Nitrogen and its compounds

1. (i) $4HN_3(g) + 5O_{2(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(g)}$
   (ii) Act as catalyst
   (iii) $Zn(NH_3)_4^{2+}$

2. a) Platinum/ copper

   b) Brown fumes ✓
   Hot rod m continues to glow red
   - NO formed reacts with oxygen to form NO_2 (brown flames)
   - Reaction highly exothermic

3. a) Calcium hydroxide
   b) $Ca(OH)_{2(g)} + 2NH_4CL_{(g)} \_\_\_\_\_ 2NH_{3(g)} + CaCL_2 + 2H_2O_{(L)}$

4. (a) It neutralizes air to prevent violent combustion reaction from occurring.
   (b) Its inert and have very low b.pt of -196^oC
   *MAT

5. a) X is Nitrogen. ✓1
   b) It is less dense than air. ✓½
   c) – In preservation of semen in artificial insemination. ✓1

6. a) (i) Solution A contains $Pb^{2+}(aq)$ ions ✓½
   (ii) Solution B contains $Al^{3+}(aq)$ ions. ✓½
   b) – A colourless liquid at cooler parts ✓1 of test-tube is formed.
   - A white reside remains in the test-tube. ✓1

7. a) to expel air that is in the combustion tube so that oxygen in it does not react with hot copper✓1
   b)brown✓½ copper metal will change to black✓½
   c)nitrogen ✓1

8. (a) To increase the surface area over which the reaction occurs hence increased rate of reaction. ✓1 ✓1
   (b) NH_3 is basic and reacts with some moles of the acid hence reduction in concentration ✓1

9. (a) (i) The solution changes from <u>green</u> ✓1 to <u>brown</u> ✓1 (1 mk)
   (ii) A brown ✓1 precipitate is formed. (1 mk) 3
   (b) $Fe^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow Fe(OH)_{3(s)}$ ✓1 (1 mk)

10. (a) – Absorbs carbon (IV) oxide from ✓1 the air. (1 mk)
    (b) $2Cu_{(s)} + O_2 \rightarrow 2CuO_{(s)}$ ✓1 (1 mk) 3
    (c) Because it has the rare gases. ✓1 (1 mk)

11. (a) Anion – CO_3
    Cation – Cu^{2+}

(b) $Cu^{2+} + 4NH_3$ $\{CuNH_3)_4\}^{2+}$

12. (a) (i) $NH_4NO_{3\ (s)}$ $N_2O_{(g)} + 2H_2O_{(g)}$

(ii) NH_4NO_3 should not be heated further if the quantity remaining is small because it may explode

or A mixture of NH_4Cl & KNO_3 can be used instead of NH_4NO_3 leading to double decomposition taking place safely without explosion

(iii) An hydrous calcium chloride in a u-tube

(iv) Reacts with oxygen to form brown fumes of Nitrogen (IV) Oxide

$2N_2O_{(g)} + O_{2(g)}$ $2NO_{2(g)}$

(v) – Has no colour

- Has a slight sweet smell

- Fairly soluble in water ✓

- Denser than air ✓

(b) (i) Provides a large surface area for the absorption of ammonia gas by the water or prevent "bricking" back of water ✓

(ii) Water would brick back into the hot preparation flask causing it to crack or break /an explosion can occur ✓

(iii) Red litmus paper would turn to blue, blue litmus paper remains blue each ✓

13. (a) B – ammonia gas ✓1

C - nitrogen (II) oxide (NO) ✓1

E – water ✓1

F – unreacted gases ✓1

(b) The mixture of ammonia and air is passed through heated/ catalyst where ammonia (II) is oxidized to nitrogen (II) oxide. ✓1

(c) Gases are cooled and air passed through heated/ catalyst where ammonia is further oxidized to nitrogen(IV) oxide. ✓1

(d) Fractional distillation, ✓½

Water with a lower boiling point ✓½ than nitric (V) acid, distills left leaving the concentrates acid.

14. a)i) Fractional distillation

ii) Argon

b) A Sulphur

B Ammonia gas

C Oteum

D Amonium sulphate

c) i) Finely divided iron

ii) Vanadium (v) Oxide

d) Speeds up the rate of reaction by lowering the activation energy

e) $2NH_{3(g)} + H_2SO_{4(aq)}$ _____ $(NH_4)2SO_{4(aq)}$

f) R.M.M of $(NH_4) = 132$

Mass of N = 28
% N = $^{28}/_{132}$ x 100 = 21.212%

g) Used as a fertilizer

15. (a) (i) Fused calcium chloride /Cao (quick lime) ✓1
(ii) To remove carbon (IV) Oxide
(iii) $4Fe^{+}_{(s)} + 3O_{2(g)} \rightarrow 3Fe_2O_{3(s)}$
OR $3Fe_{(s)} + 2O_{2(g)} \rightarrow Fe_3O_{4(s)}$
(iv) Argon/Helium/Neon/Krepton ✓1
(v) Provide very low temperature so that the semen does not decompose /is not destroyed
(b) (i) Concentrated sulphuric acid ✓1
(ii) $NaNO_{3(s)} + H_2SO_{4(l)} \rightarrow Na_2HSO_{4(aq)} + HNO_{3(aq)}$ ✓1
OR $2NaNO_3 + H_2SO_{4(l)} \rightarrow Na_2SO4 + 2HNO_3$
(reject unbalanced chemical equation)

(b) Copper reacts with 50% nitric acid to give nitrogen II Oxide which is colourless. Air oxidizes ✓1
Nitrogen II oxide to Nitrogen IV oxide which is brown.
$2NO_{(g)} + O_2 \rightarrow 2NO_{2(g)}$ 1
colourless Brown

16. (a) (i) Nitrogen – Fractional distillation of liquid air –(½ mk)
Hydrogen – Cracking of alkanes
-Electrolysis of acidified water
(ii) Temperature – 400°C – 500°C
Pressure – 400atm – 500atm
Catalyst – kinely divided iron

(iii) Catalyst P – Nickel
Gas M – Nitrogen IV oxide
(iv) (a) $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$
(b) $NO_{2(g)} + H_2O_{(l)} \rightarrow HNO_{2(aq)} + HNO_{3(aq)}$
(v) To a small portion of the nitrate liquid in a test tube add equal amount o freshly prepared iron (II) sulphate followed by some drops of conc. H_2SO_4 slowly on the sides. If a brown ring forms on the boundary of the two solutions, a nitrate is confirmed.

(vii) – Manufacture of nitrogenous fertilizers
- Manufacture of synthetic fibres e.g nylon
- Manufacture of explosives e.g TNT
- Manufacture of textile dyes
- Manufacture of other acids e.g. phosphoric acid

17. (a) (i) Nitrogen (I) Oxides.
Rej. Dinitrogen oxides.

(ii) $NH_4NO_{3(s)} \rightarrow N_2O_{(g)} + 2H_2O_{(g)}$
(iii) The gas is soluble in cold water.
(iv) An irritating choking smell of a gas.

(b) (i) Platinum wire.
(ii) $4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(g)}$

$2NO_{(g)} + O_2$ $2NO_{2(g)}$

(iii) *Nitrogen (I) Oxide* — *Nitrogen (IV) Oxide.*
Colourless. — *Reddish brown.*
Relights a glowing splint. — *Extinguishes a glowing splint.*
Has a sweet smell. — *Irritating pungent smell.*
Fairly soluble in water. — *Readily soluble in water.*
(Accept any 1 correct comparative)

(c) (i) It corrodes/reacts with rubber and cork.

(ii) I) Oxidized : Sulphur /S
Reduced: Nitric (V) acid / $HNO_{(aq)}$

II) It decomposes by heat into NO_2 which dissolves in the acid.

18. *a) Pass air through purifiers to remove dust particles by electrostatic precipitation. Then pass it through conc. Sodium Hydroxide to absorb CO2. Then through condensers at 25C to remove water vapour. It is further cooled to liquefy it. The liquefied air is then fractionally distilled to obtain oxygen at – 183C*

b) i) X – Ammonia// NH_3
Y- Air

ii) $4NO_{2(g)} + 2H_2O_{(s)} + O_{2(g)} \_\_\_\_\_ 4HNO_{3(aq)}$
Accept
$2NO_{2(g)} + H_2O_{(l)} \_\_\_\_\_ HNO_{3(aq)} + HNO_{2(aq)}$
$2HNO_{2(aq)} + O_{2(g)} \_\_\_\_\_ 2HNO_{3(aq)}$

iii) Through fractional distillation

iv) $HNO_{3(aq)} + NH_{3(g)} \_\_\_\_\_ NH4ND_{3(aq)}$
RMM of $NH_3 = 17$ *RFM of* $NH_4NO_3 = 80$
If 80g NH_4NO_3 _____ *17 g*
960000 _____ $\frac{960000}{80 \times 1000} \times 17 = 2040kg$

19. *(a) Potassium hydroxide solution*
(b) To remove dust particles
(c) Water vapour Moisture
(d) -183°C
(e) Fractional distillation of liquid air
(f) Liquid air and passed through fractionating column, where nitrogen with lowest B.P -196°C distils out first and liquid oxygen with highest distil out last.
(g) Nitrogen in liquid form is used as a refrigerant e.g. in storing semen for artificial insemination
- Used as a raw material in Haber process e.t.c
II. Air is a mixture because:
- *It contains gases which are not chemically combined*
- *- The gases are not in fixed ratios.*

20. $HOCL_{(aq)}$ + *Dye* _____ $HCL_{(aq)}$ + *[Dye + O]*
Coloured *Colourless* ✓

$H_2SO_{3(aq)}$ + [Dye +O] _____ $H_2SO_{4\,(aq)}$ + Dye
Coloured Colourless

21. a) Drying agent ✓ ½ which must be CaO
Method of collection ✓- upward delivery
Workabillity ✓ ½

b) $2NH_4CL_{(g)} + Ca(OH)_{2(g)}$ _____ $CaCL_{2(g)} + H_2O_{(l)} + 2NH_{3(g)}$ ✓

22. a) Heat
b) $Cu_{(g)} + N_2O_{(g)}$ _____ $CuO_{(g)} + N2_{(g)}$
c) - Manufacture of ammonia
- In light bulbs
- As a refrigerant

23. – At 113°C consists of S_8 rings that flow easily;
- Darkens due to breaking of S_8 rings and forming long chains consisting of thousands of atoms. The chains also entangle;
- The long chains consisting of thousands of atoms. The chains also entangle;
- The long chains break near b.p. to form shorter one;

24. Difference is at the cathode electrode where in concentrated sodium chloride sodium is deposited while in dilute sodium chloride, hydrogen is liberated, because

25. (i) $2N_2O_{(g)} + C_{(s)}$ $Co_{2(g)} + 2N_{2(g)}$
(ii) Ammonium chloride and sodium nitrate
(iii)The hydroxide ions ✓1 (Ammonia dissolves forming ammonia hydroxide.(1 mk)

26. (a) E - Ammonium chloride (½ mk)
F – Aluminium hydroxide (½ mk)
(b) $Al_3+ + 3OH^-_{(aq)}$ $AL(OH)_{3(s)}$

27.
a) Zinc hydroxide
b) [Zn (NH3)4] 2+
c) $Zn^{2+}_{(aq)} + 2OH_{(aq)}$ _____ $Zn\,(OH)\,2_{(s)}$

28. a) Plantinum/platinum Rhodium ✓1
b) $4NH_3(g) + 5O_2(g)$ $4NO(g)$ ✓1 $+ 6H_2O(l)$
c) – Fertilizers ✓1
- Preparation of Nitrogen (I) oxide.
- Explosives

29. Blue ppt ✓1 is formed which dissolves in excess to form a deep blue ✓1 solution due to formation of tetra amine Copper (II) ions

30. (a) - Finely divided iron impregnated by alumina (Al_2O_3)
- 200 atmosphere pressure
- Temperature of 450°C ✓ ½

b) - CuO is reduced to Copper metal
- NH_3 is oxidized to water and nitrogen

31. (a) Colour of copper (II) Oxide changes from black to brown

(b) (i) Nitrogen /$N_{2(g)}$

(ii) Water/$H_2O_{(l)}$