Mark schemes

Q1.

(a) (thermal) energy is transferred

allow heat is transferred

1

by delocalised electrons

1

(b) (the alloy / mixture has) different sized atoms

1

(so the) layers are distorted

1

(so the) layers cannot easily slide

allow (positive / metal) ions for atoms throughout

allow (so the) atoms cannot slide over each other

1

(c) $2\ Fe + 3\ Cl_2 \rightarrow 2\ FeCl_3$

1

(d) $1\ Fe^{2+} : 2\ Fe^{3+} : 4\ O^{2-}$

1

(e) (M_r Fe_3O_4 =) 232

1

(% Fe =) $\frac{3 \times 56}{232} \times 100$

allow $\frac{168}{232} \times 100$

allow correct use of an incorrectly determined M_r using the values of A_r given in the question

1

= 72.4 (%)

allow 72.41379 correctly rounded to at least 2 significant figures

1

(f) (40.0 kg =) 40 000 (g)

*a maximum of **4** marks can be awarded for a method which determines and uses the volume of iron oxide as a gas*

1

(moles $Fe_2O_3 = \frac{40\ 000}{160}$ =) 250

allow correct use of an incorrectly converted or unconverted mass

1

(moles $CO_2 = 250 \times \frac{3}{2}$ =) 375 *allow correct use of an incorrectly determined number of moles of Fe_2O_3*

1

(volume of CO_2 =) 375 × 24

allow correct use of an incorrectly determined number of moles of CO_2

1

= 9000 (dm^3)

1

[15]

Q2.

(a) (some) hydrogen / gas escapes (from the flask)

1

(because the reaction starts) before the stopper is put in

allow (because) stopper cannot be inserted instantly

*allow for **1** mark some air (from the conical flask) is collected*

or

allow some hydrogen remains in the conical flask

or

allow some hydrogen remains in the delivery tube

1

(b) (volume = 39 − 25 =) 14 (cm^3)

1

(14 cm^3 =) 0.014 (dm^3)

allow correct use of an incorrectly determined volume

1

(moles of hydrogen =)

$$\frac{0.014}{24}$$

allow correct use of an incorrectly determined volume

allow correct use of an incorrect / no conversion of volume

1

= 5.8×10^{-4} (mol)

allow 5.833333×10^{-4} correctly rounded to at least 2 significant figures

allow 0.00058 (mol)

1

alternative approach 1:

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

(volume = 39 − 25 =)
14 (cm^3) (1)

(moles of hydrogen =)

$\frac{14}{24000}$ (1)

allow correct use of an incorrectly determined volume

allow correct use of an incorrect / no conversion of volume

= 5.8 x 10^{-4} (mol) (1)

allow 5.833333 x 10^{-4} correctly rounded to at least 2 significant figures

allow 0.00058 (mol)

alternative approach 2:

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

(moles of hydrogen at 100 s =

$\frac{39}{24000}$ =) 0.001625

allow correct use of an incorrect / no conversion of volume

and

(moles of hydrogen at 40 s =

$\frac{25}{24000}$ =) 0.00104 (1)

(moles 100 s – moles 40 s =)
0.001625 – 0.00104 (1)

allow correct use of an incorrectly determined number of moles

= 5.8 x 10^{-4} (mol) (1)

allow 5.833333 x 10^{-4} correctly rounded to at least 2 significant figures

allow 0.00058 (mol)

alternative approach 3:

(39 cm^3 =) 0.039 (dm^3)
and
(25 cm^3 =) 0.025 (dm^3) (1)

(moles of hydrogen at 100 s =
$\frac{0.039}{24}$ =) 0.001625

allow correct use of an incorrect / no conversion of volume

and

(moles of hydrogen at 40 s =
$\frac{0.025}{24}$ =) 0.00104 (1)

(moles 100 s – moles 40 s =)
0.001625 – 0.00104 (1)

allow correct use of an incorrectly determined number of moles

= 5.8 x 10^{-4} (mol) (1)

allow 5.833333 x 10^{-4} correctly rounded to at least 2 significant figures

allow 0.00058 (mol)

(c) tangent drawn at 45 s

1

correct values for *y* step **and** *x* step from tangent

allow correct use of an incorrectly drawn tangent

allow a tolerance of ± ½ a small square for each coordinate

1

(rate =) $\frac{\text{value for } y \text{ step}}{\text{value for } x \text{ step}}$

allow correct use of incorrectly determined value(s) from the tangent for y step and/or x step

1

correct calculation of rate (mol/s)

1

rate given in standard form (mol/s)

allow a correctly calculated answer in standard form from an incorrect attempt at rate determination

1

(d) line starting at 0,0.000 and less steep than existing line

1

becomes level at 0.0084 mol

allow a tolerance of ± ½ a small square

1

(e) (increasing the temperature) increases the rate of reaction

1

(because) particles have more energy

allow (because) particles move faster

1

(so) the frequency of collisions increases

allow (so) a greater proportion of collisions have enough energy to react

ignore successful

1

[16]

Q3.

(a) (nanoparticles)
any **two** from:
- have a higher surface area to volume ratio
- less (material) needed (for the same effect)
  allow a thinner coating is needed
- more light gets through

2

allow converse arguments for fine particles

(b) (M_r TiO_2 =) 80

1

(conversion 100 kg =) 100 000 (g)

1

$\left(\text{moles } TiO_2 = \frac{100\ 000}{80} = \right)$
1250

allow correct use of an incorrectly determined M_r
allow correct use of an incorrect / no conversion of mass

1

(moles Cl_2 = 1250 × 2 =) 2500
allow correct use of an incorrectly determined number of moles of TiO_2

1

(volume Cl_2 =) 2500 x 24
allow correct use of an incorrectly determined number of moles of Cl_2

1

= 60 000 (dm^3)

1

[8]

Q4.

(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

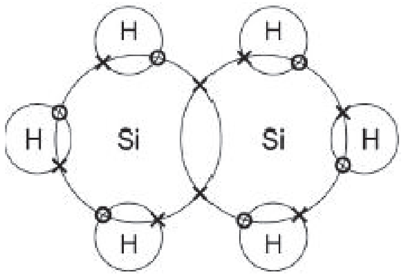
(conversion 1.2 kg =) 1200 (g) (1)

$48 \times \frac{1200}{60}$ (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 cm³ Si_2H_6 = 3.5 × 30) = 105 (cm³)

1

(volume of excess oxygen = 150 – 105) = 45 (cm³)

allow correct use of an incorrectly calculated volume of oxygen for 30 cm³ Si_2H_6

1

(volume of water (vapour) = 3 × 30) = 90 (cm³)

1

(volume of gases = 45 + 90) = 135 (cm³)

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]