

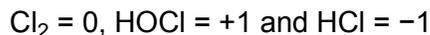
Mark schemes

1



Allow the products shown as ions.

1



1 mark for all three oxidation states correct. Allow a reaction arrow in this equation.

Oxidation states must match the species

1

(b) Hydroxide / alkali ions react with the acids

Mark independently

1

Equilibrium moves to the right

1

(c) Only used in small amounts

1

The health benefits outweigh the risks

1

[6]

2

(a) **M1** Used in a barium meal / barium swallow / barium enema

OR (used to absorb) X-rays

*Credit a correct reference to **M1** written in the explanation in **M2** unless contradictory.*

M2 BaSO₄ / barium sulfate / it is insoluble

*For **M2** penalise obvious reference to barium or to barium ions being insoluble.*

2



Or multiples.

Ignore state symbols.

1

(c) It / magnesium hydroxide is insoluble / insufficiently soluble / sparingly soluble / less soluble than barium hydroxide / forms low concentration solutions

Weak alkali alone is insufficient.

Formation of a precipitate needs explanation.

1



Or multiples.

Ignore state symbols.

1

(e) **M1** Hydrogen / H₂ produced

OR an equation to produce hydrogen / H₂



For M1

Do not penalise an incorrect equation; the mark is for H₂ or hydrogen.

*Award one mark only for 'exothermic reaction with steam / H₂O' for a student who has not scored **M1***

M2 requires correct **M1**

risk of explosion

OR forms explosive mixture (with air)

OR (highly) flammable

Ignore 'violent' reaction.

2

[7]

3

(a) General increase

If not increase then CE

Greater nuclear charge / more protons

1

Same shielding / electrons added to same shell

1

Allow similar

Stronger attraction (from nucleus) for outer electron(s)

1

Allow electron in outer shell

1

- (b) Aluminium / Al (lower than Mg)
CE if not Al or S 1
- (Outer) electron in (3)p orbital / sub-shell (level)
If 2p or 4p orbital lose M2 and M3 1
- (3p) higher in energy
Allow more shielded or weaker nuclear attraction
M3 is dependent on M2 1
- or
- Sulfur / S (lower than P)
 (Outer) electrons in (3)p orbital begin to pair
 Repel
If 2p or 4p orbital lose M2 and M3
Allow 2 electrons in (3)p
M3 is dependent on M2 1
- (c) Sulfur / S
CE if not S 1
- Large jump after 6th or between 6th and 7th
Do not allow M2 if atom/ion is removed 1
- (d) Silicon
CE if not Si 1
- Giant covalent structure / macromolecule 1
- Covalent (bonds)
Giant covalent scores M2 and M3 1
- Many / strong (covalent bonds) or
 (covalent bonds) need lots of energy to break
CE for M2-M4 if molecules / metallic / ionic / IMFs mentioned 1
- [13]

4

- (a) (i) **M1** (+) 4 **OR** IV
M2 (+) 6 **OR** VI 2
- (ii) It / Chlorine has gained / accepted electron(s)
OR
 Correctly balanced half-equation eg $\text{Cl}_2 + 2\text{e}^- \longrightarrow 2\text{Cl}^-$
Credit 1 or 2 electrons but not lone pair.
The idea of 'reduction' alone is not enough. 1

1



1



OR



Ignore charge on the electron unless incorrect.

Or multiples.

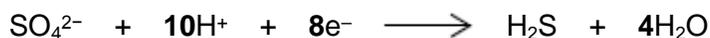
Credit the electrons being subtracted on the LHS.

Ignore state symbols.

1



OR



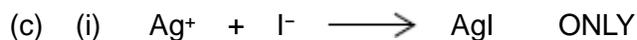
Ignore charge on the electron unless incorrect.

Or multiples.

Credit the electrons being subtracted on the RHS.

Ignore state symbols.

1



Ignore state symbols.

Not multiples.

1

(ii) The precipitate / solid / it does not dissolve / is insoluble / remains

OR a white / cream / yellow solid / precipitate

OR stays the same

OR no (visible / observable) change

OR no effect / no reaction

Ignore 'nothing (happens)'.

Ignore 'no observation'.

1

(iii) The silver nitrate is acidified to

- react with / remove (an)ions that would interfere with the test
Credit a correct reference to ions that give a 'false positive'.
- prevent the formation of other silver precipitates / insoluble silver compounds that would interfere with the test
Do not penalise an incorrect formula for an ion that is written in addition to the name.
- remove (other) ions that react with the silver nitrate
If only the formula of the ion is given, it must be correct.
- react with / remove carbonate / hydroxide / sulfite (ions)
Ignore 'sulfate'.

1

(iv) HCl would form a (white) precipitate / (white) solid (with silver nitrate and this would interfere with the test)

*It is not sufficient simply to state either that it will interfere **or** simply that the ions / compounds react to form AgCl*

1

(d) (i) Any **one** from

Ignore 'to clean water'.

- to sterilise / disinfect water
Ignore 'water purification' and 'germs'.
- to destroy / kill microorganisms / bacteria / microbes / pathogens
Credit 'remove bacteria etc' / prevent algae.

1

(ii) The (health) benefit outweighs the risk

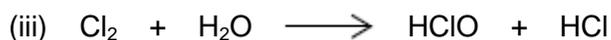
OR

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

OR

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

1



OR



OR



Credit HOCl or ClOH

Or multiples.

Credit other ionic or mixed representations.

Ignore state symbols.

1

(e) **In either order - Both required for one mark only**

Credit correct ionic formulae.

NaClO (OR NaOCl) **and** NaCl

Give credit for answers in equations unless contradicted.

1

[14]

5

(a) (i) Blue to green

Accept blue to yellow.

1

(ii) Decrease / less acid needed

Ignore references to rate

1

(iii) Gloves **or** avoid skin contact

Allow 'if reagent contacts skin wash off (immediately)' or answers to that effect.

Do not accept 'wash' only.

Ignore 'eye protection' or 'lab coat' or 'use of fume cupboard' or 'don't ingest'.

1

(iv) Less chance of losing liquid on swirling / liquid doesn't splash on swirling

Do not accept 'easier to swirl' on its own.

Do not accept 'easier to stir'.

1

(v) Idea that a single titration could be flawed / anomalous

Allow an indication that the first titration is a rough titration.

Do not allow 'to improve accuracy' without qualification.

Do not allow vague references to 'outliers'.

1

(b) (i) $2.3(3) \times 10^{-2}$

Do not penalise additional significant figures, but do not allow 0.02

1

(ii) Dilution of acid needed / may react with carbon dioxide in air

Accept 'poor end-point' or 'no suitable indicator' or 'a large volume (of calcium hydroxide) will be needed'.

Ignore references to low solubility or concentration too low.

1

[7]

6

(a) $\text{Li(g)} \rightarrow \text{Li}^{\text{+}}(\text{g}) + \text{e}^{-}(\text{g})$

$\text{Li(g)} - \text{e}^{-}(\text{g}) \rightarrow \text{Li}^{\text{+}}(\text{g})$

$\text{Li(g)} + \text{e}^{-}(\text{g}) \rightarrow \text{Li}^{\text{+}}(\text{g}) + 2\text{e}^{-}$

One mark for balanced equation with state symbols

Charge and state on electron need not be shown

1

(b) Increases

If trend wrong then CE = 0/3 for (b). If blank mark on.

1

Increasing nuclear charge / increasing no of protons

Ignore effective with regard to nuclear charge

1

Same or similar shielding / same no of shells / electron (taken) from same (sub)shell / electron closer to the nucleus / smaller atomic radius

1

(c) Lower

If not lower then CE = 0/3

1

Paired electrons in a (4) p orbital

If incorrect p orbital then M2 = 0

1

(Paired electrons) repel

If shared pair of electrons M2 + M3 = 0

1

(d) Kr is a bigger atom / has more shells / more shielding in Kr / electron removed further from nucleus / electron removed from a higher (principal or main) energy level

CE if molecule mentioned

Must be comparative answer

QWC

1

(e) 2 / two / II

1

(f) Arsenic / As

1

[10]

7

(a) (i) $\text{SrCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{SrSO}_4(\text{s}) + 2\text{NaCl}(\text{aq})$

Allow multiples, including fractions.

Allow ionic equations.

Lose this mark if any of the state symbols are missing or incorrect.

1

(ii) Add nitric acid to the mixture (until in excess)

Do not allow any suggestion that the solution is an emetic.

1

Filter (to isolate strontium sulfate)

1

(b) Insoluble barium sulfate is formed

Allow 'removes barium ions as a precipitate'.

1

(c) Add silver nitrate, then dilute ammonia (solution) **M1**

Do not allow answers which imply silver nitrate and ammonia are added at the same time.

Allow 'add silver nitrate, then concentrated ammonia (solution)'.

*Can score **M1** in the answer for **M3***

1

Cream precipitate **M2**

Allow 'off white precipitate'.

1

No visible change or precipitate dissolves slightly in dilute ammonia **M3**

Allow 'soluble / colourless solution / precipitate dissolves in concentrated ammonia'.

Allow 3 marks for:

*Add dilute ammonia (solution), then silver nitrate **M1***

*No visible change **M2***

*Cream / off white precipitate with silver nitrate **M3***

1

[7]

8

(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) \times (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 incorrect / too large mass (of silver chloride)

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

1

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

Do not allow 'to remove impurities'.

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

1



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

Allow multiples, including fractions.

Lose mark if state symbols are missing or incorrect.

Lose mark if incorrect charge on an ion.

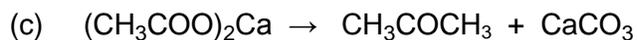
1

(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



Allow multiples.

Allow propanone as $\text{C}_3\text{H}_6\text{O}$

Allow $(\text{CH}_3\text{COO}^-)_2\text{Ca}^{2+} \rightarrow \text{CH}_3\text{COCH}_3 + \text{Ca}^{2+}\text{CO}_3^{2-}$

1



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

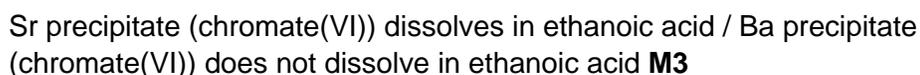
*Allow **M1** and **M2** in any order.*

1



Lose this mark if precipitate has an incorrect colour.

1



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

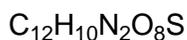
1



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



Correct answer with no working scores 1 mark only.

1

[15]

9

(a) M1 concentrated sulfuric acid OR c(onc) H_2SO_4

If no reagent or incorrect reagent in M1, CE= 0 and no marks for M2 or M3

M2 (cream solid) turns orange

OR orange / red / brown fumes / gas / vapour

If dilute sulfuric acid OR "aq" (alone) CE=0

M3 (yellow solid) turns black

OR purple fumes / gas / vapour

OR correct reference to H_2S observation (eg bad egg smell)

If H_2SO_4 / sulfuric acid given but not stated whether dilute or concentrated, penalise M1 and mark on for M2 and M3

If incorrect formula for the acid, penalise M1 but mark M2 and M3

OR as an alternative

M1 concentrated ammonia **OR** c(onc) NH_3

If NH_3 / ammonia / aq ammonia given, but not stated as

*concentrated **OR** if dilute ammonia given, penalise M1 but mark on for M2 and M3*

Ignore "partially" and ignore "clear" in M2

M2 (cream solid) dissolves / solution formed

M3 precipitate remains / does not dissolve / insoluble

OR no reaction / no change / (yellow solid) turns to white solid

If incorrect formula for ammonia, penalise M1 but mark M2 and M3

In M3 for ammonia.

ignore "nothing (happens)".

ignore "no observation".

- (b) M1 AgNO_3 **OR** silver nitrate **OR** any soluble silver salt
*If no reagent **OR** incorrect reagent in **M1**, **CE= 0** and no marks for **M2 OR M3***

M2 white precipitate or white solid / white suspension

*An insoluble silver salt OR Tollens' **OR** Ag **OR** ammoniacal silver nitrate or HCl / AgNO_3 **CE= 0** for the clip.*

M3 remains colourless **OR** no reaction **OR** no (observed) change **OR** no precipitate

*For **M1***

*Credit acidified (**OR** HNO_3) silver nitrate for **M1** and mark on.*

*If silver ions or incorrect formula for silver nitrate, penalise **M1** but mark **M2** and **M3***

Credit alternative test for nitrate ions

*For **M2***

*Ignore "cloudy solution" **OR** "suspension".*

*For **M3***

Ignore "nothing (happens)".

Ignore "no observation".

Ignore "clear".

Ignore "dissolves".

(c) M1 Br₂ **OR** bromine (water) **OR** bromine (in CCl₄ / organic solvent)

If no reagent or incorrect reagent in M1, CE= 0 and no marks for M2 or M3

Either Order

M2 (stays) Orange / red / yellow / brown / the same

OR no reaction **OR** no (observed) change

OR reference to colour going to cyclohexane layer

No credit for combustion observations; CE=0

For M2 in every case.

Ignore “nothing (happens)”.

Ignore “no observation”.

Ignore “clear”.

M3 decolourised / goes colourless / loses its colour

With bromine (water)

For M1, it must be a whole reagent and / or correct formula.

If oxidation state given in name, it must be correct.

For M1 penalise incorrect formula, but mark M2 and M3

OR as an alternative

Use KMnO₄/H₂SO₄

M1 acidified potassium manganate(VII) or KMnO₄/H₂SO₄

OR KMnO₄/ H⁺ **OR** acidified KMnO₄

M2 (stays) purple or no reaction or no (observed) change

With potassium manganate(VII)

For M1

M3 purple to colourless solution **OR** goes colourless

If “manganate” or “manganate(IV)” or incorrect formula or no acid, penalise M1 but mark M2 and M3

Credit alternative test using **iodine** (for M1)

M2 (brown) to purple or accept no change, M3 colourless

Credit alternative test using concentrated H₂ SO₄

M2 no change, M3 brown

Credit alkaline / neutral KMnO₄ for possible full marks but M3 gives brown precipitate or solution goes green.

- (d) M1 Tollens' (reagent) OR ammoniacal silver nitrate OR a description of making Tollens'
(Ignore either AgNO_3 or $[\text{Ag}(\text{NH}_3)_2]^+$ or "the silver mirror test" on their own, but mark M2 and M3)

M2 silver mirror

OR black solid / precipitate (Ignore silver precipitate)

M3 (stays) colourless or no reaction or no (observed) change

*If no reagent or incorrect reagent in **M1**, **CE= 0** and no marks for **M2** or **M3***

For M3 in every case

Ignore "nothing (happens)".

Ignore "no observation".

Alternative using Fehling's (solution)

M1 Fehling's (solution) or Benedict's solution

(Ignore $\text{Cu}^{2+}(\text{aq})$ or CuSO_4 on their own, but mark M2 and M3)

M2 Red solid / precipitate (Credit Orange or brown solid)

M3 (stays) blue or no reaction or no (observed) change

With potassium dichromate(VI)

For M1

*If "dichromate" or "(potassium) dichromate(IV)" or incorrect formula or no acid, penalise **M1** but mark **M2** and **M3***

Alternative using $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4$

M1 acidified potassium dichromate or $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4$

OR $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$ **OR** acidified $\text{K}_2\text{Cr}_2\text{O}_7$

M2 (Orange to) green solution OR goes green

M3 (stays) Orange or no reaction or no (observed) change

For M3

Ignore dichromate described as "yellow" or "red".

With potassium manganate(VII)

For M1

If "manganate" or "(potassium manganate(IV))" or incorrect formula or no acid, penalise M1 but mark M2 and M3

Alternative using $\text{KMnO}_4/\text{H}_2\text{SO}_4$

M1 acidified potassium manganate(VII) or $\text{KMnO}_4/\text{H}_2\text{SO}_4$

OR KMnO_4/H^+ **OR** acidified KMnO_4

M2 purple to colourless solution OR goes colourless

M3 (stays) purple or no reaction or no (observed) change

*Credit alkaline / neutral KMnO_4 for possible full marks but **M2** gives brown precipitate or solution goes green.*