AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.4.3 ELECTROLYSIS (PACK 1)

SCORE	PERCENTAGE
/316	%

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Q1.

(a) 3.6 (cm^3)

1

(b) hydrogen line only

1

(c) both lines

1

(d) graphite has delocalised electrons

1

(e) **cathode** **anode**

zinc (1) chlorine (1)

*do **not** accept chloride*

*allow **1** mark if chlorine and zinc the wrong way around*

1+1

hydrogen (1) bromine (1)

*do **not** accept bromide*

*allow **1** mark if bromine and hydrogen the wrong way around*

1+1

[8]

Q2.

(a) copper, zinc, sodium chloride solution

1

(b) a reactant is used up

allow the reaction stops

allow electrolyte / electrode / ions / metal / metal hydroxide / alkali for reactant

1

(c) the reaction is not reversible

1

(d) $2H_2 + O_2 \longrightarrow 2H_2O$

allow fractions / multiples

*allow **1** mark for O_2*

2

(e) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

5–6

Level 2: Some logically linked reasons are given. There may also be a simple judgement.

3–4

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Level 1: Relevant points are made. This is not logically linked.

1–2

No relevant content

0

Indicative content

reasons why fuel cells could be judged as better

from the table	from other knowledge
• time for refuelling a fuel cell is faster than recharging **or** a fuel cell does not need to be recharged • a fuel cell has a greater range	• hydrogen can be renewable if made by electrolysis using renewable energy • lithium-ion batteries can catch fire • produces only water **or** no pollutants produced • lithium-ion batteries may release toxic chemicals on disposal • lithium-ion batteries (eventually cannot be recharged so) have a finite life

reasons why the lithium-ion battery could be judged as better

from the table	from other knowledge
• lithium-ion uses energy more efficiently • cost of lithium-ion car much less • cost of recharging much less than refuelling with hydrogen	• hydrogen is often made from fossil fuels so is not renewable • charging points are more widely available than hydrogen filling stations • hydrogen takes up a lot of space **or** is difficult to store • hydrogen can be highly flammable / explosive • no emissions produced • (catalyst in the hydrogen fuel-cell eventually becomes poisoned so) have a finite life

[11]

Q3.

(a) solid (zinc chloride) does not conduct (electricity)
or

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zinc chloride needs to be in solution **or** molten

allow liquid / aqueous

1

(because) ions cannot move in the solid
or
(as) ions can (only) move in liquid / solution

*do **not** accept references to movement of electrons in zinc chloride*

1

(b) each carbon / atom forms 3 (covalent) bonds

1

one electron per carbon / atom is delocalised

1

(so) these electrons carry charge through the graphite
or
(so) these electrons move through the structure

ignore carry current / electricity

1

*if no other mark scored, allow **1** mark for delocalised / free electrons*

allow free electrons for delocalised electrons

(c) use measuring cylinders (instead of test tubes)

allow use burettes
allow use (gas) syringes
allow Hoffmann voltameter

1

(because) test tubes cannot measure volume
or
(because) test tubes have no graduations / scale

allow (so that) volume can be measured

1

(d) any **three** from:

- the volume of hydrogen collected is directly proportional to the time

  allow the (volume of) hydrogen is collected at a constant / steady rate

- the rate of collection of hydrogen is 0.45 (cm^3/min)

- up to 8 minutes chlorine is collected at an increasing rate

  allow any value from 6 to 8 minutes

  allow initially chlorine is collected at an increasing rate

- after 8 minutes the rate of collection of chlorine is the same as that of hydrogen

  allow any value from 6 to 8 minutes

  or

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after 8 minutes the rate of collection of chlorine is 0.45 (cm^3/min)

allow after 8 minutes the (volume of) chlorine is collected at a constant / steady rate

*if neither bullet point 3 nor bullet point 4 is awarded allow **1** mark for chlorine is collected slowly up to 8 minutes and then more quickly*

allow any value from 6 to 8 minutes

3

(e) chlorine reacts with water
or
chlorine dissolves (in the solution).

1

(f) $(\text{volume} =) \frac{6.6}{1000}\ (\text{dm}^3)$

or 0.0066 (dm^3)

allow 6.5 (cm^3) for 6.6 (cm^3)

1

$(\text{moles} =) \frac{0.0066}{24}$

allow use of incorrect volume from step 1

1

= 2.75×10^{-4} (mol)

allow 2.8×10^{-4} (mol)

allow answer from incorrect calculation given in standard form

alternative approach for marking points 1 and 2

24 dm^3 = 24 000 cm^3 (1)

$(\text{moles} =) \frac{6.6}{24\,000}$ (1)

1

*an answer of 2.75×10^{-4} (mol) or 2.8×10^{-4} (mol) scores **3** marks*

*an answer of 0.000275 / 0.00028 / 2.75×10^{-1} / 2.8×10^{-1} (mol) / scores **2** marks*

*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[10]

Q4.

(a) **(diagram)**
complete circuit with power supply

1

test solution in beaker or other appropriate apparatus

1

electrodes

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allow carbon, platinum or inert electrodes

1

(independent variable)
salt solutions (with different metal ions)

1

(observation)
solid / metal deposit on the negative electrode

1

(b) (sometimes) hydrogen is produced

1

(because) the metal is more reactive than hydrogen

1

(c) chlorine

1

oxygen

1

[9]

Q5.

(a) The forces between iodine molecules are stronger

1

(b) anything in range +30 to +120

1

(c) Brown

1

(d) $2\ I^- + Cl_2 \rightarrow I_2 + 2\ Cl^-$

1

(e) It contains ions which can move

1

(f) hydrogen iodine

1

[6]

Q6.

(a) electricity

allow an electric current

1

(b) (i) chlorine/Cl_2

*do **not** accept chloride*

1

(ii) (zinc ions are) positive

ignore to gain electrons

1

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and (opposite charges) attract

1

(iii) reduction

1

(c) (i) in alloy:

accept converse

different sized atoms/particles

or

no layers/rows

accept layers distorted

1

so cannot slide

1

(ii) shape memory (alloys)

accept smart

1

[8]

Q7.

(a) magnesium loses two electrons **and** chlorine gains one electron

*accept magnesium loses electrons **and** chlorine gains electrons for 1 mark*

ignore oxidation and reduction

2

one magnesium and two chlorines

accept $MgCl_2$

1

noble gas structure

or

eight electrons in the outer shell

accept full outer shell (of electrons)

or

(electrostatic) attraction between ions

or

forms ionic bonds

*do **not** accept covalent bonds*

1

*reference to incorrect particles **or** incorrect bonding **or** incorrect structure = **max 3***

(b) (i) because ions can move

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ignore ions attracted
*do **not** accept molecules / atoms moving*
*do **not** accept incorrect reference to electrons moving*

1

(and ions move) to the electrodes

or

(and ions) carry charge

1

accept converse for solid

(ii) magnesium (ions) attracted (to the electrode)

1

so magnesium ions gain electrons
accept magnesium ions are reduced
ignore oxidised

1

2 electrons
*accept a correct half equation for 2nd **and** 3rd marking points*

1

(iii) hydrogen
allow H_2

1

(iv) magnesium is more reactive than hydrogen
accept converse
*allow magnesium is high in the reactivity series **or** magnesium is very/too reactive.*
*do **not** accept magnesium ions are more reactive than hydrogen ions*

1

(v) **2** $Cl^- \rightarrow Cl_2 + \mathbf{2e^-}$
must be completely correct

1

(c) layers (of particles/atoms/ions)

1

(particles/atoms/ions/layers) can slide

1

*any mention of intermolecular / weak bonds/forces = **max 1***

[14]

Q8.

(a) (i) calcium oxide
in either order

1

carbon dioxide
accept correct formulae

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1

(ii) $C(s) + CO_2(g) \rightarrow \mathbf{2}CO(g)$

allow multiples

1

(iii) 210 (tonnes)

*award **3** marks for the correct answer with or without working*

allow ecf for arithmetical errors

*if answer incorrect allow up to **2** marks for any of the steps below:*

160 → 112

300 → 112 / 160 × 300

or

moles Fe_2O_3 = 1.875 (× 10^6) or 300 / 160

moles of Fe = 3.75 (× 10^6) or 2 × moles Fe_2O_3

mass Fe = moles Fe × 56

105 (tonnes) scores 2 (missing 1:2 ratio)

420 (tonnes) scores 2 − taken M_r of iron as 112

3

(b) (i) aluminium is more reactive than carbon **or** carbon is less reactive than aluminium

must have a comparison of reactivity of carbon and aluminium

accept comparison of position in reactivity series.

1

(ii) (because) aluminium ions are positive

ignore aluminium is positive

1

and are attracted / move / go to the negative electrode / cathode

1

where they gain electrons / are reduced / $Al^{3+} + 3e^- \rightarrow Al$

accept equation or statements involving the wrong number of electrons.

1

(iii) (because) the anodes **or** (positive) electrodes are made of carbon / graphite

1

oxygen is produced (at anode)

1

which reacts with the electrodes / anodes

*do **not** accept any reference to the anodes reacting with oxygen from the air*

*equation $C + O_2 \longrightarrow CO_2$ gains **1** mark (M3)*

1

[13]

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Q9.

(a) any **one** from:
- protection / improve lifespan
- improve appearance.

1

(b) (i) Bleach

1

(ii) Hydrogen is less reactive than sodium

1

(iii) 1 bonding pair of electrons 6 unbonded electrons on Cl

accept dot, cross or e or − or any combination

1

(iv) Covalent

1

(v) Hydrogen chloride has a low boiling point.

1

Hydrogen chloride is made of simple molecules.

1

(c) (i) oxygen

accept carbon dioxide

1

(ii) aluminium ions are positive

1

so are attracted (to the negative electrode)

allow opposites attract

1

(iii) Reduction

1

(iv) slide

allow move

1

(d) (i) C

1

(ii) strong covalent bonds

1

[14]

Q10.

(a) giant structure / lattice / layers / close packed

first 3 marks can be obtained from a suitably labelled diagram

incorrect structure or bonding or particle = max 3

1

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made up of atoms / positive ions

1

with delocalized / free electrons

1

so electrons can move / flow through the metal

accept so electrons can carry charge through the metal

accept so electrons can form a current

1

(b) an alloy (is a metal which) has different types / sizes of atoms

accept converse for pure metal throughout

both marks can be obtained from suitable diagrams

allow made of different metals

allow mixture of metals / atoms / elements

ignore particles

ignore properties

*do **not** accept compound*

1

alloy has distorted layers

allow layers are unable to slide

1

(c) (i) can return to its original shape

accept shape memory alloy

accept smart alloy

ignore other properties

1

(ii) (pure copper is too) soft

accept converse

accept malleable or bends

accept copper is running out

ignore references to strength and weakness

1

(iii) aluminium oxide

accept alumina

accept Al_2O_3

ignore bauxite / aluminium ore

1

(iv) any **one** from:

- different conditions
- different catalyst
- different pressure

allow different concentration

- different temperature.

*do **not** accept different monomers*

1

(d) any **two** from:

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- accurate
- sensitive
- rapid
- small sample.

both needed for 1 mark

1

[11]

Q11.

(a) lattice / giant structure

*max **3** if incorrect structure or bonding or particles*

1

ionic **or** (contains) ions

1

Na^+ **and** Cl^-

accept in words or dot and cross diagram: must include type and magnitude of charge for each ion

1

electrostatic attraction

allow attraction between opposite charges

1

(b) hydrogen

allow H_2

1

sodium hydroxide

allow NaOH

1

(c) any **one** from, eg:

- people should have the right to choose
- insufficient evidence of effect on individuals
- individuals may need different amounts.

allow too much could be harmful

ignore religious reasons

ignore cost

ignore reference to allergies

1

(d) (i) one bonding pair of electrons

accept dot, cross or e or − or any combination, eg



1

6 unbonded electrons on each atom

1

(ii) simple molecules

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*max **2** if incorrect structure or bonding or particles*

accept small molecules

accept simple / small molecular structure

1

with intermolecular forces

accept forces between molecules

must be no contradictory particles

1

which are weak **or** which require little energy to overcome − must be linked to second marking point

reference to weak covalent bonds negates second and third marking points

1

(iii) iodine has no delocalised / free / mobile electrons or ions

1

so cannot carry charge

*if no mark awarded iodine molecules have no charge gains **1** mark*

1

[14]

Q12.

(a) (i) points correctly plotted (± ½ small square)

*four points = **2** marks*

*three points = **1** mark*

Max 2

straight line of best fit using full range of points from 0,0

1

(ii) any **one** from:

must explain why the point is below the line

- the solution may not have been properly stirred
- the electrodes may have been a larger distance apart
- the drop of sodium chloride may have been a smaller volume / smaller

allow not enough sodium chloride added

allow smaller amount of sodium chloride

*do **not** allow too few drops added*

ignore the student may have misread the conductivity meter

1

(iii) any **one** from:

- the volume of pure water

  allow amount
- the concentration (of the solutions added)
- the volume (of the drops) of solution added

  ignore number of drops

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- the distance between the electrodes
- the same electrodes **or** electrodes made of the same material
- same depth **or** surface area of electrodes in the water
- constant power supply

  ignore current
- stirred

1

(b) (i) because (pure) water is covalent / molecular (simple) **or** contains molecules

1

therefore (pure) water has no free / mobile electrons **or** ions

*molecules do not have a charge **or** molecules do not contain ions gains **2** marks*

1

(ii) because there are ions in sodium chloride

*allow Na^+ and / or Cl^-(ions) **or** ionic bonding.*

Ignore particles other than ions for MP1.

1

which can move **or** carry the current / charge

MP2 must be linked to ions only.

1

(iii) Hydrogen

allow H_2 / H

1

[10]

Q13.

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

- one electron in the outer shell / energy level
- form ions with a 1+ charge

1

(ii) any **one** from:

- hydrogen is a non-metal
- (at RTP) hydrogen is a gas
- hydrogen does not react with water
- hydrogen has only one electron shell / energy level
- hydrogen can gain an electron **or** hydrogen can form a negative / hydride / H^-ion
- hydrogen forms covalent bonds **or** shares electrons

accept answers in terms of the Group 1 elements

1

(b) (i) (bromine) gains electrons

it = bromine

*do **not** accept bromide ion gains electrons*

ignore loss of oxygen

1

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(ii) I_2

must both be on the right hand side of the equation

1

+ $2e^-$

*$2I^- - 2e^- \rightarrow I_2$ for **2** marks*

1

(iii) fluorine is the smallest atom in Group 7 **or** has the fewest energy levels in Group 7 **or** has the smallest distance between outer shell and nucleus

*the outer shell **must** be mentioned to score 3 marks*

1

fluorine has the least shielding **or** the greatest attraction between the nucleus and the outer shell

1

therefore fluorine can gain an electron (into the outer shell) more easily

1

[8]

Q14.

(a) (i) ions cannot move

allow only conducts as a liquid

1

(ii) chlorine

1

(iii) they are positively / oppositely charged

or

they are attracted

1

(iv) 2

1

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

- not all the magnesium was collected
  allow some magnesium was lost
- *used less time **or** lower current **or** different battery / power pack **or** different balance **or** lower voltage*
- error in reading balance
- error in recording result

1

(ii) 1.11

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

*if answer incorrect, allow **1** mark for 0.99*

***or** for 1.13 + 1.11 + 1.09*

2

(c) (i) *25 – 25.3*

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*correct answer with or without working gains **2** marks.*
*If answer incorrect, allow **1** mark for 24 / 95*

2

(ii) 71

1

(d) (i) reversible reaction

1

(ii) decreases

1

[12]

Q15.

(a) (i) so ions can move (and carry charge)
accept so current can flow
allow so it can conduct (electricity)
allow so charged particles can move
*do **not** accept so electrons can move*

1

(ii) because zinc ions gain electrons
accept because zinc ions are reduced

1

2 (electrons)

1

zinc is formed
*accept correct half equation for **3** marks*
if no mark gained allow
*positive ions go to negative electrode **or***
*opposites attract **or***
*reduction (of zinc) **or***
*(zinc) gains electrons for **1** mark*

1

(iii) **2 Cl**$^-$ $\longrightarrow$ Cl_2 + **2** e^-
must be completely correct

1

(b) (i) because the magnesium is *a gas*
allow magnesium goes from solid to gas

1

(ii) (a reaction which) takes in energy (from the surroundings)
accept more energy needed to break bonds than released by forming bonds
accept correct reference to energy level diagram
allow (a reaction which) takes in heat (from the surroundings)

1

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(iii) (M_r MgO =) 40

accept (2 M_r MgO =) 80

1

1.2 / 24 (x40) **or** 0.05 (x40)

or

40 / 24 (x1.2) **or** 1.67 (x1.2)

allow ecf from step 1

1

2(.0)

allow ecf carried through from step 1

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

1

(iv) 75(%)

1

(v) any **one** from:

- the reaction is reversible

  accept incomplete reaction

  ignore equilibrium not reached
- *some lost / escaped / released (when* separated)
- some of the reactant may react in different ways from the expected reaction
- *impure reactant(s)*

ignore measurement and calculation errors

1

[12]

Q16.

(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

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(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]

Q17.

(a) Will kelp last longer than coal as an energy source?

1

(b) any **two** from:

- cannot be determined by experiment

allow can't predict how long kelp / coal will last

allow more testing needed

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- based on opinion
- ethical **or** environmental **or** economic reason
  allow could damage ecosystem allow reference to cost

2

(c) (i) 7

1

(ii) sodium (atom) loses (electron) **and** iodine (atom) gains (an electron)
*reference to incorrect bonding **or** incorrectly named particle = max **2***
any or all marks can be obtained from a labelled diagram
ignore inner shell electrons if shown

1

1 electron

1

(electrostatic) attraction **or** forms ionic bond(s)

1

(iii) ions can move (in the solution)

1

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

1

(v) hydrogen is formed

1

because sodium is more reactive (than hydrogen)

1

[11]

Q18.

(a) cannot move

1

(b) (i) a positive charge

1

(ii) atoms

1

[3]

Q19.

(a) (i) aluminium oxide
ignore (III) after aluminium

1

(ii) (because it provides) heat / energy (to overcome activation energy)

1

(b) (i) contains only one sort of atom

1

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(ii) the atoms (in cast iron) are different sizes

*any mention of molecules, maximum **1** mark*

*accept layers are distorted **or** structure is disrupted*

1

which prevents the layers / rows sliding

accept an answer in terms of pure iron being softer than cast iron for both marks

1

(c) (i) because aluminium is more reactive than carbon

'it' = aluminium must be a comparison between the elements

or

because aluminium is above carbon in the reactivity series

*do **not** accept any comparison of the reactivity of aluminium and iron*

1

(ii) reduces / lowers the temperature for the process **or** lowers the operating temperature **or** allows ions to move

ignore any temperature values

allow reduces the (effective) melting point (of Al_2O_3)

1

(iii) 3

accept multiples

1

(iv) electrons are gained (by Al^{3+})

ignore any numbers

ignore any reference to oxygen

1

(v) electrodes are made of carbon

allow graphite / coke

1

oxygen is produced (at the positive electrode / anode)

accept $2O^{2-} \rightarrow O_2 + 4e^-$

1

so the electrodes react with the oxygen / are oxidised

1

producing carbon dioxide (gas)

accept $C + O_2 \rightarrow CO_2$ for marking points 3 and 4.

1

[13]

Q20.

(a) any **two** from:

- copper / ores are running out / harder to find

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- there are no / very small amounts of high-grade copper ores left
- copper metal is in demand
- copper is expensive
- now economical to extract copper from low-grade ores

  it = copper

  allow new methods of extraction e.g. bioleaching and phytomining

  *allow high-grade ores are running out for **2** marks*

2

(b) (i) large amounts / 98% of rock to dispose of as waste

accept contains toxic (metal) compounds / bioleacher

or

waste rock takes up a lot of space

1

(ii) (copper sulfide reacts with oxygen to) produce sulfur dioxide / SO_2

allow (sulfur reacts with oxygen to) produce sulfur dioxide / SO_2

1

that causes acid rain

*allow description of effects of acid rain **or** sulfur dioxide*

*if no other mark awarded allow CO_2 produced which causes global warming **or** CO_2 produced by burning fuel or heating the furnace for **1** mark*

1

(iii) any **one** from:

- large amounts of fuels / energy used (for the furnace and electrolysis)

  allow large amounts of electricity needed

  ignore high temperature / electrolysis unqualified

- (the extraction has) many steps / stages / processes

  allow (extraction) is a long process / takes a lot of time

- large amounts of ore / material have to be mined

  allow ores contain a low percentage of copper

1

(iv) (copper ions move towards) the negative electrode */ cathode*

1

because copper ions / Cu^{2+} are positively charged **or** are oppositely charged **or** copper ions need to gain electrons

*allow because metal ions are positive **or** opposites attract*

1

(v) (growing) plants

1

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[9]

Q21.

(a) (i) was well qualified

1

(ii) check the results of the experiment

1

(b) (i) cannot move

1

(ii) melt it / make it a liquid

allow heat it

allow dissolve (in water) / make a solution

1

(iii) they are positive

*allow opposites attract **or** opposite charges*

1

(iv) atoms

1

[6]

Q22.

(a) (i) current / charge couldn't flow

allow could not conduct (electricity)

1

because the ions / particles couldn't move

*do **not** accept electrons/ molecules / atoms*

or

(salt) needs to be molten / (1) dissolved (to conduct electricity)

so that the ions / particles can move (1)

*do **not** accept electrons / molecules / atoms*

1

(ii) he had status

*accept he had authority **or** experience*

or

he had evidence / proof

accept the experiment could be repeated

1

(b) hydrogen / H_2

*do **not** allow hydrogen ions*

1

the ions are positive

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accept because opposite (charges) attract

1

potassium is more reactive (than hydrogen)

accept potassium ions are less easily discharged (than hydrogen)

***or** potassium ions are less easily reduced (than hydrogen)*

1

(c) (i) gain electron(s)

*accept fully balanced correct equation for **2** marks*

1

one electron

*if no other marks awarded allow (potassium ions) reduced for **1** mark*

1

(ii) $2\ Cl^- \rightarrow Cl_2 + \mathbf{2e}^-$

must be completely correct, including charge on electron

accept correct multiples

1

(iii) 2, 8, 8

accept any combination of dots, crosses, "e" or any other relevant symbol

ignore any charges if given

1

[10]

Q23.

(a) reduction

1

(b) carbon is less reactive than aluminium

1

(c) aluminium (ions) / they are positively charged

they = aluminium ions

ignore particle names

accept aluminium (ions) / they are cations

allow aluminium (ions they have an opposite charge

1

so they are attracted **or** they move towards the negative electrode

OR

aluminium (ions) / they need to gain electrons (1)

which come from the negative electrode (1)

*if no other marks awarded allow 'opposites attract' for **1** mark*

1

(d) aluminium has a low density

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1

aluminium is resistant to corrosion

1

(e) **advantage** less carbon dioxide is produced

1

disadvantage used aluminium cans have to be collected and transported

1

[8]

Q24.

(a) (i) A

1

(ii) E

1

(b) (i) insoluble

precipitation

2

(ii) filtration

*accept decant **or** centrifuge*

1

(iii) hydrochloric acid

1

(c) (i) melt

allow add to / dissolve in water
allow heat until liquid
allow turn it to liquid / make it molten
ignore heat

1

(ii) they are positive

or

opposite charges **or** opposites attract

*do **not** accept electrodes attracting*
*do **not** accept positive electrons*

1

(iii) chlorine

accept Cl_2
*do **not** accept chloride*

1

[9]

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Q25.

(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]

Q26.

(a) (i) cryolite

1

(ii) lower the melting point of the aluminium oxide

1

(b) (i) opposite charges **or** oxide ions are negative

1

attract

1

(ii) carbon

1

(iii) reacts with oxygen **or** forms carbon dioxide

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accept burns

1

(c) **Structure mark:**

either Al (atoms) in layers / rows

accept Al (atoms) all the same size
allow Al (atoms) in lines

or alloy (atoms) not in layers / rows

accept different sizes of atoms in alloy
allow alloy (atoms) not in lines

1

Sliding mark:

either so (Al layers) can slide

or so (alloy) layers cannot slide

1

[8]

Q27.

(a) 52.9(411765) / 53

*correct answer with or without working = **2** marks*
*if answer incorrect allow 2 x 27= 54 **or** 27/102 x 100 **or** 26.5 for **1** mark*

2

(b) (i) because it lowers the melting point (of the aluminium oxide)

allow lowers the temperature <u>needed</u>
*do **not** accept lowers boiling point*

1

so less energy is needed (to melt it)

accept so that the cell / equipment does not melt

1

(ii) **2** O^{2-} on left hand side

accept correct multiples or fractions

1

$4e^-$ on right hand side

*accept **$-4e^-$** on left hand side*

1

(iii) because the electrode reacts with oxygen **or**

because the electrode burns

1

to form carbon dioxide **or**

electrode made from carbon / graphite

1

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[8]

Q28.

(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

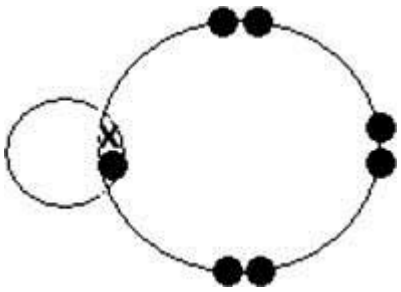
(b) hydrogen is less reactive than sodium

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]

Q29.

(a) (i) low percentage / very little of metal (in the ore)

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*accept <u>only</u> 0.5% metal in the ore **or** over 99% waste in the ore **or** nearly 100% waste in the ore*

*ignore reference to percentage of metal in the Earth's crust **or** energy used or pollution*

1

(ii) any **one** from

(it = iron)

- iron uses less energy / fuel for extraction
  ignore electrolysis / uses electricity / reactivity
- iron has more uses
- more demand for iron
  ignore high abundance in the Earth's crust / high percentage of metal in ore
- iron is stronger
  ignore harder
- cheaper / costs less
- easier to extract

1

(b) (i) has <u>mel</u>ting point lower than 950°C

(it = aluminium)

allow has a low <u>mel</u>ting point

ignore boiling point

1

(ii) electrode(s) made of carbon

1

oxygen reacts with electrode(s) / carbon

accept $C + O_2 (\rightarrow CO_2)$

*NB oxygen reacts with the carbon electrode(s) = **2** marks*

1

(iii) any **two** from:

- saves resources / non-renewable
  *accept aluminium / ore will run out **or** conserves aluminium*
- landfill problem
  accept aluminium does not corrode
- saves energy / fuel / electricity
  ignore global warming
- less carbon dioxide / carbon emissions **or** reduces carbon footprint
  ignore consequences of quarrying / mining
- less quarrying / mining

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ignore pollution / harms environment / costs / easy to recycle

2

[7]

Q30.

(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*

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- 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]

Q31.

(a) cannot move

1

(b) water

1

(c) (i) a positive charge

1

(ii) atoms

1

[4]

Q32.

(a) (i) electron(s)
allow free / delocalised / negative electrons
*do **not** accept additional particles*

1

(ii) <u>ion</u>(s)
allow named ions from table
ignore positive or negative

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*do **not** accept additional particles*

1

(b) (i) copper

accept Cu

*do **not** accept Cu^{2+}*

1

(ii) it is / they are positive (ions)

accept formula of positive ion

1

and it is the least reactive

1

(c) (i) loss of electron(s)

ignore numbers

1

(ii) $\mathbf{2H^+} + \mathbf{2e^-} \rightarrow H_2$

accept correct multiples / fractions

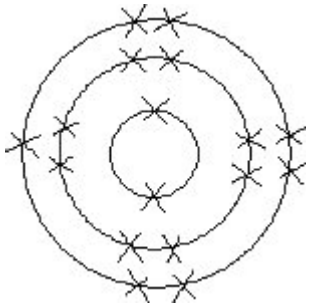
accept e / e^-

allow $\mathbf{2H^+} \rightarrow H_2 - \mathbf{2e^-}$

1

[7]

Q33.

(a) 

accept dots / crosses / e

must be drawn on diagram

electrons do not need to be paired

ignore brackets or + or -charges

ignore 2,8,7

1

(b) (one) electron

recognition that electrons are involved

1

lost / given away / transferred from sodium / transferred to chlorine owtte

must be linked to electrons

*accept loses electron(s) for **2** marks*

*NB loses 2 or more electrons gains **1** mark*

*reference to sharing / covalent max **1** mark*

ignore charges on ions formed

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1

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

- ions / atoms / they are / it is negatively charged / anions
  accept they are negative
- opposite (charges) attract
  accept they are attracted or it is oppositely charged
  ignore opposite forces attract

1

(ii) hydrogen
accept H_2
ignore H or H^+

1

(d) (i) poisons released into environment (owtte)
accept any sensible idea of harm / harmful / poisons / poisonous / pollution / damaging
*do **not** accept answers such as global warming / ozone layer etc.*
ignore safety unless qualified

1

(ii) any **one** sensible idea eg

- loss of work / unemployment
  eg shops / house prices etc.

  or
  company goes out of business
- any adverse effect on local economy (owtte)
- any adverse effect on paper production / cost of paper / cost of water (treatment)
  allow less expensive to use chlorine or converse
- chlorine (compounds) have been used (for many years) without causing harm owtte
- only a tiny amount of chlorine is released so it would not cause harm
  ignore uses of chlorine to treat drinking water unless qualified

1

(iii) ideas related to bias
accept more reliable or valid or fair
ignore more accurate / fair test

1

[8]

Q34.

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(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

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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]

Q35.

(a) positive

*accept + **or** +ve **or** plus*

1

(b) chlorine

1

(c) (i) hydroxide

Any indication of hydro…

1

(ii) destroys / damages / dissolves (owtte) the hair / follicle / root

allow burns / reacts with the hair

ignore incorrect name of compound

1

[4]

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