

M1.(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]

M2. (a) (i) nitrogen - air
accept atmosphere 1

hydrogen - north sea gas / natural gas / methane / CH₄
accept water / (crude) oil / coal / hydrocarbons / brine 1

(ii) *allow converse throughout*
• high temperature gives a low yield 1

• because reaction is exothermic
must be linked to first bullet point 1

• but at low temperatures the rate is (too) slow
if no other marks awarded accept 450°C is a compromise between yield and rate
or
450°C gives a reasonable yield in a reasonable time for 1 mark 1

(iii) nitric (acid)
accept HNO₃ 1

(b) Ammonia / Haber process can be used to make fertiliser 1

with a specified economical reason

eg raw materials for Haber process readily available
eg transport costs are lower or no need to import
eg Haber process is a continuous process

ignore employment / labour costs

1

[8]

M3. (a) same number of (gaseous) molecules / moles / volume on both sides of the equation

allow particles for molecules

*do **not** accept atoms*

ignore amount

1

(b) (forward) reaction is exothermic

accept reverse answer

1

(c) any **three** from:

- particles gain energy
- particles move faster
allow particles collide faster / quicker
ignore move more / vibrate more
- particles collide more **or** more collisions
- more of the collisions are successful **or**
more of the particles have the activation energy **or**
particles collide with more force / energy

3

(d) any **two** from:

- more product (obtained in shorter time)
accept better yield (of product)
- less fuel needed
accept less energy / heat / electricity needed
or
lower fuel costs
ignore cheaper unqualified
- less pollution caused by burning fuels

or

less specified type of pollution caused by producing heat / burning fuels

*allow correct specified pollutants caused by burning fossil fuels eg
CO₂ / greenhouse gases or correct effect of burning fossil fuels eg
global warming*

accept thermal / heat pollution

- using less fuel conserves resources

accept sustainable

accept fossil fuels are non-renewable

2

[7]

- M4.** (a) fewer product molecules than reactant molecules (owtte) **or**
accept forward reaction produces fewer molecules
accept left hand side for reactants and right hand side for products

3 reactant molecules and 1 product
or 3 volumes of gas becomes 1 volume of gas
accept high pressure favours the side with fewer molecules
ignore references to reaction rate

1

- (b) any **three** from:

- low temperature gives best yield
*accept add heat as increased temperature **or** 'less' as poor yield*
or high temperature gives poor yield
- because the reaction is exothermic
accept reverse argument if clearly expressed
- reaction too slow at low temperature
or reaction faster at high temperature
accept add heat and reaction goes faster
- temperature used gives a reasonable yield
at a fast rate / compromise explained
allow get less product but it takes less time
for 2 marks

3

[4]

M5. (a) (i) any **one** from:

- they are positive / cations
- they are H^+
- opposite charges attract
ignore atom

1

(ii) potassium is more reactive (or reverse)

assume 'it' refers to hydrogen

allow potassium reacts with water

*allow potassium is very reactive **or** most reactive metal / element*

allow hydrogen gains electrons more easily / is reduced more easily

accept potassium is higher up the reactivity series

1

(b) **6 and 2**

accept correct multiples and fractions

1

(c) (i) the reaction / it is reversible **or** a description of a reversible reaction

allow 'it is an equilibrium'

allow reversible symbol drawn correctly

allow 'the reverse / back reaction'

1

(ii) **lithium nitride**

assume that 'it' or if they do not specify means lithium nitride

assume lithium / lithium nitrate refers to lithium nitride

- hydrogen is bonded / held / absorbed / has formed a compound / reacted with lithium nitride

1

plus **one** of:

- does not explode / cause a fire
- is not free / less hydrogen
- is not under pressure
- does not leak
- is only released slowly

1

- compound of hydrogen with lithium nitride / product is (more) stable / less reactive / less chance of a reaction
accept converse for hydrogen as below

assume that gas / hydrogen means gas in the cylinder

- *hydrogen (in cylinder) / gas is not bonded / held absorbed / in a compound / reacted with lithium nitride*

1

plus one of:

- *can explode / cause a fire*
- *is free*
- *is under pressure*
- *can leak*
- *releases quickly*

1

- (d) (i) loss of an electron **or** loses electrons
do not accept any ref. to oxygen

1

- (ii) full outer shell of 8 electrons on circle
need not be paired
can be x, dot or e
*do **not** accept if extra electrons added to inner shell*

1

[10]

- M6.** (a) (i) high temperature
*accept temperature given if $\geq 400\text{ }^{\circ}\text{C}$
 ignore value if "high" stated, unless silly value* 1
- endothermic or reaction takes in energy
 or ΔH is +ve
independent marks 1
- (ii) low pressure
or up to and including 10 atmospheres 1
- (low pressure) favours a reaction in which
 more molecules are formed
*2 moles \rightarrow 4 moles
 (2 molecules \rightarrow 4 molecules)
 independent marks* 1
- (iii) nickel **and** it is a transition / transitional
 element / metal (owtte) **or** nickel **and**
 variable oxidation state / number or it is
 similar to other named transition elements
 e.g. iron 1
- (b) (i) (bonds broken =) 2005 (kJ) 1
- (bonds formed =) 2046 (kJ) 1
- energy change = $2005 - 2046 = (-)41$
for correct subtraction ignore sign 1

(ii) (exothermic)

if in part (b)(i) answer is not 41

answer is consequential on endothermic or exothermic shown

*accept correct reasoning for **incorrect** answer from (b)(i)*

energy given out forming new bonds

*do **not** accept energy needed to form new bonds*

1

greater than energy put in to break old bonds

*accept exothermic **and** more energy given out than taken in for 1 mark*

*accept negative value for energy change **or** energy in products less than energy in reactants for 1 mark*

1

[10]

M7. (a) **2 marks for comments related to temperature**

low / lower / lowest temperature (or 100 °C from graph)
ignore references to catalyst

1

any **one** from:

- (forward) reaction exothermic
or reverse reaction endothermic
- if the temperature is increased the yield of product will decrease **or**
reaction right to left
high temperature favours reverse reaction or reverse argument
the lower the temperature the greater the yield = 2 marks
2 marks for comments related to pressure

1

high / higher / highest pressure (or greater than 200 atm. from graph)

1

any **one** from:

- four reactant molecules but only two product molecules (owtte)
reverse reaction goes from 2 molecules / moles / volumes to 4
molecules / moles / volumes
- increase in pressure favours the reaction which produces
the least number of molecules
decrease in pressure favours the back reaction because it produces
the most molecules

1

(b) any **three** from:

- at low temperatures the reaction is too slow
- 450 °C gives a reasonable yield at a fast rate /
compromise between yield and rate (*)
- 200 atm. gives a reasonable yield at a reasonable cost / safely /
compromise between yield and cost / safety (*)
() or 450°C and 200 atm / these are compromise conditions for 1*
mark
- catalyst works better at higher temperature

- (very) high pressures could be dangerous (owtte)
safety factor
- (very) high pressures are expensive (owtte)
- (yield is not too important because) unreacted gases can be recycled

3

[7]

- M8.** (i) a reaction in which the products can be changed back to reactants
accept a reaction that can go forwards or backwards 1
- under certain conditions 1
- (ii) $M_r \text{CaCO}_3 = 100$ 1
- $M_r \text{CaO} = 56$ 1
- mass of CaO = 140 (tonnes) 1
- mark consequentially*

[5]