H_3O^+

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Properties of HNO_3

- Physical:

⇒ Hygroscopic and fumes in air
∴ the bottle containing HNO_3 should always be stoppered.

⇒ Aqueous solution of nitric acid (68% conc.) forms a constant boiling mixture at 121°C

⇒ Soluble in water

⇒ Non-poisones

- Chemical:

⇒ Unstable to heat or sunlight.

$$4HNO_3 \xrightarrow{\Delta} 4NO_2 + 2H_2O + O_2$$

⇒ Mono basic acid

$$HNO_3 \rightleftharpoons H^+ + NO_3^-$$

⇒ blue litmus ⟶ red
methyl orange ⟶ Pink
Phenolphthalein ⟶ colourless

> Reaction with alkalis:

→ Base + Acid → Salt + water

$K_2O + 2HNO_3 \rightarrow 2KNO_3 + H_2O$

$NaOH + HNO_3 \rightarrow NaNO_3 + H_2O$

→ neutralisation reaction

> Reaction with carbonates / bicarbonate

→ Carbonate / Bicarbonate + Acid → salt + H_2O + CO_2

$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2\uparrow$

$NaHCO_3 + HNO_3 \rightarrow NaNO_3 + H_2O + CO_2\uparrow$

> Action with metallic Sulphites / bisulphites

metallic sulphite / bi-sulphite + HNO_3 (dil) → metallic Nitrate + H_2O + SO_2

$K_2SO_3 + 2HNO_3 \rightarrow 2KNO_3 + H_2O + SO_2$

$Ca(HSO_3)_2 + 2HNO_3 \rightarrow Ca(NO_3)_2 + 2H_2O + 2SO_2$

Oxidising property

~~2HNO3~~

- Vigorously oxidies non-metals, metals inorganic compounds and organic substance

$$2HNO_3 \xrightarrow{(conc.)} 2NO_2 + H_2O + [O]$$

$$2HNO_3 \xrightarrow{(dil)} 2NO + H_2O + 3[O]$$

Action on non-metals

Non-metal + Acid → oxidised product + Water + NO_2

a. $C + 4HNO_3 \rightarrow CO_2 + 2H_2O + 4NO_2$

b. $S + 6HNO_3 \rightarrow H_2SO_4 + 2H_2O + 6NO_2$

:) Action on metals

a) Cold and dil. HNO_3

1. $3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO$

2. $3Zn + 8HNO_3 \rightarrow 3Zn(NO_3)_2 + 4H_2O + 2NO$

b) Conc. HNO_3 [or hot dil. HNO_3]

1. $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$

2. $Fe + 6HNO_3 \rightarrow Fe(NO_3)_3 + 3H_2O + 3NO_2$

→ Metals like Fe, Al, Co and Ni become passive (inert) when treated with pure concentrated HNO_3

→ ~~Why~~ is Dil. HNO_3 is considered as a typical acid

c) Very dilute acid

$$Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$$
(very dil.)

$$Mn + 2HNO_3 \rightarrow Mn(NO_3)_2 + H_2$$
(very dil)

Reaction as Aqua Regia:

(Royal water)

Aqua Regia - Conc. HNO_3 and Conc. HCl in 1:3 ratio by volume

$$HNO_3 + 3HCl \rightarrow NOCl + 2H_2O + 2[Cl]$$

(Nitrosyl chloride)

USES of HNO_3

i) To purify gold
ii) To prepare fertilizers

TESTS FOR HNO_3 and Nitrates

1. Conc. HNO_3 gives ~~red~~ brown fumes

$$4HNO_3 \xrightarrow{\Delta} 2H_2O + 4NO_2\uparrow + O_2\uparrow$$

(brown fumes)

2. Nitrates

$$\text{Metallic nitrate} \xrightarrow{\Delta} \text{metallic oxide} + NO_2\uparrow + O_2\uparrow$$

(reddish brown)

3. On adding Cu to HNO_3 or acidified nitrates

$$Cu + 4HNO_3 \xrightarrow{\Delta} Cu(NO_3)_2 + 2H_2O + 2NO_2$$

$$Cu + 4NaNO_3 + 4H_2SO_4 \xrightarrow{\Delta} 4NaHSO_4 + Cu(NO_3)_2 + 2H_2O + 2NO_2$$

4. Brown Ring Test

$$6FeSO_4 + 3H_2SO_4 + 2HNO_3 \rightarrow 3Fe(SO_4)_3 + 4H_2O + 2NO$$

$$FeSO_4 + NO \rightarrow FeSO_4 \cdot NO$$

Note:

1. freshly prepared $FeSO_4$ solution is used ∵ on exposure to air $FeSO_4$ gets oxidised to $Fe(SO_4)_3$ which will not get give the brown ring

2. The brown ring of nitrosoferrous sulphate is formed at the junction of two liquids

3. The brown ring of nitrosoferrous sulphate decomposes on distributing the test tube. The heat ~~absorbed~~