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 <u>endothermic</u> or <u>takes in / absorbs heat</u>
OR
The reverse reaction / to the left is <u>exothermic</u> or <u>gives out / releases heat</u>

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) <u>equilibrium shifts / moves</u> left to right to <u>oppose the increase in temperature</u>
For M3, the position of equilibrium shifts / moves
to <u>absorb heat</u> OR
to <u>lower the temperature</u> OR
to <u>cool down the reaction</u>

3

(ii)   **M1**
The reaction <u>gets to equilibrium faster / in less time</u>
OR
Produces a small yield <u>faster / in less time</u>
OR
<u>Increases the rate</u> (of reaction / of attainment of equilibrium)
Mark independently

M2
High pressure leads to **one** of the following
•   <u>more particles / molecules in a given volume</u>
•   <u>particles / they are closer together</u>
•   <u>higher concentration of particles / molecules</u>
AND
•   <u>more collisions in a given time</u> / <u>increased collision frequency</u>
*Penalise **M2** for reference to <u>increased</u> energy of the particles*

2

(iii)   **M1** <u>Increase in / more / large(r) / big(ger) surface area / surface sites</u>
Mark independently

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

M2 <u>increase in</u> / <u>more</u> <u>successful</u> / <u>productive</u> / <u>effective</u> <u>collisions</u> (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
<u>Equal / same</u> <u>number / amount</u> of <u>moles / molecules / particles</u> on either side of the equation
OR
2 <u>moles / molecules / particles</u> on the left and 2 <u>moles / molecules / particles</u> on the right

> ***M2** depends on a correct statement for **M1***
>
> *In **M2** not "atoms"*

2

[9]

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

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

Page 3

(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 ± one small square.*

1

Smooth curve from 0 seconds to at least 135 seconds − the line must pass through or close to all points (± 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 mol

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

1

(ii) Mol of $ZnCO_3$ = 0.0234

Mark consequentially on Q6

M1

1

Mass of $ZnCO_3$ = M1 × 125.4 = 2.9(3) or 2.9(4) g

If 0.0225 used then mass = 2.8(2) g

M2

1

(iii) Difference = (15.00 / 5) − Ans to b

If 2.87 g used then percentage is 4.3

M1

1

Percentage = (M1 / 3.00) × 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 <u>displaced to the right</u> and <u>lower</u> 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

•   <u>and</u> the new curve only crosses the original curve once

•   <u>and</u> the total area under the new curve is <u>approximately</u> the same as the original

•   <u>and</u> an attempt has been made to draw the new curve correctly towards the axis <u>above the original curve</u> 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 <u>occur at the same time</u>

   OR both are <u>occurring at once</u>

   OR both <u>occur all of the time</u>

   OR both are <u>ongoing</u>

   OR both <u>never stop</u>
   Ignore 'at equal rates'.
   Ignore reference to concentration or equilibrium.
   The idea that both reactions occur <u>simultaneously</u> 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) <u>moles / molecules</u> on both sides

2

   (ii)   **M1** Less time or it decreases or (equilibrium) <u>reached</u> 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 <u>alone</u> penalises **M1**, but mark on **M2** and **M3**.*

M2 <u>More</u> particles / molecules in a <u>given volume / space</u>

OR the particles / molecules are clos<u>er</u> together
   *If **M1** is blank, then look for all three marks in the text.*

M3 <u>More</u> <u>successful / productive</u> collisions <u>in a given time</u>

OR <u>more</u> collisions with <u>$E>E_{Act}$ in a given time</u>

OR <u>more frequent</u> <u>successful / productive</u> collisions

OR <u>increased / greater</u> <u>successful / productive</u> collision <u>frequency / rate</u>
   Ignore reference to reactants / products.
   *Penalise **M3** if an increase / decrease in the value of E_{Act} is stated.*

3
                                                                    [8]