Chapter 9 – Answers to questions (for in-chapter questions)

1  a Yes,  b Yes,  c White
   d Sodium reacts very vigorously – melts to a silvery globule, skates over the water surface producing H₂ and an alkaline solution of NaOH.

Potassium reacts violently, melts to a silvery globule which catches fire producing a lilac flame – forming H₂ and an alkaline solution of KOH.

The reaction of Na and K are similar with similar products.

\[ 2\text{Na}(s) + 2\text{H}_2\text{O}(l) \rightarrow 2\text{NaOH}(aq) + \text{H}_2(g) \]
\[ 2\text{K}(s) + 2\text{H}_2\text{O}(l) \rightarrow 2\text{KOH}(aq) + \text{H}_2(g) \]

   e Formulae of compounds are similar with both Na and K in oxidation state +1 in all their compounds.

2  Average Rel. At. Mass of Li and K  =  \frac{6.9 + 39.1}{2} = 23.0

   Rel. At. Mass Na  = 23.0.

   They are identical to one decimal place.

3  a Because, starting at any one element, the eighth element along is a kind of repetition, like the eighth note in an octave of music.
   b Li, Na and K or Be, Mg and Ca
   c S and Fe

4  a Scandium, Gallium, Germanium, Technetium.
   b Because none of them had been discovered when he published his table in 1869.

5  Compared to Na and Ca, transition metals have:
   a higher melting points and boiling points,  b higher densities,  c less vigorous reactions with water,  d more than one oxidation number in their compounds,  e coloured (non white) solid compounds and coloured aqueous solutions.

6  a below and left of the thick steps in Figure 9.6.
   b touching the thick steps in Figure 9.6.
   c Na to Ar,  d Group II,  e F,  f Cl₂ (possibly Br₂ or I₂),
   g Fe, Co or Ni,  h Ag, Au and Pt.

7  a B, C, Si – giant covalent (giant molecular) structures.
   b From Na through Mg to Al, the number of outermost shell electrons (i.e. delocalised electrons) per atom increases from 1 to 2 to 3. These electrons contribute to an electric current through the metal and so electrical conductivity increases from Na \rightarrow Mg \rightarrow Al.
8 Because each successive element has one more full shell of electrons.

9 a Those in the outermost shell.
   b It will have lost electrons from the outermost shell.
   c Because it has lost electrons from the outermost shell.
   d Because Na\(^+\), Mg\(^{2+}\) and Al\(^{3+}\) all have the same electronic structure of 2, 8, but from Na\(^+\) to Al\(^{3+}\) there is an increased positive nuclear charge which pulls the electrons closer to the nucleus.

10 a Na, b Cl, c P, d Al

11 a Group I b The ratio of I.E.s for second to first, third to second and fourth to third are approx. 5.5 : 1.3 : 1.3. This suggests that the first electron is very easy to remove relative to the second, the third is only a little more difficult than the second and the fourth only a little more difficult than the third.

12 a 4Na(s) + O\(_2\)(g) \rightarrow 2(Na\(^+\))\(_2\)O\(^{2-}\)(s)
   b i Na atoms have lost electrons (been oxidised) to form Na\(^+\) ions.
      O atoms have gained electrons (been reduced) to form O\(^{2-}\) ions.
      ii The oxidation number of Na has increased from O to +1 in Na\(^+\) ions.
      The oxidation number of O has decreased from 0 to –2 in O\(^{2-}\) ions.
   c

13 a

14 a Li +1, Be +2, B +3, C +4, N +3, O –2, F –1
   b Oxidation numbers rise from +1 in LiCl to +4 in CCl\(_4\) and then fall to –1 in ClF.
   c They are dictated by the number of electrons in the outer shell of the elements in period 2.
15  a  They change from solids to liquids and finally to a gas.
     b  They fall from high values in NaCl and MgCl₂ to an intermediate value in Al₂Cl₆ and then to low values.
     c  Very good for NaCl and MgCl₂, very poor for Al₂Cl₆ and nil for the chlorides of Si, P and S.

16  Si and P.

17  a  \( \text{Na}_2\text{O(s)} + \text{H}_2\text{O(l)} \rightarrow 2\text{NaOH(aq)} \)
     \( \text{MgO(s)} + \text{H}_2\text{O(l)} \rightleftharpoons \text{Mg(OH)_2(aq)} \)
     \( \text{P}_4\text{O}_{10(s)} + 6\text{H}_2\text{O(l)} \rightarrow 4\text{H}_3\text{PO}_4(aq) \)
     \( \text{SO}_3(g) + \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{SO}_4(aq) \)
     \( \text{Cl}_2\text{O}_7(l) + \text{H}_2\text{O(l)} \rightarrow 2\text{HClO}_4(aq) \)
     b  The oxides change from strongly basic (Na₂O) through basic (MgO), then amphoteric (Al₂O₃) and weakly acidic (SiO₂) to strongly acidic (P₄O₁₀, SO₃, Cl₂O₇).

18  Al and Si