education

Department:
Education
PROVINCE OF KWAZULU-NATAL

GRADE 12

NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P2 (CHEMISTRY)

COMMON TEST

JUNE 2019

MARKS: 100

TIME: 2 Hours

This question paper consists of 13 pages including a special sheet for question 5.6.2 and data sheets.

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INSTRUCTIONS AND INFORMATION

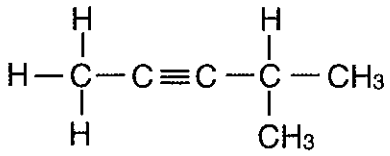
1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.
2. The question paper consists of SEVEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system 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.

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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 (1.1-1.6) in the answer book, for example 1.8 D.

1.1 The structural formula of an organic compound is given below:



The IUPAC name of this organic compound is . . .

A 1 – methylpent – 3 – yne.

B 2 – methylpent – 3 – yne.

C 4 – methylpent – 2 – yne.

D 1,1 – dimethylbut – 2 – yne. (2)

1.2 Under the same conditions of atmospheric pressure, 2 – methylpropane:

A Has a lower boiling point than butane.

B Has a higher boiling point than butane.

C Has the same boiling point as butane.

D Has the same vapour pressure as butane. (2)

1.3 Consider the following chemical reaction, in which the acid is in excess:

$$Zn(s) + 2\,HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g) \qquad \Delta H < 0$$

Which set of changes to the reaction conditions will give the GREATEST INCREASE in the reaction rate?

A	Increase pressure	Add a catalyst
B	Increase temperature	Add a catalyst
C	Use zinc powder	Increase volume of the acid
D	Increase the volume of the acid	Increase temperature

(2)

1.4 Carbon dioxide reacts with carbon in a closed system.

$$CO_2(g) + C(s) \rightleftharpoons 2\,CO(g) \qquad \Delta H > 0$$

Which ONE of the following changes at equilibrium will NOT affect the YIELD of CO (g)?

A Increasing the pressure.

B Increasing the temperature.

C Adding more carbon at constant temperature.

D Adding more carbon dioxide at constant temperature. (2)

1.5 The expression for the equilibrium constant, (Kc), of a hypothetical reaction is given as follows:

$$\frac{[A]^3}{[C][D]^2}$$

Which ONE of the following equations for a reaction at equilibrium matches the above expression?

A $C(g) + 2\,D(g) \rightleftharpoons 3\,A(s)$

B $C(aq) + 2\,D(aq) \rightleftharpoons 3\,A(\ell)$

C $C(g) + D_2(g) \rightleftharpoons 3\,A(g) + B(s)$

D $C(aq) + 2\,D(aq) \rightleftharpoons 3\,A(aq) + B(s)$ (2)

1.6 An acid-base reaction occurs as follows:

$$H\ell(aq) + NH_3(aq) \rightleftharpoons NH_4^+(aq) + \ell^-(aq)$$

The TWO bases in the above reaction are:

A $H\ell(aq)$ and $NH_4^+(aq)$.

B $H\ell(aq)$ and $\ell^-(aq)$.

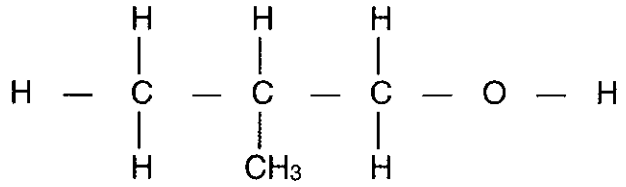
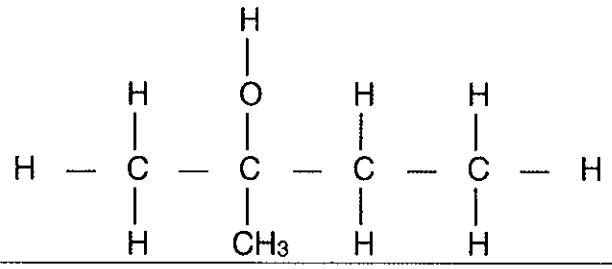
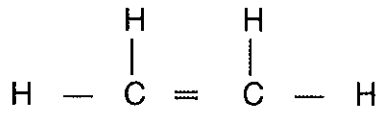
C $NH_3(aq)$ and $NH_4^+(aq)$.

D $NH_3(aq)$ and $\ell^-(aq)$. (2)

[12]

QUESTION 2 (Start on a new page.)

The letters A to D in the table below represent FOUR organic compounds.

A		**B**	
C	propyl butanoate	**D**	

Use the information in the table to answer the questions that follow.

2.1 Compounds **A** and **B** belong to the same homologous series.

2.1.1 State the definition of *homologous series.* (2)

2.1.2 Name the homologous series to which compounds **A** and **B** belong. (1)

2.2 Compounds **A** and **B** are isomers.

2.2.1 What are isomers? (2)

2.2.2 What TYPE of isomers are compounds A and B? (1)

2.3 Write down the **IUPAC** name of compound B. (2)

2.4 Write down the STRUCTURAL FORMULA of compound C. (2)

2.5 Compound **D** is the structural formula of a monomer.

2.5.1 Write down the general formula of the homologous series to which compound **D** belongs. (1)

2.5.2 Why is compound **D** said to be unsaturated? (1)

2.5.3 Write down the structural formula of the polymer that is prepared from compound **D**. (2)

[14]

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QUESTION 3 (Start on a new page.)

The table below shows the boiling points of different organic compounds that were obtained during an investigation:

Name	Molecular Mass ($g.mol^{-1}$)	Boiling Point (°C)
methanoic acid	46	100
Ethanol	46	78
propanoic acid	74	141
butan – 1 – ol	74	118

3.1 Write down the definition of *boiling point*. (2)

3.2 Write down a suitable investigative question for this investigation. (2)

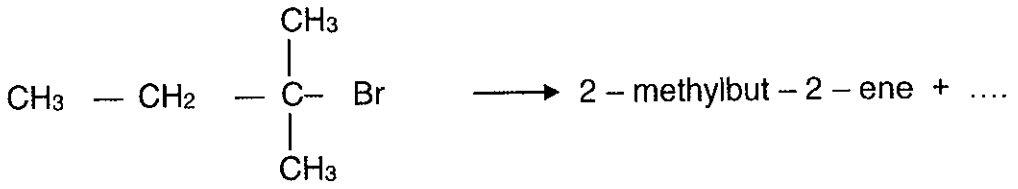
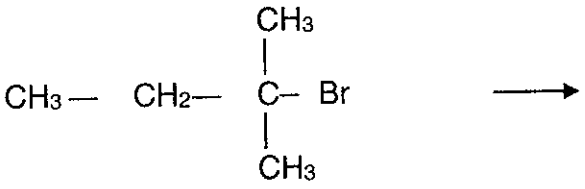
3.3 Besides the conditions for determining boiling point, state ONE controlled variable for this investigation. (1)

3.4 Explain the trend in boiling points as shown in the above table by referring to the types and strengths of the intermolecular forces and the energies involved. (4)

3.5 Which ONE of the above four compounds has the lowest vapour pressure? (1)
[10]

QUESTION 4 (Start on a new page.)

The reactions **I** to **IV** below are organic reactions:

REACTION I:	but – 1 – ene + $C\ell_2$ ⟶
REACTION II:	W + $C\ell_2$ ⟶ 2 – chlorobutane + Z
REACTION III:	
REACTION IV:	

4.1 Name the type of reaction (SUBSTITUTION, ADDITION or ELIMINATION) that takes place in:

4.1.1 REACTION I. (1)

4.1.2 REACTION II. (1)

4.2 Write down the . . .

4.2.1 IUPAC name of the product formed in REACTION I. (2)

4.2.2 STRUCTURAL FORMULA of compound W in REACTION II. (2)

4.2.3 Name or formula of product Z. (1)

4.3 State TWO reaction conditions needed for REACTION III. (2)

4.4 Is the product 2 – methylbut – 2 – ene, the MAJOR or MINOR product of REACTION III? (1)

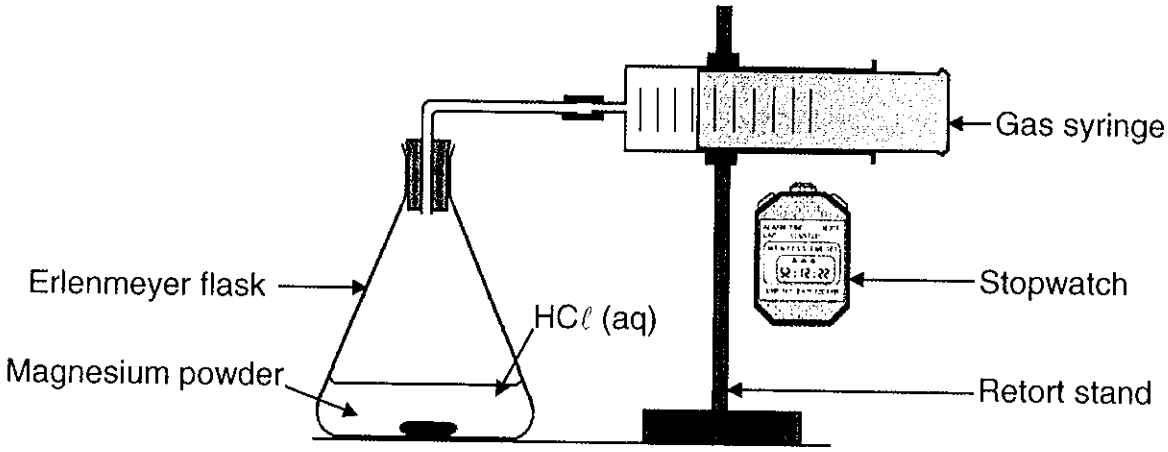
4.5 REACTION IV takes place in the presence of aqueous potassium hydroxide and mild heat. Write down the STRUCTURAL FORMULA of the major organic product that forms. (2)

[12]

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QUESTION 5 (Start on a new page.)

The apparatus shown below is used to investigate the rate at which hydrogen gas is produced when powdered magnesium is reacted with an EXCESS of a dilute hydrochloric acid solution.



The spontaneous reaction that takes place is represented by the following balanced equation:

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

The volume of hydrogen gas produced during the reaction was measured at 30 second intervals and recorded in the table below:

Time(seconds)	0	30	60	90	120	150	180	210
Volume(H_2) in dm^3	0	18	26	31	34	36	36	36

5.1 How long, in seconds, does the reaction take to reach completion? (1)

5.2 What would be the effect of using a strip of magnesium metal instead of the magnesium powder on the above reaction rate? (1)

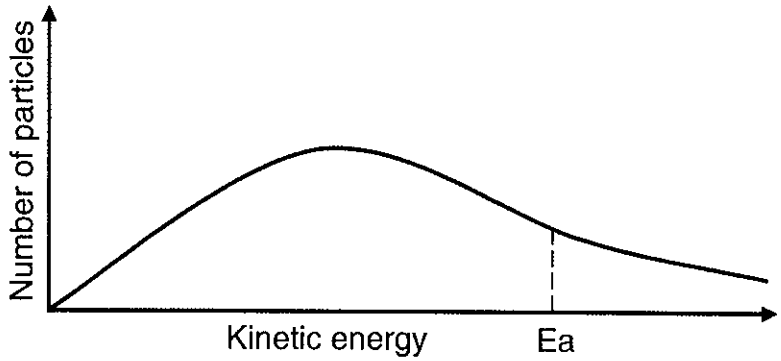
5.3 Calculate the average reaction rate in $dm^3.s^{-1}$ during the 60 to 90 second interval. (3)

5.4 It can be seen from the table that the reaction rate decreases with time. Explain this observation in terms of the collision theory. (3)

5.5 Calculate the mass of magnesium powder that was used in this investigation? Take the molar gas volume to be 24,83 dm^3. (6)

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5.6 A graph for the above reaction is given below:



5.6.1 What name is given to the above graph? (1)

5.6.2 Draw (on the special answer sheet provided), the curve that will be obtained if the reaction was carried out a LOWER temperature. Label this curve L. (2)

[17]

QUESTION 6 (Start on a new page.)

A chemical equilibrium is established at 310 K, in a container when thiocyanate ions (SCN^-) are added to iron (III) ions (Fe^{3+}). The resulting aqueous solution is a dark red colour.

The equation representing the equilibrium reaction and the colours of each species involved is given below.

$$\underset{\text{(pale orange)}}{Fe^{3+}(aq)} + \underset{\text{(colourless)}}{SCN^-(aq)} \rightleftharpoons \underset{\text{(dark red)}}{FeSCN^{2+}(aq)}$$

6.1 State what is meant by the phrase "A chemical equilibrium". (2)

6.2 The K_c value for the above equilibrium at 310 K is 4,0.
The initial concentration of each of the solutions is **X** $mol.dm^{-3}$.
Calculate the value of **X**, if the equilibrium concentration of the $FeSCN^{2+}$ ions is 1 $mol.dm^{-3}$. (7)

6.3 A concentrated solution of sodium fluoride (NaF) is now added to the above equilibrium mixture.

The following reaction takes place in the container.

$$3\ F^-(aq) + Fe^{3+}(aq) \rightarrow FeF_3(s)$$

6.3.1 State Le Chatelier's Principle. (2)

The FeF_3 formed is insoluble.

6.3.2 What colour change, if any, will take place in the original dark red solution when the NaF is added? (1)

6.3.3 Explain the answer to question 6.3.2. (3)

[15]

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QUESTION 7 (Start on a new page.)

7.1 The hydrogen carbonate ion (HCO_3^-) is an ampholyte.

7.1.1 Write down the definition of an *ampholyte.* (2)

7.1.2 Write a balanced equation to show the reaction that occurs when the hydrogen carbonate ion reacts with water. (3)

7.1.3 Refer to Arrhenius's theory and give a reason why the hydrogen carbonate ion behaves as a base. (2)

7.2 Some magnesium hydroxide is dissolved in distilled water to make a solution of volume 200 cm^3.
During a titration 16 cm^3 of the magnesium hydroxide solution is completely neutralized by 28 cm^3 of a hydrochloric acid solution of pH 0,108.

The balanced equation for the reaction that takes place is given below:

$$2\ HC\ell(aq) + Mg(OH)_2(aq) \rightleftharpoons MgC\ell_2(aq) + 2\ H_2O(\ell)$$

7.2.1 Why is magnesium hydroxide a **strong** base? (2)

7.2.2 Calculate the concentration of the hydrochloric acid solution. (3)

7.2.3 Calculate the mass of magnesium hydroxide that was initially dissolved in the distilled water. (8)
[20]

TOTAL: 100

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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 x 10^5 Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	-1,6 x 10^{-19} C
Avogadro's constant *Avogadro-konstante*	N_A	6,02 x 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	

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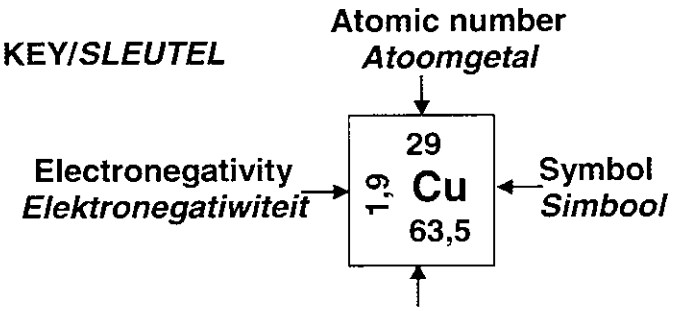
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TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEME

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)
																	2 He 4
1 H 2,1 1																	
3 Li 1,0 7	4 Be 1,5 9											5 B 2,0 11	6 C 2,5 12	7 N 3,0 14	8 O 3,5 16	9 F 4,0 19	10 Ne 20
11 Na 0,9 23	12 Mg 1,2 24											13 Aℓ 1,5 27	14 Si 1,8 28	15 P 2,1 31	16 S 2,5 32	17 Cℓ 3,0 35,5	18 Ar 40
19 K 0,8 39	20 Ca 1,0 40	21 Sc 1,3 45	22 Ti 1,5 48	23 V 1,6 51	24 Cr 1,6 52	25 Mn 1,5 55	26 Fe 1,8 56	27 Co 1,8 59	28 Ni 1,8 59	29 Cu 1,9 63,5	30 Zn 1,6 65	31 Ga 1,6 70	32 Ge 1,8 73	33 As 2,0 75	34 Se 2,4 79	35 Br 2,8 80	36 Kr 84
37 Rb 0,8 86	38 Sr 1,0 88	39 Y 1,2 89	40 Zr 1,4 91	41 Nb 92	42 Mo 1,8 96	43 Tc 1,9	44 Ru 2,2 101	45 Rh 2,2 103	46 Pd 2,2 106	47 Ag 1,9 108	48 Cd 1,7 112	49 In 1,7 115	50 Sn 1,8 119	51 Sb 1,9 122	52 Te 2,1 128	53 I 2,5 127	54 Xe 131
55 Cs 0,7 133	56 Ba 0,9 137	57 La 139	72 Hf 1,6 179	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 Tℓ 1,8 204	82 Pb 1,8 207	83 Bi 1,9 209	84 Po 2,0	85 At 2,5	86 Rn
87 Fr 0,7	88 Ra 0,9 226	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

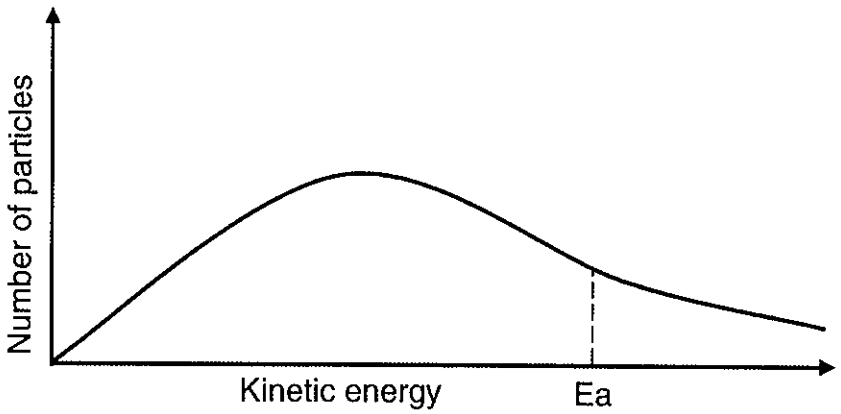
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SPECIAL ANSWER SHEET FOR QUESTION 5.6.2

NAME	
GRADE	



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PROVINCE OF KWAZULU-NATAL

GRADE 12

NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P2 (CHEMISTRY)

COMMON PAPER

JUNE 2019

MARKING GUIDELINE

MARKS : 100

This marking guideline consists of 7 pages.

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

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QUESTION 1

1.1 C ✓✓ (2)

1.2 A✓✓ (2)

1.3 B✓✓ (2)

1.4 C✓✓ (2)

1.5 D✓✓ (2)

1.6 D✓✓ (2)

[12]

QUESTION 2

2.1.1 a series of organic compounds that can be described by the same general formula ✓✓
OR a series of organic compounds in which one member differs from the next by a CH_2 group. (2 or 0) (2)

2.1.2 alcohols ✓ (1)

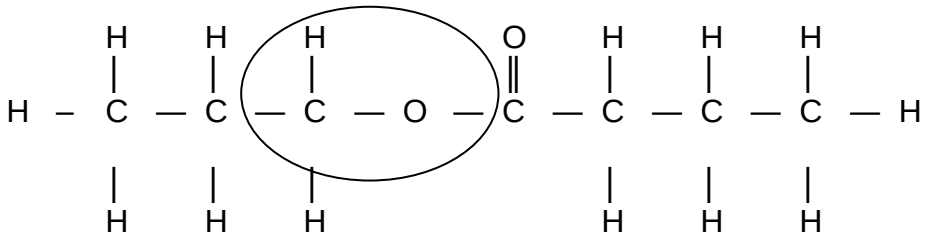
2.2.1 organic molecules with the same molecular formulae✓ but different structural formulae✓ (2)

2.2.2 positional✓ (1)

2.3 2 - methylbutan – 2 – ol✓✓ (2)

✓ functional group ✓ whole structure correct

2.4



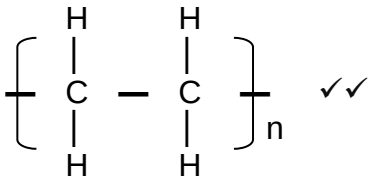
• Whole structure correct:	2/2
• Only functional group correct	1/2
• More than one functional group	0/2

(2)

2.5.1 C_nH_{2n}✓ (1)

2.5.2 contains a double bond between atoms of carbon. ✓ (1)

2.5.3



✓✓ (2)

If hydrogen missing: $\frac{1}{2}$

[14]

QUESTION 3

3.1 temperature at which the vapour pressure of a substance equals the atmospheric pressure. ✓✓

(2)

THE FOLLOWING QUESTIONS HAVE TWO POSSIBLE ANSWERS.

3.2 What is the relationship between boiling point and type of functional group/homologous series/chain length?✓ (2)

✓correct variables
✓relationship stated as a question

3.3 molecular mass✓ (1)

3.4

- carboxylic acids have a higher boiling point than alcohols with the same molecular mass✓
- carboxylic acid has TWO sites for hydrogen bonding compared to the alcohols which have only ONE site✓
- intermolecular forces between acid molecules are therefore stronger than between alcohol molecules✓
- more energy is required to overcome intermolecular forces between acid molecules✓

OR

- alcohols have a lower boiling point than carboxylic acids with the same molecular mass ✓
- alcohols which have only ONE site compared to the carboxylic acid has TWO sites for hydrogen bonding ✓
- intermolecular forces between alcohol molecules are therefore weaker than between carboxylic acid molecules✓
- less energy is required to overcome intermolecular forces between alcohol molecules✓ (4)

OR

3.2 What is the relationship between boiling point and length of carbon change? ✓✓ (2)

✓correct variables
✓relationship stated as a question

3.3 Type of functional groups ✓ (1)

3.4 As the length of the chains ✓ of the carboxylic acids and alcohols increases the boiling points increase. ✓
There will be more sites for London Forces. ✓
More energy needed to separate the molecules. ✓ (4)

3.5 propanoic acid✓ (1)

[10]

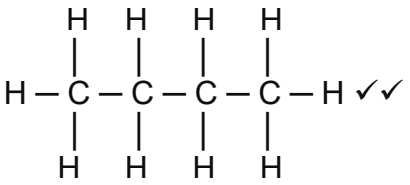
QUESTION 4

4.1.1 addition✓ (1)

4.1.2 substitution✓ (1)

4.2.1 1,2 - dichlorobutane✓✓ (2)

4.2.2



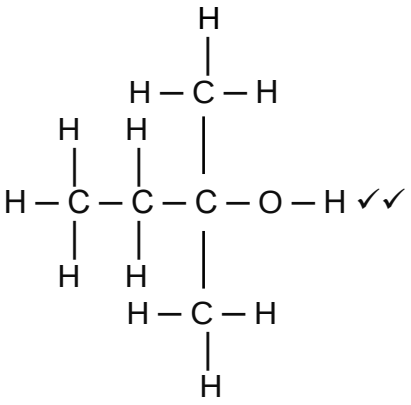
(2)

4.2.3 hydrogen chloride/HCℓ✓ (1)

4.3 concentrated KOH/NaOH in ethanol✓
heat (under reflux)✓ (2)

4.4 major✓ (1)

4.5



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

(2)
[12]

QUESTION 5

5.1 150 s✓ (1)

5.2 reaction will take longer than 150 s to reach completion/rate of reaction decreases✓ (1)

5.3

$$\text{rate} = \frac{\Delta V(H_2)}{\Delta t}$$

$$\text{rate} = \frac{31 - 26}{90 - 60} \quad ✓ \quad ✓$$

$$= 0{,}167\ cm^3.s^{-1} \quad ✓$$

(3)

5.4 Amount of magnesium/concentration of HCl decreases✓
Number of collisions per unit time decreases ✓
Number of effective collisions per unit time decreases✓ (3)

5.5

$n = \frac{V}{V_m}$ ✓

$= \frac{36}{24,83}$ ✓

$= 1,45$ mol

$n(Mg) = n(H_2)$ / $= 1,45$ mol any one✓

$m(Mg) = nM$ ✓

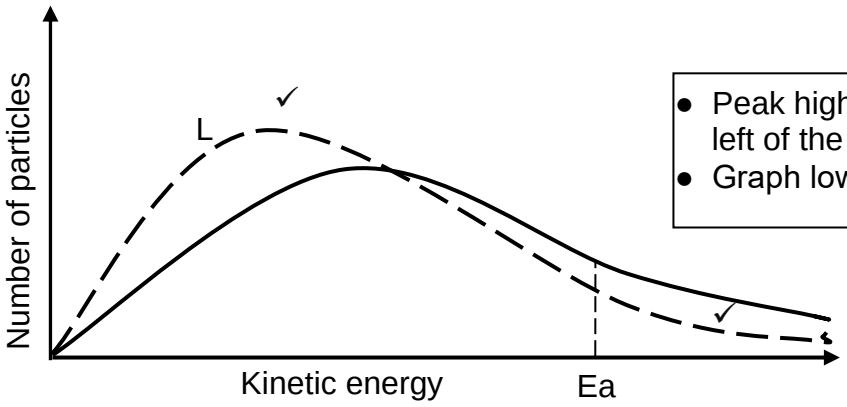
$= (1,45)(24)$ ✓

$= 34,8$ g✓

(6)

5.6.1 Maxwell – Boltzmann Distribution curve✓ (1)

5.6.2



- Peak higher and to the left of the original
- Graph lower on the right

(2)

[18]

QUESTION 6

6.1 The system where the rate of the forward reaction equals the rate of the reverse reaction. ✓✓ (2)

6.2

	Fe^{3+}	SCN^-	$FeSCN^{2+}$
Initial concentration ($mol.dm^{-3}$)	x	x	0
Change($mol.dm^{-3}$)	-1	-1	+1
Equilibrium concentration($mol.dm^{-3}$)	x – 1	x – 1	1

✓ ratio ✓ ✓

$K_c = \frac{[FeSCN^{2+}]^2}{[Fe^{3+}][SCN^-]}$ ✓ $= \frac{(1)}{(x-1)(x-1)}$ ✓ $= 4$ ✓

X = 1,5 mol. dm^{-3}✓ (7)

6.3.1 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 or 0) (2)

6.3.2 Turns orange✓ (1)

– marking

6.3.3 The formation of an insoluble FeF_3 decreases the concentration of Fe^{3+}✓
The system reacts by favouring the reverse reaction.✓
More Fe^{3+} forms✓ (3)
[15]

QUESTION 7

7.1.1 A substance that can act as an acid or a base✓✓ (2)

7.1.2 $HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$ LHS✓ RHS✓ BAL✓ (3)

7.1.3 HCO_3^- is not an Arrhenius base ✓ ✓

OR

Accept:
HCO_3^- produces hydroxyl ions/hydroxide ions/OH^- when dissolved in water according to the given reaction ✓✓ (2)

7.2.1 Dissociates completely in water to form hydroxide/hydroxyl (OH^-) ions. ✓✓ (2)

7.2.2

$$\begin{array}{lcl} pH & = & -\ \log[H_3O^+] \ \checkmark \\ 0{,}108 & = & -\ \log[H_3O^+] \ \checkmark \\ [H_3O^+] & = & 0{,}78\ mol.dm^{-3} \ \checkmark \end{array}$$

(3)

7.2.3 (POSITIVE MARKING FROM Q. 7.2.2)

Option 1:

$n(Mg(OH)_2) = \frac{1}{2}n((HC\ell)$ ✓

$= \frac{1}{2}CV$ ✓

$= \frac{1}{2}\underline{(0,78)(0,028)}$ ✓

$= 0.01092$ mols

Option 2:

$\frac{C_A\ V_A}{C_B\ V_B} = \frac{n_A}{n_B}$ ✓

$\frac{(0,78)\ (28)}{(c_B)\ (16)}$ ✓ $= \frac{2}{1}$ ✓

$C_B = 0,6825\ mol.dm^{-3}$ ✓

$n(Mg(OH)_2) = CV$

$= (0,6825)(0,016)$ ✓

$= 0,01092$ mol

$m = CMV$ ✓

✓ ✓

$= (0,6825)\ (58)\ (0,2)$

$= 7,92$ g ✓

$n(Mg(OH)_2)$ in 16 $cm^3 = 0.01092$ mols

$n(Mg(OH)_2)$ in 200 $cm^3 = 0,1365$ mols ✓✓

$m(Mg(OH)_2)$ in 200 $cm^3 = nM$ ✓

$= \underline{(0,1365)(58)}$ ✓

$= 7,92$ g ✓

(8)

[20]

TOTAL: 100

PLEASE NOTE:

DUE TO THE TECHNICAL ERROR IN QUESTION 2.2.2 THE TOTAL MARKS HAS BEEN ADJUSTED TO 99.

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