



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) $\text{PbO}_2 + 4\text{H}^+ + 2\text{e} \rightarrow \text{Pb}^{2+} + 2\text{H}_2\text{O}$
 $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}$
 $\text{PbO}_2 + 4\text{H}^+ + 2\text{Cl}^- \rightarrow \text{Pb}^{2+} + \text{Cl}_2 + 2\text{H}_2\text{O}$
- b) $2\text{S}_2\text{O}_3^{2-} \rightarrow \text{S}_4\text{O}_6^{2-} + 2\text{e}$
 $\text{I}_2 + 2\text{e} \rightarrow 2\text{I}^-$
 $2\text{S}_2\text{O}_3^{2-} + \text{I}_2 \rightarrow \text{S}_4\text{O}_6^{2-} + 2\text{I}^-$
- c) $2\text{IO}_3^- + 12\text{H}^+ + 10\text{e} \rightarrow \text{I}_2 + 6\text{H}_2\text{O}$
 $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}$
 $\text{IO}_3^- + 6\text{H}^+ + 5\text{I}^- \rightarrow 3\text{I}_2 + 3\text{H}_2\text{O}$
- d) $\text{ClO}^- + 2\text{H}_2\text{O} \rightarrow \text{ClO}_3^- + 4\text{H}^+ + 4\text{e}$
 $\text{ClO}^- + 2\text{H}^+ + 2\text{e} \rightarrow \text{Cl}^- + \text{H}_2\text{O}$
 $3\text{ClO}^- \rightarrow 2\text{Cl}^- + \text{ClO}_3^-$
- e) $\text{H}_2\text{SO}_4 + 2\text{H}^+ + 2\text{e} \rightarrow \text{SO}_2 + 2\text{H}_2\text{O}$
 $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}$
 $\text{H}_2\text{SO}_4 + 2\text{H}^+ + 2\text{Br}^- \rightarrow \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O}$
- f) $\text{H}_2\text{SO}_4 + 6\text{H}^+ + 6\text{e} \rightarrow \text{S} + 4\text{H}_2\text{O}$
 $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}$
 $\text{H}_2\text{SO}_4 + 6\text{H}^+ + 6\text{I}^- \rightarrow \text{S} + 3\text{I}_2 + 4\text{H}_2\text{O}$
- g) $\text{H}_2\text{SO}_4 + 8\text{H}^+ + 8\text{e} \rightarrow \text{H}_2\text{S} + 4\text{H}_2\text{O}$
 $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}$
 $\text{H}_2\text{SO}_4 + 8\text{H}^+ + 8\text{I}^- \rightarrow \text{H}_2\text{S} + 4\text{I}_2 + 4\text{H}_2\text{O}$
- h) $\text{ClO}^- + 2\text{H}^+ + 2\text{e} \rightarrow \text{Cl}^- + \text{H}_2\text{O}$
 $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}$
 $\text{ClO}^- + 2\text{H}^+ + 2\text{I}^- \rightarrow \text{Cl}^- + \text{H}_2\text{O} + \text{I}_2$
- i) $\text{PbO}_2 + 4\text{H}^+ + 2\text{e} \rightarrow \text{Pb}^{2+} + 2\text{H}_2\text{O}$
 $\text{SO}_3^{2-} + \text{H}_2\text{O} \rightarrow \text{SO}_4^{2-} + 2\text{H}^+ + 2\text{e}$
 $\text{PbO}_2 + 2\text{H}^+ + \text{SO}_3^{2-} \rightarrow \text{Pb}^{2+} + \text{SO}_4^{2-} + \text{H}_2\text{O}$



4.

Equation	Oxidising agent	Reducing agent
a) PbO_2	Cl^-	
b) I_2	$\text{S}_2\text{O}_3^{2-}$	
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

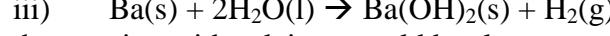
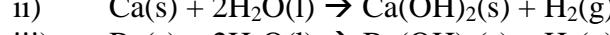
4. The size of the cations increases down the group

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



c) the reaction with calcium would be slower

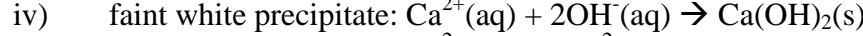
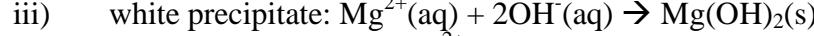
and the solution would go cloudy

6. a) decreases down Group II

b) increases down Group II



ii) no reaction



vi) no reaction

d) Add dilute hydrochloric acid followed by barium chloride solution

A white precipitate will be observed



- e) BaSO₄ 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) MgSO₄ is consumed in order to treat Mg deficiency
7. a) Mg(OH)₂(s) + 2HCl(aq) → MgCl₂(aq) + 2H₂O(l)
- b) Ca(OH)₂(s) + 2HCl(aq) → CaCl₂(aq) + 2H₂O(l)
- c) CaO(s) + SO₂(g) → CaSO₃(s)
- d) CaCO₃(s) + SO₂(g) → CaSO₃(s) + CO₂(g)
8. a) used to treat indigestion caused by excess stomach acid
- b) used to neutralize acidic soils
- c) used to remove SO₂ from factory chimneys
- d) used to remove SO₂ from factory chimneys
9. The Mg reduces the TiCl₄ to Ti by the reaction TiCl₄ + 2Mg → Ti + 2MgCl₂

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; Cl₂(aq) + 2I⁻(aq) → 2Cl⁻(aq) + I₂(aq)
c) no change; stays brown
d) brown solution; Br₂(aq) + 2I⁻(aq) → 2Br⁻(aq) + I₂(aq)
e) no change; stays orange
f) yellow/orange solution; Cl₂(aq) + 2Br⁻(aq) → 2Cl⁻(aq) + Br₂(aq)
8. a) 2I⁻ → I₂ + 2e
b) 2Br⁻ → Br₂ + 2e
c) H₂SO₄ + 2H⁺ + 2e → SO₂ + 2H₂O
d) H₂SO₄ + 8H⁺ + 8e → H₂S + 4H₂O
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:

- $\text{H}_2\text{SO}_4 + 2\text{H}^+ + 2\text{Br}^- \rightarrow \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O}$
 - $\text{H}_2\text{SO}_4 + 8\text{H}^+ + 8\text{I}^- \rightarrow \text{H}_2\text{S} + 4\text{I}_2 + 4\text{H}_2\text{O}$
10. $\text{H}_2\text{SO}_4 + \text{Cl}^- \rightarrow \text{HSO}_4^- + \text{HCl}$
The oxidation number of S is +6 in both reactant and product

Topic 6 Exercise 4

- a) $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HCl}(\text{aq}) + \text{HClO}(\text{aq})$
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
- a) $2\text{Cl}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{HCl} + \text{O}_2$
b) Cl is reduced (from 0 to -1) and O is oxidized (from -2 to 0)
- Chlorine is added to the water supply to kill harmful bacteria (ie to sterilize the water)
- 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
- a) $\text{Cl}_2 + \text{NaOH} \rightarrow \text{NaCl}(\text{aq}) + \text{NaClO}(\text{aq}) + \text{H}_2\text{O}$
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	$\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
Br^-	aq AgNO_3 and dil HNO_3	cream precipitate	$\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})$
I^-	aq AgNO_3 and dil HNO_3	yellow precipitate	$\text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{AgI}(\text{s})$
CO_3^{2-}	dil HCl	effervescence	$2\text{H}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
SO_4^{2-}	aq BaCl_2 and dil HCl	thick white precipitate	$\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$
OH^-	dil NH_4Cl and warm	pungent smell	$\text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l})$

2.

Cation	Reagent	Observation	Ionic equation
Mg^{2+}	aq NaOH	thick white precipitate	$\text{Mg}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Mg}(\text{OH})_2(\text{s})$
Ca^{2+}	aq NaOH	faint white precipitate	$\text{Ca}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Ca}(\text{OH})_2(\text{s})$
Sr^{2+}	dil H_2SO_4	faint white precipitate	$\text{Sr}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{SrSO}_4(\text{s})$
Ba^{2+}	dil H_2SO_4	thick white precipitate	$\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$
NH_4^+	aq NaOH and warm	pungent smell	$\text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l})$
H^+	aq Na_2CO_3	effervescence	$2\text{H}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$



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