

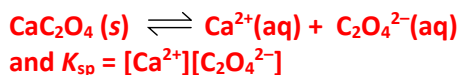
Q6 Solutions and solubility

[3 + 2 + 2 = 7 marks]

- a) Calcium oxalate is the major source of kidney stones.
If the solubility product, K_{sp} , of calcium oxalate, CaC_2O_4 , in water at 25 °C is 2.32×10^{-9} , calculate the molar solubility of calcium oxalate and the solubility in g L^{-1} at this temperature.

Hint: M_r for $\text{CaC}_2\text{O}_4 = 128.097 \text{ g mol}^{-1}$.

[3 marks]



From the reaction stoichiometry, for each mole of $\text{CaC}_2\text{O}_4(s)$ that dissolves, 1 mole of Ca^{2+} and 1 mole of $\text{C}_2\text{O}_4^{2-}$ are formed.

If the molar solubility of $\text{CaC}_2\text{O}_4(s) = S \text{ M}$, then $[\text{Ca}^{2+}] = S \text{ M}$ and $[\text{C}_2\text{O}_4^{2-}] = S \text{ M}$

$$2.32 \times 10^{-9} = [S][S]$$

1 mark

$$S = \sqrt{2.32 \times 10^{-9}}$$
$$= 4.82 \times 10^{-5}$$

Molar solubility of calcium oxalate is $4.82 \times 10^{-5} \text{ M}$

1 mark

$$\begin{aligned} \text{Solubility in } \text{g L}^{-1} &= \text{molar solubility} \times M_r \\ &= 4.82 \times 10^{-5} \times 128.097 \\ &= 6.17 \times 10^{-3} \text{ g L}^{-1} \end{aligned}$$

Solubility of calcium oxalate is $6.17 \times 10^{-3} \text{ g L}^{-1}$

1 mark

3 significant figures required

- b) Explain why the colligative properties of solutions of ionic compounds are more pronounced than the colligative properties of solutions of molecular compounds.

[2 marks]

Ionic compounds dissociate in solution which results in an increase in the number of particles in solution. For example, one NaCl 'molecule' dissociates into two ions: Na^+ and Cl^- . 1 mark

Colligative properties depend on the number of particles so any compound that dissociates into multiple particles has pronounced effects on the colligative properties of solutions. 1 mark

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Q6 (continued) Solutions and solubility

[3 + 2 + 2 = 7 marks]

- c) Calculate the mass of glucose, $C_6H_{12}O_6$, (a sugar found in many foods) which would have to be dissolved in 500 g of water to give a solution of molality $0.133 \text{ mol kg}^{-1}$.

Data: $M_r C_6H_{12}O_6 = 180.156 \text{ g mol}^{-1}$

$M_r H_2O = 18.015 \text{ g mol}^{-1}$

[2 marks]

Using $\text{molality}(b) = \frac{\text{amount of substance (number of moles)}}{\text{mass of solvent expressed in kilogram}}$

Amount of glucose **= molality \times mass of solvent**
Amount of glucose **= 0.133×0.500**
 = 0.0665 mol

1 mark

Mass glucose **= 0.0665×180.1**
 = 11.98 g

1 mark

Must include unit, should be 3 significant figures (12.0 g)

2 marks for correct answer with no unit and 3 significant figures, otherwise partial marks for working as above.