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 CaC_2O_4 = 128.097 g mol^{-1}.

[3 marks]

$CaC_2O_4(s) \rightleftharpoons Ca^{2+}(aq) + C_2O_4^{2-}(aq)$
and $K_{sp} = [Ca^{2+}][C_2O_4^{2-}]$

From the reaction stoichiometry, for each mole of $CaC_2O_4(s)$ that dissolves, 1 mole of Ca^{2+} and 1 mole of $C_2O_4^{2-}$ are formed.
If the molar solubility of $CaC_2O_4(s)$ = S M, then $[Ca^{2+}]$ = S M and $[C_2O_4^{2-}]$ = S 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 4.82×10^{-5} M **1 mark**

Solubility in g L^{-1} = molar solubility × Mr
$= 4.82 \times 10^{-5} \times 128.097$
$= 6.17 \times 10–3$ g L^{-1}
Solubility of calcium oxalate is 6.17×10^{-3} 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**

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 mol kg^{-1}.

Data: $M_r\ C_6H_{12}O_6 = 180.156\ g\ mol^{-1}$ $M_r\ H_2O = 18.015\ g\ mol^{-1}$

[2 marks]

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

Amount of glucose = molality × 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.