Mark schemes

Q1.

(a) (an acid which) is partially ionised

allow (an acid which) is partially dissociated

1

in aqueous solution

allow (when dissolved) in water

MP2 is dependent on the award of MP1

1

(b) pH increases

1

(because) the concentration of hydrogen ions decreases

1

(c) use a (volumetric) pipette to add the alkali

ignore beaker

1

any **two** from:

- into a conical flask
- add an indicator (to the alkali)
- take the initial burette reading
- use a white tile (under a conical flask)

allow named indicator

*do **not** accept add universal indicator*

2

(d)

$$\left(\text{volume of HCl} = \frac{0.0045}{0.15}\right)$$

$= 0.030\ (dm^3)$

1

(conversion 0.030 dm^3 =)

30 (cm^3)

allow correct conversion of an incorrectly determined volume in dm^3

1

alternative approach

$$\left(\text{concentration} = \frac{0.15}{1000} =\right)$$

0.00015 (mol/cm^3) (1)

$$\left(\text{volume} = \frac{0.0045}{0.00015} =\right)$$

30 (cm^3) (1)

allow correct use of an incorrectly determined concentration in mol/cm^3

(e) (calcium's) outer shell / electrons are further from the nucleus

allow converse arguments in terms of magnesium
allow energy level for shell
allow calcium has more shells
ignore calcium atoms are larger

1

(so) the outer electrons are less strongly attracted to the nucleus

allow (so) the outer electrons are more shielded from the nucleus

1

(so) positive ions are formed more easily

allow (so) electrons are more easily lost

1

[12]

Q2.

(a) (atoms of) argon have a stable arrangement of electrons

allow (atoms of) argon have a full outer shell (of electrons)

1

(so) argon (atoms) do not share / transfer electrons

1

(b) PH_3

allow H_3P

1

(c) yes, because tellurium is towards the right of the periodic table

allow yes, because tellurium is in Group 6

1

(so) tellurium is a non-metal

allow (so) tellurium will gain electrons (from a metal)

1

MP2 is dependent upon MP1 being awarded

OR

yes, because tellurium is in the same group as oxygen / sulfur (1)

(and) oxygen / sulfur will react with metals (1)

allow (so) tellurium is a non-metal
allow (so) tellurium will gain electrons (from a metal)

OR

no, because tellurium is towards the bottom of the periodic table (1)

(so) tellurium is a metal (1)

allow (so) difficult for tellurium to gain electrons (from a metal) (1)

OR

cannot predict as tellurium is towards the bottom and to the right of the periodic table (1)

(so) don't know whether tellurium is a metal or non-metal (1)

allow (so) don't know whether tellurium will gain electrons

(d) any **two** from:

- effervescence / fizzing / bubbles

  ignore produces a gas
- barium disappears

  allow barium gets smaller
- forms a colourless solution
- temperature increases

  allow barium moves around

  2

  ignore references to floating / flames

(e) $Ba + 2\ HCl \rightarrow BaCl_2 + H_2$

allow multiples

3

*allow **1** mark for $BaCl_2$*

*allow **1** mark for H_2*

ignore state symbols

[10]

Q3.

(a) (substance reduced) Fe_2O_3

allow iron oxide

1

(reason)
(Fe_2O_3) loses oxygen

MP2 is dependent upon MP1 being awarded

ignore Fe^{3+} gains electrons

1

(b) $\frac{3}{2} \times 12g$

1

(c) **A** loses electrons and **B**$^+$ gains electrons

1

(d) **D**

1

(e) (metal) **C**

1

(explanation) aluminium forms ions with a charge 3+

allow aluminium forms Al^{3+} (ions)

1

(so) 3 nitrate ions are needed for 1 aluminium ion

allow (so) 3 nitrate ions are needed to balance the 3+ charge on 1 aluminium (ion)

1

(f) (percentage atom economy =)

$$\frac{A_r\mathbf{X}}{A_r\mathbf{X} + 54} \times 100 = 77.3$$

1

$100\ A_r\mathbf{X} = 77.3\ (A_r\mathbf{X} + 54)$

allow $A_r\mathbf{X} = 0.773\ (A_r\mathbf{X} + 54)$

allow correct use of an incorrectly determined value of the M_r of the non-useful reactant atoms

1

$22.7\ A_r\mathbf{X} = 4174.2$

allow $0.227\ A_r\mathbf{X} = 41.742$

1

$A_r\mathbf{X} = 184$

allow 183.8854626 correctly rounded to at least three significant figures

1

alternative approach 1:

($3M_r$ H_2O = (3 × 16) + (6 × 1) =) 54
and (percentage = 100 - 77.3 =) 22.7% (1)

(total M_r of reactants =)
$\frac{100}{22.7}$ × 54 (1)

allow correct use of an incorrectly determined value for $3M_r$ H_2O and/or percentage of unwanted products

= 238 (1)

(A_r**X** = 238 - 54)
or
$\left(A_r\mathbf{X} = 238 \times \frac{77.3}{100}\right)$
= 184 (1)

allow correct use of an incorrectly determined value of total M_r of reactants and/or value for $3M_r$ H_2O

allow 183.8854626 correctly rounded to at least three significant figures

alternative approach 2:

($3M_r$ H_2O = (3 × 16) + (6 × 1) =) 54
and (percentage = 100 - 77.3 =) 22.7% (1)

$\left(\frac{1}{22.7} \times 54 =\right)$ 2.3788546 (1)

allow correct use of an incorrectly determined value for $3M_r$ H_2O and/or percentage of unwanted products

2.3788546 × 77.3 (1)

allow correct use of an incorrectly determined value for 1% of the total M_r of reactants

= 184 (1)

allow 183.8854626 correctly rounded to at least three significant figures

[12]

Q4.

(a) (zinc oxide) solid remaining

allow (zinc oxide) solid no longer disappears

ignore references to colour / effervescence

1

(b) (excess) zinc oxide can be filtered off

allow converse statement for hydrochloric acid

allow separation / removal of (excess) zinc oxide is easier

ignore to ensure all the (hydrochloric) acid is used up

1

(c) any **one** from:

- zinc hydroxide

  allow $Zn(OH_2)$

- zinc carbonate

  allow $ZnCO_3$

1

(d) heat (the solution) until crystallisation point is reached

allow heat (the solution) until crystals start to form

allow heat (the solution) to reduce the volume

allow heat (the solution) to evaporate (some of the water)

1

leave the solution (to cool / crystallise)

1

*if no other mark is awarded allow **1** mark for heat the solution to dryness*

(e) $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

ignore state symbols

1

(f) zinc (atoms) lose (2) electrons

*do **not** accept references to oxygen*

1

(g) (a diagram showing)

solution in a container

ignore labels

1

zinc electrode
and
copper electrode
both inserted into solution

ignore polarities on electrodes

1

complete circuit that would function as an electrochemical cell including a labelled electrolyte

allow a named electrolyte in solution

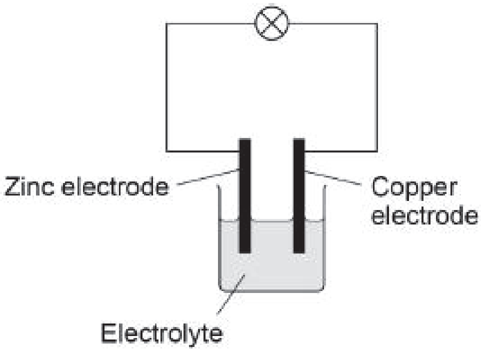
allow a named molten electrolyte

*do **not** accept cell / battery in external circuit*

*do **not** accept a wire between the electrodes*

1

an answer of



scores **3** marks

ignore voltmeter / ammeter regardless of location

[10]

Q5.

(a) any **one** from:

- more vigorous bubbling (for rubidium)
- bigger / brighter flame (for rubidium)

allow converse statements for potassium

allow (rubidium) catches fire more quickly

allow (rubidium) moves around more quickly

allow (rubidium) explodes

allow (rubidium) disappears more quickly

allow (rubidium) melts more quickly

1

(b) (rubidium's) outer shell / electron is further from the nucleus

allow the (rubidium) atom is larger

allow (rubidium) has more shells

1

(so) there is less (electrostatic) attraction between the nucleus and the outer electron (in rubidium)

allow (so) there is more shielding between the outer electron and the nucleus (in rubidium)

1

(so) the outer electron (in rubidium) is more easily lost

allow (so) less energy is needed to remove the (outer) electron (in rubidium)

1

allow energy level for shell throughout

allow converse argument in terms of potassium

(c) $2\ Rb + 2\ H_2O \rightarrow 2\ RbOH + H_2$

ignore state symbols

allow multiples

*allow **1** mark for H_2*

*allow **1** mark for RbOH*

3

(d) the noble gases have boiling points that increase going down the group

1

(e) (relative atomic mass =) $\frac{(90.48 \times 20)+(0.27 \times 21)+(9.25 \times 22)}{100}$

allow (relative atomic mass =) $\frac{1809.6 + 5.67 + 203.5}{100}$

allow (relative atomic mass =) 18.096 + 0.0567 + 2.035

1

= 20.1877

1

= 20.2

allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses all of the values in the table

ignore units

1

[11]

Q6.

(a) silicon is less reactive than carbon

allow converse

allow silicon is below carbon (in the reactivity series)

1

(because) carbon displaces silicon (from silicon dioxide)

ignore (because) carbon reduces silicon dioxide

1

ignore references to hydrogen

(b) more energy is needed (to obtain aluminium)

ignore references to electricity

1

(because) aluminium is obtained (from aluminium oxide) by electrolysis

1

(c) both products are solid

1

(d) (M_r of SiO_2 = 28 + (2 × 16)) = 60

1

(conversion 1.2 kg =) 1200 (g)

1

(number of moles of SiO_2 = $\frac{1200}{60}$) = 20

allow correct use of an incorrectly converted or unconverted mass of SiO_2

allow correct use of an incorrectly calculated M_r of SiO_2

1

(number of moles of Mg = 20 × 2) = 40

allow correct use of an incorrectly calculated number of moles of SiO_2

1

(mass of Mg = 40 × 24) = 960 (g)

allow correct use of an incorrectly calculated number of moles of Mg

1

alternative approach:

(M_r of SiO_2 = 28 + (2 × 16)) = 60 (1)

48 g Mg reacts with 60 g SiO_2 (1)

allow correct use of an incorrectly calculated M_r of SiO_2

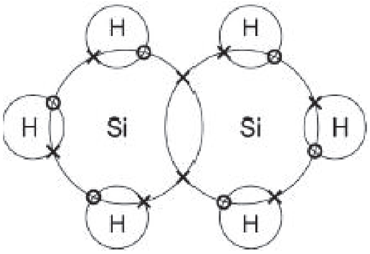
(conversion 1.2 kg =) 1200 (g) (1)

$48 \times \frac{1200}{60}$ (g Mg reacts with 1200 g SiO_2) (1)

allow correct use of an incorrectly calculated mass of Mg and / or incorrectly converted or unconverted mass of SiO_2

= 960 (g) (1)

(e)



allow any combination of x, •, o, $e^{(-)}$ for electrons

1

(f) (volume of oxygen for 30 cm^3 Si_2H_6 = 3.5 × 30) = 105 (cm^3)

1

(volume of excess oxygen = 150 – 105) = 45 (cm^3)

allow correct use of an incorrectly calculated volume of oxygen for 30 cm^3 Si_2H_6

1

(volume of water (vapour) = 3 × 30) = 90 (cm^3)

1

(volume of gases = 45 + 90) = 135 (cm^3)

allow correct use of incorrectly calculated volumes of excess oxygen and / or water vapour

1

allowed alternative approach:

(moles S_2H_6 = $\frac{0.03}{24}$) 0.00125 (1)

(moles water vapour formed = 3 × 0.00125 =) 0.00375
and
(moles oxygen used = 3.5 × 0.00125 =) 0.004375 (1)

allow correct use of an incorrectly calculated number of moles of Si_2H_6

(moles excess oxygen = $\frac{0.15}{24}$ − 0.004375 =) 0.001875 (1)

allow correct use of an incorrectly calculated number of moles of oxygen used

(volume of gases = 24 × (0.00375 + 0.001875) = 0.135 dm^3 =) 135 (cm^3) (1)

allow correct use of an incorrectly calculated number of moles of excess oxygen and / or moles of water vapour formed

[15]