ICSE CLASS 10 CHEMISTRY – PRACTICE PAPER

STEP-BY-STEP SOLUTIONS AND MARKING SCHEME

Chapter 9: Study of Compounds – Ammonia | Maximum Marks: 40

SECTION A (20 Marks)

Question 1 [8 × 1 = 8]

Part	Ans	Step-by-step reasoning
(i)	(c)	Quicklime (CaO) is basic and does not react with ammonia. Conc. H_2SO_4, P_2O_5 and anhydrous $CaCl_2$ all react with ammonia.
(ii)	(a)	$2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O + 2NH_3$. NH_4NO_3 decomposes explosively on heating; NaCl and HCl are unsuitable.
(iii)	(b)	Finely divided iron is the catalyst, with molybdenum or Al_2O_3 as promoter. Platinum is used in the Ostwald process.
(iv)	(b)	$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$; ammonia burns with a yellowish green flame.
(v)	(a)	Platinum gauze at about 800 °C.
(vi)	(c)	Both are true; the acid–base reaction $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ is the reason (R explains A).
(vii)	(b)	With excess chlorine: $NH_3 + 3Cl_2 \rightarrow NCl_3 + 3HCl$; the product is the explosive yellow liquid nitrogen trichloride.
(viii)	(a)	$3CuO + 2NH_3 \rightarrow 3Cu + 3H_2O + N_2$: black CuO is reduced to reddish brown copper.

Question 2 [3 + 3 = 6]

(i) **[3 × 1]**

(a) **high** – four volumes of reactants give two volumes of product, so high pressure (about 250 atm) shifts the equilibrium towards ammonia.

(b) **800 °C** – the Pt-catalysed oxidation of NH_3 to NO is done at about 800 °C (the oxidation of NO to NO_2 is at about 50 °C).

(c) **weak** – NH_4OH is only partially ionised: $NH_4OH \leftrightarrow NH_4^+ + OH^-$.

(ii) **[3 × 1]**

(a) NH_4OH in excess with $CuSO_4$ → **1** (deep blue solution of the complex $[Cu(NH_3)_4]SO_4$).

(b) Excess chlorine with ammonia → **2** (nitrogen trichloride, NCl_3).

(c) Ammonium salt with Nessler's reagent → **3** (brown colour or precipitate).

Statement 4 (pale green precipitate) is the extra option; it is formed by Fe^{2+} with NH_4OH.

Question 3 [3 + 3 = 6]

(i) **[3 × 1]**

(a) P is a mixture of **ammonium chloride and calcium hydroxide** (2 : 3 by weight). **$2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O + 2NH_3$**.

(b) Q is **quicklime (CaO)**. Conc. H_2SO_4 reacts with ammonia: $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$.

(c) Ammonia is lighter than air (V.D. 8.5, air 14.4), so it is collected by downward displacement of air in an inverted jar; it rises and displaces the air downwards.

(ii) **[3 × 1]**

(a) NH_4NO_3 decomposes on heating ($NH_4NO_3 \rightarrow N_2O + 2H_2O$) and is explosive, so ammonia is not obtained.

(b) Ammonia is highly soluble in water (1 volume of water dissolves about 702 volumes of ammonia at 20 °C).

(c) Aqueous ammonia is alkaline; it emulsifies / dissolves grease and fats.

SECTION B (20 Marks)

Question 4 [4 + 3 + 3 = 10]

(i) **[4 × 1]**

(a) **Haber's process**. **$N_2 + 3H_2 \leftrightarrow 2NH_3$ + heat** (450–500 °C, about 250 atm).

(b) P is the **compressor (compression pump)**: it raises the pressure of the mixture (N_2 : H_2 = 1 : 3 by volume) to about 250 atm.

(c) Q = **finely divided iron**; promoter = **molybdenum** (or Al_2O_3).

(d) Nitrogen: fractional distillation of liquid air. Hydrogen: from water gas (Bosch process) or natural gas.

(ii) **[3 × 1]**

(a) The forward reaction decreases the volume (4 volumes → 2 volumes). By Le Chatelier's principle high pressure favours the product.

(b) At low temperature the reaction is too slow, so a compromise temperature of 450–500 °C is used.

(c) Ammonia has a much higher boiling point, so on cooling it **liquefies** while N_2 and H_2 do not; the unchanged gases are recirculated.

(iii) **[3 × 1]**

(a) **$3CuO + 2NH_3 \rightarrow 3Cu + 3H_2O + N_2$**

(b) The black copper(II) oxide is reduced to **reddish brown copper**; a colourless gas (nitrogen) is evolved.

(c) The water formed condenses in the U-tube; it turns **anhydrous copper sulphate blue**.

Question 5 [4 + 3 + 3 = 10]

(i) **[4 × 1]**

(a) **Dirty green** precipitate of $Fe(OH)_2$.

(b) The precipitate is **insoluble** in excess NH_4OH.

(c) The precipitate **dissolves** in excess NH_4OH ($Zn(OH)_2$ forms a soluble complex).

(d) **Pale blue** precipitate of $Cu(OH)_2$.

(ii) **[3 × 1]**

(a) $\mathbf{FeCl_3 + 3NH_4OH \rightarrow Fe(OH)_3\downarrow + 3NH_4Cl}$

(b) $\mathbf{Pb(NO_3)_2 + 2NH_4OH \rightarrow Pb(OH)_2\downarrow + 2NH_4NO_3}$

(c) $\mathbf{2NH_4OH + H_2SO_4 \rightarrow (NH_4)_2SO_4 + 2H_2O}$

(iii) **[3 × 1]**

(a) $\mathbf{8NH_3 + 3Cl_2 \rightarrow N_2 + 6NH_4Cl}$ (excess ammonia).

(b) The yellowish green colour of chlorine disappears and dense white fumes of ammonium chloride are formed.

(c) With excess chlorine: **nitrogen trichloride** ($NH_3 + 3Cl_2 \rightarrow NCl_3 + 3HCl$), a highly explosive yellow liquid. These reactions show that ammonia is a **reducing agent**.

Question 6 [4 + 3 + 3 = 10]

(i) **[4 × 1]**

(a) **Ostwald process**. Gas A is **nitric oxide (NO)**.

(b) $\mathbf{4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O + heat}$ (Pt, 800 °C).

(c) $\mathbf{2NO + O_2 \rightarrow 2NO_2}$ (oxidation chamber, about 50 °C).

(d) $\mathbf{4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3}$.

(ii) **[3 × 1]**

(a) Oxygen is only about one-fifth of air and is required in all three chambers, so a large excess of air is used.

(b) The oxidation of ammonia is strongly exothermic; the heat evolved keeps the catalyst red hot.

(c) Quartz is acid-resistant; packed in layers it ensures NO_2 dissolves uniformly in the water trickling down.

(iii) **[3 × 1]**

(a) A glass rod dipped in conc. HCl is held near the gas: **dense white fumes** of ammonium chloride are formed ($NH_3 + HCl \rightarrow NH_4Cl$).

(b) It turns moist red litmus paper **blue** (ammonia is basic).

(c) CFCs deplete the ozone layer and contribute to global warming; ammonia does not harm the ozone layer.

Marks summary	Section A: Q1 = 8, Q2 = 6, Q3 = 6 → **20** | Section B: any two of Q4, Q5, Q6 at 10 each → **20** | Total = **40**