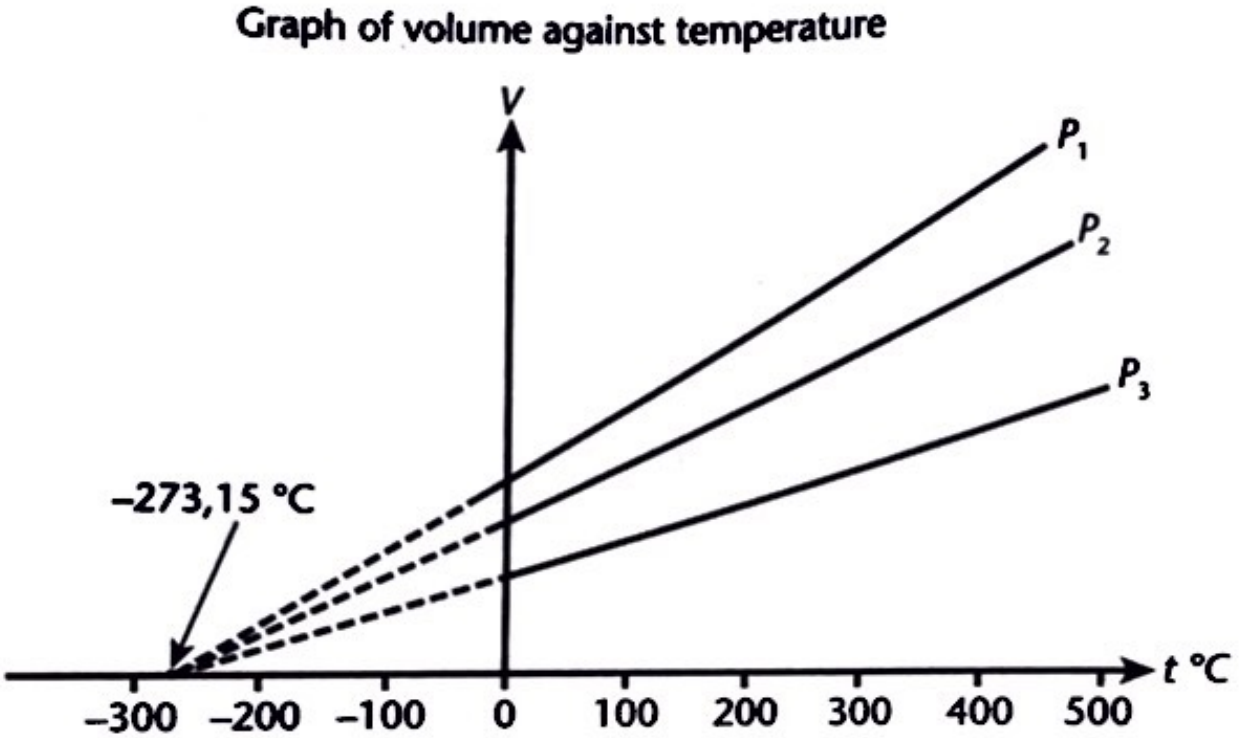
3.3 Explain the answer to question 3.2 above. (3)

3.4 Use the results in the table and arrange the liquids in order of INCREASING STRENGTH of intermolecular force that is, from the weakest intermolecular force to the strongest intermolecular force. (2)

3.5. Identify the liquid with the highest boiling point. (1)
[8]

QUESTION 4

4.1 The graph below shows the relationship between the volume and Celsius temperature of an enclosed gas maintained at a constant pressure, P_1. The experiment is repeated for different constant pressures P_2 and P_3.



4.1.1 Give the name, and state in words, the Law that is illustrated in the graph. (3)

4.1.2 Apart from pressure, state ONE other variable that must be kept constant for each experiment (1)

4.1.3 What is the relationship between the volume and temperature of the gas? (1)

4.1.4 Which one of the 3 pressures, P_1; P_2 or P_3 is the HIGHEST ? (1)

4.1.5 Fully explain the answer to question 4.1.4 above. Use a relevant equation to support your explanation. (3)

4.2 A 10 dm^3 steel vessel that holds a sample of oxygen gas at 25°C and 100kPa develops a leak. Some of the oxygen gas escapes before the leak is repaired. The pressure of the O_2 in the vessel after the leak is repaired is 55kPa. The temperature remains at 25°C.

Calculate the mass of oxygen gas that leaked. (8)
[17]

QUESTION 5

A compound contains the elements carbon, hydrogen and oxygen only. It consists of 54.56% carbon and 36.36% hydrogen. The molar mass of the compound is 132 $g.mol^{-1}$.

5.1 State the definition of *empirical formula*. (2)

5.2 Calculate the empirical formula of the compound. (6)

5.3 Determine the molecular formula of the compound. (2)

[10]

QUESTION 6

Iron is recovered from iron ore (Fe_2O_3) in a blast furnace. The following reaction takes place.

$$Fe_2O_3\,(s) + 3CO(g) \rightarrow 2\,Fe\,(s) + 3CO_2(g)$$

In one such reaction, 160g of **impure** iron ore was reacted and 63 dm^3 of CO_2 was produced at STP.

6.1 Write down the definition of the *mole*. (2)

6.2 Calculate the number of CO_2 molecules that formed at STP (4)

6.3 Calculate the maximum no of moles of iron that will be formed in the above reaction. (2)

6.4 Calculate the percentage purity of the iron ore sample used. (4)

[12]

QUESTION 7

Industrially, vanadium metal, (V) which is used in steel alloys can be obtained by reacting vanadium pentoxide(V_2O_5) with calcium at high temperatures. The balanced equation for the reaction is:

$$5Ca + V_2O_5 \rightarrow 5\,CaO + 2\,V$$

During an industrial process 31850 g of V_2O_5 reacts with 2×10^4 g of Ca.

7.1 State the definition of a *limiting reagent*. (2)

7.2 Calculate the theoretical yield of vanadium. (6)

7.3 Calculate the percentage yield if $8{,}67 \times 10^3$ g of vanadium is obtained. (2)

[10]

QUESTION 8

4.14 g of solid $LiNO_3$ is first dissolved in a small amount of water and then made up to a certain final volume so that the concentration of the solution is 0,05 $mol.dm^{-3}$

8.1 Write down the definition of *concentration*. (2)

8.2 Calculate the number of moles of $LiNO_3$ used. (2)

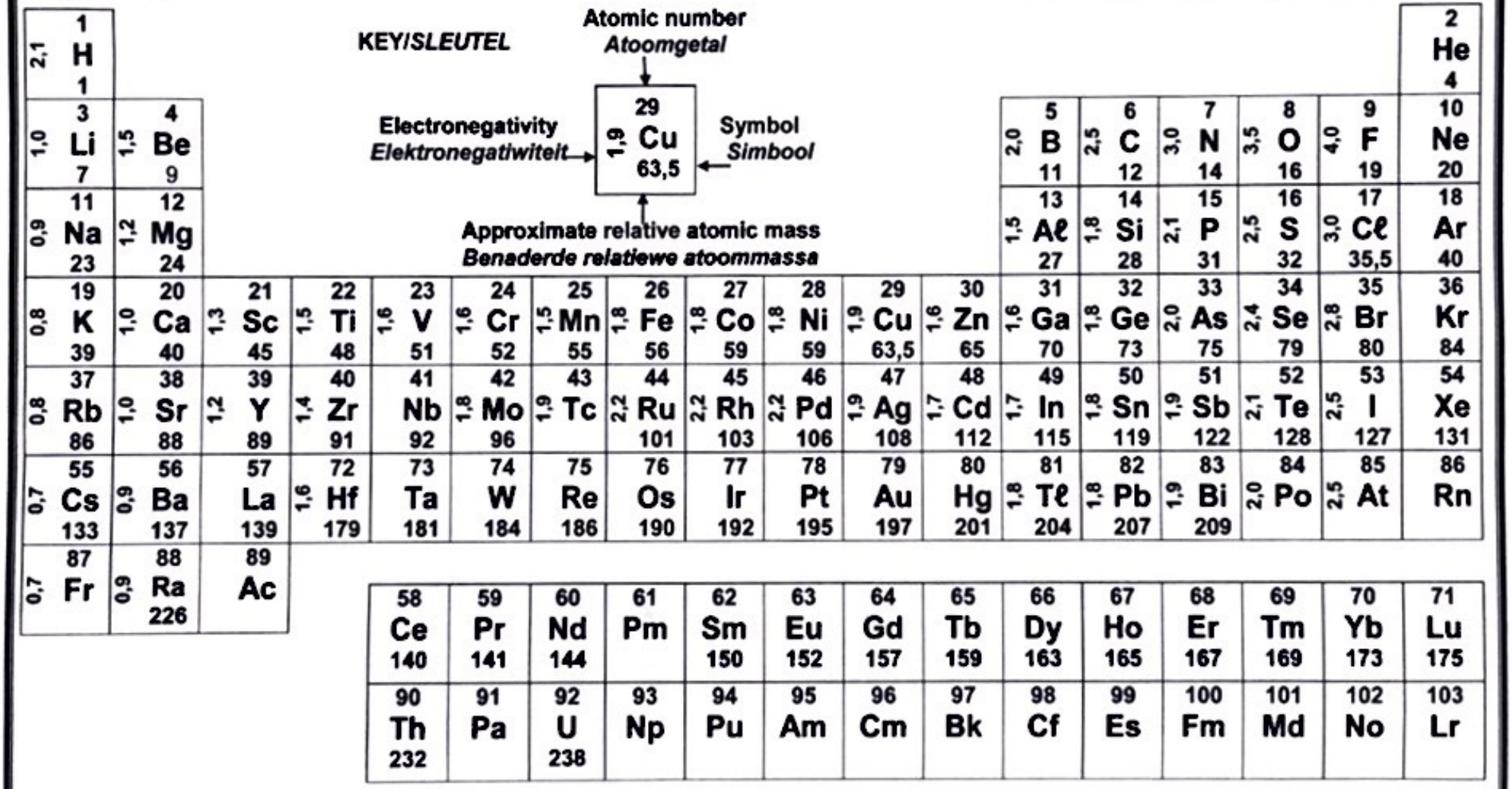
8.3 Calculate the final volume of the solution. (3)

8.4 An additional 250 cm^3 of water is now added to this solution. Calculate the new concentration of the solution (4)

[11]

TOTAL MARKS: 100

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																	2 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	10 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	18 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	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	41 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	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr 87	0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

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}
Charge on Electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

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

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MARKING GUIDELINE

NATIONAL SENIOR CERTIFICATE

GRADE 11

TIME: 2 hours

MARKS: 100

This marking guideline consists of 7 pages.

QUESTION 1

1.1. C ✓✓
1.2. B ✓✓
1.3. A ✓✓
1.4. D ✓✓
1.5. C ✓✓
1.6. B ✓✓
1.7. A ✓✓ 7x2 = (14)

QUESTION 2

2.1.1 A✓ and I✓ (2)

2.1.2. (B and F) ✓ ✓ OR (D and F) (2 or 0) (2)

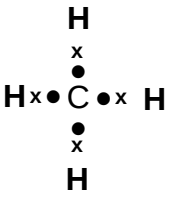
2.1.3. G ✓ (1)

2.1.4. G✓ (1)

2.1.5. C ✓ (1)

2.1.6. E ✓ (1)

2.2 H_2O has hydrogen bonding ✓and H_2S has dipole- dipole forces. ✓ The intermolecular forces in water are stronger ✓Therefore more energy is required to break the IMF in water. ✓ (4)

2.3.  ✓✓ (2)

2.4.1 NON- POLAR✓

- CO_2 is a symmetrical molecule with even distribution of electrons✓

There is no net dipole moment/dipoles cancel out✓/. There is no distinct opposite positive and negative ends. (3)

2.4.2 London forces ✓ (1)

[18]

QUESTION 3

3.1. Capillarity / height ✓ (1)

3.2. Nail polish remover✓ (1)

3.3. It has the weakest intermolecular forces /cohesive forces ✓ molecules separate easily. ✓ The adhesive forces are stronger than the cohesive forces/IMF ✓ (3)

3.4. Nail polish remover; water ; glycerine ✓✓ (2)

3.5 Glycerine✓ (1)

[8]

QUESTION 4

4.1.1 Charle's Law --✓ The volume of an enclosed gas is directly proportional to its Kelvin temperature provided the pressure is kept constant. ✓✓ (3)

4.1.2. Amount/mass of gas✓ (1)

4.1.3. volume is directly proportional to Kelvin temperature/ Vα T✓ / volume is linearly proportional to Celsius temperature

ACCEPT As temperature increases, volume increases. (1)

4.1.4. P_3 ✓ (1)

4.1.5 From pV = nRT , gradient which is V/T is equal to nR/P. ✓Since R and n are constant, ✓ Gradient is inversely proportional to the pressure/ higher pressure represents smaller gradient. ✓ (3)

OR

From Boyles law --- at a constant temperature, ✓ the gas with the highest volume will have the lowest pressure✓ pV = k✓

4.2.

OPTION 1

Change in pressure = 100-55 = 45kPa✓

pV = nRT✓

$\underline{45 \times 10^3 \times 10 \times 10^{-3}}$ ✓= n x $\underline{8.31 \times 298}$✓

n = 0.182mol✓

n = m/M✓

$\underline{0.182 = m/32}$✓

m = 5.824g ✓ of O_2 is lost

NB: ACCEPT p values in kPa with V values in dm^3

OPTION 2

pV = nRT✓

$\underline{100 \times 10^3 \times 10 \times 10^{-3} = n \times 8.31 \times 298}$✓

n= 0.404mol (original no. of moles of oxygen in vessel)

pV = nRT

$\underline{55 \times 10^3 \times 10 \times 10^{-3} = n \times 8.31 \times 298}$✓

n= 0.222mol (no of mol in vessel after leak is repaired)

no of moles of gas leaked
=0.404 – 0.222✓
= 0.182mol✓

n = m/M✓

$\underline{0.182 = m/32}$✓

m = 5.824g ✓ of O_2 is lost

(8)

[17]

QUESTION 5

5.1 Simplest whole number ratio in which elements in a compound combine ✓✓ (2)

5.2.

Element	Mass per 100 g	n=m/M(mol)	Simplest ratio
C	54.56	54.56/12 = 4.547✓	4.547/2.2725 = 2
H	9.08✓	9.08/1 = 9.08✓	9.08/2.2725 = 4 ✓
O	36.36	36.36/16 = 2.2725✓	2.2725/2.2725 = 1

Empirical formula is C_2H_4O✓ (6)

5.3 n = True M_r/ Empirical M_r

= 132/44

= 3✓

Molecular formula is $C_6H_{12}O_3$✓ (award both marks if answer correct without calculation) (2)

[10]

QUESTION 6

6.1. The amount of substance having the same number of particles as there are atoms in 12g of C-12. ✓✓/ Amount of substance having 6,02 x 10^{23} elementary particles. (2)

6.2.

$n = V/V_m$ ✓

$= \underline{63/22.4}$ ✓

$= 2.8125$ mol

$N = \underline{2.8125 \times 6.02 \times 10^{23}}$✓

$= 1.693 \times 10^{24}$ molecules✓ of CO_2

(4)

6.3

POSITIVE MARKING FROM 6.2

Fe : CO_2

2 : 3 ✓

$n_{Fe} = 2.8125 \times 2/3$

$= 1.875$mol✓

(4)

(2)

6.4.

Positive marking form 6.2/6.3

$CO_2 : Fe_2O_3$ **OR** Fe : Fe_2O_3

3 : 1 2 : 1

$nFe_2O_3 = 2.8125/3$✓ $nFe_2O_3 = 1.875/2$

$= 0.9375$ mol $= 0.9375$ mol

$mFe_2O_3 = nM$

$= \underline{0.9375 \times 160}$✓

$= 150$ g

% purity = $\underline{150/160 \times 100}$✓

= 93,75% ✓

(4)

[12]

QUESTION 7

7.1 Substance that is used up completely in a reaction. ✓ ✓ (2)

7.2

Ratio	**5**	**1**	**5**	**2**
Moles	*Ca*	*V_2O_5*	*CaO*	*V*
Initial	500✓	175 ✓	0	0
Change	500✓	100	500	200✓
End	0	75	500	200

Ca

n = m/M

= 20 000/40

= 500 mol

V_2O_5

n = m/M

= 31 850/182

= 175mol

n_V formed = 200 mol

m = nxM

= 200 x 51✓

= 10 200 g ✓ (6)

7.3 % yield = 8670/10 200 x 100✓

= 85 %✓ (2)

[10]

QUESTION 8

8.1 Amount of solute per litre of solution. ✓ ✓ (2)

8.2. n = m/M

= 4.14/69 ✓

= 0.06mol ✓ (2)

8.3 **Positive marking from 8.2.**

c = n/V✓

0.05 =0.06/V✓

V = 1,20 dm^3 ✓ (3)

8.4

Positive marking from 8.3

$c_1V_1 = c_2V_2$ ✓

0.05 x 1.20✓ = c_2 x 1.45✓

C_2 = 0.04 $mol.dm^{-3}$✓

Positive marking from 8.2. and 8.3

c = n/V✓

=0.06✓/1.45✓

c= 0.04 $mol.dm^{-3}$✓

(4)

[11]

TOTAL MARKS : 100