education

Department:
Education
PROVINCE OF KWAZULU-NATAL

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

COMMON TEST

JUNE 2018

MARKS: 100

TIME: 2 Hours

This question paper consists of 11 pages and 2 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 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.

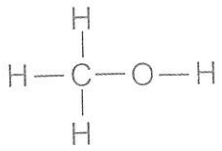
11. Give brief motivations, discussions, et cetera where required.

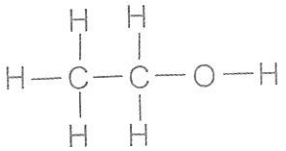
12. Write neatly and legibly.

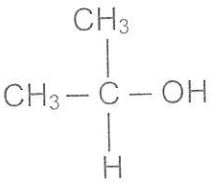
QUESTION 1: MULTIPLE – CHOICE QUESTIONS

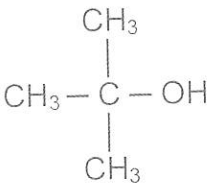
Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) next to the question number (1.1 – 1.7) in the ANSWER BOOK, for example 1.8 D.

1.1 Which one of the following organic compounds is a tertiary alcohol?

A 

B 

C 

D 

(2)

1.2 The melting points of four hydrocarbons that are chain isomers are shown in the table below:

Hydrocarbon	Melting Point (°C)
P	28
Q	–56,5
R	–95
S	–182,5

The hydrocarbon with the longest chain is . . .

A P
B Q
C R
D S

(2)

1.3 A polymer that is the product of a condensation polymerisation reaction is, . . .

A polyactic acid
B polypropylene
C polyvinyl chloride
D polytetrafluoroethene (2)

1.4 The reaction below reaches equilibrium at 900 °C.

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

The Kc expression at 900 °C is equal to . . .

A $\frac{[CaCO_3][CaO]}{[CO_2]}$

B $\frac{[CO_2]}{[CaCO_3][CaO]}$

C $[CO_2]$

D $[CaCO_3][CaO]$ (2)

1.5 The rate of a chemical reaction can be expressed in . . .

A moles of product formed per litre of solution.
B volume of gas formed per unit time.
C energy consumed per mole.
D grams per mole. (2)

1.6 The equation below represents a chemical reaction at equilibrium in a closed container:

$$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g) \qquad \Delta H < 0$$

The yield of $SO_3(g)$ can be increased by . . .

A removing some of the $O_2(g)$ from the reaction.
B removing some of the $SO_2(g)$ from the reaction.
C increasing the temperature at which the reaction occurs.
D decreasing the temperature at which the reaction occurs. (2)

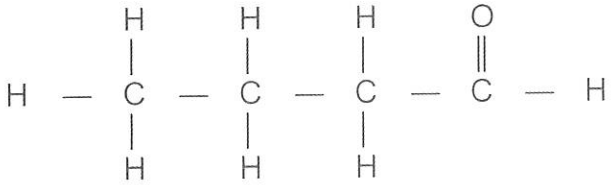
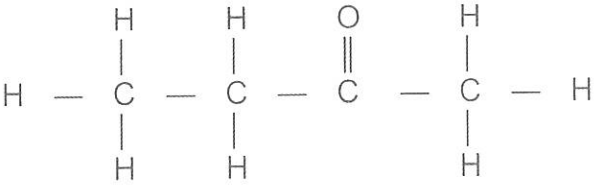
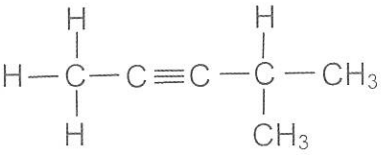
1.7 Which one of the following aqueous solutions is a WEAK base?

A 0,5 mol.dm^{-3} HCℓ
B 0,5 mol.dm^{-3} NaOH
C 0,5 mol.dm^{-3} Na_2CO_3
D 0,5 mol.dm^{-3} CH_3COOH (2)

[14]

QUESTION 2 (Start on a new page.)

The letters A to E in the table below represent five organic compounds.

A		**B**	
C	$CH_3CH(CH_3)CH_2CH(CH_3)CH_2CH_3$	**D**	
E	Ethene		

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

2.1.1 An isomer of 4-methylheptane (1)

2.1.2 A ketone (1)

2.2 For compound D, write down:

2.2.1 It's IUPAC name. (2)

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

2.3 Write down the structural formula of the polymer of compound E. (1)

[6]

QUESTION 3 (Start on a new page.)

M and N are TWO straight chain organic compounds that belong to different homologous series.

3.1 Explain what is meant by the underlined phrase in the above statement. (1)

Both M and N have the molecular formula, $C_3H_6O_2$.

3.2 Name the type of isomer that compounds M and N represent.
(Choose from CHAIN, POSITIONAL or FUNCTIONAL isomer) (1)

3.3 Compound M has a higher vapour pressure than compound N.

3.3.1 Define vapour pressure. (2)

3.3.2 Explain in terms of intermolecular forces and energy the difference in the vapour pressure of compound M and compound N. (3)

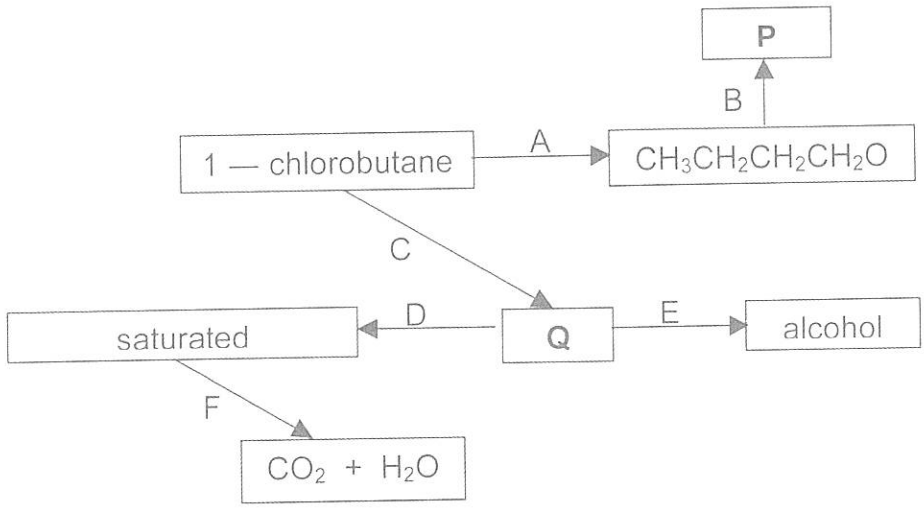
3.3.3 Which compound, M or N has a higher boiling point? Give a reason for the answer. (2)

3.3.4 Write down the IUPAC name and structural formula of compound N. (3)

[12]

QUESTION 4 (Start on a new page.)

In the flow diagram below, A, B, C, D, E and F represent organic reactions. **P** and **Q** represent organic compounds.



Reaction C represents a dehydrohalogenation reaction.

4.1 Name the type of reaction represented by:

4.1.1 A (1)

4.1.2 D (1)

4.1.3 F (1)

4.2 Give a reason why the hydrocarbon produced by reaction D is described as saturated. (1)

4.3 Write down the name or formula of the catalyst needed for reaction D. (1)

4.4 Reaction B is carried out in a water bath to produce a pleasant smelling organic compound, P, with the molecular formula $C_7H_{14}O_2$.

4.4.1 Give a reason why reaction B is carried out in water bath instead of direct heating over a flame. (1)

4.4.2 Draw the structural formulae for compound P. (3)

4.5 State the conditions that must be satisfied for reaction C. (2)

4.6 The alcohol produced by reaction E is a positional isomer of the alcohol produced by reaction A.

4.6.1 Write down the structural formula for compound Q. (2)

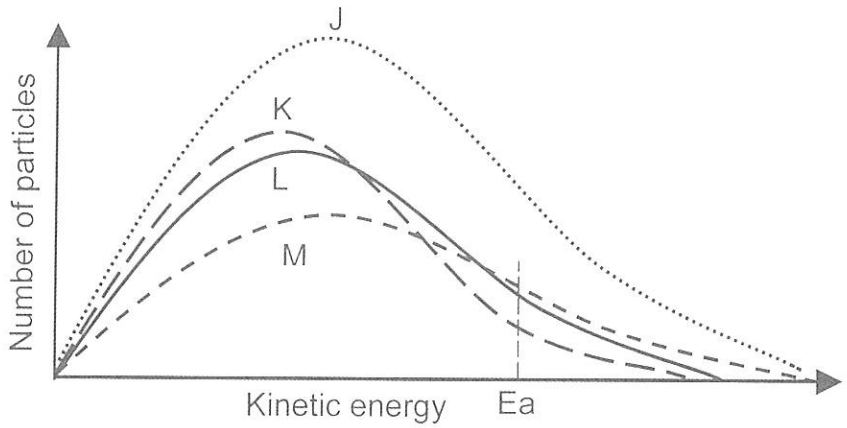
4.6.2 Give the IUPAC name of the alcohol produced by reaction E. (2)

4.7 Write a balanced equation, using molecular formulae to show the reaction that takes place when reaction F takes place in excess oxygen. (3)
[18]

QUESTION 5 (Start on a new page)

5.1 The Maxwell-Boltzmann curve labelled L, below, represents the number of particles against kinetic energy for a hypothetical reaction:

$$A(g) + 2B(g) \rightarrow 3C(g)$$



J, K and M represent the curves obtained when the reaction conditions are changed for the hypothetical reaction.

5.1.1 Identify the reaction condition that was changed to obtain curve J. (1)

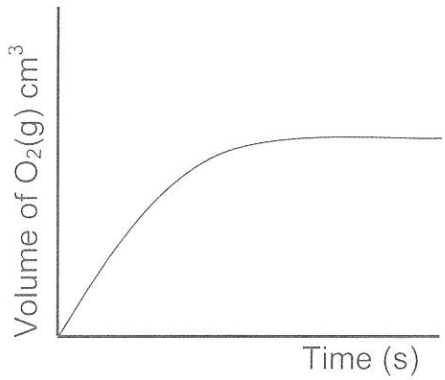
5.1.2 Explain how the change identified in question 5.1.1 affects the rate of the reaction. (3)

5.1.3 State the change that was made to the reaction conditions to obtain curve K. (1)

5.2 Learners use copper(II)oxide(CuO) powder to decompose hydrogen peroxide, during a class experiment. They add 1 g copper(II)oxide to 100 cm^3 hydrogen peroxide in a flask connected to a delivery tube. The reaction that takes place is represented by the following balanced equation.

$$2H_2O_2(\ell) \xrightarrow{CuO(s)} 2H_2O(\ell) + O_2(g)$$

The volume of oxygen produced is measured every 10 seconds. The results obtained are shown in the sketch graph below:



5.2.1 What happens to the gradient of the above graph as the reaction proceeds. (Choose from INCREASES, DECREASES or REMAINS THE SAME) (1)

5.2.2 Give a reason for the answer to question 5.2.1. (1)

The learners repeat the above experiment but this time forget to add the copper(II)oxide powder. They notice that the volume of oxygen gas produced per second decreases.

5.2.3 Copy the above graph in your answer book and label it A.
On the same system of axes sketch a graph to show the results that will be obtained. Label this graph B. (3)

5.2.4 Explain fully why the volume of oxygen gas produced per second decreases. (4)
[14]

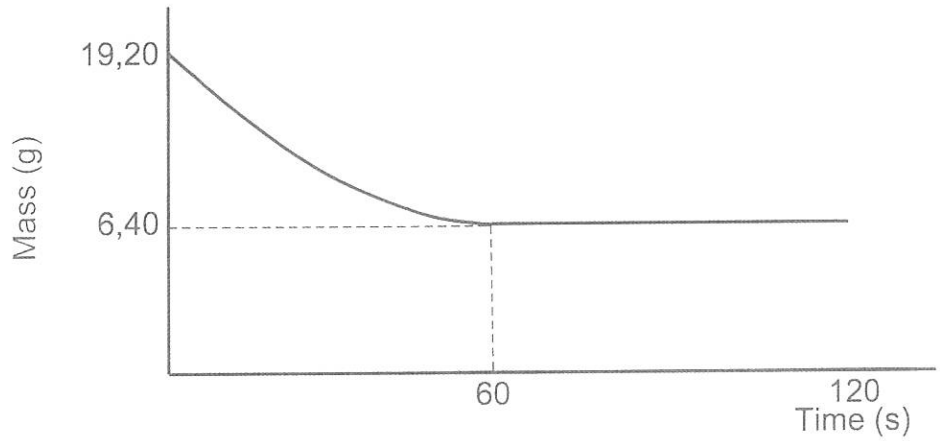
QUESTION 6 (Start on a new page)

Sulphur dioxide gas reacts with an unknown quantity of oxygen gas in a sealed 2 dm^3 container at a temperature T °C, according to the following balanced equation:

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

The equilibrium constant Kc for this reaction at T °C is 160.

The graph below, not drawn to scale, shows how the mass of $SO_2(g)$ present in the container changes with time at T °C.



The reaction between the gases sulphur dioxide and oxygen reaches equilibrium after 60 s.

6.1 Why is the reaction said to be in equilibrium after 60 s? (2)

6.2 Calculate the initial number of moles of $O_2(g)$ that was present in the container. (8)

6.3 The temperature is NOW increased. The Kc value decreases.

6.3.1 State Le Chatelier's Principle. (2)

6.3.2 Is the reaction between sulphur dioxide and oxygen endothermic or exothermic? Explain the answer. (4)
[16]

QUESTION 7 (Start on a new page.)

7.1 A learner dissolves sodium acetate crystals in water and measures the pH of the solution.

7.1.1 Define the term *hydrolysis of a salt.* (2)

7.1.2 Will the pH of the solution be GREATER THAN, SMALLER THAN or EQUAL TO 7? (1)

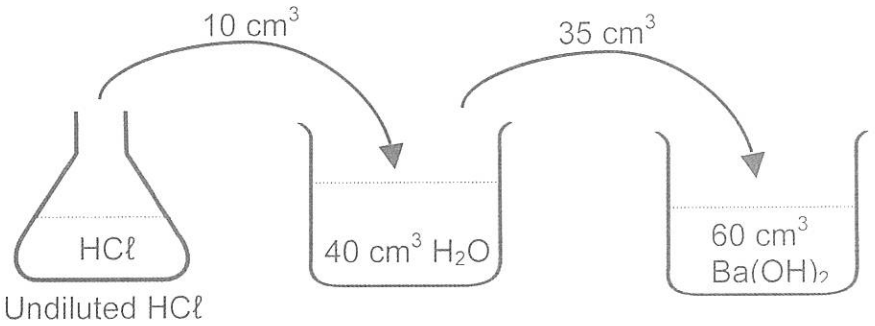
7.1.3 Write a relevant balanced equation to support the answer to question 7.1.2. (3)

7.2 Hydrochloric acid is a strong monoprotic acid.

7.2.1 Define an acid in terms of the Lowry Brønsted theory. (2)

7.2.2 Give a reason why hydrochloric acid is referred to as a monoprotic acid. (1)

7.3 In a titration to determine the concentration of undiluted hydrochloric acid, a standard solution of a strong base, barium hydroxide of concentration 0,1 mol.dm^{-3} is used. 10 cm^3 of the hydrochloric acid is diluted with 40 cm^3 water to a volume of 50 cm^3.



60 cm^3 of the barium hydroxide solution neutralizes exactly 35 cm^3 of the diluted hydrochloric acid solution.

7.3.1 The following indicators are available for the titration:

INDICATOR	pH range
P	3,10 – 4,40
Q	6,60 – 7,60
R	8,30 – 10,00

Which ONE of the above indicators (P, Q or R) is most suitable to indicate the exact endpoint in this titration? Give a reason for the answer. (2)

7.3.2 Calculate the concentration of the undiluted hydrochloric acid. The balanced equation for the reaction is:

$$2\ HC\ell\ (aq) + Ba(OH)_2(aq) \rightleftharpoons BaC\ell_2\ (aq) + 2\ H_2O(\ell)$$ (9)

[20]

TOTAL MARKS: 100

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*

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

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

Grades 12, 11, 10

education

Department:
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PROVINCE OF KWAZULU-NATAL

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKING GUIDELINE

COMMON TEST

JUNE 2018

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS: 100

TIME: 2 hours

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.

QUESTION 1

1.1 D ✓✓ (2)

1.2 A ✓✓ (2)

1.3 A ✓✓ (2)

1.4 C ✓✓ (2)

1.5 B✓✓ (2)

1.6 D ✓✓ (2)

1.7 C ✓✓ (2)

[14]

QUESTION 2

2.1

2.1.1 C ✓ (1)

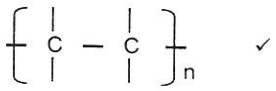
2.1.2 B ✓ (1)

2.2

2.2.1 4-methyl✓pent-2-yne ✓ (2)

2.2.2 C_nH_{2n-2}✓ (1)

2.3



✓ (1)

[6]

QUESTION 3

3.1 They have different functional groups ✓ (1)

3.2 functional ✓ (1)

3.3

3.3.1 Pressure exerted by a vapour at equilibrium with its liquid in a closed system. ✓✓ (2)

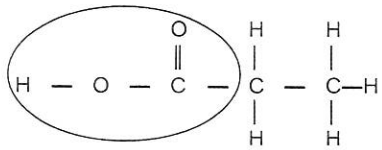
3.3.2 The intermolecular forces between molecules of M are weaker than the intermolecular forces of N✓
They will require less energy to overcome✓
M has a higher vapour pressure✓

OR

The intermolecular forces between molecules of N are stronger than the intermolecular forces of M✓
They will require more energy to overcome✓
N has a lower vapour pressure✓ (3)

3.3.4 N✓ has a lower vapour pressure ✓ (2)

3.3.4



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

(3)
[12]

QUESTION 4

4.1

4.1.1 substitution/hydrolysis ✓ (1)

4.1.2 addition/hydrogenation ✓ (1)

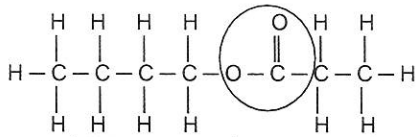
4.1.3 <u>combustion</u> ✓ (1)

4.2 contains only single bonds between atoms of carbon/no multiple bonds between atoms of carbon✓ (1)

4.3 Pt/platinum✓ (1)

4.4 4.4.1 alcohol is flammable/burns easily ✓ (1)

4.4.2

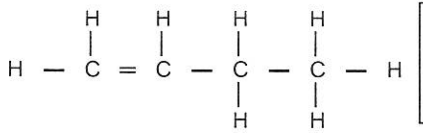


✓alkyl ✓alkanoate ✓functional group

(3)

4.5 (Strongly) heat the haloalkane under reflux ✓
With a concentrated solution of sodium hydroxide/potassium hydroxide in ethanol ✓ (2)

4.6 4.6.1



- ✓ double bond between first and second carbon
- ✓ 4 carbon atoms

(2)

4.6.2 <u>butan</u>✓-2-ol ✓ (2)

4.7 $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$ ✓LHS ✓RHS ✓BAL (3)
[18]

QUESTION 5

5.1

5.1.1 concentration ✓ (1)

5.1.2 an increase in concentration increases the number of reacting molecules✓
number of effective collision that occur per unit time increases✓
reaction rate increases ✓ (3)

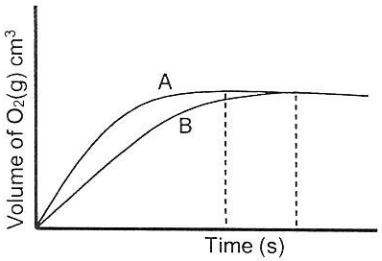
5.1.3 temperature decreases ✓ (1)

5.2

5.2.1 decreases ✓ (1)

5.2.2 reaction rate decreases ✓ (1)

5.2.3



✓less steep gradient
✓same amount of product
✓B reaches completion after A.

(3)

5.2.4 CuO is a catalyst✓
Removal of the catalyst increases the activation energy ✓
Fewer particles have sufficient energy. ✓
Number of effective collisions that occur per unit time decreases✓ (4)
[14]

QUESTION 6

6.1 The rate of the forward reaction equals the rate of the reverse reaction./
amount of reactants and products remain the same ✓✓ (2)

6.2

	SO_2	O_2	SO_3	
Initial quantity(mol)	$\frac{19,2}{64} = 0,3$✓	x	0	
Change(mol)	-0,2	-0,1	+0,2	Ratio ✓
Quantity at equilibrium(mol)	$\frac{6,4}{64} = 0,1$✓	$x - 0,1$	0,2	✓
Equilibrium concentration($mol.dm^{-3}$)	$\frac{0,1}{2} = 0,05$	$\frac{x-0,1}{2}$	$\frac{0,2}{2} = 0,1$	Divide by 2✓

$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$ ✓= $\frac{(0,1)^2}{(0,05)^2(\frac{x-0,1}{2})}$ ✓ = 160

x = 0,15 mol✓ (8)

6.3

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 exothermic✓
Kc decreases: concentration of products decreases while concentration of reactants increases ✓
Reverse reaction is favoured ✓
According to Le Chatelier's Principle an increase in temperature Favours the endothermic reaction✓ (4)
[16]

QUESTION 7

7.1

7.1.1 the reaction of a salt with water ✓✓ (2)

7.1.2 greater than✓ (1)

7.1.3 $CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$ LHS✓ RHS✓ BAL✓ (3)

7.2

7.2.1 a substance that produces hydrogen ions/hydronium ions/oxonium ions/H_3O^+ when it dissolves in water. ✓✓ (2)

7.2.2 it ionises to produce ONE proton✓ (1)

7.3

7.3.1 Q✓
Reaction is between a strong acid and a strong base. ✓ OR
pH at the endpoint will be approximately 7. ✓ (2)

7.3.2

Option 1:

$n(HCl) = 2n((Ba(OH)_2)$ ✓
$= 2cV$ ✓
$= 2(0,1)$✓$(0,06)$ ✓
$= 0.012$ mols
$c(HCl) = n/V$ ✓
$= 0,012/0,035$✓
$c = 0,343\ dm^3$ ✓

OR

Option 2:

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

$\frac{c_A}{(0,1)\checkmark}\frac{(35)\checkmark}{(60)\checkmark} = \frac{2}{1}$ ✓

$c_A = 0,343\ mol.dm^{-3}$✓

$c_1V_1 = c_2V_2$ for equating $n_{diluted}/n_{undiluted}$
$c(0,1)\checkmark = (0,343)(50)\checkmark$
$c = 1,715\ mol.dm^{-3}$✓

0,343 mol HCl in 1 dm^3 } ✓
x mol HCl in 0,050 dm^3 }
$x = 0,0171$ mol
$c = n/V$
$= 0,0171/0,01$✓
$= 1,71\ mol.dm^{-3}$✓

(9)
[20]

TOTAL MARKS: 100