

## Question 21 (7 marks)

Evaluate the impact of industrial sources of sulfur dioxide and nitrogen oxides on the environment, making use of appropriate chemical equations.

7

Sulfur dioxide ( $\text{SO}_2$ ) is usually emitted by industry in the extraction of metals from sulfide ores. This gas could also come from the combustion of natural gas containing traces of sulfur:  $\text{S}_{(s)} + \text{O}_{2(g)} \rightarrow \text{SO}_2$ .

Sulfur dioxide from these sources only causes breathing difficulty because of its pungent odour. It is hard to detect because it is colourless and diffuses well in air. However, advantages had been taken from this pollutant by collecting it in scrubbers (consisting of lime which absorbs the gas) installed on the gas emission columns of industrial plants. Sulfur dioxide can be used as a food preservative and in the bleaching of paper and textiles. Ultimately, it does contribute to acid rain formation when released to the atmosphere: <sup>and reacts with water vapour</sup>

$\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3$  (aq). Solid particles in the air catalyses the conversion of ~~sulfur~~ sulfurous acid into sulfuric acid:  $\text{H}_2\text{SO}_3 + \text{H}_2\text{O} \xrightarrow{\text{catalyst}} \text{H}_2\text{SO}_4$ . ~~The gas~~ Sulfur dioxide is soluble, hence it gets washed out by rain.

Nitrogen dioxides could also cause environmental problems. Nitrogen oxide monoxide ( $\text{NO}$ ) forms in localized spots of high temperature such as car engines. It can be collected and its ~~use range~~ <sup>used to make nitric acid and explosives and fertilisers</sup> ~~from propellants in spray cans and anaesthetic laughing gas.~~ It contributes to the formation of nitrogen dioxide ( $\text{NO}_2$ ), a brown gas which causes

acid rain:  $\text{NO} + \frac{1}{2}\text{O}_2 \xrightarrow[\text{carbon compounds}]{\text{sunlight}} \text{NO}_2$ ;  $2\text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3 + \text{HNO}_2$ . Acid rain damages pine forests and decreases the pH of lakes making them too acidic

for marine creatures to survive. Acid rain also leaches sandstone and limestone buildings and statues, degrading their features. The final  $\text{NO}_x$  gas is nitrous oxide ( $\text{N}_2\text{O}$ ) which forms from the bacterial decay of nitrogen-rich fertilisers and waste from industrials.  $\text{N}_2\text{O}$  causes the least problem because it is insoluble in water hence does not create acid rain.  $\text{N}_2\text{O}$  can be used as an anaesthetic laughing gas and propellants in spray cans.