

M1.(a) (i) M1

High (temperature) OR Increase (the temperature)

If M1 is incorrect CE = 0 for the clip

*If M1 is blank, mark on and seek to **credit the correct information in the text***

M2

The (forward) reaction / to the right is endothermic or takes in / absorbs heat

OR

The reverse reaction / to the left is exothermic or gives out / releases heat

M3 depends on correct M2 and must refer to temperature / heat

M3 depends on a correct statement for M2

At high temperature, the (position of) equilibrium shifts / moves left to right to oppose the increase in temperature

For M3, the position of equilibrium shifts / moves

to absorb heat OR

to lower the temperature OR

to cool down the reaction

3

(ii) M1

The reaction gets to equilibrium faster / in less time

OR

Produces a small yield faster / in less time

OR

Increases the rate (of reaction / of attainment of equilibrium)

Mark independently

M2

High pressure leads to **one** of the following

• more particles / molecules in a given volume

• particles / they are closer together

• higher concentration of particles / molecules

AND

• more collisions in a given time / increased collision frequency

Penalise M2 for reference to increased energy of the particles

2

(iii) M1 Increase in / more / large(r) / big(ger) surface area / surface sites

Mark independently

For **M1** accept "an increase in surface"

M2 increase in / more successful / productive / effective collisions (in a given time) (on the surface of the catalyst / with the nickel)

For **M2** not simply "more collisions"

Ignore "the chance or likelihood" of collisions

2

(b) **M1**

No effect / None

If **M1** is incorrect **CE = 0** for the clip

If **M1** is blank, mark on and seek to **credit the correct information in the text**

M2 requires a correct M1

Equal / same number / amount of moles / molecules / particles on either side of the equation

OR

2 moles / molecules / particles on the left and 2 moles / molecules / particles on the right

M2 depends on a correct statement for M1

In **M2** not "atoms"

2

[9]

M2.(a) (Measure the) volume of gas / mass of the container + contents

1

Suitable named piece of equipment

Gas syringe (or inverted burette or measuring cylinder, as long as student has referred to the cylinder being filled with water) / balance.

Equipment must be correct for the measurement stated.

1

(b) Any **one** of:

- Mass of magnesium
Allow amount of magnesium.
- Surface area of magnesium

1

- (c) (i) Gravity: Conical flask or beaker and funnel /

Vacuum: Sealed container with a side arm and Buchner or Hirsch funnel

Must be either gravity filtration (with a V-shaped funnel) or vacuum filtration (with a side-arm conical flask) appropriately drawn.

1

Filter paper

Must show filter paper as at least two sides of a triangle (V-shaped) for gravity filtration or horizontal filter paper for vacuum filtration.

1

- (ii) Wash with / add (a small amount of cold) water

Ignore filtering.

1

[6]

- M3.(a) (i) Uses sensible scales.

*Lose this mark if the **plotted points** do not cover half of the paper.*

Lose this mark if the graph plot goes off the squared paper

Lose this mark if volume is plotted on the x-axis

1

All points plotted correctly

Allow \pm one small square.

1

Smooth curve from 0 seconds to at least 135 seconds – the line must pass through or close to all points (\pm one small square).

Make some allowance for the difficulties of drawing a curve but do not allow very thick or doubled lines.

1

- (ii) Any value in the range 91 to 105 s

Allow a range of times within this but not if 90 quoted.

1

- (b) (i) Using $pV = nRT$

This mark can be gained in a correctly substituted equation.

1

$$100\,000 \times 570 \times 10^{-6} = n \times 8.31 \times 293$$

Correct answer with no working scores one mark only.

1

$$n = 0.0234 \text{ mol}$$

Do not penalise precision of answer but must have a minimum of 2 significant figures.

1

(ii) Mol of $\text{ZnCO}_3 = 0.0234$

Mark consequentially on Q6

M1

1

$$\text{Mass of } \text{ZnCO}_3 = M1 \times 125.4 = 2.9(3) \text{ or } 2.9(4) \text{ g}$$

If 0.0225 used then mass = 2.8(2) g

M2

1

(iii) Difference = $(15.00 / 5) - \text{Ans to b}$

If 2.87 g used then percentage is 4.3

M1

1

$$\text{Percentage} = (M1 / 3.00) \times 100$$

Ignore precision beyond 2 significant figures in the final answer

If 2.82 g used from (ii) then percentage = 6.0

M2

1

(c) A reaction vessel which is clearly airtight round the bung

1

Gas collection over water or in a syringe

Collection vessel must be graduated by label or markings

Ignore any numbered volume markings.

1

[13]

M4.(a) Amount / number / proportion / percentage / fraction / moles of molecules / particles

Penalise an incorrect qualification of the number eg NOT

*number of molecules with E greater than Ea.
Not 'atoms'.*

1

- (b) There are no molecules / particles with zero energy

OR

All of the molecules / particles are moving / have some energy

Not 'atoms'.

The answer should relate the energy to the molecules.

1

- (c) **C** (The most probable energy)

1

- (d) **M1** The peak of the new curve is displaced to the right and lower than the original

M2 All of the following needed

- The new curve starts at the origin and should begin to separate from the original almost immediately
- and the new curve only crosses the original curve once
- and the total area under the new curve is approximately the same as the original
- and an attempt has been made to draw the new curve correctly towards the axis above the original curve but not to touch the original curve

2

- (e) None / no effect / stays the same

1

[6]

M5.C

[1]

M6.(a) (i) Award mark for **X on the time axis** at the point where the lines just become **horizontal**
Allow this mark if X is above the letters “sh” in the word “show” in part(ii) - in the range of lines 31 to 33.

1

(ii) They are equal / the same

OR

Forward (rate) = Reverse / backward (rate)

Allow the word ‘speed’ in this context.

Ignore reference to concentration.

1

(b) Both **OR** forward and reverse reactions occur at the same time

OR both are occurring at once

OR both occur all of the time

OR both are ongoing

OR both never stop

Ignore ‘at equal rates’.

Ignore reference to concentration or equilibrium.

The idea that both reactions occur simultaneously is essential.

The simple idea of ‘both reactions occurring’ is insufficient for the mark.

1

(c) (i) **M1** No effect / no change / none / stays the same

M2 requires correct **M1**

*In **M2**, ignore reference to particles or atoms.*

M2 Equal (number of) moles / molecules on both sides

2

(ii) **M1** Less time or it decreases or (equilibrium) reached faster (ie **M1** is a reference to time taken)

*If **M1** is ‘more time / it increases’ or ‘no effect’, then **CE=0** for the clip.*

*Reference to faster / increased rate / increased speed alone penalises **M1**, but mark on **M2** and **M3**.*

M2 More particles / molecules in a given volume / space

OR the particles / molecules are closer together

*If **M1** is blank, then look for all three marks in the text.*

M3 More successful / productive collisions in a given time

OR more collisions with $E > E_{\text{Act}}$ in a given time

OR more frequent successful / productive collisions

OR increased / greater successful / productive collision frequency / rate

Ignore reference to reactants / products.

*Penalise **M3** if an increase / decrease in the value of E_{Act} is stated.*

3

[8]