5.2 ANSWERS TO EXERCISES

5.2 Exercise 1

1. a) $2Na(s) + 2H_2O(l) \rightarrow 2NaOH + H_2(g)$
   b) $Mg(s) + H_2O(g) \rightarrow MgO(s) + H_2(g)$

2. a) $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$
   b) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
   c) $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$
   d) $Si(s) + O_2(g) \rightarrow SiO_2(s)$
   e) $4P(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$
   f) $S(s) + O_2(g) \rightarrow SO_2(g)$

5.2 Exercise 2

1. a) the charges on Mg^{2+} and Al^{3+} are larger than the charge on Na^+
   and Mg^{2+} and Al^{3+} are smaller in size than Na^+
   so the attraction between Mg^{2+} and O^{2-}, and between Al^{3+} and O^{2-} is greater than the attraction between Na^+ and O^{2-}
   so more energy is needed to separate the ions
   b) SiO_2 is giant covalent
   and much energy is required
   to break the covalent bonds between Si and O atoms
   c) P_4O_{10} and SO_2 are simple molecular
   SiO_2 is giant covalent
   Less energy is required to break intermolecular forces between P_4O_{10} or SO_2 molecules
   Than is required to break covalent bonds between Si and O atoms
   d) The P_4O_{10} molecules are larger than SO_2 molecules
   so the intermolecular forces between P_4O_{10} molecules
   are larger than the intermolecular forces between SO_2 molecules
   so more energy is required to separate P_4O_{10} molecules than SO_2 molecules

2. a)
   i) $Na_2O(s) + H_2O(l) \rightarrow 2NaOH(aq)$ pH 12 - 14
   ii) $MgO(s) + H_2O(l) \rightarrow Mg(OH)_2(s)$ pH 8 – 9
   iii) $P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq)$ pH 2 – 4
   iv) $SO_2(g) + H_2O(l) \rightarrow H_2SO_3(aq)$ pH 2 - 4
   v) $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$ pH 1 - 3

   b)
   i) $Na_2O(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l)$
   ii) $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$
   iii) $Al_2O_3(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2O(l)$

   c)
   i) $Al_2O_3(s) + 2NaOH(aq) + 3H_2O(l) \rightarrow 2NaAl(OH)_4(aq)$
   ii) $SiO_2(s) + 2NaOH(aq) \rightarrow Na_2SiO_3(aq) + H_2O(l)$

iii) $P_4O_{10}(s) + 12NaOH(aq) \rightarrow 4Na_3PO_4(aq) + 6H_2O(l)$
iv) $SO_2(g) + 2NaOH(aq) \rightarrow Na_2SO_3(aq) + H_2O(l)$
v) $SO_3(g) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + H_2O(l)$

d) Na_2O and MgO are basic
they react with water to give solutions with pH greater than 7
and they react with acids.
These oxides are basic because the bonding is ionic.
Al_2O_3 is amphoteric
It reacts with acids and with alkalis
Al_2O_3 is amphoteric because the bonding is intermediate between ionic and covalent
SiO_2, P_4O_{10}, SO_2 and SO_3 are acidic
They react with water to give solutions with pH less than 7
And they react with alkalis
These oxides are acidic because the bonding is covalent.