Mark schemes

Q1.

(a) (equation contains the symbol) ⇌

allow description of arrow / symbol

1

(b) the mass of each substance does not change

1

the rates of the forward reaction and reverse reaction are equal

1

(c) the mixture will have become a paler purple

1

(d) increases

must be in this order

1

decreases

1

increases

1

(e) change the temperature

or

add a catalyst

ignore references to pressure

1

[8]

Q2.

(a) (the reaction is) reversible

allow description of a reversible reaction

1

(b) iron

1

(c) activation energy with a catalyst

1

(d) bar to 22 (%) labelled phosphorus / P

allow a tolerance of ± ½ a small square

1

bar to 25 (%) labelled potassium / K

*if no other mark is awarded, allow **1***
mark for two bars drawn to 22% and

25%

1

(e) there are other elements in the fertiliser (besides phosphorus and potassium)

or

there is nitrogen in the fertiliser

allow there are other substances in the fertiliser (besides phosphorus and potassium)

1

(f) **B**

1

(g) **B**

1

[8]

Q3.

(a) water

allow H_2O

1

(b) becomes (more) red

1

(because the position of) equilibrium moves to the right

allow (because) the concentration of $FeSCN^{2+}$ (ions) increases

allow (because) the forward reaction is favoured

1

(so that) the (increase in the) concentration of thiocyanate (ions) is reduced

allow (so that) the increase in the concentration of thiocyanate (ions) is counteracted

1

(c) (the position of) equilibrium moves to the left

allow the concentration of Fe^{3+} (ions) increases

allow the reverse reaction is favoured

1

(so that) the (increase in the) temperature is reduced

allow (so that) the increase in the temperature is counteracted

1

(therefore) the forward reaction is exothermic

allow (therefore) the forward reaction releases energy (to the surroundings)

1

(d) no change in equilibrium position

1

(because) no gases are present

allow (because) only aqueous solutions are present

1

(e) Co^{2+}

1

[10]

Q4.

(a) (equation contains a) ⇌ (symbol)

allow description of arrow / symbol

1

(b) exothermic

1

(c) to reduce costs

1

to use less energy

1

(d) (the world production of ammonia) increased

1

(the increase was) not steady / linear

*do **not** accept decreases*
ignore levels off

1

(e) the demand for food changed

1

the world population changed

1

(f) **C** and **D**

1

(g) **D**

1

[10]

Q5.

(a)

an answer of 17.6470588 (%) correctly rounded to at least 2 significant figures scores 2 marks

$\frac{6}{34} \times 100$

1

= 17.6 (%)

allow 17.6470588 (%) correctly rounded to at least 2 significant figures

1

(b)

allow converse arguments in terms of higher pressure
ignore references to rate

higher yield (of hydrogen or carbon monoxide or product)

allow more hydrogen or more carbon monoxide or more product
allow equilibrium moves to the right
allow equilibrium moves in the forward direction

1

(because) fewer moles / molecules / particles on left hand side
or
(because) more moles / molecules / particles on right hand side

allow (because) the reverse reaction produces fewer moles / molecules / particles
or
allow (because) the forward reaction produces more moles / molecules / particles
*do **not** accept fewer / more atoms*

1

(c) no effect (on yield of hydrogen)

allow position of equilibrium unaffected by pressure
ignore references to rate of reaction

1

(d)

*an answer of 2.25 scores **3** marks*

350 (°C) and 285 (atmospheres) = 63 (%)
and
450 (°C) and 200 (atmospheres) = 28 (%)

allow a value between 62 (%) and 64 (%) inclusive

1

$\frac{63}{28}$

allow a correct expression using incorrectly determined value(s) for percentage yield

1

= 2.25 (times greater)

allow a correct calculation using incorrectly determined value(s) for percentage yield correctly evaluated and rounded to at least 2 significant figures

1

(e)

allow converse arguments in terms of low(er) pressure

any **one** from:

- the energy costs would be high(er)
  ignore energy / cost unqualified
- the equipment would need to be strong(er)
  allow the equipment would be (more) expensive (to build / maintain)
- high(er) pressures are (more) dangerous
  allow (more) dangerous because (greater) risk of explosion

1

(f) higher temperatures produce a lower (percentage) yield (of ammonia)

allow converse
allow correct reference to shift in equilibrium
ignore references to pressure

1

(g) world population has increased

1

any **one** from:

- demand for fertiliser has increased
  allow more food needed
- increased demand for other specified ammonia-based products e.g. nitric acid, drugs, dyes, explosives

1

[12]

Q6.

(a) in a closed system

1

the rate of the forward and backward reactions are equal

1

(b) concentration increases

1

(because) reaction / equilibrium moves to the left / reactant side

1

(since the) reverse reaction is exothermic

allow (so that) temperature increases

1

(c) becomes blue

1

(because) reaction / equilibrium moves to the right / product side

1

(so) concentration of blue cobalt compound increases

allow (so that) concentration of hydrochloric acid decreases

1

(d) (cobalt has) ions with different charges

allow (cobalt is a) transition metal

1

(e) Co^{3+}

1

(f) they allow reactions to reach equilibrium more quickly

1

they provide a different reaction pathway

1

(g) $\mathbf{13}H_2 + \mathbf{6}CO \rightarrow C_6H_{14} + \mathbf{6}H_2O$

allow multiples

1

(h) C_8H_{18}

1

(i) curve below printed curve

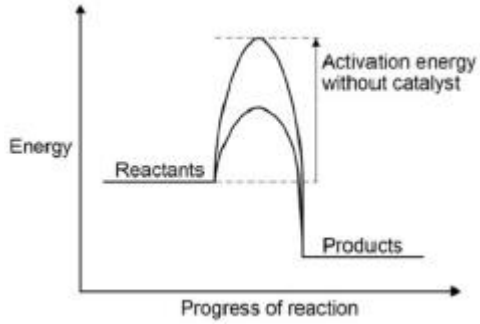
*do **not** accept different reactant or product levels*

1

vertical arrow from reactant level to peak of **printed** curve

1

an answer of:



scores **2** marks

[16]

Q7.

(a) reversible

allow equilibrium

1

(b) The colour changed from blue to pink

1

(c) 8.3 (°C)

1

(d) endothermic

allow dehydration
ignore reversible

1

[4]

Q8.

(a) both water vapour and ethanol will condense

allow steam for water vapour
allow they both become liquids
allow ethane condenses at a lower temperature
allow some of the steam hasn't reacted
allow it is a reversible reaction / equilibrium

1

(b) amount will decrease

1

because the equilibrium will move to the left

1

(c) more ethanol will be produced

1

because system moves to least / fewer molecules

1

[5]

Q9.

(a) enzyme

1

(b) 2.0×10^3 moles

1

(c) smaller yield

allow less methanol is produced

1

(because) favours endothermic reaction

allow (because) favours reverse reaction
allow equilibrium / reaction shifts to the left
allow equilibrium / reaction shifts to reduce the temperature

ignore reference to forward reaction is exothermic
ignore references to rate

1

(d) (yield)
equilibrium position moves to the product side

allow equilibrium / reaction moves to the right
allow equilibrium / reaction shifts to reduce the pressure

1

(because) fewer molecules / moles / particles on product side

allow (because) fewer molecules / moles / particles on the right
allow (because) smaller volume on product side

1

(rate)
more collisions per unit time

allow increases collision frequency / rate

ignore more collisions alone
ignore faster collisions
*do **not** accept any indication of more energetic / forceful collisions*

1

(because) more molecules / particles per unit volume

allow (gas) molecules / particles closer together

ignore more molecules / particles alone

1

allow converse arguments

(e) provides different reaction pathway

allow provides a different mechanism / route

1

(which has a) lower activation energy

1

ignore references to collisions

(f) less energy is needed

allow reduces the temperature required
allow reduces costs

ignore references to pressure
ignore references to rate or time

1

(g) no effect / change

1

[12]