MEGA LECTURE

Answers to Topic 6 Exercises

Topic 6 Exercise 1

1. a) loss of electrons
   b) gain of electrons
   c) electron acceptor
   d) electron donor
   e) a reaction in which electrons are transferred

2. a) +4 b) -2 c) +4 d) +6 e) +5
   f) +3 g) 0 h) +2 i) +1 j) +5
   k) +1 l) -1 m) -1 n) +3 o) +5
   p) +7 q) +2 r) +8/3 s) +2.5 t) +2

3. a) $PbO_2 + 4H^+ + 2e \rightarrow Pb^{2+} + 2H_2O$
   $2Cl^- \rightarrow Cl_2 + 2e$
   $PbO_2 + 4H^+ + 2Cl^- \rightarrow Pb^{2+} + Cl_2 + 2H_2O$
   b) $2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2e$
   $I_2 + 2e \rightarrow 2I^-$
   $2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$
   c) $2IO_3^- + 12H^+ + 10e \rightarrow I_2 + 6H_2O$
   $2I^- \rightarrow I_2 + 2e$
   $IO_3^- + 6H^+ + 5I^- \rightarrow 3I_2 + 3H_2O$
   d) $ClO^- + 2H_2O \rightarrow ClO_3^- + 4H^+ + 4e$
   $ClO^- + 2H^+ + 2e \rightarrow Cl^- + H_2O$
   $3ClO^- \rightarrow 2Cl^- + ClO_3^-$
   e) $H_2SO_4 + 2H^+ + 2e \rightarrow SO_2 + 2H_2O$
   $2Br^- \rightarrow Br_2 + 2e$
   $H_2SO_4 + 2H^+ + 2Br^- \rightarrow SO_2 + Br_2 + 2H_2O$
   f) $H_2SO_4 + 6H^+ + 6e \rightarrow S + 4H_2O$
   $2I^- \rightarrow I_2 + 2e$
   $H_2SO_4 + 6H^+ + 6I^- \rightarrow S + 3I_2 + 4H_2O$
   g) $H_2SO_4 + 8H^+ + 8e \rightarrow H_2S + 4H_2O$
   $2I^- \rightarrow I_2 + 2e$
   $H_2SO_4 + 8H^+ + 8I^- \rightarrow H_2S + 4I_2 + 4H_2O$
   h) $ClO^- + 2H^+ + 2e \rightarrow Cl^- + H_2O$
   $2I^- \rightarrow I_2 + 2e$
   $ClO^- + 2H^+ + 2I^- \rightarrow Cl^- + H_2O + I_2$
   i) $PbO_2 + 4H^+ + 2e \rightarrow Pb^{2+} + 2H_2O$
   $SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e$
   $PbO_2 + 2H^+ + SO_3^{2-} \rightarrow Pb^{2+} + SO_4^{2-} + H_2O$

4.

Equation	Oxidising agent	Reducing agent
a)	PbO_2	Cl^-
b)	I_2	$S_2O_3^{2-}$
c)	IO_3^-	I^-
d)	ClO^-	ClO^-
e)	H_2SO_4	Br^-
f)	H_2SO_4	I^-
g)	H_2SO_4	I^-
h)	ClO^-	I^-
i)	PbO_2	SO_3^{2-}

5. only reaction (d) is a disproportionation reaction

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	$2H^+(aq) + CO_3^{2-}(aq) \rightarrow CO_2(g) + H_2O(l)$