**M1.**(a) add excess copper carbonate (to dilute hydrochloric acid)

*accept alternatives to excess, such as 'until no more reacts'*

**1**

filter (to remove excess copper carbonate)

*reject heat until dry*

**1**

heat filtrate to evaporate some water **or** heat to point of crystallisation

*accept leave to evaporate or leave in evaporating basin*

**1**

leave to cool (so crystals form)

*until crystals form*

**1**

*must be in correct order to gain **4** marks*

(b) $M_r$ $CuCl_2$ = 134.5

*correct answer scores **4** marks*

**1**

moles copper chloride = (mass / $M_r$ = 11 / 134.5) = 0.0817843866

**1**

$M_r$ $CuCO_3$= 123.5

**1**

Mass $CuCO_3$ (=moles × $M_2$= 0.08178 × 123.5) = 10.1(00)

**1**

*accept 10.1 with no working shown for **4** marks*

(c) $\frac{79.1}{100} \times 11.0$

**or**

11.0 × 0.791

**1**

8.70 (g)

**1**

*accept 8.70(g) with no working shown for **2** marks*

(d) Total mass of reactants = 152.5

**1**

134.5

152.5

*allow ecf from step 1*

**1**

88.20 (%)

**1**

*allow 88.20 with no working shown for **3** marks*

(e) atom economy using carbonate lower because an additional product is made **or** carbon dioxide is made as well

*allow ecf*

**1**

**[14]**

**M2.**(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**

$3.96 \times 10^{-3}$

**1**

*accept 0.00396 or $3.96 \times 10^{-3}$ 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]**

**M3.**(a) **X:**

$Fe^{2+}$ / iron(II), $SO_4^{2-}$ / sulfate

*allow iron(II) sulfate*
***or*** *$FeSO_4$*

**1**

**Y:**

$Na^+$ / sodium, $I^-$ / iodide

*allow sodium iodide*
***or*** *NaI*

**1**

**Z:**

$Fe^{3+}$ / iron(III), $Br^-$ / bromide

*allow iron(III) bromide*
***or*** *$FeBr_3$*
*correct identification of any two ions = one mark*
*correct identification of any four ions = two marks*

**1**

(b) any **five** from:

*allow converse arguments*

method 1

- weighing is accurate
- not all barium sulfate may be precipitated
- precipitate may be lost
- precipitate may not be dry
- takes longer
- requires energy

*allow not all the barium hydroxide has reacted*

method 2

- accurate
- works for low concentrations

*allow reliable / precise*

**5**

**[8]**

**M4.**(a) copper has delocalised electrons

*accept copper has free electronsignore sea of electrons **or** mobile electrons*

**1**

(electrons) which can move through the metal / structure

*allow (electrons) which can carry a charge through the metal / structure*

**1**

(b) (i) ($M_r$ $FeCl_3$ =) 162.5

*correct answer with or without working gains **3** marks*

*can be credited from correct substitution in step **2***

**1**

**or**

2 (moles of) $FeCl_3$ = 325

**or**

112 → 325

$$\frac{11.20}{56} \times 162.5$$

*allow ecf from step 1*

*accept* $\frac{325}{112} \times 11.2$

**1**

= 32.5

*accept 32.48*

**1**

(ii) 74.8

*accept 74.77 - 75*

*accept ecf from (b)(i)*

*if there is no answer to part(i)*

***or***

*if candidate chooses not to use their answer then accept 86.79 - 87*

**1**

**[6]**