

Electrolytes and the Dissolving Process

Answer key with worked solutions

A. Ideas

1. Definitions.

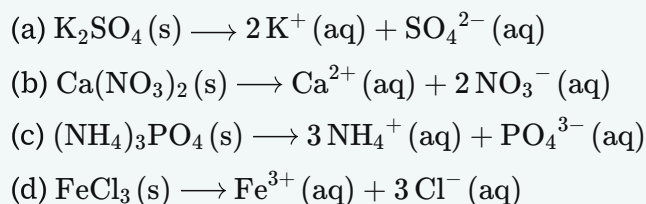
(a) **Solute**: the substance dissolved. **Solvent**: the substance it dissolves in. **Electrolyte**: a substance that forms ions in solution, so the solution conducts. (b) Salt separates into **mobile ions** (Na^+ and Cl^-) that carry charge. Sugar dissolves as **whole molecules** with no charge, so nothing carries the current.

2. Classify.

(a) **strong** (b) **non-electrolyte** (c) **strong** (d) **weak** (e) **strong** (f) **non-electrolyte**

B. Dissociation and ion concentrations

3. Dissociation equations.



4. Ion concentrations.

(a) $[\text{K}^+] = 2 \times 0.200 \text{ mol/L} = \mathbf{0.400 \text{ mol/L}}$; $[\text{SO}_4^{2-}] = \mathbf{0.200 \text{ mol/L}}$ (b) $[\text{Fe}^{3+}] = \mathbf{0.150 \text{ mol/L}}$; $[\text{Cl}^-] = 3 \times 0.150 \text{ mol/L} = \mathbf{0.450 \text{ mol/L}}$

5. Best conductor.

CaCl_2 ; it gives 3 ions per formula unit, 0.30 mol/L of ions in total. NaCl gives 0.20 mol/L of ions; ethanoic acid is only slightly ionized; glucose gives no ions.

6. Mixing.

$$\text{Total volume} = 0.0500 \text{ L} + 0.0500 \text{ L} = 0.1000 \text{ L}$$

$$\text{Ca}^{2+}: 0.100 \text{ mol/L} \times 0.0500 \text{ L} = 5.00 \times 10^{-3} \text{ mol, so } [\text{Ca}^{2+}] = \frac{5.00 \times 10^{-3} \text{ mol}}{0.1000 \text{ L}} = \mathbf{0.0500 \text{ mol/L}}$$

$$\text{K}^{+}: 0.200 \text{ mol/L} \times 0.0500 \text{ L} = 1.00 \times 10^{-2} \text{ mol, so } [\text{K}^{+}] = \mathbf{0.100 \text{ mol/L}}$$

$$\text{Cl}^{-}: 2 \times 5.00 \times 10^{-3} \text{ mol} + 1.00 \times 10^{-2} \text{ mol} = 2.00 \times 10^{-2} \text{ mol, so } [\text{Cl}^{-}] = \mathbf{0.200 \text{ mol/L}}$$

C. Energy changes

7. Hot or cold.

Dissolving an ionic solid needs energy to **break up the lattice** (endothermic) and releases energy when the ions are **hydrated** (exothermic). If hydration releases **more** energy than the lattice needs, the overall change is exothermic and the water warms (e.g. CaCl_2). If it releases **less**, the overall change is endothermic and the energy comes from the water, which cools (e.g. NH_4NO_3).

D. Challenge

8. Hand warmer.

$$n = \frac{5.00 \text{ g}}{110.98 \text{ g/mol}} = 0.04505 \text{ mol}$$

$$\text{Heat released: } 0.04505 \text{ mol} \times 82.8 \text{ kJ/mol} = 3.730 \text{ kJ} = 3730 \text{ J}$$

$$\begin{aligned} \Delta T &= \frac{q}{mc} = \frac{3730 \text{ J}}{105 \text{ g} \times 4.184 \text{ J/(g} \cdot ^\circ\text{C)}} \\ &= \mathbf{8.49 ^\circ\text{C rise}} \end{aligned}$$