basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2017

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number 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, for example 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, et cetera where required.
12. 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 number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The IUPAC name of an organic compound with molecular formula $C_7H_{14}O_2$:

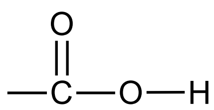
A Heptanal

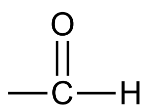
B Heptan-1-ol

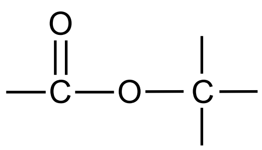
C Heptan-2-ol

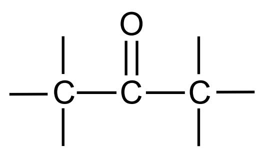
D Heptanoic acid (2)

1.2 Which ONE of the following structures is the functional group of aldehydes?

A


B


C


D


(2)

1.3 Which ONE of the following equations represents a cracking process?

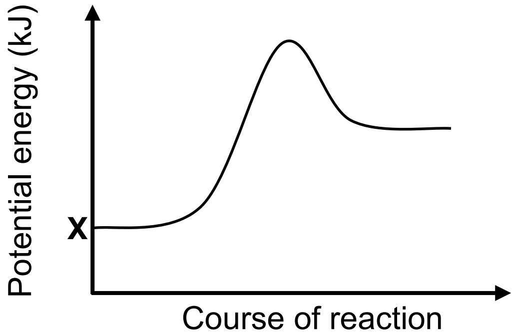
A $5CH_2 = CH_2 \rightarrow —(CH_2CH_2)_5—$

B $CH_3(CH_2)_5CH = CH_2 + H_2 \rightarrow CH_3(CH_2)_6CH_3$

C $CH_3(CH_2)_6CH_3 \rightarrow CH_3(CH_2)_4CH_3 + CH_2 = CH_2$

D $CH_3(CH_2)_7OH \rightarrow CH_3(CH_2)_5CH = CH_2 + H_2O$ (2)

1.4 The potential energy diagram for a chemical reaction is shown below.



Consider the following statements regarding the graph above:

I: **X** represents the potential energy of the products formed during the reverse reaction.

II: The graph could be a representation of the change in potential energy for the following reaction:

$$CaCO_3(s) \rightleftharpoons Ca^{2+}(aq) + CO_3^{2-}(aq) \quad \Delta H > 0$$

III: The graph could be a representation of the change in potential energy for the combustion of methane.

Which of the statements above are TRUE?

A **I** and **II** only

B **II** and **III** only

C **I** and **III** only

D **I**, **II** and **III** (2)

1.5 A certain chemical reaction reaches equilibrium at 25 °C. The equilibrium constant, K_c, for the reaction at this temperature is $1,0 \times 10^{-4}$.

Which ONE of the following statements regarding this reaction at equilibrium is CORRECT?

A The concentration of the products is equal to that of the reactants.

B The concentration of the products is higher than that of the reactants.

C The concentration of the products is lower than that of the reactants.

D The rate of the forward reaction is lower than the rate of the reverse reaction. (2)

1.6 Consider the following chemical reaction at equilibrium in a closed container:

$$2HgO(s) \rightleftharpoons 2Hg(\ell) + O_2(g)$$

More HgO(s) is now added to the container at constant temperature.

How will the number (in moles) of $O_2(g)$ and the value of K_c be affected at equilibrium?

	NUMBER OF MOLES OF O_2	K_c
A	Increases	Increases
B	Increases	Remains the same
C	Remains the same	Remains the same
D	Remains the same	Increases

(2)

1.7 Which ONE of the following solutions, each of concentration 0,1 mol·dm^{-3}, has the highest pH?

A $HNO_3(aq)$

B $NH_4C\ell(aq)$

C $Na_2CO_3(aq)$

D $CH_3COOH(aq)$ (2)

1.8 The cell notation for a galvanic cell is as follows:

$$Ni(s) \mid Ni^{2+}\ (1\ mol \cdot dm^{-3}) \parallel Pb^{2+}\ (1\ mol \cdot dm^{-3}) \mid Pb(s)$$

Which ONE of the following statements is CORRECT for this cell?

A Ni is oxidised.

B Pb(s) is reduced.

C $Ni^{2+}(aq)$ is the oxidising agent.

D Pb^{2+} is the reducing agent. (2)

1.9 Which ONE of the following combinations CORRECTLY shows the products formed during the electrolysis of a CONCENTRATED sodium chloride solution?

	CATHODE	**ANODE**
A	Hydrogen	Sodium
B	Hydrogen	Chlorine
C	Chlorine	Sodium
D	Chlorine	Hydrogen

(2)

1.10 Which ONE of the following is NOT part of the eutrophication process?

A Algal bloom

B Bacterial nitrogen fixation

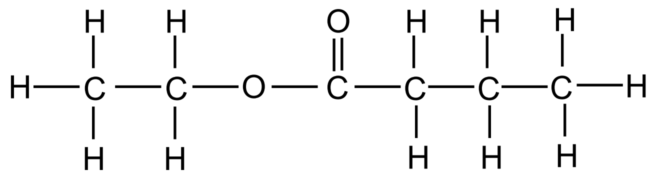
C Depletion of oxygen in water

D Increase in plant nutrients in water (2)

[20]

QUESTION 2 (Start on a new page.)

2.1 Study the structural formula below.



For this compound, write down the:

2.1.1 Homologous series to which it belongs (1)

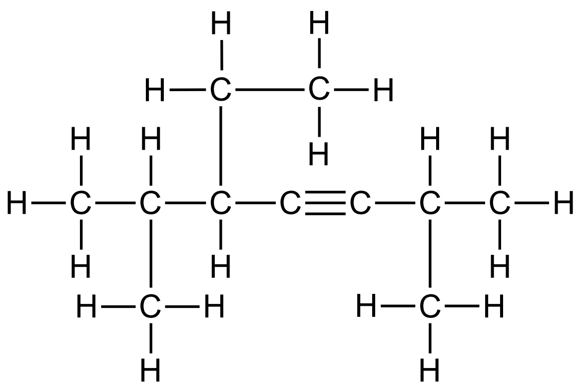
2.1.2 IUPAC name (2)

2.1.3 IUPAC name of the organic acid used in its preparation (1)

2.1.4 STRUCTURAL FORMULA of its straight chain (unbranched) functional isomer (2)

2.2 Write down the structural formula of 4-methylpentan-2-one. (3)

2.3 Consider the structural formula below.



For this compound, write down the:

2.3.1 General formula of the homologous series to which it belongs (1)

2.3.2 IUPAC name (3)
[13]

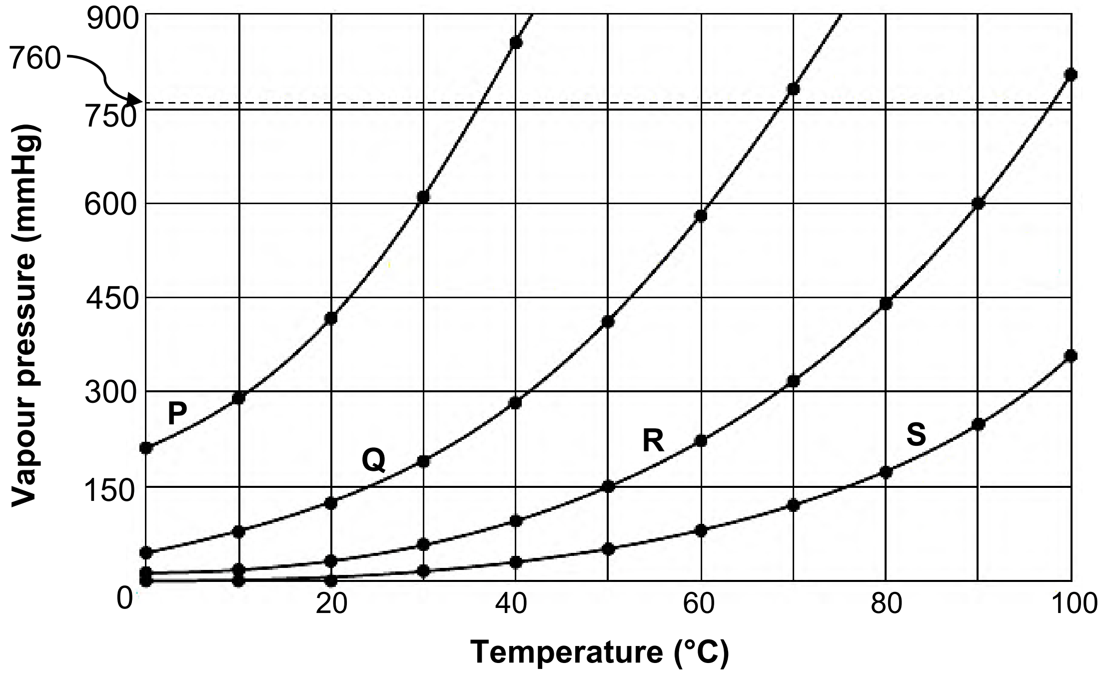
QUESTION 3 (Start on a new page.)

The vapour pressure versus temperature graph below was obtained for four straight chain (unbranched) alkanes (**P**, **Q**, **R** and **S**).

FROM **P** TO **S**, EACH COMPOUND DIFFERS FROM THE PREVIOUS COMPOUND BY A $–CH_2$ GROUP.

The vapour pressures are measured in mmHg. Atmospheric pressure is 760 mmHg.

Graph of vapour pressure versus temperature



3.1 Give a reason why alkanes are said to be SATURATED. (1)

3.2 Define *vapour pressure.* (2)

3.3 Use the information in the graph above to answer the following questions.

3.3.1 What is the effect of an increase in temperature on vapour pressure? Choose from INCREASES, DECREASES or NO EFFECT. (1)

3.3.2 Which compound has a boiling point of approximately 68 °C? Give a reason for the answer. (2)

3.3.3 Which compound has the longest chain length? Fully explain the answer. (4)

3.4 Compound **P** has FIVE carbon atoms.

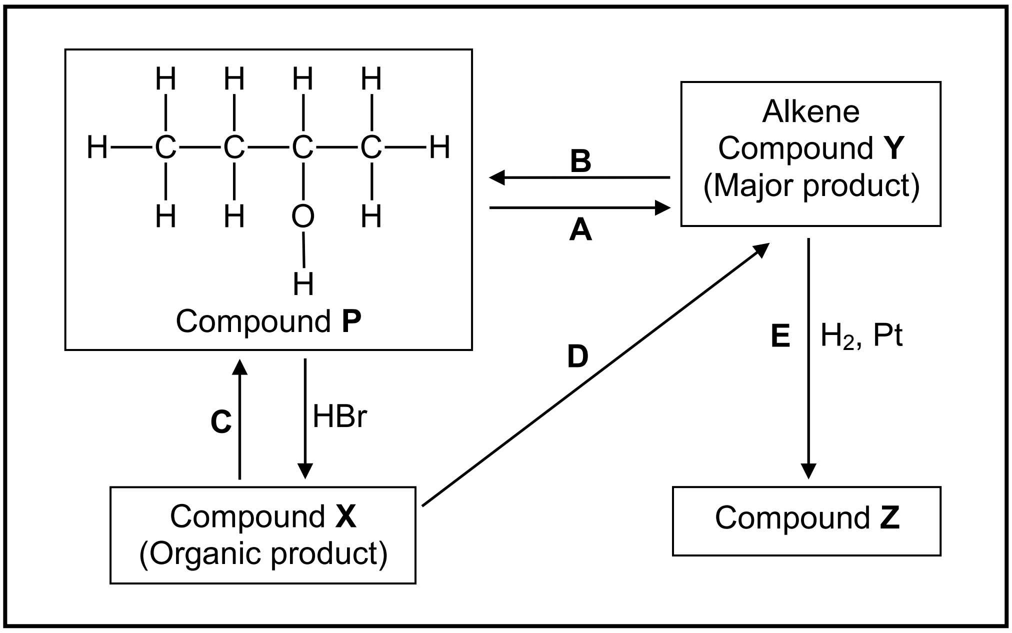
3.4.1 Draw the structural formula of a chain isomer of **P**. Write down the IUPAC name of this isomer. (3)

3.4.2 How will the vapour pressure of this isomer compare with that of compound **P**? Choose from HIGHER THAN, LOWER THAN or EQUAL TO. (1)

[14]

QUESTION 4 (Start on a new page.)

The flow diagram below shows how an alcohol (compound **P**) can be used to prepare other organic compounds. The letters **A** to **E** represent different organic reactions. **X**, **Y** and **Z** are organic compounds.



4.1 Is compound **P** a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)

4.2 Write down the type of:

4.2.1 Elimination reaction represented by **A** (1)

4.2.2 Addition reaction represented by **B** (1)

4.2.3 Elimination reaction represented by **D** (1)

4.3 Sodium hydroxide is used as one of the reactants in reaction **C**.

4.3.1 What type of reaction takes place here? (1)

4.3.2 State the TWO reaction conditions for this reaction. (2)

4.3.3 Write down the IUPAC name of compound **X**. (2)

4.4 Write down the FORMULA of an inorganic reactant needed for reaction **D**. (1)

4.5 Using STRUCTURAL FORMULAE, write down a balanced equation for reaction **E**. (3)

4.6 Write down the IUPAC name of compound **Z**. (1)
[15]

QUESTION 5 (Start on a new page.)

A group of learners uses the reaction between powdered zinc and EXCESS dilute hydrochloric acid to investigate one of the factors that affects the rate of a chemical reaction. The balanced equation for the reaction is:

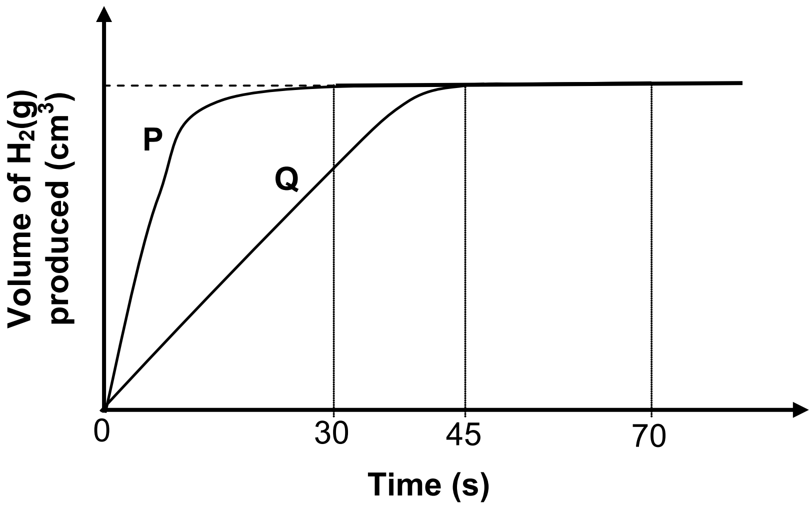
$$Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

They conduct two experiments. The reaction conditions used are summarised in the table below.

EXPERIMENT	TEMPERATURE (°C)	VOLUME OF HCℓ (cm^3)	CONCENTRATION OF HCℓ ($mol \cdot dm^{-3}$)	MASS OF Zn (g)
I	25	200	0,25	x
II	25	200	0,40	x

The results obtained are shown in the graph (not drawn to scale) below.

Graph of volume of $H_2(g)$ produced versus time



5.1 Define *reaction rate*. (2)

5.2 Write down an investigative question for this investigation. (2)

5.3 Which curve, **P** or **Q**, represents the results of experiment **I**? Explain the answer. (3)

5.4 The average rate of the production of hydrogen gas, as represented by graph **P**, was 15 $cm^3 \cdot s^{-1}$. Calculate the mass of zinc used. **Take the molar gas volume at 25 °C as 24 000 cm^3.** (5)

5.5 In a third experiment (experiment **III**), 200 cm^3 of a 0,25 $mol \cdot dm^{-3}$ dilute hydrochloric acid solution at 35 °C reacts with the same amount of zinc powder as in experiment **I** and experiment **II**.

5.5.1 How will the heat of reaction of experiment **II** compare with that of experiment **III**? Choose from MORE THAN, LESS THAN or EQUAL TO. (1)

5.5.2 How will the activation energy of the reaction in experiment **I** compare with that of the reaction in experiment **III**? Choose from MORE THAN, LESS THAN or EQUAL TO. (1)

5.6 The rate of the reaction in experiment **III** is higher than that of experiment **I**.

Fully explain this statement by referring to the collision theory. (3)
[17]

QUESTION 6 (Start on a new page.)

Carbonyl bromide, $COBr_2$, decomposes into carbon monoxide and bromine according to the following balanced equation:

$$COBr_2(g) \rightleftharpoons CO(g) + Br_2(g) \qquad \Delta H > 0$$

Initially $COBr_2(g)$ is sealed in a 2 dm^3 container and heated to 73 °C. The reaction is allowed to reach equilibrium at this temperature. The equilibrium constant for the reaction at this temperature is 0,19.

6.1 Define *chemical equilibrium*. (2)

At equilibrium it is found that 1,12 g CO(g) is present in the container.

6.2 Calculate the:

6.2.1 Equilibrium concentration of the $COBr_2(g)$ (7)

6.2.2 Percentage of $COBr_2(g)$ that decomposed at 73 °C (4)

6.3 Which ONE of the following CORRECTLY describes the K_c value when equilibrium is reached at a lower temperature?

$K_c < 0,19$	$K_c > 0,19$	$K_c = 0,19$

(1)

6.4 The pressure of the system is now decreased by increasing the volume of the container at 73 °C and the system is allowed to reach equilibrium.

How will the number of moles of $COBr_2(g)$ be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)
[17]

QUESTION 7 (Start on a new page.)

7.1 Ammonia ionises in water to form a basic solution according to the following balanced equation:

$$NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

7.1.1 Is ammonia a WEAK or a STRONG base? Give a reason for the answer. (2)

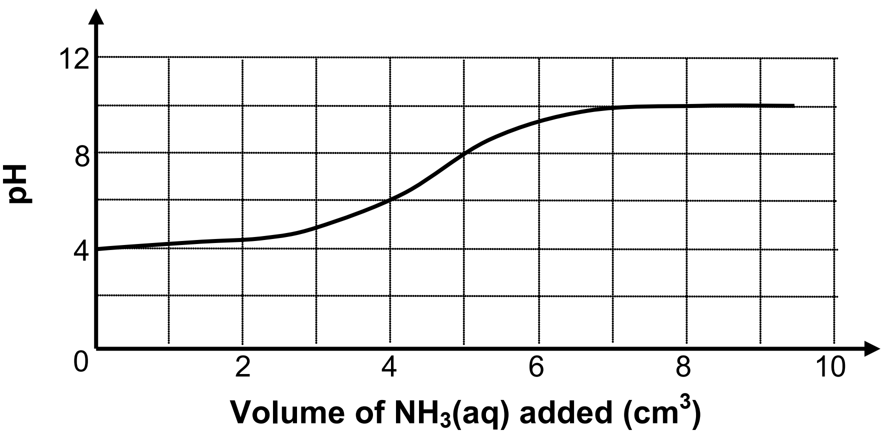
7.1.2 Write down the conjugate acid of $NH_3(g)$. (1)

7.1.3 Identify ONE substance in this reaction that can behave as an ampholyte in some reactions. (1)

7.2 A learner adds distilled water to a soil sample and then filters the mixture. The pH of the filtered liquid is then measured.

He then gradually adds an ammonia solution, $NH_3(aq)$, to this liquid and measures the pH of the solution at regular intervals. The graph below shows the results obtained.

Graph of pH versus volume of NH_3(aq)

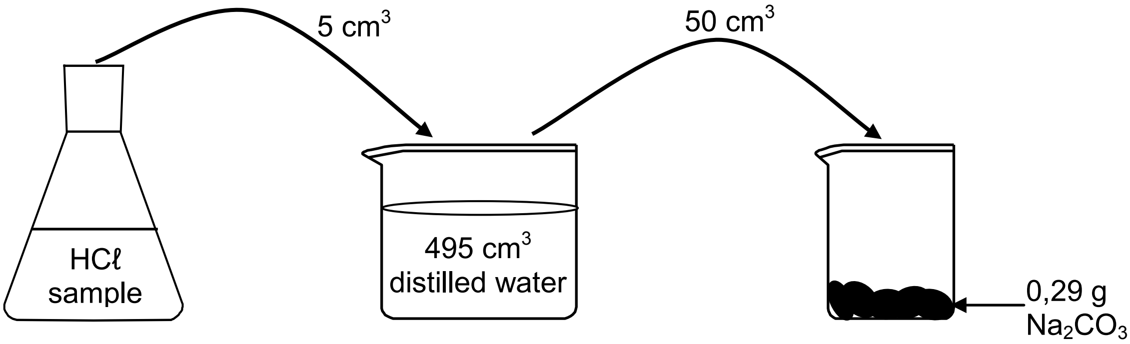


7.2.1 Is the soil sample ACIDIC or BASIC? Refer to the graph above and give a reason for the answer. (2)

7.2.2 Calculate the concentration of the hydroxide ions (OH^-) in the reaction mixture after the addition of 4 cm^3 of $NH_3(aq)$. (4)

7.3 A laboratory technician wants to determine the concentration of a hydrochloric acid ($HC\ell$) sample. He adds 5 cm^3 of the $HC\ell$ sample to 495 cm^3 of distilled water to give 500 cm^3 of dilute hydrochloric acid, $HC\ell(aq)$.

During a reaction 50 cm^3 of this dilute hydrochloric acid solution, $HC\ell(aq)$, reacts completely with 0,29 g of sodium carbonate, $Na_2CO_3(s)$.



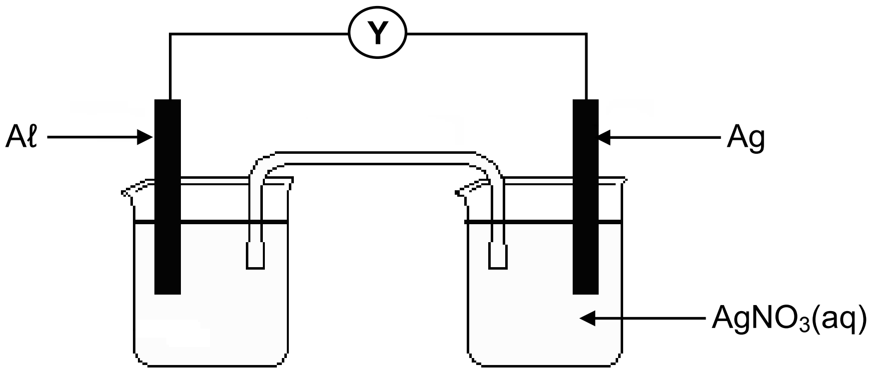
The balanced equation for the reaction is:

$$Na_2CO_3(s) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + CO_2(g) + H_2O(\ell)$$

Calculate the concentration of the hydrochloric acid sample. (7)
[17]

QUESTION 8 (Start on a new page.)

8.1 Learners set up a galvanic cell and measure its emf under standard conditions.



8.1.1 Write down the name of component **Y**. (1)

8.1.2 Is $A\ell$ the ANODE or the CATHODE? (1)

8.1.3 Write down the overall (net) cell reaction that takes place in this cell when it is working. (3)

8.1.4 Calculate the initial emf of this cell. (4)

8.2 Consider the half-cells, **P**, **Q** and **R**, represented in the table below.

HALF-CELL		
P	**Q**	**R**
$Zn \mid Zn^{2+}(aq)$	$C\ell_2 \mid C\ell^-(aq)$	$Cu \mid Cu^{2+}(aq)$

Different combinations of the half-cells above are compared to determine the highest emf produced under standard conditions.

8.2.1 Write down the NAME of a suitable electrode for half-cell **Q**. (1)

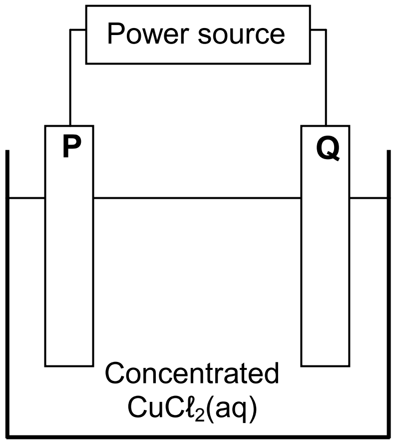
8.2.2 State the standard conditions under which the half-cells should operate to ensure a fair comparison. (2)

8.2.3 Write down the NAME or FORMULA of the strongest reducing agent in the half-cells above. (1)

8.2.4 Which combination of half-cells will produce the highest emf? Choose from **PR**, **PQ** or **QR**. (NO calculation is required.) (1)
[14]

QUESTION 9 (Start on a new page.)

The simplified diagram below represents an electrochemical cell used in the refining of copper. One of the electrodes consists of impure copper.



9.1 What type of power source, AC or DC, is used to drive the reaction in this cell? (1)

9.2 When an electric current passes through the $CuC\ell_2$(aq), the mass of electrode **P** increases.

Is electrode **P** the CATHODE or the ANODE?
Write down the relevant half-reaction to support the answer. (3)

9.3 The impure copper contains zinc impurities which are oxidised to zinc ions.

Refer to the relative strengths of oxidising agents to explain why zinc ions will not influence the quality of the pure copper produced in this cell. (3)

9.4 Electrodes **P** and **Q** are now replaced by carbon electrodes.

9.4.1 What will be observed at electrode **Q**? (1)

9.4.2 How will the concentration of the electrolyte change as the reaction proceeds? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[9]

QUESTION 10 (Start on a new page.)

10.1 The equations below represent two industrial processes involved in the preparation of ammonium nitrate.

Process X

I: **A** + $5O_2(g) \rightarrow 4NO + 6H_2O(g)$

II: $2NO(g) + O_2(g) \rightarrow 2$**B**

III: **B** + $H_2O(g) \rightarrow HNO_3(g) + NO(g)$

Process Y

IV: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

Ammonium nitrate

Write down the:

10.1.1 NAME of substance **A** (1)

10.1.2 FORMULA of substance **B** (1)

10.1.3 NAME given for reaction **I** (1)

10.1.4 NAME or FORMULA of the catalyst used in reaction **I** (1)

10.1.5 Name of process **X** (1)

10.1.6 Name of process **Y** (1)

10.1.7 Balanced equation for the preparation of ammonium nitrate from the products obtained in process **X** and process **Y** (3)

10.2 A 15 kg bag of fertiliser contains 5% phosphorus, 10% nitrogen and 15% potassium.

Calculate the:

10.2.1 Mass of phosphorus in the bag (2)

10.2.2 Mass of filler in the bag (3)
[14]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
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	$22{,}4\ dm^{3}\cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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

KEY/*SLEUTEL*

Electronegativity / *Elektronegatiwiteit*	Atomic number / *Atoomgetal*	Symbol / *Simbool*	Approximate relative atomic mass / *Benaderde relatiewe atoommassa*
1,9	29	Cu	63,5

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)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 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	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 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 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↑)

Increasing reducing ability/*Toenemende reduserende vermoë* (↓)

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↓)

Increasing reducing ability/*Toenemende reduserende vermoë* (↑)

Half-reactions/*Halfreaksies*			E^θ (V)
$Li^+ + e^-$	⇌	Li	− 3,05
$K^+ + e^-$	⇌	K	− 2,93
$Cs^+ + e^-$	⇌	Cs	− 2,92
$Ba^{2+} + 2e^-$	⇌	Ba	− 2,90
$Sr^{2+} + 2e^-$	⇌	Sr	− 2,89
$Ca^{2+} + 2e^-$	⇌	Ca	− 2,87
$Na^+ + e^-$	⇌	Na	− 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	− 2,36
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	− 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	− 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	− 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	− 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	− 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	− 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	− 0,40
$Co^{2+} + 2e^-$	⇌	Co	− 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	− 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	− 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	− 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	− 0,06
$\mathbf{2H^+ + 2e^-}$	⇌	$\mathbf{H_2(g)}$	**0,00**
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2017

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 11 pages.
Hierdie nasienriglyne bestaan uit 11 bladsye.

QUESTION/*VRAAG 1*

1.1 D ✓✓ (2)

1.2 B ✓✓ (2)

1.3 C ✓✓ (2)

1.4 A ✓✓ (2)

1.5 C ✓✓ (2)

1.6 C ✓✓ (2)

1.7 C ✓✓ (2)

1.8 A ✓✓ (2)

1.9 B ✓✓ (2)

1.10 B ✓✓ (2)
[20]

QUESTION/*VRAAG 2*

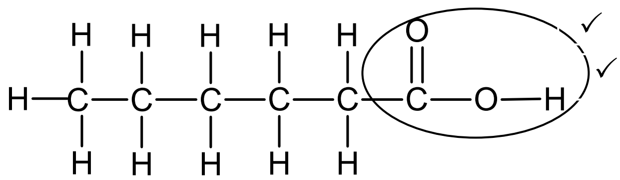
2.1

2.1.1 Esters ✓ (1)

2.1.2 Ethyl ✓ butanoate ✓/*Etielbutanoaat* (2)

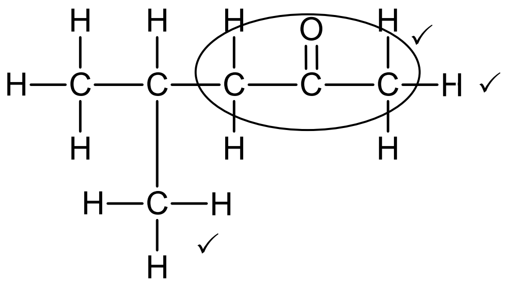
2.1.3 Butanoic acid/*Butanoësuur* ✓ (1)

2.1.4



(2)

2.2



(3)

2.3

2.3.1 C_nH_{2n-2} ✓ (1)

2.3.2 5-ethyl-2,6-dimethylhept-3-yne/5-ethyl-2,6-dimethyl-3-heptyne
5-etiel-2,6-dimetielhept-3-yn/5-etiel-2,6-dimetiel-3-heptyn (3)

[13]

QUESTION/*VRAAG 3*

3.1 **ANY ONE/*ENIGE EEN*:**

- They have ONLY single bonds. ✓
  Hulle het SLEGS enkelbindings.
- They have single bonds between C atoms.
  Hulle het enkelbindings tussen C-atome.
- They have no double OR triple bonds OR multiple bonds.
  Hulle het geen dubbel- OF trippelbindings OF meervoudige bindings nie.
- They contain the maximum number of H atoms bonded to C atoms.
  Hulle bevat die maksimum getal H-atome gebind aan C-atome.
- Each C atom is bonded to four other atoms.
  Elke C-atoom is gebind aan vier ander atome. (1)

3.2 The pressure exerted by a vapour in equilibrium with its liquid ✓ in a closed system. ✓
Die druk uitgeoefen deur 'n damp in ewewig met sy vloeistof in 'n geslote sisteem. (2)

3.3

3.3.1 Increases/*Verhoog* ✓ (1)

3.3.2 Q ✓
It is the temperature where the graph intercepts the dotted line. ✓
Dit is die temperatuur waar die grafiek die stippellyn sny.

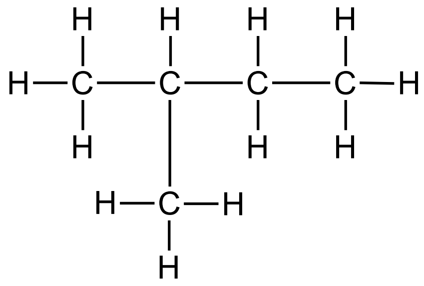
OR/*OF*
It is the temperature where the vapour pressure of compound **Q** equals atmospheric pressure/is equal to 760 mmHg.
*Dit is die temperatuur waar die dampdruk van verbinding **Q** gelyk is aan atmosferiese druk/gelyk is aan 760 mmHg.* (2)

3.3.3 S ✓

- At a given temperature, **S** has the lowest vapour pressure/highest boiling point. ✓
  *By 'n gegewe temperatuur het **S** die laagste dampdruk/hoogste kookpunt.*
- Strongest intermolecular forces/London forces/dispersion forces/induced dipole forces. ✓
  Sterkste intermolekulêre kragte/London-kragte/dispersiekragte/ geïnduseerde dipoolkragte.
- Highest energy needed to overcome/break the intermolecular forces. ✓
  Hoogste energie benodig om intermolekulêre kragte te oorkom/breek. (4)

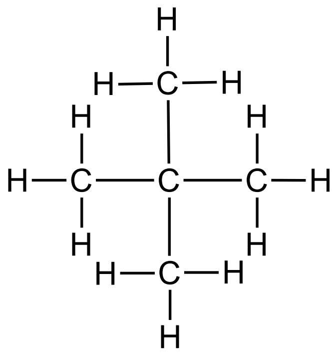
3.4

3.4.1



✓✓

OR/*OF*



2-methylbutane ✓ 2,2-dimethylpropane✓
2-metielbutaan *2,2-dimetielpropaan*

(3)

3.4.2 Higher than/*Hoër as* ✓ (1)

[14]

QUESTION/*VRAAG 4*

4.1 Secondary/*Sekondêre* ✓
The C atom bonded to the –OH group is bonded to TWO other C atoms. ✓
Die C-atoom gebind aan die –OH-groep is aan TWEE ander C-atome gebind. (2)

4.2

4.2.1 Dehydration ✓
Dehidrasie/dehidratering (1)

4.2.2 Hydration ✓
Hidrasie/hidratering (1)

4.2.3 Dehydrohalogenation/dehydrobromination ✓
Dehidrohalogenasie/dehidrohalogenering/dehidrobrominasie/ dehidrobrominering (1)

4.3

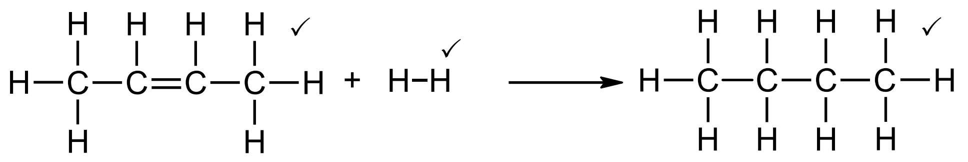
4.3.1 Substitution/Hydrolysis ✓
Substitusie/Hidrolise (1)

4.3.2
- Dilute base/sodium hydroxide/NaOH ✓
  Verdunde basis/natriumhidroksied/NaOH
- Moderate temperature/(mild) heat ✓
  Matige temperatuur/(matige) hitte (2)

4.3.3 2-✓<u>bromobutane</u> ✓/*2-bromobutaan* (2)

4.4 NaOH/KOH ✓ (1)

4.5



(3)

4.6 Butane/*Butaan* (1)

[15]

QUESTION/*VRAAG* 5

5.1 **<u>ANY ONE/*ENIGE EEN*</u>:**

- <u>Change in concentration of products/reactants per (unit) time</u>. ✓✓
  <u>Verandering in konsentrasie van produkte/reaktanse</u> <u>per (eenheid) tyd</u>.

- <u>Rate of change in concentration.</u>
  <u>Tempo van verandering in konsentrasie</u>.

- <u>Change in amount/number of moles/volume/mass</u> of products or reactants <u>per (unit) time</u>.
  <u>Verandering in hoeveelheid/getal mol/volume/massa</u> van produkte of reaktanse <u>per (eenheid) tyd.</u>

- <u>Amount/number of moles/volume/mass</u> of products formed or reactants used <u>per (unit) time</u>.
  <u>Hoeveelheid/getal mol/volume/massa</u> van produkte gevorm of reaktanse gebruik <u>per (eenheid) tyd.</u> (2)

5.2

Marking criteria/*Nasienriglyne:*	
Dependent and independent variables correctly identified. *Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.*	✓
Ask a question about the relationship between the independent and dependent variables./*Vra* 'n *vraag oor die verwantskap tussen die afhanklike en onafhanklike veranderlikes.*	✓

<u>Examples/*Voorbeelde*</u>:

- What is the relationship between concentration and reaction rate?
  Wat is die verwantskap tussen konsentrasie en reaksietempo?
- How does the reaction rate change when the concentration changes/increases/decreases?
  Hoe sal die reaksietempo verander wanneer die konsentrasie verander/ verhoog/verlaag? (2)

5.3 Q ✓

- Smaller gradient./Less steep. ✓
  Kleiner gradiënt./Minder steil.
- Reaction **I** <u>has the lowest HCℓ concentration</u> and will <u>take longer</u> to reach completion/for the maximum volume of gas to be formed. ✓
  *Reaksie **I** <u>het die laagste</u> <u>HCℓ-konsentrasie</u> en <u>neem langer</u> om voltooi te word/die maksimum volume gas te vorm.* (3)

5.4

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
Ave rate/*Gem. tempo* = $\frac{\Delta V}{\Delta t}$ $15 = \frac{\Delta V}{30 - 0}$ ✓ $V(H_2)_{produced/berei}$ = 450 cm^3 $n(H_2)_{produced/berei} = \frac{V}{V_m}$ $= \frac{450}{24\,000}$ ✓ = 0,0188 mol $n(Zn) = n(H_2)$ = 0,0188 mol ✓ $n(Zn)_{used/gebruik} = \frac{m}{M}$ $\therefore 0,0188 = \frac{m}{65}$ ✓ $\therefore$ m(Zn) = 1,22 g ✓	Ave rate/*Gem. tempo* = $\frac{15}{24\,000}$ ✓ = $6,25 \times 10^{-4}$ mol·s^{-1} $V(H_2)_{produced/berei} = 6,25 \times 30$ ✓ = 0,0188 mol $n(Zn) = n(H_2)$ = 0,0188 mol ✓ $n(Zn)_{used} = \frac{m}{M}$ $0,0188 = \frac{m}{65}$ ✓ $\therefore$ m(Zn) = 1,22 g ✓ **OPTION 3/*OPSIE 3*** Ave rate/*Gem. tempo* = $\frac{\Delta V}{\Delta t}$ $15 = \frac{\Delta V}{30 - 0}$ ✓ $V(H_2)_{produced/berei}$ = 450 cm^3 65 g ✓ Zn ……… 24 000 cm^3 ✓ x g Zn ……………450 cm^3 ✓ x = 1,22 g ✓

(5)

5.5

5.5.1 Equal to/*Gelyk aan* ✓ (1)

5.5.2 Equal to/*Gelyk aan* ✓ (1)

5.6
- At higher temperature the <u>average kinetic energy of particles is higher</u>. ✓
  By hoër temperatuur is die <u>gemiddelde kinetiese energie van deeltjies hoër</u>.
- <u>More molecules gain sufficient/enough kinetic energy</u> **OR** more molecules have kinetic energy equal to or greater than the activation energy. ✓
  <u>Meer molekule het voldoende/genoeg kinetiese energie</u> ***OF*** *meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.*
- <u>More effective collisions per unit time</u>./Frequency of effective collisions increases. ✓
  <u>Meer effektiewe botsings per eenheidtyd</u>./Frekwensie van effektiewe botsings neem toe.

(3)

[17]

QUESTION/*VRAAG 6*

6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓
Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie.

OR/*OF*
The stage in a chemical reaction when the concentrations of reactants and products remain constant. ✓✓
Die stadium in 'n chemiese reaksie wanneer die konsentrasies van reaktanse en produkte konstant bly. (2)

6.2

6.2.1 **OPTION 1/*OPSIE 1***

$n = \frac{m}{M}$

$= \frac{1{,}12}{28}$ ✓

$= 0{,}04$ mol

	$COBr_2$	CO	Br_2	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*		0	0	
Change (mol) *Verandering (mol)*	0,04	0,04	0,04	
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*		0,04	0,04 ✓	
Equilibrium concentration/ *Ewewigskonsentrasie* (mol·dm^{-3})		0,02	0,02	Divide by 2 ✓ *Deel deur 2*

$K_c = \frac{[CO][Br_2]}{[COBr_2]}$ ✓

$0{,}19$ ✓ $= \frac{(0{,}02)^2}{[COBr_2]}$ ✓

$[COBr_2] = 2{,}11 \times 10^{-3}$ mol·dm^{-3} ✓

OPTION 2/*OPSIE 2*

$n = \frac{m}{M}$

$= \frac{1,2}{28}$ ✓

$= 0,04$ mol

$n(CO)_{formed/gevorm} = n(Br_2)_{formed/gevorm}$ ✓

$= 0,04$ mol

$c(CO)_{eq/ewe} = c(Br_2)_{eq/ewe}$

$= \frac{n}{V}$

$= \frac{0,04}{2}$ ✓

$= 0,02$ mol·dm^{-3}

$K_c = \frac{[CO][Br_2]}{[COBr_2]}$ ✓

$0,19$ ✓ $= \frac{(0,2)^2}{[COBr_2]}$ ✓

$[COBr_2] = 2,11 \times 10^{-3}$ mol·dm^{-3} ✓ (7)

6.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n(COBr_2)_{eq/ewewig} = cV$ $= 2,11 \times 10^{-3} \times 2$ ✓ $= 4,22 \times 10^{-3}$ mol $n(COBr_2)_{initial/begin}$ $= 0,04 + 4,22 \times 10^{-3}$ ✓ $= 0,044$ mol % decomposed $= \frac{0,04}{0,044}$ ✓ $\times 100$ $= 90,46\%$ ✓ Range/*Gebied*: 90,46 – 90,9%	$n(COBr_2)_{eq/ewewig} = cV$ $= 2,11 \times 10^{-3} \times 2$ ✓ $= 4,22 \times 10^{-3}$ mol $n(COBr_2)_{initial/begin}$ $= 0,04 + 4,22 \times 10^{-3}$ ✓ $= 0,044$ mol $m(COBr_2)_{initial/begin} = nM$ $= 0,044 \times 188$ $= 8,27$ g $m(COBr_2)_{reacted/reageer} = 0,04 \times 188$ $= 7,52$ g % decomposed/*ontbind* $= \frac{7,52}{8,27}$ ✓ $\times 100$ $= 90,9\%$ ✓

(4)

6.3 $K_c < 0,19$ (1)

6.4 Decreases/*Verminder* ✓

A decreases in pressure favours the reaction that produces the larger number of moles of gas./*'n Afname in druk bevoordeel die reaksie wat die groter aantal mol gas lewer.* ✓

The forward reaction will be favoured./*Die voorwaartse reaksie sal bevoordeel word.* ✓ (3)

[17]

QUESTION/*VRAAG* 7

7.1

7.1.1 Weak/*Swak* ✓
Dissociates/Ionises incompletely (in water) ✓
Dissosieer/Ioniseer onvolledig (in water) (2)

7.1.2 NH_4^+ ✓ (1)

7.1.3 H_2O/water **OR/*OF*** NH_3 ✓ (1)

7.2

7.2.1 Acidic/*Suur* ✓
pH < 7 ✓ (2)

7.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
pH = -log[H_3O^+] ✓ 6 ✓ = -log[H_3O^+] [H_3O^+] = 1×10^{-6} mol·dm^{-3} [H_3O^+][OH^-] = 10^{-14} ✓ [OH^-] = 1×10^{-8} mol·dm^{-3} ✓	pH + pOH = 14 ✓ 6 ✓+ pOH = 14 pOH = -log[OH^-] ✓ 8 = -log[OH^-] [OH^-] = 1×10^{-8} mol·dm^{-3} ✓

(4)

7.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n(Na_2CO_3) = \frac{m}{M}$ ✓ $= \frac{0,29}{106}$ ✓ $= 2,74 \times 10^{-3}$ mol n(HCℓ) = 2n(Na_2CO_3) ✓ $= 5,47 \times 10^{-3}$ mol c(HCℓ)$_{dilute/verdun}$ $= \frac{n}{V}$ $= \frac{5,47 \times 10^{-3}}{0,05}$ ✓ = 0,1094 mol·dm^{-3} cV(HCℓ)$_{dilute/verdun}$ = cV(HCℓ)$_{conc/gekons}$ $0,1094 \times 500$ ✓ = (HCℓ)$_{conc/gekons}$ $\times 5$ ✓ ∴ c(HCℓ)$_{conc/gekons}$ = 10,94 mol·dm^{-3} ✓	$n(Na_2CO_3) = \frac{m}{M}$ ✓ $= \frac{0,29}{106}$ ✓ $= 2,74 \times 10^{-3}$ mol n(HCℓ) = 2n(Na_2CO_3) ✓ $= 5,47 \times 10^{-3}$ mol In 50 cm^3: n(HCℓ) = $5,47 \times 10^{-3}$ mol In 500 cm^3: n(HCℓ) = $\frac{500}{50}$✓ $(5,47 \times 10^{-3})$ ✓ = 0,547 mol c(HCℓ)$_{conc/gekons}$ $= 0,547 \times \frac{1000}{5}$ ✓ = 10,94 mol·dm^{-3} ✓

(7)
[17]

QUESTION/*VRAAG* 8

8.

8.1.1 Voltmeter/Multimeter ✓ (1)

8.1.2 Anode ✓ (1)

8.1.3 $3Ag^{+}(aq) + Aℓ(s)$ ✓ → $3Ag(s) + Aℓ^{3+}(aq)$ ✓ Bal. ✓ (3)

8.1.4

<u>OPTION1/*OPSIE 1*</u> $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ = +0,80 ✓- (- 1,66) ✓ = 2,46 V ✓
<u>OPTION 2/*OPSIE 2*</u> ✓ $Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$ 0,80 V ✓ $Aℓ(s) \rightarrow Aℓ^{3+}(aq) + 3e^{-}$ 1,66 V ✓ $3Ag^{+}(aq) + Aℓ(s) \rightarrow 3Ag(s) + Aℓ^{3+}(aq)$ 2,46 V ✓

(4)

8.2

8.2.1 Platinum/Pt/Carbon/C/*Koolstof* ✓ (1)

8.2.2 **ANY TWO/*ENIGE TWEE*:**
Concentration/*Konsentrasie*: <u>1 mol·dm^{-3}</u> ✓
Temperature/*Temperatuur*: <u>25 °C/298 K</u> ✓
Pressure/*Druk:* <u>101,3 kPa/1,01 x 10^{5} Pa/1 atm</u> (2)

8.2.3 Zinc/Zn/*sink* ✓ (1)

8.2.4 PQ ✓ (1)
[14]

QUESTION/*VRAAG 9*

9.1 DC ✓ (1)

9.2 Cathode/*Katode* ✓
$Cu^{2+}(aq) + 2e^{-} \rightarrow Cu$ ✓✓

9.3 Cu^{2+} is a stronger oxidising agent ✓ than Zn^{2+} ions ✓ and therefore Zn^{2+} ions will not be reduced (to Zn). ✓
Cu^{2+} is 'n sterker oksideermiddel as Zn^{2+}-ione en dus sal Zn^{2+}-ione nie gereduseer word nie (na Zn). (3)

9.4

9.4.1 (Chlorine) gas/bubbles is/are formed. ✓
(Chloor)gas/borrels vorm. (1)

9.4.2 Decreases/*Verlaag* ✓ (1)
[9]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 Ammonia/*Ammoniak* ✓ (1)

10.1.2 NO_2 ✓ (1)

10.1.3 Catalytic oxidation of ammonia ✓
Katalitiese oksidasie van ammoniak (1)

10.1.4 Platinum/Pt ✓ (1)

10.1.5 Ostwald (process)/*Ostwald(proses)*✓ (1)

10.1.6 Haber (process)/*Haber(proses)*✓ (1)

10.1.7 $NH_3 + HNO_3$ ✓ → NH_4NO_3 ✓ Bal. ✓ (3)

10.2

10.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
N : P : K 10 : 5 : 15 m(fertiliser/*kunsmis*) = $\frac{30}{100}$ x 15 = 4,5 kg m(P) = $\frac{5}{30}$ x 4,5 ✓ = 0,75 kg ✓	m(fertiliser/*kunsmis*) = $\frac{5}{100}$ x 15 ✓ = 0,75 kg ✓

(2)

10.2.2 %fertiliser/*kunsmis* = 10 + 5 + 15 = 30%
%filler/*bindstof* = 100 – 30 = 70%
$m_{(filler/bindstof)} = \frac{70}{100}$ ✓ x 15 ✓
= 10,5 kg ✓ (3)

[14]

TOTAL/*TOTAAL*: 150