

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

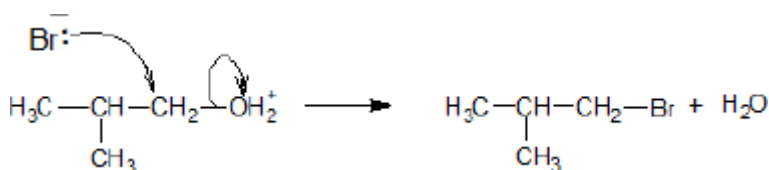
[9]

M2.(a) (i) **M1** double-headed curly arrow from the lone pair of the bromide ion to the C atom of the CH_2

Penalise additional arrows.

M2 double-headed arrow from the bond to the O atom

As follows



2

(ii) **M1** nucleophilic substitution

M1 both words needed (allow phonetic spelling).

M2 1-bromo(-2-)methylpropane

M2 Require correct spelling in the name but ignore any

- (b) **M1** hydrolysis
For M1 give credit for 'hydration' on this occasion only.
- M2** C≡N with absorption range 2220–2260 (cm⁻¹)
Credit 1 mark from M2 and M3 for identifying C≡N and either O–H(acids) or C=O or C–O without reference to wavenumbers or with incorrect wavenumbers.
- M3** O–H(acids) with absorption range 2500–3000 (cm⁻¹)
- OR**
- C=O with absorption range 1680–1750 (cm⁻¹)
- OR**
- C–O with absorption range 1000–1300 (cm⁻¹)
Apply the list principle to M3

- (c) (i) **M1** Yield / product **OR** ester increases / goes up / gets more
- M2** (By Le Chateliers principle) the position of equilibrium is driven / shifts / moves to the right / L to R / in the forward direction / to the product(s)
- M3 – requires a correct statement in M2**
- (The position of equilibrium moves)*
- to oppose the increased concentration of ethanol*
- to oppose the increased moles of ethanol*
- to lower the concentration of ethanol*
- to oppose the change and decrease the ethanol*
- If no reference to M1, marks M2 and M3 can still score BUT if M1 is incorrect CE=0*
- If there is reference to 'pressure' award M1 ONLY.*

- (ii) **M1**

Catalysts provide an alternative route / pathway / mechanism

OR

surface adsorption / surface reaction occurs

For **M1**, not simply 'provides a surface' as the only statement.

M1 may be scored by reference to a specific example.

M2

that has a lower / reduced activation energy

OR

lowers / reduces the activation energy

Penalise **M2** for reference to an increase in the energy of the molecules.

For **M2**, the student may use a definition of activation energy without referring to the term.

Reference to an increase in successful collisions in unit time alone is not sufficient for **M2** since it does not explain why this has occurred.

2

[12]

M3.(a) (If any factor is changed which affects an equilibrium), the (position of) equilibrium will shift / move so as to oppose / counteract the change.

Must refer to equilibrium

Ignore reference to "system" alone

A variety of wording will be seen here and the key part is the last phrase

OR

(When a system / reaction in equilibrium is disturbed), the (position of) equilibrium shifts / moves in a direction which tends to reduce the disturbance

An alternative to shift / move would be the idea of changing / altering the position of equilibrium

1

(b) (i) **M1**

A substance that speeds up the reaction / alters the rate but is chemically unchanged at the end / not used up

Both ideas needed for **M1**

Credit can score for **M1**, **M2** and **M3** from anywhere within the answer

M2

Catalysts provide an alternative route / alternative pathway / different mechanism

M3
that has a lower activation energy / E_a

OR
lowers the activation energy / E_a

3

(ii) (Time is) less / shorter / decreases / reduces
Credit "faster", "speeds up", "quicker" or words to this effect

1

(iii) None

1

(c) (i) R

1

(ii) T

1

(iii) R

1

(iv) P

1

(v) Q

1

[11]

M4. (a) **M1** The activation energy is the minimum / least / lowest energy
Mark independently

Ignore "heat" and ignore "enthalpy"

M2 (energy) for a reaction to occur / to go / to start

OR (energy) for a successful / effective collision

Ignore "breaking the bonds"

2

(b) **M1** Catalysts provide an alternative route OR an alternative mechanism OR alternative / different path(way)

M2 Lowers the activation energy

Mark independently

Ignore reference to "surface"

2

(c) (i) Stay(s) the same

1

(ii) Increases

Credit "increase" or "increased"

1

(iii) Increases

Credit "increase" or "increased"

1

(iv) Stay(s) the same

1

(d) (i) **M1** yeast or zymase

M2 ethanol

Ignore "enzyme"

In M2, ignore "alcohol" and ignore any formula

2

(ii) **M1** (Concentrated) H_3PO_4 OR (Concentrated) H_2SO_4

M2 butan-2-ol

Credit correct names

Ignore "hydrogenphosphate or hydrogensulfate"

Ignore "dilute" or "aq"

Do not penalise absence of hyphens in name.

In M2, ignore any formula

M5. (a) Award in either order for curve

“Steeper” requires line to be on the left of the original line, starting from the origin

M1 curve is steeper than original and starts at the origin

M2 curve levels at the top line on the graph

2

(b) Award in either order for curve

“Shallower” requires line to be on the right of the original line, starting from the origin

M1 curve is shallower than original and starts at the origin

M2 curve levels at the first line on the graph

2

(c) M1 curve would be steeper than original

“Steeper” requires line to be on the left of the original line, starting from the origin

M2 curve levels at the same original volume of O_2

2

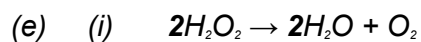
- (d) M1** The (concentration / amount of) H_2O_2 or reactant falls / decreases / used up
Mark independently

OR

The number of H_2O_2 or reactant molecules/ particles falls / decreases

M2

The rate of reaction / rate of decomposition / rate of formation of oxygen / frequency of collisions / (effective) collisions in a given time decreases / is slower



Ignore state symbols

Accept only this equation or its multiples

Extra species must be crossed through

1

(ii) *hydrogen bromide / it does not appear in the overall equation*

OR

hydrogen bromide / it is not used up in the reaction / unchanged at the end of the reaction

OR

hydrogen bromide / it is regenerated / re-formed (in Step 2)

1

[10]