Car exhausts, acid rain and corrosion
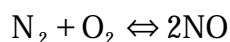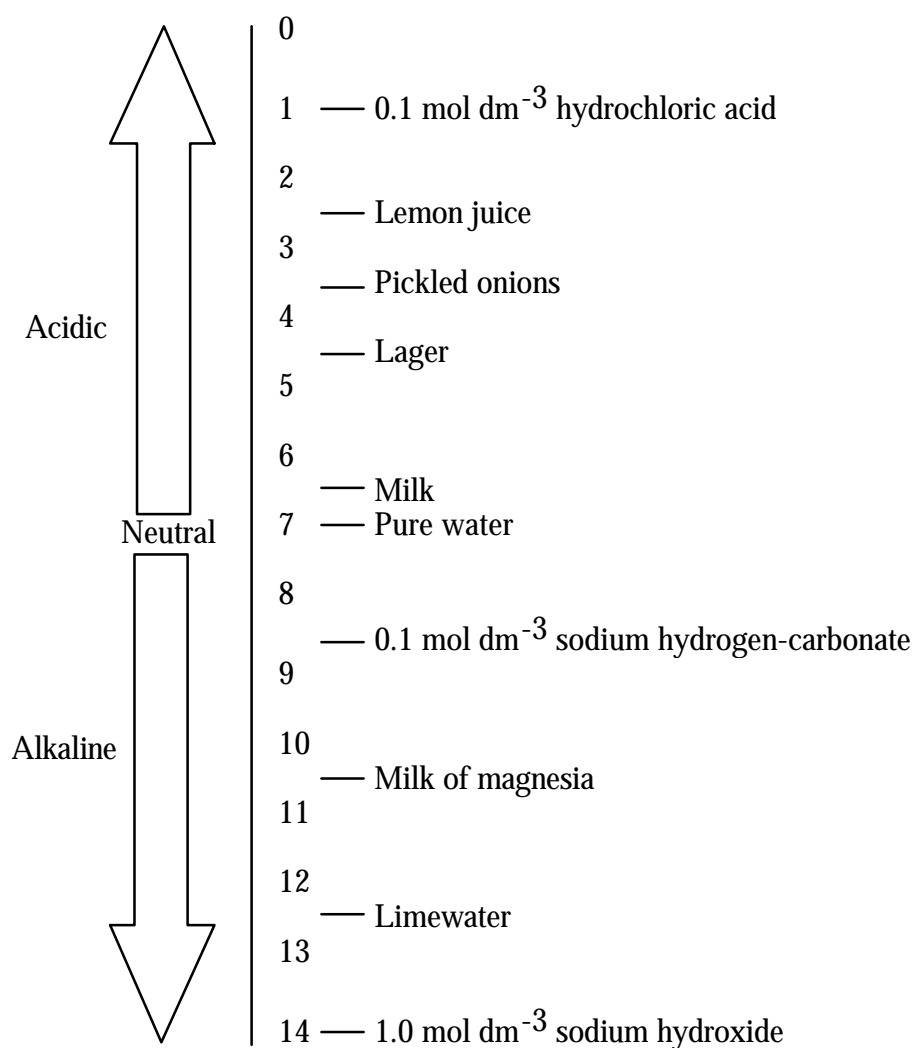
When petrol is burned in car engines, and air is drawn in, nitrogen oxides are produced.

$$N_2 + O_2 \Leftrightarrow 2NO$$

This happens at the very high temperatures inside an engine: when the gas leaves the exhaust it cools very quickly, and is rapidly oxidised to nitrogen dioxide, NO_2, a major pollutant.

Both nitrogen oxide and nitrogen dioxide also dissolve in rainwater to form dilute solutions of nitrous and nitric acids, which are components in the **acid rain** responsible for the erosion of much stonework, and damaging to trees and to life in streams and lakes.

In looking at the acidity of solutions (such as acid rain) the **pH scale** is generally used. The pH of a solution is a measure of the concentration of hydrogen (H_3O^+) ions and is shown below.

0

1 —— 0.1 mol dm^{-3} hydrochloric acid

2

—— Lemon juice

3

—— Pickled onions

4

—— Lager

5

6

—— Milk

Neutral 7 —— Pure water

8

—— 0.1 mol dm^{-3} sodium hydrogen-carbonate

9

10

—— Milk of magnesia

11

12

—— Limewater

13

14 —— 1.0 mol dm^{-3} sodium hydroxide

Acidic

Alkaline

Photo-copiable

The pH of unpolluted rain is between 5.5 and 6.0. (It is slightly acidic because of the carbon dioxide in the air.)

Polluted urban rain regularly has a pH of 4.5, and often a pH of 4.

pH values as low as 2.5 or 2.4 have been recorded for acid rain, at which point it is extremely harmful.

The Excel datafile 'Acid Rain' contains pH measures for rain collected in 25 different locations at ten 6-monthly intervals.

Use the data to examine differences between places and times in the incidence of acid rain.

You should **group** your data for some of your analyses: decide what different categories of acidity/harmfulness you want to use. (The pH chart will help you.)

Aim to use (and label clearly):

> bar charts
>
> pie charts
>
> line graphs

Explain and comment on your results.