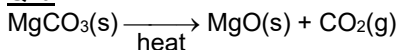


Answers to Self-Check Questions

Q1a



Q1b

Mg^{2+} ion has a smaller ionic radius than the Ba^{2+} ion. Thus, the Mg^{2+} ion has a higher charge density and consequently a stronger polarising power than the Ba^{2+} ion. The more polarising Mg^{2+} ion distorts the electron cloud of the CO_3^{2-} anion to a larger extent and hence weakens the covalent bonds within the CO_3^{2-} anion to a greater extent. Thus, less heat energy is required to decompose MgCO_3 than BaCO_3 . Hence MgCO_3 decomposes at a lower temperature than BaCO_3 .

Q1c

$$\left| \text{lattice energy} \right| \propto \left| \frac{q_+ \times q_-}{r_+ + r_-} \right|$$

Mg^{2+} has the same charge as Ba^{2+} but Mg^{2+} has a smaller ionic radius than Ba^{2+} . Hence the magnitude of the lattice energy of MgCO_3 is larger than that of BaCO_3 .

Q2a



Mass of CO_2 produced = 1.34 g

$$\text{Amount of } \text{CO}_2 = \frac{1.34}{44.0} = 0.03045 \text{ mol}$$

Amount of $\text{MCO}_3 = 0.03045 \text{ mol}$

Mass of 0.03045 mol of $\text{MCO}_3 = 4.50 \text{ g}$

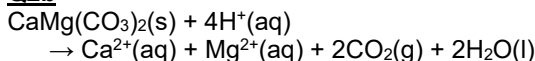
Mass of 1 mol of $\text{MCO}_3 = 147.8 \text{ g}$

M_r of $\text{MCO}_3 = 147.8$

A_r of M = $147.8 - 12.0 - (3)(16.0) = 87.8$

Hence M is Sr.

Q2b



Amount of $\text{CO}_2 = 0.45/44.0 = 0.01023 \text{ mol}$

Amount of $\text{CaMg}(\text{CO}_3)_2 = (\frac{1}{2})(0.01023) = 0.005115 \text{ mol}$

M_r of $\text{CaMg}(\text{CO}_3)_2 = 184.4$

Mass of $\text{CaMg}(\text{CO}_3)_2 = 0.005115 \times 184.4 = 0.943 \text{ g}$

Percentage purity of dolomite = $0.943/1.00 \times 100\% = \underline{94.3\%}$

Q2c



Molar mass of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O} = 172.2$

Amount of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O} = \frac{100}{172.2} = 0.5807 \text{ mol}$

Mass of H_2O lost = 15.7 g

Amount of H_2O lost = $\frac{15.7}{18.0} = 0.8722 \text{ mol}$

Molar ratio of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ to H_2O

$$= 1 : (2-n)$$

$$= 0.5807 : 0.8722 = 1 : 1.5$$

Hence $(2-n) = 1.5$

$$n = 0.5$$

$\therefore$ formula of plaster of Paris is $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$

Q2d(i)

Mass of gaseous mixture = $1.00 - 0.438 = 0.562 \text{ g}$

Amt of gases = $374/24000 = 0.01558 \text{ mol}$

Average molar mass of gaseous mixture = $0.562 / 0.01558 = 36.1 \text{ g mol}^{-1}$

Average $M_r = \underline{36.1}$

Q2d(ii)

The gas which reacted with $\text{NaOH}(\text{aq})$ is CO_2 .

Q2d(iii)

Let the other gas be X.

Volume of $\text{CO}_2 = 187 \text{ cm}^3$

Volume of X = $374 - 187 = 187 \text{ cm}^3$

Since volume of X = volume of CO_2 , the mixture contains equal amounts of the X and CO_2 .

Mole fraction of each gas = $\frac{1}{2}$

$$(\frac{1}{2})(M_r \text{ of X}) + (\frac{1}{2})(M_r \text{ of } \text{CO}_2) = 36.1$$

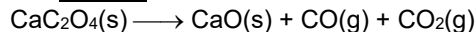
$$(\frac{1}{2})(M_r \text{ of X}) + (\frac{1}{2})(44.0) = 36.1$$

$$M_r \text{ of X} = \underline{28.2}$$

Hence X is CO .

Q2d(iv)

E is CaC_2O_4 .



Q3

	chlorine	bromine	iodine
Physical state at rtp	gas	liquid	solid

Trend:

Volatility decreases in the order: $\text{Cl}_2 > \text{Br}_2 > \text{I}_2$.

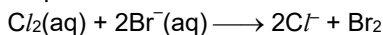
Explanation:

- Cl_2 , Br_2 and I_2 exist as simple, non-polar diatomic molecules with intermolecular instantaneous dipole-induced dipole (id-id) interactions.
- Boiling involves overcoming these intermolecular id-id attractions.
- From Cl_2 to I_2 , the size of the electron cloud increases. Thus, the electron cloud becomes more easily distorted/ polarisable.
- The id-id attractions become stronger and more energy is required to break the intermolecular forces of attraction

- Hence, boiling point increases in the order: $\text{Cl}_2 < \text{Br}_2 < \text{I}_2$ and volatility decreases in the order: $\text{Cl}_2 > \text{Br}_2 > \text{I}_2$.

Q4 (Ans: D)

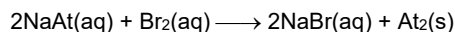
Displacement reaction has occurred.



Since CCl_4 is immiscible and denser than water, the bottom layer should be orange-red in colour.

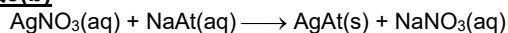
Note: As most non-polar Br_2 entered the non-polar CCl_4 solvent (due to formation of favourable id-id interactions), the concentration of Br_2 in the aqueous layer is low and hence its colour is less intense (it appears yellow instead of orange).

Q5(a)



Observations: Orange $\text{Br}_2(\text{aq})$ is decolourised. A black solid, At_2 , is formed.

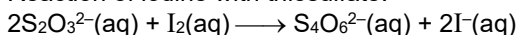
Q5(b)



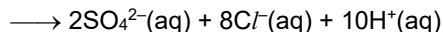
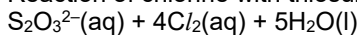
Observations: A yellow precipitate, AgAt , is formed. Ppt is insoluble in excess $\text{NH}_3(\text{aq})$.

Q6 (Ans: C)

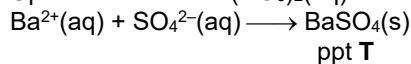
Reaction of iodine with thiosulfate:



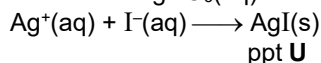
Reaction of chlorine with thiosulfate:



Upon addition of $\text{Ba}(\text{NO}_3)_2(\text{aq})$:



Addition of $\text{AgNO}_3(\text{aq})$ to filtrate:

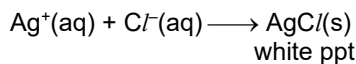
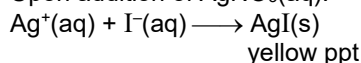


Note: $\text{AgCl}(\text{s})$ is also formed, but it dissolves in excess $\text{NH}_3(\text{aq})$.

Q7 (Ans: D)

When $\text{CH}_2\text{C}/\text{CHICO}_2\text{H}$ is heated with Na, $\text{NaC}/$ and NaI are formed.

Upon addition of $\text{AgNO}_3(\text{aq})$:



Upon addition of conc NH_3 , $\text{AgCl}(\text{s})$ dissolves and only $\text{AgI}(\text{s})$ remains insoluble. Hence, the precipitate in the solution appears 'more yellow' in colour.