

## Period 3 (Na to Ar): Oxides:

### Oxides:

- Binary compounds
- There may be oxides of all elements except fluorine.

### Physical Properties:

#### 1) Structure:

Formula of oxide	$\text{Na}_2\text{O}_{(s)}$	$\text{MgO}_{(s)}$	$\text{Al}_2\text{O}_{3(s)}$	$\text{SiO}_{2(s)}$	$\text{P}_4\text{O}_{10(s)}$ $\text{P}_4\text{O}_{6(s)}$	$\text{SO}_{3(l)}$ $\text{SO}_{2(g)}$	$\text{Cl}_2\text{O}_{7(l)}$ $\text{Cl}_2\text{O}_{(g)}$
Oxidation number	+1	+2	+3	+4	+5/+3	+6/+4	+7/+1
Structure	Giant ionic			Giant covalent	Molecular covalent		

## 2) M.P/B.P :

- Giant structures of these (Na,Mg,Al) metal oxides and silicon dioxides ( $\text{SiO}_2$ ) will have high melting and boiling points, because;
  - ★ a lot of energy is needed to break the **strong bonds of (ionic or covalent) operating in three dimensions.**
- The oxides of phosphorous, Sulphur and chlorine will have low melting and boiling points, because;
  - ★ these oxides consist of **individual molecules (some small and simple and other polymeric)**, having **weak attractive forces**(Vander Waal's dispersion and dipole-dipole interactions).

- **These forces vary depending on the**

- ★ **size,**

- ★ **shape and**

- ★ **polarity of various molecules,**

**but will always be much weaker than the ionic or covalent bonds required in a giant structure.**

- **The oxides are either**

- ★ **Gases,**

- ★ **Liquids or**

- ★ **Low melting solids.**

### 3) Electrical conductivity:

- The ionic oxides of Na, Mg and Al are
  - ★ **good conductors** in solution form or molten state (due to movement of ions) and
  - ★ **bad conductors** in solid state (not have any free electrons).
- The covalent oxides of Si, P, S and Cl are
  - ★ **non-conductors** because they are non-ionizable.

## Chemical Properties: (Acid-Base behavior of oxides:)

### (1) Trend:

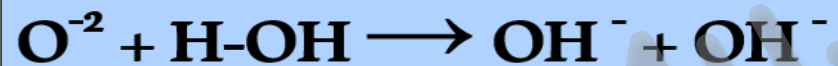
Formula of oxide	$\text{Na}_2\text{O}_{(s)}$	$\text{MgO}_{(s)}$	$\text{Al}_2\text{O}_{3(s)}$	$\text{SiO}_{2(s)}$	$\text{P}_4\text{O}_{10(s)}$ $\text{P}_4\text{O}_{6(s)}$	$\text{SO}_{3(l)}$ $\text{SO}_{2(g)}$	$\text{Cl}_2\text{O}_{7(l)}$ $\text{Cl}_2\text{O}_{(g)}$
Nature of oxides	Basic (Alkaline)	Basic (Weakly Alkaline)	Amphoteric	Weakly Acidic	Acidic	Strongly Acidic	very strongly Acidic

## (2) Reactions of oxides with water, acids and bases:

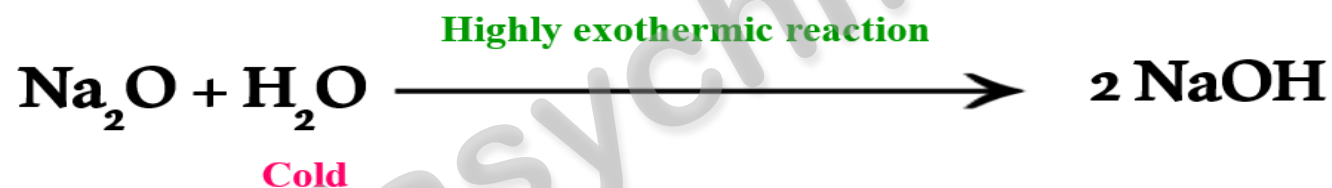
### (1) Sodium oxide (Na<sub>2</sub>O):

- It is simple **strongly** basic oxide.

**Reason:** It is basic because it contains the oxide ion O<sup>2-</sup>, which is a very strong base with a high tendency to combine with hydrogen ions.

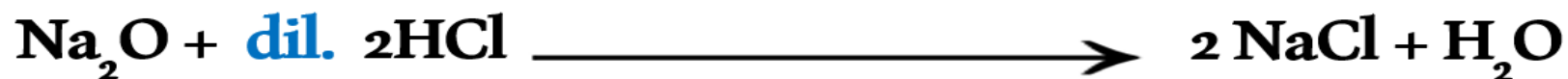


### Reaction with water :



Depending on its concentration, this will have a pH around 14

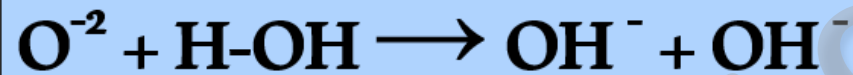
### Reaction with Acids :



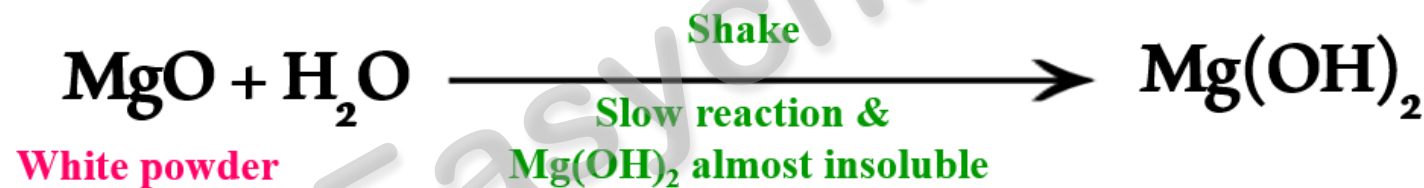
## (2) Magnesium oxide (MgO):

- It is simple basic oxide.

**Reason:** It is basic because it also contains the oxide ion  $O^{2-}$ , which is a very strong base with a high tendency to combine with hydrogen ions.

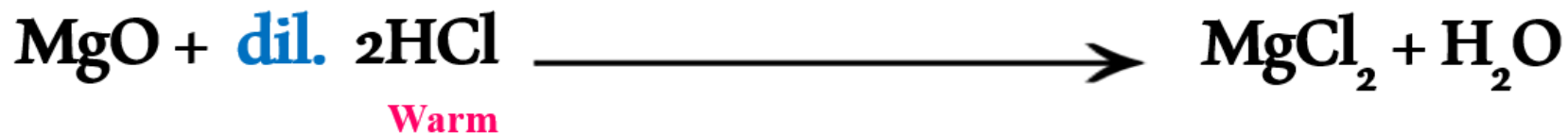


### Reaction with water :



Depending on its concentration, this will have a pH around 9 (slightly alkaline)

### Reaction with Acids :



- MgO is less basic than Na<sub>2</sub>O.



- MgO is not as strongly basic as Na<sub>2</sub>O, because its oxide ions O<sup>-2</sup> are not so free.

**Reason:**

- In the Na<sub>2</sub>O case, the solid is held together by attractions between Na<sup>+</sup> ion and O<sup>-2</sup> ions.
- In the MgO case, the solid is held together by attractions between Mg<sup>+2</sup> ion and O<sup>-2</sup> ions.
- It takes more energy to break the crystal lattice of MgO having smaller ions.
- Thus, **lattice energy of MgO is greater** than Na<sub>2</sub>O, so it is less basic.

### (3) Aluminium oxide (Al<sub>2</sub>O<sub>3</sub>):

- It is an amphoteric oxide. (Act as both an acid and a base)

**Act as a base:** It is an ionic oxide, which allows it to act as a base.

**Act as an acid:** The ions in it have high charge density and hence has a partial covalent character allowing it to act as an acid.

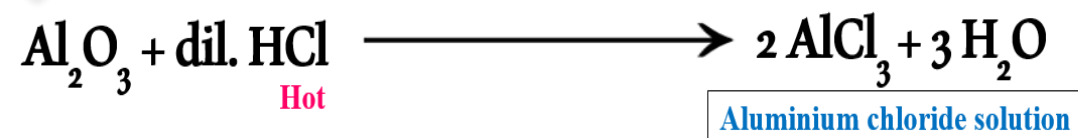
#### Reaction with water:

- Aluminium oxide

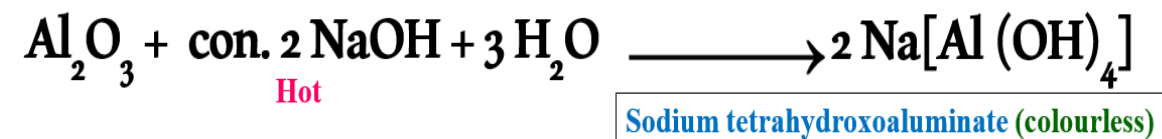
★ does not react with water and

★ does not dissolve in it

#### Reaction with acids :



#### Reaction with bases :



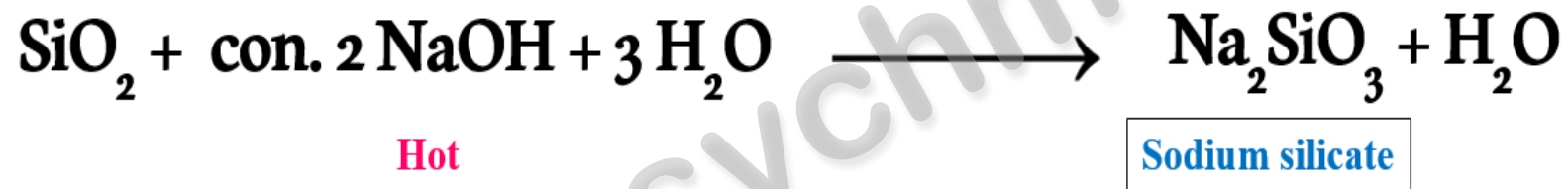
because ions are held strongly in the solid lattice to react with water

#### (4) Silicon dioxide (SiO<sub>2</sub>): (weakly acidic)

##### Reaction with water :

- Silicon dioxide is insoluble in water, because of
- ★ difficulty of breaking up large and giant covalent structure.

##### Reaction with bases :



##### Note:

- It also reacts with basic metal oxides (Na<sub>2</sub>O, K<sub>2</sub>O, CaO, PbO, ZnO or mixture of oxides) forming silicates and glasses.

## Balochistan Textbook board, Quetta:

Silicon dioxide is a stable compound and does not react with most of the acids at normal conditions. It reacts only with hydrofluoric acid (HF).



Tetrafluorosilane ( $\text{SiF}_4$ ) reacts further with HF to produce hexafluorosilicic acid.

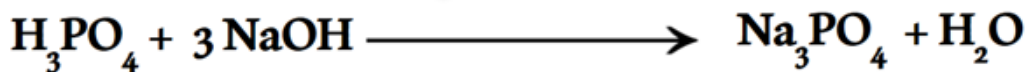


(5) Phosphorous(v) oxide ( $P_4O_{10}$ ): (Acidic)

Reaction with water :



Reaction with bases :



Sodium phosphate

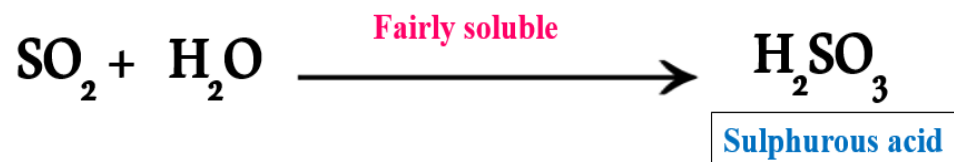
Sodium phosphate

## (6) Sulphur oxides (SO<sub>x</sub>): (Strongly acidic)

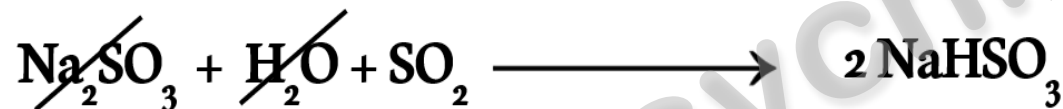
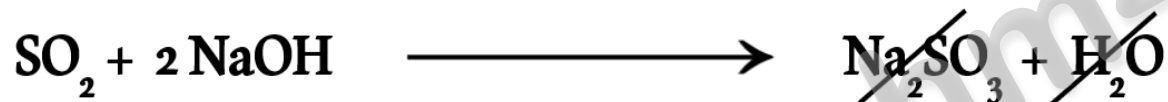
Sulphur has two oxides i.e., SO<sub>2</sub> & SO<sub>3</sub>.

### (i) SO<sub>2</sub>:

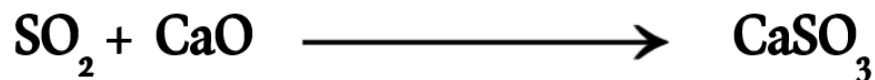
#### Reaction with water :



#### Reaction with bases :

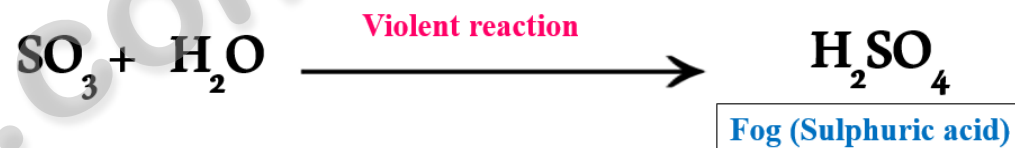


#### Reaction with basic oxides :

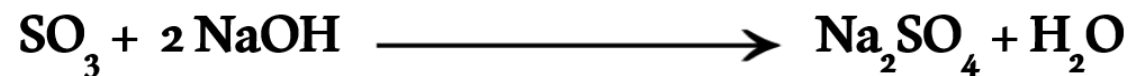


### (ii) SO<sub>3</sub>:

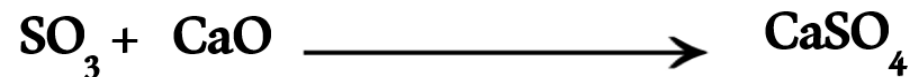
#### Reaction with water :



#### Reaction with bases :



#### Reaction with basic oxides :

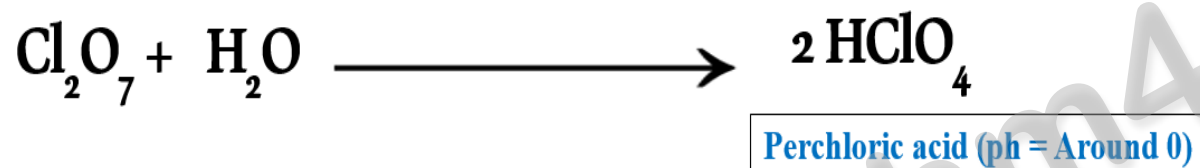


## (7) Chlorine oxides ( $\text{Cl}_2\text{O}_x$ ):

Chlorine has many oxides, two of them are:  $\text{Cl}_2\text{O}_7$ ,  $\text{Cl}_2\text{O}$ .

### (i) Chlorine (VII) oxide, $\text{Cl}_2\text{O}_7$ : (Very strongly acidic)

#### Reaction with water :

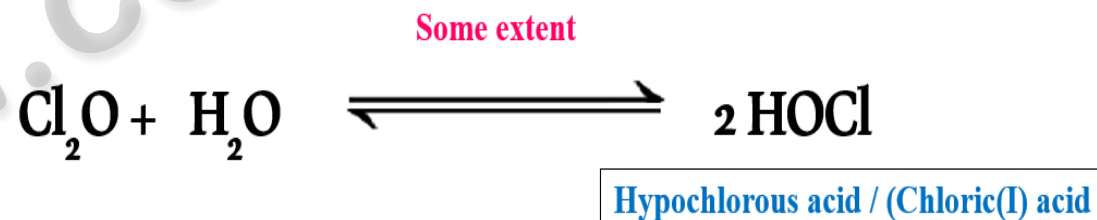


#### Reaction with bases :

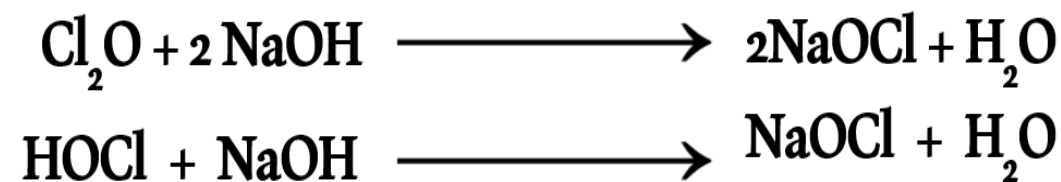


### (ii) Chlorine (I) oxide, $\text{Cl}_2\text{O}$ : (Far less acidic than chlorine (VII) oxide)

#### Reaction with water :

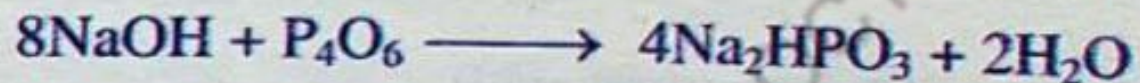
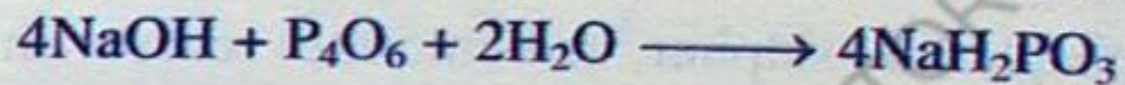


#### Reaction with base :

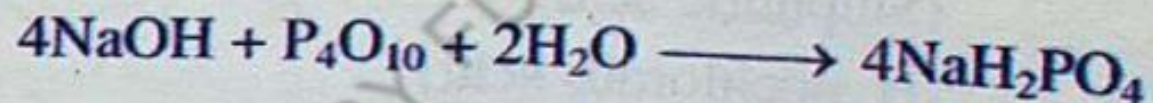


## Balochistan Textbook board, Quetta:

Phosphorus trioxide reacts directly with sodium hydroxide to produce two series of salts (sodium dihydrogenphosphite and sodium hydrogenphosphite).



Phosphorus pentaoxide reacts directly with sodium hydroxide to produce three series of salts (sodium dihydrogen phosphate, sodium hydrogen phosphate and sodium phosphate).



## Balochistan Textbook board, Quetta:

