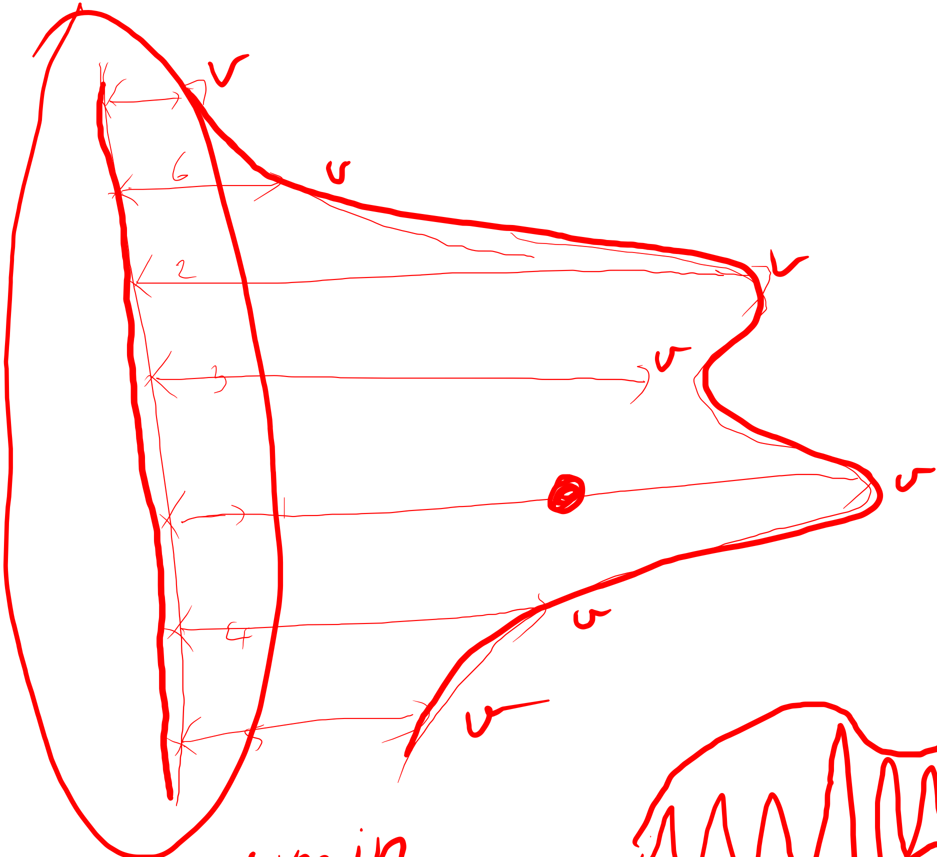
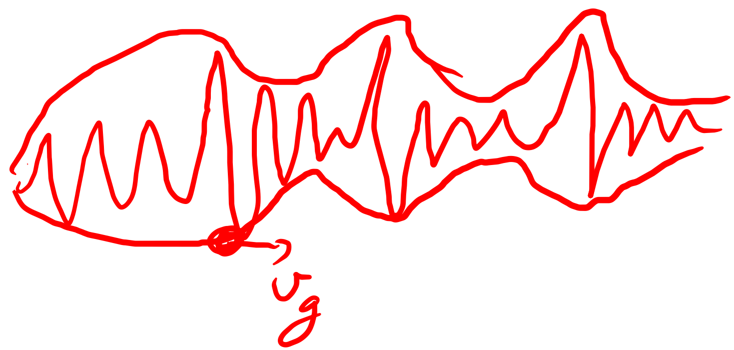


1 min



wave trains

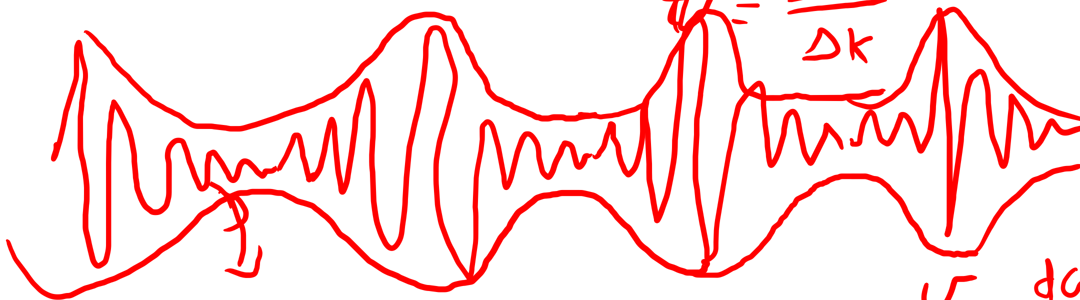
wave packets

$$Y = \cos\left((k+\Delta k)x + (\omega+\Delta\omega)t\right) + \cos\left((k-\Delta k)x + (\omega-\Delta\omega)t\right)$$

$$Y = \cos A + \cos B = 2\cos\left(\frac{A+B}{2}\right)\cos\left(\frac{A-B}{2}\right)$$

$$Y = \underbrace{2\cos\left(\Delta k x + \Delta\omega t\right)}\underbrace{\cos\left(kx + \omega t\right)}$$

$$v_p = \frac{\Delta\omega}{\Delta k}$$



$$v_g = \frac{d\omega}{dk}$$

$$\frac{d^2E}{dt^2} = c^2 \frac{d^2E}{dx^2}$$

$$\frac{d^2B}{dt^2} = c^2 \frac{d^2B}{dx^2}$$

$$\vec F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}\hat r$$

$$q_1 \xrightarrow{\hat r} q_2$$

$$\downarrow$$

$$\vec F = \frac{1}{4\pi\varepsilon}\frac{q_1 q_2}{r^2}\hat r$$

$$\varepsilon = \varepsilon_0 \varepsilon_r$$

$$\varepsilon_r = \frac{\varepsilon}{\varepsilon_0}$$

$$\vec E = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{r^2}\hat r$$

$$q_2 = +1C$$

$$\downarrow$$

$$E = \frac{q_1}{4\pi\varepsilon_0}\left(-\vec\nabla\left(\frac{1}{r}\right)\right)$$

$$\frac{1}{r^2}\hat r = -\nabla\left(\frac{1}{r}\right)$$

$$\vec\nabla r^n = n r^{n-1}\hat r$$

$$n = -1$$

$$\vec\nabla\left(\frac{1}{r}\right) = -1\, r^{-2}\hat r$$

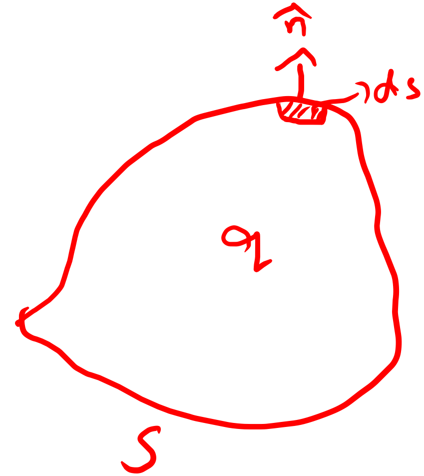
$$E = -\nabla\underbrace{\left(\frac{q_1}{4\pi\varepsilon_0}\frac{1}{r}\right)}$$

$$\vec{E} = -\vec{\nabla} V$$

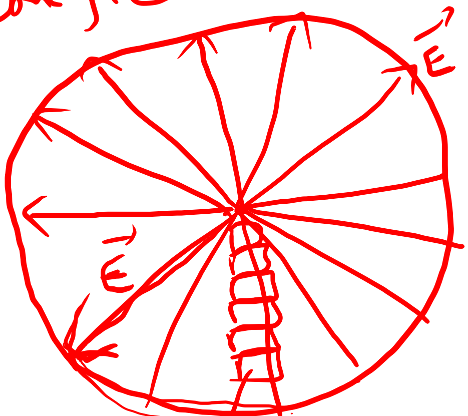
$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q \quad q_2}{r}$$

$$\underbrace{\Phi}_{\text{Net outward flow of electric field}} = \underbrace{\oint \vec{E}\cdot d\vec{s}}\, = \frac{q}{\varepsilon_0}$$



$$d\vec{s} = \hat{n}\,ds$$



$$d\vec{s} = \hat{n}\,ds$$

$$\underbrace{(\vec{\nabla}\cdot\vec{E})} \longrightarrow \frac{\text{Net outward flow}}{\text{Volume}}$$

$$\int_V \underbrace{\vec{\nabla}\cdot\vec{E}\,dv} = \oint_S \vec{E}\cdot d\vec{s} = \Phi$$

$$\int_V \underbrace{\vec{\nabla}\cdot\vec{E}}\, dv = \frac{q}{\varepsilon_0}$$

$$\rho_v = \frac{q}{v} \qquad \sigma = \frac{q}{A}$$

$$q = \int_V \rho\, dv$$

$$\int_V \vec{\nabla}\cdot\vec{E}\, dv = \frac{1}{\varepsilon_0}\int_V \rho\, dv$$

$$\int_V \underbrace{\vec{\nabla}\cdot\vec{E}}\, dv = \int_V \underbrace{\frac{\rho}{\varepsilon_0}}\, dv$$

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

$$\nabla\cdot E = \rho(x,y,z)$$

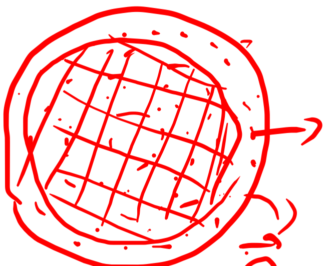
1) $\vec{E} = x^2\hat{x} + y^2\hat{y} + z^2\hat{z}$

$$\vec{\nabla}\cdot\vec{E} = \frac{(2x + 2y + 2z)}{\varepsilon_0}$$

$$\rho = \varepsilon_0 \vec{\nabla}\cdot\vec{E}$$

$$\underline{\underline{\rho}} = \underline{\underline{\rho_f}} + \underline{\underline{\rho_b}}$$

$$\oint_S \underbrace{\nabla \cdot E}_{\text{some}} \, \underline{ds} = 0$$

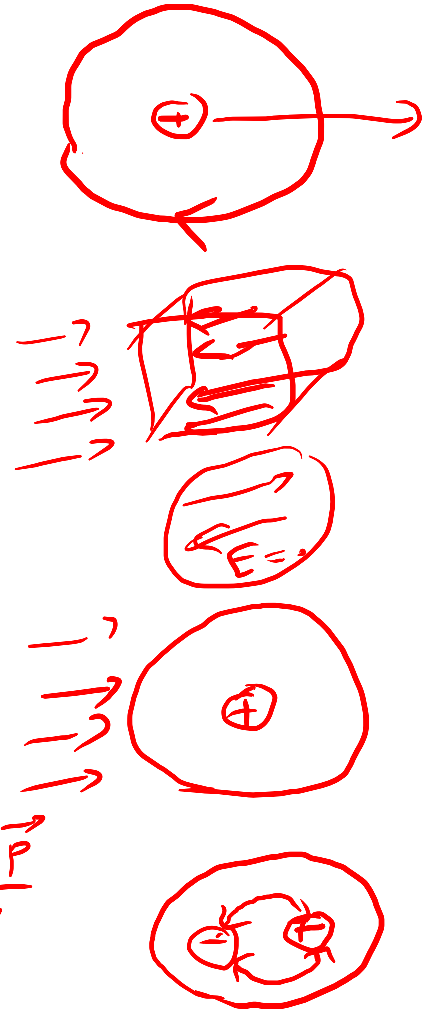


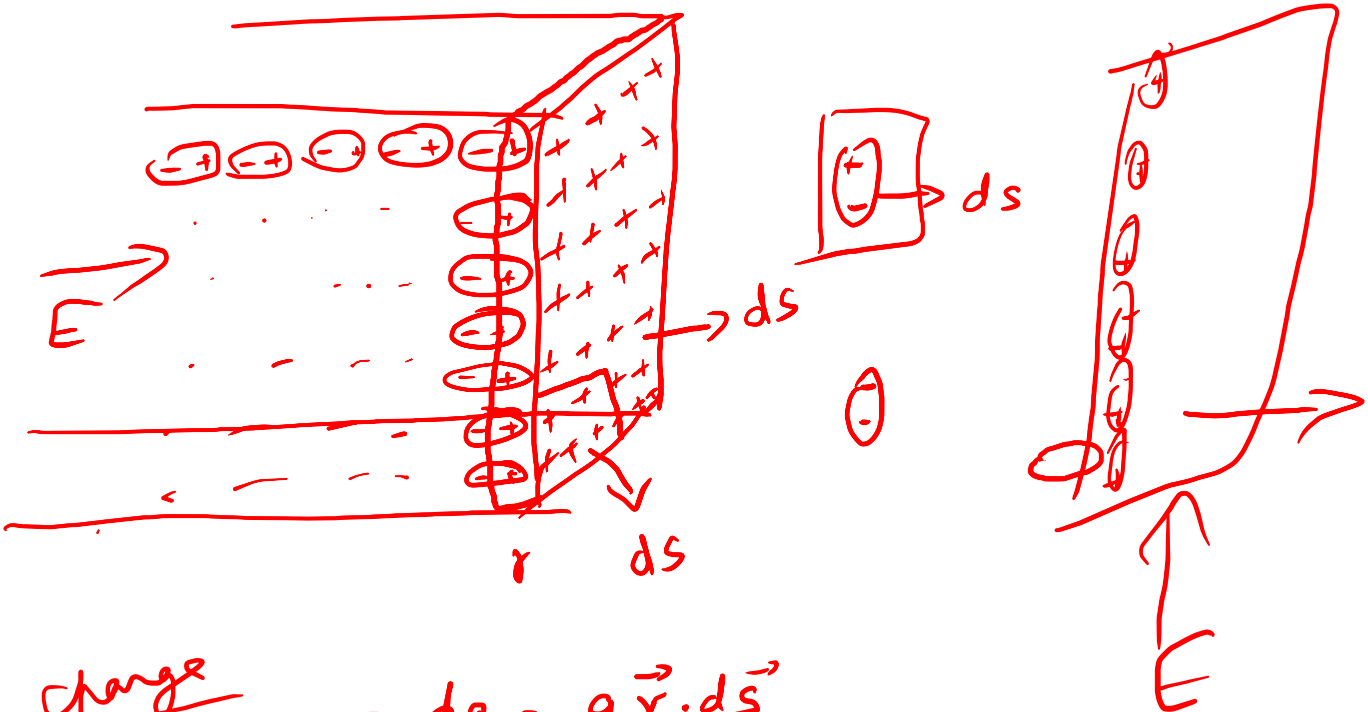
$$\vec{p} = q r$$

$$N \vec{p} = \underline{N q r}$$

$$\vec{p}_t =$$

$$\boxed{\vec{P} = \frac{p}{V} = \frac{N q r}{V} = \frac{N \vec{p}}{V}}$$





charge due to one dipole molecule $= \underbrace{dq}_{} = \underbrace{q\vec{r}\cdot d\vec{s}}_{}$

$$dQ = \underbrace{\frac{N}{V} q\vec{r}}_{}\cdot d\vec{s} \qquad \frac{N}{V}$$

$$dQ = \vec{P}\cdot d\vec{s}$$

$$dQ = \vec{P} \cdot d\vec{s}$$

$$d\vec{s} = \hat{n}\, ds$$

$$dQ = \vec{P} \cdot \hat{n}\, ds$$

$$\sigma = \frac{dQ}{ds} = \vec{P} \cdot \hat{n}$$

$$\sigma = \vec{P} \cdot \hat{n}$$

$\underline{\nabla s}$