**Unit 2 Section 1 ANSWERS**

**Topic 6 Exercise 2**

1. alkali earth metals
2. Size increases down Group II
   The number of shells, and hence the shielding increases
   So the outer shell electrons are further from the nucleus
3. On descending the group
   The number of shells, and hence the shielding increases
   So the attraction between the nucleus and outer electrons decreases
4. The size of the cations increases down the group
   So the attraction between cations and delocalised electrons decreases
   So the metallic bonding gets weaker
5. a) On descending the group
      The number of shells, and hence the shielding increases
      So the attraction between the nucleus and outer electrons decreases
      So the outer electrons are more easily lost
   b) i) $Mg(s) + H_2O(g) \rightarrow MgO(s) + H_2(g)$
      ii) $Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + H_2(g)$
      iii) $Ba(s) + 2H_2O(l) \rightarrow Ba(OH)_2(s) + H_2(g)$
   c) the reaction with calcium would be slower
      and the solution would go cloudy
6. a) decreases down Group II
   b) increases down Group II
   c) i) white precipitate: $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$
      ii) no reaction
      iii) white precipitate: $Mg^{2+}(aq) + 2OH^-(aq) \rightarrow Mg(OH)_2(s)$
      iv) faint white precipitate: $Ca^{2+}(aq) + 2OH^-(aq) \rightarrow Ca(OH)_2(s)$
      v) faint white precipitate: $Ca^{2+}(aq) + SO_4^{2-}(aq) \rightarrow CaSO_4(s)$
      vi) no reaction
   d) Add dilute hydrochloric acid followed by barium chloride solution
      A white precipitate will be observed
   e) $BaSO_4$ is consumed in a "barium meal"; it absorbs X-rays and so its path through the digestive system can be tracked using X-rays
   f) $MgSO_4$ is consumed in order to treat Mg deficiency
7. a) $Mg(OH)_2(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + 2H_2O(l)$
   b) $Ca(OH)_2(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$
   c) $CaO(s) + SO_2(g) \rightarrow CaSO_3(s)$
   d) $CaCO_3(s) + SO_2(g) \rightarrow CaSO_3(s) + CO_2(g)$
8. a) used to treat indigestion caused by excess stomach acid
   b) used to neutralize acidic soils
   c) used to remove $SO_2$ from factory chimneys
   d) used to remove $SO_2$ from factory chimneys
9. The Mg reduces the $TiCl_4$ to Ti by the reaction $TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$

**Topic 6 Exercise 3**

1. Halogens
2. Halides
3. decreases down group
   more shells
   so bonding electrons are more shielded from nucleus
   and atom is less able to attract bonding electrons towards itself
4. increases down group
   molecules have more electrons/larger surface area
   so stronger Van der Waal's forces
   so more energy required to separate the molecules
5. they have only seven electrons in the outer shell so can act as electron acceptors and become halides
   Oxidising ability decreases down group
   More shells means more shielding
   So the incoming electron is less strongly attracted to the nucleus
6. they can lose electrons to become halogens
   reducing ability increases down group
   more shells means more shielding
   So electrons can be more easily lost from the outer shell
7. a) no change; stays brown
   b) brown solution; $Cl_2(aq) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(aq)$
   c) no change; stays brown
   d) brown solution; $Br_2(aq) + 2I^-(aq) \rightarrow 2Br^-(aq) + I_2(aq)$
   e) no change; stays orange
   f) yellow/orange solution; $Cl_2(aq) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$
8. a) $2I^- \rightarrow I_2 + 2e$
   b) $2Br^- \rightarrow Br_2 + 2e$
   c) $H_2SO_4 + 2H^+ + 2e \rightarrow SO_2 + 2H_2O$
   d) $H_2SO_4 + 8H^+ + 8e \rightarrow H_2S + 4H_2O$
9. $Cl^-$ is the weakest reducing agent and $I^-$ is the strongest reducing agent
   Reducing power increases down the group; more shells and more shielding mean that the attraction between the outermost electrons and the nucleus is weaker and the species is a better electron donor
   $Cl^-$ cannot reduce $H_2SO_4$; $Br^-$ reduces S in $H_2SO_4$ from +6 to +4; $I^-$ reduces S in $H_2SO_4$ from +6 to -2:
   a) $H_2SO_4 + 2H^+ + 2Br^- \rightarrow SO_2 + Br_2 + 2H_2O$
   b) $H_2SO_4 + 8H^+ + 8I^- \rightarrow H_2S + 4I_2 + 4H_2O$
10. $H_2SO_4 + Cl^- \rightarrow HSO_4^- + HCl$
    The oxidation number of S is +6 in both reactant and product

**Topic 6 Exercise 4**

1. a) $Cl_2 + H_2O == HCl(aq) + HClO(aq)$
   b) Cl is both oxidised (from 0 to +1) and reduced (from 0 to -1)

c) this is used to sterilise water; HClO is a sterilising agent

2. a) $2Cl_2 + 2H_2O \rightarrow 4HCl + O_2$
   b) Cl is reduced (from 0 to -1) and O is oxidized (from -2 to 0)

3. Chlorine is added to the water supply to kill harmful bacteria (ie to sterilize the water)

4. Adding chemicals to the water supply can have health benefits by killing harmful toxins or providing important nutrients.
   The chemicals added to the water supply can themselves be toxic to some people and they take away the right of the individual to choose whether to add chemicals to their water

5. a) $Cl_2 + NaOH \rightarrow NaCl(aq) + NaClO(aq) + H_2O$
   b) Cl is both oxidised (from 0 to +1) and reduced (from 0 to -1)
   c) this is used to make bleach

**Topic 6 Exercise 5**

1.

| Anion | Reagent | Observation | Ionic equation |
|---|---|---|---|
| $Cl^-$ | aq $AgNO_3$ and dil $HNO_3$ | white precipitate | $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ |
| $Br^-$ | aq $AgNO_3$ and dil $HNO_3$ | cream precipitate | $Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ |
| $I^-$ | aq $AgNO_3$ and dil $HNO_3$ | yellow precipitate | $Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$ |
| $CO_3^{2-}$ | dil HCl | effervescence | $2H^+(aq) + CO_3^{2-}(aq) \rightarrow CO_2(g) + H_2O(l)$ |
| $SO_4^{2-}$ | aq $BaCl_2$ and dil HCl | thick white precipitate | $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ |
| $OH^-$ | dil $NH_4Cl$ and warm | pungent smell | $NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$ |

2.

| Cation | Reagent | Observation | Ionic equation |
|---|---|---|---|
| $Mg^{2+}$ | aq NaOH | thick white precipitate | $Mg^{2+}(aq) + 2OH^-(aq) \rightarrow Mg(OH)_2(s)$ |
| $Ca^{2+}$ | aq NaOH | faint white precipitate | $Ca^{2+}(aq) + 2OH^-(aq) \rightarrow Ca(OH)_2(s)$ |
| $Sr^{2+}$ | dil $H_2SO_4$ | faint white precipitate | $Sr^{2+}(aq) + SO_4^{2-}(aq) \rightarrow SrSO_4(s)$ |
| $Ba^{2+}$ | dil $H_2SO_4$ | thick white precipitate | $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ |
| $NH_4^+$ | aq NaOH and warm | pungent smell | $NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$ |
| $H^+$ | aq $Na_2CO_3$ | effervescence | $2H^+(aq) + CO_3^{2-}(aq) \rightarrow CO_2(g) + H_2O(l)$ |