Mark schemes

1   (a)   **Method 1**

           Allow working throughout to 2sf

     M1   Moles of Mg = 0.396/24.3 = 0.0163

                                                                                        1

     M2   Moles of CH_3COOH = 0.600 × 30.0/1000 = 0.018

                                                                                          1

     M3   Mark for showing Mg is in excess: either
           0.018 mol of CH_3COOH reacts with 0.009 mol of Mg OR
           0.0163 mol of Mg reacts with 0.0326 mol of CH_3COOH OR
           0.0073 mol of Mg is in excess

                                                                                       1

           If candidate gets 16.3 mol (as not converted mg to g) in method 1 or
           3 then can only score 1 mark maximum (M2)
           Accept other valid calculations that show the Mg is in excess

     Method 2
     M1   Moles of CH_3COOH = 0.600 × 30.0/1000 = 0.018

     M2   Moles of Mg that would react with this = 0.009

     M3   Mass of Mg needed = 24.3 × 0.009 = 0.219 g which is less
           than 0.396 g OR
           Moles of Mg = 0.0163 which is more than 0.009 required

     Method 3
     M1   Moles of Mg = 0.396/24.3 = 0.0163

     M2   Moles of CH_3COOH that would react with this = 0.0326

     M3   Volume of CH_3COOH needed = 0.0326 / 0.60 = 0.0543 dm^3
           (54.3 cm^3) which is more than 0.030 dm^3 (30 cm^3)

  (b)   M1   Line starts at origin and is steeper

                                                                                        1

     M2   (moles CH_3COOH = 0.800 × 20/1000 = 0.016) line levels out
           on 8th line up (line below the original 9th line)

           M2 for line on 8th line on grid (original on 9th line) – allow some
           leniency so long as clear it ends at (or very close to) the 8th line;
           and line does not significantly wobble

                                                                                      1

                                                                                               [5]

2   C

                                                                                                                      [1]

3 **(a)** **(i)** Curve drawn from origin with peak clearly lower and to right.

*New curve crosses original once only, finishes above original and does **not** clearly curve up*

IGNORE relative areas

1

(ii) (Relative areas under curves indicate) <u>many</u> (owtte) more molecules with E greater than or equal to Ea (at higher T) or reverse argument

***ALLOW** 'particles'*

***IGNORE** 'atoms'*

1

(Large) increase in (number of) <u>successful</u> (owtte) <u>collisions per unit</u> time

OR '<u>frequency</u> of successful <u>collisions</u>'

1

(b) **(i)** Yield increases

Yield decreases/stays the same CE = 0

If not answered mark on

1

More moles/molecules (of gas) on left/fewer on right/3 on left 1 on right

1

<u>Equilibrium shifts/moves</u> (to right) to reduce pressure/oppose higher pressure

No M3 if 'more moles on right' in M2

***IGNORE** 'favours'*

***NOT** just 'oppose the change'*

QoL means that M3 is only awarded if these ideas are clearly linked in one statement

1

(ii) Higher T would increase rate but decrease yield/make less methanol

OR

Lower T decreases rate but increases yield;

*If no mention of both rate **AND** (idea of) yield max 1*

1

Chosen T is a compromise/balance (between rate and yield) owtte

1

[8]

4 C

[1]

5 B

[1]

6 A

[1]

7 C

[1]

8 (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>

<u>**AND**</u>
- <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 "an increase in surface"*

M2 <u>increase in / 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
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]

9   (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]

10 (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 ongoing

      OR both never stop
         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 More <u>successful / productive</u> collisions <u>in a given time</u>

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

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]