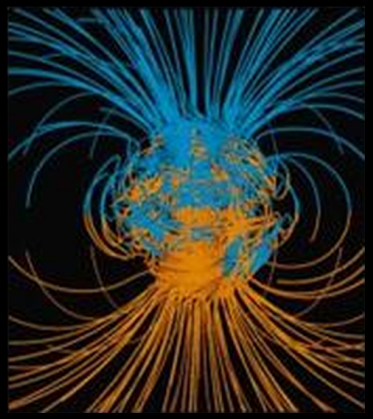


Phy2005
Applied Physics II
Spring 2018

Announcements:

January	19	F	**5**	Q3, 3, 4	19.1 - 19.5	charge, conductor/insulator, induced charge	pithballs, pingpong, electroscope
January	22	M	**6**	5, 9, 11, 12, 14,17, 19	19.6 - 19.7	Coulomb's law, superposition	
January	24	W	**7**	23, 27, 28, 31, 32, 37	19.8 - 19.12	E-field and electric potential	Faraday shielding, cell ph demo
January	26	F	**8**	40, 42, 48, 49	19.13 - 19.16	potential energy, motion of charge in E-field	van de graaff

Last time: Mechanics review I

- conservation of energy
- work-kinetic energy theorem

Today: Electric charge

Science news page

SCIENCE TICKER ASTRONOMY, GRAVITATIONAL WAVES

As first run of gravitational wave search winds down, rumors abound

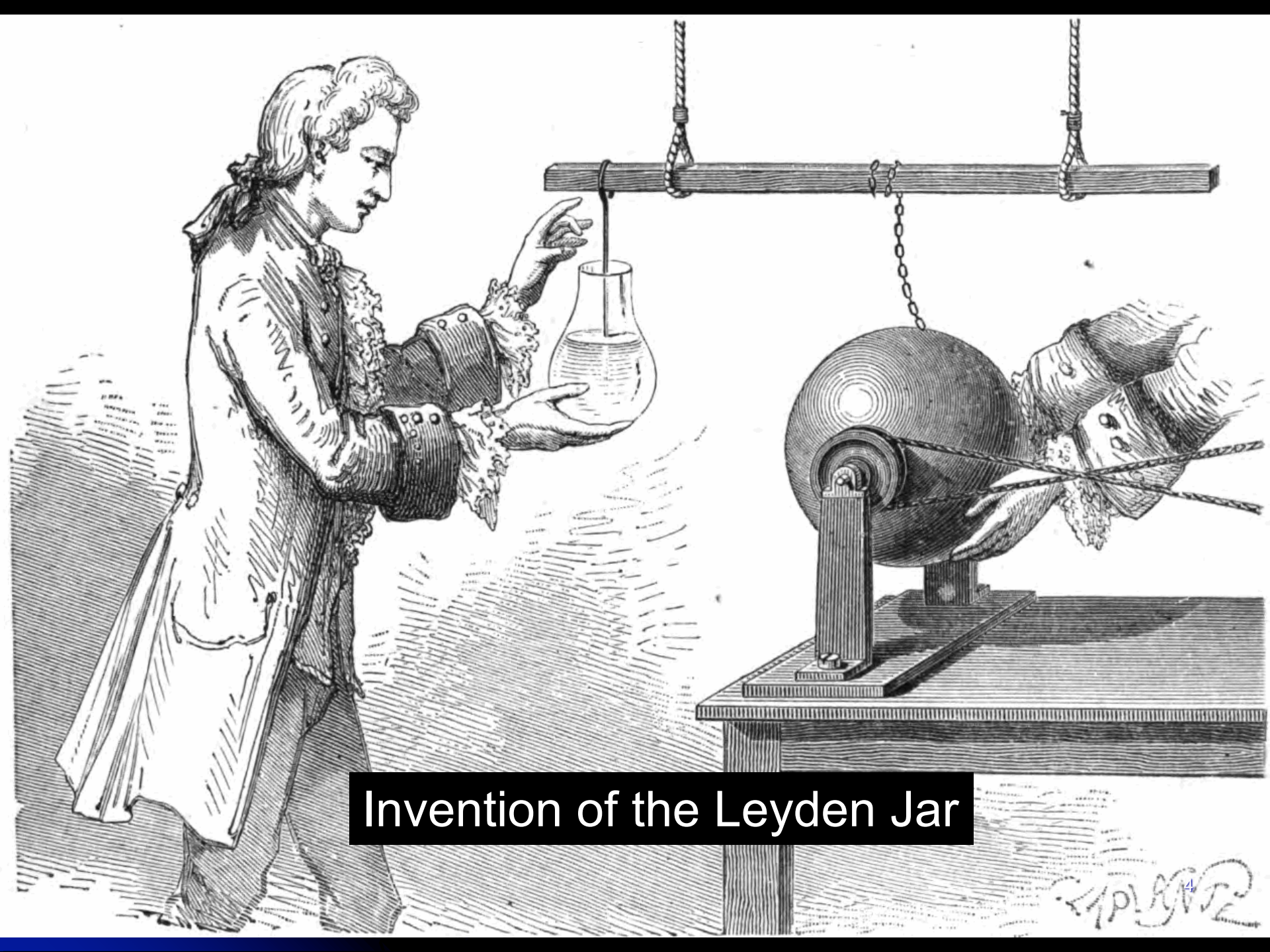
BY ANDREW GRANT 12:39PM, JANUARY 14, 2016

CATCHING A WAVE Laser beams inside the long tubes at Advanced LIGO in Livingston, La., could allow scientists to get their first direct look at gravitational waves.

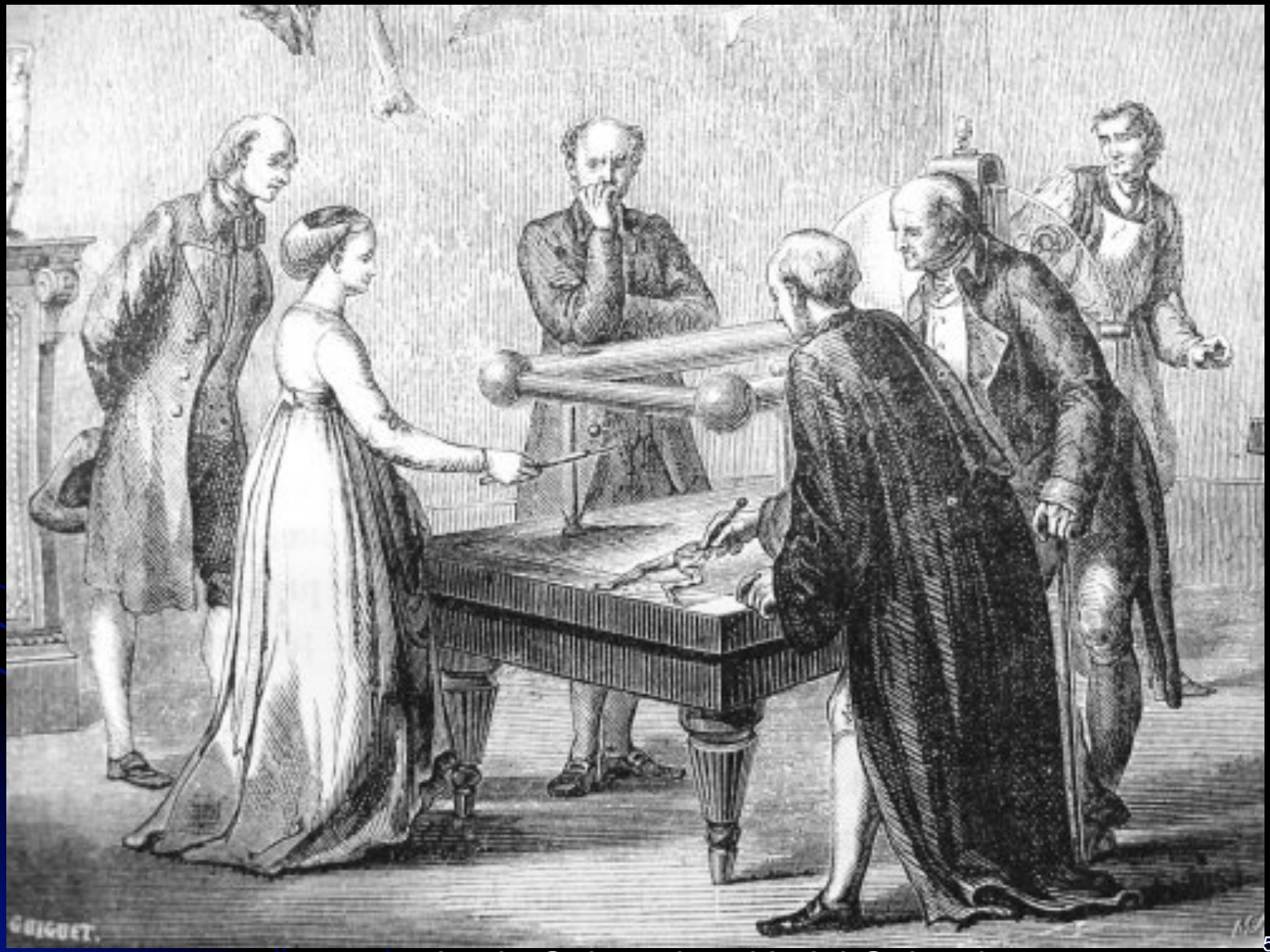
LIGO = Laser Interferometer Gravitational Wave Observatory

What was electricity?

Franklin thought of it as a weightless fluid that repelled itself but was attracted to normal matter



Invention of the Leyden Jar



Lucia Galeazzi and Luigi Galvani

Mary Shelley 1818: *Frankenstein*

“Force conversions ??”

Electrical Charge

- There are only two types of charges: (+) and (-) (Franklin)
  same type of charges repel each other.
  opposite type of charges attract each other.

- Charge is never created nor destroyed: Charge conservation
  one of the fundamental laws in physics
  (e.g. energy conservation, momentum conservation)
  charge (mainly (-) charge) just redistributes!!

- Charge comes in a discrete quantity as a multiple of e**.
  $e = 1.6 \times 10^{-19}$ C (Coulomb)

  one electron carries charge, –e
  and one proton carries charge, +e.

Top Hat Quiz Time

ACADEMIC HONESTY

Each student is expected to hold himself/herself to a high standard of academic honesty. Under the UF academic honesty policy. Violations of this policy will be dealt with severely. There will be no warnings or exceptions.

Have your phone ready!

Q1 A conducting sphere is charged and has 10^8 excess electrons. How much charge is on the conductor?

(1) 1.6×10^{-19} amp
(2) 1.9×10^{-8} C
(3) -1.6×10^{-11} C
(4) -1.9×10^{-11} amp
(5) $-1.6\ \mu C$

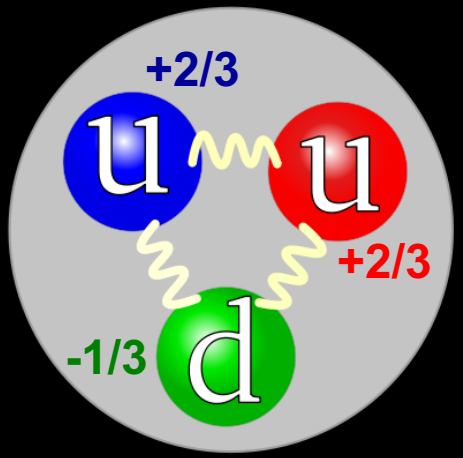
Q2 Each of three objects (A, B, and C) carries a net charge. A attracts B. Objects B and C attracts each other. Which one of the following configurations is a possible combination of charge of three objects?

	A	B	C
(1)	+	-	+
(2)	+	-	-
(3)	-	-	+
(4)	0	-	+
(5)	+	0	+

Elementary Particles

Quarks	u up	c charm	t top	$+\frac{2}{3}e$	Force Carriers
	d down	s strange	b bottom	$-\frac{1}{3}e$	
Leptons	ν_e e neutrino	ν_μ μ neutrino	ν_τ τ neutrino	W W boson	
	e electron	μ muon	τ tau	Z Z boson	
$3 \rightarrow$	I	II	III	$\leftarrow$ Generations	

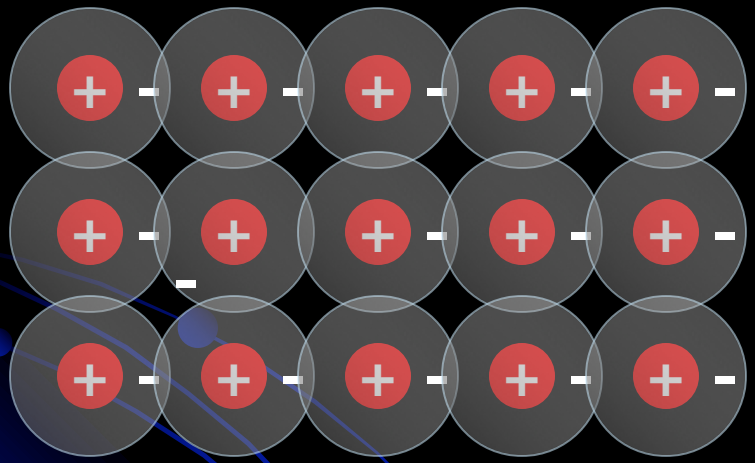
proton (+e)



Heavy nucleus with (+)
Light electrons with (-)

neutral atom

Conductor



free electrons

Insulator

localized electrons

Solid Hydrogen (insulator)

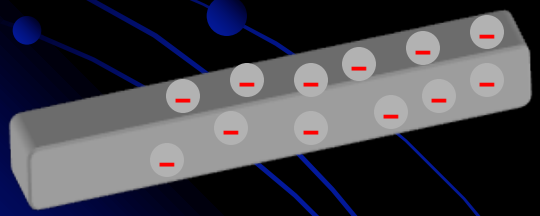
It is expected to become a conductor at high pressure above 450 GPa (4.5 Mbar). Scientists at Lawrence Livermore National Laboratory observed metallic liquid hydrogen at around 1 Mbar of pressure and around 1000 K.

Read this article for more information:
http://physicsworld.com/cws/article/news/5307

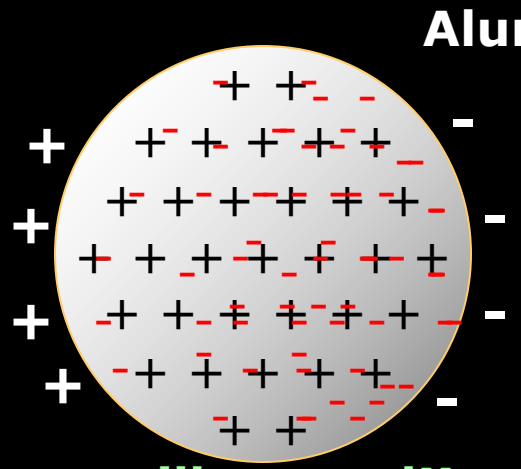
In conductors, electrons are mobile in the (+) charged background. → free electrons

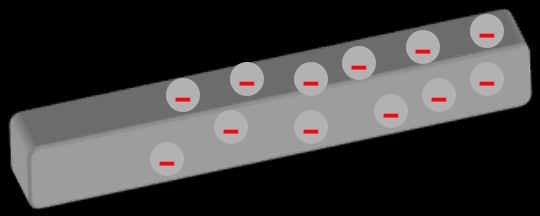
In insulators, electrons are bound around (+) charge.
→ Electrons cannot move freely.

Most electrostatic phenomena are caused by redistribution of electrons (negative charge) since (+) charge is immobile.

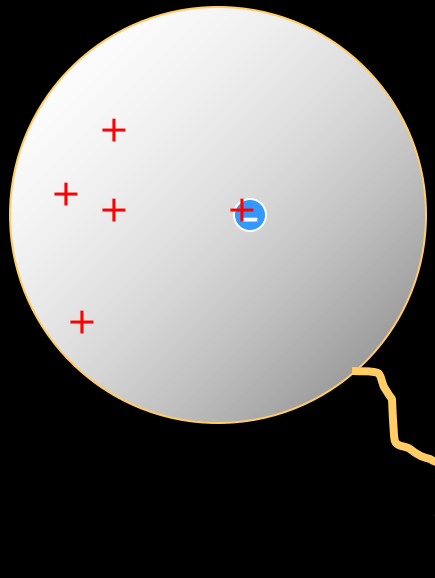


negatively charged plastic rod





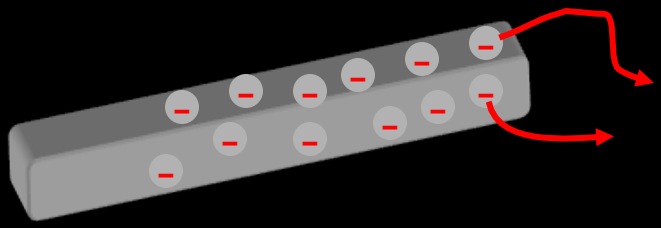
(+) net charge on the sphere

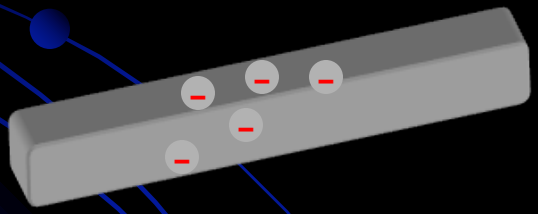


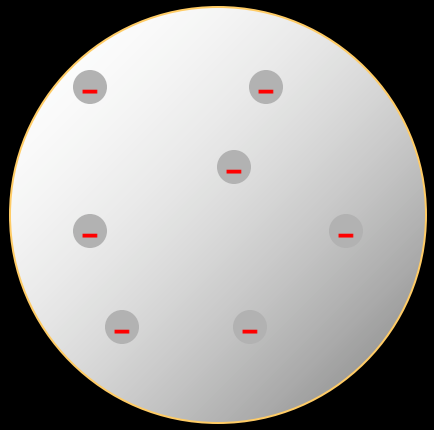
Grounded (Earthed)

Connected to a infinitely large charge reservoir and source.

Then, disconnect from the ground → Sphere is charged by induction.







Now (-) charged!!
Electrons are transferred.

Demos!

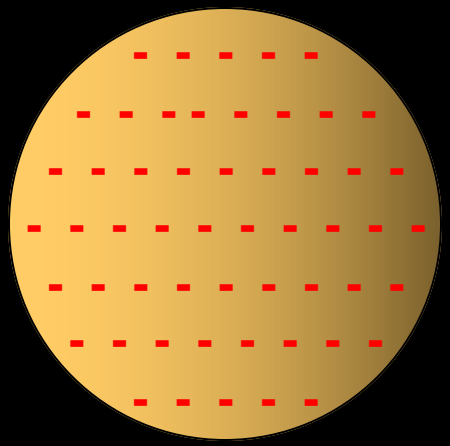
- Electroscope
- Static electricity – 2 types
- Charging by induction
- Faraday cup – charge is on outside of conductor

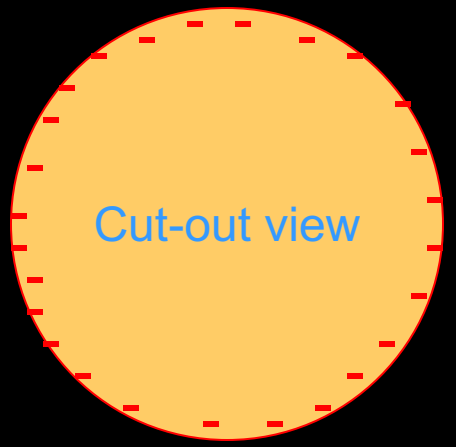
Ex 5-1 A conducting sphere is charged to have a net charge of -4×10^{-17} C. How many excess electrons are on the surface of the sphere?

250 excess electrons on the surface of the conductor!

Copper Sphere

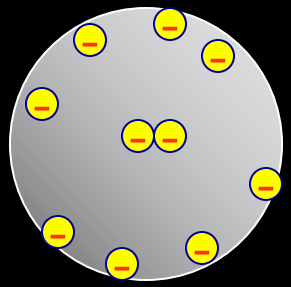
Charges are distributed uniformly on the ***surface*** of a conductor!



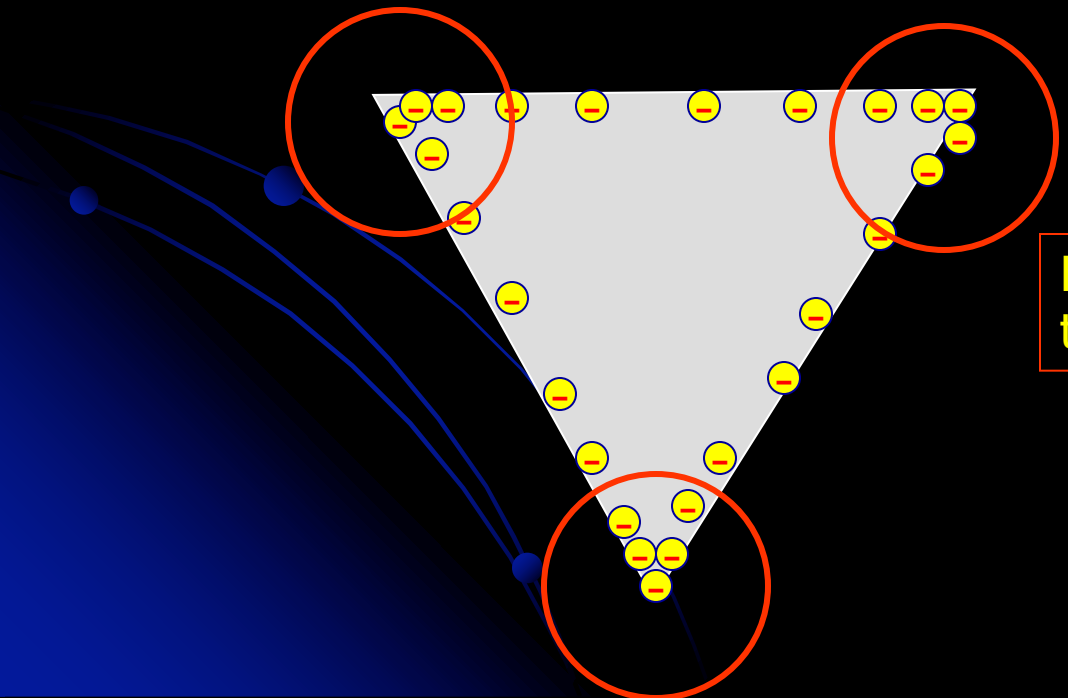


Transfer excess electrons → negatively charged!

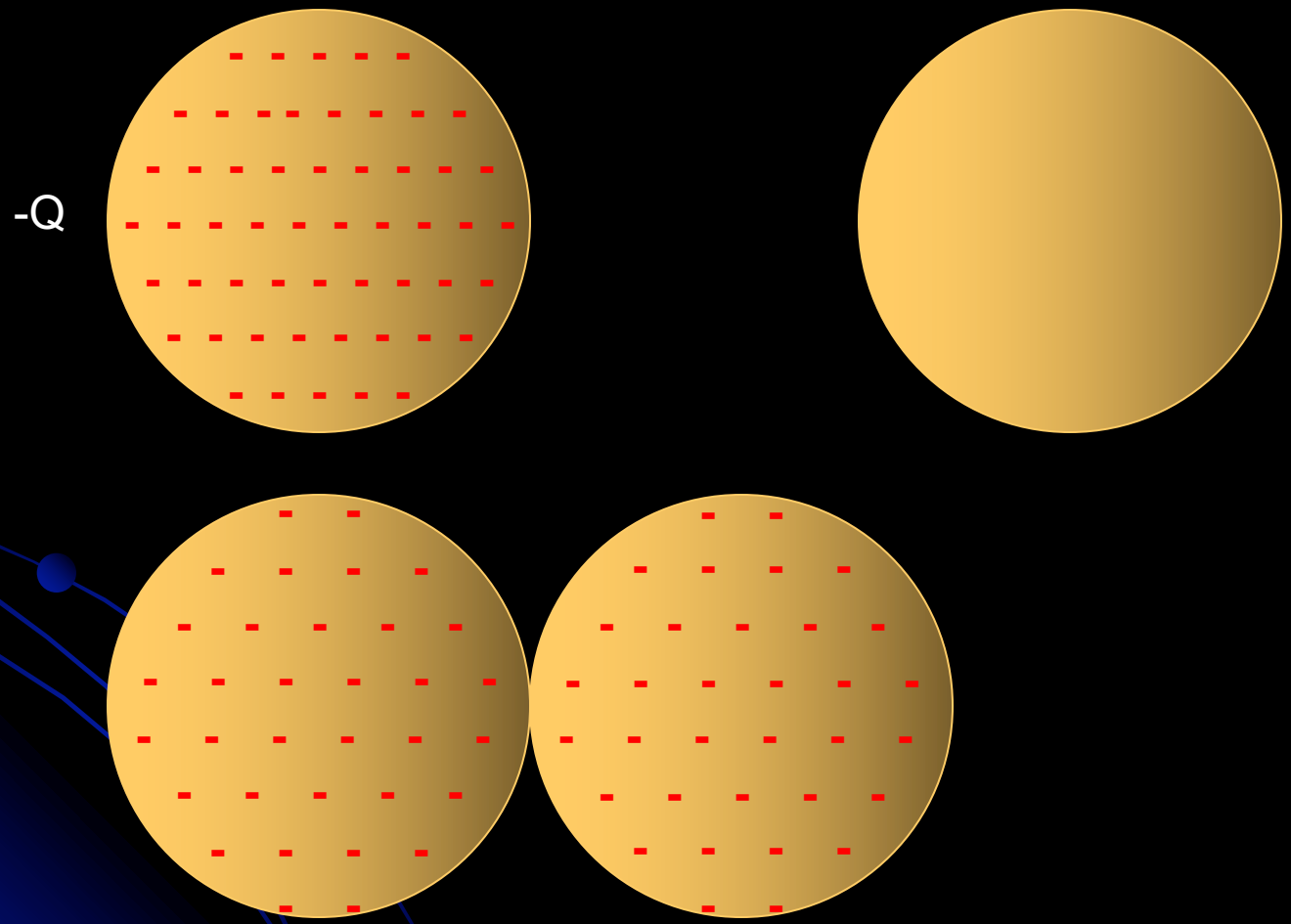
Neutral
# of positive charge = # of negative charge



In a conductor, charges tend to distribute themselves uniformly on the surface.



Higher density of charges at the sharp corners.


-Q
-Q/2
+
-Q/2
= -Q (conservation of charge)

Ex 5.4 Two identical conducting spheres carry charges of +5 μC and -17 μC. The are brought together to touch each other and separated again. What is the amount of charge on each sphere? Is charge conserved before and after?

-6 μC on each sphere
The total charge before the touch is (+5) + (-17) = -12 μC
and after touch 2 x (-6) = -12 μC

Q3 Three identical conducting spheres carry net charges of +3 μC (A), +7 μC (B), and -13 μC (C). They are brought to touch together and then separated. What is the net charge on each sphere in μC?

	A	B	C
(1)	+3	+7	-13
(2)	+7	-13	+3
(3)	0	0	0
(4)	-1	-1	-1
(5)	-3	-3	-3