1 (a) (i) different boiling points [1]

(ii) methane **or** water **or** petroleum **or** named petroleum fraction **or** alkane
Any TWO [2]

(b) (i) volume decrease for forward reaction **or** fewer moles of gas on products side [1]
favoured by increase in pressure [1]
or increase in pressure moves position of equilibrium to right

(ii) increase [1]
exothermic reaction favoured by lower temperature [1]

(iii) 300 to 600 ^{0}C
1:3 volume ratio
iron (catalyst)
150 to 300 atm
Any TWO [2]

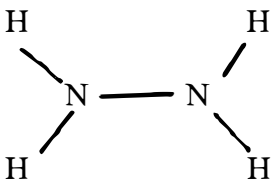
(c) (i) proton [2]
hydrogen ion **or** H^+ **ONLY** [1]

(ii) correct equation molecular **or** ionic [1]
$NH_3 + HCl = NH_4Cl$
$NH_3 + H^+ = NH_4^+$ accept NH_4OH

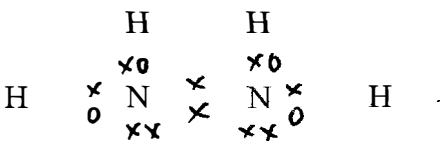
(d) measure pH **or** add universal indicator **or** pH meter [1]
ammonia has lower pH if numerical values given

must be appropriate that is above 7 with ammonia having the lower value **or** correct colours, green and blue are acceptable [1]
OR measure conductivity [1]
ammonia has poorer conductivity [1]

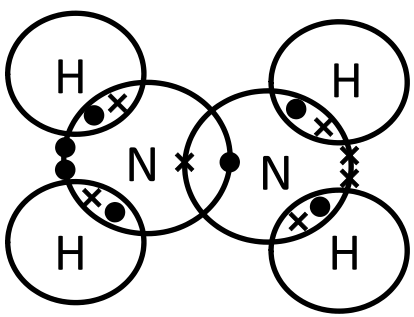
(e) (i) correct structural formula [1]



(ii) 8e around nitrogen [1]
2e around each hydrogen [1]



TOTAL = 17

Question	Answer	Marks
2(a)(i)	pressure in range 150–300 atmospheres / atm; temperature in range 370–470 °C; iron (catalyst); balanced equation: $N_2 + 3H_2 \rightarrow 2NH_3$; equilibrium / reversible;	**5**
(a)(ii)	manufacture of fertilisers / nylon / nitric acid / cleaning agent(allow oven cleaner) / hair dye / urea / refrigeration / explosives;	**1**
(b)	 **M1** all shared electrons correct (5 bonds); **M2** exactly two non-bonding electrons on each N and no additional non-bonding electrons;	**2**
(c)(i)	/ H^+ acceptor;	**1**
(c)(ii)	$_2H_4 + H_2O) \rightarrow N_2H_5^+ + OH$; **or** $(N_2H_4) + 2H_2O \rightarrow N_2H_6^{2+} + 2OH$;	**1**
(d)(i)	rain / effect of acid rain / (photochemical) smog / (producing) low level ozone;	**1**
(d)(ii)	**M1** nitrogen and oxygen (from the air) react / combine or word equation; **M2** at high temperature / spark / very hot;	**2**

Question	Answer	Marks	Guidance
3(a)(i)	(Haber process makes) ammonia / NH_3 ; (ammonia converted into) fertilisers / nitrates / ammonium salts or names or formulae of examples e.g. ammonium nitrate / NH_4NO_3 / ammonium sulfate / $(NH_4)_2SO_4$ / calcium nitrate / $Ca(NO_3)_2$ / urea / $CO(NH_2)_2$;	2	**A** 2 marks for 'ammonia is a fertiliser' **A** ammonia is used to make sodium nitrate Haber process used to make fertilisers gets second mark only
(a)(ii)	it (refers to sodium nitrate) / sodium nitrate would dissolve (in rain) / soluble (in water) / wash away / leach / drain off;	1	**A** reacts with water **I** reference to fertiliser **R** sodium reacts / dissolves **A** because they are not dissolved by rainfall (implication is in desert)
(a)(iii)	potassium (is required by plants as well as nitrogen) / NP**K**;	1	comments about pH / better for soil / %N higher / reactivity of potassium **I** comments about what K does for plants e.g. combat disease
(b)(i)	$_3 \rightarrow 2NaNO_2 + O_2$ species; balancing;	2	**A** multiples **I** state symbols / word equation

Question	Answer	Marks	Guidance
3(b)(ii)	(colour changes) from pink / purple; to colourless / decolourised;	**2**	**I** clear / discoloured / effervescence **I** brown fumes / brown gas **NOTE:** stays pink or purple gets first mark but turns purple or pink is 0
(b)(iii)	the more reactive the metal the lower rate of decomposition / more difficult the decomposition / more stable the nitrate / more energy needed to decompose / decomposes at higher temperature ora;	**1**	**A** less (extent the) decomposition **A** reactive metals produce nitrates difficult to decompose ora i.e. comparatives not essential **A** the more reactive the metal the less it decomposes is acceptable because we can assume that *it* refers to the nitrate BOD **A** inverse relationship with further qualification **A** group 1 / reactive metals produce nitrite (and oxygen) **and** less reactive metals produce oxide (+ NO_2 + O_2) (both required for mark) **I** less products (unqualified) **R** less products / metals decompose
3(c)(i)	(changes from) blue solid / blue crystals; black solid formed; brown gas / brown vapour / (pungent) smell;	**3**	**R** precipitate **A** one mark out of the first two for changes from blue to black (without solid or crystals) **I** red / melt **I** water / steam / condensation given off **I** reference to glowing / burning splints / colourless gas / effervescence **I** names / formulae

Question	Answer	Marks	Guidance
3(c)(ii)	Avogadro('s) number / constant / 6.02×10^{23}; **COND** particles; **OR** (the number of particles which is equal to the number of atoms in) 12 g of carbon 12; **COND** atoms; **OR** the mass **in grams** which contains Avogadro('s) Number; **COND** particles; **OR** (the amount of substance which has a mass equal to) its <u>relative</u> formula mass / RFM / <u>relative</u> atomic mass / Ar / <u>relative</u> molecular mass / Mr / molar mass; **COND** in grams; **OR** (the amount of substance which has a volume equal to) 24 dm^3; **COND** of a gas **at** RTP;	**2**	**A** any values from 6 to 6.023×10^{23} **A** atoms / ions / molecules / electrons **A** one mark for reference to C12 **A** equivalent statement for any element **or** compound e.g. 32 grams of oxygen(1) **COND** <u>molecules</u> / O_2 (1) e.g. 16 grams of oxygen (1) **COND** <u>atoms</u> / O(1) **A** different volumes under different conditions e.g. 22.4 dm^3 at STP or volumes in different units e.g. 24 000 cm^3 at RTP
(c)(iii)	(number of moles of CuO formed =) **0.03**; M2 (number of moles of $Cu(NO_3)_2.xH_2O$ in 7.26 g =) **0.03**; M3 (mass of 1 mole of $Cu(NO_3)_2.xH_2O$ 7.26 ÷ 0.03 =) **242** (g); (mass of 1 mole of $Cu(NO_3)_2$ is 188 g) M4 the value of x = **3**;	**4**	ecf same as M1 ecf 7.26 ÷ M2 ecf M3 – 188 ÷ 18