Group 7 Q and A

Q1 This question is about halogens and halide ions.

(a) Explain why the electronegativity of the halogens decreases down the group.

_____

_____

_____

_____

_____

_____

_____

_____

(2

Concentrated sulfuric acid reacts with solid sodium chloride and with solid sodium bromide.

(b) State **one** similarity in, and **one** difference between, these reactions.

Similarity _____

_____

_____

_____

Difference _____

_____

_____

_____

(2)

(c) Solid sodium iodide reacts with concentrated sulfuric acid to form hydrogen sulfide.

Give a half-equation to show the oxidation of iodide ions.

Give a half-equation to show the reduction of concentrated sulfuric acid to hydrogen sulfide.

Use your half-equations to deduce an overall equation for this reaction.

Half-equation 1

_____

_____

Half-equation 2

_____

Overall equation

_____

(3)
(Total 7 marks)

_____

Overall equation

_____

(3)
(Total 7 marks)

Q2

Which species is the strongest reducing agent?

A F_2 ○

B I_2 ○

C F^- ○

D I^- ○

(Total 1 mark)

Q3 Redox/G7

Iodide ions can be oxidised to iodine using oxidising agents such as iodate(V) ions (IO_3^-) and concentrated sulfuric acid.

(a) State, in terms of electrons, the meaning of the term oxidising agent.

_____

_____

_____

_____

(1)

In acidic solution, IO_3^- ions oxidise iodide ions to iodine.

$$IO_3^- + 5\ I^- + 6\ H^+ \rightarrow 3\ I_2 + 3\ H_2O$$

(b) Give a half-equation for the oxidation of iodide ions to iodine.

Deduce the half-equation to show the reduction process in this reaction.

Oxidation half-equation

_____

_____

Reduction half-equation

_____

_____

(2)

(c) When iodide ions are oxidised using concentrated sulfuric acid, sulfur dioxide, a yellow solid and a foul-smelling gas are all formed.

Give an equation to show the reaction between iodide ions and concentrated sulfuric acid to form the yellow solid.

Identify the foul-smelling gas.

Equation

_____

_____

Identity of foul-smelling gas _____

(2)

(Total 5 marks)

Q4 synopsis g7 and g2

A student does two test-tube reactions on four colourless solutions (**A**, **B**, **C** and **D**).

The table below shows the student's observations.

Solution	**Test 1** Add $Na_2CO_3(s)$	**Test 2** Add acidified $AgNO_3(aq)$
A	Effervescence	No visible change
B	Effervescence	White precipitate
C	No visible change	No visible change
D	No visible change	Very pale yellow precipitate

(a) Identify the gas formed in **Test 1**.

Describe a further test to confirm the identity of this gas.

Identity of gas _____

Test

_____
_____

_____
_____

(2)

(b) Explain how the observations from **Test 1** and **Test 2** can be used to show that solution **B** contains hydrochloric acid.

_____
_____

_____
_____

_____
_____

_____
_____

(2)

(c) Describe a series of tests that the student can use to show that solution **C** contains ammonium sulfate.

(4)

(d) The student does an additional experiment to show that solution **D** contains a mixture of halide ions. One of the halide ions is chloride.

Method:

Step 1 Add an excess of $AgNO_3(aq)$ to 10.0 cm^3 of solution **D**.
Step 2 Filter, wash, dry and weigh the precipitate.
Step 3 Add an excess of dilute ammonia to the dry precipitate.
Step 4 Filter, wash, dry and weigh the solid that remains.

Explain how the masses recorded during this experiment can be used to show that solution **D** contains a mixture of halide ions.

(2)

(Total 10 marks)

Q5

Which is a correct trend down Group 7 from fluorine to iodine?

A The boiling point of the element decreases. ⬭

B The oxidising ability of the element decreases. ⬭

C The electronegativity of the atom increases. ⬭

D The first ionisation energy of the atom increases. ⬭

(Total 1 mark)

Q6

Which statement is correct?

A Chloride ions reduce concentrated sulfuric acid to form sulfur dioxide. ⬭

B Bromide ions reduce concentrated sulfuric acid to form sulfur. ⬭

C Bromide ions reduce iodine to form iodide ions. ⬭

D Iodide ions reduce chlorine to form chloride ions. ⬭

(Total 1 mark)

Q7

This question is about some elements in Group 7 and their compounds.

(a) Chlorine is added to some drinking water supplies to decrease the risk of people suffering from diseases such as cholera.

State why the amount of chlorine added must be controlled.

_____

_____

_____

_____

(1)

(b) Give an equation for the reaction of chlorine with water to form a solution containing **two** acids.

Explain, with reference to electrons, why this is a redox reaction.

Equation

Explanation

(2)

(c) A student bubbles chlorine gas through a solution of sodium iodide.

State the observation the student would make.

Give an ionic equation for the reaction.

Observation

Ionic equation

(2)

(d) The student adds a few drops of concentrated sulfuric acid to a small amount of solid sodium iodide.

Two gaseous sulfur-containing products are formed.

Give an equation for the formation of each of these sulfur-containing products.

State the role of sulfuric acid in the formation of these products.

Equation 1

Equation 2

_____

_____

Role _____

_____

(3)

(e) The student adds a few drops of acidified silver nitrate solution to a solution of an unknown **impure** sodium halide.
The student observes bubbles of gas and a colourless solution.
The student bubbles the gas through calcium hydroxide solution and a white precipitate forms.

Deduce the identity of the sodium halide.

Suggest the identity of the gas.

Give an ionic equation for the formation of this gas from the impurity.

Identity of sodium halide _____

Identity of gas _____

Ionic equation

_____

_____

(3)

(f) The ClF_2^+ ion contains two different Group 7 elements.

Use your understanding of the electron pair repulsion theory to draw the shape of this ion.

Include any lone pairs of electrons that influence the shape.

Explain why the ion has the shape you have drawn.

Suggest a value for the bond angle in the ion.

Shape

Explanation _____

_____

_____

_____

Bond angle _____

(3)

(g) Magnesium is used in the extraction of titanium from titanium(IV) chloride.

Give an equation for this reaction.

_____

_____

(1)

(Total 15 marks)

Q8

A test for chloride ions in aqueous solution involves adding dilute nitric acid followed by aqueous silver nitrate.

What is the reason for adding the nitric acid?

A To convert $AgNO_3$ into $[Ag(NO_3)_2]^-$ ⬭

B To decrease the solubility of silver chloride ⬭

C To increase the pH of the solution ⬭

D To prevent the precipitation of other silver compounds ⬭

(Total 1 mark)

Q9

Which pair of solutions, when mixed, reacts to form a dark brown solution?

A $NaF(aq) + Cl_2(aq)$ ⬭

B $NaCl(aq) + Br_2(aq)$ ⬭

C $NaBr(aq) + Cl_2(aq)$ ⬭

D $NaI(aq) + Br_2(aq)$ ⬭

(Total 1 mark)

Q10

Some solid sodium halides are reacted with concentrated sulfuric acid.

Which solid sodium halide does **not** produce a sulfur-containing gas as one of the products?

A NaCl ⬭

B NaBr ⬭

C NaI ⬭

D NaAt ⬭

(Total 1 mark)

Q11

This question is about Group 7 chemistry.

(a) Give an equation for the reaction of solid sodium bromide with concentrated sulfuric acid to form bromine.

State **one** observation made during this reaction.

Equation

_____

_____

Observation _____

_____

_____

_____

_____

_____

(2)

(b) A solution that is thought to contain chloride ions and iodide ions is tested.

1. Dilute nitric acid is added to the solution.
2. Aqueous silver nitrate is added to the solution.
3. A pale yellow precipitate forms.
4. Excess dilute aqueous ammonia is added to the mixture.
5. Some of the precipitate dissolves and a darker yellow precipitate remains.

Give a reason for the use of each reagent.

Explain the observations.

Give ionic equations for any reactions.

(5)

(Total 7 marks)

Q12

This question is about Group 7 elements and their compounds.

(a) Chlorine is used to treat water even though it is toxic to humans.

Give **one** reason why water is treated with chlorine.

Explain why chlorine is added to water even though it is toxic.

Give an equation for the reaction of chlorine with cold water.

Reason

_____

_____

Explanation

_____

_____

_____

_____

_____

Equation

_____

_____

(3)

(b) Solid sodium iodide reacts with concentrated sulfuric acid to form iodine and sulfur in a redox reaction.

Give a half-equation to show the conversion of iodide ions to iodine.

Give a half-equation to show the conversion of sulfuric acid to sulfur.

Give an overall equation for this redox reaction.

Identify one other sulfur-containing reduction product formed when solid sodium iodide reacts with concentrated sulfuric acid.

Half-equation for the conversion of iodide ions to iodine

_____

_____

Half-equation for the conversion of sulfuric acid to sulfur

Overall equation

Other sulfur-containing reduction product

(4)

A student completes an experiment to determine the percentage by mass of sodium chloride in a mixture of sodium chloride and sodium iodide.

The student uses this method.

- 600 mg of the mixture are dissolved in water to form a solution.
- An excess of aqueous silver nitrate is added to the solution. This forms a precipitate containing silver chloride and silver iodide.
- Excess dilute ammonia solution is then added to the precipitate. The silver chloride dissolves.
- The silver iodide is filtered off from the solution, and is then washed and dried.

The mass of the silver iodide obtained is 315 mg

(c) Silver nitrate is added to the solution.

Suggest why an excess is used.

(1)

Q13

This question is about sodium halides.

(a) State what is observed when silver nitrate solution is added to sodium fluoride solution.

_____

(1)

(b) State **one** observation when solid sodium chloride reacts with concentrated sulfuric acid.

Give an equation for the reaction.

State the role of the chloride ions in the reaction.

Observation

_____

Equation

_____

Role

_____

(3)

(c) Give an equation for the redox reaction between solid sodium bromide and concentrated sulfuric acid.

Explain, using oxidation states, why this is a redox reaction.

Equation

_____

Explanation

_____

_____

_____

_____

(3)

(d) State what is observed when aqueous chlorine is added to sodium bromide solution.

Give an ionic equation for the reaction.

Observation

_____

Ionic equation

_____

_____

(2)

Q14 ions test tube rxns

The following pairs of compounds, each in aqueous solution, can be distinguished by simple test-tube reactions.

Give a reagent, or combination of reagents, that can be added to the solutions in each pair to distinguish between them in a single reaction.

State what is observed in each case.

(a) NaCl(aq) and $BaCl_2$(aq)

Reagent

_____

Observation with NaCl

_____

Observation with $BaCl_2$ _____

(3)

(b) NaCl(aq) and Na_2CO_3(aq)

Reagent

_____

Observation with NaCl

_____

Observation with Na_2CO_3 _____

(3)

(Total 6 marks)

Q15

What is the best oxidising agent?

A F_2 ⬭

B F^- ⬭

C I_2 ⬭

D I^- ⬭

(Total 1 mark)

Q16

This question is about some Group 7 compounds.

(a) Solid sodium chloride reacts with concentrated sulfuric acid.

Give an equation for this reaction.
State the role of the sulfuric acid in this reaction.

Equation

_____
_____

Role

_____
____

(2)

(b) Fumes of sulfur dioxide are formed when sodium bromide reacts with concentrated sulfuric acid.

For **this** reaction
- give an equation
- give **one** other observation
- state the role of the sulfuric acid.

Equation

_____

Observation

_____

_____

Role

_____

(3)

(c) Chlorine reacts with hot aqueous sodium hydroxide as shown in the equation.

$$3\ Cl_2 + 6\ NaOH \rightarrow NaClO_3 + 5\ NaCl + 3\ H_2O$$

Give the oxidation state of chlorine in $NaClO_3$ and in NaCl

$NaClO_3$ _____

NaCl _____

(1)

(d) State, in terms of redox, what happens to chlorine in the reaction in part **(c)**.

_____

_____

(1)

(e) Solution **Y** contains **two** different negative ions.

To a sample of solution **Y** in a test tube a student adds
- silver nitrate solution
- then an excess of dilute nitric acid
- finally an excess of concentrated ammonia solution.

The observations after each addition are recorded in the table.

Reagent added to solution Y	Observation
silver nitrate solution	cream precipitate containing compound **D** and compound **E**
excess dilute nitric acid	cream precipitate **D** and bubbles of gas **F**
excess concentrated ammonia solution	colourless solution containing complex ion **G**

Give the formulas of **D**, **E** and **F**.
Give an **ionic** equation to show the formation of **E**.
Give an equation to show the conversion of **D** into **G**.

Formula of **D** _____

Formula of **E** _____

Formula of **F** _____

Ionic equation to form **E**

_____

Equation to show the conversion of **D** into **G**

_____

(6)

Q17

A student oxidised a solution of hydrochloric acid with a few drops of sodium chlorate(I) solution. The reaction mixture effervesced and turned pale green. The gas formed bleached universal indicator paper.

(a) Write a half-equation for the oxidation of chloride ions.

_____

(1)

(b) Write a half-equation for the reduction of chlorate(l) ions to chlorine in acidic conditions.

(1)

(c) Write an overall equation for the redox reaction of chlorate(I) ions with hydrochloric acid.

(1)

(d) A solution of sodium chlorate(l) was added to a colourless solution of potassium iodide.
Suggest what is observed.

Explain the reaction that leads to this observation.

(3)

(Total 6 marks)

Q18

The halogens are the elements in Group 7.

(a) The electronegativities of the halogens are shown in the table.

Halogen	**Fluorine**	**Chlorine**	**Bromine**	**Iodine**
Electronegativity	4.0	3.0	2.8	2.5

Explain the trend in electronegativities shown by the halogens.

_____

_____

_____

_____

(2)

(b) The halogens can all behave as oxidising agents in reactions.

(i) Explain, in terms of electron transfer, the meaning of the term oxidising agent.

_____

_____

(1)

(ii) An equation for the reaction that takes place when chlorine gas is bubbled through aqueous potassium bromide is shown.

$$Cl_2(g) + 2KBr(aq) \longrightarrow Br_2(aq) + 2KCl(aq)$$

Explain, with reference to the oxidation states, why this is a redox reaction.

_____

_____

_____

_____

_____

_____

(1)

(c) Solid sodium halides react with concentrated sulfuric acid.

(i) A sample of solid sodium iodide is reacted with concentrated sulfuric acid.
A black solid forms and hydrogen sulfide gas is produced.

Write a half-equation for the reaction of sulfuric acid to form hydrogen sulfide.

_____

_____

(1)

(ii) Write a half-equation for the formation of the black solid.

_____

_____

(1)

(iii) Use your answers to parts (c) (i) and (c) (ii) to write an overall equation for the reaction of sodium iodide with concentrated sulfuric acid.

_____

_____

(1)

(iv) Give the role of sulfuric acid in its reaction with sodium iodide.

Tick (✓) **one** box.

Acid	☐
Oxidising agent	☐
Reducing agent	☐
Electrophile	☐

(1)

(v) Write an equation for the reaction of concentrated sulfuric acid with solid sodium fluoride.

(1)

(vi) Suggest **one** reason why the reaction of sodium fluoride with concentrated sulfuric acid is different from the reaction with sodium iodide.

(1)

(d) Chlorine reacts with water to form an equilibrium mixture containing hydrochloric acid and chloric(I) acid.

(i) Write an equation for the formation of this equilibrium mixture.

(1)

(ii) Household bleach contains sodium chlorate(I) and sodium chloride. State and explain, with reference to your equation in part **(d)(i)**, why it is dangerous to acidify an aqueous mixture of sodium chlorate(I) and sodium chloride.

(2)

(Total 13 marks)

Mark scheme

Q1

(a) **M1** Larger atoms / more electron shells / more shielding / bonding pair of electrons further from the nucleus

M2
weaker attraction between nucleus and bonding pair of electrons /
weaker attraction between nucleus and shared pair of electrons /
weaker attraction between nucleus and electron density in the covalent bond

Ignore references to outer electrons

2

(b) Similarity: one from

form hydrogen halides / undergo acid-base reaction / misty white fumes are observed / form sodium sulfate / form sodium hydrogensulfate / exothermic / effervescence

Difference: one from

bromide undergoes a redox reaction / bromide ions are oxidised / bromide ions reduce sulfur in sulfuric acid / red-brown-orange fumes are observed with bromide / Br_2 produced with bromide / (choking gas) SO_2 produced with bromide / different hydrogen halides

2

(c) Half Equation 1:

$2\ I^- \rightarrow I_2 + 2\ e^-$

Ignore state symbols

Half Equation 2:

$H_2SO_4 + 8\ H^+ + 8\ e^- \rightarrow H_2S + 4\ H_2O$

$SO_4^{2-} + 10\ H^+ + 8\ e^- \rightarrow H_2S + 4\ H_2O$

Overall Equation:

$H_2SO_4 + 8\ H^+ + 8\ I^- \rightarrow 4\ I_2 + H_2S + 4\ H_2O$

$SO_4^{2-} + 10\ H^+ + 8\ I^- \rightarrow 4\ I_2 + H_2S + 4\ H_2O$

$H_2SO_4 + 8\ HI \rightarrow 4\ I_2 + H_2S + 4\ H_2O$

3

[7]

Q2

D

[1]

Q3

(a) Electron acceptor / gains electrons

Do not allow

electron pair acceptor / gain of electrons

1

(b) Oxidation half equation

$2\ I^- \rightarrow I_2 + 2\ e^-$

Allow multiples.

1

Reduction half equation

$2\ IO_3^- + 12\ H^+ + 10\ e^- \rightarrow I_2 + 6\ H_2O$

Award 1 mark if the two equations are shown transposed

1

(c) Equation:

$6\ I^- + 6\ H^+ + H_2SO_4 \rightarrow S + 3\ I_2 + 4\ H_2O$

Allow 6HI

Allow $6I^- + 8H^+ + SO_4^{2-}$

1

Foul smelling gas – H_2S / hydrogen sulphide

1

[5]

Q4

(a) Identity of gas: Carbon dioxide / CO_2

1

Test: When gas bubbled through limewater, a white ppt formed

When gas bubbled through limewater, it turns milky/cloudy

M2 dependent on M1

1

(b) Effervescence (with Na_2CO_3), so contains H^+ ions /
Effervescence (with Na_2CO_3), so is acidic

The result from Test 1 shows the presence of H^+ / acidic

1

White ppt (with $AgNO_3$), so contains chloride ions

The result from Test 2 shows the presence of chloride ions.

1

Allow balanced equation for each test that links to each observation

(c) (Warm with some) NaOH,

1

Damp red litmus at the mouth of the tube turns blue

Do not allow red litmus dipped in solution

1

Add (acidified) $BaCl_2$ / $Ba(NO_3)_2$

If reagent incorrect, cannot score observation mark

1

White ppt formed

If reagent incomplete, mark on

1

Use of $Ba(OH)_2$ can score M1 and M3

(d) The second mass is smaller / the mass after step 4 is smaller than the mass after step 2

1

AgCl dissolves in dilute ammonia / some ppt dissolves as AgCl is soluble in dilute ammonia

The ppt formed by chloride ions dissolves in dilute ammonia.

1

[10]

Q5

B

The oxidising ability of the element decreases.

[1]

Q6

D

Iodide ions reduce chlorine to form chloride ions.

[1]

Q7

(a) toxic/poisonous/too much chlorine causes death

1

(b) $Cl_2 + H_2O \rightarrow HCl + HClO$

allow $Cl_2 + H_2O \rightarrow 2\ H^+ + Cl^- + ClO^-$

1

chlorine/Cl/Cl_2 gains electron(s) (to form Cl^-) **and** loses electron(s) (to form ClO^-)

1

ignore chlorine is oxidised and reduced

ignore disproportionation

ignore oxidation numbers unless incorrect

(c) brown solution **or** black solid (forms)

*do **not** accept purple*

1

$Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$

allow multiples

ignore state symbols

1

(d) $H_2SO_4 + 2H^+ + 2I^- \rightarrow SO_2 + 2H_2O + I_2$

allow $SO_4^{2-} + 4H^+ + 2I^- \rightarrow SO_2 + 2H_2O + I_2$

1

$H_2SO_4 + 8H^+ + 8I^- \rightarrow H_2S + 4H_2O + 4I_2$

allow $SO_4^{2-} + 10H^+ + 8I^- \rightarrow H_2S + 4H_2O + 4I_2$

1

oxidising agent

1

equations can be in either order

allow alternative correct balanced equations starting from NaI to form SO_2 and H_2S

eg

$2\ H_2SO_4 + 2\ NaI \rightarrow Na_2SO_4 + SO_2 + 2\ H_2O + I_2$

$3\ H_2SO_4 + 2\ NaI \rightarrow 2\ NaHSO_4 + SO_2 + 2\ H_2O + I_2$

$5\ H_2SO_4 + 8\ NaI \rightarrow 4\ Na_2SO_4 + H_2S + 4\ H_2O + 4I_2$

$9\ H_2SO_4 + 8\ NaI \rightarrow 8\ NaHSO_4 + H_2S + 4\ H_2O + 4I_2$

(e) NaF **or** sodium fluoride

1

CO_2 **or** carbon dioxide

1

$CO_3^{2-} + 2H^+ \rightarrow CO_2 + H_2O$

allow multiples

1

(f)

Allow shape with 2 lp and 2 bp

ignore absence of charge

1

lone pair–lone pair repulsion > bond pair–bond pair repulsion

or

lone pair repel to be as far apart as possible

allow lp−lp repulsion > bp−bp repulsion

1

104 to 106(°)

allow 95 to 106(°)

1

(g) $TiCl_4 + 2Mg \rightarrow 2MgCl_2 + Ti$

allow multiples

ignore state symbols

1

[15]

Q8

D

To prevent the precipitation of other silver compounds

[1

Q9

D

NaI(aq) + Br_2(aq)

[1]

Q10

A

NaCl

[1]

Q11

(a) **M1** $2H_2SO_4 + 2NaBr \rightarrow Na_2SO_4 + SO_2 + Br_2 + 2H_2O$

allow *ionic and equation forming $NaHSO_4$*

$3H_2SO_4 + 2NaBr \rightarrow 2NaHSO_4 + SO_2 + Br_2 + 2H_2O$

$2H^+ + 2Br^- + H_2SO_4 \rightarrow SO_2 + Br_2 + 2H_2O$

not *equation from HBr unless formation of HBr shown in separate equation*

1

M2 orange/brown fumes/solution

not *liquid / yellow solid / bad eggs smell / white ppt*

ignore *choking gas/fumes / steamy/white fumes*

1

(b) HNO_3 removes (hydroxide/carbonate) ions that may give other ppts with $AgNO_3$

1

$AgNO_3$ produces ppts with chloride/iodide/halide

not *chlorine/iodine/halogen*

1

$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ **OR**
$Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$

allow *$Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$*

*state symbols not required but **not** if wrong*

1

NH_3 dissolves AgCl (leaving yellow AgI)

allow *chloride/iodide salt/ppt*

1

$AgCl(s) + 2NH_3(aq) \rightarrow Ag(NH_3)_2^+(aq) + Cl^-(aq)$

allow *with $Ag^+(aq)$*

1

[7]

Q12

(a) Reason: sterilise water / disinfect water / kill bacteria / kill microorganisms / kill microbes

1

Explanation: health benefit outweighs risk / only used in small quantities/low concentrations

1

Equation:
$Cl_2 + H_2O \rightleftharpoons HCl + HClO$

$2\ Cl_2 + 2\ H_2O \rightarrow 4\ HCl + O_2$

1

(b) $2I^- \rightarrow I_2 + 2e^-$

1

$H_2SO_4 + 6H^+ + 6e^- \rightarrow S + 4H_2O$

Allow S_8

1

$6H^+ + 6I^- + H_2SO_4 \rightarrow 3I_2 + S + 4H_2O$

Allow correct equations using $8H^+ + SO_4^{2-}$

1

SO_2 or H_2S

Mark independently

1

(c) To ensure that all the halide ions (chloride and iodide) are removed from the solution / to ensure that all the halide ions precipitate out of solution

Must refer either to both halide ions, or to all halide ions.

1

[8]

Q13

(a) Colourless (solution)

Allow no (visible) change, no reaction or no ppt (formed)

Ignore none or nothing

1

(b) **M1** Misty or steamy or white fumes/gas

1

M2 $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$ OR $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$

Accept multiples

1

M3 Base OR proton acceptor

1

(c) **M1** $2NaBr + 2H_2SO_4 \rightarrow Na_2SO_4 + Br_2 + SO_2 + 2\ H_2O$ OR $2Br^- + 2H^+ + H_2SO_4 \rightarrow SO_2 + Br_2 + 2H_2O$

M1 *Allow ionic equations*

$2Br^- + 2H_2SO_4 \rightarrow Br_2 + SO_4^{2-} + SO_2 + 2H_2O$ OR

$2Br^- + 4H^+ + SO_4^{2-} \rightarrow Br_2 + SO_2 + 2H_2O$

1

Br changes oxidation state from <u>−1 to 0</u> and is <u>oxidised</u>

1

S changes oxidation state from <u>+6 to +4</u> and is <u>reduced</u>

1

(d) **M1** Yellow or orange <u>solution</u>

M1 *Do not accept brown solution*

1

M2 $Cl_2 + 2\ Br^- \rightarrow 2\ Cl^- + Br_2$

M2 *Accept multiples*

1

[9]

Q14

(a) Reagent: H_2SO_4 / Na_2SO_4 / any soluble sulfate

Observation with NaCl: no (visible) change

Observation with $BaCl_2$: white ppt / white solid formed

If reagent incorrect then cannot score observations (ignore conc for H_2SO_4)

If reagent incomplete (e.g. SO_4^{2-}), then lose M1 but mark on

Allow "no reaction","nvc","no change";

Do not allow "nothing","no observation" and observations by omission (e.g. no ppt)

3

(b) Reagent: H_2SO_4 / HCl / HNO_3

If reagent incorrect then CE=0

*If reagent incomplete (e.g. H^+), then lose **M1** but mark on.*

*If reagent is acid and limewater, lose **M1**, but mark on.*

Observation with NaCl: no (visible) change

Allow "no reaction"; Do not allow "nothing"

Observation with Na_2CO_3: effervescence/bubbles/fizzing

Allow (CO_2) gas produced

Allow "no reaction","nvc","no change"; Do not allow "nothing","no observation" and observations by omission (e.g. no fizzing)

OR

Reagent: <u>acidified</u> $AgNO_3$

If reagent = $AgNO_3$ (not acidified) – do not allow reagent mark, but allow white ppt for observation with NaCl and white ppt for observation with Na_2CO_3 (do not allow nvc for Na_2CO_3)

If acid given as HCl with $AgNO_3$, then do not allow reagent mark, but mark on.

Observation with NaCl: white ppt / white solid formed

Observation with Na_2CO_3: effervescence/bubbles/fizzing

Ignore references to ppt for observation with Na_2CO_3

Allow (CO_2) gas produced

Allow "no reaction","nvc", "no change"; Do not allow "nothing", "no observation" and observations by omission (e.g. no ppt / no fizzing) Allow alternative reagents (e.g. $BaCl_2$) that would distinguish in a single reaction.

Q15

A

[1]

Q16

(a) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

Allow 2 NaCl + $H_2SO_4 \rightarrow Na_2SO_4$ + 2 HCl

1

Proton donor

Allow (Bronsted-Lowry) acid

1

(b) $2\ NaBr + 2\ H_2SO_4 \rightarrow Na_2SO_4 + SO_2 + Br_2 + 2\ H_2O$

Or

$2\ NaBr + 3\ H_2SO_4 \rightarrow 2\ NaHSO_4 + SO_2 + Br_2 + 2\ H_2O$

Or

$2\ H^+ + 2\ Br^- + H_2SO_4 \rightarrow SO_2 + Br_2 + 2\ H_2O$

Or

$4\ H^+ + 2\ Br^- + SO_4^{2-} \rightarrow SO_2 + Br_2 + 2\ H_2O$

Ignore 2 NaBr + $H_2SO_4 \rightarrow Na_2SO_4$ + 2 HBr

Ignore NaBr + $H_2SO_4 \rightarrow NaHSO_4$ + HBr

1

brown gas or brown fumes or orange gas or orange fumes

Do not accept yellow solid

Ignore fizzing and misty fumes

1

Oxidising agent

Allow electron acceptor

Ignore acid / proton donor

1

(c) (+)5 and -1

1

(d) Is oxidised and reduced

Allow undergoes disproportionation

Allows gains and loses electrons

1

(e) D AgBr

Ignore state symbols

1

E Ag_2CO_3

1

F CO_2

1

$2\ Ag^+ + CO_3^{2-} \rightarrow Ag_2CO_3$

1

$AgBr + 2\ NH_3 \rightarrow Ag(NH_3)_2^+ + Br^-$

Or → $Ag(NH_3)_2Br$

One mark for $Ag(NH_3)_2^+$ and 1 mark for equation

If D = AgCl, then allow 2 marks for

$AgCl + 2\ NH_3 \rightarrow Ag(NH_3)_2^+ + Cl^-$

2

Q17

(a) $2Cl^- \longrightarrow Cl_2 + 2e^{(-)}$

Allow $2Cl^- - 2e^{(-)} \longrightarrow Cl_2$

Allow correct equation forming ClO^- but not Cl^+

1

(b) $2ClO^- + 4H^+ + 2e^- \longrightarrow Cl_2 + 2H_2O$

Allow HClO in correctly balanced equation

1

(c) $ClO^- + Cl^- + 2H^+ \longrightarrow Cl_2 + H_2O$

allow $HClO + HCl + \longrightarrow Cl_2 + H_2O$

1

(d) Goes brown (or shades of brown)

Allow black ppt/solid but NOT black solution or purple

1

Due to iodine or I_3^-

Correct ½ equation scores M2 and M3

1

Because I^- oxidised

1

[6]

Q18

(a) Increasing atomic radius / shielding / number of shells / size (down group) or reverse argument

NOT *'molecules'*

1

Decreasing attraction of <u>nucleus/protons</u> for shared (electron) pair / bond electrons

NOT *if attraction for single electron implied*

1

(b) (i) Electron acceptor / species that accepts electrons / species that gains electrons

NOT *electron pair*

NOT *just 'gain of electrons'*

1

(ii) Chlorine 0 to –1 / oxidation state/number of chlorine decreases
AND
Bromine –1 to 0 / oxidation state/number of bromine increases

Penalise if oxidised for chlorine and/or reduced for bromine

Credit oxidation states if labelled on equation

1

(c) (i) $H_2SO_4 + 8H^+ + 8e^{(-)} \longrightarrow H_2S + 4H_2O$

ALLOW $SO_4^{2-} + 10H^+ + 8e^{(-)} \longrightarrow H_2S + 4H_2O$

ALLOW *fractions/multiples*

IGNORE *state symbols*

1

(ii) $2I^- \longrightarrow I_2 + 2e^{(-)}$

ALLOW *fractions/multiples*

IGNORE *state symbols*

ALLOW $2I^- - 2e^{(-)} \longrightarrow I_2$

1

(iii) $H_2SO_4 + 8H^+ + 8I^- \longrightarrow H_2S + 4H_2O + 4I_2$

ALLOW

$H_2SO_4 + 8HI \longrightarrow H_2S + 4H_2O + 4I_2$

$SO_4^{2-} + 2H^+ + 8HI \longrightarrow H_2S + 4H_2O + 4I_2$

$SO_4^{2-} + 10H^+ + 8I^- \longrightarrow H_2S + 4H_2O + 4I_2$

$9H_2SO_4 + 8I^- \longrightarrow H_2S + 4H_2O + 4I_2 + 8HSO_4^-$

$9H_2SO_4 + 8NaI \longrightarrow H_2S + 4H_2O + 4I_2 + 8NaHSO_4$

$H_2SO_4 + 8H^+ + 8NaI \longrightarrow H_2S + 4H_2O + 4I_2 + 8Na^+$

$5H_2SO_4 + 8I^- \longrightarrow H_2S + 4H_2O + 4I_2 + 4SO_4^{2-}$

$5H_2SO_4 + 8NaI \longrightarrow H_2S + 4H_2O + 4I_2 + 4Na_2SO_4$

1

(iv) 'Oxidising agent' box ticked

1

(v) $H_2SO_4 + 2NaF \longrightarrow Na_2SO_4 + 2HF$

OR

$H_2SO_4 + NaF \longrightarrow NaHSO_4 + HF$

1

(vi) Fluoride less powerful reducing agent (than iodide)

OR

Fluoride less easily oxidised than iodide

Or reverse argument in either case

***NOT** general group VII trend statement*

***NOT** fluorine/F or iodine/I*

Must be comparative

1

(d) (i) $Cl_2 + H_2O \rightleftharpoons 2H^+ + Cl^- + ClO^-/HCl + HOCl$

***ALLOW** $\longrightarrow$ for $\rightleftharpoons$*

1

(ii) Equilibrium shifts/moves left

1

(Producing) chlorine (which) is toxic/poisonous

Mark independently

1

[13]