

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 I

SECTION A

Question No.	Key	Question No.	Key
Part I		Part II	
1.	C (79%)	25.	D (57%)
2.	D (83%)	26.	C (86%)
3.	D (54%)	27.	B (79%)
4.	C (52%)	28.	C (58%)
5.	D (57%)	29.	B (69%)
6.	B (67%)	30.	C (49%)
7.	A (74%)	31.	D (64%)
8.	A (70%)	32.	A (62%)
9.	C (89%)	33.	B (47%)
10.	B (74%)	34.	C (79%)
11.	D (77%)	35.	A (56%)
12.	A (84%)	36.	B (81%)
13.	A (74%)		
14.	C (82%)		
15.	B (64%)		
16.	C (76%)		
17.	B (77%)		
18.	D (68%)		
19.	A (66%)		
20.	D (51%)		
21.	D (81%)		
22.	A (73%)		
23.	B (75%)		
24.	B (53%)		

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

2024年香港中學文憑考試
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2024

CHEMISTRY PAPER 1
SECTION B

MARKING SCHEME

本評卷參考乃香港考試及評核局專為今年本科考試而編寫，供閱卷員參考之用。本評卷參考之使用，均受制於閱卷員有關之服務合約及閱卷員指引。特別是：

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- 在任何情況下，均不得容許本評卷參考之全部或其部份落入學生手中。本局籲請各閱卷員/教師通力合作，堅守上述原則。

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- Under no circumstances should students be given access to this marking scheme or any part of it. The Authority is counting on the co-operation of markers/teachers in this regard.



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INSTRUCTIONS TO MARKERS

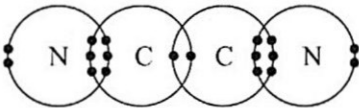
1. In order to maintain a uniform standard in marking, markers should adhere to the marking scheme agreed at the markers' meeting.
2. The marking scheme may not exhaust all possible answers for each question. Markers should exercise their professional discretion and judgment in accepting alternative 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 answer.
*	Step-mark (for questions involving calculations)
†	Correct spelling required

4. In questions asking for a specified number of answers, if a candidate gives more than the required number, the extra answers should not be marked. For instance, in a question asking candidates to provide two examples, if a candidate gives three answers, only the first two answers should be marked.
5. In cases where a candidate answers more questions than required, the answers to all questions should be marked. However, the excess answer(s) receiving the lowest score(s) will be disregarded in the calculation of the final mark.
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 the answer is easily understandable. No effective communication marks will be awarded if an answer contains a lot of irrelevant material and/or wrong chemistry concepts.

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Part IMarks

1. (a) (i) The mass number of a ^{13}C atom is greater than that of a ^{12}C atom. /
The mass number of a ^{12}C atom is 12 while the mass number of a ^{13}C atom is 13. /
A ^{13}C atom has (one) more neutron than a ^{12}C atom. /
A ^{12}C atom has 6 neutrons while a ^{13}C atom has 7 neutrons. 1
- (ii) $12x + 13(1 - x) = 12.011$ 1*
 $x = 0.989 = 98.9\%$ 1
- (b) Similarity:
Both diamond and graphite have a giant covalent structure / giant covalent network. 1
- Difference :
In diamond, each carbon atom forms 4 covalent bonds with other carbon atoms. 1
In graphite, each carbon atom forms 3 covalent bonds with other carbon atoms.
- As there are no delocalised electrons in diamond, diamond is a poor conductor of electricity. 1
As there are delocalised electrons in graphite, graphite is a good conductor of electricity.
- (c)  1
2. (a) In the presence of air (oxygen) and water. 1
- (b) phenolphthalein / phenolphthalein in the presence of hydroxide ions
(NOT accept: hydroxide ions / $\text{OH}^-(\text{aq})$) 1
- (c) Iron loses electrons / oxidises to form iron(II) ions / $\text{Fe}^{2+}(\text{aq})$. 1
 $\text{Fe}^{2+}(\text{aq})$ ions react with potassium hexacyanoferrate(III) to form a blue colour. 1
- (d) $\text{Y} > \text{iron} > \text{X}$ / $\text{Y} > \text{Fe} > \text{X}$ 1
No blue colour is observed / no rusting occurs in set-up 2, this implies that Y loses electrons / oxidises more readily than iron / Y has sacrificial protection for iron. 1
Blue colour is observed / rusting occurs in set-up 1, this implies that iron loses electrons / oxidises more readily than X.
- Or, No blue colour is observed / no rusting occurs in set-up 2, this implies that Y loses electrons / oxidises more readily than iron / Y has sacrificial protection for iron. (1)
Thus, Y is more reactive than iron.
Blue colour is observed / rusting occurs in set-up 1, this implies that iron loses electrons / oxidises more readily than X. (1)
Thus, iron is more reactive than X.

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	<u>Marks</u>
3. (a) voltmeter / multimeter	1
(b) To complete the circuit. / To balance the charges in the two half cells. / To allow the flow of ions between the two half cells.	1
(c) (i) $\text{AgNO}_3(\text{aq}) / \text{Ag}^+(\text{aq})$ reacts with $\text{KCl}(\text{aq}) / \text{Cl}^-(\text{aq})$ to form water-insoluble $\text{AgCl}(\text{s})$ which can block the ion flow in the salt bridge. / Solid AgCl will be formed.	1
(ii) (saturated / conc.) potassium nitrate (solution) / $\text{KNO}_3(\text{aq})$ (Accept: other solutions without reaction with the electrolytes used in the chemical cell) (NOT accept: solution containing $\text{Cl}^-(\text{aq}) / \text{Br}^-(\text{aq}) / \text{I}^-(\text{aq}) / \text{OH}^-(\text{aq}) / \text{CO}_3^{2-}(\text{aq}) / \text{SO}_3^{2-}(\text{aq}) /$ $\text{Ag}^+(\text{aq}) / \text{Ca}^{2+}(\text{aq}) / \text{Ba}^{2+}(\text{aq}) / \text{Pb}^{2+}(\text{aq})$)	1
(d) (i) Mn With the use of the same metal-metal ion in half-cell A, the voltage of chemical cell 3 is of the greatest positive value / is the highest.	1 1
(ii) $+1.15 - (-0.46) = +1.61$ (Must show '+' sign for the final answer.)	1
(iii) $\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$	1
4. (a) (i) no. of moles of H = $3.09 / 1.0 = 3.09$ no. of moles of N = $14.42 / 14.0 = 1.03$ no. of moles of S = $33.06 / 32.1 = 1.03$ no. of moles of O = $49.43 / 16.0 = 3.09$ mole ratio of H : N : S : O = 3 : 1 : 1 : 3 Empirical formula is H_3NSO_3 .	1* 1
(ii) Let the molecular formula be $(\text{H}_3\text{NSO}_3)_n$. $(3 \times 1.0 + 14.0 + 32.1 + 3 \times 16.0) \times n = 97.1$ $n = 1$ The molecular formula is H_3NSO_3 .	 1
(b) (i) no. of moles of NaOH that reacted with the $\text{H}_2\text{SO}_4(\text{aq})$ $= 2 \times 0.202 \times 24.80 / 1000 = 0.010$	1
(ii) no. of moles of NaOH that reacted with the sulphamic acid $= 0.150 \times 100.0 / 1000 - 0.010 = 0.005$	1
(iii) no. of moles of the sulphamic acid that reacted with $\text{NaOH}(\text{aq})$ $= 0.486 / 97.1 = 0.005$ Mole ratio of $\text{H}_3\text{NSO}_3 : \text{NaOH} = 0.005 : 0.005 = 1 : 1$ The basicity of sulphamic acid is 1. / Sulphamic acid is a monobasic acid.	 1
(c) $2\text{H}^+(\text{aq}) + \text{CaCO}_3(\text{s}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$ (NOT accept : $2\text{H}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$)	1

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Part IMarks

5. (a) Fractional distillation 1
 Different hydrocarbons evaporate and condense as different fractions at different temperatures. 1
- (b) (i) † cracking 1
- (ii) Prevent sucking back of water (and the sudden cooling may break the hot boiling tube). 1
- (iii) The gas mixture contains alkenes which can react with Br₂(aq) to give colourless products. 1
- (iv) • Kerosene would vaporise quickly (without reaction). 1
 • The broken unglazed porcelain is not hot enough (to have the catalytic function) for cracking of kerosene to occur. 1
6. (a) (i) NH₃(aq) and FeSO₄(aq) 1
- (ii) † iron(II) hydroxide 1
- (b) (i) Mg(NO₃)₂(aq) and Na₂CO₃(aq) 1
- (ii) Mg²⁺(aq) + CO₃²⁻(aq) → MgCO₃(s) 1
- (c) H₂SO₄(aq) and Na₂CO₃(aq) 1
7. (a) (i) 1
-
- (ii) • C-H bonds are polar because C and H have different electronegativities. / C is more electronegative than H. 1
 • C-Cl bonds are polar because C and Cl have different electronegativities. / Cl is more electronegative than C. 1
- (iii) Dichloromethane is a polar molecule, because the polarities of C-H bonds and C-Cl bonds do not cancel out each other. 1
- (b) There are weak van der Waals' forces between dichloromethane molecules. 1
 There are strong hydrogen bonds between ethanol molecules. 1

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	<u>Marks</u>
8. (a) Energy released = $1.0 \times (50.0 + 50.0) \times 4.20 \times 6.8 \div 1000$ = 2.856 kJ	1*
Enthalpy change of neutralisation = $-2.856 \div (1.0 \times 50 \div 1000) = -57.12$ / -57.1 (kJ mol ⁻¹)	1
(b) All <u>acids and alkalis</u> used in experiments 1- 4 <u>completely dissociate</u> in water.	1
(c) By Hess's Law, $\Delta H = -50.10 - (-57.12) / -50.10 - (-57.1)$ = +7.02 / +7.00 / +7.0 kJ mol ⁻¹	1* 1
9. Chemical knowledge	
• Silver metal can be obtained by heating silver oxide alone / directly.	1
• Lead metal can be obtained by heating a mixture of lead(II) oxide and carbon / charcoal / coke.	1
• Aluminium metal can be obtained by electrolysis of aluminium oxide in molten state.	1
• The more reactive a metal is / the higher position of the metal in the metal reactivity series, the extraction method of the metal is more difficult.	1
Communication mark	1
Chemical knowledge = 0 to 2, communication mark = 0	
Chemical knowledge = 3 to 4, communication mark = 0 or 1	
Incomplete answer or difficult to understand, communication mark = 0	

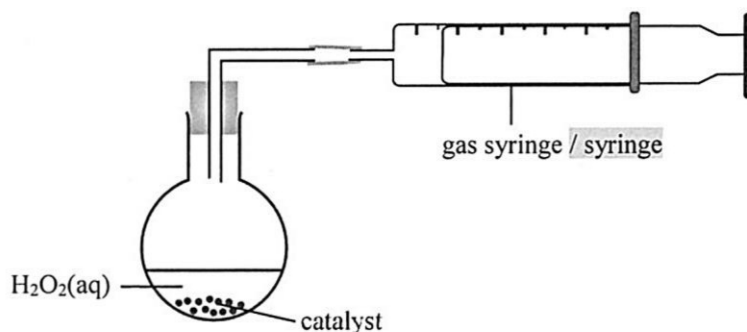
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Part II

Marks

10. (a)

1



(b) A, because it takes the shortest / shorter time for the reaction to finish / the initial rate of the reaction is the highest / higher.

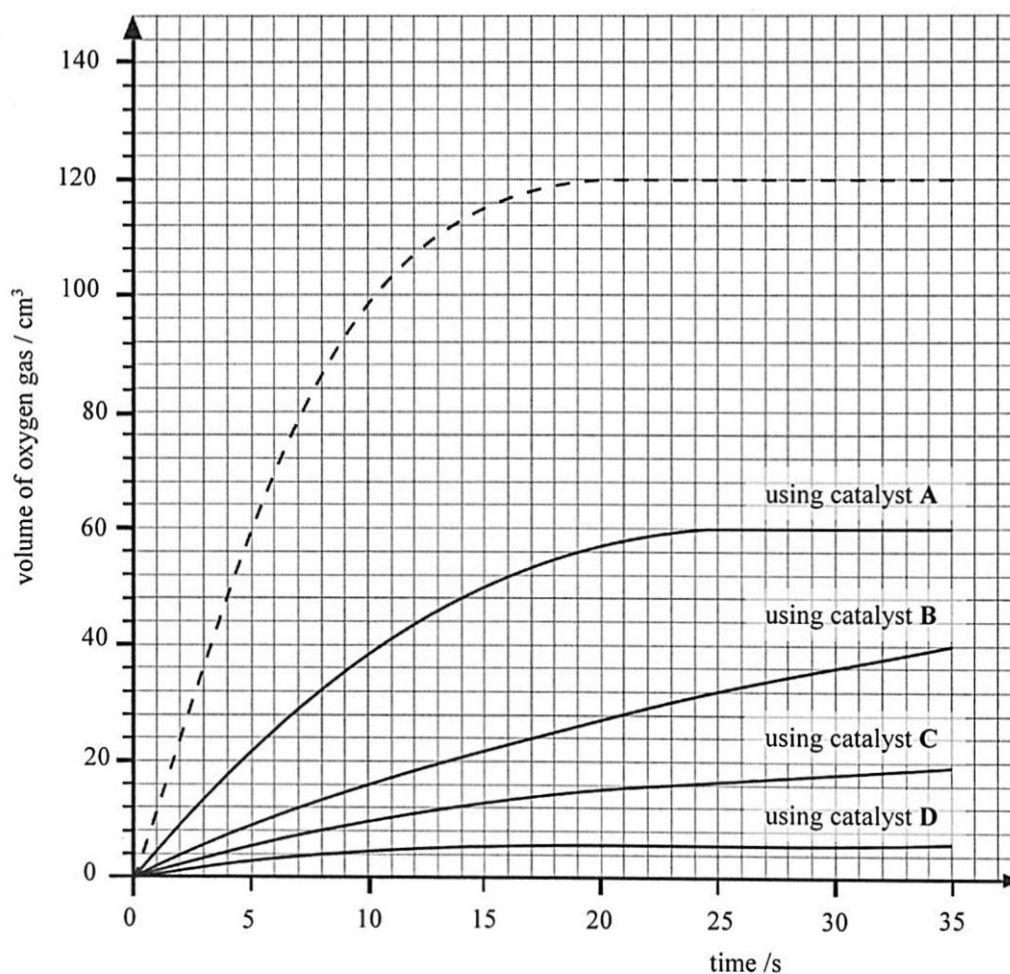
1

(c) 60 cm^3 / 0.06 dm^3
(Correct unit is required)

1

(d)

2



(Comparing with curve A :

1 mark for the curve with greater slope at 0-20 s);

1 mark for final volume of oxygen gas is 120 cm^3)

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Marks

11. (a) 1. LiAlH_4 , dry ether 2. $\text{H}^+(\text{aq})$
 OR,
 NaBH_4

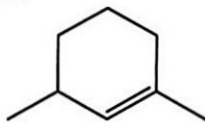
1

- (b) dehydration / elimination

1

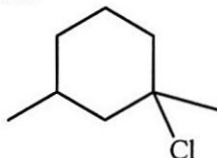
- (c) R :

1



- (d) S :

1



- (e)

Q	R

1

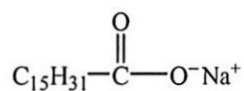
1+1

12. (a) † propane-1,2,3-triol

1

- (b)

1



- (c) (i) There are no two distinct liquid layers after the mixture is rested for a long time. /
One persisting milky layer is formed.

1

- (ii) The ionic head (COO^-) dissolves in water / is hydrophilic, while the hydrocarbon tail
 ($\text{C}_{15}\text{H}_{31}$) dissolves in oil / is hydrophobic.
 The negatively charged / ionic heads of the oil droplets repel each other.

1

1

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Marks

13. (a) Al_2O_3 acts as a basic oxide and reacts with $\text{HCl}(\text{aq})$ to form $\text{AlCl}_3(\text{aq})$ and H_2O . / 1
 $\text{Al}_2\text{O}_3(\text{s}) + 6\text{HCl}(\text{aq}) \rightarrow 2\text{AlCl}_3(\text{aq}) + 3\text{H}_2\text{O}(\text{l})$

Al_2O_3 acts as an acidic oxide and reacts with $\text{NaOH}(\text{aq})$ to form $\text{NaAl}(\text{OH})_4$ / NaAlO_2 and H_2O . / 1
 $\text{Al}_2\text{O}_3(\text{s}) + 2\text{NaOH}(\text{aq}) + 3\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaAl}(\text{OH})_4(\text{aq})$ /
 $\text{Al}_2\text{O}_3(\text{s}) + 2\text{NaOH}(\text{aq}) \rightarrow 2\text{NaAlO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$

Thus, aluminium oxide can act as both an acidic oxide and a basic oxide. / Al_2O_3 is amphoteric. 1

- (b) Both S_8 and Cl_2 have simple molecular structure, and there are weak van der Waals' forces between their respective molecules. 1

The molecular size of S_8 is larger than that of Cl_2 , the van der Waals' forces between S_8 molecules are stronger than those between Cl_2 molecules. 1

14. Chemical knowledge

Observable change in both cases :

- the colour of the equilibrium mixture turns from pink to blue / becomes more intense in blue / darker in blue 1

Addition of $\text{NaCl}(\text{s})$:

- The concentration of $\text{Cl}^-(\text{aq})$ ions increases / $Q_c < K_c$, so the equilibrium position shifts to the right. 1
- The equilibrium constant / K_c remains unchanged. 1

Increase in the temperature :

- Because the forward reaction is endothermic, when temperature increases, the equilibrium position shifts to the right / an increase in temperature favours the forward / endothermic reaction. 1
- The equilibrium constant / K_c increases. 1

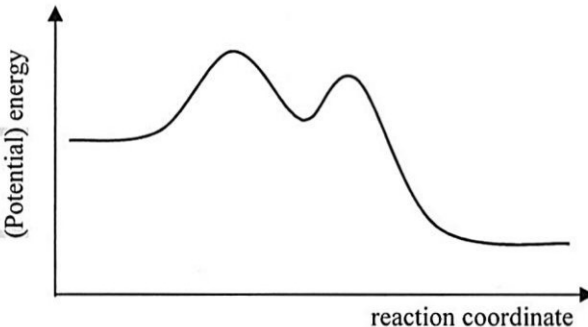
Communication mark 1

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

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	<u>Marks</u>
1. (a) (i) (1) † Haber (process)	1
(2) It is a fertiliser. / It can increase the crop yield.	1
(ii) (1) concentrated / saturated sodium chloride solution / brine	1
(2) Any one of the following:	1
• No toxic mercury will be produced by membrane electrolytic cells but toxic mercury may leak out from flowing mercury cells.	
• The operation of membrane electrolytic cells requires less energy than flowing mercury cells.	
(Has comparative sense.)	
(iii) Yeast provides enzyme / (biological) catalyst.	1
(b) (i)	2
 (1 mark for a curve showing energy of product is lower than that of reactant; 1 mark for correct labels of two axes)	
(ii) $\frac{4 \times 60.0}{2 \times 58.0 + 5 \times 32.0} \times 100\% = 87.0\%$	1
(show step)	
(iii) $\text{CH}_3\text{OH} + \text{CO} \rightarrow \text{CH}_3\text{COOH}$	1
(iv) HI / It is regenerated at the end of the reaction.	1
(v) (1) No toxic substance is used in Method 1, while toxic reagent e.g. CH_3OH / CO / HI or corrosive reagent e.g. HI is used in Method 2.	1
(2) The atom economy is 100% in Method 2 but not in Method 1. / Method 2 has higher atom economy than Method 1.	1
(Has comparative sense.)	

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	<u>Marks</u>
1. (c) (i) Use a (gas) syringe / to follow (the change in) the volume of the gaseous mixture at regular time intervals / against time. OR, Use a pressure sensor (connected to a data logger) / to follow (the change in) the pressure of the gaseous mixture at regular time intervals / against time. (instrument + time or parameter change + time)	1
(ii) (1) (a =) 1	1
(2) $\log \frac{k_2}{k_1} = \frac{E_a}{2.3R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$ Or, $\log (k / 4.29 \times 10^{-4}) = \frac{108500}{2.3 (8.31)} \left(\frac{1}{318} - \frac{1}{338} \right)$ $k = 4.88 \times 10^{-3} \text{ s}^{-1}$ (Range: 4.87 – 4.93)	1* 1
(iii) (1) B	1
(2) • An increase in temperature can increase the (average kinetic) energy of the molecules. • There is a larger portion of molecules having (kinetic) energy equal to or greater than the activation energy. • This will increase the <u>effective collision frequency</u> / the <u>number of effective collisions per unit time</u> .	1 1 1

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Marks

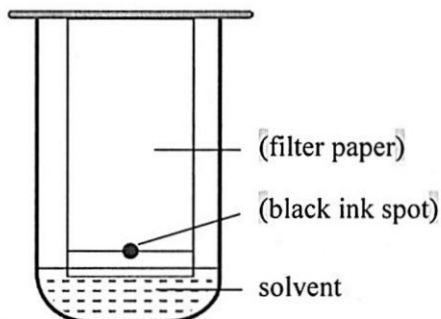
3. (a) (i) • Add 2,4-dinitrophenylhydrazine. 1
 • Compound A forms a yellow / orange / red precipitate while compound B does not. 1
 Or,
 • Add $\text{Na}_2\text{CO}_3(\text{aq})$ / $\text{NaHCO}_3(\text{aq})$. / Add deionised water and then add $\text{Mg}(\text{s})$.
 • Compound B gives off (colourless) gas bubbles while compound A does not.

(Has comparative sense.

1 mark for reagent ; 1 mark for observation)

(ii)

2



(1 mark for set-up diagram : a (covered) container + filter paper immersed in solvent ;
 1 mark for label of 'solvent' & the starting position of black ink spot higher than the level of solvent)

- (iii) Any one of the following : 1
 • These solvents are immiscible (with water).
 • These solvents do not react with the organic compounds.
 • These solvents can dissolve more organic compounds than water can.
 • These solvents have low boiling points / can evaporate easily.

- (b) (i) To ensure that $\text{PbCO}_3(\text{s})$ and $\text{CuCO}_3(\text{s})$ / (all) solids are completely reacted. 1

- (ii) A (deep) blue solution would be formed. 1

- (iii) (1) Washing is to remove (water-soluble) impurities and drying is to remove water. 1
 This ensures (more) accurate weighing of the mass of $\text{Pb}(\text{OH})_2(\text{s})$. 1

- (2) lead(II) hydroxide / $\text{Pb}(\text{OH})_2$ 1

- (3) No. of moles of $\text{Pb}(\text{OH})_2$ formed

$$= \frac{1.47}{(207.2 + 1.0 \times 2 + 16.0 \times 2)} = 0.00609 \quad 1$$

Percentage by mass of PbCO_3 in the solid sample

$$= \frac{1.47}{(207.2 + 1.0 \times 2 + 16.0 \times 2)} \times (207.2 + 12.0 + 16.0 \times 3) \div 2.03 \times 100\%$$

$$= 80.22\% \quad 1$$

(Range : 80.1 – 80.3)

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	<u>Marks</u>
3. (c) (i) The infra-red spectrum of the indoor air sample shows strong <u>absorption / peak</u> at <u>1 680 (cm⁻¹) to 1 800 (cm⁻¹)</u> corresponding to the <u>carbonyl</u> group / C=O bond / <u>aldehyde / -CHO</u> of formaldehyde.	1
(ii) <u>HCO⁺ / CHO⁺</u>	1
(iii) (1) <u>† colorimeter</u>	1
(2) The absorbance is <u>direct(ly) proportional</u> to the concentration of formaldehyde.	1
(3) From the graph, the concentration of formaldehyde in solution S is <u>0.25</u> mg dm ⁻³ . (Range : 0.245 – 0.255)	1
Mass of formaldehyde = 0.25 × 0.03 = <u>0.0075</u> (mg) (Range : 0.00735 – 0.00765)	1
(4) Concentration of formaldehyde in the indoor air sample = 0.0075 / 0.1 = <u>0.075</u> mg m ⁻³ < 0.1 mg m ⁻³ Thus, the quality of that indoor air sample is good.	1
(5) Instrumental analytical methods are sensitive <u>enough /</u> to measure very low levels / <u>concentration</u> of formaldehyde.	1