Marking Schemes

This document was prepared for markers' reference. It should not be regarded as a set of model answers. Candidates and teachers who were not involved in the marking process are advised to interpret its content with care.

Chemistry
Paper 1

SECTION A

Question No.	Key	Question No.	Key
Part I		**Part II**	
1.	B (56%)	25.	D (76%)
2.	C (70%)	26.	B (71%)
3.	D (78%)	27.	A (57%)
4.	D (60%)	28.	B (69%)
5.	C (80%)	29.	B (48%)
6.	B (65%)	30.	D (83%)
7.	B (68%)	31.	B (43%)
8.	C (82%)	32.	D (45%)
9.	A (59%)	33.	A (58%)
10.	A (63%)	34.	C (55%)
11.	D (50%)	35.	A (59%)
12.	B (79%)	36.	C (65%)
13.	B (75%)		
14	C (49%)		
15.	C (83%)		
16.	A (65%)		
17.	D (42%)		
18.	A (66%)		
19.	D (68%)		
20.	A (63%)		
21.	B (41%)		
22.	A (72%)		
23.	C (47%)		
24.	C (48%)		

Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.

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

2018年香港中學文憑
HONG KONG DIPLOMA OF SECONDARY EDUCATION 2018

CHEMISTRY PAPER 1 & COMBINED SCIENCE (CHEMISTRY) SECTION B

MARKING SCHEME

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/	A single slash indicates an acceptable alternative within an answer.
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6. Award zero marks for answers which are contradictory.

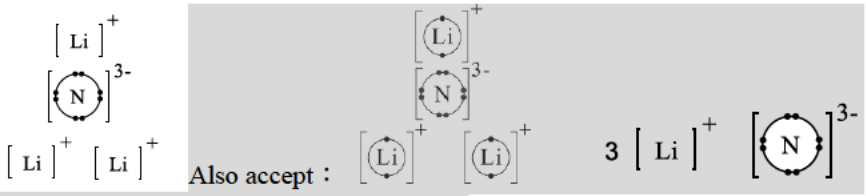
7. Chemical equations should be balanced except those in reaction schemes for organic synthesis. For energetics, the chemical equations given should include the correct state symbols of the chemical species involved.

8. 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 answers which are easily understandable. No marks for effective communication will be awarded if the answers produced by candidates contain a lot of irrelevant materials and/or wrong concepts in chemistry.

Part I

Marks

1. (a) (i) $6.0\,x + 7.0\,(1-x) = 6.9$ 1*
$x = 0.1 = 10.0\%$ (Accept answer without unit) (Accept 0.1, 10, 10.0) 1

(ii) 

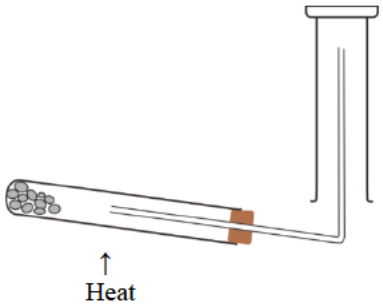
(The electron diagram should have brackets) 1

(b) (i) $6Li + N_2 \rightarrow 2Li_3N$ 1
(State symbols not required) (Ignore incorrect state symbols)

(ii) $y / 6.9 = 3 \times (1.25 / 34.7)$ 1*
$y = 0.746$ g (Also accept 0.745, 0.75; Not accept 0.750) (Correct unit is required) 1
(Accept max. 4 decimal places)

(c) Lithium oxide / Lithium peroxide † 1

2. (a) Set-up for preparation - boiling tube with reagents and HEAT (with stopper) 1
(Accept heating the reagents in a flask)
Upward delivery of ammonia gas (without stopper) 1
(Accept collecting the gas with a gas syringe)



(b) (i) Ammonia is soluble in water / Ammonia reacts with water to form aqueous ammonia. 1
As all ammonia dissolves, the atmospheric pressure forces the water in the trough to inject into the flask through the glass tubing / the pressure inside the flask is reduced. 1

(ii) The water in the flask turns from colourless to pink. 1
It is because aqueous ammonia is alkaline. 1

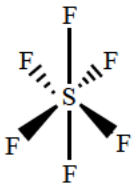
Marks

3. (a) The electrostatic attraction between Ba^{2+} and Cl^- in $BaCl_2$ is ionic bond while intermolecular attraction between OCl_2 molecules are van der Waals' forces. / 1
$BaCl_2$ is an ionic compound while OCl_2 has a simple molecular structure.
As ionic bond is much stronger than van der Waals' forces / intermolecular forces between OCl_2 molecules, $BaCl_2$ would have a higher melting point than OCl_2. 1

(b) $NH_3 > PH_3 > CH_4$
- Both molecules of PH_3 and CH_4 are held by van der Waals' forces / intermolecular forces. 1
- The van der Waals' forces between PH_3 are stronger that those between CH_4 because of the larger molecular size of PH_3 than CH_4. 1
(Accept: PH_3 molecule has more electrons than CH_4;
Not Accept: PH_3 has a higher molecular mass than CH_4)

OR
- Intermolecular forces between PH_3 molecules are stronger than that between CH_4 molecules as PH_3 is polar while CH_4 is non-polar. (2)
- Hydrogen bond exists among NH_3 molecules that is stronger than van der Waals' forces. 1

(c) 1



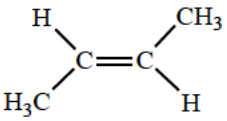
For CS:

(b) (i) carboxylic acid / carboxyl † 1
ester † 1

(ii) -COOH group of aspirin reacts with hydrogencarbonate ions in water 1
to give a soluble sodium salt / soluble ions / soluble $-COO^-$. 1
(Not accept soluble substance / soluble compound)
(Accept: $RCOOH \xrightarrow{HCO_3^-}$ soluble $RCOO^-$ / $RCOO^-$ (aq)) (2)

Marks

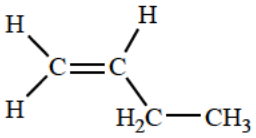
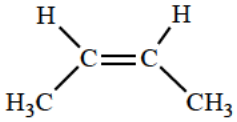
4. (a) • Petroleum is formed when large quantities of dead marine organisms (, such as planktons and algaes), 1
• that are buried underneath sedimentary rock and subjected to intense heat and pressure for a long time. 1

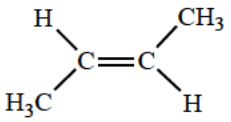
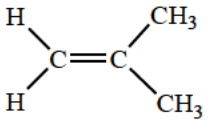
(b) (i)  1

(ii) but-1-ene or 2-methylpropene / methylpropene † 1

For CS:

(b) Any two: 2

 or  or

 or 

Accept：

$CH_3CH{=}CHCH_3$

$CH_3CH_2CH{=}CH_2$ $CH_3{-}\overset{\overset{CH_3}{|}}{C}{=}CH_2$

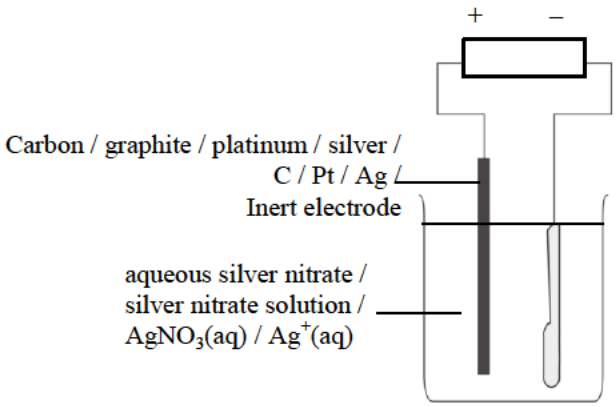
(c) (i) Pass excess H_2 to ethene in the presence of Pt / Pd / Ni. / 1
Catalytic hydrogenation
(For CS: Need not to mention catalysis)

(ii) Ethene turns Br_2(in CH_3CCl_3), 1
from brown / orange to colourless while ethane does not. (Not accept yellow) 1
(Aceept $KMnO_4/H^+$ - purple to colourless /
$KMnO_4$ - purple to brown (precipitate)
$KMnO_4/OH^-$ - purple to brown (precipitate))

(Accept: Combustion test (1); ethene gives more sooty flame, while ethane gives less sooty flame (1))

Marks

5. (a)



2

- All 3 labels correct: 2 marks
- Any 1 label correct: 1 mark

(Accept drawing of battery with correct poles / only + and – signs at the correct positions / electron flows in correct direction in the external circuit.)

(b)
- Connect zinc/magnesium blocks (through connecting wires) to the surface of the pipelines. / Sacrificial protection. 1
- Zinc/Magnesium can release electrons more readily than iron. / Zinc/Magnesium is more reactive than iron. / Zinc/Magnesium has greater reducing power than iron. / Zinc/Magnesium is higher than iron in the ECS. 1

OR

- Connect the negative electrode of a D.C. source (through connecting wires) to the surface of the pipelines (and the positive electrode to a platinum electrode) / Cathodic protection (1)
- The electrons provided by the D.C. source prevent iron from releasing electrons. (1)

(Do not accept wrapping with plastics / alloying / use stainless steel pipelines)

6. (a) (i) $6CO_2(g) + 6H_2O(l) \rightarrow C_6H_{12}O_6(s) + 6O_2(g)$ (Ignore state symbols) 1

(ii) $\Delta H = \underline{-1274 - 6 \times (-394-286)} = -1274 - 6 \times (-680) = -1274 - (-4080)$ 1*

$= +2806$ kJ mol^{-1} (Do not accept + 2800, + 2810 kJ mol^{-1}) 1

(iii) Light / solar energy changes to chemical energy. 1

(b) (i) Let C be the heat capacity of the calorimeter,

$-715 \times (1.58 / 32.0) = -C \times 18.5$ … (1) 1*

$\Delta H \times (1.02 / 100.0) = -C \times 25.8$ … (2) 1*

$\Delta H = -4826.8$ kJ mol^{-1} (Accept –4823 to –4831.1) 1

Accept $\Delta H \times m/M = C \times \Delta T$ as an alternative to (1) .

(ii) Incomplete combustion. / Some methanol or heptane evaporates. 1

Marks

7. (a) conical flask † 1

(b) yellow to orange (Do not accept red) 1

(c) Number of moles of $B_4O_7^{2-}(aq)$ = 0.125 × 0.01898 × ½ = 1.187×10^{-3} 1*
(201.2 + 18 n) = 0.452 / 1.187×10^{-3} 1*
n = 10 1

(d) (i) Solutions with accurately known concentrations. 1

(ii) It can be used to determine the concentration of another reagent / number of water of crystallization / molar mass, etc. via titration / to prepare a calibration curve. 1

8. (a) An acid which can (almost) completely ionize/ ionise / highly ionise / dissociate to H^+ ions in water. 1

(b) (i) chlorine / $Cl_2(g)$ 1

(ii) It is a redox reaction: O.N. of Cl changes from -1 to 0 / of Mn changes from +7 to +2 / Cl^- transfers electrons to MnO_4^- / O.N. of Mn and Cl change at the same time / MnO_4^- is reduced and Cl^- is oxidised. 1

(c) The filter paper turns yellowish brown. (Do not accept yellow / orange) 1
$2I^- + Cl_2 \rightarrow 2Cl^- + I_2$ (Ignore state symbols) 1

(d) The experiment should be performed in a fume cupboard as chlorine gas is toxic / toxic gas is released. 1
(Do not accept well-ventilated benches, etc.)

9. Five knowledge points (1 mark for each point), a maximum of 4 marks: 4
- Unsaturated compounds / Compounds with C=C bonds can undergo addition polymerisation.
- No small molecules will be eliminated during addition polymerisation.
- High temp / High Pressure / Catalyst is used. (Any 2 conditions)
- Structure of the monomer : $CF_2=CF_2$
- Structure of the repeating unit : $-CF_2-CF_2-$ OR the polymer : $-[CF_2-CF_2]_n-$

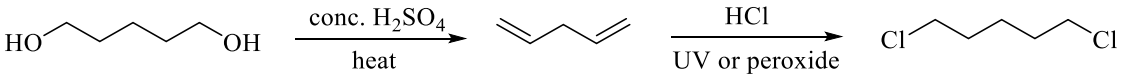
Communication mark 1
(Chemical knowledge = 0 to 2, communication mark = 0,
Chemical knowledge = 3 to 4, communication mark = 0 or 1)

Marks

10. (1) $LiAlH_4$ (2) H_3O^+ 1
$HOCH_2CH_2CH_2CH_2CH_2OH$ 1
PCl_3 / PCl_5 / HCl / $SOCl_2$ 1
(Intermediate: 1 mark; reagent for **each step**: 1 mark)

For 1st step:
1. Not accept $LiAlH_4$ in acidic / aqueous medium. Not accept $NaBH_4$ for reducing –COOH
2. Acidification is required after reduction with $LiAlH_4$. $LiAlH_4$ and acidification should be expressed clearly as two steps.
3. Accept "dry ether" is omitted in the $LiAlH_4$ step.

For conversion of –OH to –Cl, also accept:



11. (a) (i) colour intensity / absorbance (Not accept transmittance) 1

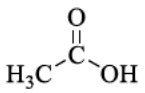
(ii) (On the graph) Plot a tangent (a straight line) at time = 0 on the curve. 1
The initial rate equals to the slope of the tangent /straight line. 1

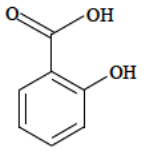
(iii) The absorbance is (directly) proportional to $[Br_2(aq)]$ / number of Br_2 molecules in the reaction mixture. / 1
The $[Br_2(aq)]$ / number of Br_2 molecules in the reaction mixture at A is higher than that at B,
therefore the frequency of (effective) collisions between molecules at A is higher than that at B. 1

(b) Measure the volume of CO_2 gas formed (at different time). / Measure the (total) pressure of the system (at different time). (the reaction proceeds in a closed system) / Measure the mass of the reaction mixture (at different time). (Not accept measuring the pH of the reaction mixture) 1

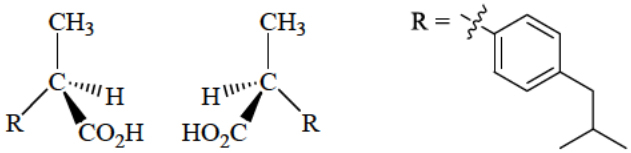
12. (a) Reduce fever / inflammation / risk of heart attack / Rheumatoid arthritis 1
(Not accept hypertension)

(b) -COOH group of aspirin reacts with hydrogencarbonate ions in water 1
to give a soluble sodium salt / soluble ions / soluble $-COO^-$. 1
(Not accept soluble substance / soluble compound)
(Accept: $RCOOH \xrightarrow{HCO_3^-}$ soluble $RCOO^-$ / $RCOO^-$ (aq)) (2)

(c) (i)  1

 1

(ii) Hydrolysis of ester in acidic medium is a reversible reaction / 1
and if the reaction mixture is heated under reflux for a long time, it attains equilibrium position and reactants and products co-exist in the system.

(d)  2

Note:
1 mark for the correct spatial arrangements of the chiral centers of the two enantiomers.
1 mark for the correct structures of the four substituents connected to the chiral center.

13. (a) None of the final concentrations of X(g), Y(g) and Z(g) is equal to zero. / 1
X, Y, Z co-exist in the system, and their concentrations remain unchanged after a long period of time. /
The concentration of the reactant, Y, is still not equal to zero after a long period of time.

(b) $2Y(g) \rightleftharpoons 3X(g) + Z(g)$ (1 mark for correct equation or K_c expression) 1*

$K_c = [X(g)]^3 [Z(g)] / [Y(g)]^2$ (1*)
$= (0.60)^3 (0.20) / (0.30)^2$ (1 mark for correct final concentrations of X, Y and Z, and substituting the numbers into the expression) 1*
$= 0.48 \text{ mol}^2 \text{ dm}^{-6}$ (Correct unit is required) (Not accept M^2) 1

(c) The statement is INCORRECT.
At the 25th minute after the reaction has started, the reaction attained dynamic equilibrium. / 1
The rate of forward reaction is equal to the rate of backward reaction(, and both of the rates are not equal to zero).

Marks

14. • $Na_2O(s)$ dissolves in water to give NaOH(aq) / 1
$Na_2O(s)$ reacts with HCl(aq) to give NaCl(aq) and H_2O (or similar reactions) /
$Na_2O(s) + H_2O(l) \rightarrow 2NaOH(aq)$ /
$Na_2O(s) + 2HCl(l) \rightarrow 2NaCl(aq) + H_2O(l)$

• $Al_2O_3(s)$ reacts with HCl(aq) to give $AlCl_3$ (aq) and H_2O (or similar reactions) / 1
$Al_2O_3(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2O(l)$

• $Al_2O_3(s)$ reacts with NaOH(aq) to give $NaAl(OH)_4(aq)$ (or similar reactions) / 1
$Al_2O_3(s) + 2NaOH(aq) + 3H_2O(l) \rightarrow 2NaAl(OH)_4(aq)$ /
$Al_2O_3(s) + 2NaOH(aq) \rightarrow 2Na[AlO_2](aq) + H_2O(l)$
(At the reactant side, accept NaOH(aq) / NaOH solution without explicitly mentioning water)

• $SO_2(g)$ dissolves in water to give $H_2SO_3(aq)$ / 1
$SO_2(g)$ reacts with NaOH(aq) to give Na_2SO_3 (aq) and H_2O (or similar reactions) /
$SO_2(g) + H_2O(l) \rightarrow H_2SO_3(aq)$ /
$SO_2(g) + 2NaOH(aq) \rightarrow Na_2SO_3(aq) + H_2O(l)$

• Able to mention Na_2O is a basic (alkaline) oxide, Al_2O_3 is an amphoteric oxide, and SO_2 is an acidic oxide. 1

• *Communication mark* 1
(Chemical knowledge = 0 to 3, communication mark = 0
Chemical knowledge = 4 to 5, communication mark = 0 or 1
Incomplete answer or difficult to understand, communication mark = 0)

Note:
1. If the candidate gives the answer in the form of a chemical equation, it is not necessary to have the chemical equation correctly balanced.
2. The answer should state the reagents and products correctly (including the water formed in the neutralization reaction).
3. If the candidate gives the answer in the form of a correct ionic equation, or state the reagents and the products in correct ionic forms, the answer is considered to have correct chemical concept, but failed to state the reagents and products completely. (Maximum) Deduct 1 mark for the whole question.
Example: If the candidate only stated 4 correct ionic equations, but in each of the entries the reagents and the products were not stated explicitly, maximum 3 marks will be awarded for the chemical knowledge.
4. The following answers are considered to have the products stated correctly.
$Na_2O(s) + 2HCl(l) \rightarrow 2Na^+(aq) + 2Cl^-(aq) + H_2O(l)$
$SO_2(g) + 2NaOH(aq) \rightarrow 2Na^+(aq) + SO_3^{2-}(aq) + H_2O(l)$

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CHEMISTRY PAPER 2

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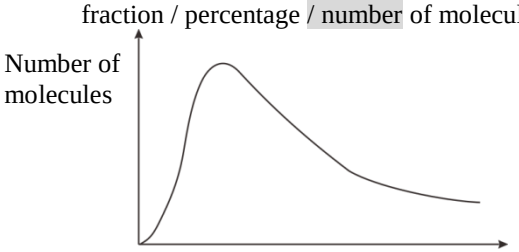
6. Award zero marks for answers which are contradictory.

7. 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.

Marks

1. (a) (i) $2H^+(aq) + 2e^- \rightarrow H_2(g)$ [Cathode, negative electrode] 1
Or $2H_2O(l) + 2e^- \rightarrow 2OH^-(aq) + H_2(g)$ (1)
$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ [Anode, positive electrode] 1

(ii) x-axis: (molecular) kinetic energy / K.E. / velocity of molecules (particles);; y-axis: fraction / percentage / number of molecules (particles) 1



1

(iii) Glucose / the fourth one 1

(b) (i) (1) Cu / ZnO / Al_2O_3 / Cr_2O_3 [Mark the first one] 1

(2) May be due to higher activation energy / energy barrier. 1

(3) Number of moles of gaseous products is less than that of gaseous reactants. 1
Increasing the pressure will shift the equilibrium position to the right 1
OR increase in collision frequency /effective collisions (1)
make the reaction faster to reach equilibrium. (1)

(ii) (1) This reaction does not involve poisonous reagent / CO but the original one involves poisonous CO. 1

(2) It reduces the amount of atmospheric carbon dioxide and hence may alleviate global warming / greenhouse effect. 1

(iii) $CH_3OH(g) + CO(g) \rightarrow CH_3CO_2H(g)$ 1

(c) (i) Order of reaction is not affected by temperature change. / The order of reaction is the same. 1

(ii) From line ℓ_1 on the graph,
slope = [(–1.4) – (–2)] ÷ [(0)–(–0.6)] = 1 1*
It is first order with respect to $N_2O_5(g)$. 1

(iii) *log* k = –2 1
k = 0.01 s^{-1} 1

(iv) The y-intercepts of ℓ_1 and ℓ_2 are –1.4 / *log* 0.0398 / *log* $10^{-1.4}$ and (–2 / *log* 0.01 / *log* 10^{-2}) respectively. [OR represented in equation] 1
Since the y-intercept = *log* k
log k = *log* A – Ea/2.3RT [OR $k = Ae^{-Ea/RT}$] 1
log k_2 – *log* k_1 = Ea $(1/T_1 - 1/T_2)$ /2.3 R (1)
(–2) – (–1.4) = Ea (1/360 – 1/345) / 2.3 x 8.31
Ea = 94.95 kJ mol^{-1} [Range: 92 – 98, Accept 0/1/2 decimal places] 1

Marks

2. (a) (i)
- Catalyst is used. 1
- High atom economy / atom economy = 172 ÷ 208 = 82.7% 1
- (Water generated possesses little or no toxicity to human health and the environment.) (1)

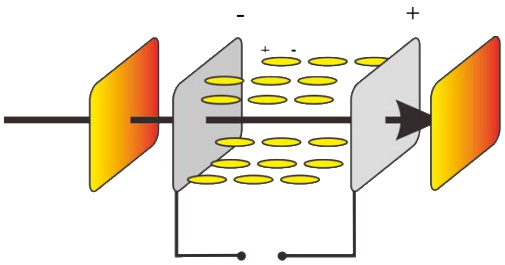
(ii) (1) chitin † 1

(2) It can form extensive inter-molecular hydrogen bonds / hydrogen bonds between chains. 1

(iii) **A** 1

(b) (i) cholesteric liquid crystal† 1
The molecules are arranged along a long axis / line and in positions such that they are slightly twisted from the molecules next to them giving rise to a helical-like arrangement. 1

(ii) (1)



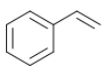
Voltage applied

Show: With the applied voltage, the molecules arrange in lines / not twisted. 1
Show: The polarity of the molecules and that of electrodes are opposite. 1

(2) Polarisers are perpendicular to each other. 1
The polarised light will pass through the liquid crystal layer without rotating the plane of polarisation / polarised light. The polarised light is completely blocked by the polariser at the right, giving a black pixel. 1

(iii) When temperature is higher than the upper end of the operation range, the liquid crystal will liquefy / melt. 1

(c) (i) $HOCH_2CH_2OCH_2CH_2OH$ 1
HOOC–CH=CH–COOH / Cl–CO–CH=CH–CO–Cl (Show double bond) 1

(ii) (1)  / $C_6H_5CH=CH_2$ (Show double bond) 1

(2) thermosetting / hardening under formation with heating 1

(3) Adjust the relative amounts of **X** and **A** 1
The rigidity depends on its degree / amount of cross-linking. 1

(iii) (1) compression moulding 1

(2) **Y** will not corrode / rust easily but iron will. / **Y** is less dense than iron. 1

Marks

3. (a) (i) calcium (ion) / Ca^{2+} 1

(ii) Add $Ba(NO_3)_2(aq)$ acidified with $HNO_3(aq)$ to the sample, 1
white precipitate forms for $K_2SO_4(aq)$ whereas no precipitate will form for $K_2SO_3(aq)$. 1
[Accept other answers: 1 mark for the reagent and 1 mark for the observation]
[$Cl_2(aq)$: reagent – 0 mark, observation – 0 mark
if use Br_2 / $Br_2(l)$: reagent - 0 mark, correct observation – 1 mark]

Reagent	Observation
$H^+(aq)$ / acid	Only SO_3^{2-} gives a gas with pungent smell
$Cr_2O_7^{2-}/H^+(aq)$	Only SO_3^{2-} turns the solution from orange to green
$MnO_4^-/H^+(aq)$	Only SO_3^{2-} turns the solution from purple to colourless
$Br_2(aq)$	Only SO_3^{2-} turns the solution from orange / brown to colourless
$I_2(aq)$	Only SO_3^{2-} turns the solution from brown to colourless

(iii) 'R_f value' of a substance is the ratio between the migration distance of the substance and the migration distance of the solvent front during chromatography. 2
[1 mark: indicating ratio; 1 mark: other parts correct]
[Can be represented by labeled diagram indicating 2 distances and correct mathematical expression]

(b) (i) Place the dissolved sample into a (250.0 cm^3) volumetric flask. 1
(Deionised) water should be added to the mark of the volumetric flask. 1

(ii) $ClO_3^-(aq) + 6I^-(aq) + 6H^+(aq) \rightarrow Cl^-(aq) + 3I_2(aq) + 3H_2O(l)$ 1

(iii) The solution turns from blue to colourless. 1

(iv) $I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$
number of moles of $I_2(aq)$ =0.112 × 0.02788 × ½ = 0.001561 1
number of moles of $NaClO_3$ in the sample = 0.001561 ÷ 3 × (250.0 / 10.00) = 0.01301 1*
percentage by mass of $NaClO_3$ in the sample 1
= 0.01301 × 106.5 ÷ 1.63 × 100% = 85.0 %
[Range: 84 – 86, Accept 0 / 1 / 2 decimal places]

(c) (i) Boiling points of **X** and **Y** are too close. 1

(ii) (1) Absorption peak at wavenumber about 1700 cm^{-1} corresponds to a C=O group. / 1
Absorption peak at wavenumber about 1650 cm^{-1} corresponds to a C=C group.
[Range: C=O, 1680 – 1800; C=C, 1610 – 1680
one number: C=O: 1680 – 1720; C=C: 1630 – 1670]

(2) At m/z = 43: CH_3CO^+ / $C_2H_3O^+$ [CH_2CHO^+ not accepted] 1
At m/z = 55: CH_2CHCO^+ / $C_3H_3O^+$ 1

(3) CH_2=CHCOCH$_3$ [Must show C=C] 1

(iii) • positive result for 2,4-dinitrophenylhydrazine test: presence of carbonyl group 1
• negative result for Tollens' reagent test: not an aldehyde 1
[Note: If just have the conclusion,: it is a ketone : 1 mark]
• **Y** may be $CH_3CH_2COCH_3$ / butanone. 1