

**M1.(a)**  $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$  **2**

*allow 1 mark for correct formulae*

(b) sensible scales, using at least half the grid for the points **1**

all points correct

*± ½ small square*

*allow 1 mark if 8 or 9 of the points are correct*

**2**

best fit line

**1**

(c) steeper line to left of original **1**

line finishes at same overall volume of gas collected

**1**

(d) acid particles used up  
*allow marble / reactant used up* **1**

so concentration decreases

*allow surface area of marble decreases*

**1**

so less frequent collisions / fewer collisions per second  
*do not accept fewer collisions unqualified*

1

so rate decreases / reaction slows down

1

(e) mass lost of 2.2 (g)

1

time taken of  
270 s

*allow values in range 265 – 270*

1

$$\frac{2.2}{270} = 0.00814814$$

*allow ecf for values given for mass and time*

1

0.00815 (g / s)

**or**

$$8.15 \times 10^{-3}$$

*allow 1 mark for correct calculation of value to 3 sig figs  
accept 0.00815 or  $8.15 \times 10^{-3}$  with no working shown for 4 marks*

1

(f) correct tangent

1

eg 0.35 / 50

1

0.007

*allow values in range of 0.0065 – 0.0075*

**1**

$7 \times 10^{-3}$

**1**

*accept  $7 \times 10^{-3}$  with no working shown for 4 marks*

**[20]**

**M2.(a)** (s) (aq) (aq) (g)

*must be in this order*

**2 marks if all four correct**

**1 mark if 2 or 3 correct**

**2**

(b) (i) 55

*ignore units*

**1**

(ii) 54

*allow ecf from (b)(i)*

**1**

(iii) 0.92

*correct answer with or without working gains **2 marks***

*ecf from volume in (b)(i)*

*accept 2 d.p. up to calculator value*

*if answer incorrect, allow rate = (b)(i) / 60 for **1 mark***

**2**

(c) (i) circle round point at (48,22)

**1**

(ii) problem (1) and explanation (1)

*explanation **must** give lower volume of gas or slower reaction*

*ignore human error unless qualified*

**problem with bung**

e.g. bung not placed in firmly / quickly enough

so gas lost

**or**

**problem with reagent**

e.g. acid was diluted **or** acid not replaced

so reaction slower

**or**

**problem with temperature**

e.g. temperature was lower than recorded temperature

so reaction slower

**or**

**problem with measurement**

e.g. length of magnesium less than 8 cm **or** timed for less than a minute

so less gas produced

2

(d) repeat the experiment (several times)

1

because anomalous results could be excluded

1

and then the mean can be determined / calculated

*accept suggestion of alteration to method, which is explained as to why it would reduce the error, for 3 marks (e.g. place the magnesium in a container within the flask (1) so it can be tipped into the acid once the bung is in place (1). This will prevent anomalous results or gas loss (1))*

*ignore idea of more accurate gas syringe  
ignore shorter time intervals*

1

(e) (i) use clean magnesium **or** use magnesium without oxide coating

1

compare results

1

(ii) **either**

measure the temperature of the acid before (adding magnesium)

1

and after adding magnesium

**or**

place the conical flask in a water bath (at 40 °C) (1)

compare results (1)

1

[16]

M3. (a) 118 1

(b) it loses / transfers electrons  
*it = Au / gold atom* 1

three electrons  
*sharing / covalency = max 1 mark* 1

(c) (i) O<sub>2</sub> 1

2 CO and 2 CO<sub>2</sub>  
or  
correct balancing of equation from O  
*accept correct multiples / fractions throughout* 1

(ii) *reference to incorrect bonding = 1 mark max*  
because carbon dioxide is simple molecular / small molecules 1

there are intermolecular forces (between the molecules)  
*allow intermolecular bonds* 1

so a small amount of energy needed (to separate molecules) or (*intermolecular forces*) are weak 1

(d) any **three** from:

- gold is the only catalyst for some reactions
- catalysts are not used up
- improves speed of reaction

reduces amount of energy **or** process needs low(er) temperature

*if no mark awarded, allow catalyst reduce costs (of the process)  
for **1** mark*

- only small quantities (of catalyst) needed

**3**

**[11]**



**M4.** (a) same number of (gaseous) molecules / moles / volume on both sides of the equation

*allow particles for molecules*

*do **not** accept atoms*

*ignore amount*

1

(b) (forward) reaction is exothermic

*accept reverse answer*

1

(c) any **three** from:

- particles gain energy
- particles move faster  
*allow particles collide faster / quicker*  
*ignore move more / vibrate more*
- particles collide more **or** more collisions
- more of the collisions are successful **or**  
more of the particles have the activation energy **or**  
particles collide with more force / energy

3

(d) any **two** from:

- more product (obtained in shorter time)  
*accept better yield (of product)*
- less fuel needed  
*accept less energy / heat / electricity needed*  
**or**  
lower fuel costs  
*ignore cheaper unqualified*
- less pollution caused by burning fuels

**or**

less specified type of pollution caused by producing heat / burning fuels

*allow correct specified pollutants caused by burning fossil fuels eg  
CO<sub>2</sub> / greenhouse gases **or** correct effect of burning fossil fuels eg  
global warming*

*accept thermal / heat pollution*

- using less fuel conserves resources

*accept sustainable*

*accept fossil fuels are non-renewable*

2

[7]