



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 11

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2018

MARKS: 150

TIME: 3 hours

This question paper consists of 12 pages, 4 data sheets and 1 answer sheet.



INSTRUCTIONS AND INFORMATION

1. Write your name and class (e.g. 11A) in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK except QUESTION 4.3 that must be answered on the attached ANSWER SHEET.
3. Hand in the ANSWER SHEET with the ANSWER BOOK.
4. Start EACH question on a NEW page in the ANSWER BOOK.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
7. You may use a non-programmable calculator.
8. You may use appropriate mathematical instruments.
9. You are advised to use the attached DATA SHEETS.
10. Show ALL formulae and substitutions in ALL calculations.
11. Round off your FINAL numerical answers to a minimum of TWO decimal places.
12. Give brief motivations, discussions, etc. where required.
13. Write neatly and legibly.



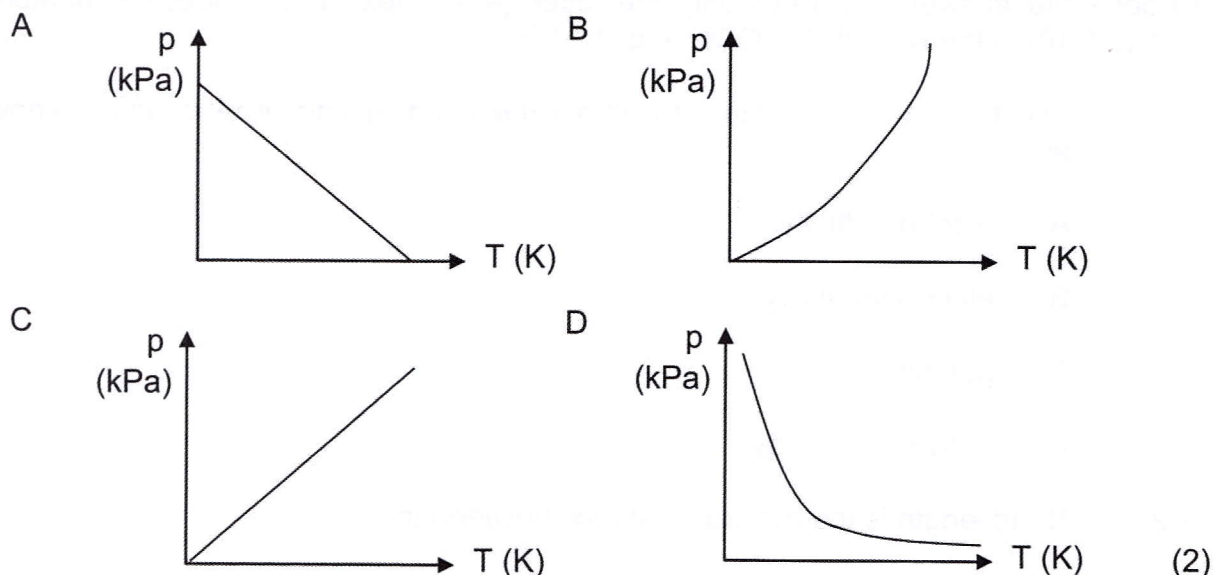
QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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.

- 1.1 The tendency of an atom to attract the bonding pair of electrons is known as ...
- A electron affinity.
 - B electronegativity.
 - C polarity.
 - D activation energy. (2)
- 1.2 Bond length is the average distance between the ...
- A orbitals of two bonded atoms.
 - B electrons in two bonded atoms.
 - C nuclei of two bonded atoms.
 - D molecules of the same substance. (2)
- 1.3 Hydrogen bonds and London forces (induced dipole forces) have a common characteristic in that they ...
- A are both stronger than chemical bonds.
 - B both occur between non-polar molecules.
 - C both occur between polar molecules.
 - D are both intermolecular forces. (2)
- 1.4 In order to double the volume of a fixed amount of moles of an enclosed gas, the temperature in ... at constant pressure.
- A °C can be doubled
 - B K can be doubled
 - C °C can be halved
 - D K can be halved (2)



- 1.5 The graph that CORRECTLY represents the relationship between the pressure (kPa) and the temperature (K) of an enclosed gas at constant volume is ...



- 1.6 The solution that will have the greatest concentration of H^+ ions if complete ionisation takes place, is ...

- A 0,4 dm³ of a 1 mol·dm⁻³ H₂SO₄ solution.
 B 0,4 dm³ of a 1 mol·dm⁻³ HCl solution.
 C 1 dm³ of a 1 mol·dm⁻³ HCl solution.
 D 0,4 dm³ of a 1 mol·dm⁻³ CH₃COOH solution. (2)

- 1.7 Which ONE of the following is NOT a typical reaction of hydrochloric acid?

- A It neutralises a base with the release of hydrogen gas.
 B It forms hydronium ions in water.
 C It colours litmus paper red.
 D It forms CO₂ when reacting with a metal carbonate. (2)



- 1.8 Which ONE of the following pairs represents the conjugate acid and conjugate base of HPO_4^{2-} ?

	CONJUGATE ACID	CONJUGATE BASE
A	PO_4^{3-}	H_2PO_4^-
B	H_2PO_4^-	PO_4^{3-}
C	H_2PO_4^-	H_3PO_4
D	$\text{H}_2\text{PO}_4^{2-}$	PO_4^{2-}

(2)

- 1.9 Which ONE of the following indicates the CORRECT colour of bromothymol blue in an acid and a base?

	BROMOTHYMOLOL BLUE IN AN ACID	BROMOTHYMOLOL BLUE IN A BASE
A	Orange	Yellow
B	Blue	Red
C	Pink	Colourless
D	Yellow	Blue

(2)

- 1.10 In which ONE of the following reactions is HCl oxidised?

- A $\text{HCl}(\text{aq}) + \text{H}_2\text{O}(\ell) \rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
- B $\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\ell) + \text{CO}_2(\text{g})$
- C $\text{NH}_3(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{NH}_4\text{Cl}(\text{aq})$
- D $\text{MnO}_2(\text{aq}) + 4\text{HCl}(\text{aq}) \rightarrow \text{MnCl}_2(\text{aq}) + \text{H}_2\text{O}(\ell) + \text{Cl}_2(\text{g})$

(2)
[20]

QUESTION 2 (Start on a new page.)

Hydrogen cyanide (HCN) is a very poisonous compound used in the manufacturing of plastics, mining of gold and as a poison.

- 2.1 Define the term *chemical bond*. (2)
- 2.2 Draw Lewis structures for:
- 2.2.1 HCN (2)
- 2.2.2 H₂O (2)
- 2.3 What is the shape of the HCN molecule? (1)
- 2.4 Calculate the electronegativity difference for the CN bond. (1)
- 2.5 What is polarity of the HCN molecule? Write only POLAR or NON-POLAR. (1)

The table below indicates the values of the bond length and bond energy of the different bonds in HCN.

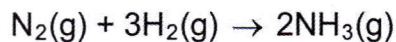
BOND	BOND LENGTH (nm)	BOND ENERGY (kJ·mol ⁻¹)
CH	0,109	413
CN	0,116	890

- 2.6 Explain why the bond energy of the CN bond is more than the bond energy of the CH bond. (2)
- 2.7 Explain the difference between the *bond length of the CH bond* and the *bond length of the CN bond*. (2)
- 2.8 Will HCN be soluble in water? Write only YES or NO. (1)
- 2.9 Explain the answer to QUESTION 2.8 by referring to the polarity and intermolecular forces of the compounds. (3)
- [17]**



QUESTION 3 (Start on a new page.)

The reaction below is used in the Haber process to manufacture ammonia.



The boiling points of the substances in the reaction are as follows:

SUBSTANCE	BOILING POINT (°C)
H ₂	-252,9
N ₂	-195,8
NH ₃	-33,3

- 3.1 Refer to the intermolecular forces and explain the difference in boiling point between NH₃ and N₂. (3)
- 3.2 Write down the FORMULA of the substance in the table that will have the lowest melting point. (1)
- 3.3 Explain why H₂ will evaporate faster than N₂. Refer to the type and relative strength of the intermolecular forces. (3)
- 3.4 Write down the FORMULA of the substance in the table that will have the highest vapour pressure. Explain your answer. (3)
- [10]**



QUESTION 4 (Start on a new page.)

A certain amount of gas is sealed in a container of which the volume can change. The relationship between the pressure and volume of the gas at 20 °C is investigated. The results of the experiment are given in the table below.

PRESSURE (kPa)	VOLUME (dm ³)
70	174
95	128
130	93,6
165	74
205	59
240	51
260	47

- 4.1 Name the gas law that is represented by the results of the experiment. (1)
- 4.2 Write down a hypothesis for the investigation. (2)
- 4.3 Draw a graph of volume versus pressure on the ANSWER SHEET attached. (3)
- 4.4 Calculate the volume of the gas at 300 kPa. (3)
- 4.5 When the volume of the gas is measured at 300 kPa, it is 44 dm³. Explain why the measured volume differs from the volume calculated in QUESTION 4.4. (2)
- 4.6 Which temperature condition will cause a gas to deviate from ideal behaviour? Write only HIGH or LOW. (1)
- 4.7 Explain the answer to QUESTION 4.6. (2)
- 4.8 Calculate the number of moles of the gas in the container at the INITIAL pressure and volume. (4)

[18]

QUESTION 5 (Start on a new page.)

A balloon is filled with 160 g of argon gas (Ar). The pressure of the gas is 120 kPa at a temperature of 15 °C.

- 5.1 Calculate the volume of the balloon. (4)
- 5.2 The temperature of the gas is now increased BY 20 °C and the initial pressure is doubled. Calculate the new volume of the balloon. (4)

[8]**QUESTION 6 (Start on a new page.)**

- 6.1 In an experiment, a learner added 1,5 g of sodium carbonate (Na_2CO_3) to hydrochloric acid (HCl). A volume of 306 cm^3 of carbon dioxide gas was formed and collected under standard pressure at room temperature. Take the molar gas volume at room temperature (V_m) as 24,45 dm^3 .

The unbalanced equation for the reaction is:

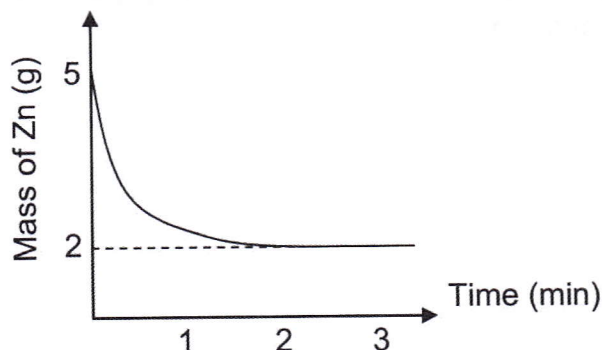


K H O M O C M

- 6.1.1 Define the term *one mole of a substance*. (2)
- 6.1.2 Balance the equation for the reaction. (2)
- 6.1.3 Calculate the mass of sodium carbonate that reacted. (7)
- 6.1.4 Calculate the percentage of sodium carbonate in excess. (2)
- 6.2 Zinc reacts with sulphuric acid according to the reaction below.



The mass of zinc is recorded during the experiment and is shown on the graph below. The reaction stops after 2 minutes.

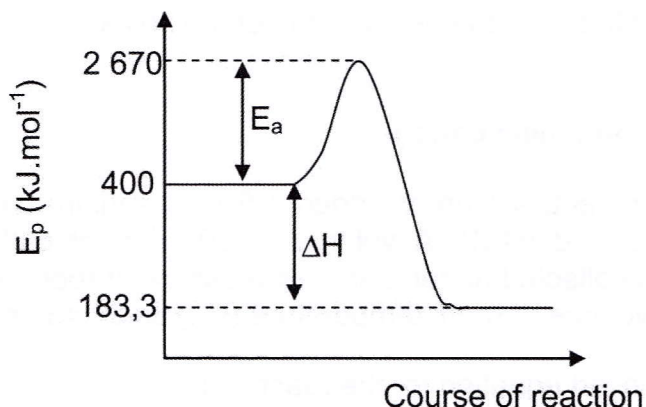


- 6.2.1 Name the substance that is the limiting reagent. (1)
- 6.2.2 Calculate the initial concentration of the sulphuric acid if 50 cm^3 of the acid was used. (5)

[19]

QUESTION 7 (Start on a new page.)

The following reaction between ammonia and oxygen takes place in a closed system at constant pressure and temperature:

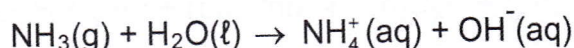


- 7.1 Define the term *activation energy*. (2)
- 7.2 Give a reason why this reaction is exothermic. (1)
- 7.3 Calculate the heat of reaction. (3)
- 7.4 Redraw the graph and indicate with a dotted line the effect of a catalyst on the activation energy. (2)
- 7.5 State *Avogadro's law* in words. (2)
- 7.6 If 6 dm^3 of NH_3 and 9 dm^3 of O_2 are used, calculate the TOTAL VOLUME of the gases at the end of the reaction. (4)
- 7.7 The reaction above is the first step in the manufacturing of an acid. This acid contains 1,59% hydrogen, 22,2% nitrogen and 76,2% oxygen. Determine the empirical formula of the acid. (5)

[19]

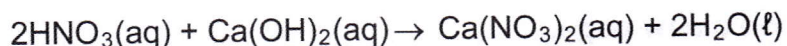
QUESTION 8 (Start on a new page.)

Ammonia can readily dissolve in water according to the equation below:



- 8.1 Explain why a hydroxide ion is regarded as a Lowry-Brønsted base. (2)
- 8.2 Identify the type of bond responsible for the formation of the ammonium ion in the above equation. (1)
- 8.3 Write a balanced equation to show how the ampholyte in the above equation will act as a base when it reacts with hydrochloric acid (HCl). (2)

5 dm³ of nitric acid (HNO₃), with a concentration of 0,75 mol·dm⁻³, is spilled accidentally in a small pond of water. The acid and water has a total volume of 1 000 dm³. To neutralise the acid, calcium hydroxide is added to the water.

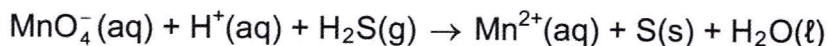


- 8.4 Define the term *concentration*. (2)
- 8.5 Calculate the concentration of the acid AFTER it was spilled in the pond. (4)
- 8.6 Use calculations to determine if 120 g of calcium hydroxide will be sufficient to react completely with ALL the acid in the pond. (6)

[17]

QUESTION 9 (Start on a new page.)

The reaction between permanganate ions (MnO_4^-) and hydrogen sulphide (H_2S) is given below.

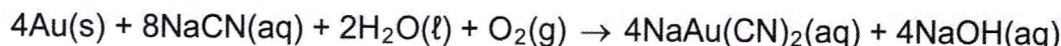


- 9.1 Define *reduction* in terms of oxidation numbers. (2)
- 9.2 Determine the oxidation number of manganese in the permanganate ion. (1)
- 9.3 Write down the FORMULA of the substance that undergoes oxidation. (1)
- 9.4 Explain the answer to QUESTION 9.3 in terms of oxidation numbers. (2)
- 9.5 Write down the FORMULA for the oxidising agent. (1)
- 9.6 Write down the oxidation half-reaction. (2)
- 9.7 Use the ion-electron method and write down the balanced net ionic equation. (3)
- [12]**

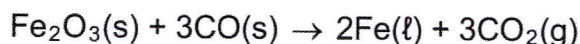
QUESTION 10 (Start on a new page.)

Gold and iron extraction are important mining processes in South Africa. Refining takes place according to the following reactions:

Gold is dissolved using cyanide ions (CN^-) to extract it from the ore:



Iron(III)oxide is burned in a furnace in the presence of CO:



- 10.1 Name TWO disadvantages of deep-shaft mining in comparison with open-cast mining. (2)
- 10.2 Write down the FORMULA of the substance that is reduced in the reaction used to extract gold. (1)
- 10.3 Use oxidation numbers to explain how you arrived at the answer to QUESTION 10.2. (1)
- 10.4 Write the reduction half-reaction for the iron extraction reaction. (2)
- 10.5 Calculate the percentage of iron present in Fe_2O_3 . (2)
- 10.6 Only 65% of the ore contains iron. If 2 500 kg of ore is used, calculate the mass of iron that can be extracted from the ore. (2)
- [10]**

TOTAL: 150



TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/Halfreaksies	E° (V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+ 1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	0,00
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	- 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	- 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	- 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	- 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	- 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	- 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	- 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	- 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	- 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	- 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	- 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	- 1,18
$Al^{3+} + 3e^- \rightleftharpoons Al$	- 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	- 2,36
$Na^+ + e^- \rightleftharpoons Na$	- 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	- 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	- 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	- 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	- 2,93
$Li^+ + e^- \rightleftharpoons Li$	- 3,05

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë



