GCSE Chemistry

Gases and Solutions

Mark Scheme

Time available: 56 minutes
Marks available: 52 marks

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1.

(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

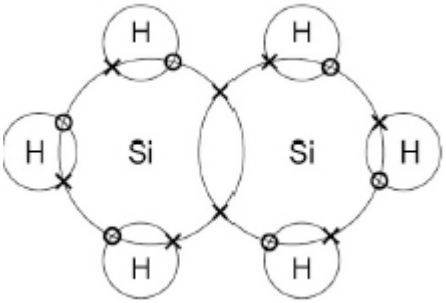
(conversion 1.2 kg =) 1200 (g) (1)

$48 \times \frac{1200}{60}$ (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]

2. (a) potassium chloride

allow KCl

1

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

ignore state symbols

1

(c) copper carbonate and copper oxide only

1

(d) (Step 2) to speed up the reaction

1

(Step 5) to make sure all the (hydrochloric) acid reacts

1

(Step 6) to remove the excess magnesium oxide

ignore to remove impurities

1

(e) using a (boiling) water bath
or
using an electric heater

1

(f) (moles Fe = $\frac{14}{56}$ =) 0.25 (mol)

1

(moles Cl_2 = $\frac{3}{2}$ × 0.25 =) 0.375 (mol)

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

1

(volume Cl_2 = 24 × 0.375) = 9.0 (dm^3)

allow correct use of an incorrectly calculated number of moles of Cl_2

1

[10]

3.

(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]

4. (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

3.96×10^{-3}

1

*accept 0.00396 or 3.96 × 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]