education GREENBURY

Department:
Education
PROVINCE OF KWAZULU-NATAL

NATIONAL SENIOR CERTIFICATE: PREPARATORY EXAMINATION
SEPTEMBER 2018

TO: THE CHIEF INVIGILATOR OF ALL SCHOOLS OFFERING
PHYSICAL SCIENCES P2: GRADE 12

ERRATA

Please take note of the following change:

Page	ERROR	CORRECTION
4 (1.6)	A mixture of **sulphur dioxide** and oxygen	A mixture of **ammonia** and oxygen ....
6	The letters A to G ..... represent **six** organic compounds.	The letters A to G ..... represent organic compounds **and functional groups of some organic compounds**.
11 (5.1.6)	Use the attached ..... to show how the rate of **the reverse** reaction	Use the attached ..... to show how the rate of reaction .....
17 (10.4)	A **farm** wants ...	A **farmer** wants ...
10 (5.1.3)	Calculate the volume of **hydrochloric acid** .....reach completion.	Calculate the volume of carbon dioxide that will be produced under standard conditions."

Kindly ensure that candidates are informed of the Errata.

Coetzee

MS H.J.E. COETZEE
ASSITANT DIRECTOR
PROVINCIAL EXAMINATION

11/9/2018
DATE

...Championing Quality Education-Creating and Securing a Brighter Future

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Education

KwaZulu-Natal Department of Education

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2018

MARKS : 150

TIME : 3 Hours

This question paper consists of 22 pages including data sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name and other 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 applicable.
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 Which ONE of the following equations represents the **incomplete** combustion of pentane?

A $2\ CH_3CH_2CH_2CH_2CH_3 + 11\ O_2 \rightarrow 10\ CO_2 + 12\ H_2O$

B $2\ CH_3CH_2CH_2CH_2CH_3 + 11\ O_2 \rightarrow 10\ CO + 12\ H_2O$

C $CH_3CH_2CH_2CH_2CH_3 + 8\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$

D $CH_3CH_2CH_2CH_2CH_3 + 8\ O_2 \rightarrow 5\ CO + 6\ H_2O$ (2)

1.2 A polymer formed as a result of addition polymerisation is most likely to be derived from a monomer that is …

A An ester.
B An alcohol.
C A hydrocarbon.
D A carboxylic acid. (2)

1.3 The IUPAC name of an organic compound with the molecular formula $C_5H_{10}O$ can be:

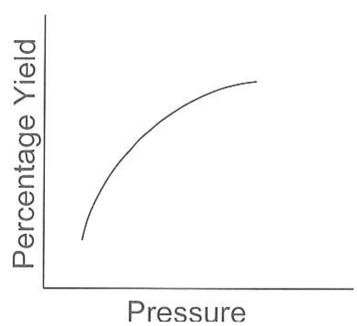
A pentan-1-ol
B pentanoic acid
C 3-methylbutanal
D 3-methylbutan-1-one (2)

1.4 The following reaction reaches equilibrium in a sealed container.

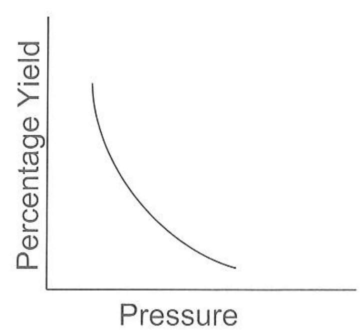
$$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$$

Which ONE of the following graphs correctly illustrates the relationship between percentage yield of $SO_3(g)$ and pressure for the above reaction, at constant temperature.

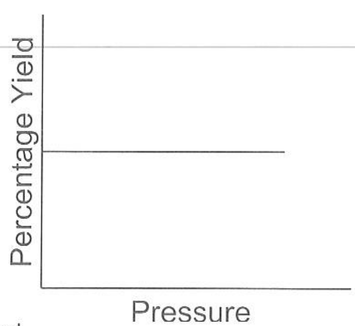
A



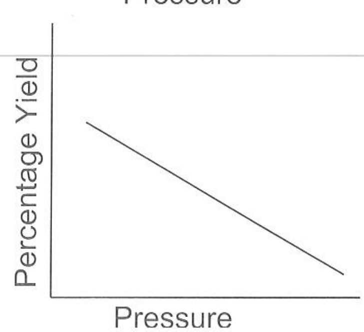
B



C



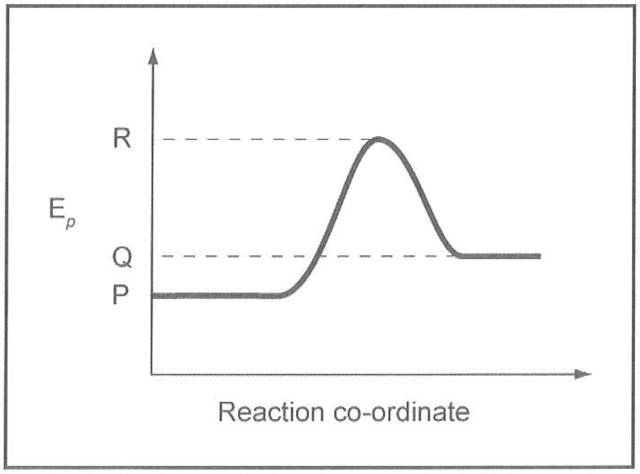
D



(2)

1.5 The graph below represents the change in potential energy against time for the following reaction:

$A_2(g) + 2B_2(g) \rightleftharpoons 2AB_2(g)$



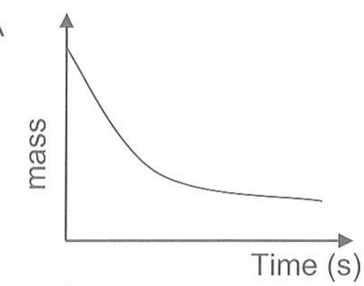
Which ONE of the following statements is correct?

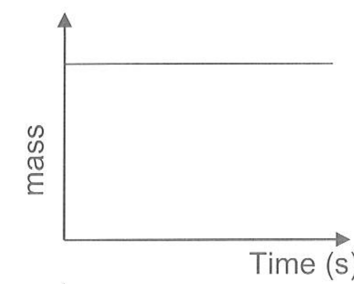
A The forward reaction is exothermic.
B The heat of reaction for the forward reaction is Q – P.
C The activation energy for the forward reaction is R – Q.
D The activation energy for the reverse reaction is R – P. (2)

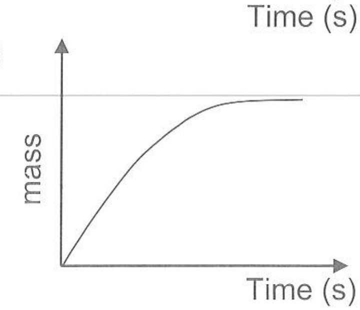
1.6 A mixture of sulphur dioxide and oxygen gases, together with a suitable catalyst, are placed in an evacuated, sealed container.
The following reaction takes place in the container at constant temperature:

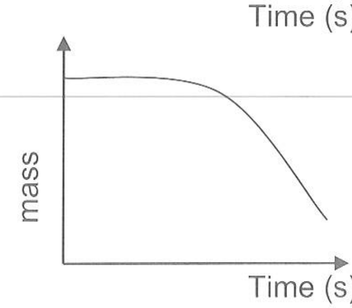
$$4\,NH_3(g) + 5\,O_2(g) \rightleftharpoons 4\,NO(g) + 6\,H_2O(g)$$

The mass of the catalyst is measured over time.
Which ONE of the following graphs correctly illustrates the relationship between the mass of the catalyst and time?

A


B


C


D


(2)

1.7 The balanced equation below represents the first step in the ionization of sulphuric acid in water:

$$H_2SO_4(\ell) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + HSO_4^-(aq)$$

The TWO Bronsted bases in the equation above are:

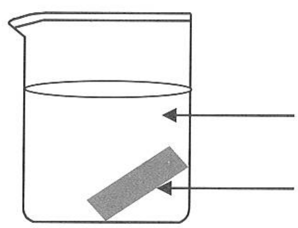
A H_2SO_4 and H_2O

B H_3O^+ and HSO_4^-

C H_2SO_4 and H_3O^+

D H_2O and HSO_4^- (2)

1.8 A piece of magnesium ribbon is placed in a beaker containing a blue solution of copper(II)sulphate.



After a while, it is observed that the solution becomes colourless. The reason that the solution becomes colourless is:

A The Cu^{2+} is a stronger oxidising agent than Mg^{2+} and is reduced to Cu.
B The Mg^{2+} is a stronger oxidising agent than Cu^{2+} and is reduced to Mg.
C Mg is a weaker reducing agent than Cu and will reduce Cu^{2+} to Cu.
D Cu is a stronger reducing agent than Mg and will oxidise Mg to Mg^{2+}. (2)

1.9 Which ONE of the following statements about the extraction of aluminium is TRUE?

A Aluminium oxide is dissolved in molten cryolite.
B The ore of aluminium oxide is called cryolite.
C When the cell is in operation, aluminium forms at the anode.
D When the cell is in operation, carbon dioxide gas forms at the cathode. (2)

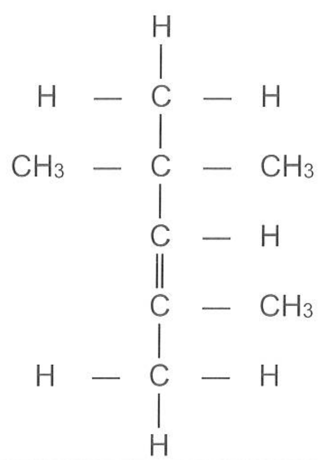
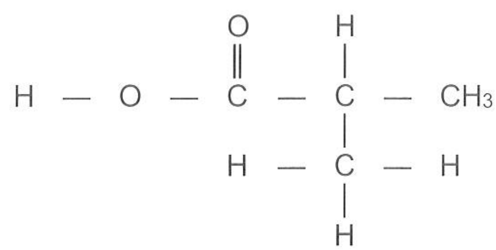
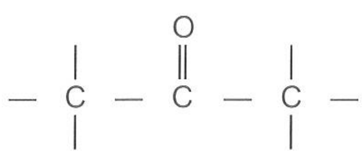
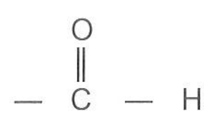
1.10 Which ONE of the following is a primary nutrient for plants?

A Carbon
B Oxygen
C Potassium
D Magnesium

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters A to G in the table below represent six organic compounds.

A		**B**	
C		**D**	$CH_3CH_2CH(CH_3)CH_2CH(CH_3)CH_3$
E		**F**	
G	Ethene		

2.1 Write down the LETTER that represents EACH of the following:

2.1.1 A functional isomer of butanoic acid. (1)

2.1.2 The compound that has a carboxyl group. (1)

2.1.3 A saturated hydrocarbon. (1)

2.1.4 The structural formula of the functional group of an aldehyde. (1)

2.1.5 The smallest organic molecule that can be covalently bonded to each other in a repeating pattern. (1)

2.2 For compound A, write down the:

2.2.1 IUPAC name. (2)

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

2.3 Consider compound E:

2.3.1 Write down the IUPAC name of the alcohol required to prepare compound E. (1)

2.3.2 The name of the catalyst that is used in the reaction that produces Compound E. (1)

[10]

QUESTION 3 (Start on a new page.)

The boiling points of organic compounds from 3 different homologous series are given in the table below:

COMPOUND	BOILING POINT
A	78,40 °C
B	-89,00 °C
C	118,50 °C

3.1 Define each of the following terms:

3.1.1 homologous series. (2)

3.1.2 boiling point. (2)

3.2 Which compound A, B or C will have the lowest vapour pressure? Explain the answer. (3)

3.3 Which compound A, B or C is a gas at room temperature? (1)

3.4 The homologous series to which the three compounds A, B and C belong, were identified in random order as : ***ETHANOIC ACID, ETHANOL AND ETHANE***.

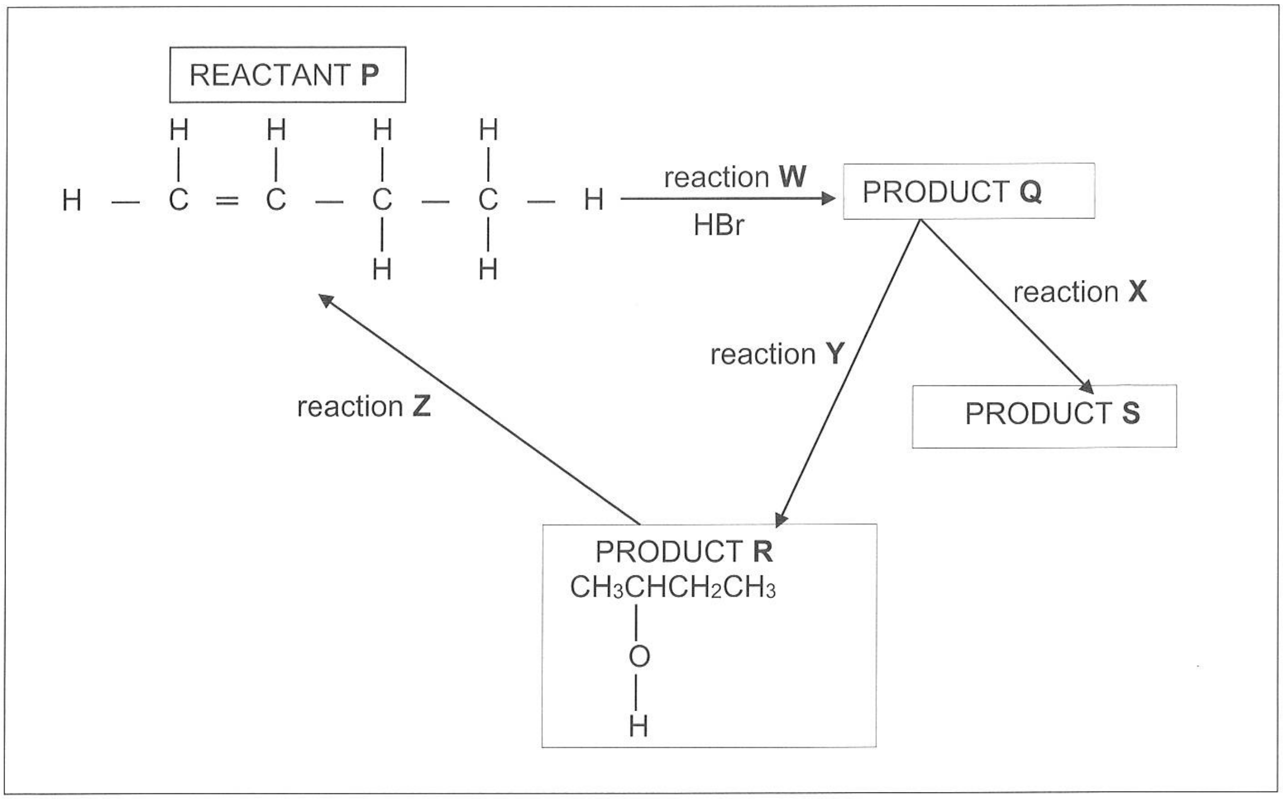
3.4.1 What is the boiling point of ethanoic acid? (1)

3.4.2 Explain the answer to question 3.4.1 by referring to the type of intermolecular forces and the energy involved in the compound from each homologous series. (4)

[13]

QUESTION 4 (Start on a new page.)

In the flow diagram below, **W**, **X**, **Y** and **Z** represent organic reactions. **Q**, **S** and **R** represents organic compounds. **Q** is the major product.



4.1 Name the type of reaction that is represented by . . .

4.1.1. **W**. (1)

4.1.2 **Y**. (1)

4.2 Write down the structural formula and IUPAC name for the product **Q**. (3)

4.3 Is product R a primary, secondary or tertiary alcohol? Give a reason for the answer. (3)

4.4 Name the type of elimination reaction represented by **Z**. (1)

4.5 State TWO reaction conditions that must be satisfied for reaction **Y** to take place. (2)

4.6 Product **S** is a positional isomer of reactant **P**.

4.6.1 Define the term positional isomer. (2)

4.6.2 Classify reaction **X** as, substitution, addition or elimination. (1)

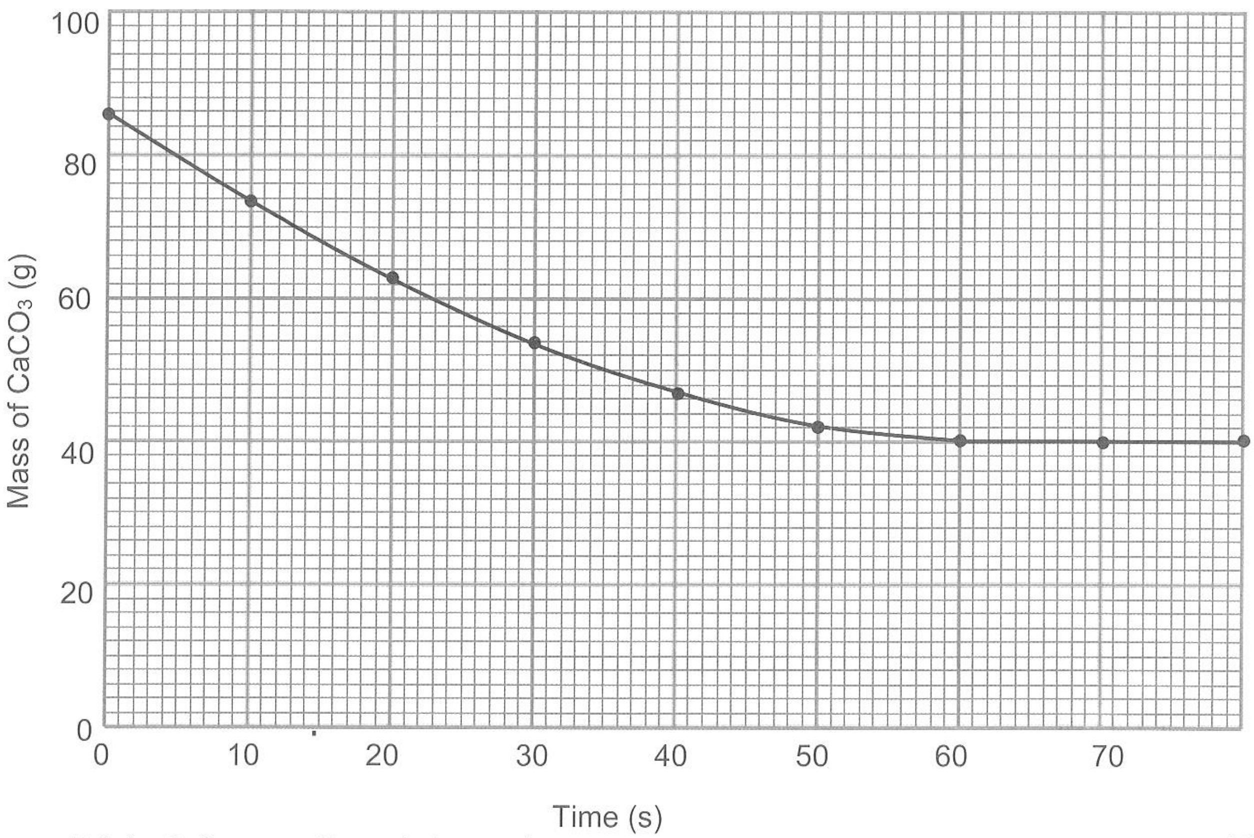
4.6.3 Use structural formulae to write a balanced equation for the formation of product S from product **Q**. (3)

[17]

QUESTION 5 (Start on a new page)

5.1 The graph drawn below shows how the mass of powdered calcium carbonate changes with time when the powdered calcium carbonate reacts with a specific volume of hydrochloric acid of known concentration at conditions of standard temperature and pressure.
The balanced equation for the reaction that takes place is given below:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$



5.1.1 Define *reaction rate* in words. (2)

5.1.2 After how many seconds does the reaction between calcium carbonate and hydrochloric acid stop? (1)

5.1.3 Calculate the volume of hydrochloric acid that was required at conditions of standard temperature and pressure for the above reaction to reach completion. (5)

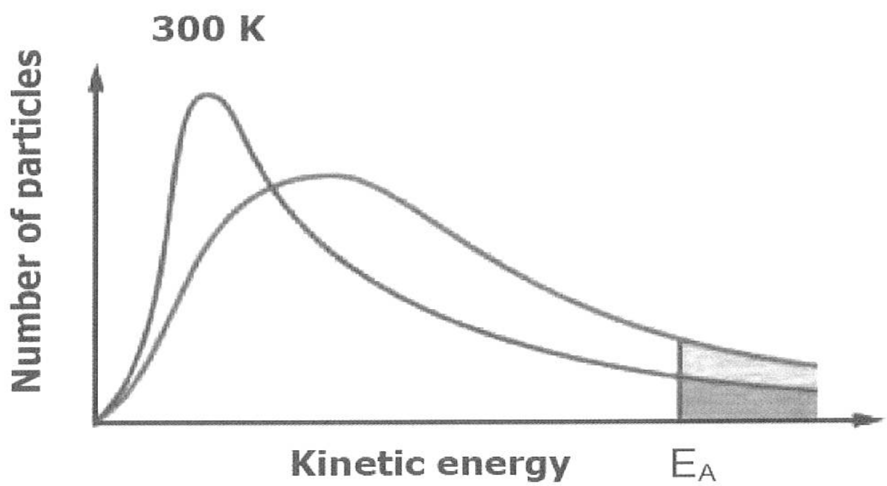
The above reaction is repeated under the same conditions but the powdered calcium carbonate is replaced by the same initial mass of lumps of calcium carbonate.

5.1.4 Write down the mass in grams of calcium carbonate at the end of the reaction. (1)

5.1.5 How will the time for the reaction to reach completion be affected? (Write down only, INCREASES, DECREASES or REMAINS THE SAME) (1)

5.1.6 Use the attached copy of the above graph and on the same set of axes sketch a graph to show how the rate of the reverse reaction changes with time for the same reaction. Label this graph lumps. (3)

5.2 The figure below shows the Maxwell-Boltzmann distribution curves for the above reaction at two different temperatures. The activation energy for this reaction is indicated on the graph by the vertical line and labelled as EA.



5.2.1 Write down the name of the theory used to explain how reactions occur at the molecular level. (1)

5.2.2 Referring to the shaded areas in the distribution curves provided, use the theory named in QUESTION 5.2.1 to explain why an increase in temperature causes an increase in reaction rate. (3)

[17]

QUESTION 6 (Start on a new page)

A mixture of 2 moles of hydrogen and 2 moles of iodine is sealed in a 4 dm^3 flask at 180 °C. The reaction reaches equilibrium according to the balanced equation below:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

The information in the table below also applies to the reaction above.

T °C	Kc
180	49
450	48

6.1 State Le Chatelier's Principle. (2)

6.2 What effect will the following changes have on the concentration of HI(g) at equilibrium?

Choose from INCREASES,DECREASES or REMAINS THE SAME

6.2.1 The pressure on the system is increased without changing the volume. (1)

6.2.2 More H_2(g) is added to the system, without a change in pressure. (1)

6.2.3 A catalyst is added. (1)

6.2.4 The temperature is decreased. (1)

6.3 Explain the answer to question 6.2.4, by referring to Le Chatlier's Principle. (3)

6.4 Calculate the mass of HI present in the container when equilibrium is reached at 180 °C. (10)

[19]

QUESTION 7 (Start on a new page.)

A learner prepares a standard solution of barium hydroxide at 25 °C. She completely dissolves an unknown mass of pure barium hydroxide in enough distilled water to make a solution of volume 250 cm^3. The prepared solution of barium hydroxide has a pH of 13,45.

7.1 Give a reason why barium hydroxide is regarded as a STRONG base. (1)

The barium hydroxide solution prepared by the learner is dilute.

7.2 Explain what is meant by the above statement. (2)

Barium hydroxide dissociates as follows:

$$Ba(OH)_2\,(aq) \rightleftharpoons Ba^{2+}\,(aq) + 2\,OH^-\,(aq)$$

7.3 Calculate the mass of the barium hydroxide that was completely dissolved to make the above solution. (7)

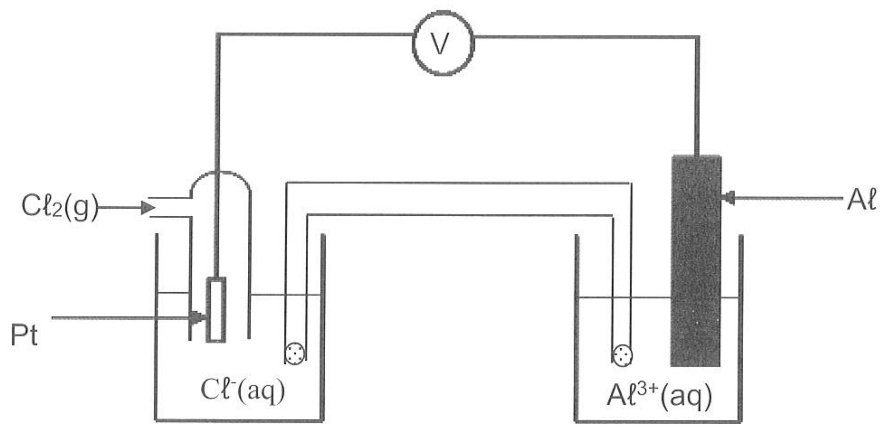
7.4 Calculate the volume of a 0,5 $mol.dm^{-3}$ hydrochloric acid solution, needed to completely neutralize 60 cm^3 of the barium hydroxide solution prepared by the learner. The balanced equation below represents the reaction that takes place.

$$2HC\ell\,(aq) + Ba(OH)_2\,(aq) \rightleftharpoons BaC\ell_2\,(aq) + 2H_2O(aq)$$ (4)

[14]

QUESTION 8 (Start on a new page.)

The electrochemical cell shown below consists of a chlorine half cell and an aluminium half cell at standard conditions.



8.1 Does the above electrochemical cell represent and ELECTROLYTIC or GALVANIC cell? Give a reason for the answer. (2)

8.2 Write down three standard conditions needed for the above cell to function. (3)

8.3 Write down the name of the oxidising agent in the above cell. (2)

8.4 Calculate the initial emf of the above cell under standard conditions. (4)

8.5 Write down the balanced NET (overall) cell reaction that takes place in this cell. No spectator ions are required. (3)

8.6 How will the initial voltmeter reading change if the:
(Write down only INCREASES, DECREASES or REMAINS THE SAME)

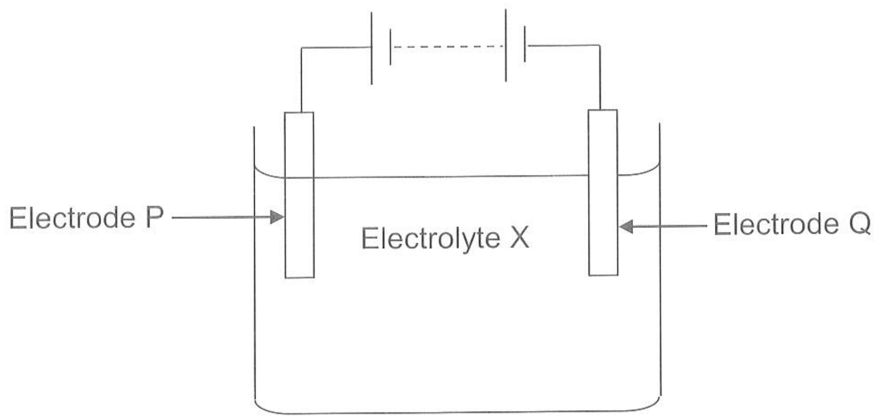
8.6.1 Size of the platinum electrode is increased. (1)

8.6.2 Initial concentration of the electrolyte in the CATHODE HALF-CELL is increased. (1)

[16]

QUESTION 9 (Start on a new page.)

The simplified diagram below shows an electrochemical cell used in refining copper.



9.1 Define an *electrolyte*. (1)

9.2 Write down the formula of the cation in the electrolyte X in the above electrochemical cell. (1)

9.3 When an electric current passes through the electrolyte the masses of the electrodes change.

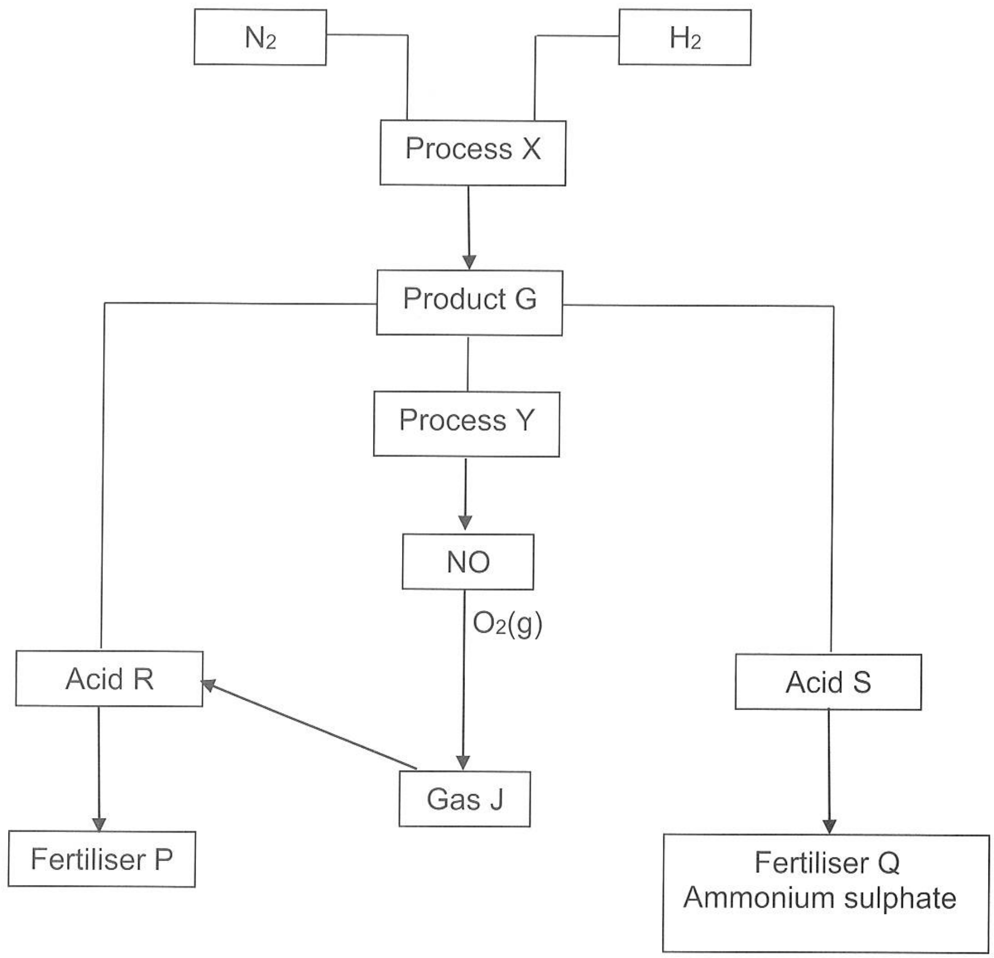
9.3.1 Does the mass of electrode P increase or decrease? (1)

9.3.2 Write down the relevant half reaction to support the answer to question 9.3.1 (2)

9.4 During the process illustrated by the above cell, a total of 2,259 x 10^{24} cations are reduced.
Calculate the mass by which the cathode should change. (4)
[9]

QUESTION 10 (Start on a new page.)

The different processes used in the preparation of fertilisers P and Q are represented in the flow diagram below:



10.1 Write down the name of:

10.1.1 Process X. (1)

10.1.2 Process Y. (1)

10.1.3 Gas J. (1)

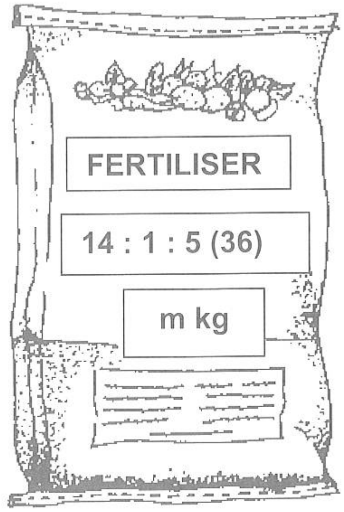
10.1.4 Fertiliser P. (1)

10.2 Product G reacts with acid S to form fertiliser Q. Write down:

10.2.1 The name or formula of acid S. (1)

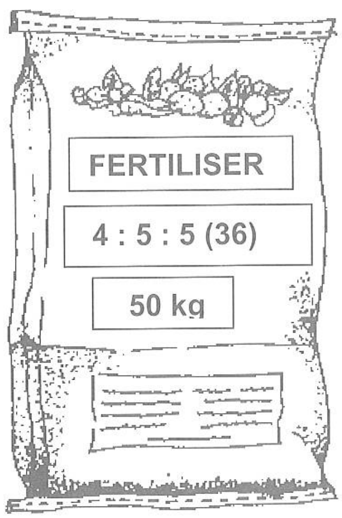
10.2.2 A balanced equation for the preparation of ammonium sulphate as shown the flow diagram above. (3)

10.3 A bag of a certain brand of fertiliser, is labelled as shown in the diagram below:

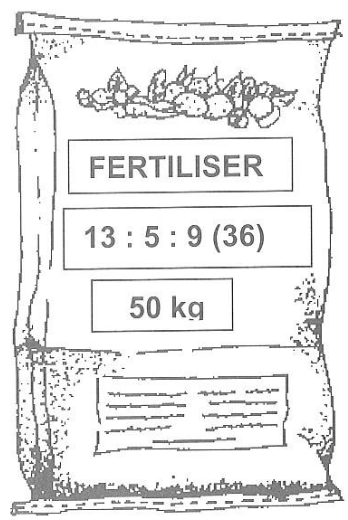


The total mass of nitrogen in the bag of fertiliser shown above is 12,60 kg. Calculate the value **m**, in kilograms indicated on the bag. (4)

10.4 A farm wants to improve the quality of fruit produced on his farm. He has available TWO bags of fertiliser as shown below:



FERTILISER A



FERTILISER B

Explain with reasons whether the farmer should apply fertiliser A or fertiliser B to improve the quality of fruit produced on his farm. (3)

[15]

TOTAL MARKS: 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*

$E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

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

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

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

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

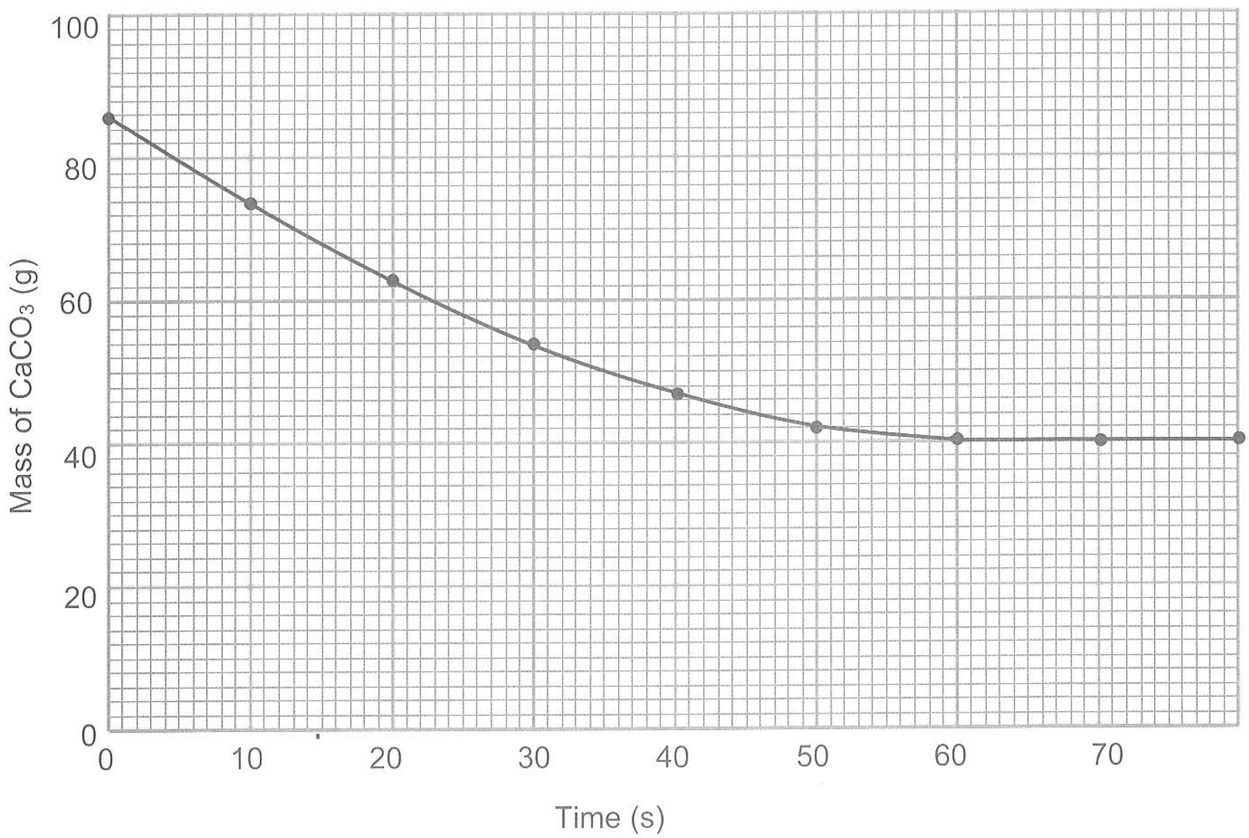
TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD- REDUKSIEPOTENSIALE

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
$2H^+ + 2e^-$	⇌	**$H_2(g)$**	**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

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

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

QUESTION 5.1.6



Education

KwaZulu-Natal Department of Education

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2018

MEMORANDUM

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS : 150

This memorandum consists of 9 pages.

The marking guidelines as per 2014 Examination Guidelines, pages 34-37 must be applied when marking this Paper.

QUESTION 1

1.1	B ✓✓	(2)
1.2	C✓✓	(2)
1.3	C✓✓	(2)
1.4	A✓✓	(2)
1.5	B✓✓	(2)
1.6	B✓✓	(2)
1.7	D✓✓	(2)
1.8	A✓✓	(2)
1.9	A✓✓	(2)
1.10	C✓✓	(2) [20]

QUESTION 2

2.1.1	E ✓	(1)
2.1.2	B ✓	(1)
2.1.3	D✓	(1)
2.1.4	F✓	(1)
2.1.5	G✓	(1)
2.2.1	2,4,4-trimethylpent-2-ene✓✓	(2)
2.2.2	C_nH_{2n} ✓	(1)
2.3.1	ethanol✓	(1)
2.3.2	sulphuric acid✓	(1) [10]

QUESTION 3

3.1.1 a series of organic compounds that can be described by the same general formula✓ in which one member differs from the next with a CH_2 group. ✓ (2)

3.1.2 the temperature at which the vapour pressure equals atmospheric/external pressure. ✓✓ (2 or 0) (2)

3.2 C✓
As the boiling point increases the vapour pressure decreases. ✓
C has the highest boiling point. ✓ (3)

3.3 B✓ (1)

3.4.1 118,50 °C✓ (1)

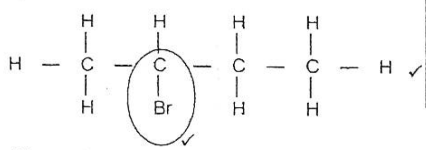
3.4.2 In addition to London forces and dipole-dipole forces, C has two sites for hydrogen bonding between the molecules✓ resulting in the strongest intermolecular forces occurring between molecules of C.✓
The intermolecular forces between molecules of C require the most amount of energy to overcome. ✓
C will therefore have the highest boiling point. ✓ (4)
[13]

QUESTION 4

4.1.1 Addition/hydrohalogenation✓ (1)

4.1.2 Substitution/hydrolysis✓ (1)

4.2



- Whole structure correct: 2/2
- Only functional group correct 1/2
- More than one functional group 0/2

2-bromobutane✓ (3)

4.3 Secondary✓
The carbon to which the —O—H✓ is bonded to, is bonded to TWO other carbon atoms. ✓ (3)

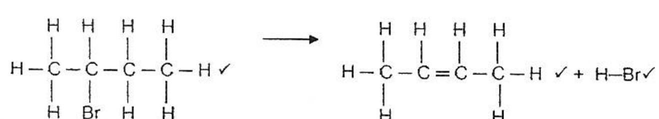
4.4 Dehydration✓ (1)

4.5 (Gentle) heat✓
Aqueous/dilute strong base (accept NaOH(dilute) or KOH(dilute) ✓ (2)

4.6.1 Compounds with the same molecular formula, ✓ but different positions of the side chain/substituents/functional groups on the parent chain.✓ (2)

4.6.2 Elimination✓ (1)

4.6.3



1 mark for each reactant and product (3)
[17]

QUESTION 5

5.1.1 **ANY ONE**

- The change in concentration✓ of reactants/products per unit time. ✓
- Rate of ✓change in concentration of reactants or products. ✓
- Change in amount/number of moles/volume/mass of reactants/products ✓ per (unit) time. ✓
- Amount/number of moles/volume/mass of products formed OR reactants used ✓ per (unit) time.✓ (2)

5.1.2 60 - 61(s) ✓ (1)

5.1.3 $n(CO_2) = n(CaCO_3)$ ✓

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

$= (\frac{86-40}{100})$✓

$= 0,46$ mols

$n = \frac{V}{V_m}$

$0,46$ ✓ $= \frac{V}{22,4}$ ✓

$V = 10,304\ dm^3$✓ (5)

Marking criteria
- Use mol ratio: $n(CO_2) = n(CaCO_3) = 1:1$ ✓
- Substitute $\frac{86-40}{100}$ in $n = \frac{m}{M}$ ✓
- Substitute 0,46✓ mols and
- Substitute 22,4 dm^3✓ in $n = \frac{V}{V_m}$
- Final answer: $V = 10,304\ dm^3$

5.1.4 40 g✓ (1)
5.1.5 INCREASES✓ (1)
5.1.6 See attached graph. (3)

- Curve starts at 86 g and ends at 40g✓
- The completion time is above 60 or 61s✓
- The curve above the original✓

5.2.1 Collision theory ✓ (1)

5.2.2 The shaded areas in the distribution curves represent the number of molecules with sufficient kinetic energy to overcome the activation energy ✓. An increase in the temperature of the system results in a greater number of particles with sufficient kinetic energy to overcome the activation energy of the reaction ✓. This results in more effective collisions per unit time OR a higher chance of an effective collision occurring✓, resulting in a higher reaction rate. (3)
[17]

QUESTION 6

6.1 When the equilibrium in a closed system is disturbed✓, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓ (2)

6.2.1 REMAINS THE SAME✓ (1)

6.2.2 INCREASES✓ (1)

6.2.3 REMAINS THE SAME ✓ (1)

6.2.4 INCREASES✓ (1)

Apply negative marking from 6.2.4

6.3 According to Le Chatelier's Principle a decrease in temperature favours the exothermic reaction✓ A decrease in temperature increases the equilibrium constant✓.Therefore the forward reaction is favoured✓ (3)

6.4

Marking criteria:

- Indicating that the number of mols of H_2 decreases by an unknown amout✓
- Correct mol ratio✓
- Calculating in terms of x the quantity(mol) at equilibrium of all three substances ✓
- Substitute V = 4 dm^3 in $c = \frac{n}{V}$ to determine concentration at equilibrium of H_2/I_2 and HI.✓
- K_c expression✓
- Substitution of concentrations in K_c expression ✓
- Substitution of 49 for Kc✓
- Equation: $n = \frac{m}{M}$ ✓
- Substituting in the above equation✓
- Final answer: 399,36 g✓

No K_c expression, correct substitution: Max. $^{9}/_{10}$

Wrong K_c expression : Max. $^{6}/_{10}$

	H_2	I_2	HI	
Initial quantity(mol)	2	2	0	
Change(mol)	-x✓	-x	+2x	Ratio ✓
Quantity at equilibrium(mol)	2-x	2-x	2x	✓
Equilibrium concentration($mol.dm^{-3}$)	$\frac{2-x}{4}$	$\frac{2-x}{4}$	$\frac{x}{2}$	Divide by 4✓

$$K_c = \frac{[HI]^2}{[H_2][I_2]} ✓ = \frac{(\frac{x}{2})^2}{(\frac{2-x}{4})(\frac{2-x}{4})} ✓ = 49 ✓$$

x = 1,56 mol

m(HI) = nM✓
= (2)(1,56)(128) ✓
= 399,36 g✓

(10)
[19]

QUESTION 7

7.1 It dissociates/ionises completely in water to form a high concentration of OH^- ions. ✓ (1)

7.2 It contains a small amount (number of moles) of base✓ in proportion to the volume of water✓ (2)

7.3

- Formula pH = - log [H_3O^+] ✓/ pOH = - log [OH^-] ✓
- Substitute 13,45 for pH✓/0,55 for pOH✓
- c(OH^-) = 0,282 $mol.dm^{-3}$✓
- Using ratio of 1: 2 to calculate c(($Ba(OH)_2$) ✓
- Formula m = cVM✓
- Substituting into the above formula✓
- Answer✓

Option 1:

pH = - log [H_3O^+] ✓
13,45✓ = - log [H_3O^+]
∴ [H_3O^+] = 3,54 x 10^{-14} $mol.dm^{-3}$
[H_3O^+][OH^-] = 1 x 10^{-14}
c(OH^-) = 0,282 $mol.dm^{-3}$✓
c(($Ba(OH)_2$) = 0,141 $mol.dm^{-3}$✓
m = cVM✓
= (0,141)(0,25)(171) ✓
= 6,03 g✓

Option 2:

pOH = - log [OH^-] ✓
0,55✓ = - log [OH^-]
∴ [OH^-] = 0,282 $mol.dm^{-3}$✓
c(($Ba(OH)_2$) = 0,141 $mol.dm^{-3}$✓
m = cVM✓
= (0,141)(0,25)(171) ✓
= 6,03 g✓

(7)

7.4 **Positive marking from question 7.3: concentration of $Ba(OH)_2$**

Marking guidelines

- Formulae: $c = \frac{n}{V}$ /n = cV/ $\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ ✓
- Substitution of: 0,141 x 60 /0,141 x 0,06 ✓
- Use mol ratio: $n_a : n_b = 2 : 1$ ✓
- Final answer: 33,84 cm^3 / 0,03384 dm^3 ✓

Option 1:

n(HCℓ) = 2n(($Ba(OH)_2$)
= 2cV
= 2(0,141)(0,06) ✓
= 0.01692 mols
c(HCℓ) = n/V✓
0,5✓ = 0,01692/V
V = 0,03384 dm^3/33,84cm^3 ✓

Option 2:

$\frac{c_A}{c_B}\frac{V_A}{V_B} = \frac{n_A}{n_B}$ ✓

$\frac{0,5}{0,141}\frac{V_A}{0,06}$ ✓= $\frac{2}{1}$ ✓

V_A = 0,03384 dm^3✓

Accept V_B = 60 cm^3
V_A = 33,84 cm^3

(4)
[14]

QUESTION 8

8.1 GALVANIC, ✓ converts chemical energy to electrical energy✓ or no dc power supply. (2)

8.2 Temperature of 25 °C/298K✓
Pressure 101,3 kPa✓
Concentration of electrolyte of 1mol.dm^{-3}✓ (3)

8.3 Chlorine (molecule)✓ ✓ (2)

8.4 **OPTION 1**

$E^\ominus_{cell} = E^\ominus_{cathode} - E^\ominus_{anode}$ ✓
$= 1,36$ ✓ $- (-1,66)$ ✓
$= 3,02$ V ✓

> **Notes**
> - Accept any other correct formula from the data sheet.
> - Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:
> *$E°_{sel} = E°_{OM} - E°_{RM}$ Max/: $\frac{3}{4}$*

OPTION 2

✓ { $Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$ 1,36 (V) ✓
$Al(s) \rightarrow Al^{3+}(aq) + 3e^-$ -1,66 (V) ✓
$Al(s) + Cl_2(g) \rightarrow Al^{3+}(aq) + 2Cl^-(aq)$ 3,02 (V) ✓ (4)

8.5 $3Cl_2(g) + 2Al(s) \rightarrow 6Cl^-(aq) + 2Al^{3+}(aq)$

> **Notes**
> - Reactants ✓ Products ✓ Balancing ✓
> - Ignore phases.
> - Marking rule 6.3.10
> - Marking rule 3.9.
> - Marking rule 3.4: One mark is forfeited when the charge of an ion is omitted per equation (not for the charge on the electron)

(3)

8.6.1 REMAINS THE SAME✓ (1)

8.6.2 DECREASES✓ (1)
[16]

QUESTION 9

9.1 A solution that conducts electricity through the movement of ions. ✓ (1)

9.2 Cu^{2+}✓ (1)

9.3.1 Decreases✓ (1)

9.3.2 $Cu \rightarrow Cu^{2+} + 2e^-$

> **Notes**
> - $Cu^{2+} + 2e^- \leftarrow Cu$ $(\frac{2}{2})$ $Cu^{2+} + 2e^- \rightleftharpoons Cu$ $(\frac{0}{2})$
> $Cu \rightleftharpoons Cu^{2+} + 2e^-$ $(\frac{1}{2})$ $Cu^{2+} + 2e \rightarrow Cu$ $(\frac{0}{2})$
> - Ignore if charge on electron is omitted.
> - If a charge of an ion is omitted e.g. $Cu \rightarrow Cu^2 + 2e^-$ *is* $Cu \rightarrow Cu^2 + 2e^-$ Max.: $\frac{1}{2}$

(2)

9.3.4

> **Marking criteria**
> - Calculate number of mols of cations: $2,259 \times 10^{24} = n(6,023 \times 10^{23})$✓
> - Formula: $n = \frac{m}{M}$ ✓
> - Substitute calculated number of moles of cations and 63,5 in $n = \frac{m}{M}$ ✓
> - Final answer 238,125 g✓

$n_e = nNA$
$2,259 \times 10^{24} = n(6,023 \times 10^{23})$ ✓
$n = 3,75$ mols
$m = nM$✓
$= (3,75)(63,5)$ ✓
$= 238,125$ g. ✓ (4)
[9]

QUESTION 10

10.1.1 Haber✓ (1)
10.1.2 Catalytic oxidation of ammonia✓ (1)
10.1.3 Nitrogen dioxide✓ (1)
10.1.4 Ammonium nitrate✓ (1)

10.2.1 Sulphuric acid/H_2SO_4✓ (1)

10.2.2 $H_2SO_4 + 2NH_3 \rightarrow (NH_4)_2SO_4$

> **Notes:**
> - Reactants ✓ Products ✓ Balancing ✓
> - Marking rule 6.3.10.

(3)

10.3 % N = 14/20 x 36
= 25,2%✓
Mass of N = 25,2/100 x **m**
12,60✓= 25,2/100 x **m**✓
m = 50 kg ✓ (4)

10.4 Fertiliser A✓
Fertilizer A has a high percentage of Phosphorus compared to fertilizer B. ✓✓ (3)
[15]

TOTAL MARKS: 150

QUESTION 5.1.6