Mark schemes

Q1.

(a) by filtration

1

(b) 10 minutes per 2 cm on x-axis

allow 5 minutes per 1 cm on x-axis

1

all points plotted correctly

allow a tolerance of ± ½ a small square

allow 1 mark for 3 or 4 points plotted correctly

2

line of best fit

allow line of best fit drawn using incorrect plots

1

(c) 0.14 (g)

allow ecf from question (b)

allow a tolerance of ± ½ a small square

1

(d) (copper sulfate solution) pink / orange / red / brown solid

allow copper plating

allow metal for solid

1

(sodium chloride solution) bubbles / effervescence / fizzing

if no other mark awarded allow 1 mark for

copper and hydrogen

1

(e) toxic / poisonous (fumes)

allow harmful / corrosive (fumes)

ignore dangerous / deadly / lethal

1

(f)

Molten compound electrolysed	Product at the negative electrode	Product at the positive electrode
(zinc chloride)	zinc (1)	chlorine (1)
potassium iodide	(potassium)	(iodine)

allow 1 mark if zinc and chlorine the wrong way round

2
1

[12]

Q2.

(a) electrolysis uses electricity to produce a chemical reaction

allow voltage for electricity
allow potential difference for electricity
allow (electrical) current for electricity
allow electrolysis uses electricity to decompose a compound / electrolyte

1

(but) cells use a chemical reaction to produce electricity

1

(b) $2Br^- \rightarrow Br_2 + 2e^-$

allow multiples
allow 1 mark for Br_2 and e^-

2

(c)

Salt solution	Product at positive electrode	Product at negative electrode
(copper nitrate)	oxygen (1)	(copper)
(potassium iodide)	iodine (1)	hydrogen (1)

1
2

(d) filter the mixture

1

wash and dry the copper / residue

1

weigh the copper collected

1

add to the increase in mass of the electrode

1

(e) (for given current) straight line through the origin

allow (for given current) when time doubles, mass doubles

1

(f) (for given time) when current doubles, mass doubles with supporting data

1

(g) copper ions are discharged (from the solution)

allow the solution becomes less concentrated

allow copper ions are removed (from the solution)

allow copper ions are used up (from the solution)

1

(h) (number of moles = $\frac{0.24}{63.5}$ =)
3.78 × 10–3 or 0.00378

1

(number of atoms =)
0.00378 × 6.02 × 1023

allow correct use of an incorrectly calculated number of moles

1

= 2.28×10^{21}

allow a correct evaluation to 3 significant figures of an incorrect expression which involves only a mass from the graph, the Ar of copper and the Avogadro constant

1

[17]

Q3.

(a) (negative electrode) solid produced

allow the electrode changes colour

ignore metal produced

1

(positive electrode) bubbles / fizzing / effervescence

ignore gas produced

1

(b) potassium nitrate

1

hydrogen is not a metal

allow hydrogen is a gas
allow hydrogen is not a solid
allow the products at both electrodes are gases
allow the product at the negative electrode is not potassium
allow potassium is more reactive than hydrogen

1

(c) (graphite) conducts (electricity)

allow (graphite) has delocalised / free electrons

1

(graphite) is inert

allow (graphite) is unreactive

1

(d) the ions move towards the positive electrode

1

the electrode attracts ions of the opposite charge

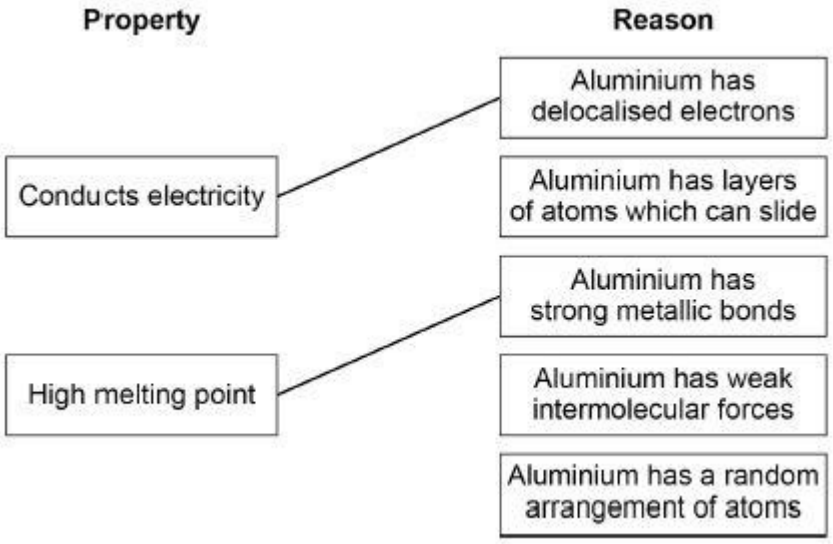
allow opposite charges attract

1

[8]

Q4.

(a)



1

additional line from a box on the left negates the mark from that box

1

(b) a mixture of metals

allow a mixture of a metal with other elements

1

(c) bauxite contains a variable percentage of aluminium

allow converse argument

allow bauxite does not have a fixed proportion / percentage of aluminium

1

(d) any two from:

- danger of dam bursting

allow the lake (of mud) could overflow

- leakage of toxic substances from mud to environment
- water pollution
- damage to habitats
- visual pollution
- (dam) blocks light
- reduces the value of houses

allow unpleasant smell

2

(e) 10 / ten

1

(f) to lower the melting point of the mixture

1

(g) oxygen

must be in this order

1

carbon

1

(h)

$$\frac{25}{100} \times 300\,000$$

1

=75 000

1

= 7.5 ×104 (kg)

allow correct conversion to standard form of an incorrectly calculated mass

1

[13]

Q5.

(a) CrO_4^{2-} / chromate ions moved to the positive electrode

allow anode for positive electrode

allow yellow (coloured) ions moved to the positive electrode

1

(because) opposite charges attract

allow (because) negative ions are attracted to the positive electrode

1

(b) water

ignore copper chromate solution

1

(c) copper ions gain two electrons

allow Cu2+ for copper ions
allow 1 mark for copper ions gain electrons
or
allow 1 mark for copper ions are reduced
do not accept copper ions are oxidised

2

(to) form copper (atoms)

allow Cu for copper (atoms)
the equation:
Cu2+ + 2e- → Cu
scores 3 marks

1

(d) (negative electrode) hydrogen

allow H2

1

(positive electrode) iodine

allow I_2

1

[8]

Q6.

(a) mixture has a lower melting point (than aluminium oxide)

allow cryolite lowers melting point (of aluminium oxide)
ignore boiling point
do not accept cryolite is a catalyst

1

(so) less energy needed

ignore cost

1

(b) aluminium ions gain electrons

1

(c) 2 O2- → O2 + 4 e-

allow multiples
allow 1 mark for an unbalanced equation containing correct species

2

(d) the electrode reacts with oxygen

1

the electrode is carbon / graphite

1

(so) carbon dioxide is produced

allow (so) the electrode / carbon /

graphite is used up
allow (so) the electrode / carbon / graphite is burned away
ignore (so) the electrode / carbon / graphite is worn away ignore (so) the electrode / carbon / graphite is corroded

1

(e)

an answer of 941 (kg) scores 4 marks

(*M*r of Al2O3 =) 102

$\left(\frac{2\,000\,000}{102} =\right)$ 19 608 (mol Al_2O_3)

allow correct calculation using incorrectly calculated value of Mr of Al2O3

1

$\left(19\,608 \times \frac{3}{2} =\right)$ 29 412 (mol O_2)

allow correct calculation using incorrectly calculated value of moles of Al2O3

1

$\left(\frac{29\,412 \times 32}{1000} =\right)$ 941 (kg)

allow 941.1764706 (kg) correctly rounded to at least 2 significant figures
allow correct answer using incorrectly calculated value of moles of O2

1

alternative approach:

(2 *M*r of Al2O3 =) 204 (1)

204 (kg of Al2O3) gives 96 (kg of O2) (1)

(2000 kg of Al2O3 gives)

$\frac{2000}{204} \times 96$ (kg of O_2)

or

$\frac{2000000}{204} \times 96$ (g of O_2) (1)

= 941 (kg) (1)

(f) hydrogen (gas) would be produced (instead of sodium)

1

(because) sodium is more reactive than hydrogen

1

(g)

an answer of 50700 (dm3) scores 2 marks
an answer of 50.7 (dm3) scores 1 mark

$\left(\frac{150\,000}{71} =\right)$ 2113 (mol of Cl_2)

1

or

(volume of 1 g of Cl2 = $\frac{24}{71}$ =) 0.34 (dm3)

$(\frac{150\,000}{71} \times 24) = 50700\ (dm^3)$

allow 50704.22535 (dm^3) correctly rounded to at least 2 significant figures
allow correct calculation using their calculated number of moles and/or calculated volume of 1 g

1

[16]

Q7.

(a) 3.6 (cm3)

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]

Q8.

(a) solid (zinc chloride) does not conduct (electricity)
or
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 (cm3/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
  after 8 minutes the rate of collection of chlorine is 0.45 (cm3/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 (dm3)

allow 6.5 (cm3) for 6.6 (cm3)

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 dm3 = 24 000 cm3 (1)

(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]

Q9.

(a) (diagram)
complete circuit with power supply
1

test solution in beaker or other appropriate apparatus
1

electrodes
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]

Q10.

(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]

Q11.

(a) electricity

allow an electric current

1

(b) (i) chlorine/Cl2

do not accept chloride

1

(ii) (zinc ions are) positive

ignore to gain electrons

1

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]

Q12.

(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 MgCl2

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

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 H2

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) $2\ Cl^- \rightarrow Cl_2 + 2e^-$

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]