basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2018

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 (e.g. 10A) in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of TEN 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 two 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. Each question has only ONE correct answer. 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 D.

1.1 Which ONE of the following substances is NOT a pure substance?

A Iron

B Sugar

C Steel

D Graphite (2)

1.2 The CORRECT chemical formula for potassium nitrate is …

A K_3N

B PNO_3

C KNO_3

D $K_2 NO_3$ (2)

1.3 Different isotopes of the same element have different …

A atomic numbers.

B numbers of neutrons.

C numbers of protons.

D numbers of electrons. (2)

1.4 Which ONE of the following ionisation equations represents the second ionisation of magnesium?

A $Mg(g) + \text{energy} \rightarrow Mg^+ + e^-$

B $Mg^+(s) + \text{energy} \rightarrow Mg^{2+} + 2e^-$

C $Mg^+(g) + \text{energy} \rightarrow Mg^{2+} + 2e^-$

D $Mg(s) + \text{energy} \rightarrow Mg^+ + e^-$ (2)

1.5 Which PAIR of elements is most likely to have a similar arrangement of outer electrons and similar chemical behaviour?

A Boron and aluminium

B Helium and fluorine

C Carbon and nitrogen

D Chlorine and oxygen (2)

1.6 Which ONE of the following statements is INCORRECT about the properties of a physical change?

A When a physical change occurs, the compounds may rearrange themselves, but the bonds in between the atoms will not break.

B Physical change in matter is reversible.

C Energy is absorbed when matter changes from a solid to a liquid.

D Molecules are not conserved during a physical change. (2)

1.7 In the compound, H_2O, the ratio of the MASS of hydrogen to oxygen is always …

A 1 : 2.

B 2 : 1.

C 1 : 8.

D 1 : 16. (2)

1.8 One mole of H_2SO_4 contains …

A 7 atoms.

B 1 molecule.

C $6{,}02\times10^{23}$ molecules.

D $42{,}14\times10^{23}$ molecules. (2)

1.9 Which ONE of the following solutions will NOT form a precipitate if added to a solution of silver nitrate?

A $NaCl(aq)$

B $MgBr_2(aq)$

C $KI(aq)$

D $Mg(NO_3)_2(aq)$ (2)

1.10 The sphere in which minerals are found is known as …

A atmosphere.

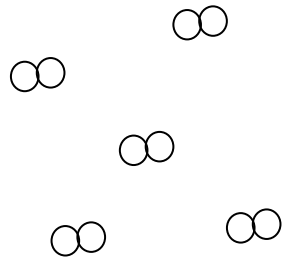
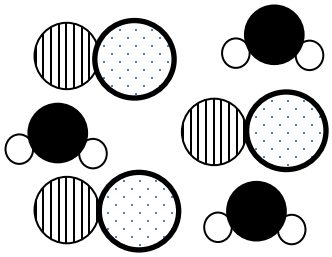
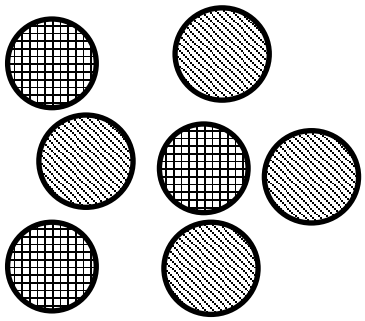
B biosphere.

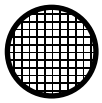
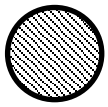
C lithosphere.

D stratosphere. (2)
[20]

QUESTION 2 (Start on a new page.)

The diagram below shows three different substances, **P**, **Q** and **R**.

SUBSTANCE P	SUBSTANCE Q	SUBSTANCE R
		

KEY			
○	Hydrogen		Chlorine
●	Oxygen		Sulphur
	Sodium		Iron

2.1 Define the term *element*. (2)

Use the diagram and the key provided to answer the questions that follow.

2.2 Write down a LETTER that represents the following:

2.2.1 Pure substance (1)

2.2.2 Homogeneous mixture (1)

2.2.3 Heterogeneous mixture (1)

2.3 Indicate whether the pure substance identified in QUESTION 2.2.1 is an element or a compound. (1)

2.4 Which physical method would you use to separate substance **Q** into its components? (1)

2.5 Write down the physical property upon which the separation techniques are based to separate the following substances into their individual components:

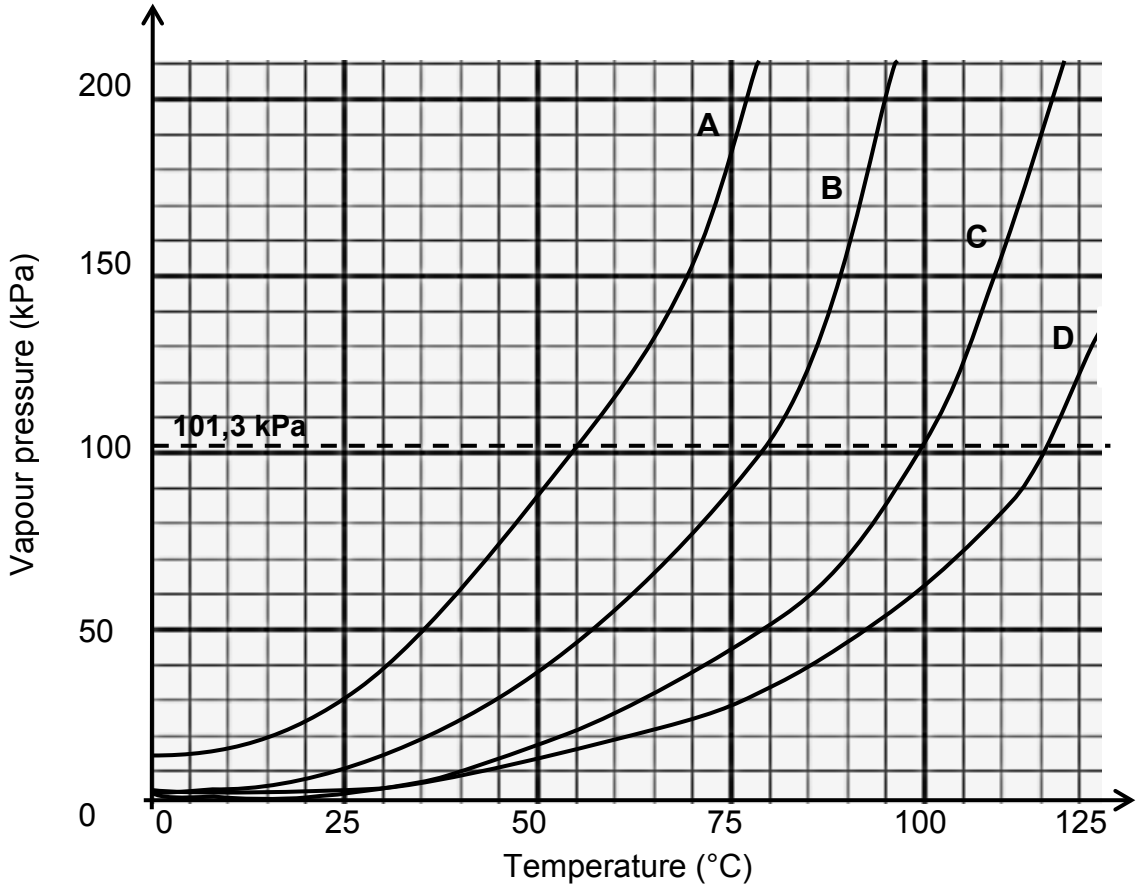
2.5.1 **Q** (1)

2.5.2 **R** (1)
[9]

QUESTION 3 (Start on a new page.)

The vapour pressure versus temperature graph below was obtained for four unknown liquids (**A**, **B**, **C** and **D**). Atmospheric pressure is measured as 101,3 kPa.

Vapour pressure versus temperature



3.1 Define the term *boiling point*. (2)

Use the information given in the graph to answer the questions that follow.

3.2 Write down the:

3.2.1 Boiling point of liquid **B** (1)

3.2.2 Liquid which remains a liquid at 115 °C (1)

3.2.3 Liquid that is most likely to be water (1)

3.3 State the PHASE CHANGE that takes place at the stage when the vapour pressure is equal to atmospheric pressure. (1)

3.4 What happens to the temperature of a liquid during a phase change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

3.5 Explain the answer to QUESTION 3.4. (2)

3.6 Which liquid (**A**, **B**, **C** or **D**) has the weakest intermolecular forces? Give a reason for the answer. (3)

3.7 What is the relationship between vapour pressure of the liquid and temperature? (2)

[14]

QUESTION 4 (Start on a new page.)

Study the table below and answer the questions that follow.

ELEMENT/ION	NUMBER OF PROTONS	NUMBER OF NEUTRONS	NUMBER OF ELECTRONS
P	11	12	11
Q	14	16	14
R	16	16	18

4.1 Define the term *atomic number.* (2)

4.2 Write down the:

4.2.1 Chemical symbol of element **Q** using the notation ${}^{A}_{Z}X$ (2)

4.2.2 Element (**P**, **Q** or **R**) that is an alkali metal (1)

4.2.3 Chemical symbol of **R** (2)

4.3 Element **P** reacts with oxygen to form the compound with the chemical formula P_2O.

4.3.1 Predict the chemical formula that element Rb in the periodic table will form when it reacts with oxygen. (2)

4.3.2 Explain the answer to QUESTION 4.3.1. (2)

4.4 What is the trend in ionisation energy as you move from element **P** to element **R**? Write down only INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (4)

4.5 How many electrons does an ION of element **P** have? Draw the Aufbau diagram of this ion. (3)

4.6 When orbitals of identical energy are available, electrons are placed in individual orbitals before they are paired. Give the name of this rule. (1)

4.7 Element **Y** occurs as these isotopes in the following proportions:

Y – 28(92,23%); **Y** – 29(4,68%); **Y** – 30(3,09%)

Calculate the relative atomic mass of element **Y**. (3)
[22]

QUESTION 5 (Start on a new page.)

Study the physical and chemical processes below and answer the questions that follow.

X: $H_2O(s) \rightarrow H_2O(g)$

Y: $CaCO_3(s) \xrightarrow[\Delta]{} CaO(s) + CO_2(g)$

Z: Iron + Oxygen $\rightarrow$ Iron(III) oxide

5.1 Define the term *physical change.* (2)

5.2 Write down the LETTER of the process that represents the following:

5.2.1 Physical change (1)

5.2.2 Decomposition reaction (1)

5.3 Give the name of the physical change stated in QUESTION 5.2.1. (1)

5.4 State TWO properties of a reaction that indicate that a chemical change has taken place. (2)

5.5 For process **Z**, write down:

5.5.1 What the symbol Δ represents (1)

5.5.2 A BALANCED CHEMICAL EQUATION (Show the phases of ALL reactants and products.) (4)

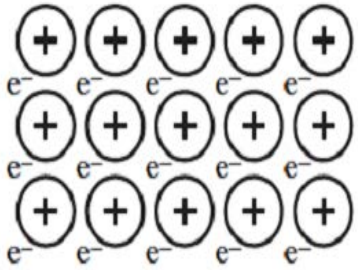
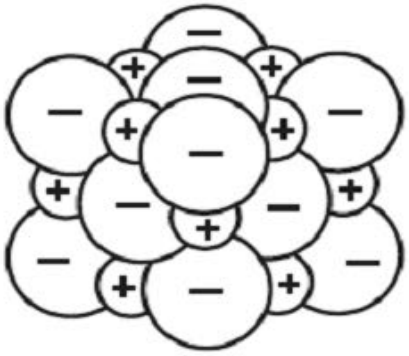
5.6 A 20 g sample of $CaCO_3(s)$ in process **Y** decomposes to form 11,2 g of CaO. In a second sample, 30 g decomposes to form x g of CO_2.

5.6.1 State the *law of constant composition*. (2)

5.6.2 Use the law in QUESTION 5.6.1 to calculate mass x of the CO_2 formed. (4)
[18]

QUESTION 6 (Start on a new page.)

Study the diagram below showing structures of two different substances (**A** and **B**) and answer the questions that follow.

SUBSTANCE A	SUBSTANCE B
	

6.1 Choose the substance (**A** or **B**) that describes the following:

6.1.1 Metallic structure (1)

6.1.2 Structure of magnesium chloride (1)

6.2 Explain how the type of bond in substance **A** forms. (2)

6.3 Name the type of bond that exists in substance **B**. (1)

6.4 Magnesium and chlorine react to form compound magnesium chloride.

6.4.1 Define the term *compound.* (2)

6.4.2 Write down the NAME of the group to which magnesium belongs. (1)

6.4.3 Write down the valency of a chlorine atom. (1)

6.4.4 Use the Lewis dot diagram to show the formation of magnesium chloride. (3)
[12]

QUESTION 7 (Start on a new page.)

A group of learners prepare a 0,25 mol·dm^{-3} solution of sodium carbonate by dissolving a 14,2 g sample of hydrated sodium carbonate ($Na_2CO_3 \cdot xH_2O$) in 200 cm^3 of water.

7.1 Explain the meaning of the term *hydrated*. (1)

7.2 Write down a BALANCED CHEMICAL EQUATION to show how sodium carbonate dissociates in water. (2)

7.3 Learners then take 10 cm^3 of the prepared solution and allow it to react completely with 5 cm^3 of dilute hydrochloric acid, according the following balanced chemical equation:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

7.3.1 Define the term *a mole of a substance.* (2)

7.3.2 What type of chemical reaction is represented by the chemical equation above? (1)

7.3.3 Calculate the number of moles of hydrochloric acid in 5 cm^3 of hydrochloric acid if its concentration is 1 mol·dm^{-3}. (3)

7.4 Calculate the mass of sodium chloride formed in the reaction in QUESTION 7.3. (5)
[14]

QUESTION 8 (Start on a new page.)

Learners investigate how the type of substance affects electrical conductivity of the substance. They conduct three experiments using three different substances under the same conditions, as shown in the table below.

EXPERIMENT	MASS OF SUBSTANCE (g)	TYPE OF SUBSTANCE	TEMPERATURE (°C)
1	2	Solution of $CaCl_2$	25
2	2	Solution of KCl	25
3	2	Solution of sugar	25

8.1 Define the term *electrolyte.* (2)

8.2 For the investigation, write down the:

8.2.1 Investigative question (2)

8.2.2 Dependent variable (1)

8.2.3 Independent variable (1)

8.2.4 Controlled variable (1)

8.3 For the investigation, predict with reasons the substance that will yield the following:

8.3.1 The highest conductivity (2)

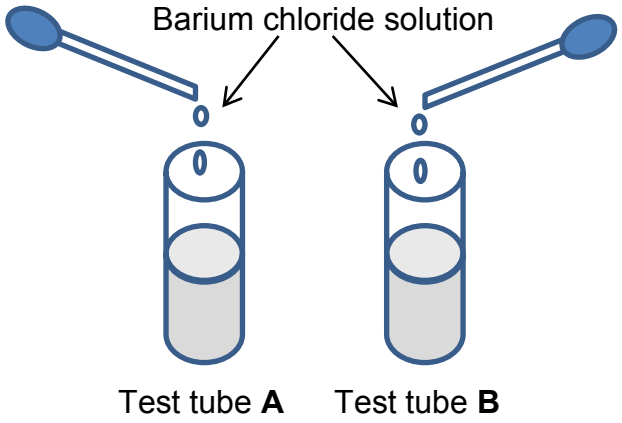
8.3.2 Zero conductivity (2)

8.4 The substance tested in Experiment **3** was analysed. It was found to contain 40% carbon, 6,67% hydrogen and 53,33% oxygen.

Determine the molecular formula if the molar mass is 180 $g \cdot mol^{-1}$. (7)
[18]

QUESTION 9 (Start on a new page.)

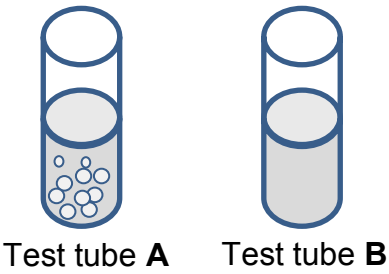
Two test tubes, **A** and **B**, both contain a sodium salt solution. After a small amount of barium chloride is added, the solution in both test tubes forms a white precipitate.



9.1 Write down the type of reaction that takes place in the test tubes. (1)

9.2 A concentrated nitric acid solution is then added into each test tube to establish which one contains carbonate ions and which one contains sulphate ions.

Bubbles are formed in test tube **A**. There is no reaction in test tube **B**.



9.2.1 Identify which IONS (CARBONATE or SULPHATE) are present in test tube **B**. (1)

9.2.2 Write down a BALANCED CHEMICAL EQUATION that represents the reaction between nitric acid and the precipitate formed in test tube **A**. (3)

9.3 A solution of sodium carbonate was prepared by dissolving 5 g of the powder in 100 cm^3 of water. The solution reacted with a barium chloride solution, according to the following balanced chemical equation:

$$Na_2CO_3(aq) + BaCl_2(aq) \rightarrow BaCO_3(s) + 2NaCl(aq)$$

9.3.1 Calculate the mass of barium carbonate that should form in this reaction. (5)

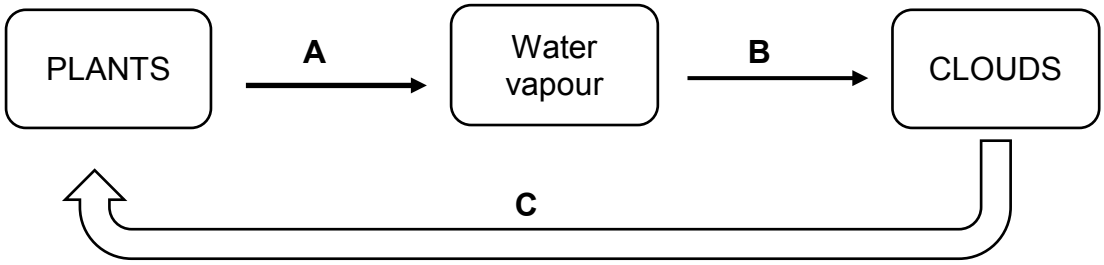
It was found that only 8,3 g precipitate formed.

9.3.2 Calculate the percentage yield. (2)

[12]

QUESTION 10 (Start on a new page)

The diagram below shows how the hydrosphere is linked to the biosphere. Study the diagram and answer the questions that follow.



10.1 Differentiate between the *hydrosphere* and *biosphere*. (2)

10.2 Write down the name of process:

10.2.1 **A** (1)

10.2.2 **B** (1)

10.2.3 **C** (1)

10.3 Describe the energy changes during processes **A** and **B**. Write down only ENERGY GAINED or ENERGY LOST. (2)

10.4 Describe the interaction between the hydrosphere and plants. (4)
[11]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 10
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 10
VRAESTEL 2 (CHEMIE)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	1,013 x 10^5 Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	1,6 x 10^{-19} C

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

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

TABLE 3: THE PERIODIC TABLE OF ELEMENTS/*TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE*