education

Department:
Education
PROVINCE OF KWAZULU-NATAL

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

PREPARATORY EXAMINATION

SEPTEMBER 2020

Time: 3 hours

Marks: 150

NB. This question paper consists of 15 pages and 4 Data Sheets.

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of NINE questions.
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, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. You are advised to use the attached DATA SHEETS.
11. Write neatly and legibly.
12. Answer ALL the questions in the ANSWER BOOK.

QUESTION 1 MULTIPLE CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter A, B, C or D next to the question number in the ANSWER BOOK, e.g. 1.11 A

1.1 Which ONE of the following organic compounds is UNSATURATED?

A. dichloromethane

B. 1-bromo-2-iodopropane

C. butan-1-ol

D. 1-chloro-2-floroethene (2)

1.2 Which ONE of the following is TRUE for alcohols?

	Functional group	General formula	Type of chemical reaction
A.	$-\overset{\vert}{\underset{\vert}{C}}-OH$	$C_nH_{2n+2}OH$	Can undergo substitution reaction
B.	$-\overset{\vert}{\underset{\vert}{C}}-OH$	$C_nH_{2n}OH$	Can undergo elimination reaction
C.	$-\overset{\vert}{\underset{\vert}{C}}-OH$	$C_nH_{2n+1}OH$	Can undergo substitution reaction
D.	$-\overset{\vert}{\underset{H}{\underset{\vert}{C}}}=O$	$C_nH_{2n}OH$	Can undergo addition reaction

(2)

1.3 Which ONE of the following sets of compounds shows the order of INCREASING STRENGTH of intermolecular forces?

A. chloroethane < ethane < ethanol <ethanoic acid

B. ethanol < chloroethane < ethane < ethanoic acid

C. ethane< chloroethane < ethanoic acid < ethanol

D. ethane < chloroethane < ethanol < ethanoic acid (2)

1.4 According to the Collision Theory, reaction rate increases when … decreases

A. Temperature

B. Concentration

C. Activation energy

D. Kinetic energy of molecules (2)

1.5 Consider the following statements about the chemical equilibrium …

$4A(s) + CD_2(g) \rightleftharpoons 2A_2D(s) + C(s)$ ($\Delta H < 0$)

I the reverse reaction is endothermic.
II the equilibrium constant depends on the concentration of CD_2.
III the concentration of C increases when the temperature is decreased.
IV adding more A(s) will increase the amount of C(s) at equilibrium.

Which statements are CORRECT?

A. I and II

B. II and III

C. II and IV

D. III and IV (2)

1.6 Consider the following hypothetical reaction taking place in a container that has a fixed volume:

$A_3 (g) + B_3 (g) \rightleftharpoons 3AB (g)$ $\Delta H < 0$

What will be the result of doubling the temperature, on the NUMBER OF MOLES of A_3(g) and the TOTAL MASS of the gases?

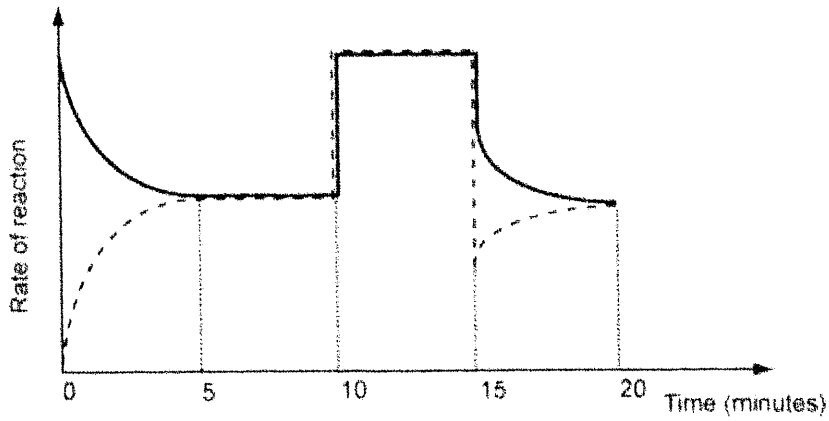
	NUMBER OF MOLES of A_3(g)	TOTAL MASS of GASES
A.	Decrease	Increase
B.	Increase	Decrease
C.	Increase	Remains constant
D.	Decrease	Remains constant

(2)

1.7 The following reversible reaction reaches equilibrium in a closed container:

$H_2 (g) + I_2 (g) \rightleftharpoons 2HI (g) \quad \Delta H < 0$

Equilibrium was first established after 5 minutes.
(The broken line on the graph represents the reverse reaction.)



What possible change could have been made to the reaction conditions at t = 10 minutes?

A. A catalyst was added.

B. The temperature was increased.

C. The temperature was decreased.

D. The external pressure on the reaction mixture was decreased. (2)

1.8 Which ONE of the following statements BEST describes an ACID according to Arrhenius Theory?

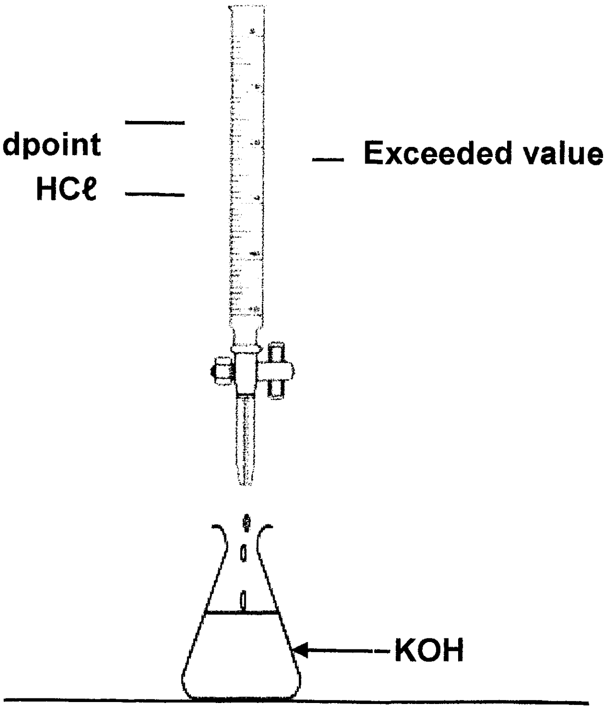
A. An acid is a proton donor

B. It is a substance which decreases the pH of water

C. A substance which when added to water increases the hydroxyl ion concentration

D. A substance which when added to water increases the hydronium ion concentration (2)

1.9 In a titration involving HCℓ and KOH, as shown in the sketch below, a learner accidentally exceeds the endpoint.



Which ONE of the following is correct for the solution now in the conical flask?

A. $[H^+] > [OH^-]$ and pH > 7

B. $[H^+] < [OH^-]$ and pH > 7

C. $[H^+] < [OH^-]$ and pH < 7

D. $[H^+] > [OH^-]$ and pH < 7 (2)

1.10 In the equation:

$$H_2O(\ell) + Y(aq) \leftrightharpoons OH^-(aq) + H_2CO_3(aq)$$

The symbol Y represents ...

A. an acid having the formula CO_3^{2-}

B. a base having the formula CO_3^{2-}

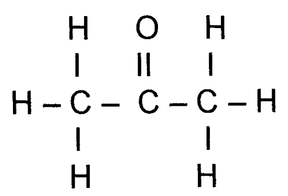
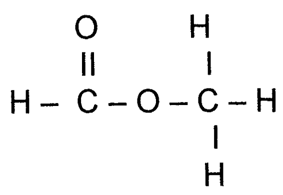
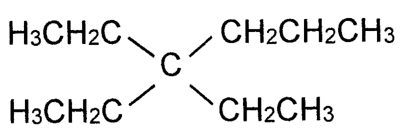
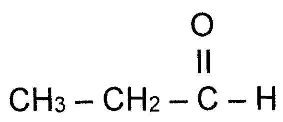
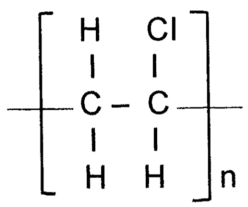
C. an acid having the formula HCO_3^-

D. a base having the formula HCO_3^- (2)

[20]

QUESTION 2 **(Start on a new page)**

The letters A to F in the table below represent six organic compounds. Use the information in the table to answer the questions that follow.

A		**B**	
C		**D**	
E		**F**	$CH_3 - CH_2 - CH_2 - OH$

Write down the following:

2.1 The IUPAC name of compound C. (2)

2.2 The letters of two compounds that are FUNCTIONAL isomers. (1)

2.3 The letter of the compound that is the product of a DEHYDRATION reaction. (1)

2.4 The IUPAC NAME and STRUCTURAL FORMULA of the monomer of compound E. (3)

2.5 The name of the FUNCTIONAL group of compound D. (1)

2.6 The compound with the GENERAL FORMULA C_nH_{2n+2}. (1)

2.7 The IUPAC name of the POSITIONAL isomer of compound F. (1)

[10]

QUESTION 3 (Start on a new page)

Compounds A, B and C were used to investigate one of the factors that influences boiling point.

	NAME OF COMPOUND	FORMULA	BOILING POINT (°C)
A	Butane	$CH_3CH_2CH_2CH_3$	-0,5
B	Ethanoic acid	CH_3COOH	118
C	Propanol	$CH_3CH_2CH_2OH$	?

3.1 Define *boiling point*. (2)

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

3.3 Name ONE variable, apart from atmospheric pressure, that must be kept constant during this investigation. (1)

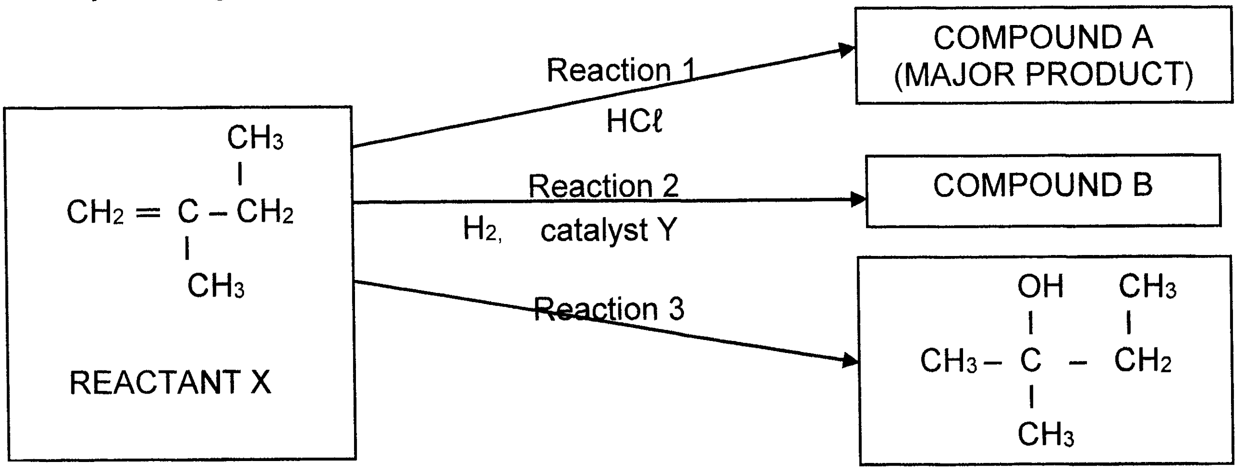
3.4 By referring to the TYPES of intermolecular forces, FULLY EXPLAIN the difference in the boiling points of compounds A and B. (4)

3.5 How will the vapour pressure of compound A compare with that of compound B? (Choose from: HIGHER THAN, EQUAL TO or LOWER THAN).
Give a reason for your answer. (2)

3.6 Will the boiling point of compound C be HIGHER THAN or LOWER THAN compound B? Explain your answer. (3)
[14]

QUESTION 4 (Start on a new page)

Study the diagram of various organic reactions and answer the questions that follow.



4.1. Write down the IUPAC name of reactant X. (2)

4.2 Consider REACTION 1:

4.2.1 Name the TYPE of addition reaction that occurs. (1)

4.2.2 Write down the STRUCTURAL FORMULA and IUPAC name of compound A. (4)

4.3 Study REACTION 2 and provide:

4.3.1 The name OR formula of catalyst Y. (1)

4.3.2 The IUPAC name of compound B. (2)

4.4 For REACTION 3,

4.4.1 State TWO reaction conditions for this reaction. (2)

4.4.2 Name the TYPE of addition reaction. (1)

4.4.3 Is the product formed in this reaction a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)

4.4.4 The PRODUCT of reaction 3 undergoes an ELIMINATION reaction. Write down the STRUCTURAL FORMULA and IUPAC NAME of the MAJOR product of this reaction. (4)
[19]

QUESTION 5 (Start on a new page)

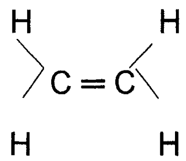
5.1 Propyl heptanoate is a sweet- scented clear liquid that is used in the fragrance industry. It is prepared by the following reaction:

$$C_3H_8O(aq) + C_7H_{14}O_2\,(aq) \longrightarrow C_{10}H_{20}O_2\,(aq) + H_2O(\ell)$$

5.1.1 Write down the IUPAC name of the ORGANIC acid used in the preparation of propyl hexanoate. (2)

5.1.2 Write down the STRUCTURAL FORMULA of propyl heptanoate. (3)

5.2 The flow diagram below is an example of a *Cracking reaction*

Compound **P** $C_{15}H_{32}$ —High pressure / High temperature→  + Q + Octane

5.2.1 Define a "*Cracking Reaction*" (2)

5.2.2 Name the TYPE of Cracking reaction above. (1)

5.2.3 Provide the IUPAC name of compound **Q.** (2)

5.2.4 Using MOLECULAR FORMULA, write down the balanced equation for the combustion reaction of octane. (3)

[13]

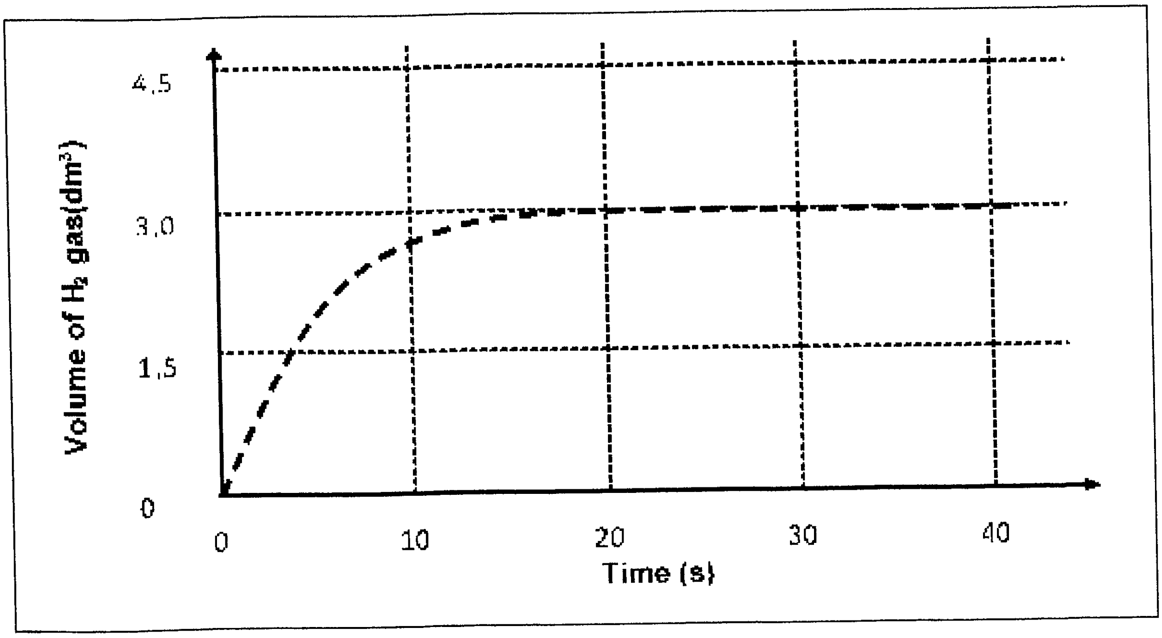
QUESTION 6 (Start on a new page)

A group of learners perform a series of experiments to test the effect of certain factors on reaction rate when magnesium metal is added to EXCESS hydrochloric acid.

$$Mg(s) + 2HC\ell(aq) \rightarrow 2MgC\ell_2(aq) + H_2(g) \quad \Delta H < 0$$

EXPERIMENT	STATE OF MAGNESIUM	MASS OF MAGNESIUM (g)	TEMPERATURE (°C)
1	ribbon	6,0	25
2	ribbon	6,0	15
3	fine powder	4,5	25

The results of **EXPERIMENT 1** were collected and plotted on the graph below:



6.1 Define *reaction rate*. (2)

6.2 What volume of hydrogen gas was collected in experiment 1 after 40s? (1)

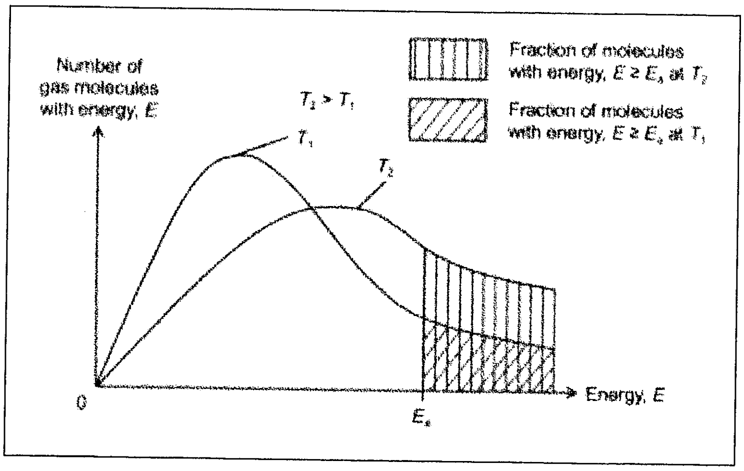
6.3 Calculate the average rate of reaction (in $dm^3.s^{-1}$) for experiment 1 over the first 20s. (3)

6.4 How will the rate of reaction be affected if a higher concentration of $HC\ell$ (aq) is used. Assume that the temperature remains constant.
(Choose from INCREASES, DECREASES or REMAINS THE SAME.)
Explain the answer in terms of the Collision Theory. (4)

6.5 Redraw the above graph of experiment 1 in your answer book and on the same system of axes sketch the graphs that will be obtained for experiments 2 and 3. Clearly label your graphs for each experiment. (4)
[14]

QUESTION 7 **(Start on a new page)**

The following diagram shows a Maxwell-Boltzmann distribution curve of a gas sample at temperatures T_1 and T_2.



7.1 Provide labels for the x and y axes of the graph, respectively. (2)

7.2 Which graph (T_1 or T_2) represents the gas at a higher temperature? (1)

7.3 What does the shaded area to the right of label **P** represent? (1)

7.4 What would happen to the area under the graph T_1 when a catalyst is added to the reaction mixture. Give a reason (2)

7.5 Give a reason why the curve goes through the origin? (1)

[7]

QUESTION 8 **(Start on a new page)**

The table below shows the effect of temperature changes on the value of the equilibrium constant (Kc) when the following reaction takes place in a sealed gas jar:

$$N_2O_4 (g) \rightleftharpoons 2NO_2 (g)$$
(colourless gas) (brown gas)

TEMPERATURE (K)	EQUILIBRIUM CONSTANT Kc
300	$1{,}00 \times 10^{-1}$
400	$3{,}00 \times 10^{1}$
500	$1{,}00 \times 10^{3}$
600	$1{,}00 \times 10^{4}$
700	$1{,}20 \times 10^{4}$

8.1 State Le Chatelier's principle. (2)

8.2 What will be the appearance of the gas jar at 700K? (Choose from COLOURLESS or BROWN) (1)

8.3 Is the reaction EXOTHERMIC or ENDOTHERMIC? Explain. (4)

8.4 Write down two ways, other than temperature change, that can increase the RATE of the forward reaction at 500 K. (2)

8.5 84,64g of N_2O_4 gas was sealed in a 2 dm^3 container and heated up to a temperature T. At equilibrium, it was found that 20,7% of the N_2O_4 gas had decomposed to NO_2. Determine, by means of appropriate calculations, the temperature T at which the reaction took place. (9)

8.6 State the effect of adding more N_2O_4(g) on the value of the equilibrium constant, Kc.
(Choose from INCREASES, DECREASES or REMAINS THE SAME).
Give a reason for your answer. (3)

[21]

QUESTION 9 **(Start on a new page)**

Two groups of grade 12 learners were given separate experiments to conduct using a strong base (sodium hydroxide) and weak acids (oxalic acid and ethanoic acid) respectively.

GROUP 1

Learners were asked to determine the percentage purity of a sample of oxalic acid ($H_2C_2O_4$). To do this, they followed the procedure below:

(I) Prepared a standard solution of sodium hydroxide by diluting 50,00 cm^3 of NaOH solution of concentration 0,63 mol.dm^{-3} to a volume of 1,00 dm^3.

(II) Prepared a solution of oxalic acid by dissolving 0,25 g of the IMPURE SAMPLE in 75 cm^3 of water.

(III) Titrated the oxalic acid solution against the standard NaOH solution. The titration required 40,02 cm^3 of the NaOH solution to neutralize ALL the oxalic acid solution in STEP II above.

The equation for the reaction is:

$$2NaOH(aq) + H_2C_2O_4(aq) \rightarrow Na_2C_2O_4(aq) + 2H_2O(\ell)$$

9.1 Define a *standard solution*? (2)

9.2 Calculate the concentration of the standard NaOH solution. (3)

9.3 Calculate the percentage purity of the oxalic acid sample. (7)

GROUP 2

Learners were required to find the concentration and percentage of ethanoic acid in household vinegar. To do this they used the following procedure:

(I) Diluted a vinegar sample by placing $25 cm^3$ household vinegar in a $250 cm^3$ volumetric flask and adding water up to the $250 cm^3$ mark.

(II) Titrated the diluted vinegar sample with a solution of NaOH of concentration $0,2 mol.dm^{-3}$.

9.4 Calculate the pH of the NaOH solution. (4)

In the titration, $15 cm^3$ of the diluted vinegar sample needed $30,25 cm^3$ of the sodium hydroxide solution for the endpoint to be reached.

$$NaOH(aq) + CH_3COOH(aq) \rightarrow CH_3COONa(aq) + H_2O(\ell)$$

9.5 Define *end point.* (2)

9.6 Calculate the concentration of dilute vinegar solution (in ethanoic acid). (4)

9.7 If $1 cm^3$ vinegar has a mass of 1g, calculate the percentage ethanoic acid by mass, present in the vinegar. (5)

9.8 Sodium ethanoate, CH_3COONa, undergoes hydrolysis.

9.8.1 Define a *hydrolysis reaction.* (2)

9.8.2 How will the pH of the water be affected by the hydrolysis reaction? (Choose from INCREASES, DECREASES or REMAINS THE SAME) Write a balanced equation that will explain the answer. (3)

[32]

TOTAL MARLS: 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* $c=\frac{m}{MV}$	$n=\frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b}=\frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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

KEY

Electronegativity	Atomic number	Symbol	Relative atomic mass (approximately)
1,9	29	Cu	63,5

Each cell: atomic number, symbol, relative atomic mass, (electronegativity).

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

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

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

Half-reactions/*Halfreaksies*			**E^{θ} (V)**
$Li^+ + e^-$	⇌	Li	−3,05
$K^+ + e^-$	⇌	K	−2,93
$Cs^+ + e^-$	⇌	Cs	−2,92
$Ba^{2+} + 2e^-$	⇌	Ba	−2,90
$Sr^{2+} + 2e^-$	⇌	Sr	−2,89
$Ca^{2+} + 2e^-$	⇌	Ca	−2,87
$Na^+ + e^-$	⇌	Na	−2,71
$Mg^{2+} + 2e^-$	⇌	Mg	−2,36
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	−1,66
$Mn^{2+} + 2e^-$	⇌	Mn	−1,18
$Cr^{2+} + 2e^-$	⇌	Cr	−0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	−0,83
$Zn^{2+} + 2e^-$	⇌	Zn	−0,76
$Cr^{3+} + 3e^-$	⇌	Cr	−0,74
$Fe^{2+} + 2e^-$	⇌	Fe	−0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	−0,41
$Cd^{2+} + 2e^-$	⇌	Cd	−0,40
$Co^{2+} + 2e^-$	⇌	Co	−0,28
$Ni^{2+} + 2e^-$	⇌	Ni	−0,27
$Sn^{2+} + 2e^-$	⇌	Sn	−0,14
$Pb^{2+} + 2e^-$	⇌	Pb	−0,13
$Fe^{3+} + 3e^-$	⇌	Fe	−0,06
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**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

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
PREPARATORY EXAMINATION
MARKING GUIDELINES
SEPTEMBER 2020

Time: 3 hours

Marks: 150

NB. This marking guideline consists of 10 pages.

QUESTION 1

1.1 D ✓✓ (2)

1.2 C ✓✓ (2)

1.3 D ✓✓ (2)

1.4 C✓✓ (2)

1.5 A✓✓ (2)

1.6 C✓✓ (2)

1.7 A✓✓ (2)

1.8 B✓✓ (2)

1.9 D✓✓ (2)

1.10 D✓✓ (2)

[20]

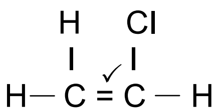
QUESTION 2

2.1 3,3✓-diethyl✓hexane (2)

2.2 A and D ✓ (1)

2.3 B ✓ (1)

2.4



whole structure ✓ chloroethene ✓ (3)

2.5 formyl group ✓ (1)

2.6 C ✓ (1)

2.7 propan-2-ol✓/2-propanol (1)

[10]

QUESTION 3

3.1 Temperature at which the vapour pressure of a substance is equal to the atmospheric pressure. ✓ ✓ (2)

3.2 How does the type of functional group affect the boiling point of an organic compound? (2)

OR

What is the relationship between the functional groups of different organic compounds and their boiling points?

Dependent and independent variable correctly identified i.e. boiling point and functional group	✓
Relationship between dependent and independent variables given in the form of a question that cannot be answered by YES or NO.	✓

3.3 Molecular mass✓ (1)

3.4 Compound A has London/induced dipole forces ✓
whereas compound B has London forces and hydrogen bonds. ✓
Hydrogen bonds are stronger that London forces. ✓ (4)
Therefore more energy is required to overcome the intermolecular forces in compound B. ✓

3.5 Higher than. ✓
(-) The lower the boiling point, the higher the vapour pressure. ✓ (2)

3.6 Lower than. ✓
(-) Compound C has only one site for hydrogen bonding while compound B has two sites for hydrogen bonding. ✓therefore more energy required to separate molecules of B✓ (3)

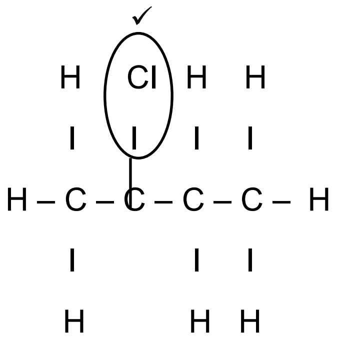
[14]

QUESTION 4

4.1 2-methylbut-1-ene ✓ ✓ (2)

4.2.1 hydrohalogenation ✓ (1)

4.2.2



✓ whole structure ✓ ✓ (4)

4.3.1 Pt / Pd /Ni /platinum/palladium/nickel ✓ (1)

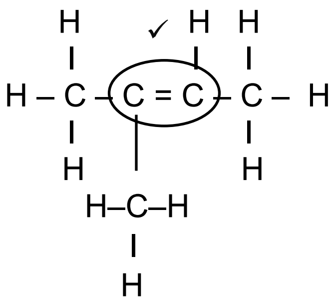
4.3.2 2-methylbutane ✓ ✓ (2)

4.4.1 Dilute H_2SO_4 ✓✓ / dilute H_3PO_4 ✓✓
Mild heat ✓
excess water✓
H_2SO_4✓ OR H_3PO_4 ✓ (2)

4.4.2 Hydration ✓ (1)

4.4.3 Tertiary. ✓
The -OH/hydroxyl group is joined to the carbon that is joined to 3 other carbon atoms. ✓ (2)

4.4.4



✓ whole structure

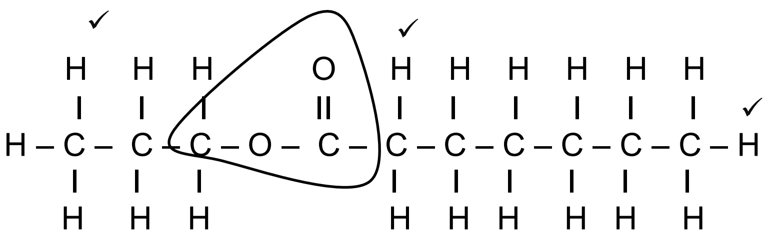
✓ 2-methylbut-2-ene✓ (4)

[19]

QUESTION 5

5.1.1 Heptanoic acid ✓✓ / hexanoic acid (2)

5.1.2



(3)

5.2.1 The breaking of organic molecules into smaller more useable units. ✓✓ (2)

5.2.2 thermal✓ (1)

5.2.3 pentene / pent-1-ene / pent-2-ene ✓✓ (2)

5.2.4 $2C_8H_{18}$ + $25O_2$ ✓ → $16CO_2$ + $18H_2O$ ✓ ✓bal (3)

[13]

QUESTION 6

6.1 Change in concentration / mass / moles/ amount/ volume of reactants (or products) per unit time. ✓✓ (2)

6.2 3,0 dm^3 ✓ (1)

6.3 Rate of Reaction = $\frac{\Delta V}{\Delta t}$

= $\frac{3,0 - 0}{20 - 0}$ ✓ ✓

= 0,15 $dm^3 \cdot s^{-1}$ ✓ (3)

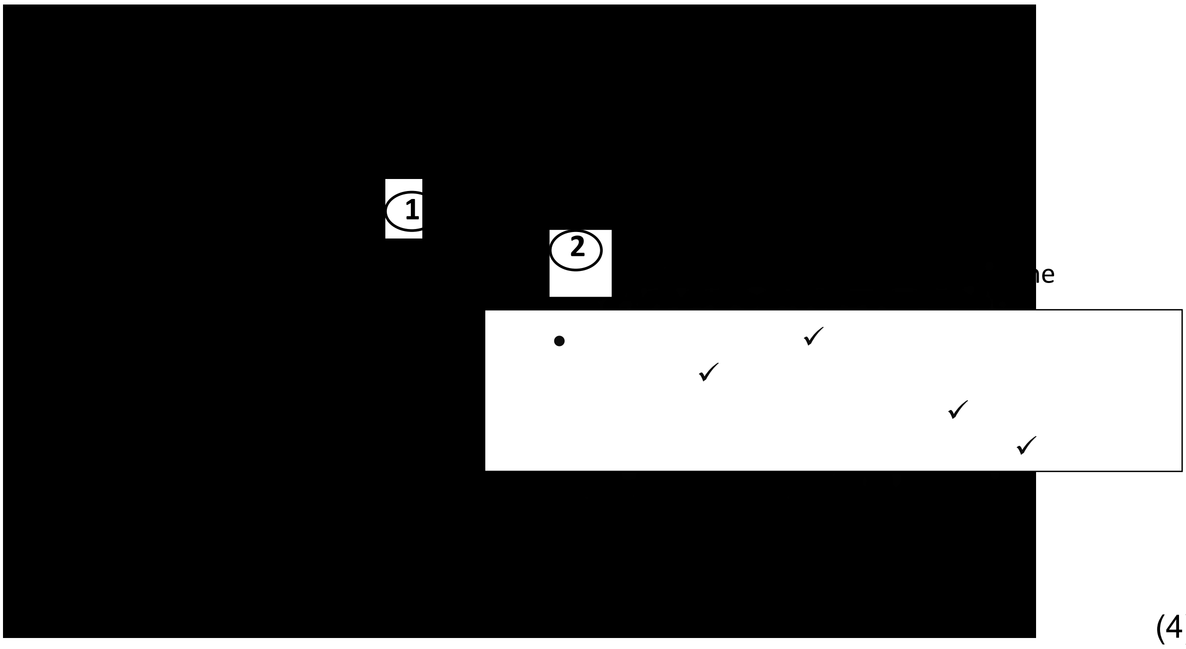
6.4 Increases ✓

A higher concentration means that there is a greater number of particles per unit volume. ✓

This leads to an increase in the number of collisions per unit time✓.

This leads to an increase in the number of effective collisions per unit time. ✓ (4)

6.5



(4)

[14]

QUESTION 7

7.1 x axis- Kinetic Energy (of molecules)✓
y axis- % of molecules/no of particles✓ (2)

7.2 T_2✓ (1)

7.3 It indicates the percentage of molecules that have more energy than the activation energy at a specific temperature. / It is the percentage of molecules that are capable of effective collisions. ✓ (1)

7.4 The area under the curves remains the same. ✓
The number of molecules in the reaction mixture stays the same/does not change. ✓ (2)

7.5 There are no molecules/particles with ZERO energy. ✓ (1)

[7]

QUESTION 8

8.1 When the equilibrium in a closed system is disturbed, the system will reinstate a new equilibrium by favouring the reaction that will oppose the disturbance.✓✓ (2)

8.2 Brown✓ (1)

8.3 Endothermic. ✓
An increase in temperature will favour the endothermic reaction in an equilibrium reaction. ✓
Since an increase in temperature resulted in an increase in the value of Kc, ✓
It can be concluded that the forward reaction is favoured✓ (4)

8.4 Add a catalyst✓
Increase the pressure. ✓
<u>Increase concentration of reactant</u> (any two) (2)

8.5

	N_2O_4	NO_2
Ratio	1	2
Initial mass	84,64g	0
Initial mole	$\frac{84,64}{92}$ ✓ = 0,92 mol	0
Change in mole	0,19✓	0,38
Moles at equilibrium	0,73mol	0,38mol
Equilibrium concentration ($mol.dm^{-3}$)	$\frac{0,73}{2}$ = 0,365	$\frac{0,38}{2}$ = 0,19✓

$$Kc = \frac{[NO_2]^2}{[N_2O_4]} \checkmark$$

$$= \frac{(0,19)^2}{0,365} \checkmark$$

$$= 0,1 \checkmark$$

(9)

Therefore the temperature is 300K✓

8.6 Remains the same. ✓
Only change in temperature affects Kc. ✓✓ (3)

[21]

QUESTION 9

9.1 A standard solution is one whose concentration is precisely known. ✓✓ (2)

9.2 $(C \times V)_{dilute} = (C \times V)_{conc}$

$$C_{dilute} = \frac{(C \times V)_{conc}}{V_{dilute}}$$

$$= \frac{0,63 \times 0,05}{1 \checkmark} \checkmark$$

$$= 0,0315\ mol.dm^{-3} \checkmark$$

(3)

9.3 Positive marking from Q9.2

n_{NaOH} = C x V
= 0,0315 x 0,04 ✓
= 1,26 x 10^{-3}mol ✓

n_{NaOH}: $n_{C_2H_2O_4}$
2 : 1

$n_{C_2H_2O_4}$ = 6,3 x 10^{-4}mol ✓

$m_{C_2H_2O_4}$ = n x M ✓
= 6,3 x 10^{-4} x 90 ✓
= 0,0567g

% purity = $\frac{0,0567}{0,25}$ ✓ x $\frac{100}{1}$

= 22,68 % ✓ (7)

9.4

option 1

Kw = $[H_3O^+][OH^-]$ = 1x10^{-14} ✓
1x10^{-14} = $[H_3O^+]$ (0,20)
$[H_3O^+]$ = 5 x10^{-14} ✓

pH = -log $[H_3O^+]$ ✓
= -log (5 x10^{-14})
= 13,3 ✓

option 2

pOH = -log$[OH^-]$ ✓
= -log (0,2)
= 0,70 ✓

pH + pOH = 14 ✓
pH + 0,70 = 14
pH = 13,3 ✓ (4)

9.5 Is the point in a titration where the indicator changes colour. ✓✓ (2)

9.6 $\frac{C_aV_a}{C_bV_b} = \frac{n_a}{n_b}$

$\frac{C_a (15)}{(0,2)(30,25)}$ ✓ ✓ = $\frac{1}{1}$ ✓(ratio)

C_a = 0,40 mol.dm^{-3} ✓ (4)

- Sub on LHS✓✓
- Sub no moles on RHS✓
- Answer with unit✓

9.7 **Option 1** Positive marking from Q9.6

$M(CH_3COOH) = 2(12) + 4(1) + 2(16)$
$= 60 g.mol^{-1}$ ✓

$n(CH_3COOH)_{diluted} = C \times V$
$= 0,40 \times 0,25$ ✓
$= 0,1$ mol

$m(CH_3COOH)_{dilute} = n \times M$
$= 0,1 \times 60$
$= 6,0 g$

% CH_3COOH in vinegar $= \frac{6,0}{25 ✓} \times \frac{100}{1}$ ✓

$= 24,0\%$ ✓

- Molar mass of CH_3COOH. ✓
- Substitution 0,24 x 0,25 ✓
- Mass of 25g in vinegar ✓
- Substitution of percentage ✓
- Final answer ✓

Option 2 Positive marking from Q9.6

$M(CH_3COOH) = 2(12) + 4(1) + 2(16)$
$= 60 g.mol^{-1}$ ✓

$m(CH_3COOH)_{diluted} = C \times V$
$= 0,40 \times 60 \times 0,25$ ✓
$= 6,0 g$

% CH_3COOH in vinegar $= \frac{6,0}{25 ✓} \times \frac{100}{1}$ ✓

$= 24,0\%$ ✓

- Molar mass of CH_3COOH. ✓
- Substitution 0,4 x 60 ✓
- Mass of 25g in vinegar ✓
- Substitution of percentage ✓
- Final answer ✓

(5)

9.8.1 reaction of a salt with water ✓✓ (2)

9.8.2 $CH_3COO^- + H_2O \leftrightarrows CH_3COOH + OH^-$ ✓(LHS) ✓(RHS) (3)

pH will increase ✓

[32]

TOTAL MARKS: 150