Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES: CHEMISTRY (P2)

COMMON TEST

SEPTEMBER 2017

NATIONAL SENIOR CERTIFICATE

GRADE 10

MARKS: 150

TIME: 2 hours

This question paper consists of 14 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and class (for example 10A) in the appropriate spaces on the ANSWER BOOK.
2. Answer ALL the questions in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your final answers to a minimum of TWO decimal places.
9. 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. Choose the answer and write only the letter (A – D) next to the question number (1.1 – 1.10) in the ANSWER BOOK, for example 1.11 C

1.1 Which ONE of the following is a pure substance?

A Air
B Sugar solution
C Stainless steel
D Water (2)

1.2 The energy associated with the ability of a substance to form negative ions is ...

A Ionisation energy
B Dissociation energy
C Electron affinity
D Electronegativity (2)

1.3 The collective name given to the subatomic particles in the nucleus of an atom is:

A Electron
B Neutron
C Nucleon
D Proton (2)

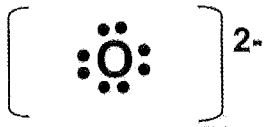
1.4 Elements in the same period in the periodic table have the same number of:

A Protons
B Electrons
C Nucleons
D Energy levels (2)

1.5 According to the kinetic molecular theory the particles of a solid...

A Vibrate in their fixed positions and have a fixed shape.
B Are free to move and are compressible.
C Are free to move and have a fixed shape.
D Vibrate in their fixed positions and are compressible. (2)

1.6 Which ONE of the following Lewis structures is INCORRECT?

A	
B	
C	
D	

(2)

1.7 Which ONE of the following represents 1 mole?

A 22,4 dm^3 of hydrogen gas

B 58,5 g $NaC\ell$

C 14 g nitrogen gas

D 16 g oxygen gas (2)

1.8 The first three ionisation energies (in $kJ.mol^{-1}$) for two elements are given in a table:

ELEMENT	FIRST IONISATION ENERGY	SECOND IONISATION ENERGY	THIRD IONISATION ENERGY
X	490	4600	6900
Y	590	880	4900

Which ONE of the following statements is TRUE?

A	X and Y are metals	X will react with chlorine to become $XC\ell$ and Y reacts with chlorine to become $YC\ell_2$
B	X and Y are metals	X will react with chlorine to become $XC\ell$ and Y reacts with chlorine to become $YC\ell$
C	X is a metal and Y is a non-metal	X will react with chlorine to become $XC\ell$ and Y reacts with sodium to become NaY
D	X is a non-metal and Y is metal	X will react with sodium to become NaX and Y reacts with chlorine to become $YC\ell_2$

(2)

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

A $SO_2(g) + H_2O(\ell) \rightarrow H_2SO_3(aq)$

B $Na_2CO_3(aq) + Mg(NO_3)_2(aq) \rightarrow 2\ NaNO_3(aq) + MgCO_3(s)$

C $Mg(s) + O_2(g) \rightarrow MgO(s)$

D $Na_2CO_3(aq) + 2\ KNO_3(aq) \rightarrow 2\ NaNO_3(aq) + K_2CO_3(aq)$ (2)

1.10 The percentage composition of nitrogen in nitrogen monoxide (NO) is:

A 50%

B 80%

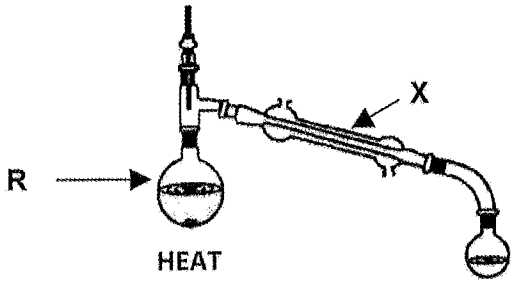
C less than 50%

D 75% (2)

[20]

QUESTION 2

2.1 Liquid A (Boiling point 40 °C) dissolves in liquid B (Boiling point 85 °C). A method to separate the solution is shown below:



2.1.1 What is the name given to this method of separation? (1)

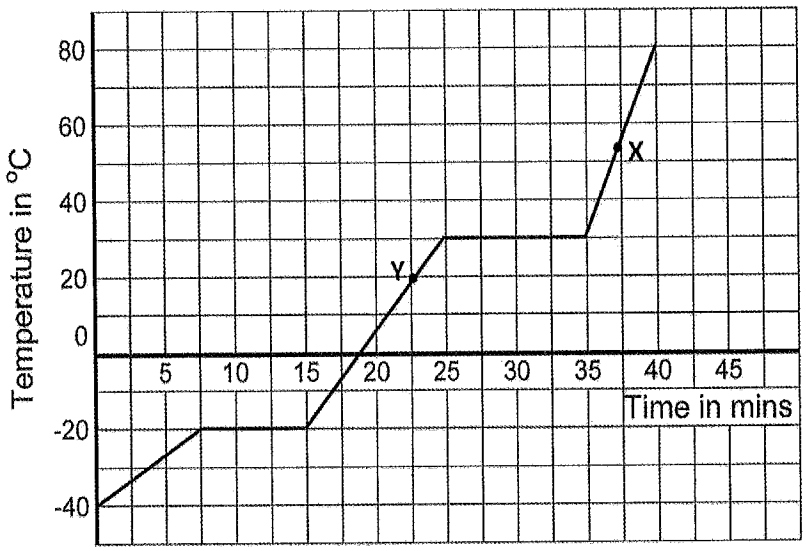
2.1.2 What physical property of the substances is used to separate them? (1)

2.1.3 State the phase change that occurs in the flask labelled R. (1)

2.1.4 Name the process that occurs in the tube labelled X. (1)

2.1.5 Which liquid remains in the flask R after the separation is completed? Explain the answer. (3)

2.2 The graph below represents the heating curve of a pure substance at sea level.



2.2.1 Define *melting point*. (2)

2.2.2 What is the melting point of this substance? (1)

2.2.3 At which point, X or Y, are the forces between the molecules of this substance weakest? Explain for your answer. (3)

2.2.4 Explain why the temperature remains constant between the 25th and 35th minute. (2)
[15]

QUESTION 3

3.1 Study the table below and answer the questions that follow:

SUBSTANCE	CHEMICAL NAME
A	Potassium bromide KBr (s)
B	Zinc Zn (s)
C	Methane (g)
D	Calcium hydroxide $Ca(OH)_2$ (s)
E	Graphite C(s)
F	Ammonium carbonate(s)
G	Sodium chloride NaCℓ(s)

Choose a substance that:

3.1.1 Is made up of a giant covalent network structure. (1)

3.1.2 Produces a cream coloured precipitate when its aqueous solution is added to a silver nitrate solution. (1)

3.1.3 Produces carbon dioxide gas when reacted with hydrochloric acid solution. (1)

3.1.4 Is a molecular compound. (1)

3.1.5 Contains delocalised electrons. (1)

3.2 State the difference between covalent bonding and ionic bonding. (2)

3.3 Use Lewis Structures to represent the bonding in the following substances:

3.3.1 N_2 (2)

3.3.2 CO_2 (2)

[11]

QUESTION 4

4.1 When hydrogen peroxide is heated strongly, the following reaction takes place:

$$2\ H_2O_2\ (\ell) \rightarrow 2\ H_2O\ (\ell) + O_2\ (g)$$

4.1.1 What type of reaction is this? Give a reason. (2)

4.1.2 Describe a simple test that can be carried out in the laboratory to confirm that the gas produced is oxygen. (1)

4.2 Balance the following reactions:

4.2.1 $Fe + C\ell_2 \rightarrow FeC\ell_3$ (2)

4.2.2 $BF_3 + Li_2SO_3 \rightarrow B_2(SO_3)_3 + LiF$ (2)

4.2.3 $HNO_3 + Cu \rightarrow Cu(NO_3)_2 + H_2O + NO_2$ (2)

4.3 Write down the chemical name for each of the following substances:

4.3.1 $FeC\ell_3$ using stock notation (2)

4.3.2 Li_2SO_3 (2)

4.3.3 $NaHCO_3$ (2)

4.4 Write down the chemical formula for each of the following substances:

4.4.1 Potassium dichromate (2)

4.4.2 Calcium carbide (2)

4.4.3 Aluminium sulphate (2)

[21]

QUESTION 5

5.1 Information on six elements, represented as P, Q, R, S, T and Y is given in the table below.

ELEMENT	ATOMIC NUMBER	MASS NUMBER	ELECTRON STRUCTURE
P	16	32	$1s^2 2s^2 2p^6 3s^2 3p^4$
Q	3	7	$1s^2 2s^1$
R	20	40	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
S	18	40	$1s^2 2s^2 2p^6 3s^2 3p^6$
T	17	37	$1s^2 2s^2 2p^6 3s^2 3p^5$
Y	19	39	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

5.1.1 Which element is a non- metal and has 20 neutrons in each atom? (1)

5.1.2 Which element is an alkali earth metal? (1)

5.1.3 Identify TWO elements that are in the same group. (2)

5.1.4 Identify TWO elements whose cations have the same electronic structure as element S. (2)

5.1.5 Identify TWO elements whose anions have the same electronic structure as element S. (2)

5.2 The table below summarises the percentage abundance and relative isotopic mass for each of the three isotope atoms of Magnesium.

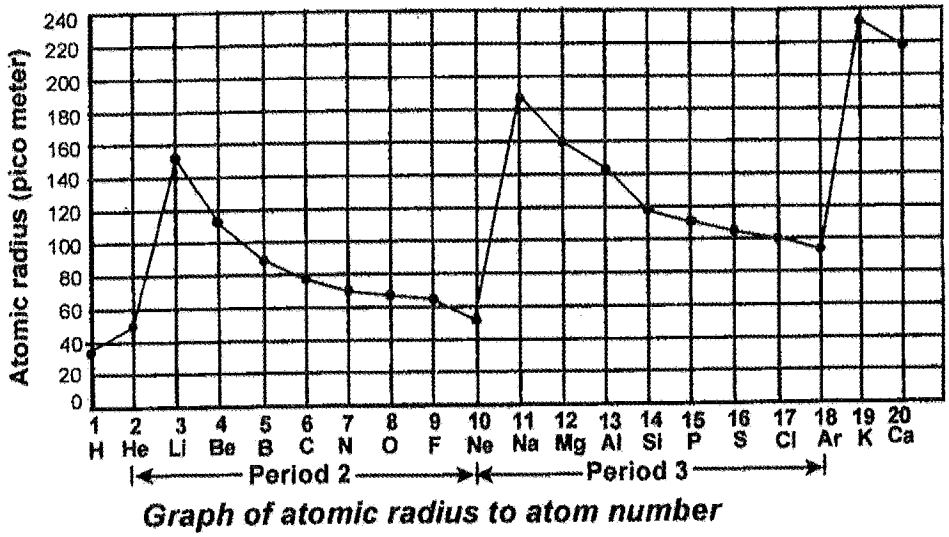
Isotopes of Magnesium	Percentage Abundance	Relative Isotopic mass
Mg-24	78,99	23,985
Mg-25	10,00	24,986
Mg-26	11,01	25,985

5.2.1 Write down the $^{Z}_{A}X$ notation for Mg-25. (1)

5.2.2 Calculate the relative atomic mass of magnesium. (4)

5.2.3 Write down two similarities in the atomic structure of the three isotopes of magnesium. (2)

5.3 The graph below shows the atomic radii of the first 20 elements.



Graph of atomic radius to atom number

5.3.1 Define *atomic radius.* (2)

5.3.2 State the general trend in the atom radii from sodium to argon as shown in the above graph. (1)

5.3.3 Explain the trend in the atom radii from sodium to argon. (3)

5.3.4 What is the relationship between atomic radius and first ionisation energy on going across a period? (2)

5.3.5 How does the first ionisation energy of magnesium compare to that of calcium?
Choose from GREATER THAN, EQUAL TO or LESS THAN
Explain the answer. (3)
[26]

QUESTION 6

6.1 The empirical formula for a certain compound is to be determined. On analysis a sample of the compound was found to contain 48,7 % C, 8,1 % H and 43,2 % O.

6.1.1 Define *empirical formula.* (2)

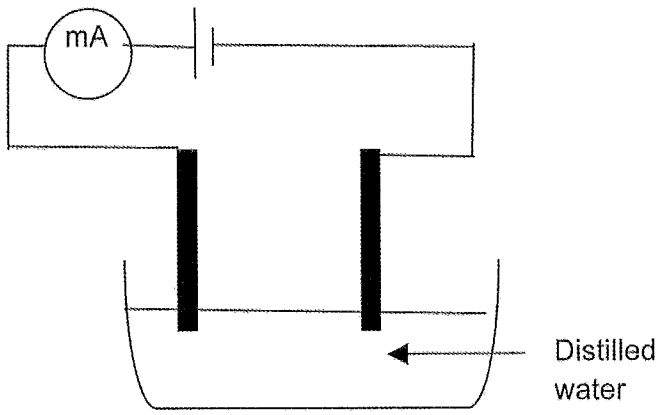
6.1.2 Determine the empirical formula of the compound. Show ALL calculations. (4)

6.2 The molar mass of hydrated copper sulphate is found to be 249,5 $g.mol^{-1}$. The formula of the hydrated copper sulphate is $CuSO_4.xH_2O$. Calculate the number of moles water of crystallisation (x) in the compound. (4)

[10]

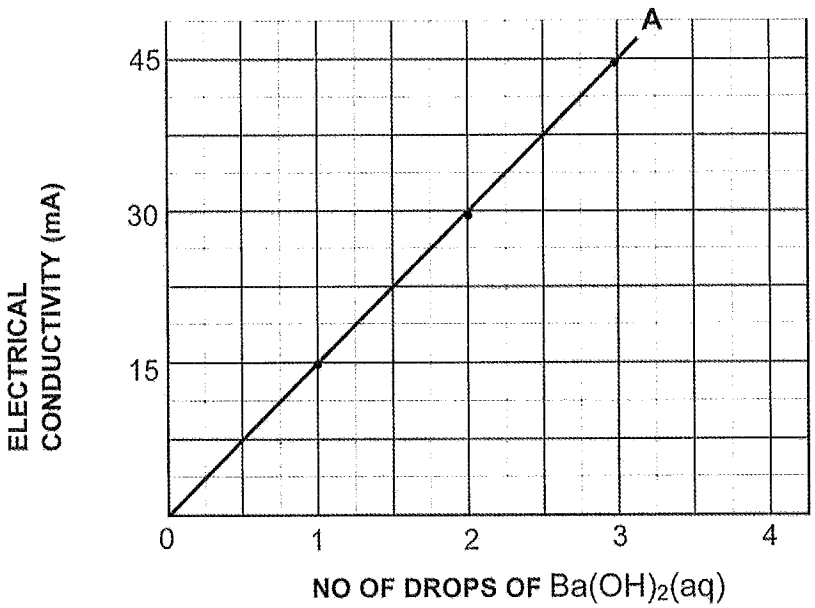
QUESTION 7

The experimental setup below is used to investigate the relationship between electrical conductivity and ion concentration of a barium hydroxide solution $Ba(OH)_2(aq)$.



The $Ba(OH)_2(aq)$ is added drop by drop to the distilled water and the ammeter reading is recorded after the addition of each drop.

Using the results obtained the following **graph A** was drawn:



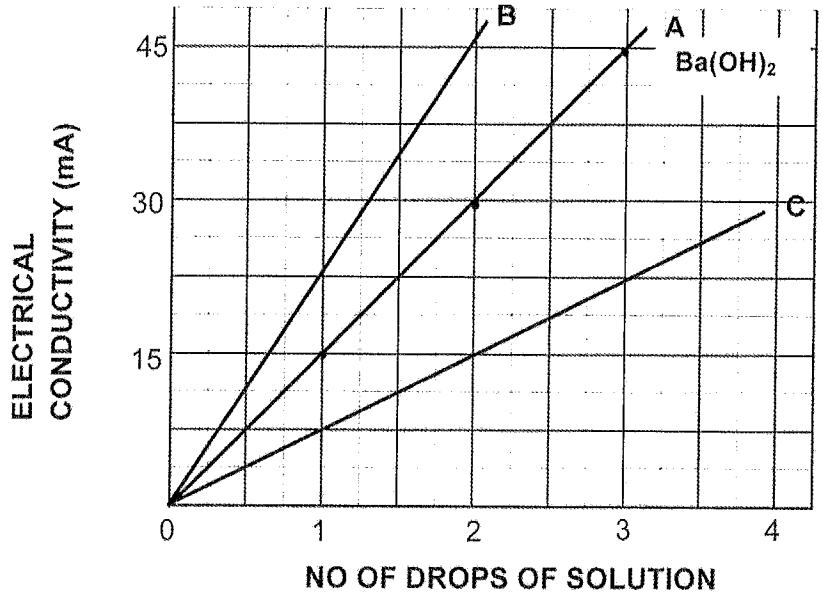
7.1 Define an *electrolyte*. (2)

7.2 Give a reason why the ammeter does not give a reading when no $Ba(OH)_2$ is added to the distilled water. (2)

7.3 Identify the independent variable for this investigation. (1)

7.4 What is the relationship between the concentration of the ions and conductivity of the solution? (2)

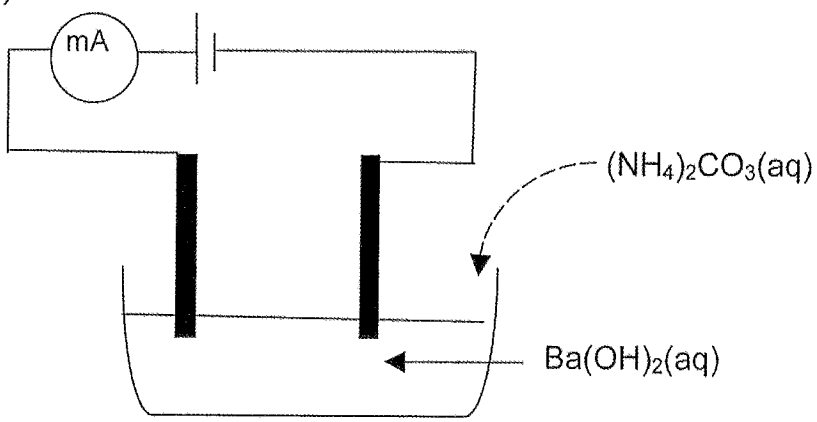
The same experiment is repeated, this time using a solution of sodium hydroxide, NaOH(aq), of the same concentration as the $Ba(OH)_2(aq)$, and the graph is plotted.



7.5 Why must the concentrations of both solutions be the same? (1)

7.6 Which graph, B or C, will most likely represent the conductivity of NaOH(aq)? Explain the answer. (3)

7.7 A learner now adds dropwise $(NH_4)_2CO_3(aq)$ to the beaker containing $Ba(OH)_2(aq)$.



7.7.1 What observable change takes place in the beaker? (1)

7.7.2 How will the ammeter reading be affected?
Choose from INCREASE, DECREASE or REMAIN THE SAME.
Explain (2)

[14]

QUESTION 8

Potassium oxide crystals, K_2O, is dissolved in 250 cm^3 of water to produce a potassium hydroxide (KOH) solution of concentration 0,25 $mol.dm^{-3}$.

8.1 Define *solubility*. (2)

8.2 Identify the solute. (1)

50 cm^3 of the KOH(aq) solution is reacted completely with sulphuric acid, $H_2SO_4(aq)$, according to the balanced equation:

$$2\ KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2\ H_2O(\ell)$$

8.3 How many moles of KOH are present in the 50 cm^3 solution? (3)

8.4 Calculate the maximum mass of K_2SO_4 that can be produced? (4)

When this experiment was done in the school laboratory, 0,87 g of K_2SO_4 was produced.

8.5 Calculate the percentage yield of K_2SO_4. (3)

[13]

QUESTION 9

9.1 Consider the following balanced chemical equation:

$$2\ X(s) + 6\ HC\ell(aq) \rightarrow 2\ XC\ell_3(aq) + 3\ H_2(g)$$

During the reaction 0,405 g of metal X reacts completely with hydrochloric acid solution to produce 504 cm^3 hydrogen gas at STP.

9.1.1 Calculate the number of moles of $H_2(g)$ produced at STP. (3)

9.1.2 How many hydrogen atoms are present in the $H_2(g)$ produced. (2)

9.1.3 Determine the molar mass of metal X. (4)

9.1.4 Identify metal X. (1)

9.2 50 cm^3 of a solution of $MgC\ell_2$ of concentration 0,25 $mol.dm^{-3}$ is added to 30 cm^3 of a solution of $NaC\ell$ of concentration 0,15 $mol.dm^{-3}$.

9.2.1 Write down the balanced equation for the dissociation of $MgC\ell_2(s)$ in water. (2)

9.2.2 Calculate the concentration of chloride ions in this solution. (8)

[20]

TOTAL MARKS: 150

DATA FOR PHYSICAL SCIENCES GRADE 10
PAPER 2 (CHEMISTRY)

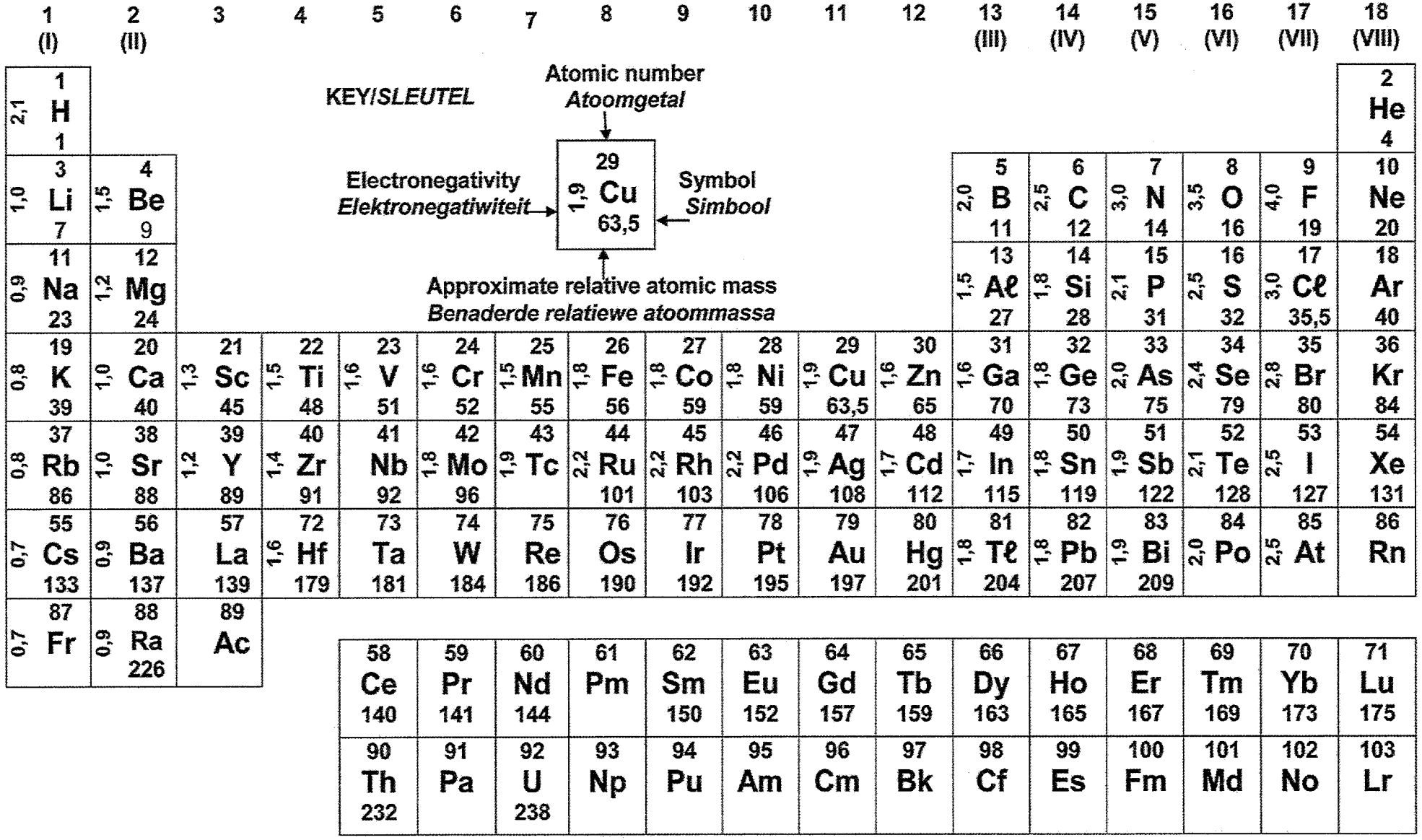
TABLE 1: PHYSICAL CONSTANTS

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
Charge on electron	e	$-1{,}6 \times 10^{-19}$ C
Avagadro's constant	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS



GR 10 & 11

Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES (P2)
(CHEMISTRY)

COMMON TEST
SEPTEMBER 2017

MARKING GUIDELINE

NATIONAL SENIOR CERTIFICATE

GRADE 10

MARKS: 150

TIME: 2 hours

This marking guideline consists of 9 pages.

QUESTION 1

1.1	D	✓✓	(2)
1.2	C	✓✓	(2)
1.3	C	✓✓	(2)
1.4	D	✓✓	(2)
1.5	A	✓✓	(2)
1.6	A	✓✓	(2)
1.7	B	✓✓	(2)
1.8	A	✓✓	(2)
1.9	C	✓✓	(2)
1.10	C	✓✓	(2)

[20]

QUESTION 2

2.1

2.1.1 Distillation ✓ (1)

2.1.2 Boiling point ✓ (1)

2.1.3 Liquid to gas/vapour ✓ (1)

2.1.4 Condensation ✓ (1)

2.1.5 Liquid B ✓ Liquid A has a lower boiling point ✓and therefore evaporates first. ✓ OR liquid B has a higher boiling point ✓ and therefore will not evaporate first ✓ (3)

2.2

2.2.1 The temperature at which a solid, given sufficient heat, becomes a liquid. ✓✓ (2)

2.2.2 -20 °C ✓ (1)

2.2.3 X ✓ Particles are in the gaseous phase ✓ (have greatest kinetic energy) and particles are very far apart ✓ (3)

2.2.4 Energy absorbed is used to break the bonds within a solid to change it to a liquid. ✓✓ (2)

[15]

QUESTION 3

3.1

3.1.1 E ✓ / C(s) ✓ (1)

3.1.2 A ✓ / KBr(s) ✓ (1)

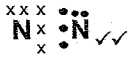
3.1.3 F ✓ / Ammonium carbonate ✓ (1)

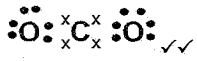
3.1.4 C ✓ / Methane ✓ (1)

3.1.5 B ✓ / Zinc (Zn) ✓ (1)

3.2 Covalent bonding: the sharing of valence electrons ✓ (between non-metal atoms)
Ionic bonding: the transfer of valence electrons ✓ (from metal to non-metal atom) (2)

3.3

3.3.1  ✓✓ (2)

3.3.2  ✓✓ (2)

[11]

QUESTION 4

4.1

4.1.1 Chemical ✓new substances are formed ✓ OR decomposition ✓one reactant forms two products ✓ (2)

4.1.2 A glowing splinter bursts into flames ✓ (1)

4.2

4.2.1 $2\ Fe + 3\ Cl_2 \rightarrow 2\ FeCl_3$ ✓✓ (2)

4.2.2 $2\ BF_3 + 3\ Li_2SO_3 \rightarrow B_2(SO_3)_3 + 6\ LiF$ ✓✓ (2)

4.2.3 $4\ HNO_3 + Cu \rightarrow Cu(NO_3)_2 + 2\ H_2O + 2\ NO_2$ ✓✓ (2)

4.3

4.3.1 Iron(III)chloride ✓✓ (2)

4.3.2 Lithium sulphite ✓✓ (2)

4.3.3 Sodium hydrogen carbonate ✓✓/ sodium bicarbonate ✓✓ (2)

4.4

4.4.1 K_2CrO_7 ✓✓ (2)

4.4.2 CaC_2 ✓✓ (2)

4.4.3 $Al_2(SO_4)_3$ ✓✓ (2)

[21]

QUESTION 5

5.1

5.1.1 T ✓ (1)

5.1.2 R ✓ (1)

5.1.3 Q ✓ and Y ✓ (2)

5.1.4 R ✓ and Y ✓ (2)

5.1.5 P ✓ and T ✓ (2)

5.2

5.2.1 $^{12}_{25}Mg$ ✓ (1)

5.2.2 Relative Atomic Mass of Mg = $\frac{\sum \text{of masses of isotopes}}{100}$ ✓✓

$= \frac{(78,99 \times 23,985) + (10 \times 24,986) + (11,01 \times 25,985)}{100}$ ✓

= 24,3053 ✓ (4)

5.2.3 Same number of protons ✓ and same number of electrons ✓ (2)

5.3

5.3.1 Radius of an atom i.e the mean difference from the nucleus to the border of the outer orbital. ✓✓ (2)

5.3.2 Atomic radius of the atoms decrease across the period ✓ (1)

5.3.3 Electrons enter the same energy levels✓ on going across a period. No. of electrons and protons increase.✓ Force of attractions between nucleus and electrons increase.✓ Hence volume decreases. (3)

5.3.4 As atomic radii decreases across period and ionisation energy increase✓✓ (2)

5.3.5 Greater than ✓

Calcium atom has a greater volume ✓ OR greater atomic radius.

Weaker forces of attraction on valence electrons ✓lesser energy needed to overcome weaker electrostatic forces (3)

OR

Magnesium has a smaller volume .✓ stronger forces of attraction on valence electrons.✓

[26]

QUESTION 6

6.1

6.1.1 Empirical formula: The simplest mole ratio of elements in a compound, ✓✓ (2)

6.1.2 Moles of C = $\frac{m}{M} = \frac{48,7}{12}$ ✓ $= \frac{4,0583}{2,7}$ ✓ $= 1,5 \times 2$ ✓ $= 3$

Moles of H = $\frac{m}{M} = \frac{8,1}{1}$ $= \frac{8,1}{2,7}$ $= 3 \times 2$ $= 6$

Moles of O = $\frac{m}{M} = \frac{43,2}{16}$ $= \frac{2,7}{2,7}$ $= 1 \times 2$ $= 2$

Empirical Formula: $C_3H_6O_2$ ✓

Marking criteria:

- Divide mass by Molar mass of C
- Divide mass by Molar mass of H
- Divide mass by Molar mass of O

} 1mark

- Divide moles of C , H and O by 2,7 - 1mark
- Multiply simplest ratios by 2- 1 mark
- Answer- 1mark

(4)

6.2 Marking criteria:

- Molar mass of $CuSO_4$ (159,5 g) -1mark
- Subtract molar mass of $CuSO_4$ (159,5 g) from 249,5 g-1mark
- Divide mass of water by 18 – 1mark
- Answer of 5 moles -1mark

Mass of water is= 249,5 – ✓159,5 ✓= 90 g

Moles of water is = $\frac{249,5 - 159,5}{18\checkmark} = \frac{90}{18}$

= 5 moles✓ (4)

[10]

QUESTION 7

7.1 A solution or liquid that conducts electricity (through the movement of ions). ✓✓ (2)

7.2 Distilled water does not contain ions ✓✓ (2)

7.3 Ion concentration ✓ (1)

7.4 Directly proportional ✓✓ OR as concentration increases, electrical conductivity also increases. ✓✓ (2)

7.5 To ensure that it is a fair test ✓ OR so that there only one independent variable ✓ (1)

7.6 C ✓ Lower ion concentration per drop of solution✓ therefore lower conductivity ✓ (3)

7.7

7.7.1 A white precipitate ✓ forms (1)

7.7.2 Decrease ✓ Amount of ions constant but volume of solution increases ✓ (2)

[14]

QUESTION 8

8.1 The maximum amount of a substance (the solute) that may be dissolved in another (the solvent)✓✓ (2)

8.2 Potassium oxide ✓ OR $K_2O(s)$ ✓ (1)

8.3 $c = \frac{n}{V}$ ✓

$n = (0,25)(50 \times 10^{-3})$ ✓

$= 0,0125$ mol✓ (3)

8.4 KOH: K_2SO_4

2 : 1

$0,0125 : 6,25 \times 10^{-3}$ ✓

$n = \frac{m}{M}$ ✓

$m = (6,25 \times 10^{-3})(174)$ ✓

$m = 1,0875$ g ✓ OR $m = 1,09$ g ✓ (4)

8.5 percentage yield $= \frac{\text{experimental yield}}{\text{theoretical yield}} \times 100$

$= \frac{0,87}{1,0875} \times 100$ ✓✓

$= 80\%$ ✓ OR 79,8 % ✓ (3)

[13]

QUESTION 9

9.1.1. $n = \frac{V}{V_m}$ ✓ OR 1 mole produces 22,4 dm^3 at STP ✓

$= \frac{504 \times 10^{-3}}{22,4}$ ✓

$= 0,0225$ mol ✓ (3)

9.1.2 $N = n.N_A \times 2$

$= (0,0225)(6,02 \times 10^{23}) \times 2$ ✓

$= 2,709 \times 10^{22}$ atoms ✓ (2)

9.1.3 X: H_2

2 : 3

0,015 : 0,0225 ✓

$n = \frac{m}{M}$ ✓

$0,015 = \frac{0,405}{M}$ ✓

$M = 27$ g.mol^{-1} ✓ (4)

9.1.4 aluminium (Aℓ) ✓ (1)

9.2.1 $MgCl_2(s) \rightarrow Mg^{2+}(aq) + 2\ Cl^-(aq)$ ✓ ✓ (2)

9.2.2 No. of moles: $MgCl_2 = c.V$

$= (0,25)(50 \times 10^{-3})$ ✓

$= 12,5 \times 10^{-3}$ mol

$: NaCl = (0,15)(30 \times 10^{-3})$ ✓

$= 4,5 \times 10^{-3}$ mol

n Cl^- in $MgCl_2 = 25 \times 10^{-3}$ mol ✓

n Cl^- in $NaCl = 4,5 \times 10^{-3}$ mol ✓

total n Cl^- $= 29,5 \times 10^{-3}$ mol ✓

$C = \frac{n}{V}$ ✓

$= \frac{29,5 \times 10^{-3}}{80 \times 10^{-3}}$ ✓

$= 0,369\ mol.dm^{-3}$ ✓ (8)

[20]

TOTAL MARKS: 150