M1.(a) both water <u>vapour</u> 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 / CH_4

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 HNO_3

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 CO_2 / 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 <u>add</u> 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 <u>add</u> 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 <u>with</u> 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 ×, dot or e

*do **not** accept if extra electrons added to inner shell*

1

[10]

M6. (a) (i) high temperature

accept temperature given if ≥ 400 °C
ignore value if "high" stated, unless silly value

1

endothermic or reaction takes in energy
or Δ H 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 → 4 moles
(2 molecules → 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 <u>not</u> 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 <u>needed</u> 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 $CaCO_3$ = 100

1

M_r CaO = 56

1

mass of CaO = 140 (tonnes)

1

mark consequentially

[5]