Oxides of Nitrogen /

Oxy acids of nitrogen

⇒ OXIDES OF NITROGEN ⇐

Formula of oxide	Name	Oxidation no. of N
N_2O ⟶	Nitrous oxide	+1 – Lowest → ous
NO ⟶	Nitric oxide	+2 – Highest → ic
NO_2 ⟶	Nitrogen dioxide	+4
N_2O_3 ⟶	Nitrogen sesquioxide (Dinitrogen trioxide)	(+3)
N_2O_4 ⟶	Dinitrogen tetraoxide	+4
N_2O_5 ⟶	Dinitrogen pentaoxide	+5

Structures

(1) N_2O ⟶ $\ddot{N} \equiv N \rightarrow O$ (Linear) [P.G. → $C_{\infty v}$] Q

(2) NO ⟶ $:\dot{N} = O$ (Linear) [P.G. → $C_{\infty v}$]
(In gaseous phase)
(Paramagnetic) Q ⟶ MOT

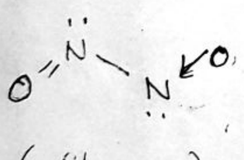
NO = 15

(7)

(8) $(\sigma 1s)^2$ $(\sigma 1s^*)^2$ $(\sigma 2s)^2$ $(\sigma 2s^*)^2$

↓

Dimer → Diamagnetic Q ✓

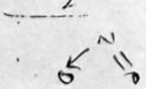


(Planar)

$O = \ddot{N} - \ddot{N} = O$
(liq or Solid phase)

[O · N – O · N ·]
(In some cases

(3) NO_2 ⟶ • (unpaired electron)



$\dot{N} = O$ → It is readily undergo dimerisation.
↙ O (Paramagnetic)

1S, 2S, 2P, 3S, 3P,

N_2O_x
└→ 2 ⟶ ~~diamg~~ diamagnetic .

N_xO_y
└→ Single ⟶ paramagnetic

N_xO_y
└→ double ⟶ diamagnetic

Oxides of Nitrogen & Oxy acids of nitrogen

OXIDES OF NITROGEN

Formula of oxide	Name	Oxidation no. of N
N_2O	Nitrous oxide	+1 — Lowest → O.S.
NO	Nitric oxide	+2 — Highest → I.C
NO_2	Nitrogen dioxide	+4
N_2O_3	Nitrogen sesquioxide	+3
N_2O_4	Dinitrogen tetraoxide (Dinitrogen dioxide)	+4
N_2O_5	Dinitrogen pentaoxide	+5

Structures

① N_2O → $\ddot{N} \equiv N \rightarrow O$ (Linear) — P.G. → $C_{\infty v}$

② NO → $:\dot{N} = O$ (Linear) — P.G. → $C_{\infty v}$

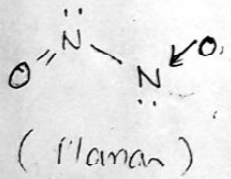
(In gaseous phase)

↓ (Paramagnetic)

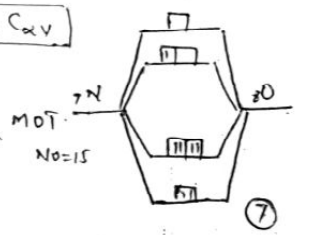
Dimer → Diamagnetic

$O=\dot{N}-\dot{N}=O$

(liq or solid phase)



(Planar)



⑦

⑧ $(\sigma 1s^2)^2$ $(\sigma 1s^*)^2$ $(\sigma 2s^2)^2$ $(\sigma 2s^*)^1$

C · N - C · N ·

(In some cases)

③ NO_2 → (unpaired electron)

$\dot{N} = O$ → It is readily undergo dimerisation.

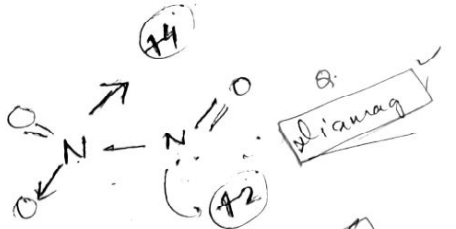
(Paramagnetic)

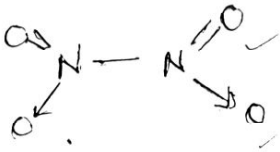
1s, 2s, 2P, 3S, 3P,

N_2O_x → x = 2 → ~~diamag~~ diamagnetic.

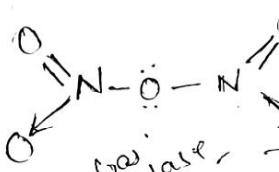
N_xO_y → double → diamagnetic

N_xO_y → Single → paramagnetic

(4) N_2O_3 → 

(5) N_2O_4 → 
Diamagnetic

(6) N_2O_5 Q. N–N Bond Absent ?


gas phase

Diamagnetic — NET

PF_5 → X ion in solid.

PCl_5 → PCl_4^+ PCl_6^-

↳ In solid state exist as $NO_2^{\oplus}$ $NO_3^{\ominus}$

Chemistry of N_2O (Laughing gas)

Prep.

$$NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$$

Used as a Local anaesthatic

$$2N_2O \xrightarrow[\Delta]{\text{high}} 2N_2 + O_2$$

Chemistry of (NO)

Prep.

$$3Cu + 8HNO_3\,(dil) \xrightarrow[\text{cold}]{} 2NO + 3Cu(NO_3)_2 + 4H_2O$$

Nitric oxide.

HNO_3 (conc.) $\xrightarrow{\Delta}$ NO_2 + ...

Gas phase of NO ⟶ Paramagnetic

In liquid or solid phase ⟶ Diamagnetic

Reaction

① $2NO + O_2 \longrightarrow 2NO_2$ (Reddish Brown colour)

② Dimerisation $NO \longrightarrow N_2O_2$

③ (*) Net — Nitrate ring test ⟶ $NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$ (salt)

$6FeSO_4 + 2HNO_3 + 3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2NO + 4H_2O$

$FeSO_4 + NO$

Oxidation state of Fe^{+1} ← $[Fe(H_2O)_5NO]^{+2}$ (Red brown ring)

$\overset{+}{NO}$

④ (*) Net — Sodium nitroprusside $Na_2[Fe(CN)_5NO]$ — Fe^{+} -3

test

⟶ $Na_2[Fe(CN)_5NO] + Na_2S$ (ferrous nitroso pseucide) {used detection of S^{2-} ions.

⟶ $Na_4[Fe(CN)_5NOS]$

Violet colour complex.

$[Fe(CN)_5(NO)]^{-2}$ (+2)

$Fe(CN)_5$

-5
+1
-4

Chemistry of NO_2

Prep. ⟶

$$2Pb(NO_3)_2 \xrightarrow{\Delta} 4NO_2 + 2PbO + O_2$$

Reactions.

NO_2 (g) ⟶	NO_2 (l) ⟶	N_2O_4 (solid)
(Reddish brown)	Brown	(colourless)
& Paramagnetic	& Paramagnetic	& Diamagnetic

$NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$

(*) Net: $2P_4 + 10NO_2 \xrightarrow{\Delta} 4P_2O_5 + 5N_2$

white phosphorus

N_2O_3

Prep → $NO + NO_2 \longrightarrow N_2O_3$

(Diamagnetic

Reaction:

$N_2O_3 + H_2O \longrightarrow 2HNO_2$ (Nitrous acid)

N_2O_5

$2HNO_3 \xrightarrow[\Delta]{P_2O_5} N_2O_5 + H_2O$

Q. N_2O_3 is th

anhydride

HNO_2

Reactions:

① $N_2O_5 + H_2O \longrightarrow 2HNO_3$

$HNO_3 + H_2O$

2) $H_2N_2O_4$ (1

HNO_2

② $N_2O_5 + 3H_2SO_4 \xrightarrow[\text{conc.}]{} 2NO_2^+ + H_3O^+ + 3HSO_4^-$

for nitration of aromatic ring

(3) It exists in ionic form in solid phase

self ionisation

$N_2O_5 \rightarrow NO_2^+ + NO_3^-$

$SPCl_5 \rightarrow PCl_4^+ PCl_6^-$

NET

But PF_5 is not ionised in solid form

OXY ACIDS OF NITROGEN → HNO_2 (Nitrous acid)

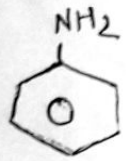
$NaNO_2 + HCl \xrightarrow[0^\circ C]{\text{below}} HNO_2 + NaCl$

(dil)

Reⁿ

$R-CH_2-NH_2 + HNO_2 \longrightarrow R-CH_2-OH + N_2 + H_2O$

Alcohol



$+ HNO_2 \longrightarrow$  $+ H_2O$

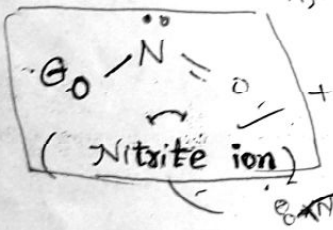
$(NaNO_2 + HCl)$ Benzene diazonium salt

Structure

$HO-\ddot{N}=O \rightarrow \ddot{O}-N=O$

ionisation

H_2O



(Nitrite ion) C_2V

HNO_2

↓

N_2O_3 (NO)

It is used as an oxidising agent. ($Fe^{+2} \rightarrow Fe^{+3}$)

Prep. HNO_3

$N_2O_5 + H_2O \longrightarrow 2HNO_3$

(2) Birkeland Eyde Process

$$N_2 + O_2 \xrightarrow[\text{Arch}]{\text{Electric}} 2NO \xrightarrow{O_2} NO_2 \xrightarrow{H_2O} HNO_3$$

(3) Ostwald process

$$4NH_3 + 5O_2 \xrightarrow[850^\circ C]{Pt/Rh,\ 5\,atm} 4NO + 6H_2O$$

$$NO + O_2 \longrightarrow NO_2$$

$$2NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$$

$$2HNO_2 \longrightarrow NO_2 + NO + H_2O$$

$$3NO_2 + H_2O \longrightarrow 2HNO_3 + NO$$

Aquaragia — Reactions HNO_3

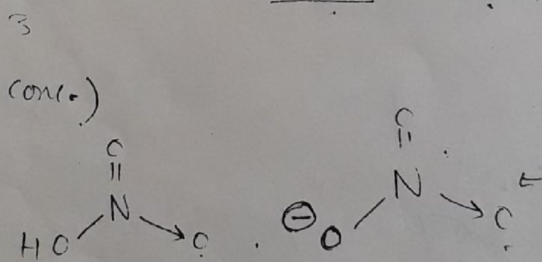
Q Net $HNO_3 + 3HCl \longrightarrow NOCl + H_2O + Cl$ (नवजात क्लोरीन / Nascent chlorine)

1 : 3

(Both are conc.)

$1\ HNO_3 + 3HCl$

HCL
1 2 3 = 3 भाग



planar (Monobasic)

planar Nitrate ion (D_{3h}) Q

⟷ Resonating Structures

Many metal salts are soluble in aqua regia due to Cl

Low O.N.	High O.N.
* Met. ous	ic
* -ve ion ite	ate

P_4O_6

$P_4 +$

(white)

P_4O_{10}

$P_4 +$

Struct

P_4

~~24-B~~

24-B

Oxides of phosphorous & oxyacids

(1) P_4O_6 ⟶ Phosphorous trioxide (P_2O_3)

$P_4 + 3O_2 \xrightarrow{\Delta} P_4O_6$

(white) (Limited supply)

Q PCl_5 - gas, PCl_4 - solid

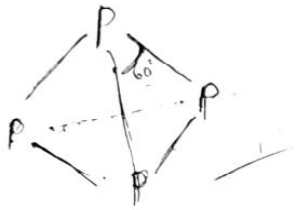
(2) P_4O_{10} ⟶ Phosphorous pentaoxide (P_2O_5)

Net Q. आते हैं P_4O_{10} पर

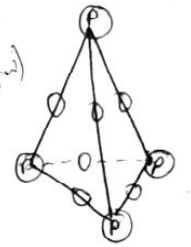
$P_4 + 5O_2 \xrightarrow{\Delta} P_4O_{10}$

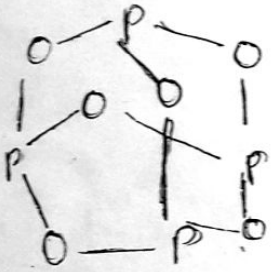
(excess)

Structures



P_4 molecule (White phosphorus)





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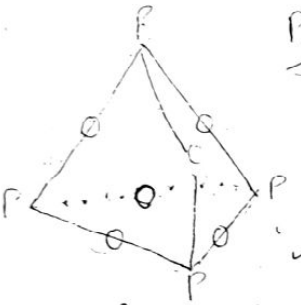
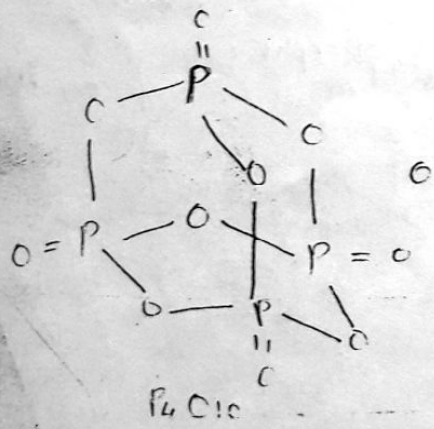
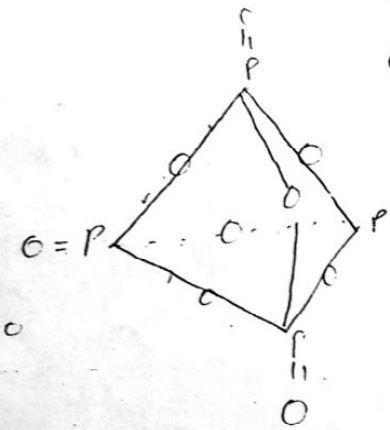


Total no of P-O bonds = 12

P_4O_6





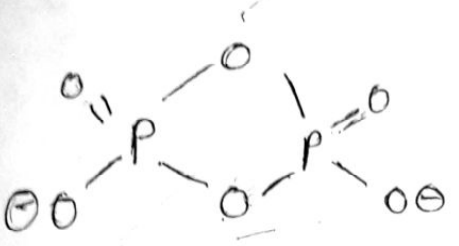
Total no. of σ : P-O bonds = 12 + 4

& π bonds (P-O) = 4

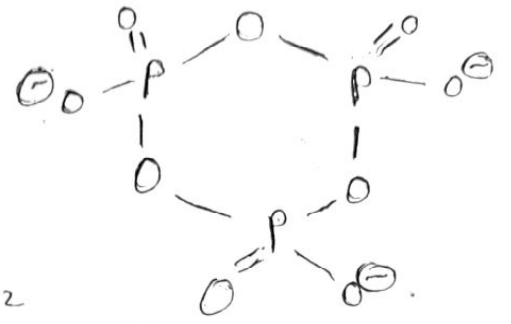
P_4O_{10} ✓ Net

(Hydrogen atom is absent)

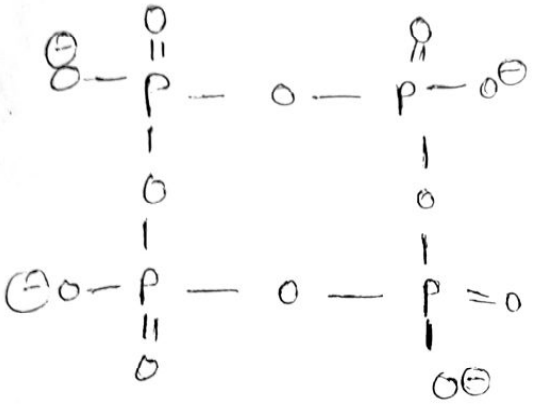
Metaphosphates → (cyclic phosphates) $(PO_3)_n$



di metaphosphate $[P_2O_6]^{-2}$



tri-metaphosphate

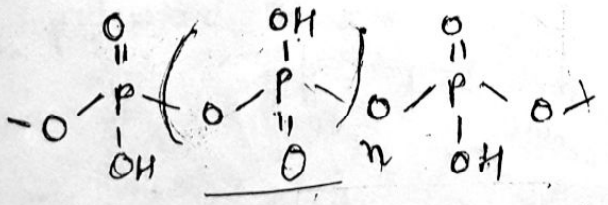


Tetrametaphosphate

Heating effect on H_3PO_4

Net

$$2H_3PO_4 \xrightarrow[(\Delta)]{220^\circ C} \underset{PPA}{H_4P_2O_7} \xrightarrow[-H_2O]{320^\circ} \underset{\text{metaphosphoric acid}}{(HPO_3)_n}$$



Structure of metaphosphoric acid

Uses

(1) Calgon → Sodium meta phosphate $(NaPO_3)_n$

(It is incorrectly called Sod. hexametaphosphate)

It is used for water softening because it removes (mean react with Ca^{+2} & Mg^{+2}) such ions, like Ca^{+2}, Mg^{+2} etc which makes hard to water. The process of water softening is called sequestration.

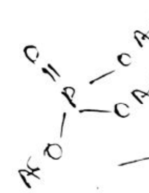
× (2) Use of Disodium dihydrogen pyrophosphate ($Na_2H_2P_2O_7$) →

It is used with $NaHCO_3$ to leaven the bread.

$$Na_2H_2P_2O_7 + 2NaHCO_3 \longrightarrow 2CO_2 + 2H_2O + Na_4P_2O_7$$

× (3) Used as a plastisizer →

eg. triarylphosphate



(P_4S_3)

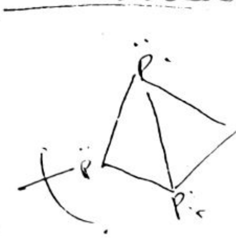
(4) Net

Phosphorous sulphide → In match industry

matchbox.

Structure of P_4 (Red & White phosphorus)

(Triangular) (Prism type)



Red phospr.

White phosphorous or yellow phospr

Phosphorus
- Black – polymer
- White – सबसे ज्या
- Red – poly