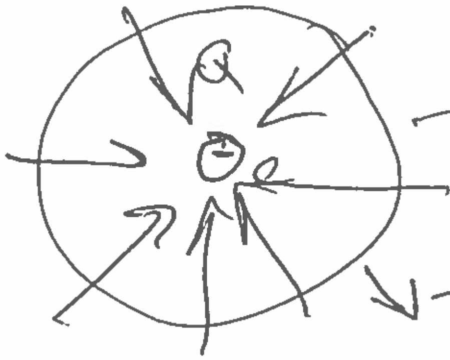


Gaussian surface is a sphere

direction of spherical area points outward

$\vec{E}$ points inward

$$\Phi_E = -EA$$

— sign due to $\vec{E}$ opposite direction of $\vec{A}$

Gauss's Law

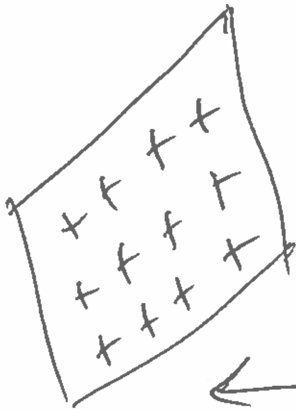
$$\Phi_E = \frac{Q_{enc}}{\varepsilon_0} = \frac{Q}{\varepsilon_0}$$

$$-EA = \frac{Q}{\varepsilon_0}$$

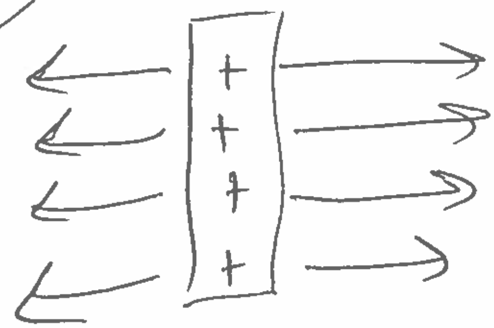
$$E = -\frac{Q}{A\,\varepsilon_0} = \frac{-Q}{4\pi r^2 \varepsilon_0}$$

$$\boxed{k = \frac{1}{4\pi\varepsilon_0}}$$

$$\vec{E} = \frac{-kQ}{r^2}(\hat{r})$$

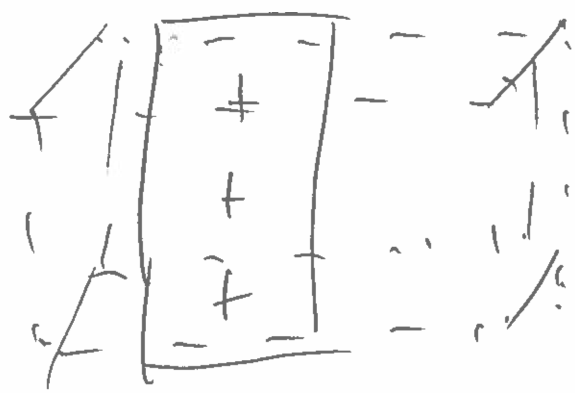


— Plane of charge

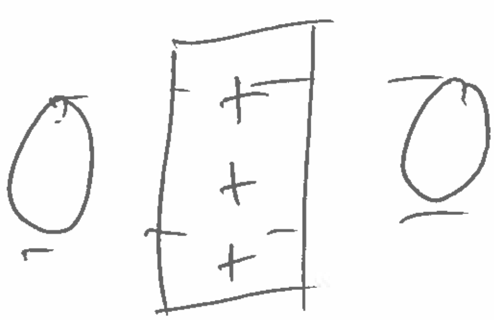


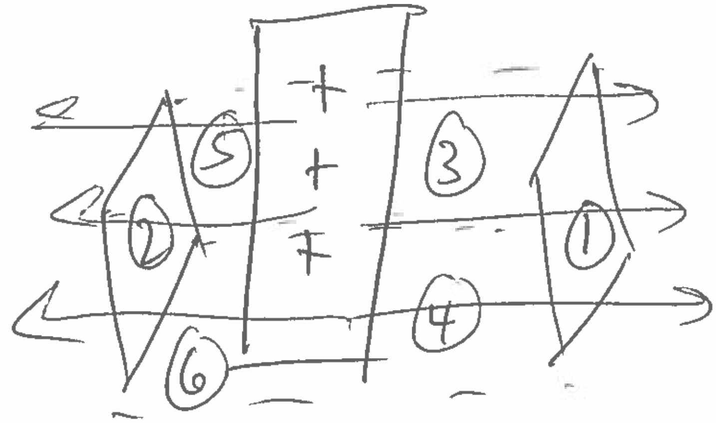
Gaussian surface "pill box"

sideways



Let's use this surface





(1) - right
(2) - Left
(3) - Back
(4) - front
(5) - Top
(6) - Bottom

$$\Phi_{Net} = \Phi_1 + \Phi_2 + \Phi_3 + \Phi_4 + \Phi_5 + \Phi_6$$

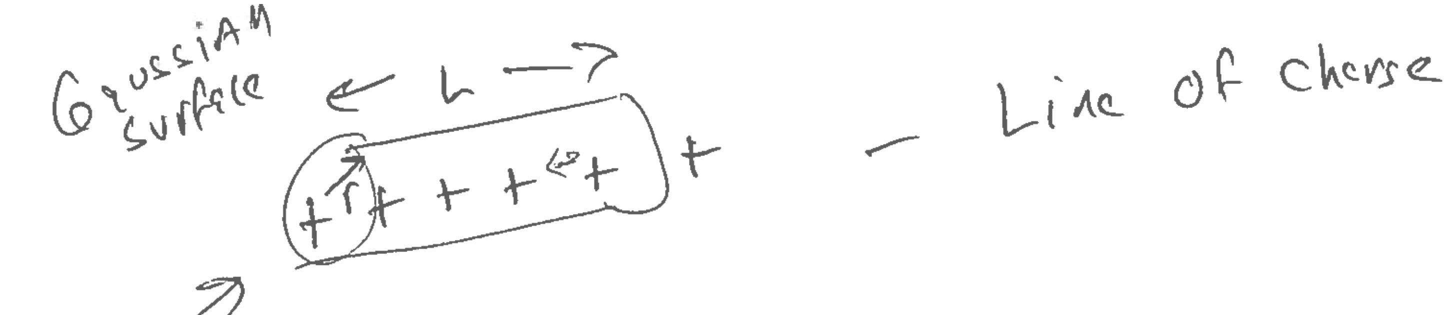
$$\Phi_1 = E_1 A_1 + E_2 A_2 + 0 + 0 + 0 + 0$$

$$\Phi_{Net} = 2EA = \frac{Q_{enc}}{\varepsilon_0} = \frac{\sigma A}{\varepsilon_0}$$

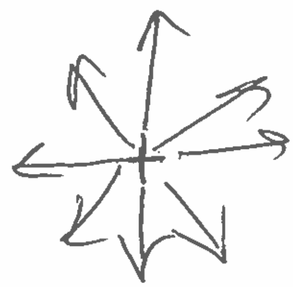
$$\sigma = \frac{\text{charge}}{\text{Area}} = \frac{Q_{Tot}}{A_{Tot}}$$

$$2EA = \frac{\sigma A}{\varepsilon_0}$$

$$\boxed{E = \frac{\sigma}{2\varepsilon_0}}$$



$$\Phi_E = E A_{cylinder} = \frac{Q_{enc}}{\varepsilon_0}$$



Sideways

$$A_{cylinder} = 2 A_{\substack{end\\caps}} + A_{Body}$$

$$2\pi r^2 \qquad 2\pi r L$$

$$\Phi = \Phi_{\substack{end\\caps}} + \Phi_{Body}$$

$$= 0 \qquad E\, 2\pi r L = \frac{Q_{enc}}{\varepsilon_0}$$

$$Q_{enc} = \lambda L \qquad \lambda = \frac{Q_{Tot}}{L_{Tot}}$$ Linear charge density

$$E\, 2\pi r L = \frac{\lambda L}{\varepsilon_0}$$

$$\boxed{\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\hat{r}}$$

$$\vec{E}_{\substack{pt\\ charge}} = \frac{Q}{4\pi\varepsilon_0 r^2}\,\hat{r}$$

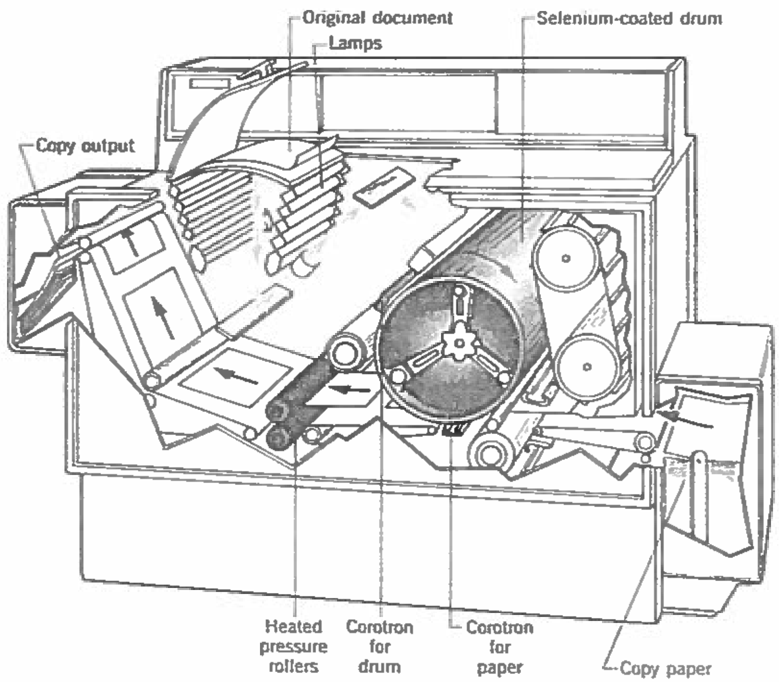
$$E_{\substack{line\\ charge}} = \frac{\lambda}{2\pi\varepsilon_0 r}\,\hat{r}$$

$$\vec{E}_{Area} = \frac{\sigma}{2\varepsilon_0}\quad \hat{x},\ (-\hat{x})$$

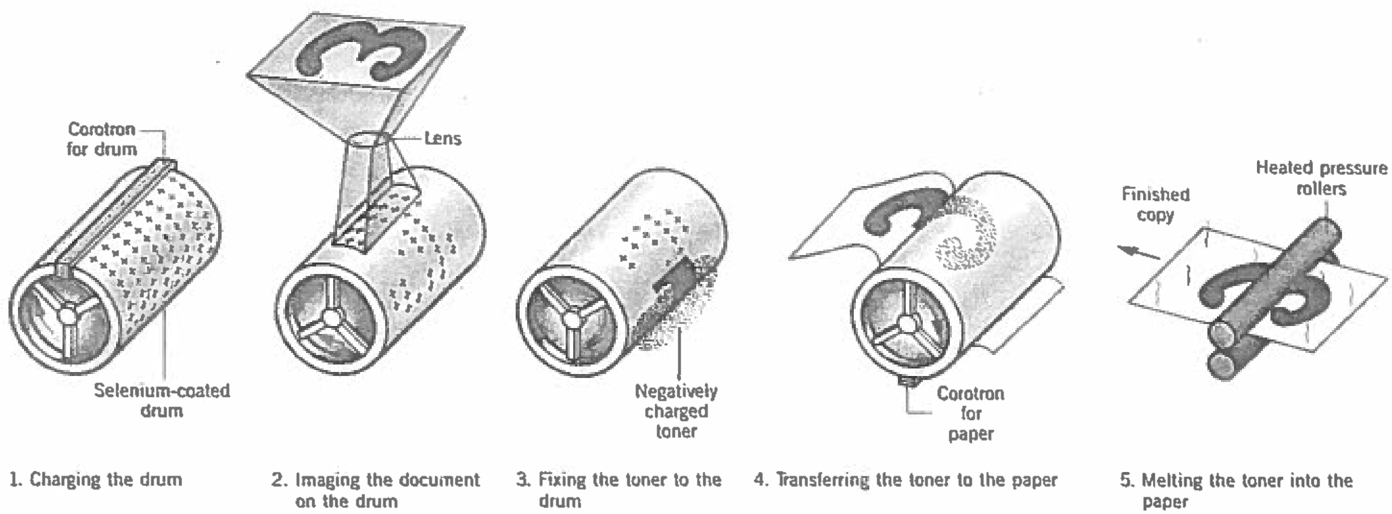
Photo copier

$$\vec{F}_{el} = \frac{k\,Q_1 Q_2}{r_{12}^2}\left(\hat{r}\right) = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}\,\hat{r}$$

$$\vec{E} = \frac{\vec{F}}{Q} \qquad \vec{F}_{2\to 1} = \vec{E}_2 Q_1$$



(a)

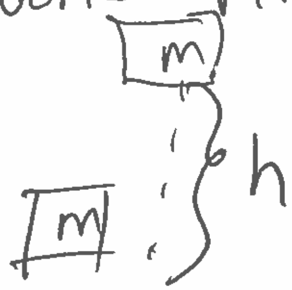


(b)

FIGURE 18.30 a, b 132

$$\sum W_{done}^{cons} = \Delta E = \Delta K + \sum \Delta U$$

work raising a mass a distance h



$$W_{done}^{cons} = -\underbrace{mg}_{F_{grav}}\ \underbrace{h}_{dist}$$

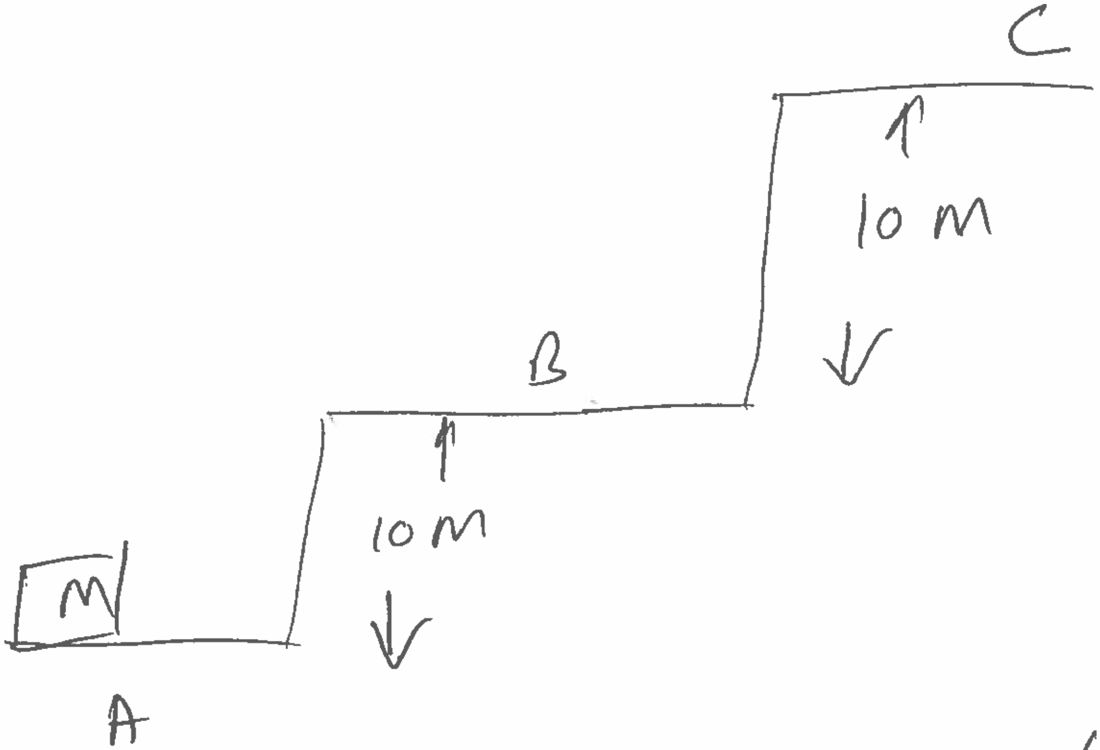
$\Delta K = 0$ if mass does not have any motion other than while it is raised.

$$\Delta U = +mgh$$

$$\sum W_{done}^{cons} = -mgh = 0 + mgh$$

X does not work

$$W_{cons} = -\Delta U$$



$$\Delta U_{A \to B} = + mg(10\,m)$$

$$\Delta U_{B \to C} = + mg(10\,m)$$

$$\Delta U_{A \to C} = + mg(20\,m)$$

$$U_B = ?$$

Potential Energy has no fixed zero point, only changes in Potential energy are Physical

Zero Potential Energy is arbitrary.

Positive potential energy means Energy is available to do work.

Negative potential energy means work must be done to move from a region of negative potential Energy.

Negative energies ⇒ bound systems.

Electrical field is Electric force per unit charge.

Electrical potential (V) is electrical potential energy per unit charge.

Unit for electrical potential is the Volt.

$$1\,V = 1\,\frac{J}{C} = \frac{\text{Joule}}{\text{Coulomb}} = \text{Volt}$$