2.4 Identify factors which can affect the equilibrium in a reversible reaction –

ALWAYS RELATE EQUILIBRIUM QUESTIONS BACK TO Le Chatelier's Principle

1. **Concentration:**
   - Removing reactants causes equilibrium to shift in the direction of reactants
   - Removing products causes equilibrium to shift in the direction of products
   - Changing the amount of solid or liquid does not shift an equilibrium as these substances have a constant concentration
2. **Pressure/Volume:**
   - Increasing pressure (decreasing volume) causes equilibrium to shift in the direction producing less moles of gas
   - Decreasing pressure (increasing volume) causes equilibrium to shift in direction produces more moles of gas
   - The addition of an inert gas will not shift the equilibrium as it will not change the partial pressure of the reacting chemicals (which is what matters)
3. **Temperature:**
   - Increasing the temperature causes equilibrium to shift in the direction of the endothermic reaction (which will decrease the temperature as it absorbs heat)
   - Decreasing the temperature will cause equilibrium to shift in the direction of the exothermic reaction (which will increase the temperature as this liberates heat)

2.10 Explain the formation and effects of acid rain –

- Normal rain is already slightly acidic due to the presence of CO_2 in the atmosphere

$$CO_{2\,(g)} + H_2O_{\,(l)} \rightarrow H_2CO_{3\,(aq)}$$

- Acid Rain is rain that has a lower pH than usual (<5.5) due to the presence of non-metal oxides e.g. sulfur and nitrogen oxides

Formation of Acid Rain:

Forms when acidic oxides dissolve in rain droplets in atmosphere & precipitate out as acid rain

1. Sulfur Dioxide reacts with rain water forming Sulfurous Acid:

$$SO_{2\,(g)} + H_2O_{\,(l)} \longrightarrow H_2SO_{3\,(aq)}$$

2. Sulfurous Acid reacts with oxygen (catalysed by air) to form Sulfuric Acid:

$$2H_2SO_{3\,(aq)} + O_{2\,(g)} \longrightarrow 2H_2SO_{4\,(aq)}$$

1. Nitrogen Dioxide reacts with rain water forming Nitric and Nitrous Acid:

$$2NO_{2\,(g)} + H_2O_{\,(l)} \longrightarrow HNO_{3\,(aq)} + HNO_{2\,(aq)}$$

2. Nitrous Acid reacts with oxygen (catalysed by air) to form Nitric Acid:

$$2HNO_{2\,(aq)} + O_{2\,(g)} \longrightarrow 2HNO_{3\,(aq)}$$

Industrialised areas (Europe/North America) are prone to low pH rain (since there are high levels of non-metal oxides in their atmosphere) → this has many adverse effects

Negative Effects of Acid Rain:

1. Surface waters and lakes become acidic, which disturbs the CO2 equilibrium. The lower pH irritates aquatic life (their skin, gills). As acid rain is corrosive, it also damages plant life (e.g. defoliation)
2. Acid rain dissolves chemicals from the ground and deposits them into waterways. Mg^{2+}, Ca^{2+} and K^{+} are important for plant growth & are removed. Other chemicals leeched may be toxic to marine life (e.g. Al^{3+}) → further stunts growth of plants and some are destroyed
3. Acid rain attacks natural and artificial structures and corrodes them. Acid rain dissolves the calcium carbonate in concrete, limestone and marble → many historically significant sites have been affected

$$CaCO_{3\,(a)} + H_2SO_{4(g)} \rightarrow CaSO_{4(aq)} + CO_{2(g)} + H_2O_{(l)}$$

$$Fe_{(s)} + H_2SO_{4\,(aq)} \rightarrow FeSO_{4(aq)} + H_{2(g)}$$