Raffles Girls' School
(SECONDARY)

Established in 1879

Name: _____

Class: 4 / _____ Register No: _____

CHEMISTRY
RAFFLES PROGRAMME/RAFFLES ACADEMY (STANDARD)
YEAR FOUR

End-of-Year Assessment

Wednesday **20 September 2017** **1h 45 min**

INSTRUCTIONS TO CANDIDATES

This question paper contains two sections.

Section A - Answer **ALL** the questions and record your answers on the OMR answer sheet.

Section B - Answer **ALL** the questions and write your answers in the spaces provided.

Use only a black or dark blue pen.

Do not use correction tape or fluid.

Omission of essential working or units, or expressing answers with incorrect significant figures will result in a loss of marks.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question. The total number of marks for this paper is 70.

A copy of the Periodic Table on page 24 is provided for your reference.

For examiners' use	
Section / Question	**Marks Obtained**
A	
B1	
B2	
B3	
B4	
B5	
B6	
B7	
B8	
Working	
Units	
Significant Figures	
Total	**70**

Parents's / guardian's Name: _____

Signature: _____ Date: _____

Section A – Multiple Choice Questions [15 marks]

*There are 15 questions in this section. Answer all questions. For each question, there are four possible answers (**A**, **B**, **C**, and **D**). Choose the most appropriate answer and record your choice on the OMR answer sheet.*

1 Which reagent(s) would best distinguish $Al(NO_3)_3$(aq) from NH_4Cl(aq)?

A Add H_2SO_4(aq)
B Add Na_2CO_3(s)
C Add NaOH(aq) in excess
D Add NaOH(aq) and *Al* powder, then warm

2 When aqueous silver nitrate was added to solution **X**, a white precipitate was formed. The precipitate dissolved partially when dilute sulfuric acid was added and a gas was evolved. The gas formed white precipitate with limewater. Upon addition of more acid, the amount of precipitate appeared to increase.

What could most likely be present in solution **X**?

A Sodium carbonate and sodium chloride
B Sodium carbonate and hydrochloric acid
C Aluminium hydroxide and carbon dioxide
D Aluminium hydroxide and sodium chloride

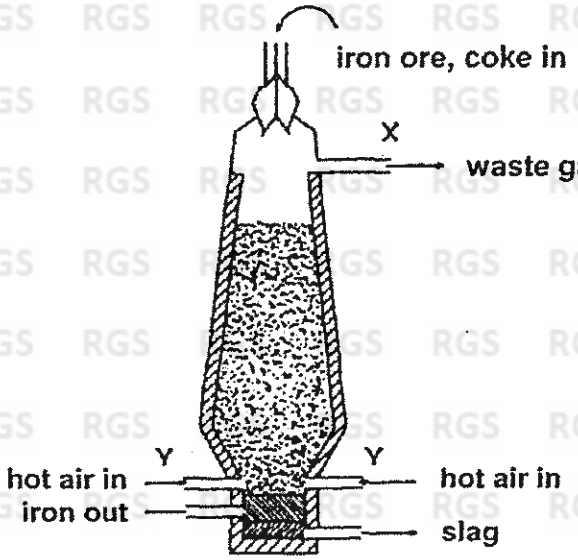
3 The following observations were made when nickel and iron were placed separately into salt solutions of three metals **P**, **Q** and **R**.

metals	salt solution of P	salt solution of Q	salt solution of R
nickel	Yes, displaced	Not displaced	Not displaced
iron	Yes, displaced	Yes, displaced	Not displaced

What is the correct order in **decreasing** reactivity of the five metals?

A R, Q, Fe, Ni, P
B R, Fe, Ni, Q, P
C R, Fe, Q, Ni, P
D R, Ni, Fe, Q, P

4 The following diagram of a Blast Furnace has been **incorrectly** labelled.



Which of the following modifications in the labelling should be made?

I Hot air should enter at **X** and waste gases should leave at **Y**.
II Iron ore, coke and limestone should be added at the top of the furnace.
III The slag should float above the iron.

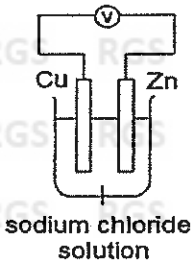
A **I** only
B **I** and **II**
C **I** and **III**
D **II** and **III**

5 In an electrolytic experiment involving aqueous silver nitrate, 1.08 g of silver was deposited at the cathode. What is the volume of the gas collected at the anode?

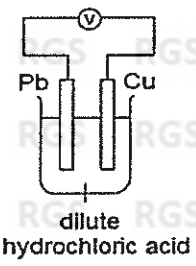
A 30.0 cm^3
B 60.0 cm^3
C 180 cm^3
D 240 cm^3

6 Which of the following set-ups will produce the greatest reading on the voltmeter?

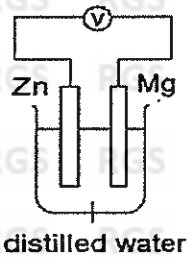
A



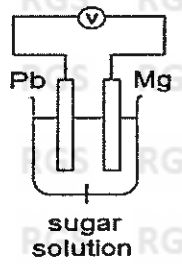
C



B



D



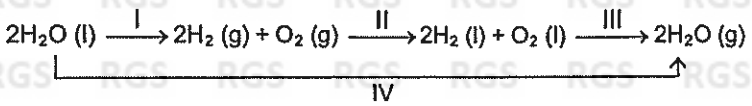
7 Commercially available 'cold packs' and 'heat packs' use reactions to cause a change in temperature.

One type of pack consists of two bags - an inner bag containing water, and an outer bag containing ammonium nitrate. When the inner bag of water is broken by squeezing the package, water that is released dissolves the ammonium nitrate. When this occurs, the temperature of the solution decreases.

Based on the information provided, which statement best explains whether ammonium nitrate is used as a cold or hot pack.

A Ammonium nitrate is used as a cold pack because it undergoes an exothermic dissolution process.
B Ammonium nitrate is used as a cold pack because it undergoes an endothermic dissolution process.
C Ammonium nitrate is used as a hot pack because it undergoes an exothermic dissolution process.
D Ammonium nitrate is used as a hot pack because it undergoes an endothermic dissolution process.

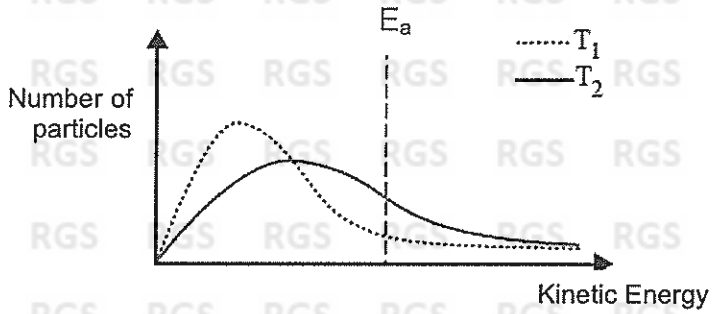
8 The scheme shows four stages **I** to **IV** in the process involving the production, storage and usage of hydrogen as a fuel.



Which stages are endothermic?

A **I** and **II**
B **I** and **IV**
C **II** and **III**
D **III** and **IV**

9 The diagram represents the distribution of kinetic energy of reactant particles at two different temperatures. Assuming that the areas under the two curves are equal, which statement is correct?



A At T_1, the activation energy is lower than that of T_2.
B At T_1, the enthalpy change of the reaction is higher than at T_2.
C At T_2, a greater number of particles have sufficient energy to react.
D At T_2, the reaction takes a longer time to complete.

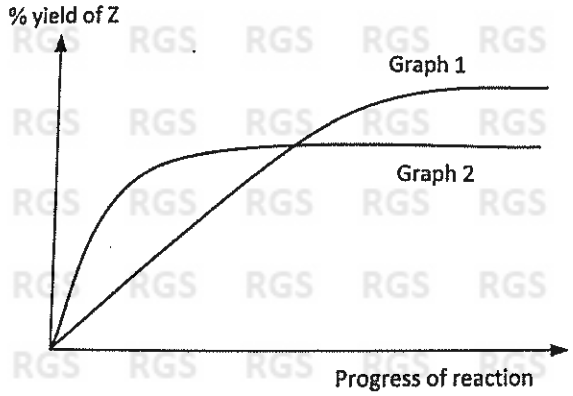
10 Which of the following correctly describes the effects on **ΔH** and **E_a** when the temperature is increased and when a catalyst is used?

	Increasing temperature		**Using catalyst**	
	ΔH	**E_a**	**ΔH**	**E_a**
A	unchanged	decrease	unchanged	decrease
B	unchanged	unchanged	unchanged	decrease
C	decrease	decrease	unchanged	decrease
D	Increase	unchanged	decrease	decrease

11 Which of the following acids will produce the fastest **initial** rate of reaction when 4.00 g of magnesium ribbon was added to it at room temperature and pressure?

A 15.0 cm^3 of 1.00 mol/dm^3 nitric acid
B 20.0 cm^3 of 1.00 mol/dm^3 sulfuric acid
C 25.0 cm^3 of 1.00 mol/dm^3 ethanoic acid
D 30.0 cm^3 of 1.00 mol/dm^3 hydrochloric acid

12 The graph for the equilibrium $X(g) + Y(g) \rightleftharpoons 3Z(g)$ with $\Delta H < 0$ is given below.



Which of the following changes could account for the change from Graph **1** to Graph **2**?

I Addition of catalyst
II Increases in temperature
III Increase in pressure

A Only **I** is correct.
B Only **II** is correct.
C **II** and **III** are correct.
D **I**, **II** and **III** are correct.

13 Which of the following alkenes can form an alcohol which **only** have **three** structural isomers?

A Butene
B Ethene
C Pentene
D Propene

14 Which of the following six-carbon organic compounds has the **lowest** boiling point?

A hexane
B cyclohexanol
C 2,2-dimethylbutane
D 3-methylpentane

15 Given that 100 tonnes of glycine, $H_2NCH_2CO_2H$, was polymerized and 68 tonnes of the polymer was obtained, which is the **maximum** percentage yield for this reaction?

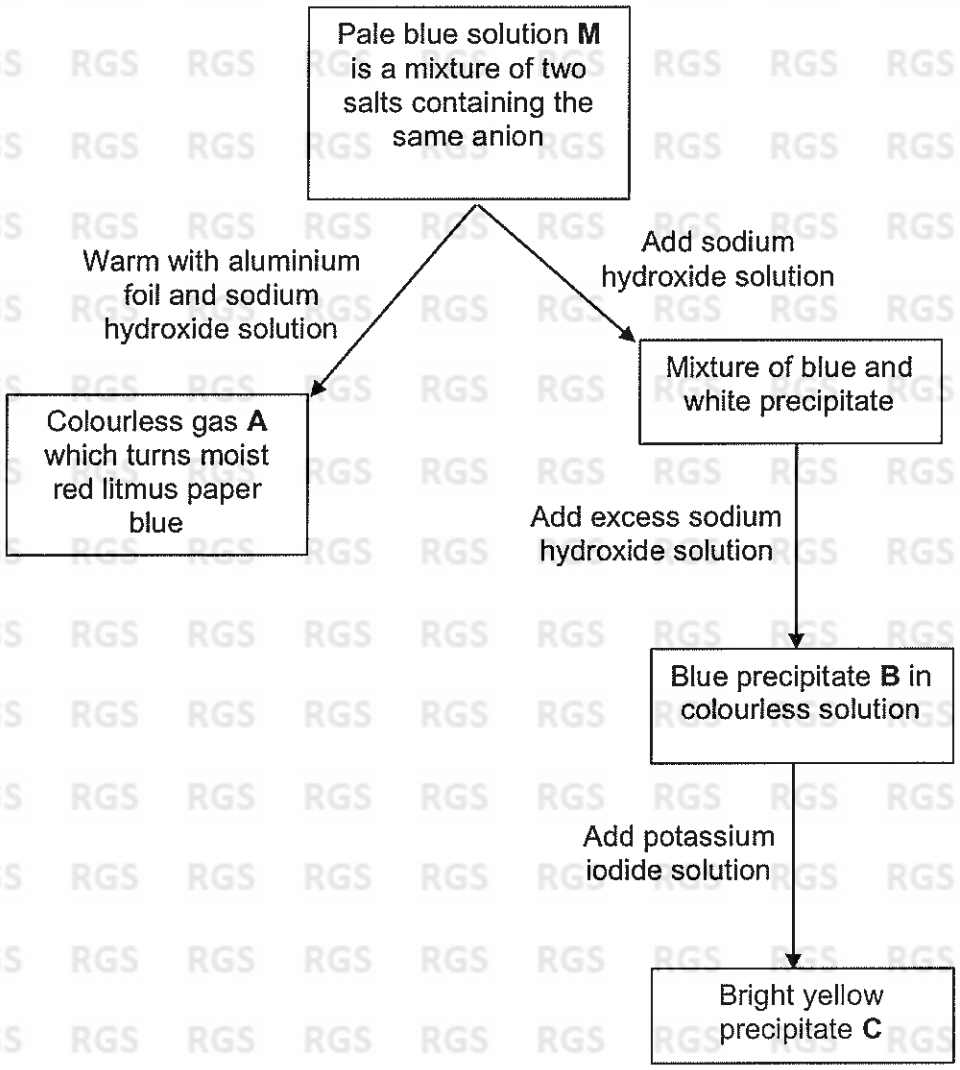
A 32 %
B 68 %
C 76 %
D 89 %

- BLANK PAGE -

Section B (55 Marks)

*Answer **ALL** questions and write your answers in the spaces provided.*

B1 Use the reaction scheme shown below to answer the following questions.



(a) Identify **A**, **B** and **C**.

A : .....

B : .....

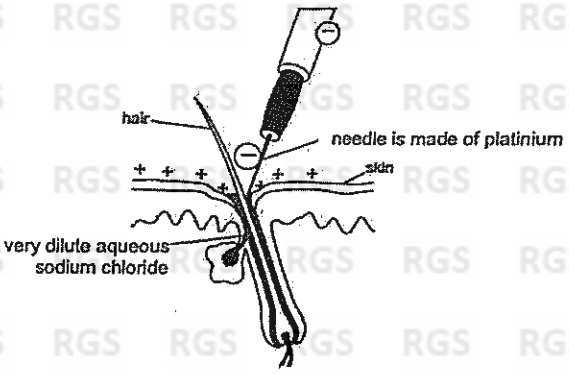
C : ..... [3]

(b) Write the **chemical formulae** of the **two salts** in mixture **M**.

..... [2]

B2 Electrolysis can be used to remove unwanted hair. The customer holds a metal bar which acts as a positive electrode. A needle, which acts as the negative electrode, is held by the operator.

(a) The solution around the tip of the needle is a very diluted sodium chloride solution.



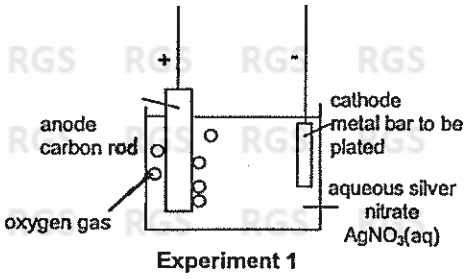
During electrolysis, a small amount of gas was formed at the surface of the skin. Name the gas formed near the needle and write the half-equation for the formation of the gas.

Name of gas formed : .....

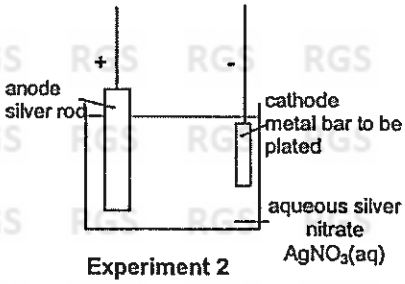
Half-equation : .....

[2]

(b) To improve the appearance of the metal bar held by the customer, two different experiments were set up by a student to electroplate the metal bar with silver.



Experiment 1



Experiment 2

After some time, it was observed that when no more silver is being deposited on the metal bar in experiment **1**, silver was still being deposited on the metal bar in experiment **2**.

Account for this observation.

.....

.....

.....

.....

.....

.....

[2]

B3 A 6.30 g sample of hydrated ethanedioic acid, $H_2C_2O_4.xH_2O$, was dissolved in water and the solution was made up to 250 cm^3.

A 25.0 cm^3 sample of this solution was acidified and titrated with 0.100 mol/dm^3 potassium manganate(VII) solution. 20.00 cm^3 of this potassium manganate(VII) solution was required to react fully with the ethanedioate ions, $C_2O_4^{2-}$, present in the sample.

(a) The MnO_4^- ions in the potassium manganate(VII) oxidise the ethanedioate ions.

(i) Complete and balance the ionic equation for the reaction between the manganate(VII) ions and the ethanedioate ions.

$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + \_\_\_\_\_H^+(aq) \rightarrow \_\_\_\_\_ Mn^{2+}(aq) + 10CO_2(g) + \_\_\_\_\_H_2O(l)$ **[1]**

(ii) Explain, using oxidation state, whether MnO_4^- has been oxidized or reduced in this reaction.

.....

.....

.....

..... **[2]**

(b) **(i)** Calculate the number of moles of manganate(VII) ions that had reacted with ethanedioate ions.

[1]

(ii) Calculate the number of moles of ethanedioate ions reacted during the titration.

[1]

(iii) Calculate the number of moles of ethanedioate ions in 250 cm^3 solution.

[1]

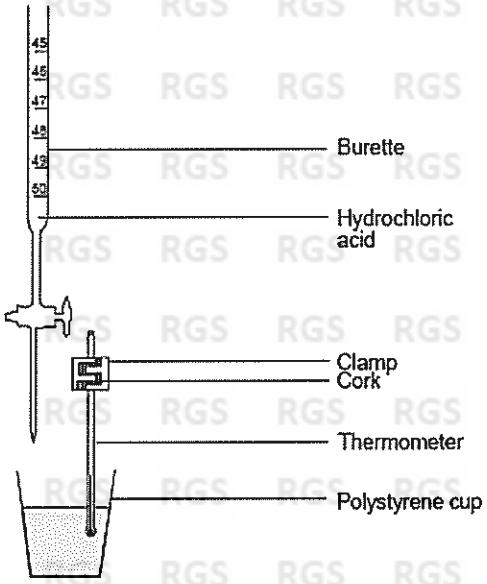
(iv) Calculate the relative molecular mass of $H_2C_2O_4.xH_2O$.

[1]

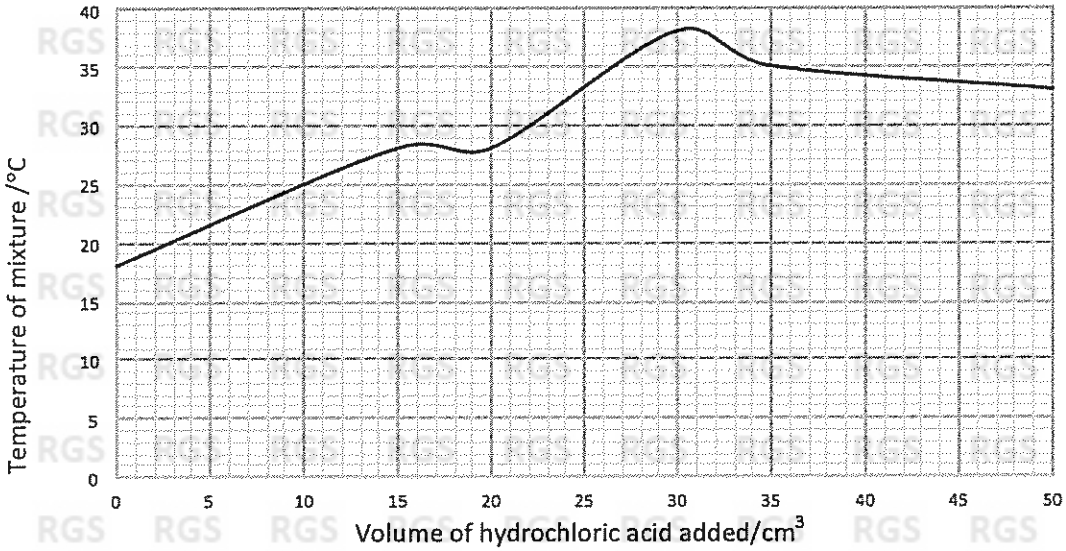
(v) Hence, prove that the value of x in $H_2C_2O_4.xH_2O$ is 2.

[1]

B4 A student investigated the energy released when hydrochloric acid completely neutralised sodium hydroxide solution. The student used the apparatus shown in the diagram below.



The student titrated hydrochloric acid of an unknown concentration against 25.0 cm^3 of 0.100 mol/dm^3 sodium hydroxide solution in a polystyrene cup. 30.00 cm^3 of the acid was required for complete neutralisation. The temperature of the mixture was measured as hydrochloric acid was added to the mixture. A graph of the results is shown below.



(a) The graph had been incorrectly drawn by including an anomalous result at 19.00 cm^3. Suggest a reason for the anomalous result when 19.00 cm^3 of hydrochloric acid was added.

.....[1]

(b) The formula to determine the amount of energy released is as follows:

$$Q = mc\Delta T$$

Where Q : amount of energy released (J)
m : mass of solution (g)
c = specific heat of water (4.2 J /g °C)
ΔT = change in temperature (°C)

Assuming that the density of the solution is equivalent to that of water, which is 1.0 g/cm^3, calculate the amount of energy released in the reaction.

[3]

(c) The student did the experiment again, starting with 50.0 cm^3 of sodium hydroxide solution instead of 25.0 cm^3.

Do you think the overall temperature change will **increase**, **decrease** or **remain the same**?

.....

[1]

B5 The speed of the following reaction is determined by how quickly ClO_2 disappears:

$$2ClO_2\,(aq) + 2OH^-\,(aq) \rightarrow ClO_3^-\,(aq) + ClO_2^-\,(aq) + H_2O\,(l)$$

Four experiments were carried out with different concentrations of ClO_2 and OH^-. The time taken for which ClO_2 disappears were measured and tabulated below.

Experiment	Concentration of ClO_2 / mol dm^{-3}	Concentration of OH^- / mol dm^{-3}	Initial rate of disappearance of ClO_2 / mol dm^{-3} s^{-1}
1	0.020	0.030	0.00276
2	0.040	0.030	0.01104
3	0.020	0.060	0.00552
4	0.040	0.060	0.02208

(a) State the relationship between the concentrations of the reactants and the rate of reaction? Justify your answer using the results in the table.

(i) The relationship between the concentration of **ClO_2** and rate of reaction based on ***experiment*** ..... and ..... is that .....

.....

.....

.....

[2]

(ii) The relationship between concentration of **OH^-** and rate of reaction based on ***experiment*** ..... and ..... is that .....

.....

.....

.....

[2]

(b) Explain the effect of **concentration** on the rate of reaction in terms of collisions between particles.

.....

.....

.....

.....

[2]

(c) Does the reaction rate depend on the concentration of ClO_2 and OH^- equally? Explain your answer with **supporting evidence** from the table of data results.

.....

.....

.....

.....

.....

.....

.....

[3]

B6 **(a)** **Reaction 1**

When hydrogen iodidie, HI, is heated in a closed tube, the following equilibrium is established.

$$2\,HI(g) \rightleftharpoons H_2(g) + I_2(g) \qquad \Delta H = +9.6\ kJ\ mol^{-1}$$

The operating conditions for reaction 1 are:

Temperature	55 °C
Pressure	Atmospheric pressure
Catalyst	No catalyst needed

Predict and ***explain*** how the equilibrium yield in **reaction 1** would change when the temperature is increased from **55 °C to 450 °C**.

.....

.....

.....

.....

.....

[3]

(b) **Reaction 2**

The following reaction is one of the steps involved in the production of sulfuric acid.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -197\ kJ\ mol^{-1}$$

The operating conditions for reaction 2 are:

Temperature	450 °C
Pressure	Atmospheric pressure
Catalyst	Vanadium(V) oxide catalyst

Explain why **reaction 2** should **not** be conducted at much higher or lower temperatures than 450 °C.

.....

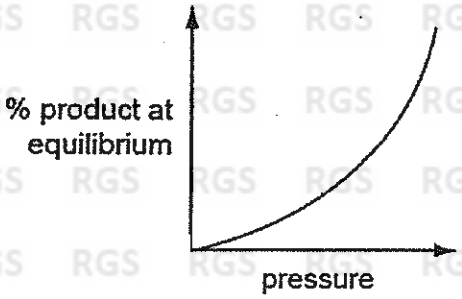
.....

.....

.....

[2]

(c) The graph below shows how the percentage of products at equilibrium could vary with pressure.



Which of the two reaction (**Reaction 1** or **Reaction 2**) does the above graph correspond to? Explain your answer.

.....

.....

.....

.....

[2]

B7 Cracking is the process of breaking down large hydrocarbon molecules into smaller hydrocarbon molecules. One mole of decane is cracked to form a mixture containing one mole of hexane and one mole of **substance X**.

(a) (i) One mole of decane is cracked to form a mixture containing one mole of hexane and one mole of **substance X**. State the molecular formula of **substance X.**

..... **[1]**

(ii) Suggest a reason why air should be prevented from entering the reactor.

..... **[1]**

(iii) In the boxes below, draw the **two *structural isomers*** of **substance X.**

Structural isomer 1	**Structural isomer 2**

[2]

(iv) State the condition(s) needed to make dichlorohexane from hexane.

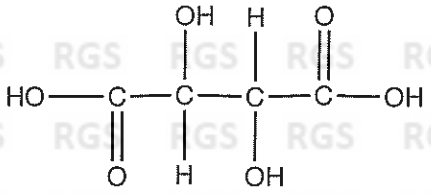
..... **[1]**

(b) Tartaric acid is found in baking powder.

(i) Tartaric acid reacts with sodium bicarbonate to form carbon dioxide. The chemical equation is as shown below:

tartaric acid + sodium carbonate → **substance Y** + carbon dioxide + water

The structure of tartaric acid is given below:



In the space below, draw the structural formula of **substance Y** from the reaction of tartaric acid with **excess** sodium carbonate.

[1]

(ii) Tartaric acid can undergo condensation polymerization with other tartaric acid molecules. In the space below, draw the **full structural formula** of the condensation polymer formed which contains **two repeating units**.

[3]

B8 (a) The flowchart below shows the reaction involving 3,3-dichloro-2-methylbutene. **Name** and **draw** the structural formula of the compounds that may be formed from these reactions.

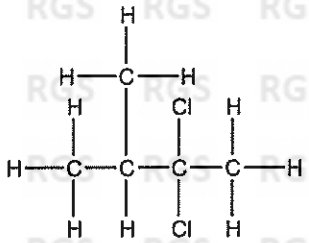
Structural formula:

Name of monomer **P**:

.....

polymer **P**

H_2, 200°C, nickel

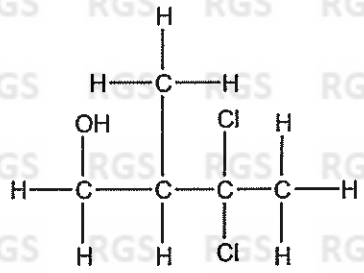


Name of Compound **T**:

.....

steam, 300°C, 60 atm; H_3PO_4

Structural formula:



Compound **Q**:
3,3-dichloro-2-methylbutanol

Hot $K_2Cr_2O_7$, H_2SO_4

Structural formula:

compound **R**

compound **Q**

Full Structural formula:

sweet-smelling compound **S**
$C_{10}H_{16}O_2Cl_4$

[6]

(b) Describe a **test** that would differentiate monomer **P** from compound **T**.

.....

.....

.....

.....

[2]

— End of Section B —

- BLANK PAGE -

- BLANK PAGE -

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key: proton (atomic) number; atomic symbol; name; relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).