M1.(a) (i) 1.08×10^{-2}

Do not penalise precision but must be to at least 2 significant figures.

Do not accept 1×10^{-2}

1

(ii) $5.4(0) \times 10^{-3}$

Allow (i) / 2

Do not penalise precision but must be to at least 2 significant figures.

1

(iii) 266.6

Lose this mark if answer not given to 1 decimal place.

1

(iv) mass = $5.4(0) \times 10^{-3} \times 266.6 = 1.44$ g **M1**

Allow (ii) × (iii).

1

percentage = $1.44 \times 100 / 2.25 = 64.0$ **M2**

*Allow consequential answer from **M1***

Lose this mark if answer not given to 3 significant figures.

*Correct answer with no working scores **M2** only.*

1

(v) 1 Would give an <u>incorrect / too large mass</u> (of silver chloride)

Do not allow 'to get an accurate result' without qualification.

1

2 <u>To remove</u> <u>soluble impurities</u> / <u>excess silver nitrate</u> (solution) / <u>strontium nitrate</u> (solution)

Do not allow 'to remove impurities'.

Do not allow 'to remove excess strontium chloride solution'.

1

(b) (i) $Mg^{2+}(aq) + 2OH^-(aq) \rightarrow Mg(OH)_2(s)$

Allow $Mg^{2+}(aq) + 2OH^-(aq) \rightarrow Mg^{2+}(OH^-)_2(s)$

Allow multiples, including fractions.

Lose mark if state symbols are missing or incorrect.

Lose mark if incorrect charge on an ion.

1

(ii) Does not produce CO_2 / gas which distends stomach / does not produce wind / does not increase pressure in stomach

Allow 'prevents flatulence' and 'prevents burping'.

Do not allow 'gas' without qualification.

1

(c) $(CH_3COO)_2Ca \rightarrow CH_3COCH_3 + CaCO_3$

Allow multiples.

Allow propanone as C_3H_6O

Allow $(CH_3COO^-)_2Ca^{2+} \rightarrow CH_3COCH_3 + Ca^{2+}CO_3^{2-}$

1

(d) Ca (salt) - no visible change with sodium chromate(VI) **M1**

Allow 'yellow solution formed' or 'no ppt. forms'.

*Allow **M1** and **M2** in any order.*

1

Sr and Ba (salts) give (yellow) <u>precipitate</u> with sodium chromate(VI) **M2**

Lose this mark if precipitate has an incorrect colour.

1

Sr precipitate (chromate(VI)) dissolves in ethanoic acid / Ba precipitate (chromate(VI)) does not dissolve in ethanoic acid **M3**

*If ethanoic acid is added first, allow access to **M1** and **M3**.*

1

(e) C 42.09 / 12, H 2.92 / 1, N 8.18 / 14, O 37.42 / 16 and S 9.39 / 32.1

Accept any other correct method of working.

If relative atomic mass has been divided by the percentage

composition is used then CE = 0 / 2

1

$C_{12}H_{10}N_2O_8S$

Correct answer with no working scores 1 mark only.

1

[15]

M2. (a) (i) **M1** iodine ***OR*** I_2 OR I_3^-

Ignore state symbols

*Credit **M1** for "iodine solution"*

M2 $Cl_2 + 2I^- \longrightarrow 2Cl^- + I_2$

OR

$\frac{1}{2} Cl_2 + I^- \longrightarrow Cl^- + \frac{1}{2} I_2$

Penalise multiples in M2 except those shown

***M2** accept correct use of I_3^-*

M3 redox or reduction-oxidation or displacement

3

(ii) **M1** (the white precipitate is) <u>silver chloride</u>

***M1** <u>must be named</u> and for <u>this mark</u> ignore incorrect formula*

M2 $Ag^+ + Cl^- \longrightarrow AgCl$

*For **M2** ignore state symbols*

Penalise multiples

M3 (white) precipitate / <u>it dissolves</u>

OR <u>colourless solution</u>

Ignore references to "clear" alone

3

(b) (i) **M1** $H_2SO_4 + 2Cl^- \longrightarrow 2HCl + SO_4^{2-}$

*For **M1** ignore state symbols*

OR $H_2SO_4 + Cl^- \longrightarrow HCl + HSO_4^-$

Penalise multiples for equations and apply the list principle

OR $H^+ + Cl^- \longrightarrow HCl$

M2 hydrogen chloride ***OR*** HCl ***OR*** hydrochloric acid

2

(ii) **M1 and M2 in either order**

*For **M1** and **M2**, ignore state symbols and credit multiples*

M1 $2I^- \longrightarrow I_2 + 2e^-$

OR

$8I^- \longrightarrow 4I_2 + 8e-$

Do not penalise absence of charge on the electron

Credit electrons shown correctly on the other side of each equation

M2 $H_2SO_4 + 8H^+ + 8e^- \longrightarrow H_2S + 4H_2O$

OR

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

Additional equations should not contradict

M3 **<u>oxidising agent</u> / <u>oxidises the iodide</u> (ions)**

OR

<u>electron acceptor</u>

M4 **sulfur *OR* S *OR* S_2 *OR* S_8 *OR* sulphur**

4

(iii) M1 The <u>NaOH / OH^- / (sodium) hydroxide reacts with / neutralises the H^+ / acid / HBr</u> (lowering its concentration)

OR **a correct neutralisation equation for H^+ or HBr with NaOH or with hydroxide ion**

Ignore reference to NaOH reacting with bromide ions

Ignore reference to NaOH reacting with HBrO alone

M2 Requires a correct statement for M1

The (position of) <u>equilibrium moves / shifts</u>(from L to R)

- **to <u>replace the H^+ / acid / HBr that has been removed / lost</u>**
- ***OR*** **to <u>increase the H^+ / acid / HBr concentration</u>**
- ***OR*** **to <u>make more H^+ / acid / HBr / product(s)</u>**
- ***OR*** **to <u>oppose the loss of H^+ / loss of product(s)</u>**

- ***OR* to <u>oppose the decrease in concentration</u> of product(s)**
  In M2, answers must refer to the (position of) <u>equilibrium shifts / moves</u> and is not enough to state simply that it / the system / the reaction shifts to oppose the change.

M3 The (health) benefit outweighs the risk or wtte

OR

a clear statement that once it has done its job, little of it remains

OR

used in (very) dilute concentrations / small amounts / low doses

3

[15]

M3.(a) M1 $Cl_2 + 2Br^- \longrightarrow 2Cl^- + Br_2$

Accept a correct equation using ½ Cl_2 ***but no other multiples***

M2 solution goes <u>orange / yellow</u> (from colourless)

Ignore reference to brown colour

Penalise incorrect observations eg fumes, precipitates

2

(b) M1 $Cl_2 + 2NaOH \longrightarrow NaClO + NaCl + H_2O$

(NaOCl)

Or a correct ionic equation

Ignore reference to "swimming pools" and to "disinfectant"

M2 bleach or kills bacteria / bacteriacide / micro-organisms / microbes

M3 <u>sodium chlorate(I)</u> ONLY

3

(c) M $Cl_2 + H_2O \rightleftharpoons HClO + HCl$

(HOCl)

Equilibrium symbol <u>required</u> in M1

Accept ionic RHS

M2

The (health) benefit outweighs the risk or wtte

OR

a clear statement that once it has done its job, little of it remains

OR

used in (very) dilute concentrations / small amounts / low doses

2

(d) M1 Silver nitrate OR $AgNO_3$ (with or without nitric acid)

For M1

If only the formula is written then it must be correct

If both the formula and the name are written then ignore incorrect attempt at the formula, but penalise an incorrect name

M2 (depends on M1)

white precipitate / white solid

If the reagent is incomplete eg Ag^+ ions, penalise M1 and mark on

M3 $Ag^+ + Cl^- \longrightarrow AgCl$

Penalise both M1 and M2 for alkaline $AgNO_3$ OR for the use of HCl to acidify the silver nitrate OR for Tollens' reagent

3

[10]

M4.M1 and M2 (either order)

Any two from

- **purple <u>vapour / gas</u>**
- **(white solid goes to) black or black / grey or black / purple <u>solid</u>**
- **bad <u>egg smell</u> or words to this effect**

Ignore misty white fumes
Ignore yellow solid
Ignore purple solid

Ignore "goes (dark) brown"

M3

Or multiples for possible equation in M3

The <u>iodide ion(s) / they lose (an) electron(s)</u>

OR

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

M4

Accept "changes by − 8"

Oxidation state of S changes from <u>+6 to −2</u> or <u>changes by 8</u>

M5

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

OR

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

[5]

M5.Test **silver nitrate (solution) (M1)**

Allow an alternative soluble silver salt eg fluoride, sulfate.

Do not allow 'silver ions' but can access second mark.

Incorrect formula loses this mark but can access second mark.

Do not allow 'silver' or an insoluble silver salt and cannot access second mark.

Ignore references to acidification of the silver nitrate.

If an acid is specified it should be nitric acid, but allow sulfuric acid in this case as there are no metal ions present.

If hydrochloric acid is used, CE = 0 / 2.

Do not allow 'add water'.

1

Observation **white precipitate (M2)**

Ignore 'cloudy'.

Do not allow 'white fumes' or 'effervescence'.

Do not allow this mark if test reagent is incorrect or

missing.

Allow named indicator paper or named indicator solution for M1.

Allow correct colour change for M2.

1

[2]

M6.(a) (i) $\frac{1}{2}Cl_2 + I^- \longrightarrow \frac{1}{2} I_2 + Cl^-$

Only these two equations.

OR

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

1

(ii) (Solution turns from colourless to) brown / red-brown solution

Allow grey / black solid.

Ignore "purple".

1

(b) $2Cl_2 + 2H_2O \longrightarrow 4HCl + O_2$

$(4H^+ + 4Cl^-)$

Credit multiples.

1

(c) M1 The relative size (of the molecules / atoms)
Chlorine is smaller than bromine OR has fewer electrons / electron shells *OR* It is smaller / It has a smaller atomic radius / it is a smaller molecule / or has smaller M_r
(or converse for bromine)

Ignore general Group 7 statements.

For M1 ignore whether it refers to molecules or atoms.

M2 How size of the intermolecular force affects energy needed
The forces between chlorine / Cl_2 molecules are weaker (than the forces between bromine / Br_2 molecules leading to less energy needed to separate the molecules)
(or converse for bromine)
OR chlorine / Cl_2 has weaker / less / fewer forces between molecules *OR* chlorine / Cl_2 has weaker / less / fewer intermolecular forces
(or converse for bromine)

CE=0 for reference to (halide) ions.

QoL for clear reference to the difference in size <u>of the force between molecules</u>.

Penalise M2 if (covalent) <u>bonds</u> are broken.

2

[5]