education

Department of
Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES P2
(CHEMISTRY)

SEPTEMBER 2019

MARKS: 150

TIME: 3 HOURS

This question paper consists of 15 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and other applicable information in the appropriate spaces on the ANSWER BOOK.

2. The 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 sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable pocket 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 where necessary.

11. Give brief motivations, discussions, et cetera where required.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four 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 your ANSWER BOOK, for example 1.11 E.

1.1 The boiling points of branched alkanes are lower than these of their straight chain isomers because branched alkanes have …

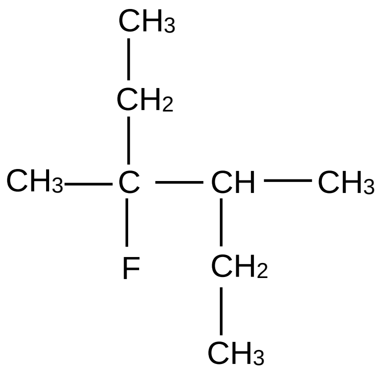
A smaller molecular masses.

B smaller number of carbon atoms.

C smaller number of hydrocarbons.

D smaller effective molecular surface areas. (2)

1.2 The condensed structural formula of an organic compound is given below.



Which ONE of the following is the correct IUPAC name of this compound?

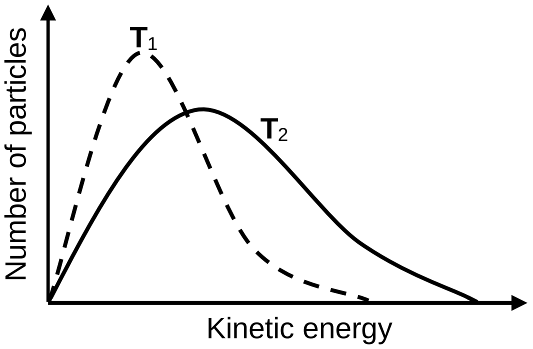
A 2-fluoro-2,3-diethylbutane

B 4-fluoro-3,4-dimethylhexane

C 3,4-dimethyl-3-fluorohexane

D 3-fluoro-3,4-dimethyhexane (2)

1.3 The energy distribution curves for particles in a fixed mass of gas at two different temperatures, **T_1** and **T_2**, are shown below.

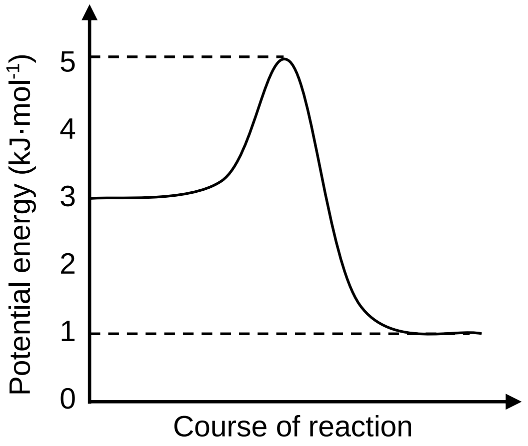


Which ONE of the following is the correct interpretation of the curves as the temperature of the gas changes from **T_1** to **T_2**?

	Activation energy (E_a)	**Number of effective collisions**
A	Remains the same	Increases
B	Decreases	Decreases
C	Decreases	Increases
D	Remains the same	Decreases

(2)

1.4 The potential energy graph for a hypothetical reaction is shown below.



Which ONE of the following represents the correct values for the heat of reaction (ΔH) and the activation energy (E_a) for the forward reaction?

	ΔH ($kJ \cdot mol^{-1}$)	**E_a ($kJ \cdot mol^{-1}$)**
A	2	-2
B	-2	2
C	2	2
D	-2	4

(2)

1.5 Which ONE of the following will have no effect on the equilibrium position of any chemical reaction?

A Addition of a catalyst

B Removal of a product

C Change in temperature

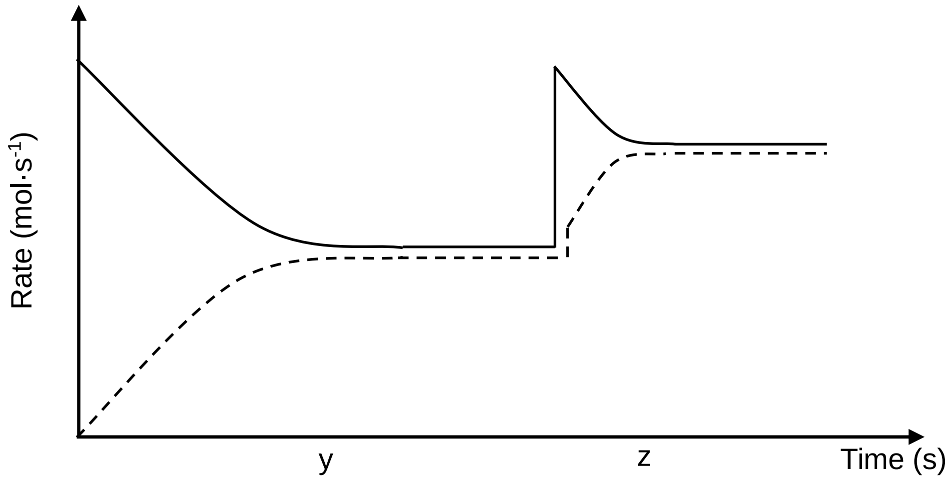
D Change in concentration (2)

1.6 The hypothetical compound $AX_3(g)$ decomposes in a closed container according to the following balanced equation:

$$2AX_3(g) \rightleftharpoons 2AX_2(g) + X_2(g)$$

Equilibrium is reached at temperature $\mathbf{T_1}$ after **y** seconds as shown in the graph below.

The temperature is INCREASED to $\mathbf{T_2}$ and a new equilibrium is established at this higher temperature after **z** seconds, as shown in the graph.



Which ONE of the following combinations is CORRECT?

	The forward reaction is:	**K_C at temperature T_1 is:**
A	Endothermic	Smaller than K_C at $\mathbf{T_2}$
B	Endothermic	Equal to K_C at $\mathbf{T_2}$
C	Exothermic	Smaller than K_C at $\mathbf{T_2}$
D	Exothermic	Larger than K_C at $\mathbf{T_2}$

(2)

1.7 Which ONE of the following is TRUE if the ACIDITY of a solution INCREASES?

	[H_3O^+]	**pH**
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Increases
D	Decreases	Decreases

(2)

1.8 Which ONE of the following correctly describes the electrode in an ELECTROLYTIC cell and its polarity?

	Electrode	**Polarity**	**Type of half-reaction**
A	Anode	Positive	Reduction
B	Anode	Negative	Oxidation
C	Cathode	Negative	Reduction
D	Cathode	Positive	Oxidation

(2)

1.9 A silver spoon is placed in a pure copper(II) sulphate solution. Which ONE of the following best explains why no reaction will take place?

A Ag is a weaker reducing agent than Cu(II) ions.

B Ag is a weaker reducing agent than Cu.

C Ag is a weaker oxidising agent than Cu(II) ions.

D Ag ions is a weaker oxidising agent than Cu(II) ions. (2)

1.10 Your lawn has a well-developed root system. You need a fertiliser that will provide nutrients for rapid growth and green leaves. Which ONE of the following fertiliser mixtures will you use on your lawn?

A 7:1:1

B 1:1:5

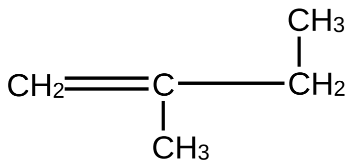
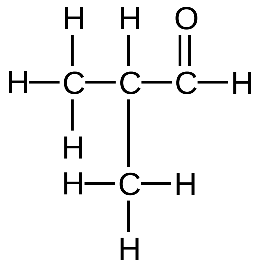
C 2:5:1

D 3:1:5 (2)

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **D** in the table below represent four organic compounds with DIFFERENT FUNCTIONAL GROUPS.

A	$CHC(CH_2)_2CH_3$	**B**	C_3H_8O
C	 $CH_2{=}\underset{CH_3}{C}-\overset{CH_3}{CH_2}$	**D**	

2.1 Define the term *homologous series.* (2)

2.2 For compound **D**, write down the:

2.2.1 Name of the homologous series to which it belongs (1)

2.2.2 Structural formula of its functional isomer (2)

2.3 Write down the IUPAC name of:

2.3.1 Compound **A** (2)

2.3.2 Compound **C** (2)

2.4 For compound **B**, write down its:

2.4.1 Structural formula (2)

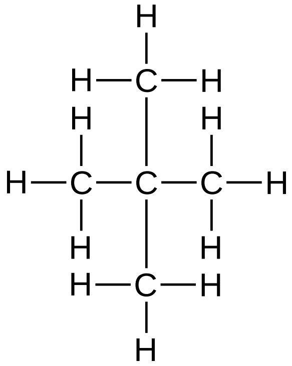
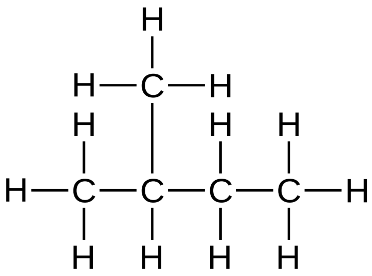
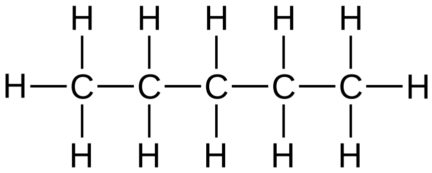
2.4.2 IUPAC name (2)

2.5 Compound **B** reacts with an organic acid to form propyl pentanoate. Write down the structural formula of the organic acid used. (2)

[15]

QUESTION 3 (Start on a new page.)

During a practical investigation the boiling points of the three structural isomers (**A**, **B** and **C**) of an alkane with five carbon atoms were determined. The results obtained were recorded in the table below.

ALKANE	**STRUCTURAL FORMULA**	**BOILING POINT (°C)**
A		9,5
B		27,7
C		36,0

3.1 Define the *boiling point*. (2)

3.2 Write down the conclusion that can be drawn from the above results. (2)

3.3 Which alkane (**A**, **B** or **C**) is a liquid at 30 °C? (1)

3.4 What type of structural isomers are compounds **A**, **B** and **C**? Choose from POSITIONAL, CHAIN or FUNCTIONAL isomers. Give a reason for the answer. (2)

3.5 The boiling point of 1-chloropentane is 108 °C. Explain the difference in boiling points of 1-chloropentane and compound **C** by referring to the TYPE of intermolecular forces present in each compound. (4)

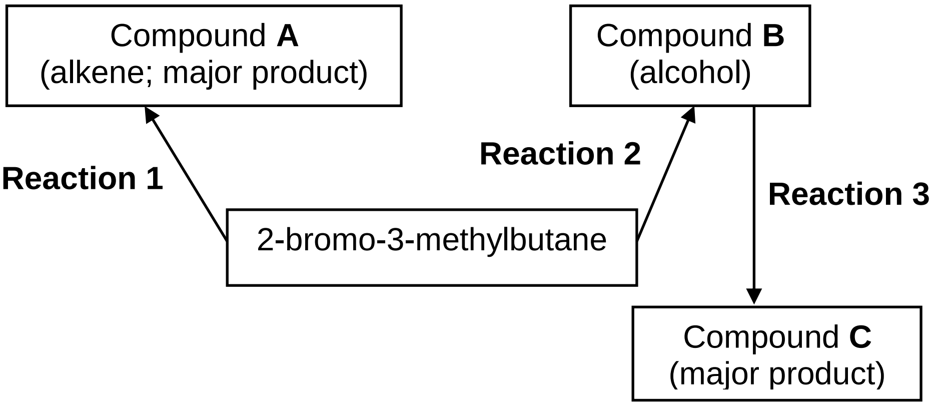
3.6 Copy the incomplete equation below for the complete combustion of compound **C** in your ANSWER BOOK. Complete and balance the equation.

$$C_5H_{12} + O_2 \rightarrow \_\_\_ + \_\_\_$$ (2)

[13]

QUESTION 4 (Start on a new page.)

The flow diagram below shows how three organic compounds can be prepared from 2-bromo-3-methylbutane.



4.1 Write down the formula of the functional group of 2-bromo-3-methylbutane. (1)

4.2 Consider **reaction 1**.

4.2.1 Write down the general formula of alkenes. (1)

4.2.2 State TWO reaction conditions needed for this reaction. (2)

4.2.3 Name the type of reaction which takes place. (1)

4.2.4 Write down the structural formula of compound **A**. (2)

4.3 **Reaction 2** is a substitution reaction. Write down the:

4.3.1 Name of the type of substitution reaction (1)

4.3.2 Balanced equation, using structural formulae for the organic compounds, for this reaction (5)

4.4 Reaction **3** takes place when compound **B** is heated in the presence of concentrated sulphuric acid.

Write down the:

4.4.1 Name of the type of reaction that takes place (1)

4.4.2 IUPAC name of compound **C** (2)

[16]

QUESTION 5 (Start on a new page.)

A learner uses the reaction of magnesium and EXCESS hydrochloric acid in three experiments. The balanced equation for the reaction is:

$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

In EXPERIMENT 1**,** magnesium ribbon of 5,0 g reacts with EXCESS hydrochloric acid of concentration 1,0 mol·dm^{-3} at room temperature.

The volume of hydrogen gas produced at regular intervals is measured and recorded in the table below.

Time (minutes)	0	1	2	3	4	5
Volume of H_2 (dm^3)	0	0,5	0,75	0,9	1,0	1,0

5.1 Define *reaction rate*. (2)

5.2 Between which TWO consecutive minutes is the rate of reaction the greatest? (1)

5.3 Calculate the average rate of the reaction (in mol·min^{-1}) during the first two minutes. The molar volume of hydrogen at room temperature is 24 dm^3·mol^{-1}. (4)

5.4 Write down the rate of the reaction (in mol·min^{-1}) after 5 minutes. (1)

5.5 Give a reason for the answer to QUESTION 5.4. (1)

5.6 The reaction conditions used in EXPERIMENT 2 and EXPERIMENT 3 are summarised in the table below.

Experiment	**Mass and surface area of magnesium**	**Concentration of HCℓ (mol·dm^{-3})**
2	3,0 g powder	1,0
3	5,0 g ribbon	0,5

5.6.1 How will the total volume of hydrogen gas produced in EXPERIMENT 1 compare to that in EXPERIMENT 2? Write down LARGER THAN, SMALLER THAN or EQUAL TO. Explain the answer. (2)

5.6.2 How will the rate of reaction in EXPERIMENT 1 compare to that in EXPERIMENT 3? Write down HIGHER THAN, LOWER THAN or EQUAL TO. Use the collision theory to explain the answer. (4)

[15]

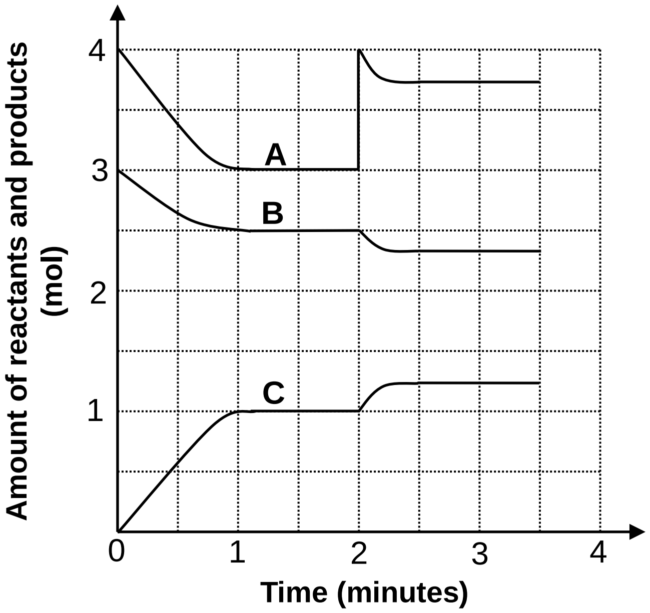
QUESTION 6 (Start on a new page.)

The equation below represents a hypothetical reaction that takes place in a closed container at 350 °C. The letters **x**, **y** and **z** represent the number of moles in the balanced equation.

$$\mathbf{x}A(g) + \mathbf{y}B(g) \rightleftharpoons \mathbf{z}C(g) \qquad \Delta H < 0$$

The graph below shows the change in the number of moles of reactants and products versus time during the reaction.

Graph of amount of reactants and products versus time



6.1 Define a *reversible reaction*. (2)

6.2 After how many minutes did the system reach equilibrium for the first time? (1)

6.3 Use the information in the graph and write down the value of:

6.3.1 **x** (1)

6.3.2 **y** (1)

6.3.3 **z** (1)

6.4 Calculate the equilibrium constant, K_c, for this reaction at 350 °C if the volume of the container is 4 dm^3. (7)

6.5 State the change made to the system at t = 2 minutes and explain the effect of this change with the aid of Le Chatelier's principle. (3)

[16]

QUESTION 7 (Start on a new page.)

A learner prepares a solution of sodium hydrogen carbonate ($NaHCO_3$) in water. The resulting solution is a base.

7.1 Define the term *hydrolysis.* (2)

7.2 Explain, with the aid of a relevant hydrolysis reaction, why the solution is a base. (3)

7.3 The learner adds 25 cm^3 $NaHCO_3(aq)$ with a concentration of 0,1 $mol{\cdot}dm^{-3}$ to an Erlenmeyer flask. This solution is now titrated with a 0,1 $mol{\cdot}dm^{-3}$ H_2SO_4 solution from a burette. In order to reach the endpoint of the titration, the learner needs to add 12,5 cm^3 $H_2SO_4(aq)$ from the burette to the Erlenmeyer flask.

The balanced equation for the reaction is:

$$2NaHCO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2CO_2(g) + 2H_2O(\ell)$$

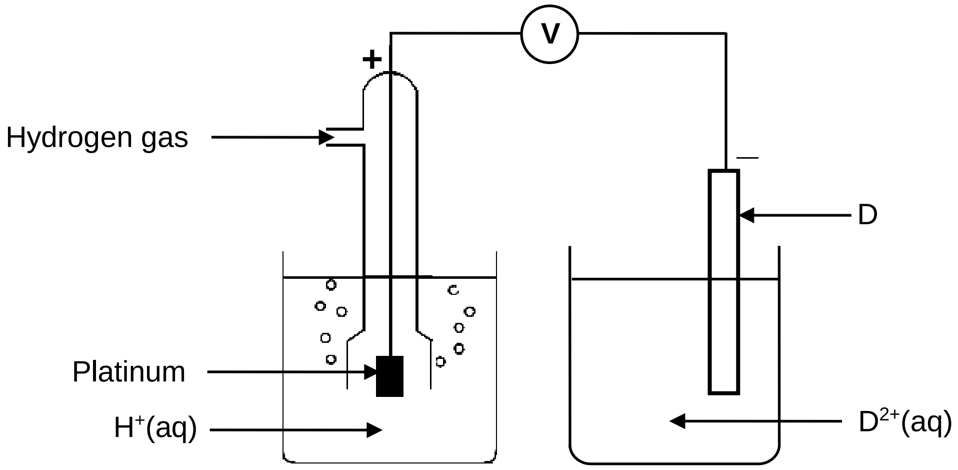
During the titration the learner accidentally exceeds the endpoint by adding an additional 4 cm^3 of the $H_2SO_4(aq)$.

Calculate the pH of the solution in the flask after completion of the titration. (7)

[12]

QUESTION 8 (Start on a new page.)

A learner sets up a standard electrochemical cell using a standard hydrogen half-cell and an unknown standard half-cell D|D^{2+} as shown below.



8.1 Name the type of electrochemical cell that converts chemical energy to electrical energy. (1)

8.2 Write down THREE conditions needed for the hydrogen half-cell to function under standard conditions. (3)

8.3 Give TWO reasons, besides being a solid, why platinum is suitable to be used as electrode in the above cell. (2)

8.4 It is found that there is no reading on the voltmeter. Give a reason for this observation. (1)

The learner now makes the necessary change to the above setup and the voltmeter registers a reading of 0,24 V.

8.5 Write down the half-reaction that takes place at the cathode of this cell whilst it is functioning. (2)

8.6 The hydrogen half-cell is now replaced by a J|J^{2+} half-cell. The cell notation of this cell is:

$$J(s) \mid J^{2+}(aq) \parallel D^{2+}(aq) \mid D(s)$$

The initial reading on the voltmeter is now 1,42 V.

8.6.1 What does the single line (|) in the above cell notation represent? (1)

8.6.2 Identify metal **J**. Show how you arrived at the answer. (5)

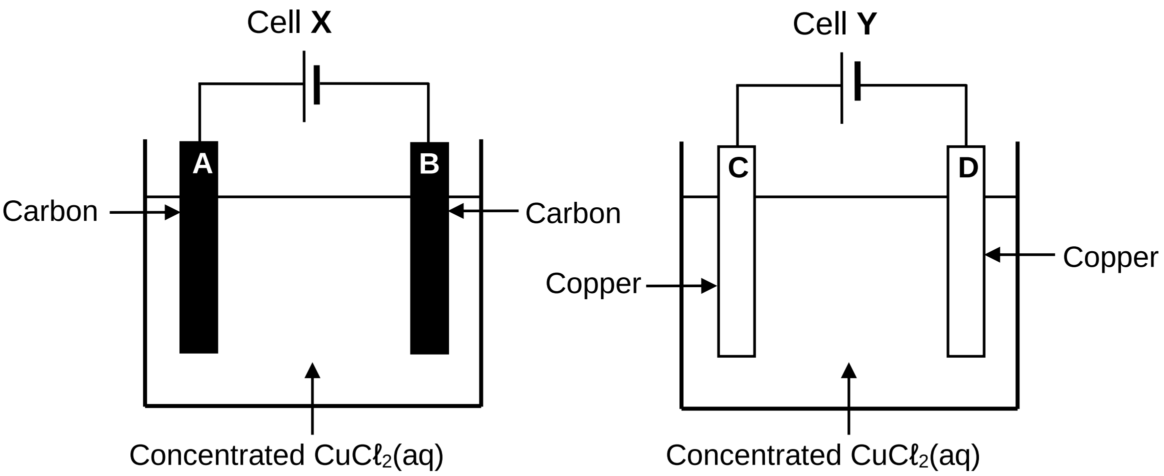
8.6.3 Is the cell reaction EXOTHERMIC or ENDOTHERMIC? (1)

8.7 Give a reason why the reading on the voltmeter becomes zero after using this cell for several hours. (1)

[17]

QUESTION 9 (Start on a new page.)

The simplified diagrams below represent two electrochemical cells, **X** and **Y**. A concentrated copper(II) chloride solution is used as electrolyte in both cells.



9.1 Define the following terms:

9.1.1 Electrolyte (2)

9.1.2 Electrolysis (2)

9.2 Which of the electrodes (**A**, **B**, **C** or **D**) will show a mass increase? Write down a half-reaction to motivate the answer. (4)

9.3 Write down the NAME or FORMULA of the product formed at:

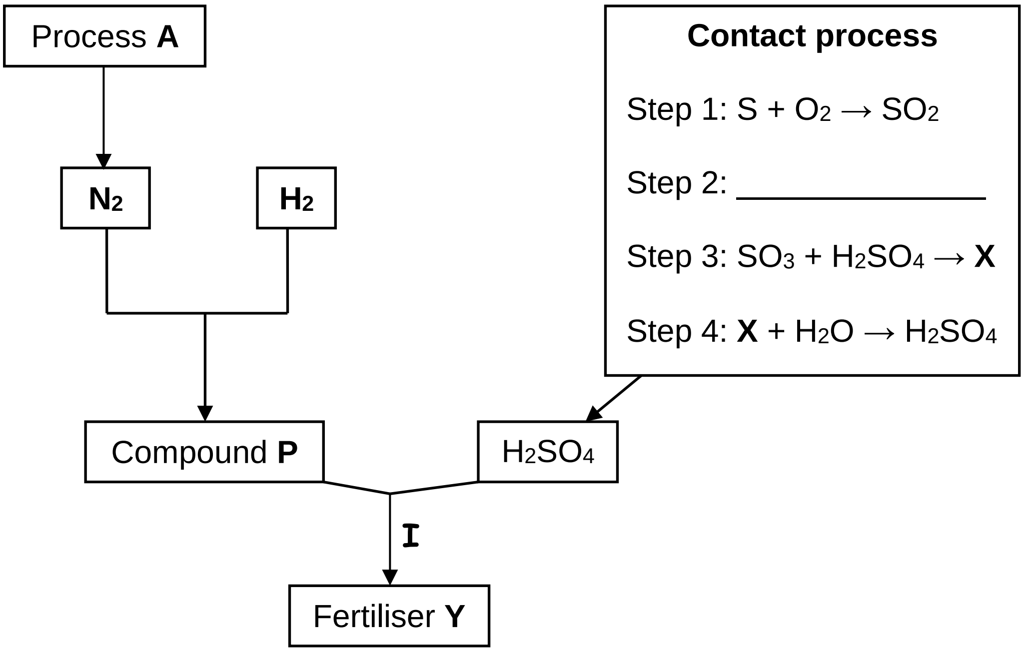
9.3.1 Electrode **A** (1)

9.3.2 Electrode **C** (1)

9.4 Fully explain the answer to QUESTION 9.3.2 by referring to the relative strengths of the reducing agents involved. (3)
[13]

QUESTION 10 (Start on a new page.)

10.1 The flow diagram below shows the processes involved in the industrial preparation of fertiliser **Y**.



Write down the NAME of:

10.1.1 Process **A** (1)

10.1.2 Compound **P** (1)

10.1.3 The type of reaction represented by **I** (1)

10.2 For the contact process, write down the:

10.2.1 Balanced equation for step **2** (3)

10.2.2 FORMULA or NAME of product **X** (1)

10.3 A 25 kg bag of NPK fertiliser is labelled 5:2:6 (22).

10.3.1 What is the meaning of NPK? (1)

10.3.2 What is the meaning of (22) on the label? (1)

10.3.3 Calculate the mass of potassium in the bag. (4)
[13]

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	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* $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$ /$E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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

KEY/*SLEUTEL*

Atomic number/*Atoomgetal*: 29
Electronegativity/*Elektronegatiwiteit*: 1,9
Symbol/*Simbool*: Cu
Approximate relative atomic mass/*Benaderde relatiewe atoommassa*: 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
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 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
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 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

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

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Increasing reducing ability/*Toenemende reduserende vermoë*