香港考試及評核局
HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

香港中學文憑考試
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION

練習卷
PRACTICE PAPER

化學　　試卷一
CHEMISTRY PAPER 1

評卷參考
MARKING SCHEME

(2012年2月22日修訂稿)
(updated as at 22 Feb 2012)

本評卷參考乃香港考試及評核局專爲本科練習卷而編寫，供教師和學生參考之用。學生不應將評卷參考視爲標準答案，硬背死記，活剝生吞。這種學習態度，既無助學生改善學習，學懂應對及解難，亦有違考試着重理解能力與運用技巧之旨。

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SECTION A

Part I

Question No.	Key
1.	B
2.	D
3.	A
4.	D
5.	C
6.	B
7.	B
8.	C
9.	B
10.	B
11.	B
12.	A
13.	A
14.	C
15.	D
16.	A
17.	D
18.	A
19.	C
20.	C
21.	B
22.	A
23.	D
24.	D

Part II

Question No.	Key
25.	A
26.	D
27.	A
28.	B
29.	C
30.	A
31.	D
32.	B
33.	D
34.	C
35.	B
36.	C

SECTION B

General Notes for Teachers on Marking

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2. The marking scheme may not exhaust all possible answers for each question. Teachers should exercise their professional discretion and judgment in accepting alternative answers that are not in the marking scheme but are correct and well reasoned.

3. The following symbols are used:

/	A single slash indicates an acceptable alternative within an answer.
*	Step-mark (for questions involving calculations)
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4. In questions asking for a specified number of reasons or examples etc. and a student gives more than the required number, the extra answers should not be marked. For instance, in a question asking students to provide two examples, and if a student gives three answers, only the first two should be marked.

5. For questions involving calculations, the number of significant figures in candidates' final answers should tally with that given in the question.

6. Chemical equations should be balanced except those in reaction schemes for organic synthesis. For energetics, the chemical equations given should include the correct state symbols of the chemical species involved.

7. In the question paper, questions which assess candidates' communication skills are marked with an asterisk (*). For these questions, the mark for effective communication (1 mark per question) will be awarded if candidates can produce paragraph-length answers which are easily understandable. No marks for effective communication will be awarded if the answers produced by candidates are written in note form, and/or contain a lot of irrelevant materials.

Part I

			Ma
1.	(a)	(i) $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$	1
		or, $ZnO + 2H^+ \rightarrow Zn^{2+} + H_2O$	(1)
		(ii) Unreacted ZnO(s) can be seen.	1
		(iii) To ensure that the product is not contaminated with sulphuric acid.	1
		or, The unreacted ZnO(s) can be removed by filtration, but it is difficult to remove the excess H_2SO_4(aq).	(1)
			(3)
	(b)	Remove a drop of the solution with a glass rod, and see whether any solid forms when the drop cools. (Accept other correct answers.)	1
			(1)
	(c)	Washing with distilled water can remove the water-soluble impurities.	1
		Using a small amount of water / cold water helps reduce loss of the salt.	1
			(2)
	(d)	Any ONE of the following :	1
		– drying the crystals between filter papers	(1)
		– putting the crystals in a desiccator.	(1)
		(DO NOT accept methods which involve strong heating.)	(1)
	(e)	Zn / $Zn(OH)_2$ / $ZnCO_3$	1
			(1)

2. (a) Some components of wine (substances with a pleasant odour) can be oxidised by oxygen in air to give products that have a flat taste. 1
or, Ethanol in wine can be oxidised by oxygen in air to give ethanal / ethanoic acid. (1)
(1)

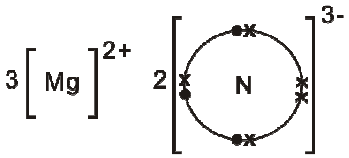
(b) (i) The outermost shell of an argon atom is a <u>stable octet structure</u>. ∴ Ar does not readily form bonds with other atoms. 1

(ii) Ar is denser than air. It displaces air from the bottle, and thus prevents the wine from contact with air. 1

(iii) He is less dense than air. It will not displace air / it will easily diffuse from the bottle. 1
(3)

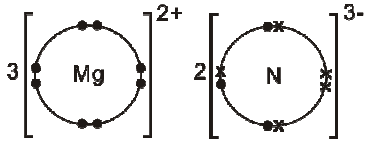
(c) The substances with a pleasant odour are <u>volatile organic compounds</u>. Pumping air out from the bottle may also remove these substances. 1
(1)

3. (a) (i)



1

or,



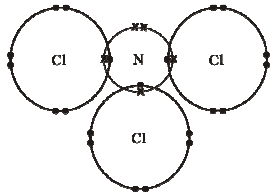
(1)

(ii) $Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$ 1

No. There is no change in oxidation number of any atom. 1

(3)

(b) (i)



1

(ii) The nitrogen in NCl_3 and that in NH_3 both have the same number of electron bond-pairs and lone electron pairs / have three electron bond-pairs and one lone electron pair in their outermost shells. 1

The repulsion between these electron pairs causes both NCl_3 and NH_3 to adopt a trigonal pyramidal shape. 1

(3)

4. (a) Dissolve 1.14 g of $\mathbf{M}_2CO_3(s)$ in some distilled water / deionised water in a beaker. Transfer the solution to a 100.0 cm^3 volumetric flask. 1

Wash the beaker with distilled water / deionised water and transfer the washings into the volumetric flask. 1

Add distilled water / deionised water up to the graduation mark of the volumetric flask. Shake the volumetric flask to ensure its content is well mixed. 1

(3)

(b) No. of moles of $H^+(aq)$ used

$= 0.085 \times 25.30 \times 10^{-3}$

$= 2.15 \times 10^{-3}$ 1

$\mathbf{M}_2CO_3 + 2H^+ \rightarrow 2\mathbf{M}^+ + CO_2 + H_2O$

No. of moles of $\mathbf{M}_2CO_3$ in 100 cm^3 of the solution

$$= 2.15\times10^{-3} \times \frac{100}{10} \times \frac{1}{2}$$ 1*

Formula mass of $\mathbf{M}_2CO_3 = \dfrac{1.14\times2}{0.0215}$

$= 106$ 1

Let x be the relative atomic mass of **M**

$2x + 12 + 16\times3 = 106$

$x = 23$

M is likely to be Na. 1

(4)

* step mark

5. (a)

	C		H
% by mass	81.8		18.2
Atom ratio	$\frac{81.8}{12}$	:	$\frac{18.2}{1}$
=	6.82	:	18.2
=	3	:	8

1*

Alkane has the general formula C_nH_{2n+2} 1

$\therefore$ **X** is propane / C_3H_8 . 1

(3)

(b) Fractional distillation of the petroleum gaseous fraction. 1

or, Cracking of naphtha / heavy oil (or any appropriate petroleum fraction) followed by fractional distillation of the products. (1)

(1)

(c) (i) **X**: C_3H_8 easily undergoes complete combustion to give CO_2 and H_2O. The products pose little harm to the environment. 1

(ii) Kerosene: kerosene undergoes incomplete combustion to give a luminous flame. The flame can be more easily seen. 1

(Accept other reasonable answers.)

(2)

* step mark

6. (a) †propane-1,3-diol / 1,3-propanediol — 1

(1)

(b) All three compounds have a hydroxyl group / are monohydric alcohols. The boiling point of these compounds depends on the strength of van der Waals forces between molecules. — 1

The strength of van der Waals forces in alcohols increases with the carbon chain length / molecular size. Boiling point increases in the order: **A < B < C** — 1

(2)

(c) For isomeric compounds with the same functional group, the <u>strength of intermolecular force is affected by the shape of the molecules</u>. — 1

The structure of $CH_3CH_2CH_2OH$ allows the molecules to have a greater area of contact than those of $CH_3CH(OH)CH_3$. $\therefore CH_3CH_2CH_2OH$ has a greater density. — 1

or, The structure of $CH_3CH(OH)CH_3$ makes the formation of H-bonds less effective. $\therefore CH_3CH(OH)CH_3$ has a smaller density. — (1)

(2)

(d) **F** — 1

The rate at which the steel balls drop depends on the <u>viscosity of the liquid / the resistance (frictional force) experienced by the ball</u>. This is related to the intermolecular attraction of the liquids. — 1

In the three compounds, the intermolecular attraction is predominately H-bond. <u>The no. of H-bonds formed per molecule is 1 in **D**, 2 in **E** and 3 in **F**. / **F** forms the greatest number of hydrogen bonds per molecule.</u> $\therefore$ **F** is the most viscous and the ball will drop most slowly. — 1

or, **F** has the highest b.p. among the three compounds. Its intermolecular attraction is strongest. $\therefore$ The ball will drop most slowly in **F**. — (1)

Effective communication (Award 1 mark if candidates can express their ideas clearly.) — 1

(4)

† correct spelling

7. (a) (i) No. of moles of CaO(s) used $= \frac{3.0}{(40.1+16)}$

$= 0.053$ 1*

Heat liberated $= 53 \times 4.2 \times (46.7 - 28.2)$ 1*

$= 4118$ J

$\Delta H = -\frac{4118}{0.053}$ 1*

$= -77.0$ kJ mol^{-1} 1

(Acceptable range: –72.6 to –77.0 kJ mol^{-1})

(ii) Any ONE of the following: 1

– PP is not a perfect heat insulator; heat is lost to the surroundings.

– Some CaO(s) may have reacted with $H_2O(\ell)$ in air.

(Accept other reasonable answers.)

(5)

(b) (i) Any THREE of the following (at least 1 mark should be allocated to each part): 3

(I) PP is a poor conductor of heat. Using PP container to hold CaO(s) will protect hands from skin burns. (1)

PP can withstand the high temperature caused by the reaction of CaO(s) with $H_2O(\ell)$. (1)

(II) Compounds of Al are non-toxic. They <u>will not cause food poisoning</u>. (1)

Al is a good conductor of heat. The heat liberated from the reaction of CaO(s) with $H_2O(\ell)$ can readily be transmitted to the coffee beverage. (1)

Aluminium is covered by a layer of unreactive $Al_2O_3(s)$, which prevents the metal from corrosion. (1)

(Accept other reasonable answers.)

(ii) The reaction of CaO(s) and $H_2O(\ell)$ is highly exothermic, and CaO(s) is an inexpensive material. 1

(Accept other reasonable answers.)

(4)

* step mark

8. (a) anode : $CH_3OH(aq) + H_2O(\ell) \rightarrow CO_2(g) + 6H^+(aq) + 6e^-$ 1
cathode : $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(\ell)$ 1
(2)

(b) (i) Methanol does not conduct electricity. It is not suitable to be used as the reaction medium for the electrochemical reaction. 1
or, H_2O is involved in the half-equations. (1)
or, Acid is involved in the electrochemical reaction. (1)

(ii) Toxic and flammable 1
(2)

(c) Accept both 'Yes' and 'No' answers. Marks will be awarded only to the explanation. 2
For 'No' answers,
– Electrical sockets can be found in most places. DMFC laptop computers will only be used in places where electric sockets are not available. (1)
– The cost for the manufacture of methanol is higher than that for the generation of electricity in most places. (1)

For 'Yes' answers,
– The use of DMFC laptop computers will become prevalent when stringent environmental laws are enforced as the disposal of DMFCs causes less harm to the environment than other rechargeable cells / methanol is a greener fuel than hydrocarbons. (1)
– DMFC laptop computers will be commonly used in field work where electric sockets are not available. (1)
(Accept other reasonable answers.)
(2)

Part II

Ma

9. (a)

	MgO	Al_2O_3	SiO_2	P_4O_{10}	SO_2	
Structure	**IC**	**IC**	**CN**	**SM**	**SM**	1
Acid-base property	**BA**	**AM**	**AC**	**AC**	**AC**	1

(2)

(b) Ionic oxides are basic, while covalent oxides are acidic. 1

(1)

(c) (In this question, award 1 mark for the reagents used in each of tests for acidic, basic and amphoteric oxides, and 1 mark for a correct observation. One possible method is shown below.) 4

Add each oxide to HCl(aq) and measure the pH of the mixture. Only MgO(s) and Al_2O_3(s) react with HCl(aq) and the pH increases. These two oxides demonstrate basic properties.

Add each oxide to NaOH(aq) and measure the pH of the mixture. Only Al_2O_3(s), SiO_2(s), P_4O_{10}(s) and SO_2(g) react with NaOH(aq) (SiO_2(s) reacts with hot conc. NaOH(aq)), and the pH decreases. These oxides demonstrate acidic properties.

Al_2O_3(s) reacts in both cases. It is amphoteric.

(Accept other experimental method.)

Effective communication (Award 1 mark if candidates can express their ideas clearly.) 1

(5)

Marks

10. (a) Colorimetry / using colorimeter 1

(1)

(b) (i) The rate of consumption of MnO_4^-(aq) ions is slow at the beginning (from 0 to 180 s) and then increases rapidly (from 200 to 340 s). 1

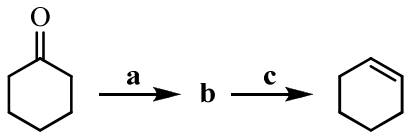
It is likely to be due to the building up of the concentration of the product which catalyses the reaction. 1

(ii) Repeat the experiment with a few drops of Mn^{2+}(aq) firstly added to the reaction mixture. 1

Consumption of MnO_4^-(aq) ions will be faster at the beginning if Mn^{2+}(aq) is a catalyst. 1

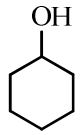
(4)

11.



a: (1) $LiAlH_4$ / ether; (2) H_3O^+ 1

b:



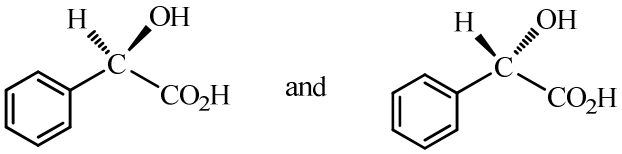
1

c: excess conc. H_3PO_4 (or conc. H_2SO_4); heat / Al_2O_3(s); heat 1

(3)

Marks

12. (a) (i)



1+1

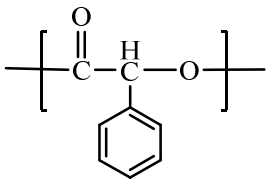
(ii) They turn the plane of polarisation of a beam of plane polarised light in opposite directions. 1

or, One of the compounds is laevorotatory while the other is dextrorotatory. (1)

or, Crystals of the two compounds have different appearance. (1)

(3)

(b) Repeating unit : 1



(1)

13. (a) $$K_c = \frac{[Cu(NH_3)_4^{2+}(aq)]}{[Cu^{2+}(aq)]\,[NH_3(aq)]^4}$$ 1

(1)

(b) $$K_c = \frac{0.08}{(0.002)\,(0.0014)^4}$$

$= 1.04 \times 10^{13}$ (mol dm^{-3})$^{-4}$ 1+1

(1 mark for answer; 1 mark for correct units)

(2)

(c) $H_2SO_4(aq)$ reacts with the $NH_3(aq)$ present:

$H^+(aq) + NH_3(aq) \rightarrow NH_4^+(aq)$ 1

or, $H_2SO_4(aq) + 2NH_3(aq) \rightarrow (NH_4)_2SO_4(aq)$ (1)

Removal of $NH_3(aq)$ causes the position of the following equilibrium to shift to the left. 1

$Cu^{2+}(aq) + 4NH_3(aq) \rightleftharpoons Cu(NH_3)_4^{2+}(aq)$

$NH_3(aq)$ is a weak base:

$NH_3(aq) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$ 1

When $[Cu^{2+}(aq)]$ builds up, it will react with the $OH^-(aq)$ ions to give the blue precipitate.

$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$ 1

When excess $H_2SO_4(aq)$ is added, it will react with the $Cu(OH)_2(s)$ formed to give a blue solution.

$Cu(OH)_2(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + 2H_2O(\ell)$ 1

(3 marks for chemical equations; 1 mark for explanation of the shift in equilibrium position; 1 mark for the formation of blue precipitate.)

(5)

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1. (a) (i) Any ONE of the following: 1
– Reichstein process is used for synthesising vitamin C, which is in great demand as it cannot be synthesised in human body. (1)
– Reichstein process provides a synthetic route to convert D-Glucose, a sugar which is highly abundant and cheap, to L-ascorbic acid. (1)
– The enzymatic reaction in Reichstein process inverts the sugars from D- to L-isomer. (1)
(Accept other reasonable answers.)
(1)

(ii) †reduction / catalytic hydrogenation 1
(1)

(iii) (I) Commonly used oxidising agents will also oxidise the other hydroxyl groups in D-sorbitol / are not selective as compared with the enzyme. 1
or, The enzyme can selectively oxidise the second –OH group in D-sorbitol to give L-sorbose. (1)

(II) At pH<4 or pH>6, the enzyme will undergo denaturation / the (tertiary/secondary) structure of the enzyme will change leading to loss of catalytic activity. 1
(2)

(iv) This method uses a catalyst (the enzyme) instead of stoichiometric reagents. 1
It uses less hazardous chemicals (e.g. MeOH / acid). 1
(2)

(b) (i) Any ONE of the following: 1
– The rate of reaction is proportional to the concentration of the reactant. (1)
– The half-life of the reaction is constant. (1)
(1)

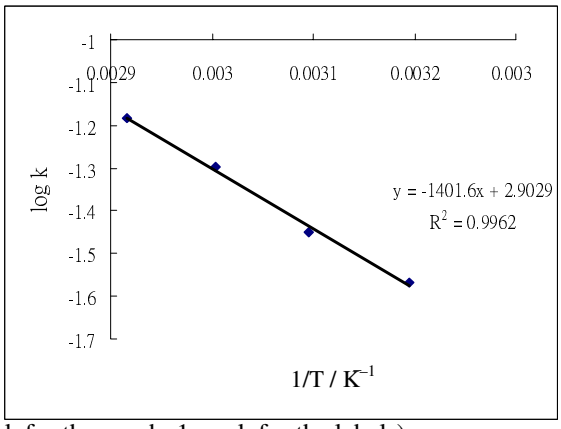
(ii) $\log\ k = \text{constant} - \dfrac{E_a}{2.3\,RT}$ 1

T	313	323	333	343
$k/10^{-3}$	27.0	35.4	50.4	65.4
$1/T$	3.195×10^{-3}	3.096×10^{-3}	3.003×10^{-3}	2.915×10^{-3}
$\log k$	–1.569	–1.451	–1.298	–1.184

† correct spelling

1. (b) (ii)

Graph of log k against $\frac{1}{T}$ 2



(1 mark for the graph; 1 mark for the labels)

Slope : $-1402 = -\frac{E_a}{2.3R}$ 1

$E_a = 1402 \times 8.31 \times 2.3$

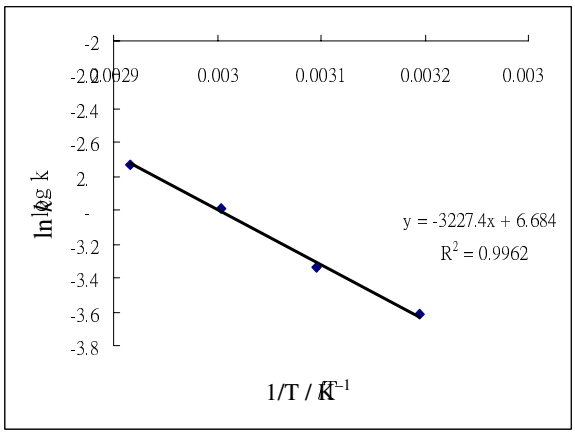
$= 26.8$ kJ mol^{-1} 1

(Acceptable range: 24.5 to 29.0 kJ mol^{-1})

or, $\ln k = \text{constant} - \frac{E_a}{RT}$ (1)

T	313	323	333	343
$k/10^{-3}$	27.0	35.4	50.4	65.4
$1/T$	3.195×10^{-3}	3.096×10^{-3}	3.003×10^{-3}	2.915×10^{-3}
$\ln k$	–3.612	–3.341	–2.988	–2.727

Graph of ln k against $\frac{1}{T}$ (2)



(1 mark for the graph; 1 mark for the labels)

Slope : $-3227 = -\frac{E_a}{R}$ (1)

$E_a = 3227 \times 8.31$

$= 26.8$ kJ mol^{-1} (1)

(Acceptable range: 24.5 to 29.0 kJ mol^{-1})

(5)

1. (c) (i) At the cathode, $H^+(aq)$ is preferentially discharged because H^+ occupies a lower position than Na^+ in the electrochemical series. 1

$2H^+(aq) + 2e^- \rightarrow H_2(g)$ 1

At the anode, $Cl^-(aq)$ is preferentially discharged because its concentration is high. 1

$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ 1

The membrane only allows cations to pass through it.

As there is a higher concentration of cations in the anode compartment (because anions are removed), there will be a net flow of $Na^+(aq)$ ions from the anode compartment to the cathode compartment, and concentrated NaOH(aq) is formed. 1

(5)

(ii) $Cl_2(g) + 2NaOH(aq) \rightarrow NaOCl(aq) + NaCl(aq) + H_2O(\ell)$ 1

or, $Cl_2(g) + 2OH^-(aq) \rightarrow OCl^-(aq) + Cl^-(aq) + H_2O(\ell)$ (1)

(1)

(iii) Accept both 'Yes' and 'No' answers.

For 'No' answers,

– The production of H_2 in chloroalkali industry requires the use of electricity, which is commonly generated by burning fossil fuel (a major source of air pollutants). 1

– $Cl_2(g)$ is the main product of the chloroalkali industry. Large scale production of $H_2(g)$ will yield surplus $Cl_2(g)$. The disposal of the unused $Cl_2(g)$ is costly and will cause air pollution problems. 1

For 'Yes' answers,

– Burning of $H_2(g)$ gives water only. (1)

– If there is a cheap source of electricity (e.g. photovoltaic cell), production of $H_2(g)$ by electrolysis of brine can be a means of reducing air pollution problems. (1)

(Accept other reasonable answers.)

(2)

2. (a) (i) (I) †face-centred cubic 1

(II) No. of atoms = $8(\frac{1}{8}) + 6(\frac{1}{2})$ 1*

$= 4$ 1

(III) $\text{Density} = \frac{4 \times 27.0}{(4.05 \times 10^{-8})^3 \times 6.02 \times 10^{23}}$ 1*

$= 2.7 \text{ g cm}^{-3}$ 1

(5)

(ii) (I) In aluminium alloys, the introduction of atoms of other elements into the lattice causes distortion of the regular arrangement of the Al atoms. 1

Relative motion between layers of atoms will be hindered. 1

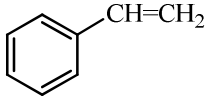
(II) Li is the least dense metal. Li-Al alloys have very low densities and are suitable materials for making aircraft bodies. 1

(3)

(iii) (I) Biotite has a layered structure. The attraction force between layers is much weaker than the attraction force between atoms within a layer. 1

(II) as insulator in capacitors 1

(2)

(b) (i) (I)  1

(II) injection moulding / vacuum forming 1

(2)

(ii) (I) SAN, in general, is not made from styrene and acrylonitrile in 1:1 mole ratio. 1

The two types of monomers distribute randomly along the polymer molecule. 1

(II) In PS, the polymer molecules are attracted to each other by weak van der Waals forces. 1

Acrylonitrile has a polar –C≡N group. 1

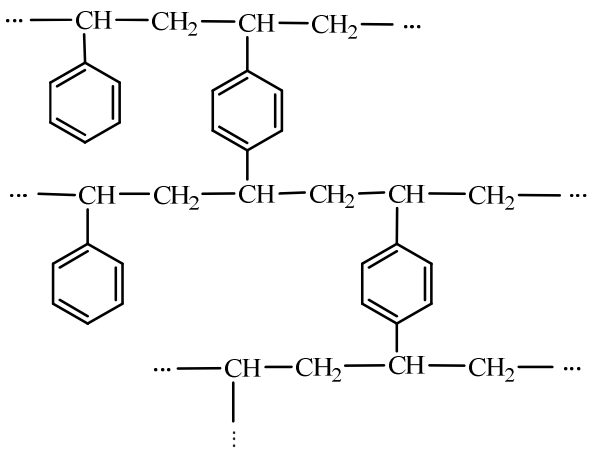
The –C≡N groups hold the polymer molecules together by stronger dipole-dipole interaction. 1

(5)

† correct spelling

* step mark

2. (b) (iii) The copolymer is a thermosetting plastic with the following structure: 1



1

(Accept other correct representations of the above structure.)

The cross-linkages make the copolymer hard and rigid. As the copolymer has a giant covalent network structure, it does not melt upon heating. 1

(3)

3. (a) (i) carboxylic acid / carboxyl group (because **X** is soluble in NaOH(aq)) 1
(Also accept phenol.)

(1)

(ii) †separating funnel 1

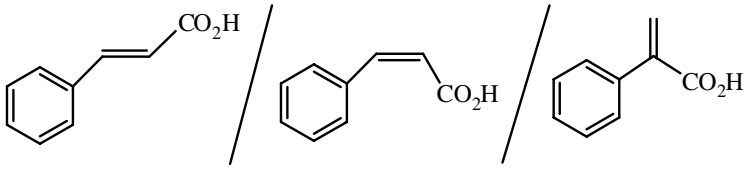
(1)

(iii) Step 1 : Allow **X** to dissolve in NaOH(aq) to give (carboxylate) anions / a salt. 1
Step 2 : Allow the non-polar impurities to dissolve in hexane while the (carboxylate) anions / salt to stay in the aqueous layer. 1
or, Separate the non-polar impurities (in hexane) from the salt of **X**. (1)
Step 3 : Regenerate the (carboxylic) acid (which is insoluble in water) by adding acid. 1

(3)

(iv) **X** possesses a C=C bond because it decolourises Br_2 in CH_3Cl_3. 1
In the mass spectrum, the peak at m/z = 148 is due to the molecular ion. 1
Any TWO of the following: 2
The peak at m/z = 131 is due to the cation formed from the molecular ion by stripping off a –OH. (1)
The peak at m/z = 103 is due to the cation formed from the molecular ion by stripping off a $–CO_2H$. (1)
The peak at m/z = 77 shows that **X** carries a benzene ring (m/z for $C_6H_5^+$ ion = 77). (1)

Possible structures of **X**: 1



(5)

(v) (I) Put the chromatographic plate into a jar that is saturated with iodine vapour. The spots will appear brown. 1

or, Irradiate the plate with UV. The stationary phase is fluorescent while the two spots are not. (1)
(Accept other correct answers.)

(II)
$$R_f = \frac{\text{distance travelled by X}}{\text{distance travelled by solvent}}$$
$$= \frac{9.5}{(50-3-2.5)}$$
$$= \frac{9.5}{44.5}$$
$$= 0.21$$ 1

(III) column chromatography (using the same moving phase and stationary phase) 1

(3)

† correct spelling

3. (b) (i) Wash the precipitate thoroughly with deionised water. 1
Dry the precipitate in an oven / ensure that the precipitate is dried before it is weighed. 1
(2)

(ii) $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

No. of moles of Ba^{2+} present $= \dfrac{0.291}{(137.3+32.1+16\times4)}$ 1*

$= 1.25\times10^{-3}$

Mass of Ba in the sample $= 1.25\times10^{-3}\times137.3$

$= 0.171$ 1*

% by mass of Ba in the sample $= \dfrac{0.171}{0.305}$

$= 56.1$ 1

(Acceptable range: 56.0 to 56.4)

(3)

(iii) Any TWO of the following: 2
– The reaction must be significantly complete, i.e. the precipitate is practically insoluble. (1)
– The product (precipitate) should have definite chemical composition. (1)
– The rate of reaction must be fast enough to be practical. (1)
(Accept other correct answers.) (2)

*step mark