

1.

(a)  $-\log_{10}(0.05) = 1.3$

(b)  $-\log_{10}(0.20) = 0.70$

(c)  $\text{pOH} = -\log_{10}(0.04) = 1.4$

$\text{pH} + \text{pOH} = 14$

$\therefore \text{pH} = 12.6$

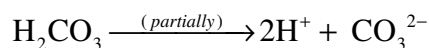
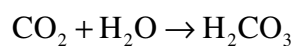
(d)  $-\log_{10}(5.4 \times 10^{-5}) = 4.3$

(e)  $\text{pOH} = -\log_{10}(3.7 \times 10^{-7}) = 6.4$

$\text{pH} + \text{pOH} = 14$

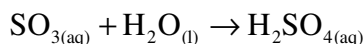
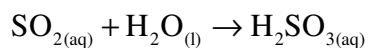
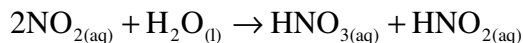
$\therefore \text{pH} = 7.6$

2.



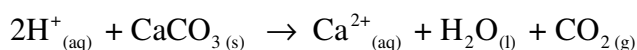
3.

(a) Acid rain forms when oxides of nitrogen or sulfur react with water.

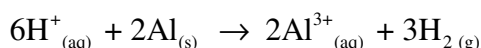
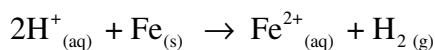


These acids then partially ionise, lowering the pH of the rain.

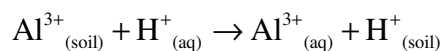
(b) Limestone is a metal carbonate and will therefore react with an acid to produce a neutral solution of metal ions.



4. Acid in acid rain corrodes the metal: it reacts to dissolve the metal into solution. The metal ions are then washed away with the rain.

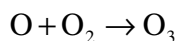
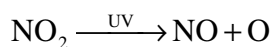


5. The hydrogen ions in the rain displace the toxic metal cations adsorbed to soil particles. The toxic metal cations are then in solution in soil water.



6.

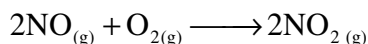
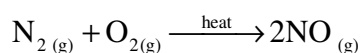
- (a) Combustion in car engines
- (b) Traffic (and therefore combustion in car engines) is high as people drive to and from work.
- (c) UV breaks oxygen away from  $\text{NO}_2$ , and this atomic oxygen reacts with  $\text{O}_2$  to form ozone. Excess energy is absorbed by a stabilising molecule.



- (d) Levels of UV are highest then.
- (e) Ozone is produced by a reaction of a primary pollutant in the atmosphere, it is not emitted directly.

7.

- (a) Atmospheric nitrogen is present in the air used during combustion. The high temperature of combustion allows  $\text{N}_2$  to react with  $\text{O}_2$  to form  $\text{NO}$ . This can then react with  $\text{O}_2$  to form  $\text{NO}_2$ .



- (b) Tropospheric ozone is a secondary pollutant produced by  $\text{NO}_x$  and UV. The two equations reduce the amount of  $\text{NO}_2$  (convert it into  $\text{N}_2$  which is generally unreactive) which therefore doesn't exist to produce ozone.

8. Salts containing  $\text{Al}^{3+}$  are added to the water. Clay particles in water are negatively charged so the cations will attract them and join them together in larger clumps which are too large to stay suspended and will settle. The clay can then be removed as a sediment or filtered out.

9.

- (a) Hypochlorite (ions)
- (b)  $\text{ClO}^- + \text{H}_2\text{O} \rightarrow \text{HOCl} + \text{OH}^-$   
Since  $\text{OH}^-$  is produced, the pH is being raised.
- (c)  $[\text{H}^+] = 10^{-\text{pH}} = 3.16 \times 10^{-8} \text{ mol L}^{-1}$

10. Chlorine gas reacts with water to form hypochlorous acid and hydrogen ions. This gives low pH (acidic) conditions. Adding a base will correct the pH closer to ideal (7.5)