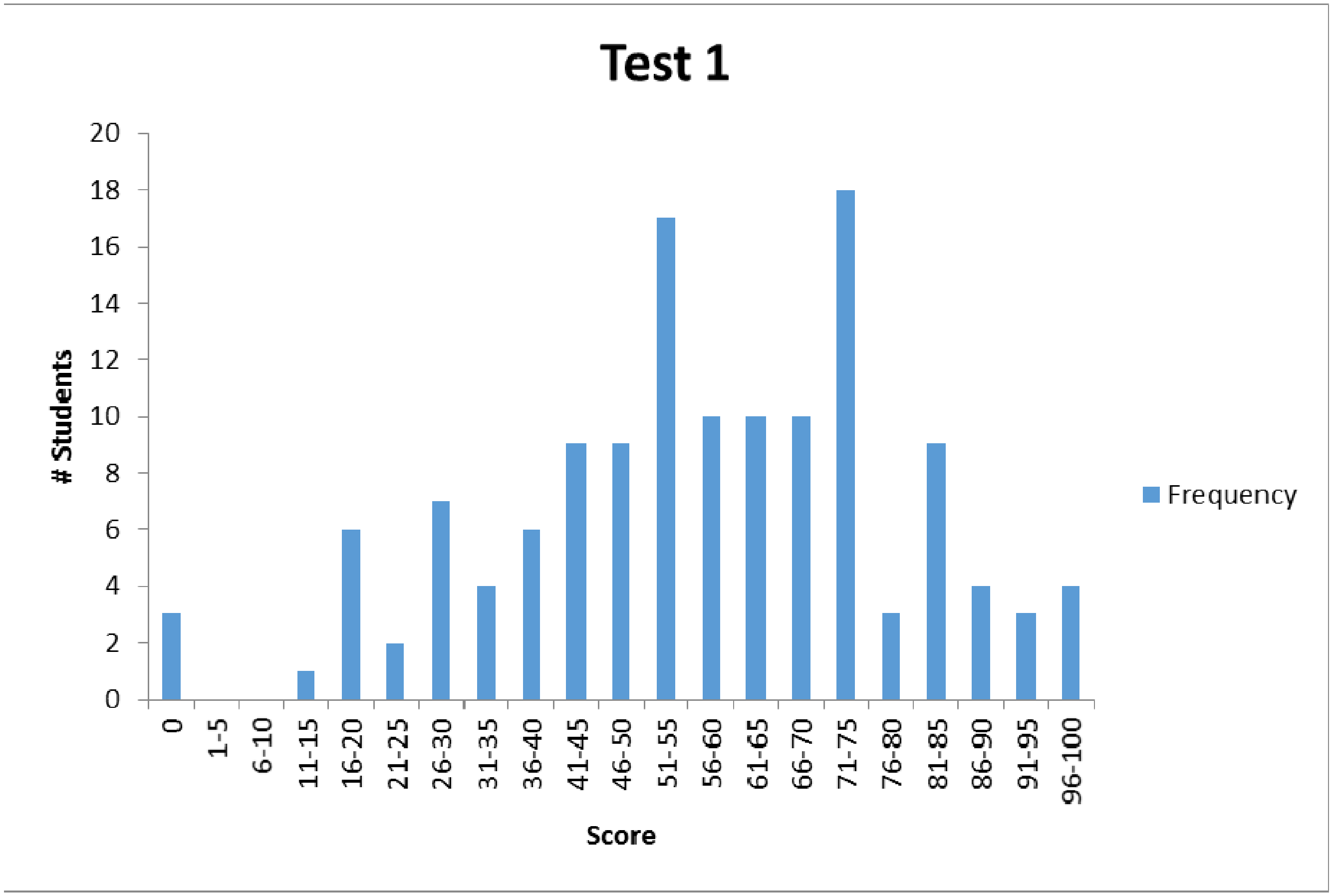


Score	*# students*
0	3
1-5	0
6-10	0
11-15	1
16-20	6
21-25	2
26-30	7
31-35	4
36-40	6
41-45	9
46-50	9
51-55	17
56-60	10
61-65	10
66-70	10
71-75	18
76-80	3
81-85	9
86-90	4
91-95	3
96-100	4

		# students
85-100	A	13
70-84	B	28
50-69	C	49
30-49	D	28
0-29	E	17

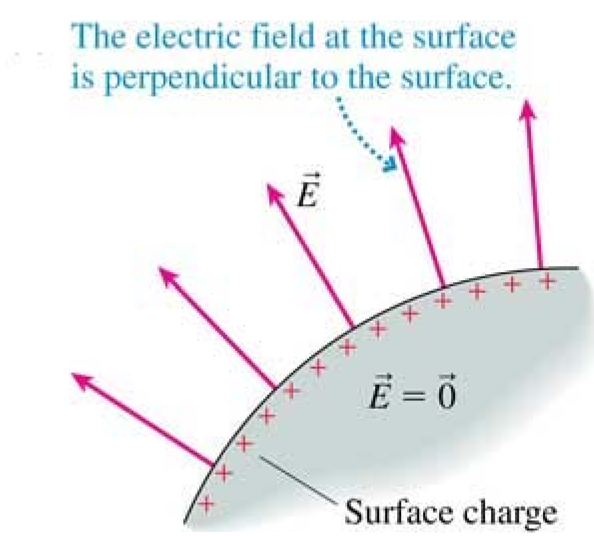
Total number of students: 135

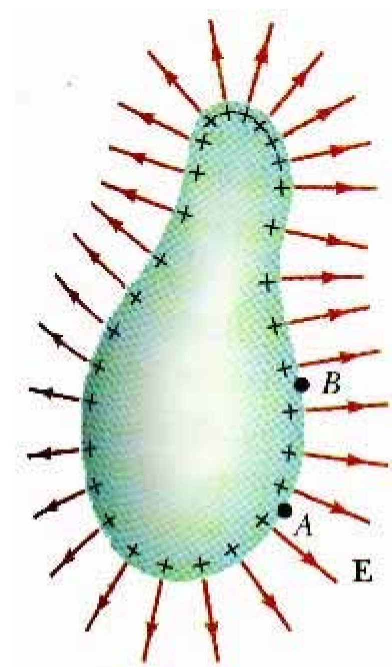
Conductors and equipotentials

All on Conductors (as a Source of Electric Field)

The following are true for any shape of a conductor, including the ones with cavities inside it (but assume there is no charge inside the cavities).

1. If the conductor has a net charge, all charges will stay on the outer surface of the conductor.
2. There is no electric field inside the conductor.
3. The electric field outside the outer surface always perpendicular to the surface in the proximity of the conductor.

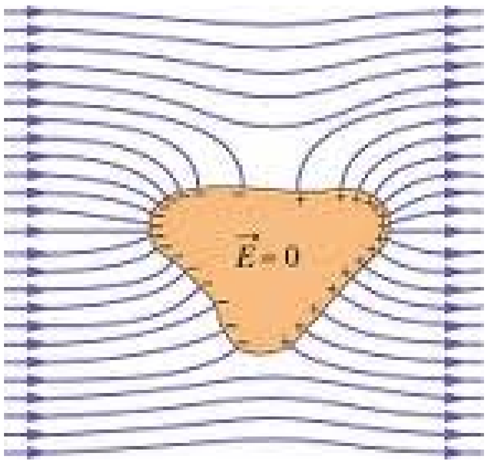


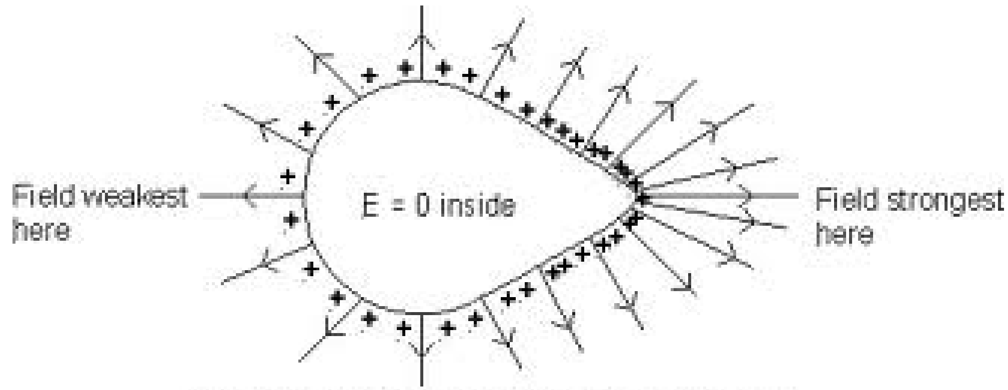


All on Conductors (as a Source of Electric Field)

(Con't)

4. Electric field is stronger at the sharper part (smaller radius of curvature) of the outer surface.

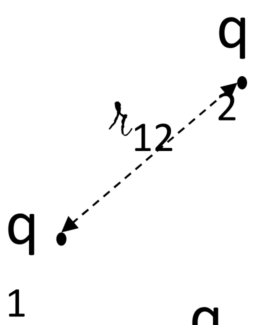




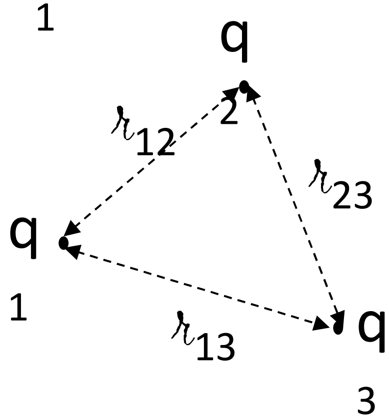
(d) Electric field & charge distribution around a pear-shaped conductor

5. The conductor has the same potential, including the cavities (unless there are charges inside the cavities) and surfaces, through out the whole body.

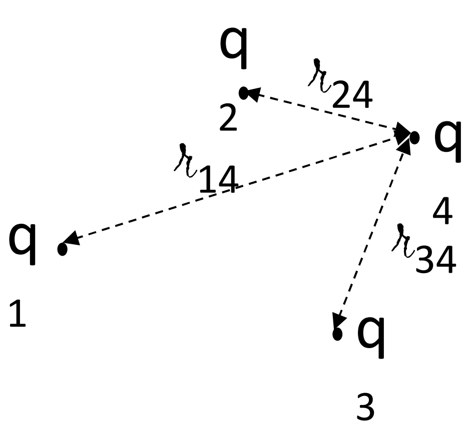
Energy to Assemble a Collection of Charges



$$W = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{\mathscr{r}_{12}}$$



$$W = \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{\mathscr{r}_{12}}\right) + \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_3}{\mathscr{r}_{13}} + \frac{1}{4\pi\varepsilon_0}\frac{q_2 q_3}{\mathscr{r}_{23}}\right)$$



$$W = \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{\mathscr{r}_{12}}\right) + \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_3}{\mathscr{r}_{13}} + \frac{1}{4\pi\varepsilon_0}\frac{q_2 q_3}{\mathscr{r}_{23}}\right)$$
$$+ \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_3}{\mathscr{r}_{14}} + \frac{1}{4\pi\varepsilon_0}\frac{q_2 q_4}{\mathscr{r}_{24}} + \frac{1}{4\pi\varepsilon_0}\frac{q_3 q_4}{\mathscr{r}_{34}}\right)$$

Class 15. Capacitance

Capacitance

Capacitance is defined between *two conductors*, with equal magnitude but opposite charges:

$$Q \propto \Delta V$$

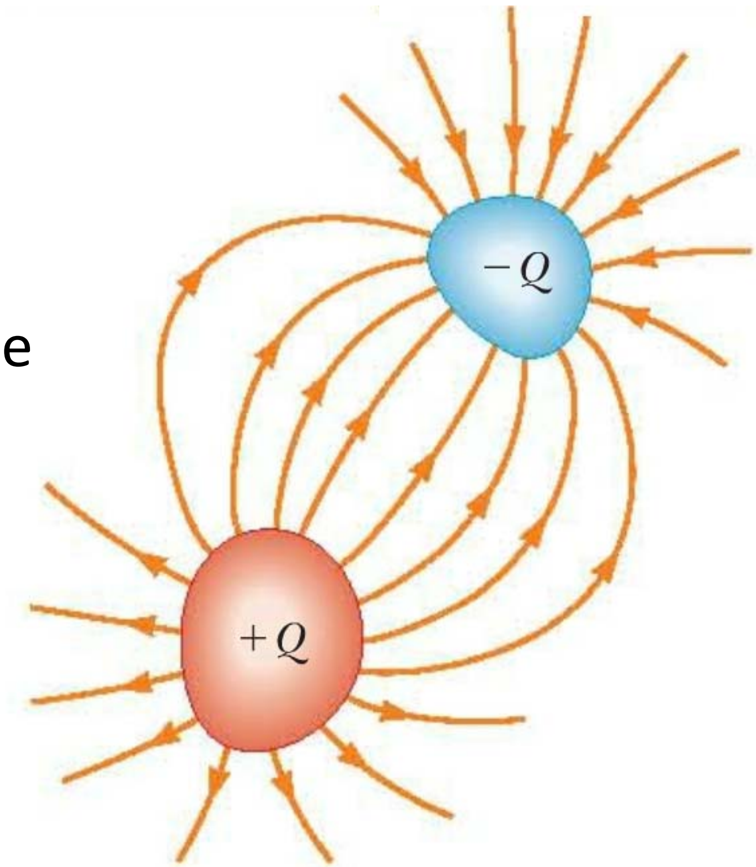
Capacitace is the charge needed to raise the potential difference by 1V:

$$C = \frac{Q}{\Delta V}$$

Very often the conductor at the lower potential is defined as the zero potential, then

$$C = \frac{Q}{V}$$

V is the potential of the other conductor.

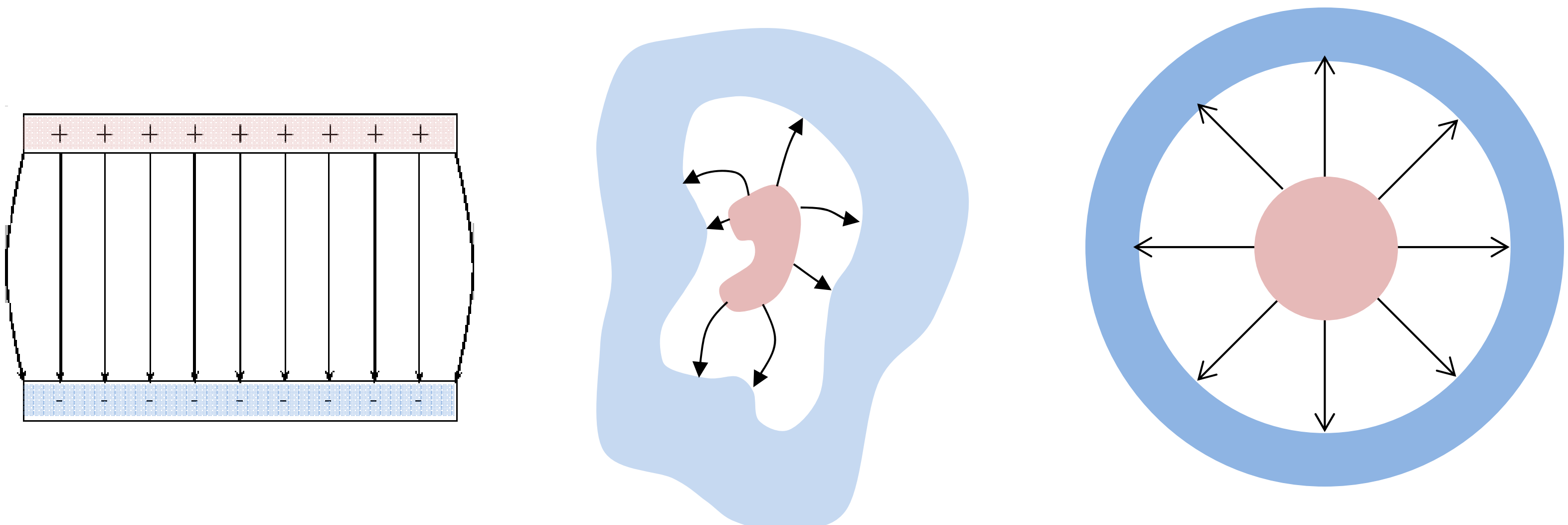


Units for capacitance:
Farad (F) $\equiv$ C/V

Special case

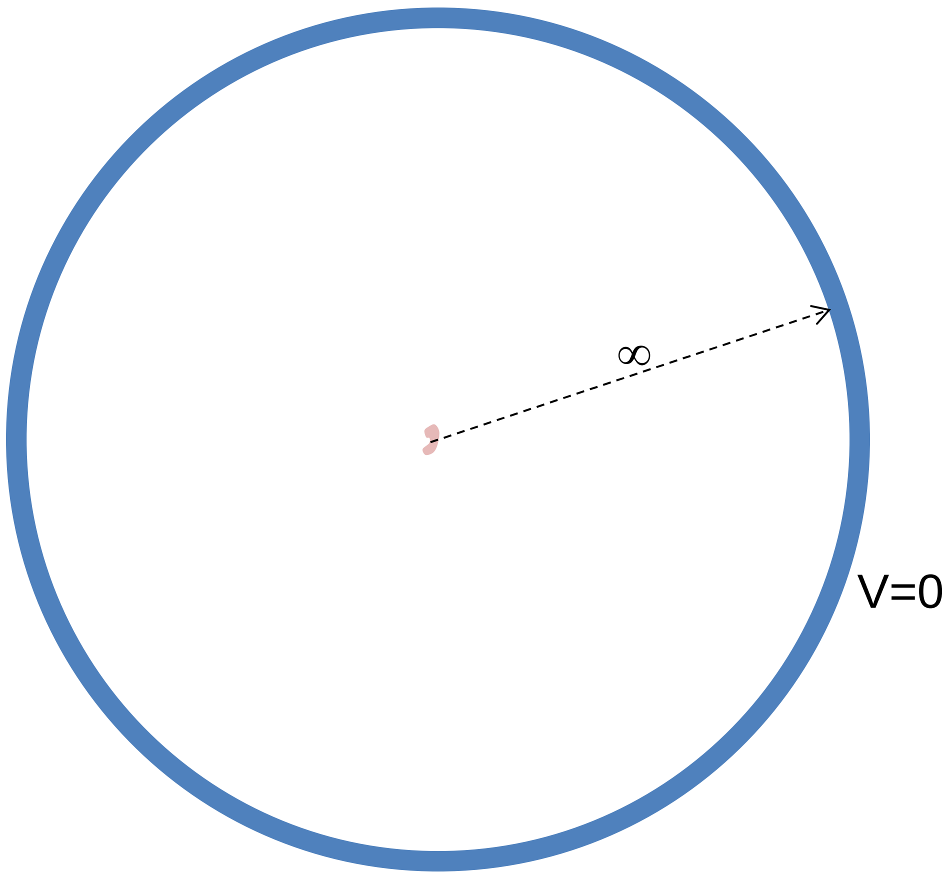
If all the field lines from one conductor ends at the other, then we just need to vary the charge in one conductor and the charge of the other conductor will follow (by induction).

Examples of this type of configuration:

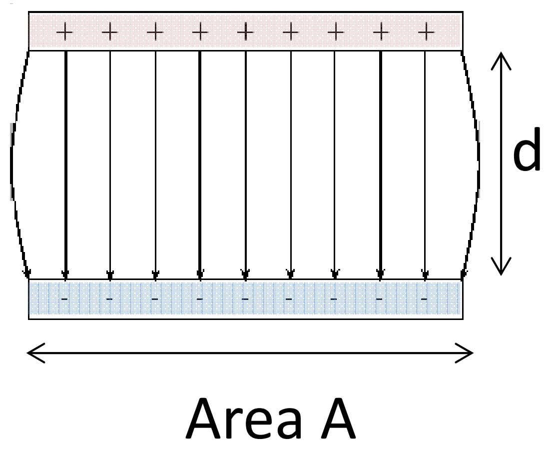


Confusing case

Sometimes we talk about the capacitance of a single conductor (e.g. the Earth). In this case we can imagine the conductor is inside a big cavity of an infinite large conductor at zero potential.



Parallel plate capacitor



$$C = \frac{\varepsilon_0 A}{d}$$

Symbol of a capacitor: