# Mark schemes

**1** (a) 36 $cm^3$

**1**

(b) all points correct

*± ½ small square*

**2**

*allow **1** mark if 6 or 7 of the points are correct*

2 best fit lines drawn

*must not deviate towards anomalous point*

**2**

*allow **1** mark if 1 line correct*

(c) The bung was not pushed in firmly enough.

**1**

The measuring cylinder was not completely over the delivery tube.

**1**

(d) as mass of lithium carbonate increases volume of gas produced increases

**1**

linear / (directly) proportional

**1**

(e) A gas / carbon dioxide is produced.

*allow because the air in the tube expands*

**1**

(f) any **one** from:

- Potassium carbonate does not decompose to produce carbon dioxide / a gas.
- Potassium carbonate does not decompose at the temperature of the Bunsen burner **or** the Bunsen burner is not hot enough to decompose potassium carbonate.
- When potassium carbonate decomposes a gas is not formed.

**1**

**[11]**

**2** (a) any **one** from:

- there was a flame
- energy was given out
- a new substance was formed
- the magnesium turned into a (white) powder

*answers must be from the figure*

**1**

(b) Magnesium oxide

**1**

(c) The reaction has a high activation energy

**1**

(d) 9

1

(e) They have a high surface area to volume ratio

1

(f) any **one** from:

- Better coverage
- More protection from the Sun's ultraviolet rays

1

(g) any **one** from:

- Potential cell damage to the body
- Harmful effects on the environment

1

(h) indication of $\frac{1}{1.6}$ = 0.625

**and**

use of indices $10^{-9} - 10^{-6} = 10^{3}$

*Both steps must be seen to score first mark*

1

0.625 × 1000 = 625 (times bigger)

1

**[9]**

**3** (a) s

1

l

*Answers **must** be in the correct order.*

1

(b) A gas was lost from the flask

1

(c) **Level 3 (5–6 marks):**
A coherent method is described with relevant detail, and in correct sequence which demonstrates a broad understanding of the relevant scientific techniques and procedures. The steps in the method are logically ordered. The method would lead to the production of valid results.

**Level 2 (3–4 marks):**
The bulk of the method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The method may not be in a completely logical sequence and may be missing some detail.

**Level 1 (1–2 marks):**
Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.

**0 marks:**
No relevant content.

**Indicative content**

- sulfuric acid in beaker (or similar)
- add copper carbonate one spatula at a time
- until copper carbonate is in excess or until no more effervescence occurs *
- filter using filter paper and funnel
- filter excess copper carbonate
- pour solution into evaporating basin / dish
- heat using Bunsen burner
- leave to crystallise / leave for water to evaporate / boil off water
- decant solution
- pat dry (using filter paper)
- wear safety spectacles / goggles

*Students. may choose to use a named indicator until it turns a neutral colour, record the number of spatulas of copper carbonate added then repeat without the indicator.

**6**

(d) Total mass of reactants = 221.5

**1**

$$\frac{159.5}{221.5}$$

*allow ecf from step 1*

**1**

72.0 (%)

**1**

*allow 72.0 with no working shown for **3** marks*

(e) any **one** from:

- Important for sustainable development
- Economic reasons
- Waste products may be pollutants / greenhouse gases

**1**

**[13]**

**4**

(a) any **one** from:

- heat
- stir

**1**

(b) filter

*accept use a centrifuge*

*accept leave longer (to settle)*

**1**

(c) any **one** from:

- wear safety spectacles
- wear an apron

**1**

(d) evaporation at **A**

**1**

condensation at **B**

**1**

(e) 100

**1**

**[6]**

**5**

(a) add excess copper carbonate (to dilute hydrochloric acid)

*accept alternatives to excess, such as 'until no more reacts'*

**1**

filter (to remove excess copper carbonate)

*reject heat until dry*

**1**

heat filtrate to evaporate some water **or** heat to point of crystallisation

*accept leave to evaporate or leave in evaporating basin*

**1**

leave to cool (so crystals form)

*until crystals form*

**1**

*must be in correct order to gain **4** marks*

(b) $M_r$ $CuCl_2$ = 134.5

*correct answer scores **4** marks*

1

moles copper chloride = (mass / $M_r$ = 11 / 134.5) = 0.0817843866

1

$M_r$ $CuCO_3$= 123.5

1

Mass $CuCO_3$ (=moles × $M_2$= 0.08178 × 123.5) = 10.1(00)

1

*accept 10.1 with no working shown for **4** marks*

(c) $\frac{79.1}{100} \times 11.0$

**or**

11.0 × 0.791

1

8.70 (g)

1

*accept 8.70(g) with no working shown for **2** marks*

(d) Total mass of reactants = 152.5

1

134.5

152.5

*allow ecf from step 1*

1

88.20 (%)

1

*allow 88.20 with no working shown for **3** marks*

(e) atom economy using carbonate lower because an additional product is made **or** carbon dioxide is made as well

*allow ecf*

1

**[14]**

**6** (a) (delivery) tube sticks into the acid

1

the acid would go into the water **or** the acid would leave the flask or go up the delivery tube

*ignore no gas collected*

1

(b) any **one** from:

- bung not put in firmly / properly
- gas lost before bung put in
- leak from tube

**1**

(c) all of the acid has reacted

**1**

(d) take more readings in range 0.34 g to 0.54 g

**1**

*take more readings is insufficient*

*ignore repeat*

(e) $\frac{95}{24000}$

**1**

0.00396

**or**

$3.96 \times 10^{-3}$

**1**

*accept 0.00396 or $3.96 \times 10^{-3}$ with no working shown for **2** marks*

(f) use a pipette / burette to measure the acid

**1**

because it is more accurate volume than a measuring cylinder
**or**
greater precision than a measuring cylinder
**or**
use a gas syringe to collect the gas

so it will not dissolve in water

**or**
use a flask with a divider

*accept description of tube suspended inside flask*

so no gas escapes when bung removed

**1**

(g) they should be collected because carbon dioxide is left in flask at end

**1**

and it has the same volume as the air collected / displaced

**1**

**[11]**

**7** (a) (sulfuric acid is) completely / fully ionised

**1**

In aqueous solution **or** when dissolved in water

**1**

(b) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

*allow multiples*

***1** mark for equation*

***1** mark for state symbols*

**2**

(c) adds indicator, eg phenolpthalein / methyl orange / litmus added to the sodium hydroxide (in the conical flask)

*do **not** accept universal indicator*

**1**

(adds the acid from a) burette

**1**

with swirling **or** dropwise towards the end point **or** until the indicator just changes colour

**1**

until the indicator changes from pink to colourless (for phenolphthalein) or yellow to red (for methyl orange) or blue to red (for litmus)

**1**

(d) titrations 3, 4 and 5
**or**

$$\frac{27.05 + 27.15 + 27.15}{3}$$

**1**

27.12 $cm^3$

*accept 27.12 with no working shown for **2** marks*

**1**

*allow 27.1166 with no working shown for **2** marks*

(e) Moles $H_2SO_4$ = conc × vol = 0.00271

*allow ecf from 8.4*

**1**

Ratio $H_2SO_4$:NaOH is 1:2
**or**
Moles NaOH = Moles $H_2SO_4$ × 2 = 0.00542

**1**

Concentration NaOH = mol / vol = 0.00542 / 0.025 = 0.2168

**1**

0.217 (mol / $dm^3$)

*accept 0.217 with no working for **4** marks*

**1**

*accept 0.2168 with no working for **3** marks*

(f) $\frac{20}{1000}$ × 0.18 = no of moles

**or**

0.15 × 40 g

**1**

0.144 (g)

**1**

*accept 0.144g with no working for **2** marks*

**[16]**

**8** (a) $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

**2**

*allow **1** mark for correct formulae*

(b) sensible scales, using at least half the grid for the points

**1**

all points correct

*± ½ small square*

*allow **1** mark if 8 or 9 of the points are correct*

**2**

best fit line

**1**

(c) steeper line to left of original

**1**

line finishes at same overall volume of gas collected

**1**

(d) acid particles used up

*allow marble / reactant used up*

**1**

so concentration decreases

*allow surface area of marble decreases*

**1**

so less frequent collisions / fewer collisions per second

*do **not** accept fewer collisions unqualified*

**1**

so rate decreases / reaction slows down

**1**

(e) mass lost of 2.2 (g)

**1**

time taken of
270 s

*allow values in range 265 − 270*

1

$\frac{2.2}{270} = 0.00814814$

*allow ecf for values given for mass and time*

1

0.00815 (g / s)

**or**

$8.15 \times 10^{-3}$

*allow **1** mark for correct calculation of value to 3 sig figs*

*accept 0.00815 or $8.15 \times 10^{-3}$ with no working shown for **4** marks*

1

(f) correct tangent

1

eg 0.35 / 50

1

0.007

*allow values in range of 0.0065 − 0.0075*

1

$7 \times 10^{-3}$

1

*accept $7 \times 10^{-3}$ with no working shown for **4** marks*

**[20]**

**9** (a) (i) neutrons

*this order only*

1

electrons

1

protons

1

(ii) box on the left ticked

1

(b) (i) effervescence / bubbling / fizzing / bubbles of gas

*do **not** accept just gas alone*

**1**

magnesium gets smaller / disappears

*allow magnesium dissolves*

*allow gets hotter **or** steam produced*

*ignore references to magnesium moving and floating / sinking and incorrectly named gases.*

**1**

(ii) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best–fit' approach to the marking.

**0 marks**
No relevant content

**Level 1 (1−2 marks)**
There are simple statements of some of the steps in a procedure for obtaining magnesium chloride.

**Level 2 (3−4 marks)**
There is a description of a laboratory procedure for obtaining magnesium chloride from dilute hydrochloric acid and magnesium.

The answer must include a way of ensuring the hydrochloric acid is fully reacted **or** a method of obtaining magnesium chloride crystals.

**Level 3 (5−6 marks)**
There is a well organised description of a laboratory procedure for obtaining magnesium chloride that can be followed by another person.

The answer must include a way of ensuring the hydrochloric acid is fully reacted **and** a method of obtaining magnesium chloride crystals.

**examples of the points made in the response:**
- hydrochloric acid in beaker (or similar)
- add small pieces of magnesium ribbon
- until magnesium is in excess or until no more effervescence occurs *
- filter using filter paper and funnel
- filter excess magnesium
- pour solution into evaporating basin / dish
- heat using Bunsen burner
- leave to crystallise / leave for water to evaporate / boil off water
- decant solution
- pat dry (using filter paper).

*Student may choose to use a named indicator until it turns a neutral colour, record the number of pieces of magnesium added then repeat without the indicator.

**6**

**[12]**

**10** (a) 31

**1**

(b) (i) any **two** from:
- incorrect reading of thermometer / temperature
- incorrect measurement of volume of acid
- incorrect measurement of volume of alkali (burette).

**2**

(ii) glass is a (heat) conductor **or** polystyrene is a (heat) insulator

*answer needs to convey idea that heat lost using glass **or** not lost using polystyrene*

*accept answers based on greater thermal capacity of glass (such as "glass absorbs more heat than polystyrene")*

**1**

(c) (i) temperature increases

**1**

(ii) no reaction takes place **or** all acid used up **or** potassium hydroxide in excess

**1**

cool / colder potassium hydroxide absorbs energy **or** lowers temperature

*ignore idea of heat energy being lost to surroundings*

**1**

(iii) take more readings

*ignore just "repeat"*

**1**

around the turning point **or** between 20 $cm^3$ and 32 $cm^3$

*accept smaller ranges as long as no lower than 20 $cm^3$ and no higher than 32 $cm^3$*

**1**

(d) 1.61 **or** 1.6(12903)

*correct answer with or without working scores **3***

*if answer incorrect, allow a maximum of **two** from:*

*moles nitric acid = (2 × 25 / 1000) = 0.05 for **1** mark*

*moles KOH = (moles nitric acid) = 0.05 for **1** mark*

*concentration KOH = 0.05 / 0.031*

*answer must be correctly rounded (1.62 is incorrect)*

**3**

(e) same amount of energy given out

**1**

which is used to heat a smaller total volume **or** mixture has lower thermal capacity
**or**
number of moles reacting is the same
but the total volume / thermal capacity is less

*if no other marks awarded award **1** mark for idea of reacting faster*

**1**

**[14]**

**11** (a) sodium loses (electron)

*sharing / covalent / metallic = max 2*

**1**

chlorine gains (electron)

**1**

1 **or** an (electron)

**1**

(b) (i) Have no overall electric charge

**1**

(ii) Should iodine be added to salt?

**1**

reason
any **one** from:
- cannot be done by experiment

  *accept difficult to get / not enough evidence*
- based on opinion / view

  *allow must be done by survey*
- ethical **or** economic issue.

**1**

(c) (i) nitric (acid)

**1**

(ii) an alkali

**1**

(iii) indicator

*accept any named acid base indicator*

**1**

(d) (i) Crystallisation

**1**

(ii) fertiliser

*allow to help crops grow*

**1**

(iii) any **one** from:
- pressure

  *allow concentration*
- temperature

  *ignore heat*
- catalyst.

**1**

**[12]**

**12** (a) (i) silver nitrate

*allow $AgNO_3$*

**1**

(ii) potassium carbonate **or**

*allow $K_2CO_3$*

sodium carbonate

*allow $Na_2CO_3$*

**1**

(b) base

*allow ionic*

*ignore insoluble or soluble*

*ignore alkali*

**1**

(c) (i) evaporate

**or**

crystallise

*allow heat or boil or leave (to evaporate)*

*allow cool*

*ignore filtration unless given as an alternative*

*do **not** accept freeze or solidify*

**1**

(ii) 2 ($HNO_3$)

*accept multiples*

**1**

(iii) 9

*accept nine*

**1**

(d) 6.21 / 207 0.72 / 16

*1 mark for dividing mass by $A_r$*

1

= 0.03 = 0.045

*1 mark for correct proportions (allow multiples)*

1

2 3

*1 mark for correct whole number ratio (allow multiples). Can be awarded from formula.*

1

$Pb_2O_3$

*allow $O_3Pb_2$*

***ecf** allowed throughout if sensible attempt at step 1*

*correct formula with no working gains **1** mark*

1

**[10]**

**13**

(a) (i) (19.5 + 18.5 + 19.0) / 3

*allow (23.0 + 19.5 + 18.5 + 19.0) / 4 for **1** mark*

2

(ii) R P Q

*allow Q P R for **1** mark*

2

(b) any **two** from:

- repeat more times
- calculate a mean
- measure to one decimal place.

2

(c) both students get similar results / similar pattern

1

**[7]**

**14**

(a) any **two** from:

- fuel

  *allow source of energy*
- solvent

  *allow perfume / aftershave*
- antiseptic

  *allow antibacterial*

2

(b) Hydrogen

1

(c) (i) oxidation

*do **not** allow redox*

**1**

(ii) correct structure

**1**

(iii) ethanoic acid is a weak / weaker acid

*it = ethanoic acid*

**1**

because it does not completely ionise.

*allow because it does not completely dissociate*

*allow it has a lower concentration of hydrogen ions*

*allow converse for hydrochloric acid*

*do **not** allow ionising*

**1**

(d) (i) ethyl ethanoate

**1**

(ii) acid

*allow any strong acid*

*allow correct formulae*

**1**

(iii) evaporates easily / quickly

*allow low boiling point*

*do **not** allow flammable*

**1**

**[10]**

**15** (a) **X:**

$Fe^{2+}$ / iron(II), $SO_4^{2-}$ / sulfate

*allow iron(II) sulfate*

***or** $FeSO_4$*

**1**

**Y:**

$Na^+$ / sodium, $I^-$ / iodide

*allow sodium iodide*

***or** NaI*

**1**

**Z:**

$Fe^{3+}$ / iron(III), $Br^-$ / bromide

*allow iron(III) bromide*

***or** $FeBr_3$*

*correct identification of any two ions = one mark*

*correct identification of any four ions = two marks*

**1**

(b) any **five** from:

*allow converse arguments*

method 1

- weighing is accurate
- not all barium sulfate may be precipitated
- precipitate may be lost
- precipitate may not be dry
- takes longer
- requires energy

*allow not all the barium hydroxide has reacted*

method 2

- accurate
- works for low concentrations

*allow reliable / precise*

**5**

**[8]**

**16** (a) any **two** from:

- temperature (of the HCl)
- mass or length of the magnesium
- surface area of the magnesium
- volume of HCl

**2**

(b) (i) (a greater concentration has) more particles per unit volume

*allow particles are closer together*

**1**

therefore more collisions <u>per unit time</u> **or** more frequent collisions.

**1**

(ii) particles move faster

*allow particles have more (kinetic) energy*

**1**

therefore more collisions <u>per unit time</u> **or** more frequent collisions

**1**

collisions more energetic (therefore more collisions have energy greater than the activation energy) **or** more productive collisions

**1**

(c) (i) add (a few drops) of indicator to the acid in the conical flask

*allow any named indicator*

**1**

add NaOH (from the burette) until the indicator changes colour **or** add the NaOH dropwise

*candidate does not have to state a colour change but penalise an incorrect colour change.*

**1**

repeat the titration

**1**

calculate the **average** volume of NaOH **or** repeat until concordant results are obtained

**1**

(ii) **moles of NaOH**

0.10 × 0.0272 = 0.00272 moles

*correct answer with or without working gains **3** marks*

**1**

**Concentration of HCl**

0.00272 / 0.005 = 0.544

*allow ecf from mp1 to mp2*

**1**

correct number of significant figures

**1**

**[14]**

**17** (a) Sulfur dioxide causes acid rain.

**1**

(b) red / orange / yellow

*do **not** accept any other colours*

**1**

because sulfur dioxide (when in solution) is an acid

**1**

(c) (there are) weak forces (of attraction)

*do **not** accept any reference to covalent bonds breaking*

**1**

between the molecules

*do **not** accept any other particles*

**1**

(these) take little energy to overcome

*award third mark only if first mark given*

**1**

(d) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

**0 marks**
No relevant content

**Level 1 (1 – 2 marks)**
A relevant comment is made about the data.

**Level 2 (3 – 4 marks)**
Relevant comparisons have been made, and an attempt made at a conclusion.

**Level 3 (5 – 6 marks)**
Relevant, detailed comparisons made and a justified conclusion given.

**examples of the points made in the response**

**effectiveness**

- W removes the most sulfur dioxide
- D removes the least sulfur dioxide

**material used**

- Both W and D use calcium carbonate
- Calcium carbonate is obtained by quarrying which will create scars on landscape / destroy habitats
- D requires thermal decomposition, this requires energy
- D produces carbon dioxide which may cause global warming / climate change
- S uses sea water, this is readily available / cheap

**waste materials**

- W product can be sold / is useful
- W makes carbon dioxide which may cause global warming / climate change
- D waste fill landfill sites
- S returned to sea / may pollute sea / easy to dispose of

**6**

**[12]**

**18** (a) (i) precipitation

**1**

(ii) (aq) on left hand side

**1**

(s) on right hand side

**1**

(iii) potassium iodide

**1**

potassium nitrate

**1**

(iv) filtration

1

(b) (i) diffusion

1

(ii) iodide ions move / diffuse faster than lead ions **or** travel further in the same time

*Must be a comparison*

*Accept converse*

1

because the lead iodide forms much closer to the lead nitrate (or **X**) than the potassium iodide (or **Y**).

*allow because iodide ions are smaller than lead ions*

*allow references to potassium iodide and lead nitrate*

1

(iii) the particles / ions move / diffuse faster

*ignore which particles / ions the student refers to*

1

because they have more energy **or** will collide / meet sooner

*ignore reference to frequency of collisions*

1

**[11]**

**19** (a) (i) copper is less reactive than hydrogen **or** copper is unreactive

1

(ii) Zinc and dilute hydrochloric acid

1

(b) (gas) syringe

1

(c) (i) 35

*allow 3*

1

because not close to others

*accept it is <u>much</u> lower than the others*

*ignore references to trends or patterns*

*dependent on the first mark*

1

(ii) (49 + 50 + 48) / 3

= 49

*correct answer with or without working gains **2** marks*

1

*allow ecf from anomaly identified in (i) for **2** marks:*

- *Exp 1 anomalous gives 43.3*
- *Exp. 2 anomalous gives 44*
- *Exp. 4 anomalous gives 44.7*

*answer of 45.5 or 46 (anomaly not excluded) gains **1** mark*

*correct working **excluding anomaly** but with wrong answer gains **1** mark*

**1**

(iii) so that a mean can be calculated

*accept improves accuracy of the mean **or** so anomalies can be identified / discarded **or** to reduce effect of random errors*

*ignore makes it a fair test*

*ignore reliability, validity, repeatability, reproducibility*

**1**

(d) (i) idea of mixing with oxygen / air, letting air / oxygen in

*accept converse*

**1**

(ii) $H_2O$

*do not accept incorrect additional products*

**1**

balancing 2 … (1) … 2

*allow fractions or multiples*

*dependent on first mark*

**1**

**[11]**

**20** (a) neutralisation

*ignore reference to exothermic or endothermic*

**1**

(b) $2\ HCl + CaO \rightarrow CaCl_2 + H_2O$

*accept multiples and fractions*

formulae

*ignore state symbols*

**1**

balancing (dependent on first mark)

**1**

(c) (the carbonate has) fizzing / bubbles / effervescence

*ignore dissolving*

*ignore gas produced*

**1**

(d) add excess calcium carbonate to acid (and stir) / add $CaCO_3$ until fizzing stops

*ignore heating the acid*

*accept answer using calcium oxide in place of calcium carbonate*

**1**

(remove excess calcium carbonate by) filter(ing)

**1**

warm until a saturated solution forms / point of crystallisation / crystals start to form

*do **not** accept heat until all water gone*

**1**

leave to cool

*dependent on previous mark*

*If solution **not** heated allow leave to evaporate (1)*

*until crystals form (1)*

**1**

(e) (i) *white* precipitate / *solid* (forms)

**1**

insoluble in excess **or** remains **or** no (further) change in excess

*dependent on a precipitate / solid forming*

**1**

(ii) same result with magnesium (ions)

*do **not** accept reference to any other ion(s) that do not give a white precipitate*

*accept other named ions that do give a white precipitate*

**1**

(iii) flame test **or** description of flame test

**1**

gives a red flame

*accept brick red **or** orange-red **or** scarlet*

*do **not** accept crimson*

**1**

**[13]**

**21** (a) (i) 14

1

(ii) isotope

1

(iii) (very) small

*accept smaller / tiny / (very) little*

1

(b) (i) C

1

(ii) $NH_3$

1

(c) (i) nitric (acid)

1

(ii) indicator

1

(iii) crystallisation **or** evaporation

*allow by heating **or** cooling **or** leave (on windowsill)*

*do not accept freezing*

1

(iv) any **one** from:

- grass grows faster
- grass grows taller **or** thicker

*allow grass grows better / greener*

1

(d) potassium (atom) loses (an electron)

*reference to incorrect bonding or particle = max **3***

1

chlorine (atom) gains (an electron)

*ignore references to full outer shells*

1

1 (electron)

1

electron

1

**[13]**

**22** (a) (i) (phosphoric) acid

*allow phosphoric*

**1**

(ii) $H^+$ / hydrogen (ion)

*if ion symbol given, charge must be correct*

**1**

(b) (i) pencil

**1**

so it will not run / smudge / *dissolve*

*ignore pencil will not interfere with / affect the results*

**or**

because ink would run / smudge / *dissolve*

*ignore ink will interfere with / affect the results*

**1**

(ii) any **three** from:

*reference to spots / dots = max **2***

*allow colouring for colour*

- *3* colours in Cola

*allow more colours in cola **or** fewer colours in fruit drink*

- *2* colours in Fruit drink
- one of the colours is the same
- two of the colours in Cola are different
- one of the colours in Fruit drink is different

*allow some of the colours in the drinks are different*

- *one of the colours in Cola is the most soluble*

*accept one of the colours in Cola has the highest $R_f$ value*

**3**

(c) different substances travel at different speeds **or** have different retention times

*accept different attraction to solid*

*ignore properties of compounds*

**1**

(d) (i) Is there caffeine in a certain brand of drink?

**1**

(ii) any **two** from:

- cannot be done by experiment
- based on opinion / *lifestyle choice*
- ethical, *social* or economic issue

*accept caffeine has different effects on different people*

**2**

**[11]**

**23** (a) **$O_2$** in correct space

1

correct balancing

*accept multiples*

1

(b) (i) rate increases

*incorrect reference to energy = max **2***

*ignore references to equilibrium*

1

because particles are closer together

*accept because there are more particles (per unit volume)*

*allow particles have less space / room to move around*

1

so frequency of collisions increases

*accept particles are more likely to collide*

*ignore more collisions*

*ignore more successful collisions*

1

(ii) has a greater surface area

1

*so the reaction is faster*

*accept so more frequent collisions*

1

(c) the (minimum) amount of energy (particles must have) to react ***or** to start a reaction*

*accept the energy needed to break bonds*

*ignore references to heat*

1

(d) (i) (potassium is) too / *very* reactive

*ignore potassium is a Group 1 / alkali metal*

1

so dangerous / *violent reaction*

*accept hydrogen produced rapidly*

1

(ii) $ZnSO_4$

*accept products in either order*

*ignore names of substances*

1

$H_2$

*do **not** accept brackets or charges in the formulae*

1

(iii) any **one** from:
- increase concentration (of sulfuric acid)
- increase temperature **or** heat it
- increase surface area of zinc

**1**

**[13]**

**24** (a) (i) burette

**1**

(ii) indicator

**1**

(iii) colour change

**1**

(b) (i) any **one** from:
- volume of (hydrochloric) acid

  *allow amount of (hydrochloric) acid*
- concentration of (hydrochloric) acid
- concentration of (sodium) hydroxide

  *allow concentration of alkali*

**1**

(ii) 22.3(0)

**1**

**[5]**

**25** (a) four

**1**

covalent

**1**

(b) because it has a high melting point

*accept it won't melt*

*accept it won't decompose or react*

*allow withstand high temperatures*

*ignore boiling point*

**1**

(c) thin

**1**

**[4]**

**26** (a) (i) sulfuric

**1**

(ii) 1

**1**

(iii) to speed up the reaction

**1**

(b) because copper oxide in excess

*allow copper oxide unreacted*

**or**

because acid all used up / neutralised

**1**

(c) evaporation

*allow heating*
*allow cooling*
*allow leave (to evaporate)*
*do **not** accept freezing*

**or**

crystallisation

**1**

(d) Some copper sulfate may have been lost during the experiment

**1**

**[6]**

**27** (a) (i) because they are positively charged

*accept they are positive / $H^+$*
*accept oppositely charged **or** opposites attract*

ignore they are attracted

**1**

(ii) gains one / an electron

*accept $H^+ + e^- \rightarrow H$ or multiples*
*allow gains electrons*

**1**

(b) 3 bonding pairs

**1**

1 lone pair

*accept 2 non-bonding electrons on outer shell of nitrogen*

**1**

(c) (i) hydroxide / $OH^-$

*do **not** accept sodium hydroxide*

**1**

(ii) $H^+ + OH^- \rightarrow H_2O$

*ignore state symbols*
*ignore word equation*

**1**

(d) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Reference material.

**0 marks**
No relevant content.

**Level 1 (1-2 marks)**
There are basic descriptions of advantages or disadvantages of the electrolysis cells.

**Level 2 (3-4 marks)**
There are clear descriptions of environmental or economic advantages or disadvantages of the electrolysis cells. Comparisons may be implied.

**Level 3 (5-6 marks)**
There are detailed descriptions of environmental and economic advantages and disadvantages, comparing the electrolysis cells.

**Examples of chemistry points made in the response:**

Accept converse where appropriate.

- mercury cell is more expensive to construct
- mercury is recycled but membranes must be replaced
- mercury is toxic but membrane / polymer is not
- removing traces of mercury from waste is expensive
- mercury cell uses more electricity
- mercury cell produces chlorine that is purer
- mercury cell produces higher concentration / better quality of sodium hydroxide (solution)

**6**

**[12]**

**28** (a) (i) to increase the rate of reaction

**1**

(ii) $H_2SO_4$ on the left hand side

**1**

$H_2O$ on right hand side

**1**

(iii) filtration

*allow centrifuging **or** decanting*

*ignore evaporation if after filtration*

**1**

(iv) crystallisation

*ignore reference to filtration*
*unless given as an alternative*

**or**

evaporation / heating / boiling / cooling

**1**

(v) any **one** from:

- because of an incomplete reaction

  *accept not all acid reacted*
  *accept impure reactants*
  *accept unexpected reaction*
  *ignore reversible reaction*

- because some (copper sulfate) lost on filtering **or** when poured into evaporating basin **or** boiled over **or** left in apparatus

  *must specify when lost*

  *accept some (copper sulfate **or** acid) spilt*

- weighing error (of copper sulfate)

**1**

(b) (i) reversible (reaction)

**1**

(ii) 300(J)

*allow the same*

**1**

(energy) given out / released

*accept exothermic / –*

*ignore increasing **or** decreasing energy*

**1**

(c)

$\frac{3.81}{63.5}$ $\frac{0.28}{14}$

***1** mark for dividing mass by $A_r$ (max **2** if $A_r$ divided by mass)*

**1**

= 0.06 = 0.02

***1** mark for correct proportions*

**1**

3 1

***1** mark for correct whole number ratio (allow multiples). Can be awarded from formula*

**1**

$Cu_3N$

***ecf*** *allowed from* ***step 2 to step 3*** *and* ***step 3 to step 4*** *if sensible attempt at step* ***1***

*correct formula gains* ***1*** *mark*

**1**

**[13]**

**29** (a) fertilisers

**1**

(b) air

**1**

(c) speeds up the reaction

*accept lowers the activation energy*

*ignore makes the reaction work*

**1**

(d) reversible reaction

**1**

(e) (i) 10

**1**

(ii) water

*accept* $H_2O$ */ hydrogen oxide*

**1**

**[6]**

**30** (a) he made urea / organic compound / he made another organic compound

*ignore he made it unless qualified eg accept he made it from non-living material / not made from animals / plants*

**1**

(b) any **one** from:

sensible ideas eg

- famous scientists / eminent scientists / high status scientists accepted the life-force theory
- sensible references to lack of status of Wöhler
- was not in line with accepted ideas of time / religious beliefs etc
  *eg it was a new idea*
- other sensible answers eg fake / anomalous results

**or** lack of evidence / proof
*accept only made 1 compound*
*ignore no evidence*

**or** not reliable / reproduced

**or** not repeated

**1**

(c) sensible ideas such as:
*accept 'other scientists repeated his experiment / made other organic compounds'*

Wöhler made another organic compound **or** more evidence **or** repeated it
*allow more proof*
*ignore he proved it*

**1**

(d) (i) nitric (acid)
*spelling must be correct*
*accept $HNO_3$ correctly written*
*ignore hydrogen nitrate*

**1**

(ii) evaporate
*allow heat / boil / cool*

**or**

allow to crystallise
*do not allow freeze*
*ignore filtration unless as an alternative*
*ignore distillation*
*ignore solidify*

**1**

**[5]**

**31** (a) (i) $H^+$

1

(ii) $OH^-$

1

(b) with ethanoic acid:

*'it' refers to ethanoic acid*

UI goes Orange/yellow

1

but HCl goes red/pink

1

**or**

ethanoic acid has pH 4 or above but less than 7 (1)

but HCl has a pH3 / or lower (1)

(c) completely

1

(d) (i) conical flask

1

(ii) titration

1

(iii) repeat

**or**

take average

*allow compare with another student's results*

1

**[8]**

**32** (a) (s) (aq) (aq) (g)

*must be in this order*

***2** marks if all four correct*

***1** mark if 2 or 3 correct*

2

(b) (i) 55

*ignore units*

1

(ii) 54

*allow ecf from **(b)(i)***

1

(iii) 0.92

*correct answer with or without working gains **2** marks*
*ecf from volume in **(b)(i)***
*accept 2 d.p. up to calculator value*
*if answer incorrect, allow rate = (b)(i) / 60 for **1** mark*

**2**

(c) (i) circle round point at (48,22)

**1**

(ii) problem (1) and explanation (1)

*explanation **must** give lower volume of gas or slower reaction*
*ignore human error unless qualified*

**problem with bung**

e.g. bung not placed in firmly / quickly enough

so gas lost

**or**

**problem with reagent**

e.g. acid was diluted **or** acid not replaced

so reaction slower

**or**

**problem with temperature**

e.g. temperature was lower than recorded temperature

so reaction slower

**or**

**problem with measurement**

e.g. length of magnesium less than 8 cm **or** timed for less than a minute

so less gas produced

**2**

(d) repeat the experiment (several times)

**1**

because anomalous results could be excluded

**1**

and then the mean can be determined / calculated

*accept suggestion of alteration to method, which is explained as to why it would reduce the error, for **3** marks (e.g. place the magnesium in a container within the flask (1) so it can be tipped into the acid once the bung is in place (1). This will prevent anomalous results or gas loss (1))*

*ignore idea of more accurate gas syringe*
*ignore shorter time intervals*

**1**

(e) (i) use clean magnesium **or** use magnesium without oxide coating

**1**

compare results

**1**

(ii) **either**

measure the temperature of the acid before (adding magnesium)

**1**

and after adding magnesium

**or**

place the conical flask in a water bath (at 40 °C) (1)

compare results (1)

**1**

**[16]**

**33** (a) (i) red

*ignore pink*

**1**

(ii) add silver nitrate (solution)

**1**

white precipitate

*dependent on addition of silver nitrate*
*ignore addition of another acid*
*if hydrochloric acid added max **1** mark*

**1**

(b) suitable named alkali / sodium hydroxide solution in burette

**1**

add alkali solution until (indicator) becomes pink / red

**1**

*if acid to acid titration described, first two marking points **not** available*

any **two** from:

- wash / rinse equipment
- add dropwise or slowly (near end point)
- swirl / mix
- read (meniscus) at eye level
- white background
- read start and final burette levels / calculate the volume needed
- repeat

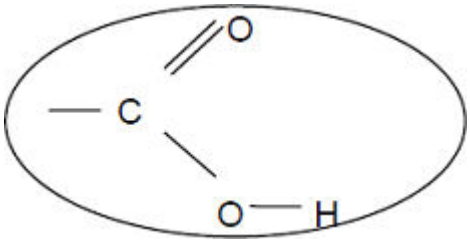
**2**

(c) does not ionise / dissociate completely

*allow <u>for acids of the same concentration</u>, weak acids have a higher pH or fewer hydrogen ions*

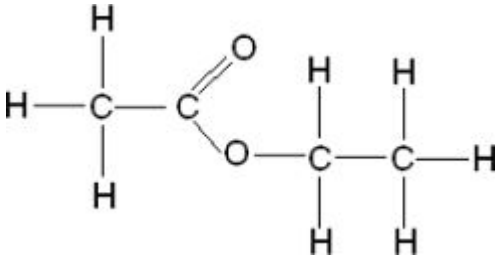
**1**

(d) (i) ring round COOH

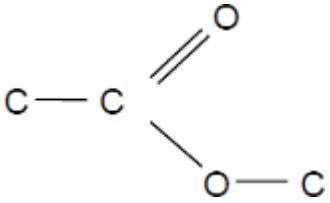


**1**

(ii)



*if not fully correct, allow **1** mark for correct ester group − minimum*



**2**

**[11]**

**34** (a) any **two** from:

- effervescence / bubbles / fizzing

  *allow gas / hydrogen is given off*
  *allow volume of gas*
  *allow magnesium floats*

- magnesium disappears / dissolves

  *allow change in mass of magnesium*

- heat given off / exothermic

  *allow temperature change*
  *do **not** accept temperature decreases*

- change in pH

  *do **not** accept pH decreases*

**2**

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance.

**0 marks**
No relevant content.

**Level 1 (1-2 marks)**
A simple plan without reference to changing any variable but should include an attempt at measuring rate **or** an attempt at fair testing

**Level 2 (3-4 marks)**
A plan including change of concentration / 'volume' of acid **and** should include an attempt at measuring rate **and** / **or** an attempt at fair testing

**Level 3 (5-6 marks)**
A workable plan including change of concentration **and** measurement of rate **and** fair testing

**Examples of chemistry points made in the response could include:**

**Plan:**

- add magnesium to acid
- time reaction / 'count bubbles' / measure volume of gas
- change concentration / 'volume' of acid

**Control Variables:**

- amount / mass / length / same 'size' of magnesium
- volume / amount of acid

**6**

**[8]**

**35** (a) limewater **or** calcium hydroxide solution

**1**

(reacts with carbon dioxide and) turns cloudy / milky

*linked to first point*

*if no other mark awarded 'puts out lighted splint' gains **1** mark*

**1**

(b) (i) any **two** from:

- same volume / amount of the acids
- concentration of the acids
- temperature
- same surface area / size / mass / amount of calcium carbonate
- same measuring equipment

**2**

(ii) any **three** from:

- (after about 4 minutes) the sulfuric acid stops reacting **or** nitric acid continues to react
  *accept more $CO_2$ with nitric acid at any time after 4 minutes*
- (initially) the reaction with sulfuric acid is faster
- (the reaction stops) because calcium sulfate is a solid
  *allow sulfuric acid produces a solid*
- (the reaction continues) because calcium nitrate is soluble / in solution / aqueous
  *allow nitric acid produces an (aqueous) solution*
- because the calcium sulfate prevents the sulfuric acid reacting with the calcium carbonate
- (the rate is faster) because sulfuric acid contains two hydrogens

**3**

**[7]**

**36** (a) (i) 10

**1**

(ii) $OH^-$

**1**

(b) (i) air

**1**

(ii) particles move faster

**1**

particles collide more often

**1**

(iii) catalyst(s)

**1**

(c) liquid

**1**

**[7]**

**37** (a) *ignore any attempts to change the charge on chloride ion*

2.8.2 (drawn as dots or crosses on the circles)
*accept e instead of dots or crosses*

**1**

2.8.8 (drawn as dots or crosses on the circles)

1

(b) (i) filtration

*accept decanting or centrifugation*

*do **not** accept evaporation*

1

(ii) hydrochloric

*accept HCl*

1

(c) (i) so that ions / particles can move (in electrolyte)

*allow so it can conduct electricity / carry charge / carry current*

*ignore reference to electrons moving in the external circuit*

*any unqualified reference to electrons moving / carrying charge / carrying current = **0** marks*

1

(ii) electrons are lost

*ignore numbers*

1

(iii) + $2e^-$ on left hand side of equation

*must be correct with no other additions*

*accept correct multiples*

1

**[7]**

**38** (a) sodium has a lower density

1

sodium is more reactive

1

(b) hydrogen

1

(c) $OH^-(aq)$

1

**[4]**

**39** (a) it / brown colour has a high(er) boiling point

*allow it / brown colour is a solid*

1

(b) (i) partially

1

(ii) for ethanoic acid –

*accept converse points for hydrochloric acid*

fewer bubbles **or** gas produced at a slower rate

**1**

more magnesium remains **or**
magnesium disappears more slowly

*accept less temperature rise or less energy released for ethanoic acid*

**1**

(c) (i) pipette

**1**

conical flask

**1**

burette

*answers must be in the order shown*

**1**

(ii) indicator

**1**

colour changes

*if indicator named then any stated colours must be correct*

**1**

(d) (i) 23.5 is anomalous / rough titration / overshot

**1**

the mean of the other 3 is 20.0

**1**

(ii) (no)

it only contained 4.8g of ethanoic acid in $100cm^3$

**1**

**[12]**

**40** (a) (i) react

*allow neutralise*
*allow bubbles / fizzes*
*accept produces gas / $CO_2F$*
*ignore rises*

**1**

(ii) stop reacting / producing

*stops on its own is insufficient allow stop working / bubbling / fizzing*

**1**

the (hydrochloric) acid / (calcium) carbonate is used up

*accept because the (calcium) carbonate has neutralised the (hydrochloric) acid*

**OR**

have been used up (1)

the graph line becomes horizontal / levels out (1)

**OR**

stays the same / no change (1)

*ignore reference to graph line*

no further reaction (1)

**1**

(iii) bubble the gas through limewater / calcium hydroxide solution

*allow (add) limewater*

*test must be correct to gain result mark*

**1**

(the solution) goes cloudy

*allow milky*

**1**

(b) advantage > Quarrying limestone provides building materials, employment and new road links

**1**

disadvantage > Quarrying limestone releases dust, and lorries release carbon dioxide from burning diesel fuel

**1**

**[7]**

**41** (a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.

Examiners should also apply a 'best-fit' approach to the marking.

**0 marks**

No relevant content.

**Level 1 (1-2 marks)**
There is a simple description of a laboratory procedure for obtaining potassium chloride.

**Level 2 (3-4 marks)**
There is a clear description of a laboratory procedure for obtaining potassium chloride from potassium hydroxide solution and hydrochloric acid that does not necessarily allow the procedure to be completed successfully by another person. The answer must include the use of an indicator or a method of obtaining crystals.

**Level 3 (5-6 marks)**
There is a detailed description of a laboratory procedure for obtaining potassium chloride from potassium hydroxide solution and hydrochloric acid that can be followed by another person. The answer must include the use of an indicator and a method of obtaining crystals.

**examples of the chemistry/social points made in the response:**

- One reagent in beaker (or similar)
- Add (any named) indicator
- Add other reagent
- Swirl or mix
- Add dropwise near end point
- Stop addition at change of indicator colour
- Note volume of reagent added
- Repeat without indicator, adding same volume of reagent **or** remove indicator using charcoal
- Pour solution into basin / dish
- Heat (using Bunsen burner)
- Leave to crystallise / leave for water to evaporate / boil off water

**Accept** any answers based on titration

**6**

(b) nitric (acid)

*allow $HNO_3$*

*ignore incorrect formula*

**1**

(c) (i) because it is a fertiliser / helps plants grow

*allow plant food*

*do **not** accept pesticide / herbicide / neutralising soil*

**1**

(ii) tick by: 'Should farmers stop using ammonium nitrate on their land?'

**1**

any **two** from:

- cannot be done by experiment
  *accept difficult to get / not enough evidence*
- based on opinion / view
  *allow must be done by survey*
- ethical **or** economic issue
  *if top box ticked allow **1** mark for drinking water varies from place to place*

**2**

**[11]**

**42** (a) (i) hydrochloric

**1**

(ii) insoluble

**1**

filtration

**1**

(iii) crystallisation

**1**

(b) any **four** from:

*any reference to incorrect bonding = max 3*

- calcium atom reacts with **2** chlorine atoms
- calcium atoms lose electrons

  *accept calcium ion is formed*
- lose **two** electrons

  *accept calcium has a 2+ charge / calcium ion has a 2+ charge*

  *allow* $Ca^{2+}$
- chlorine atoms **gain** electrons

  *accept chloride ion formed*
- gain one electron

  *accept chlorine / chloride has a negative charge / is a negative ion/ is a negative particle*

  *allow* $Cl^-$

  *if no other marks awarded allow ionic bonding **or** complete outer shell for **1** mark*

**4**

**[8]**

**43** (a) any **one** from:

- they are negative / anions

  *allow* $Cl^-$

  *ignore atoms / chlorine*

  *do **not** accept chloride ions are negative electrodes*
- they are attracted
- they are oppositely charged

**1**

(b) hydrogen is less reactive than sodium

**1**

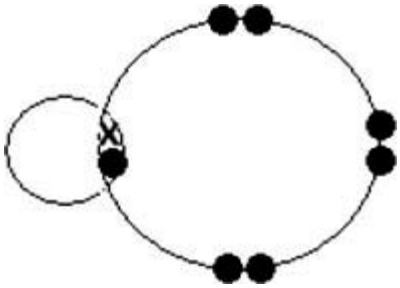
(c) hydroxide (ions) / $OH^-$

*ignore OH*

*do **not** accept NaOH / sodium hydroxide*

**1**

(d) (i)



*allow any combination of dots or crosses*
*ignore chemical symbols*

**1**

(ii) covalent
*allow close spelling errors*
*apply list principle*

**1**

(iii) hydrogen (ion) / $H^+$
*ignore (aq) / H*
*do not accept hydrochloric acid / HCl*
*apply list principle*

**1**

**[6]**

**44** (a) (i) hydrochloric (acid) / HCl
*allow phonetic spelling*
*ignore incorrect formula*
*ignore state symbols*

**1**

(ii) idea of a solid / insoluble substance being formed (from solutions)
*accept solid / insoluble product*
*ignore cloudy*
*do **not** accept evaporation*

**1**

(iii) filtration / filter
*accept decanting / centrifugation*
*ignore evaporate if after filtering*

**1**

(iv) idea of making safe (to eat)

*allow remove harmful substances / organisms **or** sterilisation*

**or**
idea of purification
**or**
idea of neutralisation

**1**

(v) crystallisation

*accept evaporation / heating / boiling*
*allow cooling*
*do **not** allow freezing / solidifying*

**1**

(b) (i) $2e^-$

*accept $e^- + e^-$*
*ignore working out*

**1**

(ii) electron(s) are lost (from calcium atoms)

*ignore numbers if given*
*do **not** accept any reference to oxygen*

**1**

**[7]**

**45** (a) (i) hydrogen ions

**1**

(ii) partially ionised

**1**

(b) (i) burette

**1**

(ii) indicator

**1**

(iii) colour change or turns pink

**1**

(c) 20.4(0)

*correct answer with or without working gains **2** marks*
*if answer incorrect allow*
*20.80 **or*** $\frac{20.30 + 20.50 + 20.40}{3}$
*for **1** mark*

**2**

(d) 50 (g)

*correct answer with or without working gains **2** marks*
*if answer incorrect allow evidence of 1.25 × 40 for **1** mark*

**2**

**[9]**

**46** (a) Hydrogen / $H^+$

*ignore state symbols*
*ignore proton / H*

**1**

(b) *it = weak acid*

pH of weak acid is higher than the pH of a strong acid

*allow converse for strong acids*
*allow correct numerical comparison*

**1**

any **one** from:

*allow converse for strong acids*

- only partially dissociated (to form ions)
  *allow ionises less*
- not as many hydrogen ions (in the solution)
  *allow fewer $H^+$ released*

**1**

(c) (i) (titration of) weak acid and strong base

**1**

(ii) 0.61

*correct answer with or without working gains **2** marks*
*if the answer is incorrect:*
*moles of sodium hydroxide = (30.5 × 0.5)/1000 = 0.01525 moles*
***or***
*(0.5 × 30.5/25) gains **1** mark*

**2**

(d) 12

*correct answer with or without working gains **2** marks or even with incorrect working.*

*if the answer is incorrect:*

*0.8 × 60 = 48g*

***or***

*evidence of dividing 48g (or ecf) by 4*

***or***

$\frac{0.8 \times 250}{1000} = \frac{0.8}{4} =$ *0.8 × 0.25 = 0.2 mol*

***or***

*evidence of multiplying 0.2mol (or ecf) by 60*

*would gain **1** mark*

**2**

**[8]**

**47**

(a) diagram **A**

**1**

(b) the atoms can slide over each other.

**1**

the atoms are in layers

**1**

(c) (i) sulfuric

**1**

(ii) bubbles are produced

**1**

the magnesium disappears

**1**

(iii) crystallisation

**1**

**[7]**

**48** (a) the ions can move / travel / flow /are free

*accept particles / they for ions*

*allow delocalised ions*

**or**

*ignore delocalised / free electrons*

*ignore references to collisions*

*accept converse with reference to solid*

the ions carry the charge / current

*ignore ions carry electricity*

**1**

(b) any **one** from:

- because they are negative / anion

  *allow $Cl^-$*

  *ignore chlorine*

- opposite charges / attract

**1**

(c) 13

**1**

(d) (i) reasonable attempt at straight line which misses the anomalous point

*must touch all five crosses*

*do **not** allow multiple lines*

**1**

(ii) 40

*ignore 2.2*

**1**

(iii) any **two** sensible errors from:

*ignore systematic / human / apparatus / zero /experimental / random / measurement / reading errors unless qualified*

- gas escapes
- weighing error

  *allow NaCl not measured correctly*
- error in measuring (volume / amount) of hydrogen
- error in measuring (volume / amount) of water

  *allow error in measuring volume / scale for **1** mark if neither hydrogen or water mentioned*
- incorrect concentration

  *allow NaCl not fully dissolved **or** spilled **or** impure*
- timing error
- change in voltage / current

  *allow faulty power supply*
- change in temperature
- recording / plotting error

**2**

(iv) any **one** from:

*ignore 'do more tests'*

- repeat the experiment
- results compared with results from /other students / other groups / other laboratories / internet / literature.
- results compared with another method

**1**

(v) increases owtte

*allow directly proportional or positive correlation*

*allow rate / it is faster / quicker*

**1**

**[9]**

**49**

(a) • made of layers / rows (atoms / ions / particles)

*ignore free / delocalised electrons*

**1**

- which can slide / slip (over each other)

  *reference to incorrect particles / covalency / intermolecular forces = max **1***

**or**

particles / ions / atoms can slide over each other

*ignore malleable / ductile / weak bonds*

**1**

(b) (i) sulfuric

*accept sulphuric*

*ignore formula*

*ignore hydrogen sulfate*

**1**

(ii) any **two** from:

*list principle applies for incorrect observations*

- (hydrogen) gas produced (or any indication of a gas such as bubbles etc.)

  *ignore just hydrogen produced*

  *ignore cloudiness / colour changes*

- magnesium / solid disappears / goes into solution

  *accept magnesium / magnesium sulfate / solid / it dissolves*

  *accept forms a liquid / solution*

- gets hot

  *allow exothermic*

  *ignore floats*

**2**

(iii) crystallisation

*accept detailed answers such as: evaporate to half volume and then allow the solution to crystallise.*

**or**

evaporation / heating / boiling / cooling

*ignore any references to filter*

**1**

**[6]**

**50** (a) (i) nitrogen - air

*accept atmosphere*

**1**

hydrogen - north sea gas / natural gas / methane / $CH_4$

*accept water / (crude) oil / coal / hydrocarbons / brine*

1

(ii) *allow converse throughout*

- high temperature gives a low yield

1

- because reaction is exothermic

*must be linked to first bullet point*

1

- but at low temperatures the rate is (too) slow

*if no other marks awarded accept 450°C is a compromise between yield and rate*

***or***

*450°C gives a reasonable yield in a reasonable time for **1** mark*

1

(iii) nitric (acid)

*accept $HNO_3$*

1

(b) Ammonia / Haber process can be used to make fertiliser

1

with a specified economical reason
eg raw materials for Haber process readily available
eg transport costs are lower or no need to import
eg Haber process is a continuous process

*ignore employment / labour costs*

1

**[8]**

**51** (a) (i) sodium hydroxide solution

1

blue

1

(ii) barium chloride

1

white

1

(b) fully ionised in water

1

(c) (i) $H^+$ ions

1

(ii) lower than

1

(d) (i) (indicator) changed colour / goes colourless

*ignore clear / discoloured*

1

(ii) 13.9

**or**

(titration) 2

1

(iii) 13.2

*ecf from (d)(ii)*

1

**[10]**

**52** (a) (i) *incorrect test or no test = **0** mark*

*testing the solution **or** using blue litmus = **0** mark*

(test ammonia / gas with red) litmus

*accept any acid-base indicator with correct result*

1

(goes) blue

**OR**

(conc.) HCl (1)

white fumes / smoke / solid (1)

*allow white gas / vapour*

**OR**

(test ammonia / gas with) Universal Indicator (1)

blue / purple (1)

1

(ii) *incorrect test or no test = **0** marks*

add barium chloride / $BaCl_2$ (solution)

*do **not** accept $H_2SO_4$ added*

**or** add barium nitrate / $Ba(NO_3)_2$ (solution)

*allow $Ba^{2+}$ solution / aqueous added*

1

white precipitate / solid (formed)

*allow white barium sulfate / $BaSO_4$*

*ignore barium sulfate / $BaSO_4$ alone*

**1**

(b) (i) fully / completely ionised / dissociated
**or** hydrogen ions fully dissociated

*accept has more ions than weaker acid / alkali of same concentration*

*ignore strongly ionised*

*do **not** accept ions are fully ionised*

*ignore concentrated **or** reference to concentrations of ions*

**1**

(ii) methyl orange

*accept correct spelling only*

*accept any strong acid-weak base indicator*

*do **not** allow phenolphthalein / litmus / universal indicator*

**1**

(iii) 32 × 0.05/1000 **or** 0.0016 (mole $H_2SO_4$ )

*accept (0.05 x 32) = (V x 25) **or** 0.05 x 32 / 25*

**1**

(reacts with) 2 × 0.0016 **or** 0.0032 (mole $NH_3$ in 25 $cm^3$)

*accept dividing rhs by 2 **or** multiplying lhs by 2*

**1**

(0.0032 × 1000/25 =) 0.128

*allow ecf from previous stage*

*correct answer 0.128 **or** 0.13 with or without working gains all **3** marks*

**1**

(iv) 2.176 **or** 2.18

*correct answer with or without working*

**or** ecf from candidate's answer to (b)(iii)

**or** 2.55 if 0.15 moles used

*if answer incorrect or no answer*

*0.128 × 17 **or** 0.13 x 17*

***or** their (b)(iii) × 17*

***or** 0.15 × 17 gains **1** mark*

**2**

**[11]**

**53**

(a) (i) mix (owtte)

*accept to allow more collisions / helps particles to collide (owtte)*
*idea of more efficient heat transfer*
*do **not** allow heat is a catalyst*

**1**

(ii) higher **and** more

**1**

powder **and** big

**1**

concentrated **and** more

**1**

(b) electrons

**1**

(c) $H^+$

**1**

**[6]**

**54**

(a) gas / g

*accept low density / low boiling point*
***or** weak intermolecular forces **or***
*small molecules **or** simple molecules*
***or** simple molecular (structure)*
*accept volatile or easy to evaporate*
*ignore very light*
*ignore incorrect name of gas*

**1**

(b) filter / filtration

*accept filter paper*
*accept decant / centrifuge*
*ignore filter funnel / sieving / drained off / funnelling*
*ignore names of compounds*
*ignore evaporation / heating if after filtration*
*do **not** accept crystallisation*

**1**

(c) evaporation / crystallisation

*accept heating / boiling*

*accept 'leave for a few days' owtte*

*allow cool*

*do **not** allow freeze*

*ignore filtration*

**1**

(d) *candidates can gain marks from any two of the three linked pairs*

hydrogen chloride escaped / released (into atmosphere) **or** (hydrogen chloride) damaged vegetation / harmful

used to make chlorine / bleach

*to get both of these **2** marks hydrogen chloride must be mentioned*

*ignore HCl formed / produced / made*

*ignore sale of hydrogen chloride*

**1**

unpleasant smell (of calcium sulfide)

**or**

waste of calcium (sulfide)

converted to sulfur

**or**

used to make sulfuric acid

*ignore calcium sulfide alone*

*allow calcium / calcium sulfate for calcium sulfide*

*to get both of these 2 marks calcium (sulfide) must be mentioned*

*ignore sale of calcium sulfide*

**1**

unreacted coal (1)

recycled / burnt / used / sold (1)

*must be linked to first coal point*

**1**

**[7]**

**55**

(a) burette

**1**

(b) indicator changed colour

*allow any indication of colour change*

**1**

(c) (i) 0.2 **or** 18.3 to 18.5

**1**

(ii) 18.4

**1**

(iii) improve reliability

*allow improve accuracy*

*allow to calculate a mean / average*

***or*** *get rid of anomalous result*

*ignore fair test / correct results / random results*

**1**

**[5]**

**56** (a) hydroxide (ion) / $OH^-$ / $OH^-(aq)$

*ignore OH*

**1**

(b) fully / all / completely ionised / dissociated

*ignore strongly ionised **or** more ions **or** concentration*

*ignore all 'noise'*

*do **not** accept <u>ions</u> are fully ionised / dissociated*

**1**

(c) *assume it = sodium hydroxide*

any valid test

*incorrect test / titration = **0** marks for question*

**1**

linked comparison

*correct result / reference to pH with no test = **1** mark*

eg UI **or** full range indicator **or** pH

paper / solution / (pH) meter (1)

NaOH has higher pH **or**

*allow converse for weak(er)*
*pH values must be above 7*

correct comparison of colours (1)

*NaOH – purple, Ammonia – blue*
*allow correct comparison of blue or purple*

**or**

conductivity test (1)

NaOH conducts better / more **or** bulb brighter (1)

**1**

**[4]**

**57**

(a) (i) (different) properties

*allow ideas of different property / behaviour / element*

**1**

(ii) any **one** from:

*they = Crawford + Cruikshank*

- they had high status

**or**

they were lecturers / doctors / professors / famous scientists

- other scientists repeated experiments

*allow experiment could be repeated*
*allow other scientists showed they had different properties*

- they had proof

**or**

lots of / strong / conclusive / enough / clear evidence
*ignore evidence unqualified*

**1**

(iii) other scientists obtained similar results / proved it

**or**

experiments were repeated

**1**

(b) (i) any **one** from:

- mass of solid / strontium (chloride) / barium (chloride)
  *allow amount / volume*
- volume of water
  *allow amount / mass*
- type of container
  *allow initial / starting temperature (of water)*
  *ignore room temperature / time / concentration*
  *ignore reference to hydrochloric acid*

**1**

(ii) 2 **and** takes in heat / energy

**or**

2 **and** temperature goes down (owtte)

**1**

(iii) temperature increased for one experiment and decreased for the other (owtte)

**or**

one was exothermic and one was endothermic (owtte)
*accept experiment 1 was exothermic*

**1**

(c) any **one** from

- positive / + (charge)
  *do **not** accept incorrect further qualification eg electrons / atoms / electrodes*
- opposite (charges) attract

**1**

**[7]**

**58** (a) (i) $H^+$

**1**

(ii) $OH^-$

**1**

(iii) lower than

**1**

(b) with HCl:

UI goes red / pink

*allow a comparison eg redder than ethanoic acid*

**1**

has a pH 0 ,1 ,2 **or** 3

*allow a comparison eg has pH less than ethanoic acid.*

*do **not** accept an incorrect pH.*

**or**

with ethanoic acid:

UI goes orange / yellow (1)

*allow a comparison with HCl*

has a pH 4 / or above (but less than 7) (1)

*allow a comparison with HCl*

**1**

(c) completely

**1**

(d) (i) conical flask

**1**

(ii) titration

**1**

(iii) repeat

*allow compare with another students results*

**or**

take average

**1**

**[9]**