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 =)
$0.00378 \times 6.02 \times 10^{23}$

allow correct use of an incorrectly calculated number of moles

1

$= 2.28 \times 10^{21}$

allow a correct evaluation to 3 significant figures of an incorrect expression which involves only a mass from the graph, the A_r 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

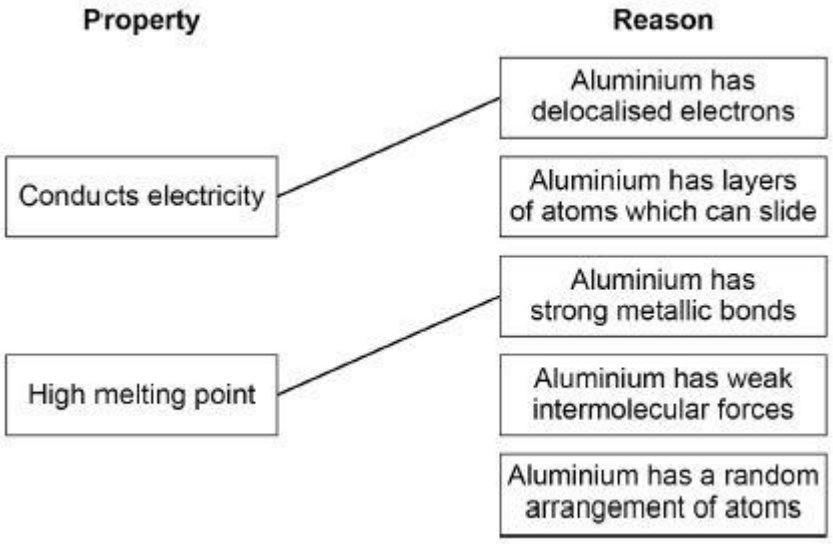
allow opposite charges attract

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

= 7.5×10^4 (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 Cu^{2+} 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:
$Cu^{2+} + 2e^- \rightarrow Cu$
*scores **3** marks*

1

(d) (negative electrode) hydrogen

allow H_2

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

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 Al_2O_3 =) 102

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

allow correct calculation using incorrectly calculated value of M_r of Al_2O_3

1

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

allow correct calculation using incorrectly calculated value of moles of Al_2O_3

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 O_2

1

alternative approach:

(2 M_r of Al_2O_3 =) 204 (1)

204 (kg of Al_2O_3) gives 96 (kg of O_2) (1)

(2000 kg of Al_2O_3 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 (dm^3) scores **2** marks*
*an answer of 50.7 (dm^3) scores **1** mark*

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

1

or

(volume of 1 g of $Cl_2 = \frac{24}{71}$ =) 0.34 (dm^3)

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

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 (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]

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

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

$= 2.75 \times 10^{-4}$ (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)

$(moles =) \frac{6.6}{24\,000}$ *(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/Cl_2

*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 $MgCl_2$

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

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]