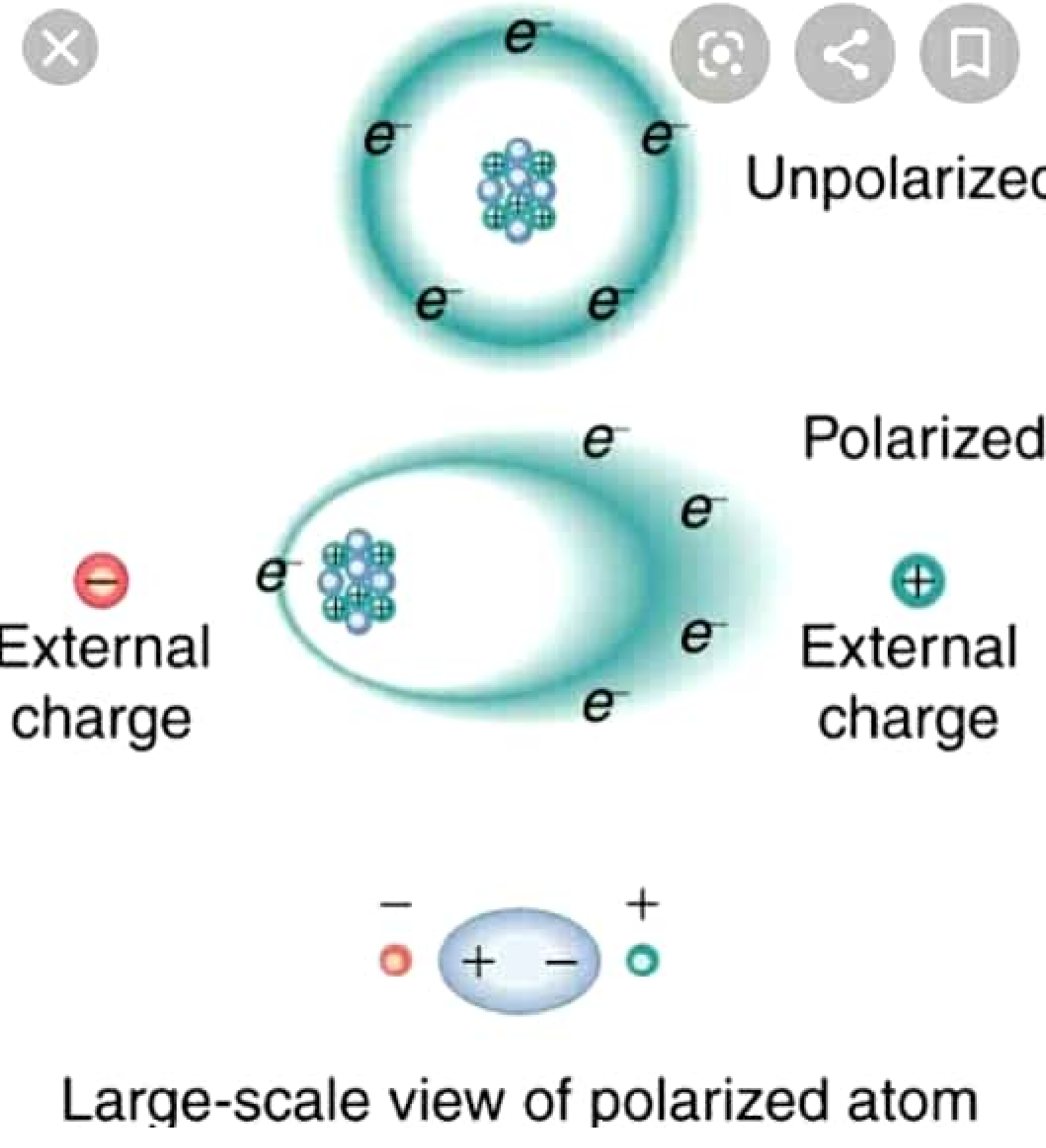
I Polarization of Atoms:

Polarization occurs when an electric field distorts the negative cloud of electrons around positive atomic nuclei in a direction opposite to the field. This slight separation of charge makes one side of the atom somewhat positive and other side somewhat negative.

Definition:

Polarization is a measure of how easily electron cloud is distorted by an electric field. Typically an electron cloud will belong to an atom, molecule or ion.



II Polarization of Molecules :

a) A **non polar molecule** is one in which centre of gravity of positive charges (protons) coincide with centre of gravity of negative charges (electrons)

Example : O_2, N_2, H_2 etc

Non polar molecules donot have dipole moments. If a non polar dielectric is placed in an electric field centre of gravity of charges get displaced. Molecules are then said to be polarized and are called **induced dipoles**. They acquire induced dipole moments in the direction of electric field. This is **induced polarization**.

b) A **polar molecule** is one, in which centre of gravity of positive charges is separated from centre of gravity of negative charges by a finite distance.

Example : N_2O, H_2O, HCl, NH_3 etc.

They have a permanent dipole moment. In absence of an electric field dipole moment of polar molecules orient themselves in random directions. Hence no net dipole moment is observed in the dielectric. When an electric field is applied, dipoles orient themselves in the direction of electric field. Hence a net dipole moment is produced.

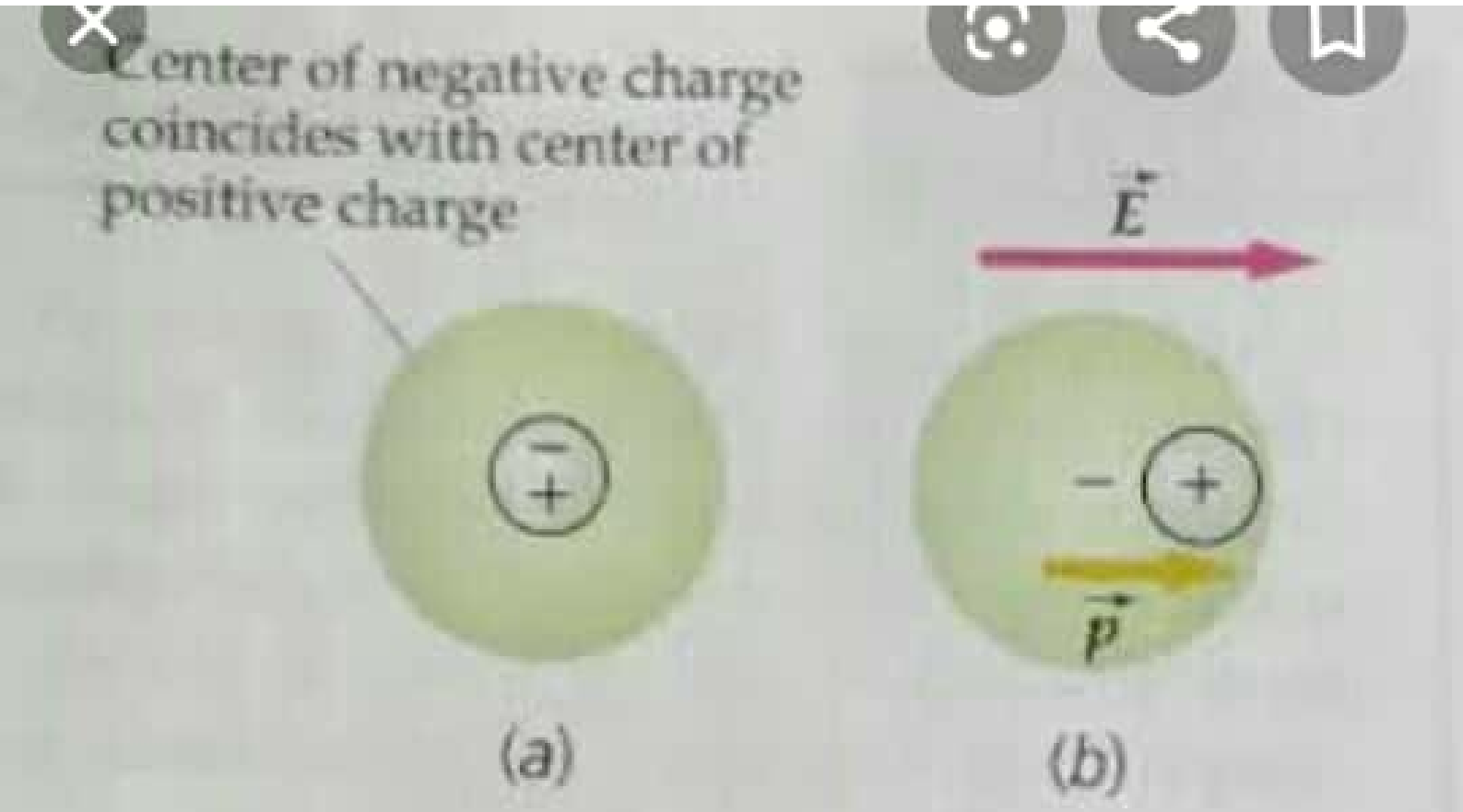


FIGURE 24-27 Schematic diagrams of the charge distributions of an atom or nonpolar molecule. (*a*) In the absence of an external electric field, the center of positive charge coincides with the center of negative charge. (*b*) In the presence of an external electric field, the centers of positive and negative charge are displaced, producing an induced dipole moment in the direction of the external field.

Alignment of dipole moments of permanent or induced dipoles in the direction of applied electric fields is called polarization or **electric polarization**.

Polarization of Molecules

(i) Polarization of Non polar Molecules (Induced Polarization)

(ii) Polarization of Polar Molecules

- Distortion Polarization
- Orientation Polarization

(i) Polarization of non polar molecules :

Although a non polar molecule, as a whole neutral, is made up of positively charged cloud and negatively charged cloud, where centre of positive charge coincides with centre of negative charge when this molecule is placed between two charge plates of electric field, negative charge cloud is attracted by positive plate of the field and positive charged cloud of the molecule is attracted by the negative plate of the electric field.

As a result of this -ve and +ve charge cloud of the molecule are distorted and within electric field +ve charge reside at one end of the molecule and -ve on the other end. Thus a +ve and -ve pole is induced in the molecule in presence of elec field. This phenomena is known as polarisation of non polar molecules or induced polarization (This polarization is temporary.)

Due to creation of +ve and -ve pole within a neutral molecule in presence of elect. field a moment can operate between +ve and -ve charge centre of the

molecule, known as induced electric dipole moment denoted by μ_{Ind}.

Magnitude of μ_{Ind} depends on strength or intensity of electric field.

So, $\mu_{Ind} \propto E$ [where E = Intensity or strength of electric field]

$$\mu_{Ind} = \alpha E \longrightarrow (1)$$

When, $E = 1$, $\mu_{Ind} = \alpha$

Here α is proportionality constant in eqn(1) → called polarizability of the molecule

Definition of Polarizability

The moment induced in a molecule in presence of electric field of strength or intensity unity is called polarizability of the molecule.

In SI. unit,

$$\alpha = \frac{\mu_{Ind}}{E} = \frac{\text{coulomb . metre}}{\text{Volt/metre}}$$

$$= \frac{C \cdot m}{V/m} = \frac{C \cdot m^2}{V} \text{ or } \frac{C^2 m^2}{J} \quad [\because J = V \cdot C$$

Total molar polarization (P_m) induced in a non polar molecule and polarizability (α) of the molecule are related by the equation:

$$P_M = \frac{D-1}{D+2}\frac{M}{\rho} = \frac{4}{3}\pi N_0 \alpha$$

This relation is known a Clausius Massotti Relation

where
- D = dielectric constant of med
- M = Mol wt. of the substance,
- ρ = density
- N_0 = Avogadro No