AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.10.4 THE HABER PROCESS AND THE USE OF NPK FERTILISERS (PACK 1)

SCORE	PERCENTAGE
/302	%

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Q1.

(a) hydrogen

allow H_2

1

(b) 450 °C

allow values in the range 400−500 °C

1

200 atm / atmospheres

allow values in the range 150−250 atm / atmospheres

*allow **1** mark if both values within range but no units given*

1

(c) ammonia has a higher boiling point

allow the other gases have lower boiling points

ignore references to melting point

1

(d) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5−6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3−4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1−2

No relevant content

0

Indicative content

changes

- carbon dioxide has decreased
- oxygen has increased

processes

- volcanic activity released water vapour
- the water vapour condensed to form oceans
- carbon dioxide dissolved in oceans
- carbonates produce sediments
- carbon locked up in sedimentary rocks

- algae and plants evolved / appeared
- algae / plants absorbed carbon dioxide
- by photosynthesis

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- which also released oxygen
- carbon locked up in fossil fuels

(e) any **one** from:

- occurred 4.6 billion years ago

  allow any indication of billions of years

  allow limited or no proof

- limited or no evidence

  ignore there was nobody there

1

[11]

Q2.

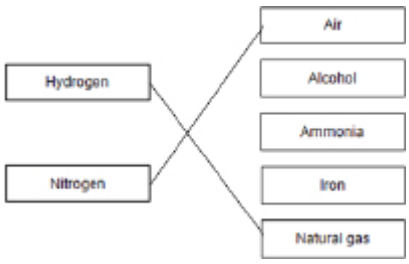
(a) 4

1

(b) reversible (reaction)

1

(c)



1
1

(d) −40 °C

1

(e) recycled to the reactor

1

(f) ionic

1

(g) nitrogen

1

phosphorus

1

(h) 0.24 × 50 × 5

allow £87.50

1

= £60

1

*an answer of £60 scores **2** marks*

(i) may need to use nitrogen, phosphorus and potassium

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allow neither fertiliser has all the elements / nutrients needed.

[12]

Q3.

(a) **Level 2 (3-4 marks):**
A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

Level 1 (1-2 marks):
Relevant points are made. These are not logically linked.

Level 0
No relevant content.

Indicative content

raw material
- wood will not run out
- aluminium (ore) will run out
- more expensive to process aluminium from its raw material

mass of frame
- wooden frame more expensive to transport
- wooden frame uses more fuel to transport
- wooden frame more difficult to handle / erect

useful lifetime
- wooden greenhouse would need replacing more often
- fewer aluminium greenhouses needed over time

end of useful life
- both materials can be put to further use
- aluminium can be recycled repeatedly

4

(b) $\frac{12000}{80}$

1

= 150

1

*an answer of 150 scores **2** marks*

(c) any **two** from:

- conserves finite ores
  allow ores will last longer
- uses less energy
- lower energy costs
- reduces landfill
  allow less waste

2

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(d) (polymer windows are) lighter

1

[9]

Q4.

(a) cool

1

to −34 °C

allow temperatures below −34 °C but above −196 °C

1

(b) recycled (to the reactor)

1

(c) $825 \times \frac{2}{3}$

1

= 550 (dm^3)

1

*an answer of 550 (dm^3) scores **2** marks*

(d) a lower pressure would decrease the equilibrium yield

1

a lower temperature would make the reaction too slow

1

(e) nitrogen / N

1

(f) **B** and **C**

1

contain nitrogen, phosphorus and potassium

1

(g) (**B**)

any **two** from:
- more stages
- uses more energy
- uses more raw materials
- takes longer

*allow converse for **C***

2

[12]

Q5.

(a) $N_2 + 3\ H_2 \rightarrow 2\ NH_3$

1

(b) catalyst

1

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(c) as pressure increases percentage yield increases

1

(d) 32−23

both readings correct

1

= 9 (%)

1

[5]

Q6.

(a) ammonia **and** nitric acid

allow NH_4OH

allow $NH_3(aq)$

1

(b) shows fertilisers are formulations

allow gives percentage / proportion of nitrogen, phosphorus and potassium in the fertiliser

1

(so) farmers can choose fertiliser with required properties

1

(c) as world population increases, ammonia production increases

1

ammonia is used to produce fertilisers

1

so increasing need for fertilisers as more food required for increased population

allow as more food produced less mortality

1

[6]

Q7.

(a) endothermic

1

(b) 82 (%)

*correct answer with working gains **3** marks*

*if 17 or 34 not shown in working **max 2** marks*

accept 82.4

accept 82.35 to full calculator display (82.35294...) correctly rounded to at least 2 sf

if no answer or incorrect answer, then

*(M_r =) 17 gains **1** mark **or***

*14/17 gains **2** marks*

OR

*($2M_r$ =) 34 gains **1** mark **or***

*28/34 gains **2** marks*

OR

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*14/their M_r shown gains **1** mark **or***
*correct calculation of 14/their M_r gains **2** marks*

3

(c) (i) 7 / seven

1

(ii) $H^+ + OH^- \rightarrow H_2O$

1

(iii) ammonium chloride
allow NH_4Cl

1

ignore an incorrect formula

(d) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

Level 3 (5 – 6 marks):
Suggestion with reasons from all three graphs, and linking of ideas which may explain a compromise.

Level 2 (3 – 4 marks):
Suggestion with reasons referring to more than one graph.

Level 1 (1 – 2 marks):
Suggestion with a reference to a graph.

0 marks:
No relevant content.

Examples of chemistry points made in response:
A reasonable suggested amount of fertiliser would be in the region of 200 kg (per ha).
Accept any suggestion from about 180 kg (per ha) to 500 kg (per ha).

Yield:
- Using fertiliser improves yield.
- Yield improved most up to about 200 kg (per ha) of fertiliser.
- Yield only increased slightly above about 200 kg (per ha).

Profit:
- About 200 kg of fertiliser gives the most profit.
- Above about 200 kg (per ha) of fertiliser profit declines.

Run off:
- Run off is at low levels until about 300 kg (per ha) of fertiliser.
- Above about 300 kg (per ha) of fertiliser, run off increases.

Examples of linking of ideas:
- Overall 200 kg gives high crop yield and most profit.
- In conclusion 200 kg gives high crop yield and low run off.
- 200 kg gives most profit and low run off.

Examples of compromise:
- Profits go down after about 200 kg (per ha) of fertiliser because cost of fertiliser is not covered by increased yield.

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- 200 kg gives the highest profit although it is not the highest yield.
- 500 kg gives the best yield but has the most runoff.

6

[13]

Q8.

(a) (i) nitrogen: air

1

hydrogen: natural gas

1

(ii) as a catalyst

1

so the reaction speeds up

allow lowers activation energy or so a lower temperature can be used

1

(iii) cooled

1

ammonia condenses / liquefies

*allow nitrogen **and** hydrogen remain in the gaseous state*

1

(iv) recycled

allow reused or returned to the reactor

1

(b) reversible arrows

1

hydrogen **and** ammonia

1

[9]

Q9.

(a) (i) natural gas

allow fossil fuels / biogas generator

1

(ii) air contains oxygen

1

this would react with / oxidise the hydrogen

allow this would react with / oxidise the iron

ignore nitrogen

1

(iii) cooled

1

ammonia condenses / liquefies (so can be separated)

1

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nitrogen and hydrogen (remain as gases and) are returned to the reactor

allow recycled

1

(b) (i) 200 °C **and** 1000 atmospheres

1

(ii) the reaction is reversible

allow stated as equilibrium or forward / backward reaction anywhere in answer

1

forward reaction is exothermic so increased temperature lowers the yield of ammonia

allow converse

1

a lower temperature would decrease rate of reaction

allow converse

1

a higher pressure would increase the yield of ammonia because the forward reaction produces the least number of (gaseous) molecules / moles

allow converse

1

higher pressures would involve high cost / energy

1

ignore risk / explosion

[12]

Q10.

(a) sodium loses (electron)

sharing / covalent / metallic = max 2

1

chlorine gains (electron)

1

1 **or** an (electron)

1

(b) (i) Have no overall electric charge

1

(ii) Should iodine be added to salt?

1

reason
any **one** from:

- cannot be done by experiment
  accept difficult to get / not enough evidence
- based on opinion / view
  allow must be done by survey
- ethical **or** economic issue.

1

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(c) (i) nitric (acid)

1

(ii) an alkali

1

(iii) indicator

accept any named acid base indicator

1

(d) (i) Crystallisation

1

(ii) fertiliser

allow to help crops grow

1

(iii) any **one** from:

- pressure

  allow concentration
- temperature

  ignore heat
- catalyst.

1

[12]

Q11.

(a) natural gas

allow correct answer shown in box if answer line blank

1

(b) (i) 450

allow correct answer shown in box if answer line blank

1

(ii) iron

allow correct answer shown in box if answer line blank

1

(iii) The catalyst lowers the activation energy.

1

(c) (the gases are) cooled

1

ammonia condenses

allow ammonia liquefies

1

nitrogen and hydrogen are recycled

*if no other mark awarded allow ammonia is separated for **1** mark*

1

[7]

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Q12.

(a) (i) nothing can enter **and** nothing can leave the reaction

allow sealed reaction vessel

1

(ii) forward and backward reactions have same rate

1

so there is no (overall) change in quantities of reactants and products

allow concentrations of reactants and products

1

(b) (i) natural gas

allow methane / CH_4

allow fossil fuels / hydrocarbons

allow water

1

(ii) provides an alternative reaction pathway

1

which has a lower activation energy

ignore references to collisions

1

(iii) the amount (of ammonia) increases

allow yield increases

1

the equilibrium moves to the side (of the equation) with fewer (gaseous) molecules / moles

allow it favours the forward reaction

1

(c) (i) vertical arrow from reactants to maximum

1

(ii) (energy of) products higher than (energy of) reactants

allow converse

1

(iii) amount of hydrogen iodide decreases

1

equilibrium moves in the direction of the endothermic reaction

allow it favours the forward reaction

1

[12]

Q13.

(a) $2NH_3$

*allow NH_3 with incorrect or missing balancing for **1** mark*

allow multiples

2

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(b) (i) 200

1

(ii) rate of reaction (too) slow

allow converse

ignore references to yield / cost

1

(iii) 400

1

(iv) lower yield

allow converse

accept shifts equilibrium to left

allow favours the backward reaction

allow favours side with more (gaseous) molecules

allow lower rate

1

(c) (gases) cooled

it = ammonia

1

ammonia liquefied

accept ammonia condensed

*accept ammonia cooled below boiling point for **2** marks*

1

[8]

Q14.

(a) fertilisers

1

(b) air

1

(c) speeds up the reaction

accept lowers the activation energy

ignore makes the reaction work

1

(d) reversible reaction

1

(e) (i) 10

1

(ii) water

accept H_2O / hydrogen oxide

1

[6]

Q15.

(a) any **two** from:

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- heat water / make steam / boil water **or** heat / steam used in stage 1 or from stage 3
- carbon dioxide from stage 3 used in stage 7 /to make urea
- nitrogen and / or hydrogen recycled
- ammonia and / or carbon dioxide recycled

allow unreacted material / gas recycled from stage 5 (to 4)

allow unreacted material / gas recycled from stage 8 (to 7)

*NB: if neither of the last two points are awarded unreacted material recycled = **1** mark*

2

(b) (i) increase yield

because (forward) reaction is exothermic

ignore references to rate

1

allow because (forward) reaction gives out heat

1

(ii) increase yield

ignore references to rate

1

because more (gaseous) reactant molecules than (gaseous) product molecules

accept because greater volume on the left than the right

1

(c) 76.9 - 77

correct answer gains 2 marks with or without working
*allow 77 **or** 76.923…*
*allow 76 **or** 0.77 **or** 0.76923 for **1** mark*
*if answer incorrect allow **1** mark for **either***

$$\frac{60}{\text{attempt at total } M_r \text{ of all reactants}} \times 100$$

or

$$\frac{\text{attempt at total } M_r \text{ of area}}{78} \times 100$$

2

[10]

Q16.

(a) three bonding pairs

*do **not** allow non-bonding electrons in hydrogen*

ignore any inner shells on nitrogen

1

two non-bonding electrons

allow either dots and crosses or combination of both

1

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(b) (i) nitric

1

(ii) fertilisers / explosives

ignore other uses

1

(iii) 80

*correct answer with or without working gains **2** marks*

*if answer incorrect, allow 14 + (1 × 4) + 14 + (16 × 3) for **1** mark*

2

(iv) 35

*allow ecf from **(b)(iii)***

*allow ecf for **1** mark for correct working but incorrect answer.*

*if answer incorrect, allow 28 / 80 × 100 for **1** mark*

*if answer is 17.5 % allow **1** mark*

2

(c) Marks awarded for this answer will be determined by the Quality of Communication (QoC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best−fit' approach to the marking.

0 marks
No relevant content

Level 1 (1 − 2 marks)
There are statements about the conditions used. There is no correct explanation of the link between rate or yield and the conditions.

Level 2 (3 − 4 marks)
There is a correct explanation of the conditions used that links the conditions to rate **or** yield

Level 3 (5 − 6 marks)
There is an explanation covering at least temperature and pressure, which shows understanding of the compromise between rate **and** yield

examples of chemistry points made in the response:

200 atmospheres pressure
- high pressure gives a high yield of ammonia
- too high a pressure causes risk of explosion
- high pressure costly to maintain
- a high pressure will cause the rate to be higher
- 4 moles of gas become 2 (or fewer moles of gas in products)

450 °C
- high temperature increases the rate of reaction
- optimum temperature
- (forward reaction is exothermic so) a high yield of ammonia requires a low temperature
- but too low a temperature causes the rate of reaction to be too slow

iron catalyst

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- a catalyst speeds up the reaction
- an iron catalyst allows a lower temperature to be used (saving energy and causing a higher yield)
- iron catalyst increases the rate of reaction equally in both reactions

others
- compromise conditions
- unreacted nitrogen and hydrogen is recycled

6

[14]

Q17.

(a) reversible

1

(b) catalyst

1

(c) recycled

allow re-used

1

(d) (Q) S R P

*allow **1**mark if one letter in correct place.*

2

[5]

Q18.

(a) air

1

(b) recycle

allow re-use

1

(unreacted) nitrogen and hydrogen

allow N_2 and H_2

1

(c) $N_2 + 3H_2 \rightarrow 2NH_3$

allow correct multiples

1

(d) *allow converse arguments*
ignore references to compromise

because a higher temperature would reduce (equilibrium) yield

allow higher temperature favours backward reaction

1

because a lower temperature would reduce rate

1

(e) (i) (energy of) reactants greater than (energy of) products

allow converse

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allow (overall) energy decreases

allow energy required to break bonds is less than the energy released making bonds

1

(ii) line starting and finishing at same levels but with lower peak

1

[8]

Q19.

(a) (i) 10

1

(ii) OH^-

1

(b) (i) air

1

(ii) particles move faster

1

particles collide more often

1

(iii) catalyst(s)

1

(c) liquid

1

[7]

Q20.

(a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a "best-fit" approach to the marking.

0 marks

No relevant content.

Level 1 (1-2 marks)
There is a simple description of a laboratory procedure for obtaining potassium chloride.

Level 2 (3-4 marks)
There is a clear description of a laboratory procedure for obtaining potassium chloride from potassium hydroxide solution and hydrochloric acid that does not necessarily allow the procedure to be completed successfully by another person. The answer must include the use of an indicator or a method of obtaining crystals.

Level 3 (5-6 marks)
There is a detailed description of a laboratory procedure for obtaining potassium chloride from potassium hydroxide solution and hydrochloric acid that can be

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followed by another person. The answer must include the use of an indicator and a method of obtaining crystals.

examples of the chemistry/social points made in the response:

- One reagent in beaker (or similar)
- Add (any named) indicator
- Add other reagent
- Swirl or mix
- Add dropwise near end point
- Stop addition at change of indicator colour
- Note volume of reagent added
- Repeat without indicator, adding same volume of reagent **or** remove indicator using charcoal
- Pour solution into basin / dish
- Heat (using Bunsen burner)
- Leave to crystallise / leave for water to evaporate / boil off water

Accept any answers based on titration

6

(b) nitric (acid)

allow HNO_3

ignore incorrect formula

1

(c) (i) because it is a fertiliser / helps plants grow

allow plant food

*do **not** accept pesticide / herbicide / neutralising soil*

1

(ii) tick by: 'Should farmers stop using ammonium nitrate on their land?'

1

any **two** from:

- cannot be done by experiment
  accept difficult to get / not enough evidence
- based on opinion / view
  allow must be done by survey
- ethical **or** economic issue
  *if top box ticked allow **1** mark for drinking water varies from place to place*

2

[11]

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Q21.

(a) mixture is cooled / cooling

1

so ammonia / it condenses

or
so ammonia <u>turns into</u> a liquid (but nitrogen and hydrogen remain as gases)

1

(b) (i) exothermic reaction

accept reverse reaction is endothermic

or
equilibrium / reaction moves in the direction which raises the temperature

ignore answers based on rate or collisions

1

(ii) they / particles / molecules move faster **or** have more (kinetic) energy

allow atoms instead of particles
ignore particles move more / vibrate
*do **not** accept electrons (max1)*

1

any **one** from:

- particles / molecules collide more often / more frequently / more likely to collide

  ignore collide faster
  ignore more collisions

- more of the collisions are successful **or** particles collide with more energy / harder **or** more of the particles have the activation energy

  accept more successful collisions

1

(iii) more molecules / particles / moles / volumes on LHS (of equation than RHS)

accept 4 molecules / particles / moles / volumes on LHS and 2 molecules / particles / moles / volumes on RHS

or
greater volume on LHS (than RHS)
or
equilibrium / reaction moves in the direction which reduces the pressure / volume

accept converse

1

(iv) cost

or
difficulty in containing such a high pressure

allow risk of explosion
ignore dangerous

1

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(c) (i) 60

1

(ii) 2.4(2857….)

*correct answer gains **3** marks with or without working*
accept any answer that rounds to 2.4
ignore units
if answer is incorrect look for evidence of correct working to a
*maximum of **2** marks.*
moles of N_2 = 2/28 = (0.0714)
moles of ammonia = 2 × 0.0714 = (0.1428)
mass of ammonia = 0.1428 × 17 = (2.4276)
or
28 → 34
1g →34/28
2g →2.4… …..

3

(d) (i) 15

1

(ii) unreacted gases are recycled

allow unreacted gases are reused

1

rate (of production) is fast

accept production is continuous
ignore compromise between rate and yield

1

[14]

Q22.

(a) increases

1

(b) the reaction is reversible

1

(c) A liquid

1

(d) recycled / reused (owtte)

accept returned to pump / start

1

[4]

Q23.

(a) (i) nitrogen - air

accept atmosphere

1

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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]

Q24.

(a) pressure

1

(b) nitrogen

1

hydrogen

1

(c) cooled

1

[4]

Q25.

(a) to speed up the reaction **or** it is a catalyst

allow higher level answers such as to reduce the activation energy

ignore cost or yield

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1

(b) (i) reaction is exothermic

*accept reverse reaction is endothermic **or** high temperature causes decomposition of ammonia*

ignore reference to rate

1

(ii) more (gaseous) reactant molecules than (gaseous) product molecules

accept 4 volumes / moles of reactant and 2 volumes / moles of product

*accept lower volume of products **or** volume lower on right hand side*

accept 'favours the reaction which produces fewer molecules'

ignore incorrect number of moles

ignore reference to 'amount' of product / reactant

ignore references to rate

1

(c) (rate is) too slow / slower owtte

allow catalyst would not work

accept at higher temperature the rate is quicker

*accept at lower temperatures particles do not collide as often **or** fewer particles have the activation energy **or** particles do not have the activation energy*

ignore reaction would not work

ignore optimum / compromise type answers

1

(d) cooled

*allow ammonia / it is turned into a liquid **or** is condensed*

ignore references to boiling point

1

[5]

Q26.

(a) (i) nitrogen + hydrogen → ammonia

accept full correct balanced equation

1

(ii) reversible (reaction) (owtte)

*do **not** allow just 'backwards' (unqualified)*

1

(iii) catalyst / speed up reaction

accept to lower activation energy

1

(iv) boiling point

1

(v) recycled (owtte)

1

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(b) (i) used to make explosives (owtte) used to make medicines (owtte)

1

(ii) used to make fertilisers (owtte)

1

(c) (i) sensible answers such as

provides workers (owtte)

good transport links

ignore reference to raw materials

1

(ii) sensible idea

1

linked reason

idea

linked reason

eg escape of chemicals /fumes /waste gases / pollution

harmful to health / environmental damage owtte

*do **not** allow harmful / damage / smell (unqualified)*

risk of explosion

because of high pressures / may endanger local people / dangerous

risk of fire

because of high temperatures / may endanger local people

noise

*any detrimental effect on quality of life **or** night and day*

lorries / traffic

danger / noise / pollution etc

unsightly

detrimental effect on quality of life / house prices / reduced tourism

uses a lot of land

loss of habitats

1

[10]

Q27.

(a) 1213.8 to 1214.3

*gains **3** marks without working*

correct answer not given then check working

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1) moles of N_2 = $\frac{1000}{28}$ = 35.7 mol

1 *mark for each correct step*
do ***not*** *penalise rounding errors in this part*

2) moles of NH_3 = 2 × (answer from (1)) = 71.4 mol

3) mass of NH_3 = (answer from 2) × 17 = 71.4 × 17 = 1214 g

3

or

- 28g of N_2 → 34g of NH_3

1 *mark for each correct step*

- 1g of N_2 → $\frac{34}{28}$ = 1.214g NH_3

do ***not*** *penalise rounding errors in this part*

- 1000 g of N_2 → 1000 × 1.214
  = 1214g

allow error carried forward eg

or

- 1000 × $\frac{34}{28}$

gains ***2*** *marks if correct answer not given*

1000 × $\frac{28}{34}$ *gains* ***1*** *mark,* ***2*** *marks if correctly calculated*

(823.5g) 1000 × $\frac{28}{17}$ *gains* ***1*** *mark if calculated correctly (1647.05g)*

or

other correct methods

look for the key ideas in the methods above

(b) 25 *I* 25.035 **or** ecf from (a)

gains ***2*** *marks even when there is no working*
incorrect answer then 304/(their answer from (a)) × 100 gains ***1*** *mark*

or using figures from part (b)

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27.6 / 28

*gains **2** marks even when there is no working*
*accept 27 for **1** mark*
*if answers incorrect then304/1100 × 100 gains **1** mark*

2

(c) (i) increase yield

1

reaction is exothermic

or

allow decreased yield because rate of reaction is slower / fewer collisions for **2** marks

***must** get both points for **2** marks*

1

(ii) increase yield

1

plus **one** from:

- more (gaseous) reactant molecules than (gaseous) product molecules (owtte)
  accept greater volume on the left than the right owtte
- increased rate of reaction / more collisions

1

(d) any **one** from:

economic

- large town provides workforce
- workers do not have to travel far to the factory. (owtte)
- transport infrastructure already in place for large town. (owtte)
- factory brings prosperity to town (owtte)
- factory provides employment
- reduced tourism
- reduction in local house prices
- any other sensible economic factor linked to town

1

any **one** from:

safety

- <u>escape</u> of dangerous / harmful chemicals / gases (owtte)
  *do **not** allow polluting gases unqualified*

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- danger of increased traffic
- risk of explosion.(owtte) /danger of high pressure
- consequences of an accident could be severe if the town is close
- any other sensible safety idea

1

any **one** from:

environmental

- factory might be unsightly (owtte)
- screening of factory (owtte)
- loss of habitats (owtte)
- plant trees/ hedges etc on and around plant site
- pollution of water / air / soil could harm plants / animals **or** noise pollution
  must be explained
- CO_2 is produced by burning fuels / heating
- CO_2 causes global warming / any effect of global warming
- eye sore
- any other sensible environmental factor

1

[12]

Q28.

(i) potassium hydroxide
accept correct formulae

1

water

1

(ii) fertiliser

1

(iii) H^+
*accept hydrogen but **not** H*

1

[4]

Q29.

(a) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ **or**

$H_3O^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

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mark for correct equation
mark for state symbols
any other symbols = 0 marks
accept correct spectator ions e.g.
$Na^+(aq) + OH^- (aq) + H^+(aq) + Cl^- (aq) \rightarrow Na^+(aq) + Cl^- (aq) + H_2O(l)$

2

(b) (i) nitric acid **and** ammonia (solution)
HNO_3 NH_3 / NH_4OH

mark for both
accept ammonium hydroxide / NH_4OH instead of ammonia
*do **not** accept ammonia hydroxide*
*do **not** accept hydrogen nitrate solution*
accept correct formulae

1

(ii) provides oxygen or oxidising (agent) **or** oxidant

*do **not** accept it contains oxygen alone*
***or** rich in oxygen*

1

[4]

Q30.

(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

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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]

Q31.

(a) put on soil **or** for plants

*accept land **or** field **or** garden **or** crops **or** plants*

accept alternative answer to provide more food for increased population

for growth

*accept to improve plant yield **or** help them grow*

*accept to replace **or** add nutrients (**not** nitrates) **or** minerals **or** to make plants grow better **or** for healthy plants*

*do **not** accept to make soil fertile **or** to feed plants*

2

(b) (i) 2

1

(ii) 80

1

[4]

Q32.

(a) (i) 78-80%

1

(ii) proteins

accept amino acids

1

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(b) (i) natural gas

accept methane (CH_4)
accept water (H_2O)

1

(ii) carbon dioxide

1

(c) (i) $N_2 + H_2$

1

correct balancing $1 + 3 \rightarrow 2$

award only if reactants are correct

1

(ii) iron

accept Fe

1

(iii) at low temperatures rate of reaction is too slow

accept very few collisions at low temperatures
accept converse

particles need enough (activation) energy to react

accept particles need enough energy for bonds to break
accept converse

1

(d) all three covalent bonds displayed correctly as electron pairs

1

two lone electrons displayed not necessarily as a pair

1

[11]

Q33.

(a) nitrogen

consider answers as a list

1

hydrogen

1

(b) speed up the reaction

accept increase rate of reaction

1

(c) fertiliser

*accept to replace **or** add nitrogen **or** nutrients*
*do **not** accept minerals or nitrates*

1

growth

*accept for protein **or** increased yield*

1

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[5]

Q34.

(a) (i) fertilisers

for 1 mark

1

(ii) 7

for 1 mark

1

(iii) 5

for 1 mark
(ignore other units)

1

(b) (i) both nitrogen and hydrogen

for 1 mark

1

(ii) two of:
nitrogen;
hydrogen/methane/natural gas;
oxygen/air;
water;
any fuel
(allow symbols, do not allow nitrogen oxides)

any two for 1 mark each

2

(c) (i) alkali/alkaline/base/basic

for 1 mark

1

(ii) must be nitrate

for 1 mark

1

(iii) thermometer or any other temperature measuring device

for 1 mark

1

[9]

Q35.

(a) 16%

for 2 marks

(attempt by drawing lines etc gains 1 mark)

2

(b) iron is a catalyst;
which speeds up the reaction

for 1 mark each

2

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(c) (from the graph) the best **yield** is obtained at high pressure;
and low temperature;
it is a reversible reaction;
in which formation of ammonia is favoured at low temperature
(because) the reaction is exothermic;
and the formation of ammonia is favoured at high pressure
because greater number of gaseous reactant molecules than
gaseous product molecules/because greater vol of reactant
than volume of product molecules;
pressure used is limited by cost/materials;
rate of reaction slow at low temperatures;
actual temperature and pressure used is a good compromise
(between a good yield and reasonable rate);
removal of ammonia makes rate more important than yield;

any 8 for 1 mark each

8

[12]

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