GAUSS LAW FOR $\bar{E}$ FIELDS (DIFFERENTIAL FORM)

RECALLING GAUSS LAW IN INTEGRAL FORM,

$$\oint_S \bar{E} \cdot \hat{n}\, ds = \frac{Q_V}{\varepsilon_0}$$

AS WE NOTED BEFORE, $Q_V = \rho\, \Delta V$. REPLACING Q_V AND ~~APPLYIN~~ DIVIDING BY ΔV,

$$\frac{1}{\Delta V} \oint_S \bar{E} \cdot \hat{n}\, ds = \frac{\rho\, \cancel{\Delta V}}{\varepsilon_0\, \cancel{\Delta V}} = \frac{\rho}{\varepsilon_0}$$

APPLYING NOW THE LIMIT WHEN $\Delta V \to 0$,

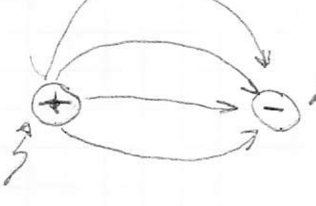
$$\underbrace{\lim_{\Delta V \to 0} \frac{1}{\Delta V} \oint_S \bar{E} \cdot \hat{n}\, ds}_{\text{DEFINITION OF DIVERGENCE}} = \frac{\rho}{\varepsilon_0}$$

THEN,

$$\boxed{\nabla \cdot \bar{E} = \frac{\rho}{\varepsilon_0}}$$

GAUSS LAW FOR $\bar{E}$ FIELD IN DIFFERENTIAL FORM.

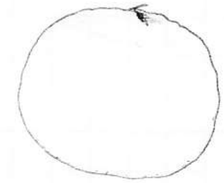
THE DIVERGENCE GIVES AN IDEA IF THE $\bar{E}$ FIELD IS ORIGINATING OR TERMINATING AT A GIVEN POINT. THIS IMPLIES THE PRESENCE OF ELECTRICAL CHARGE AT THAT POINT.



$\nabla \cdot \bar{E} < 0$ AT THIS POINT

$\nabla \cdot \bar{E} > 0$ AT THIS POINT

ELECTRIC CHARGE PRESENT



$\nabla \cdot \bar{E} = 0$ AT EVERY POINT

NO ELECTRIC CHARGE PRESENT