Outcomes

Learning
— Struggling is good. Spend more time struggling.
— If its easy, its not learning and it won't last.
— Activity: thermal expansion
— Activity: Buoyancy

Discern between the two types of charge
— Likes repel, opposites attract.
— Activity: rubbing rods with felt and silk.

Understand induced charge in conductor and insulator
— Insulators: molecular polization. Conductor: charge polarizatio
— Activity: rubbing single object and observe forces.

Know difference between insulator and conductor.
— Insulators: electrons tightly bound, conductors loosely bound (sea of electrons).
— Activity: Spheres connected with rods.

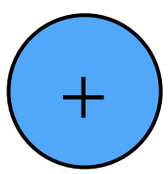
The electrophorus: rubbing charges and separating bound charges

Opposites attract and likes repel!

Anybody who's married knows this is true!

Opposites attract and likes repel!

Anybody who's married knows this is true!



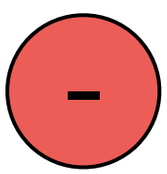
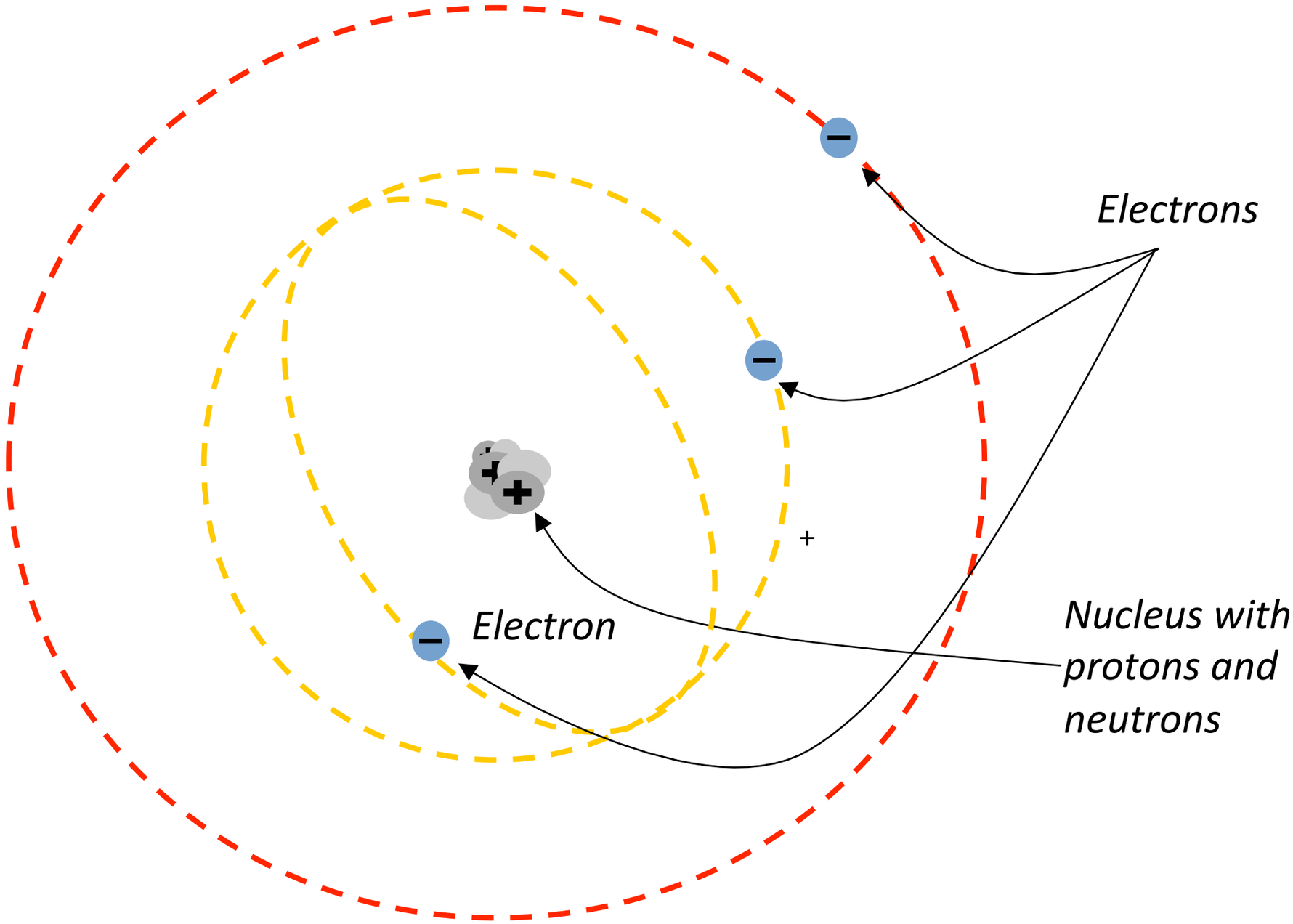


TABLE 25.1 Protons and electrons

Particle	Mass (kg)	Charge
Proton	1.67×10^{-27}	$+e$
Electron	9.11×10^{-31}	$-e$

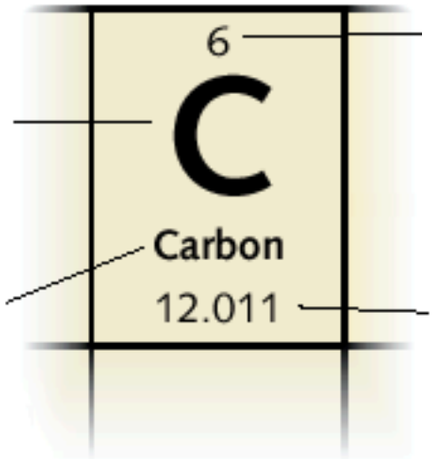


Particles not drawn to scale

Reading the periodic table

Symbol
A one- or two-letter abbreviation derived from the element's English or Latin name.

Name
Element's common name.



Mass Number
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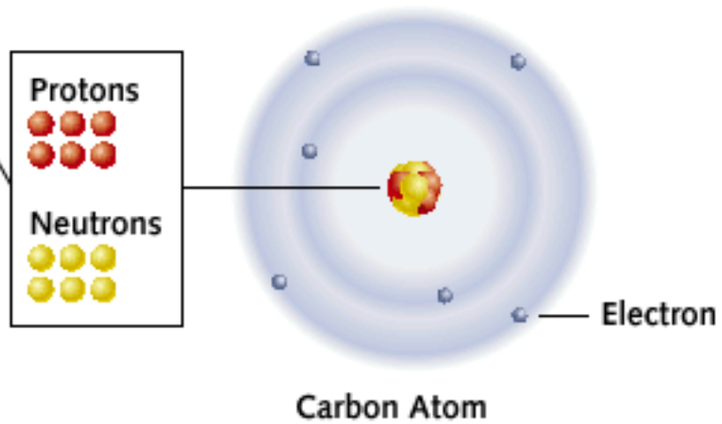

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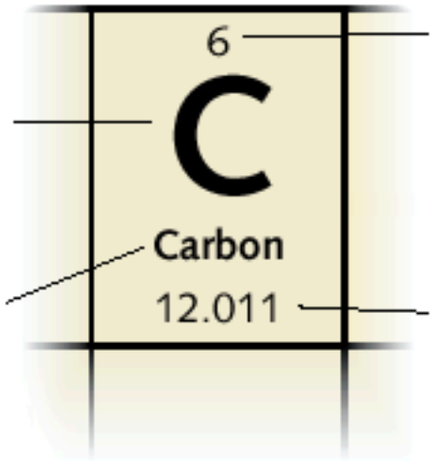

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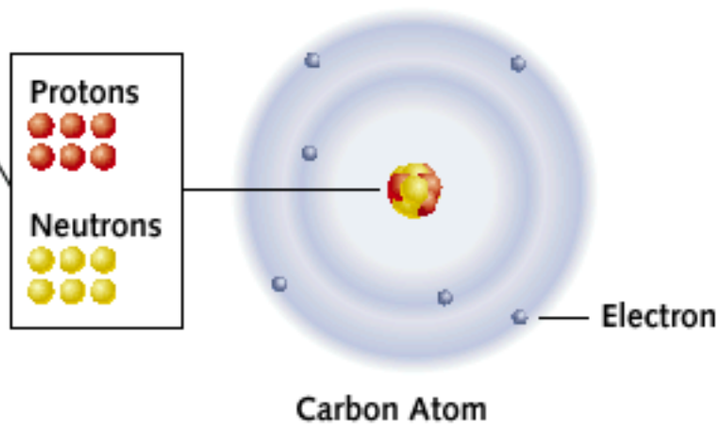

Carbon Atom

Reading the periodic table

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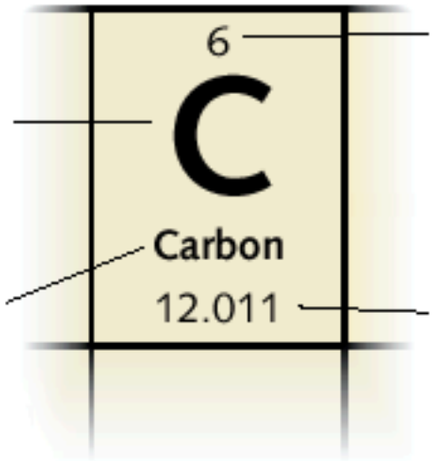

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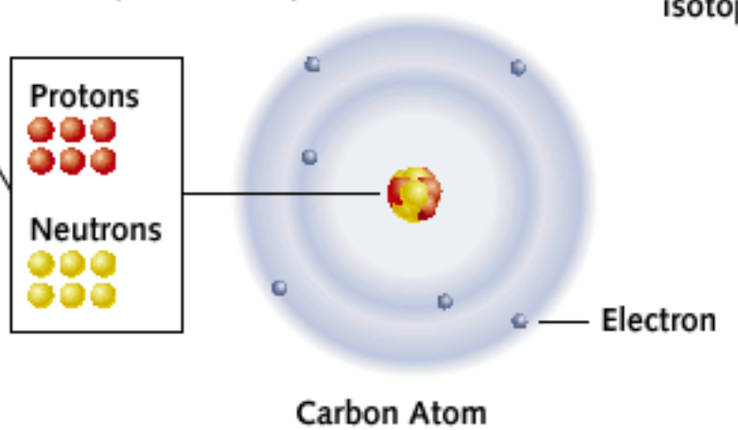

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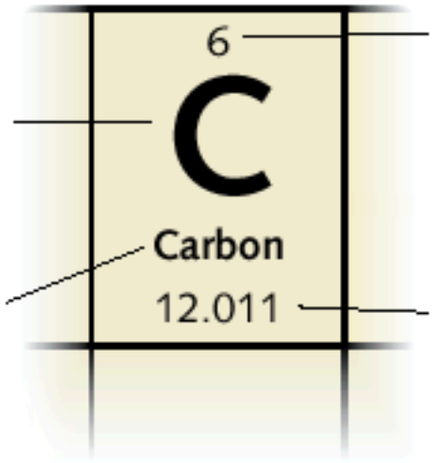

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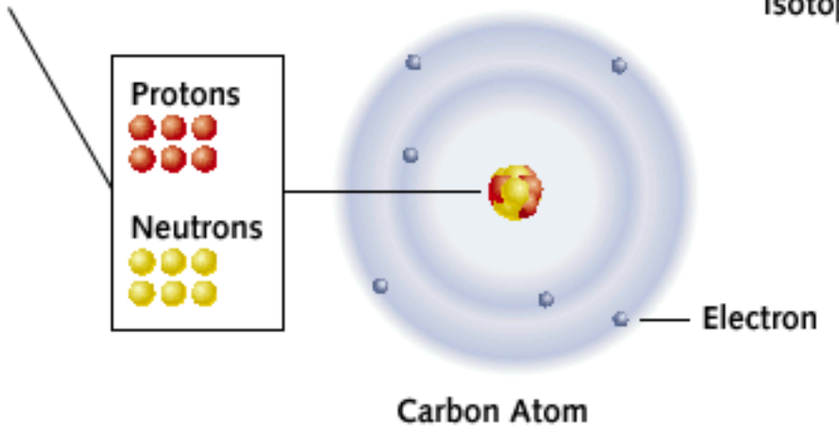

Carbon Atom

					18
					2 He Helium 4.00
13	14	15	16	17	
5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95
31 Ga Gallium 69.73	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.09	35 Br Bromine 79.90	36 Kr Krypton 84.80
49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.29
81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium [208.98]	85 At Astatine 209.98	86 Rn Radon 222.02
113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown

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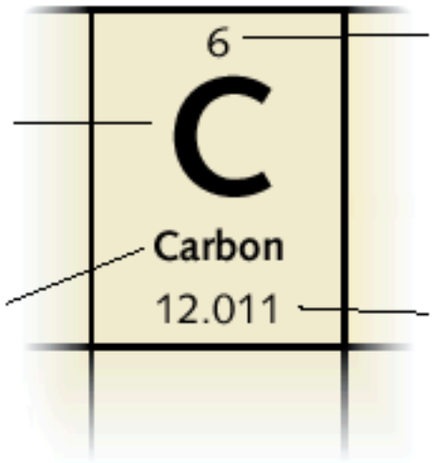

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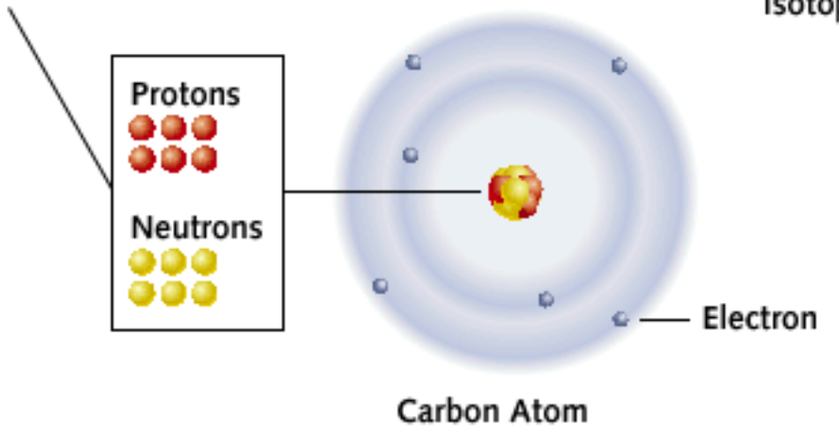

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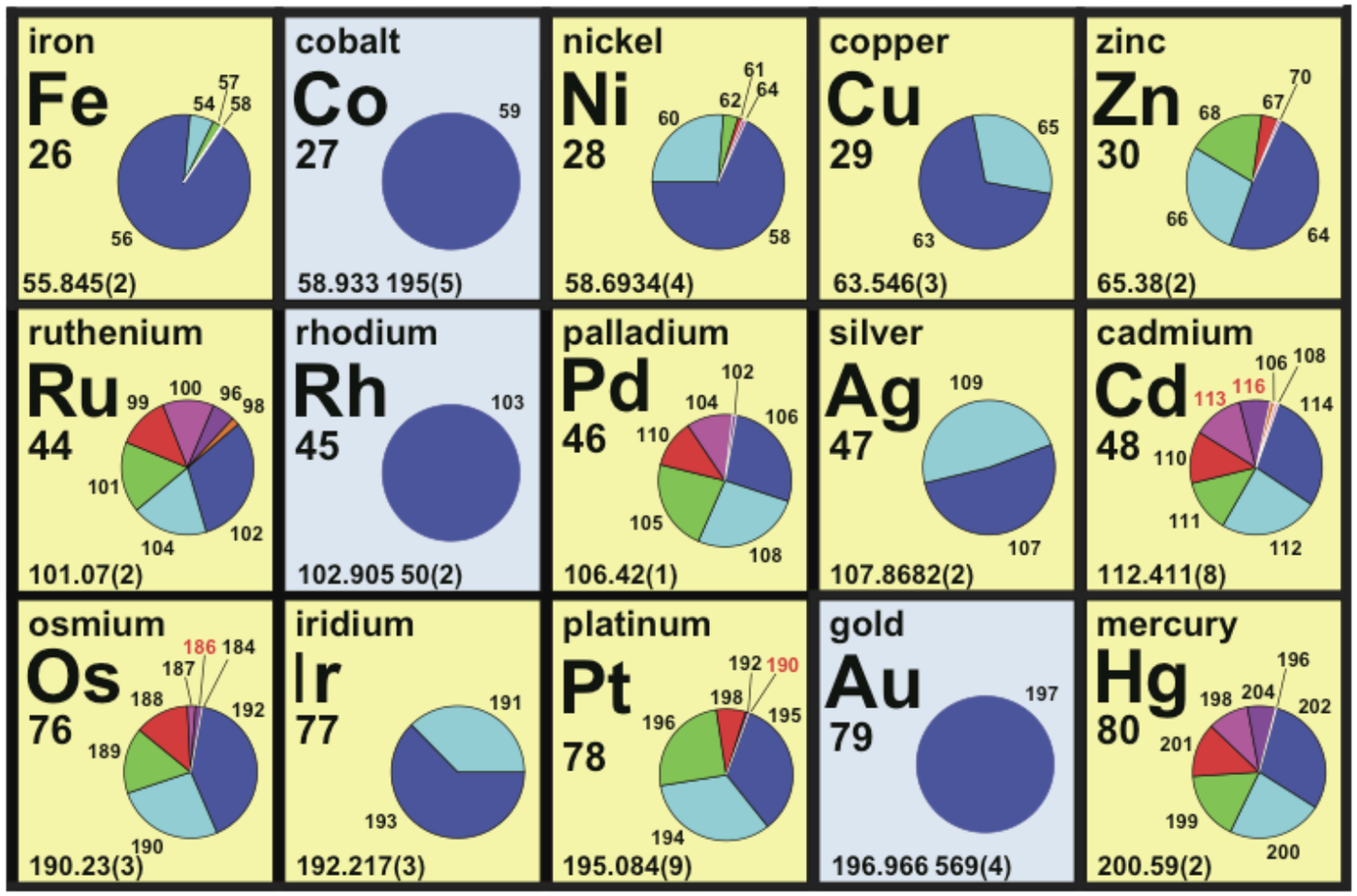

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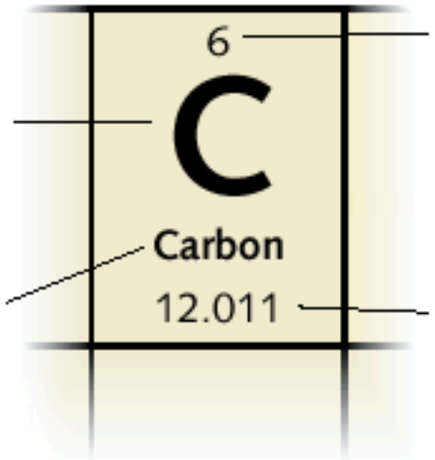

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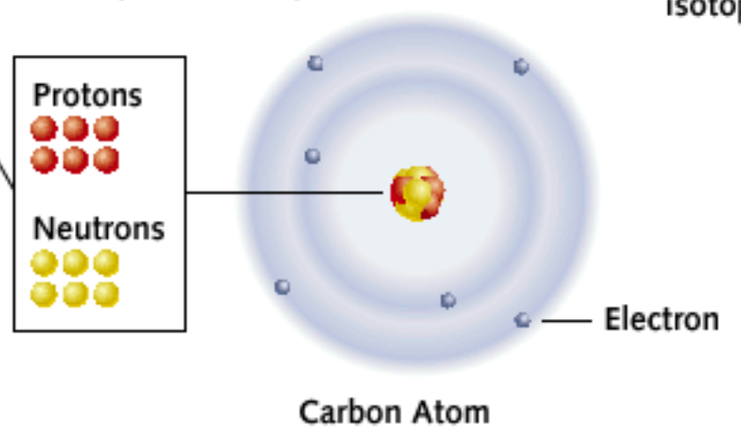
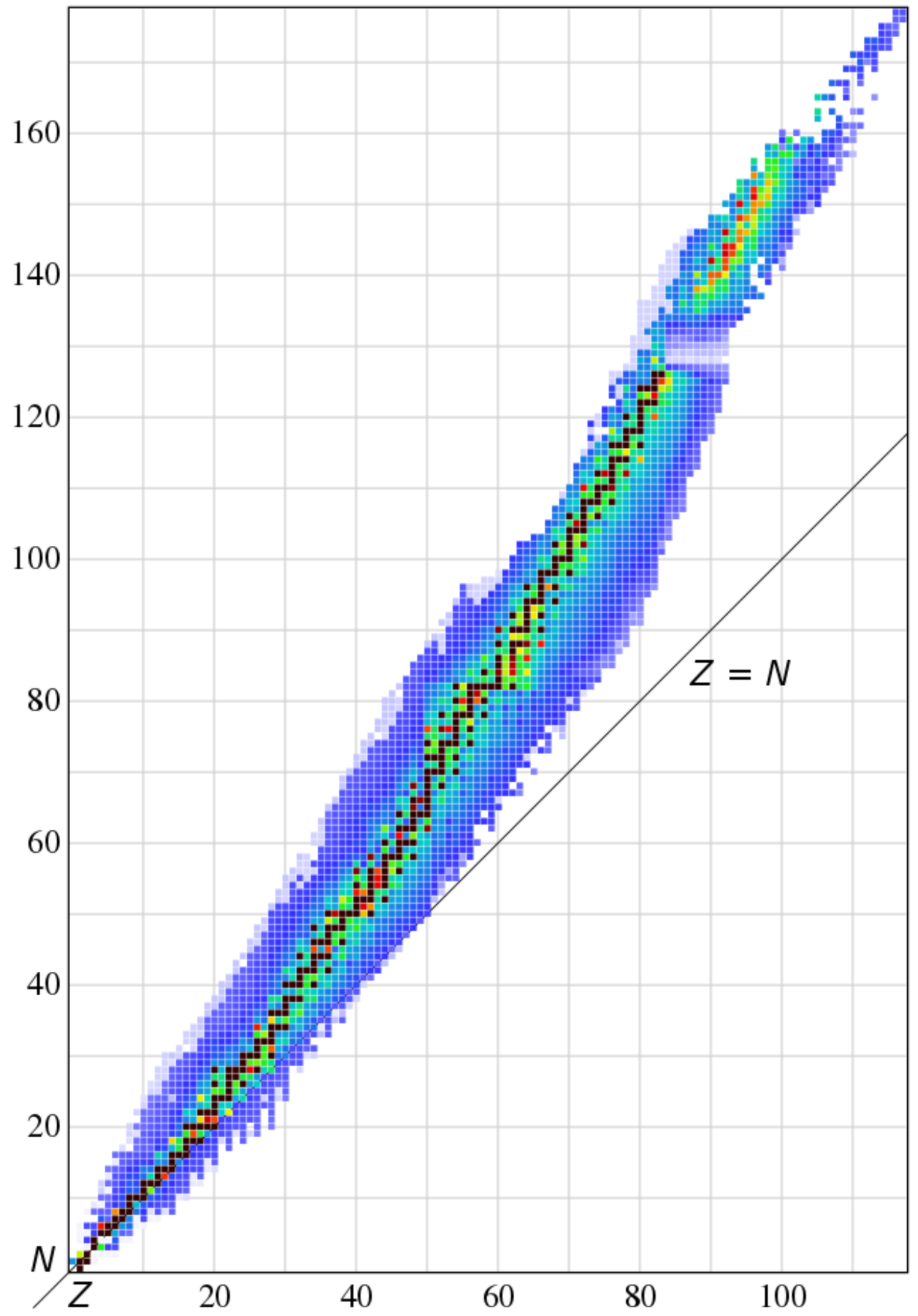
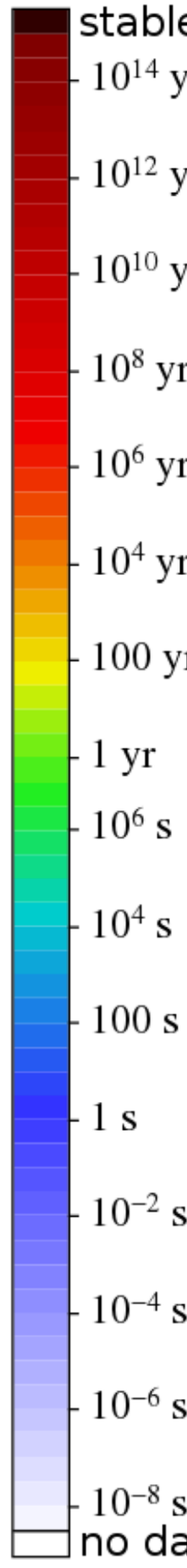


Carbon Atom





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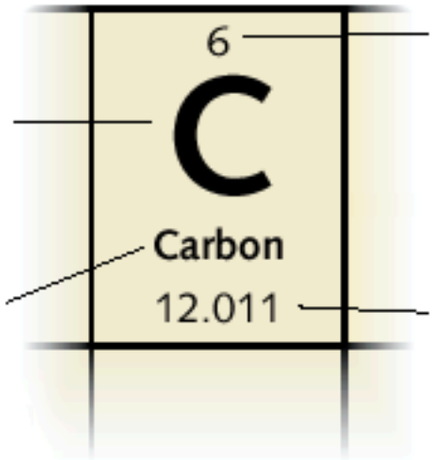

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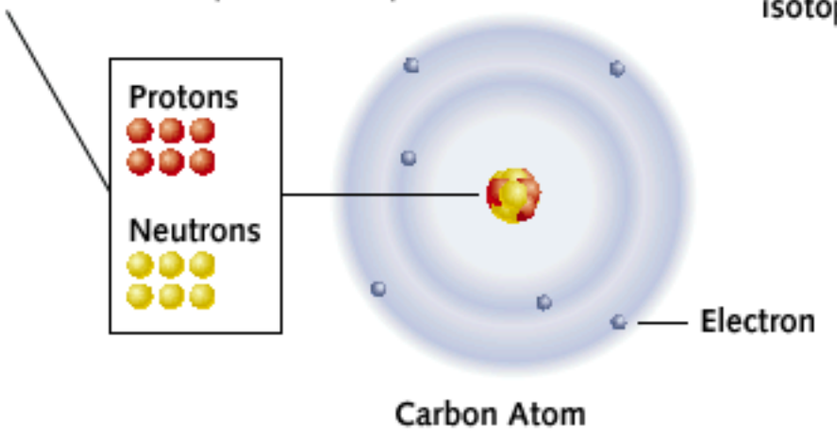
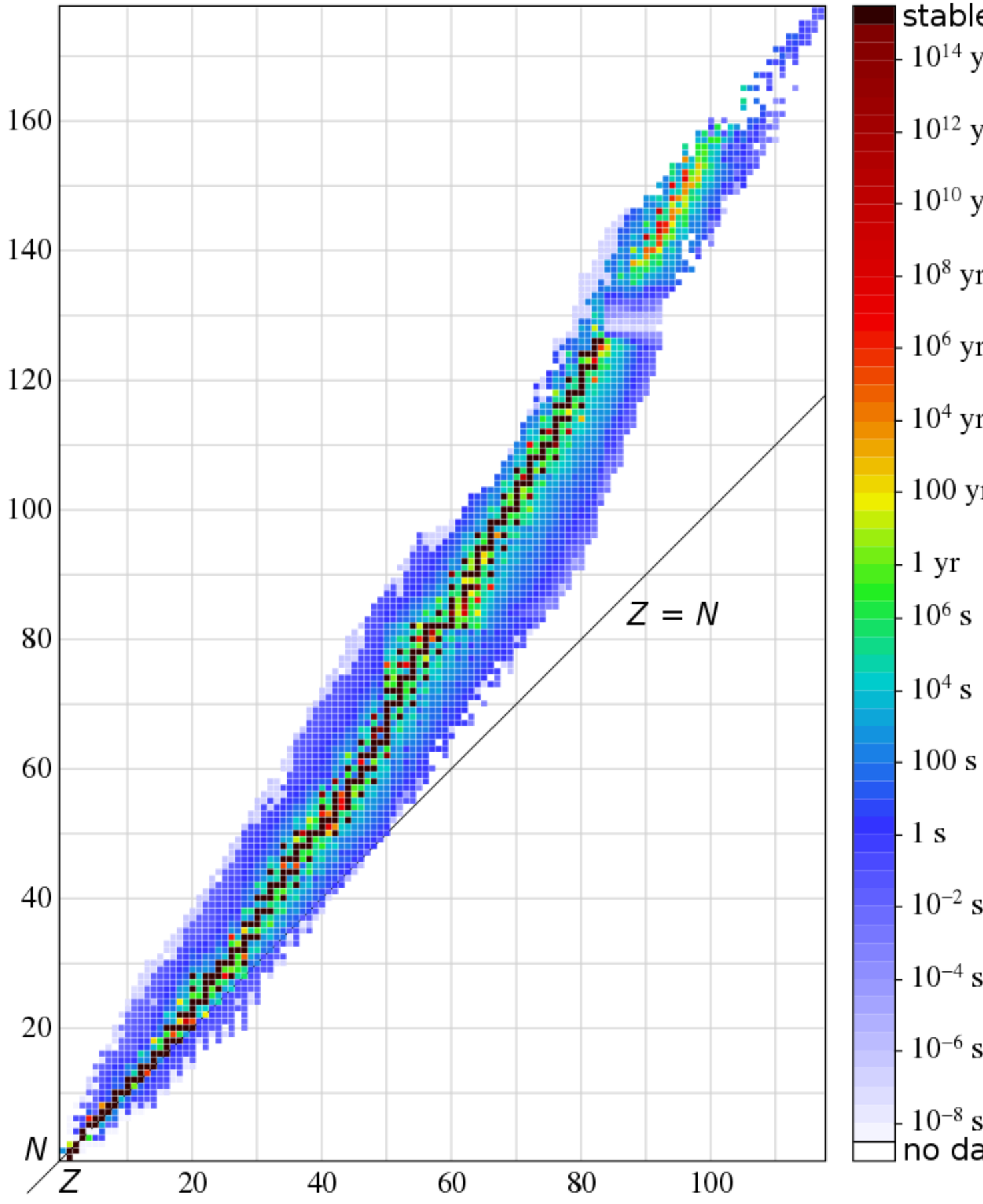


12.011 amu

1 amu = 1.6605 x 10^{-27} kg



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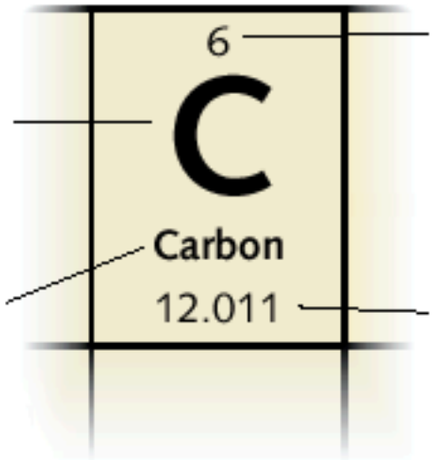

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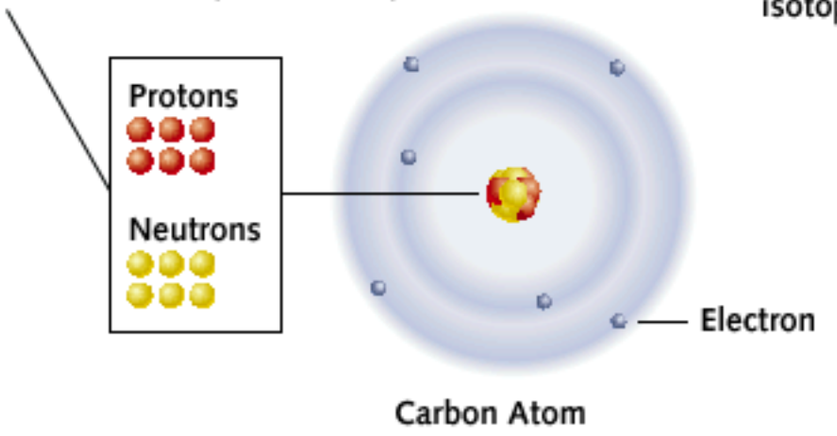


Carbon Atom

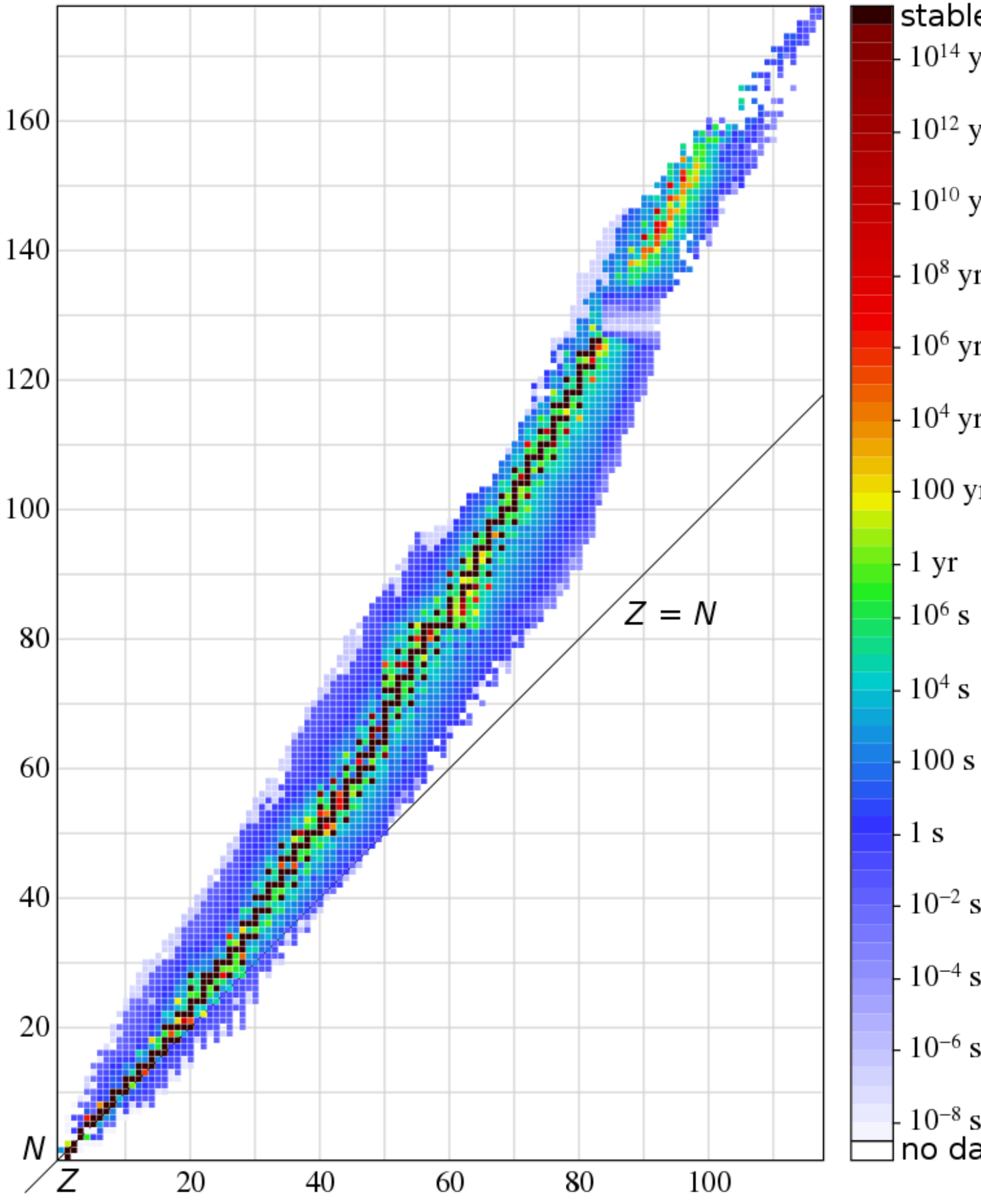
12.011 amu

1 amu = 1.6605 x 10^{-27} kg

Or

12.011 grams/mol

1 mol = 6.022 x 10^{23} atom



Pennies today are copper-plated zinc, but older pennies are 3.1 g of pure copper. What are the total positive charge and total negative charge in a solid copper penny that is electrically neutral?

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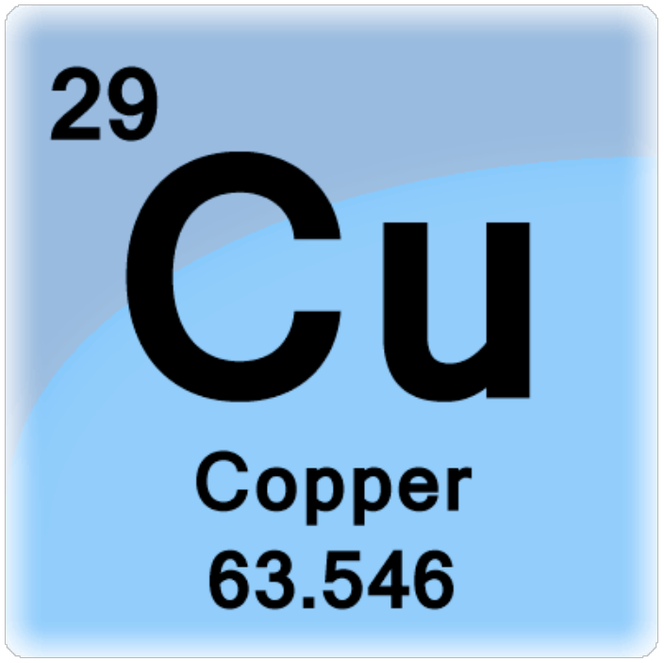

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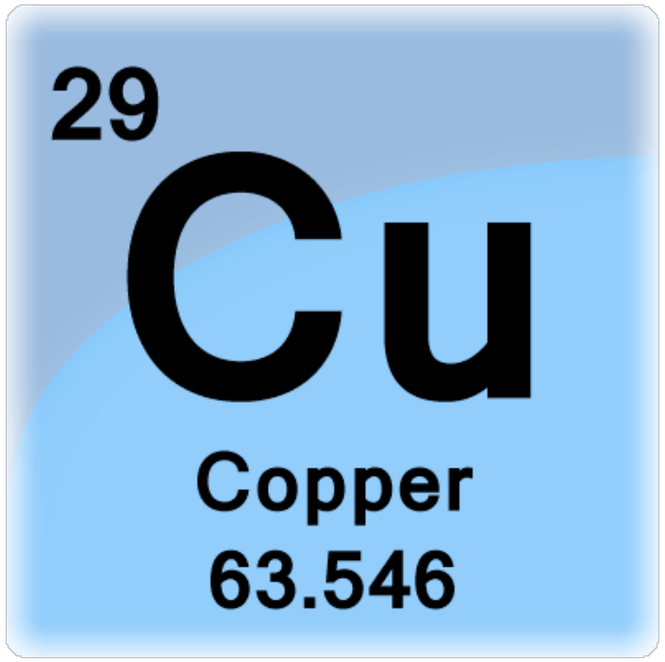
$$N_{\text{atoms}} = \frac{3.1\ \text{g}}{63.56 \times 1.6605 \times 10^{-27}} = 3.2 \times 10^{25}$$



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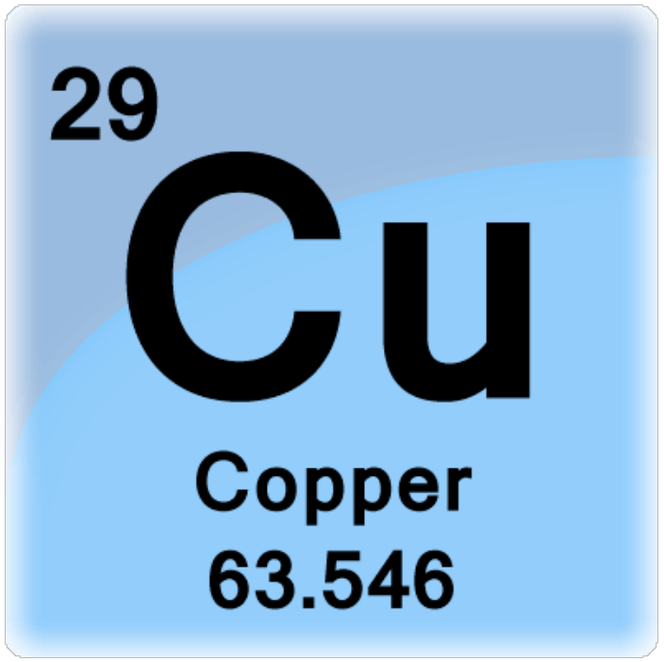

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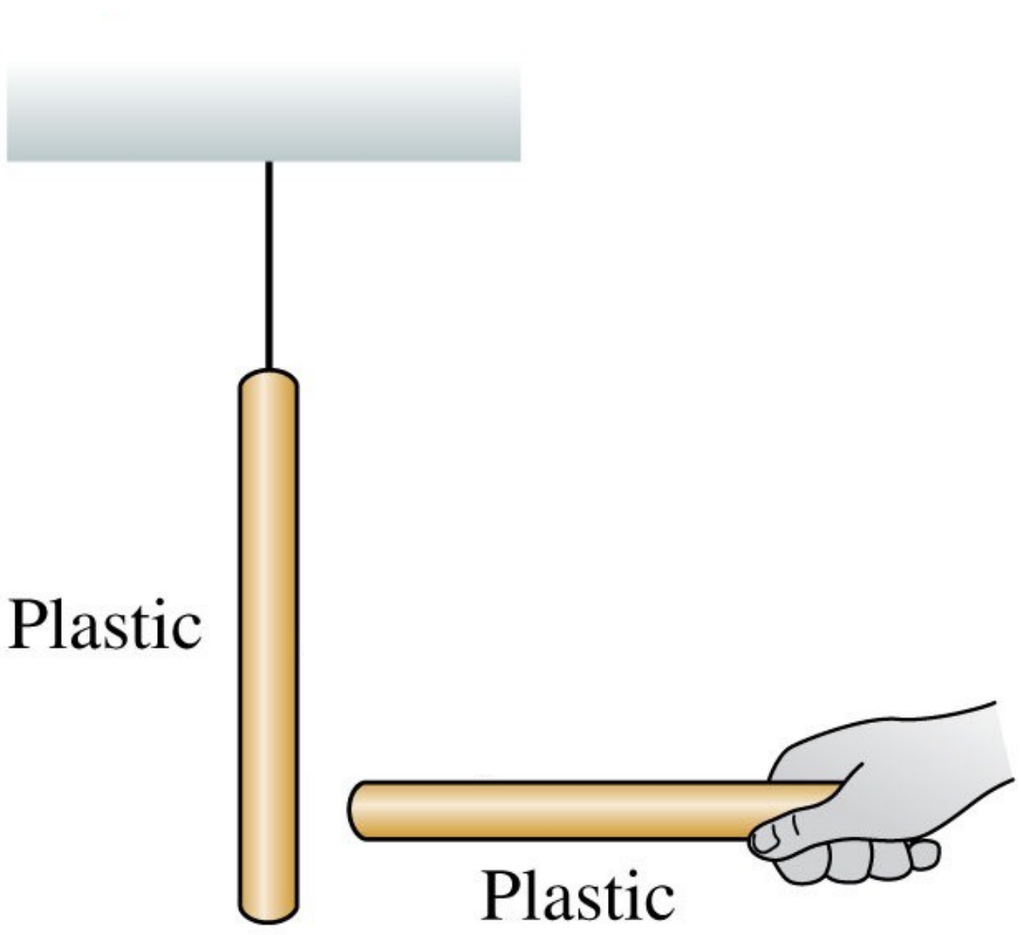
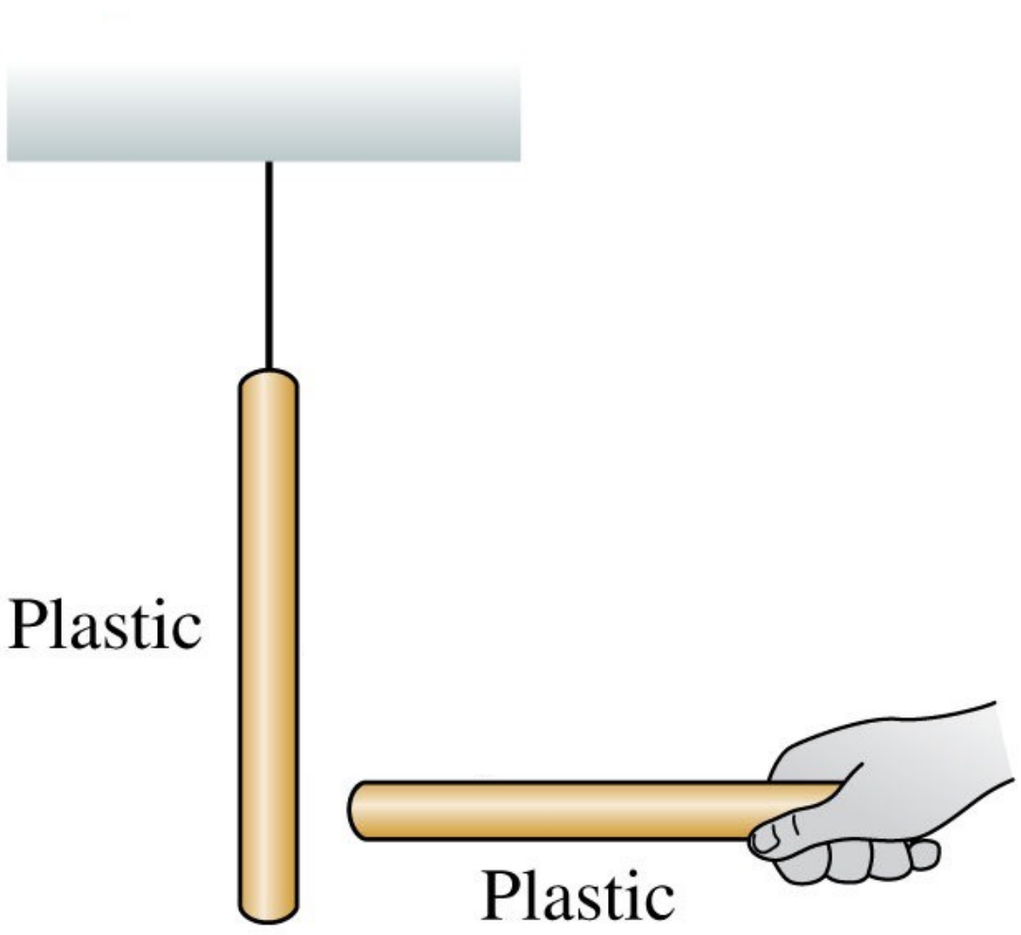
$$q = N_{\text{atoms}} \times 29 \times 1.602 \times 10^{-19} = 1.4 \times 10^{6}\ \text{C}$$

Do these plastic bars have charge?



Do these plastic bars have charge?

Why don't they attract/repel one another?



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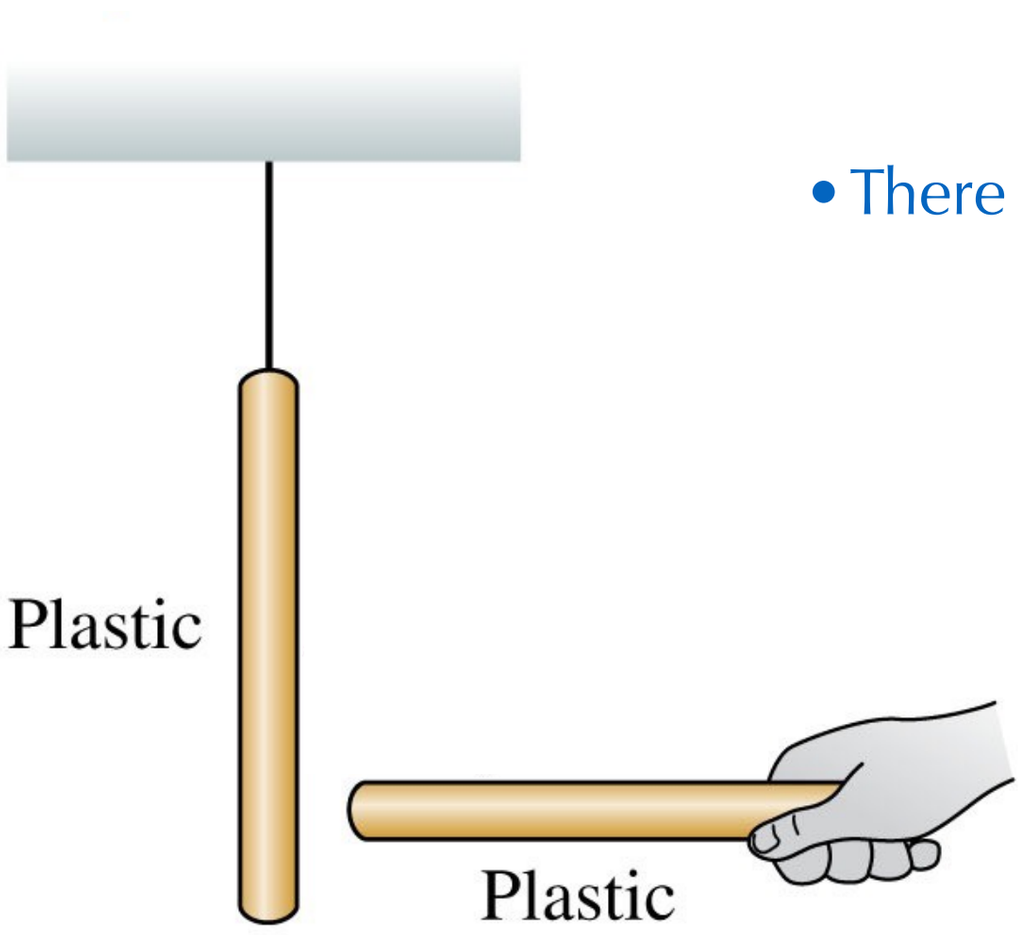

- There are two fundamental charges.

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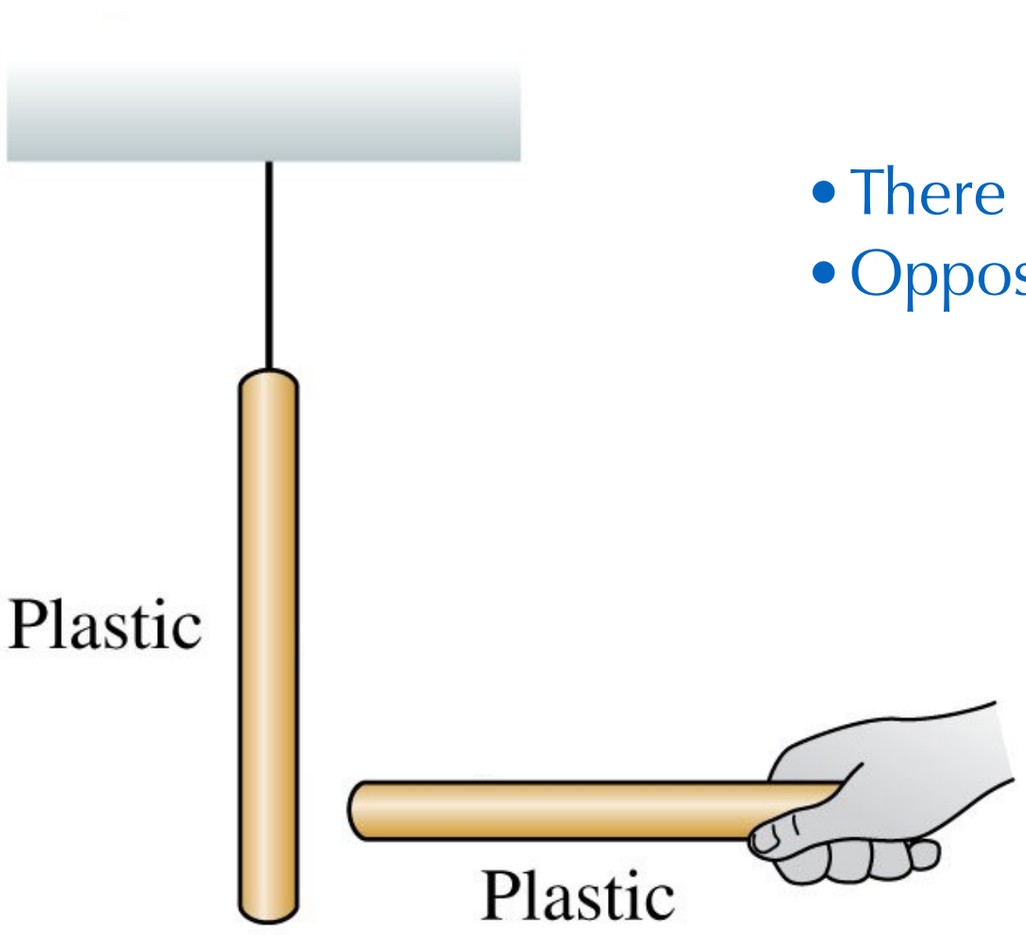

- There are two fundamental charges.
- Opposites attract, likes repel, neutrals do nothing.

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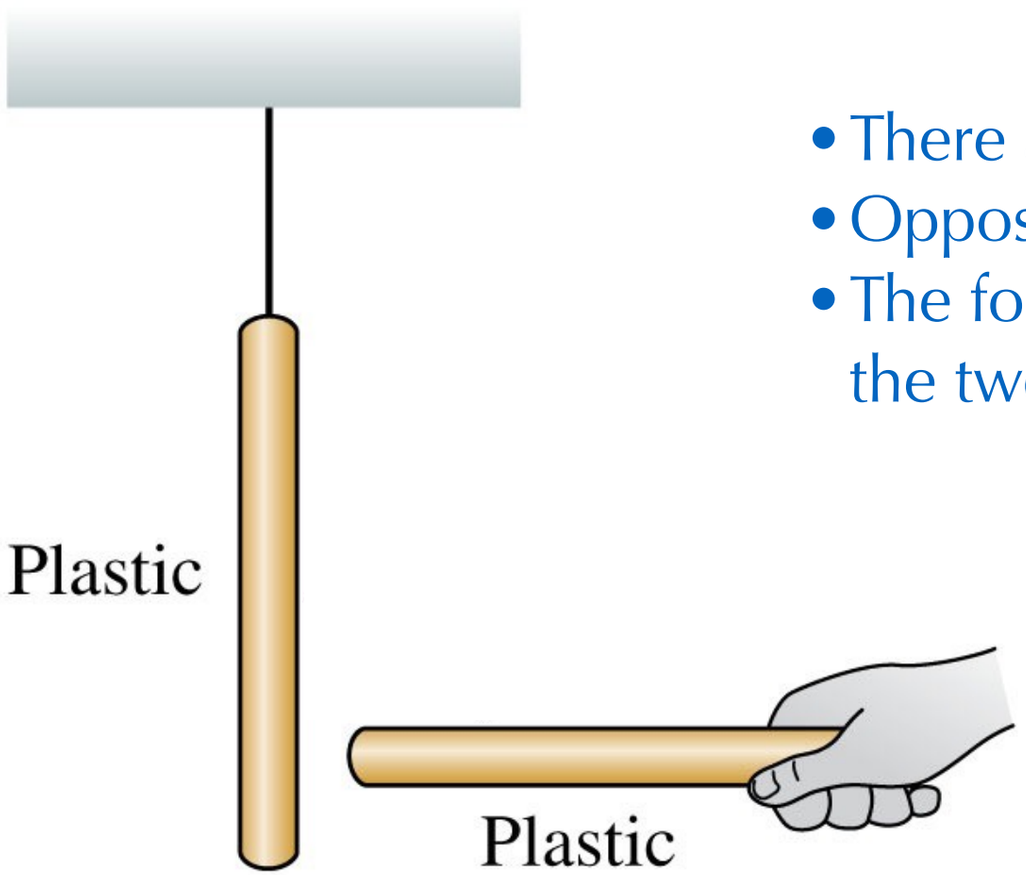

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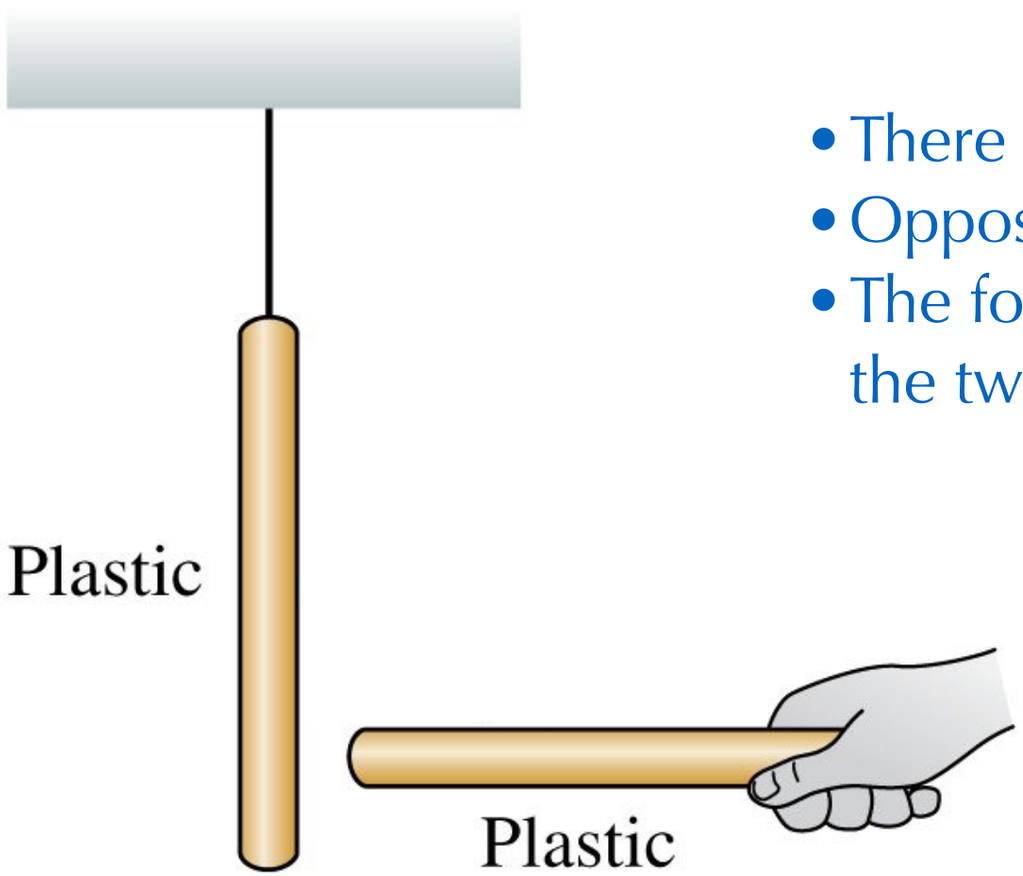

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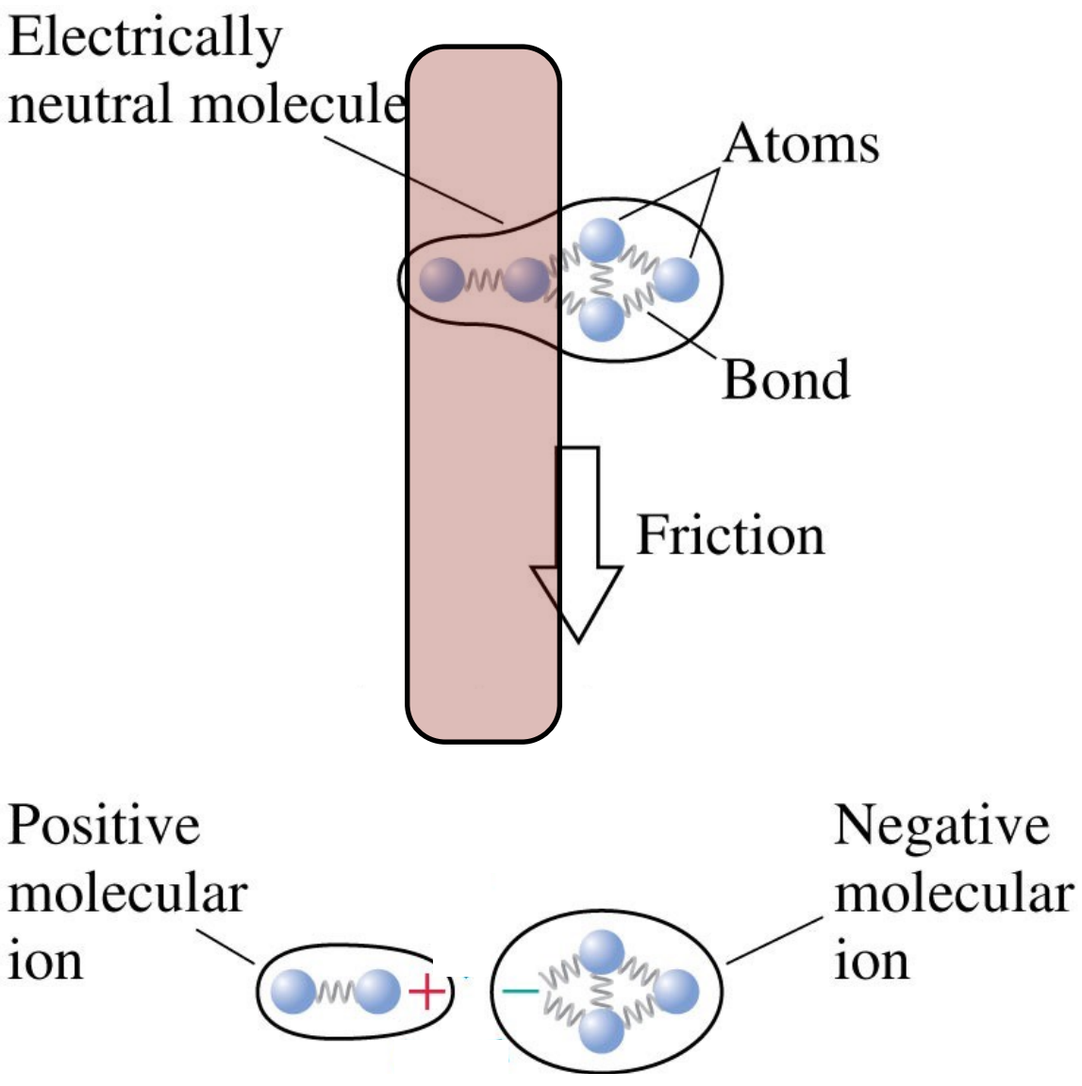
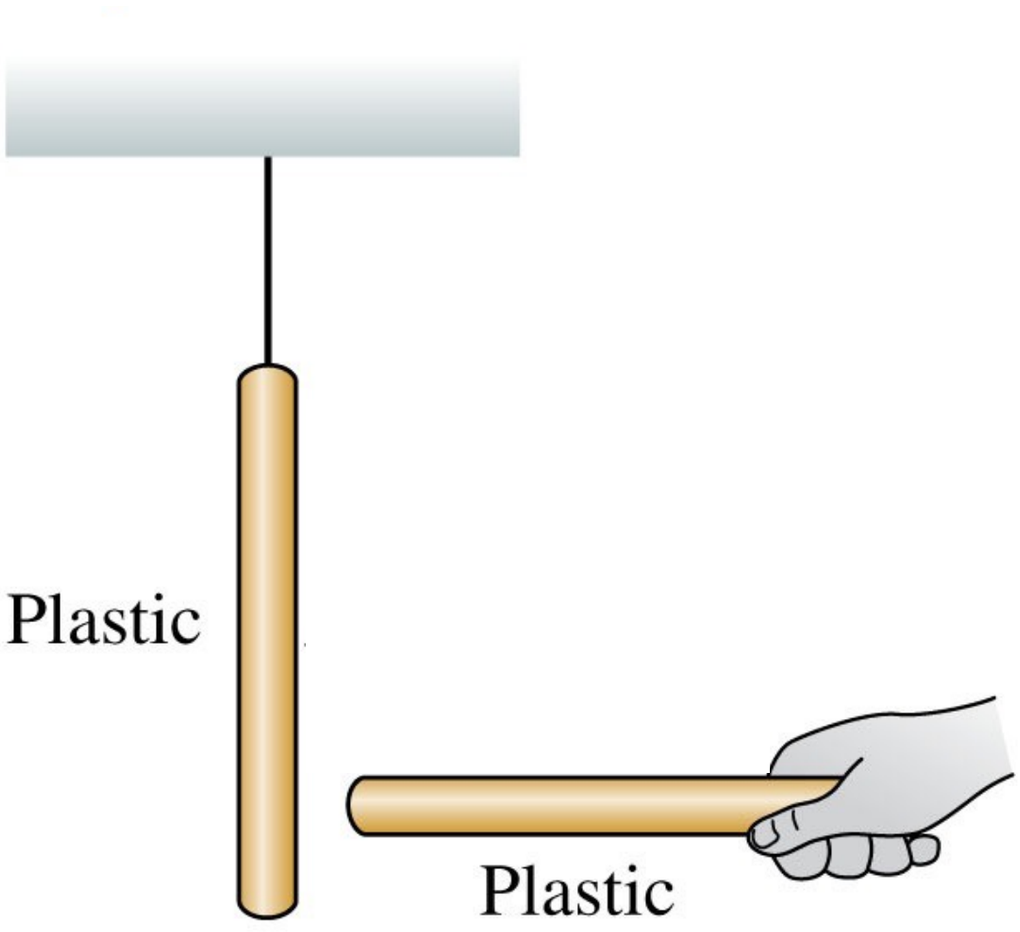
Outstanding question: What does rubbing do?

Triboelectric Effect

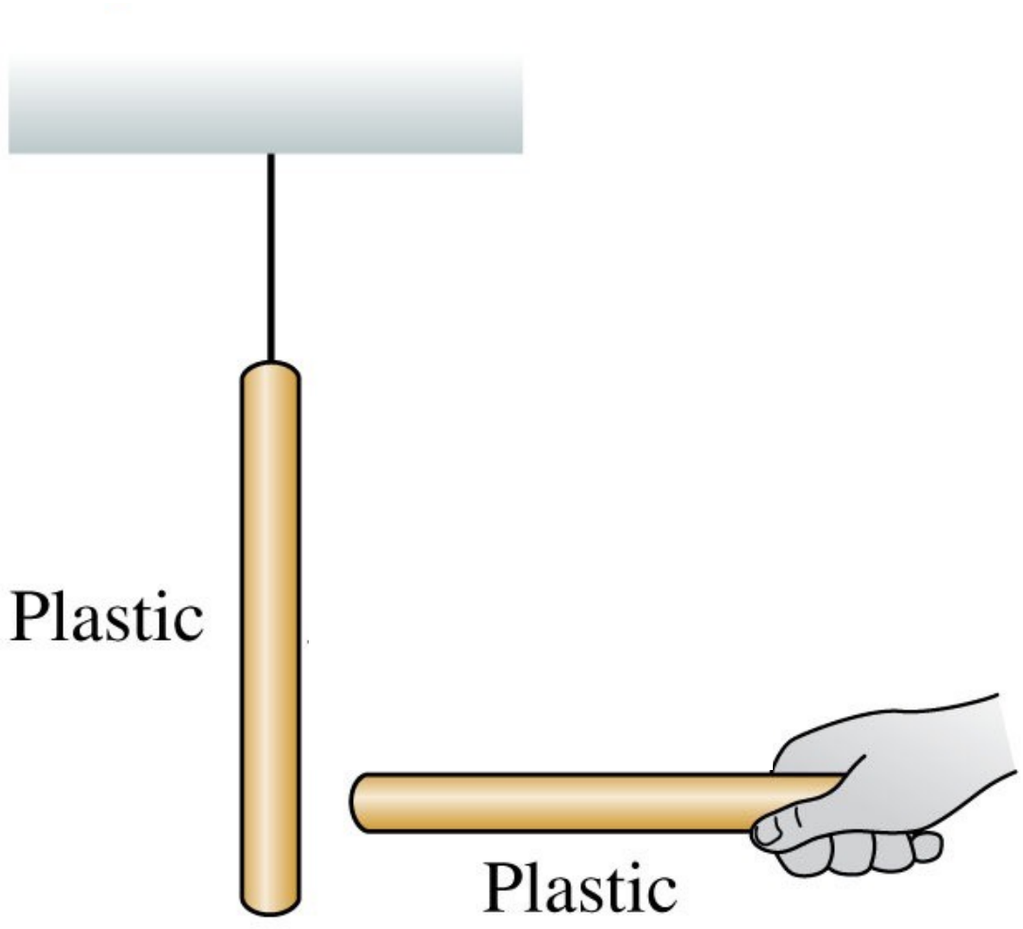


What if I only rub one of the rods?



What if I only rub one of the rods?

What if I exchange the plastic rod for a glass rod?



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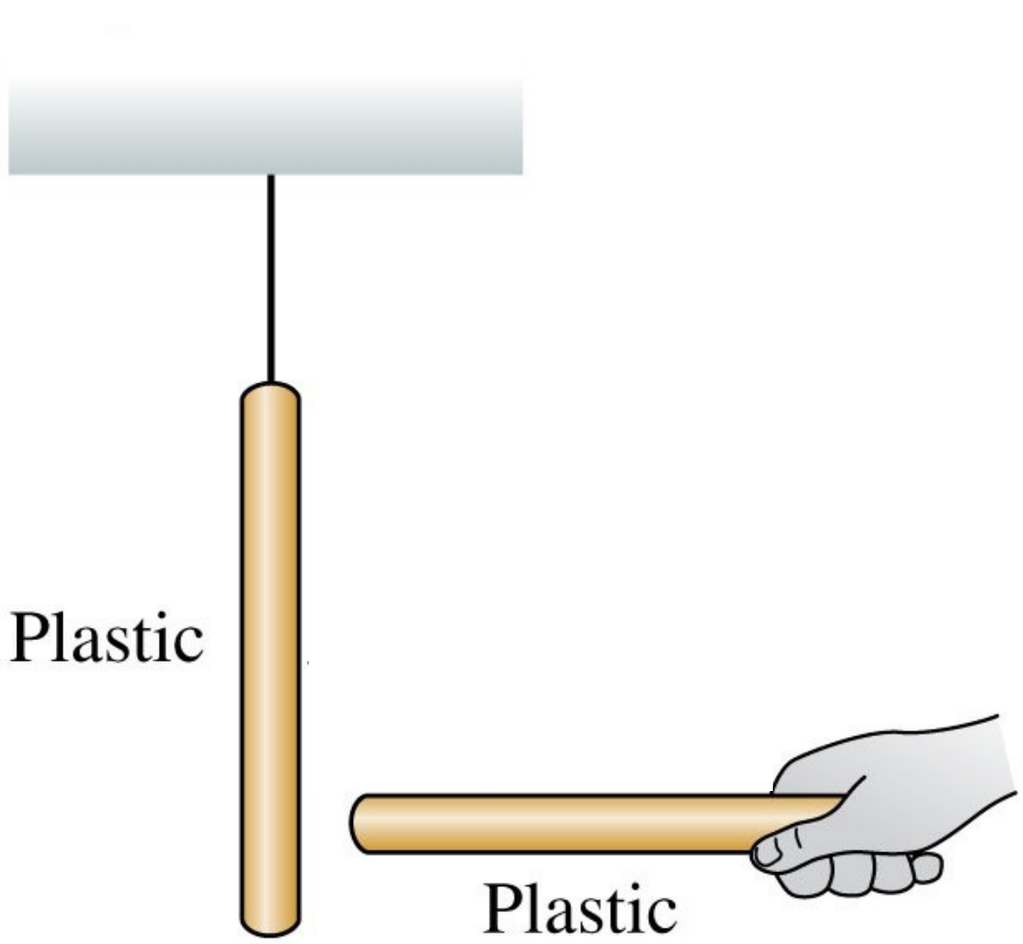

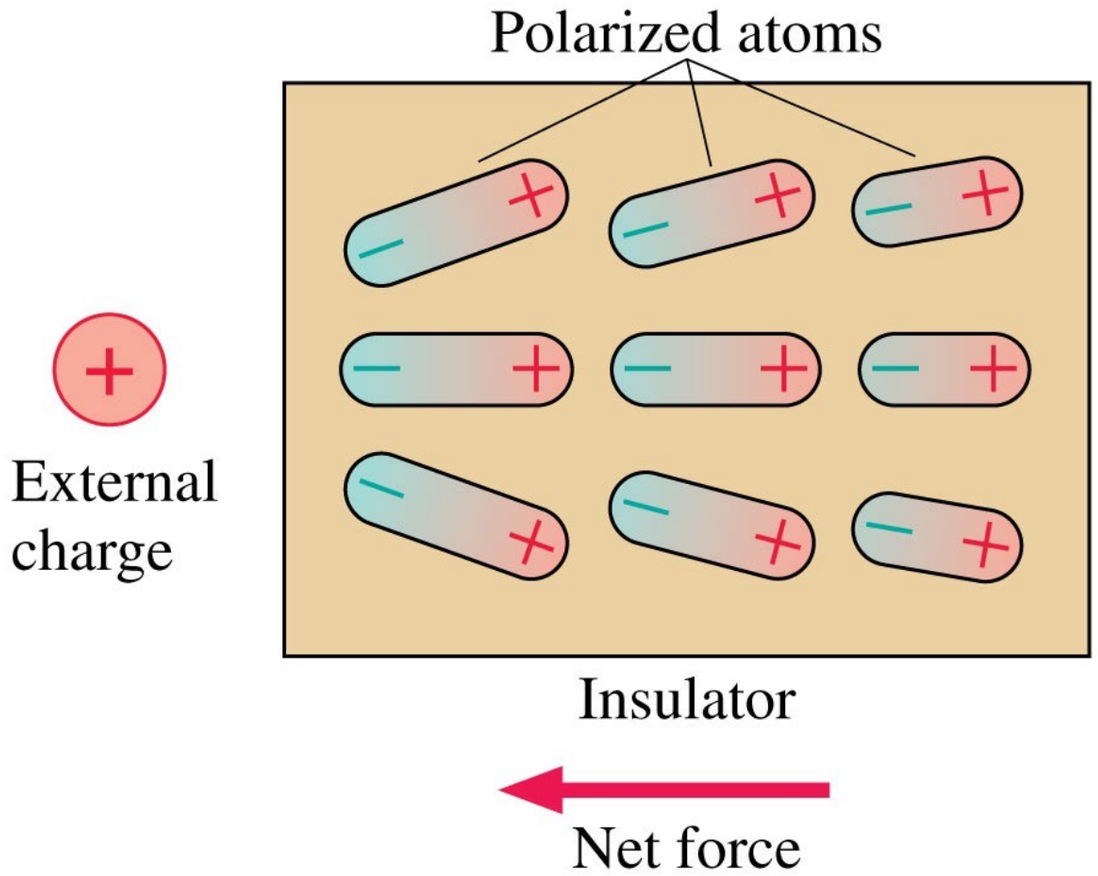

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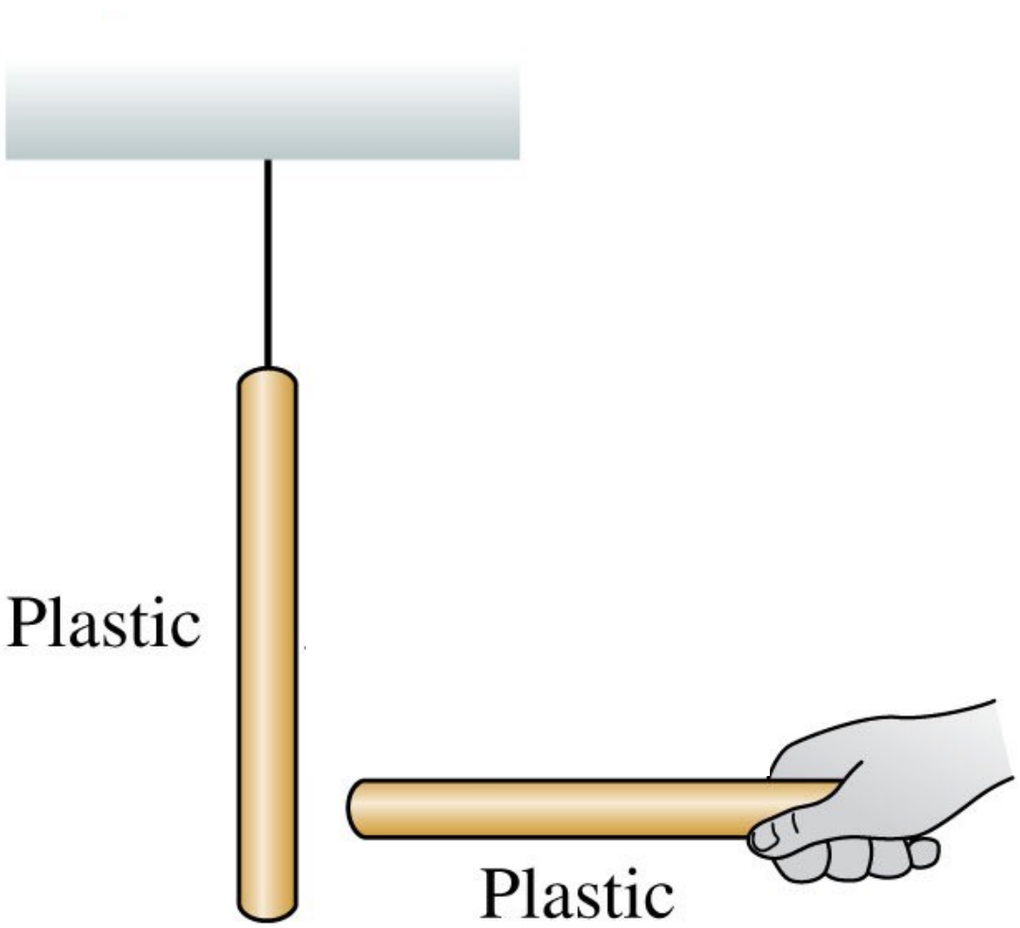
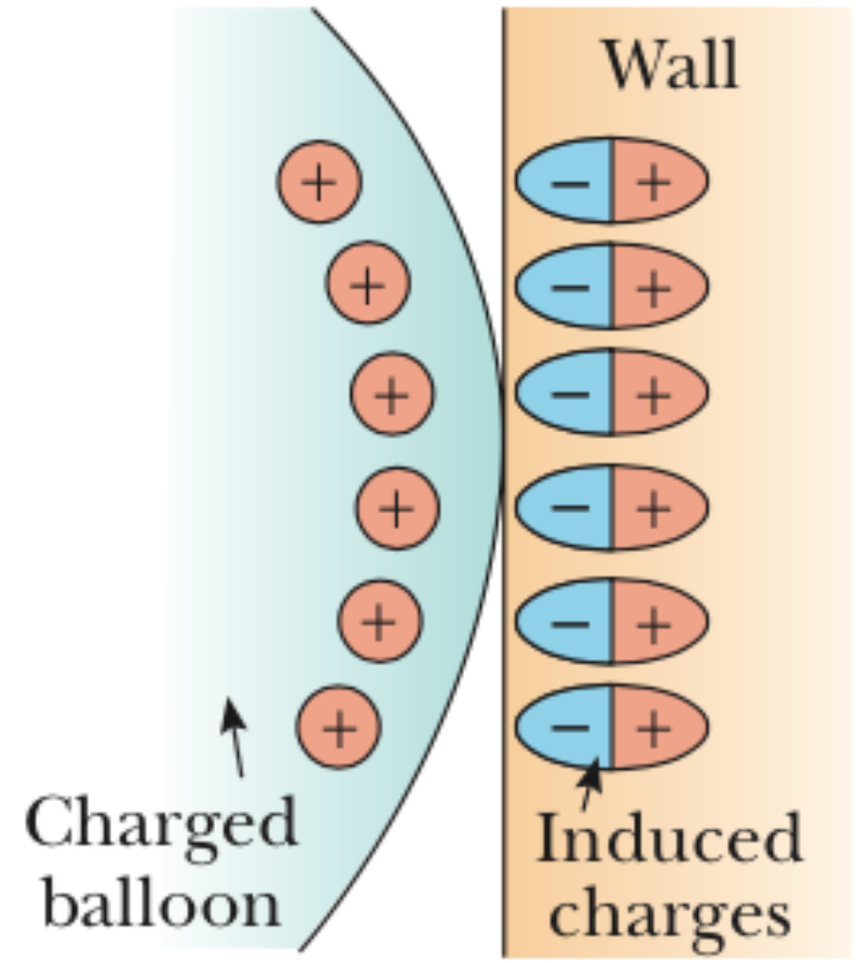
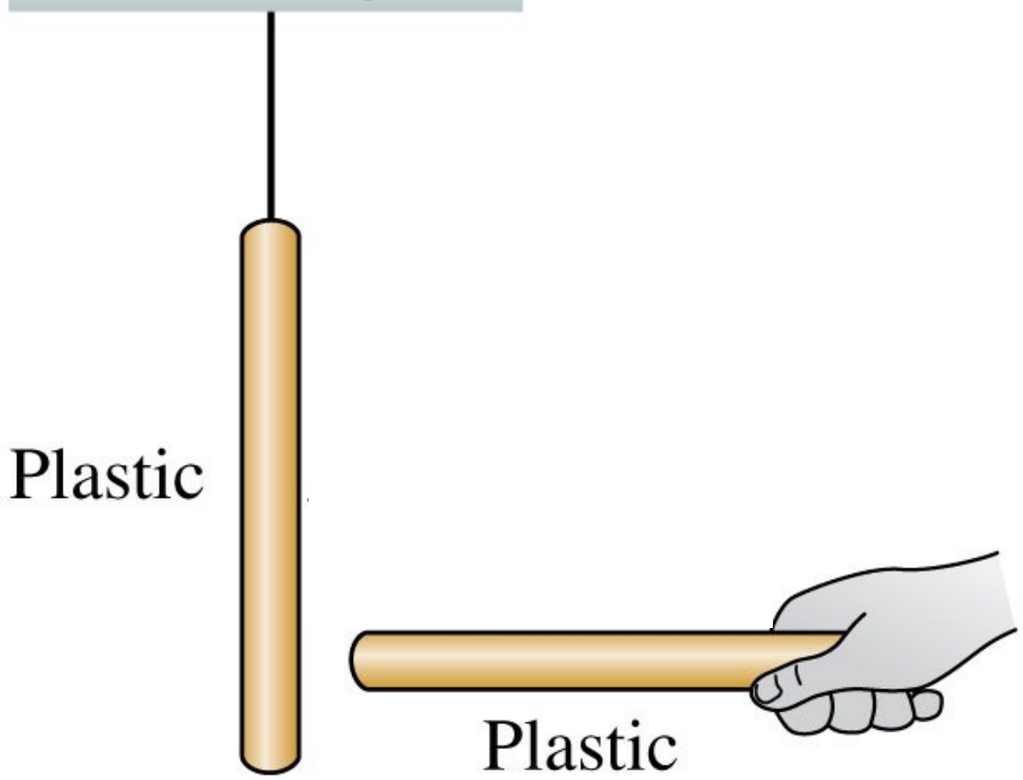


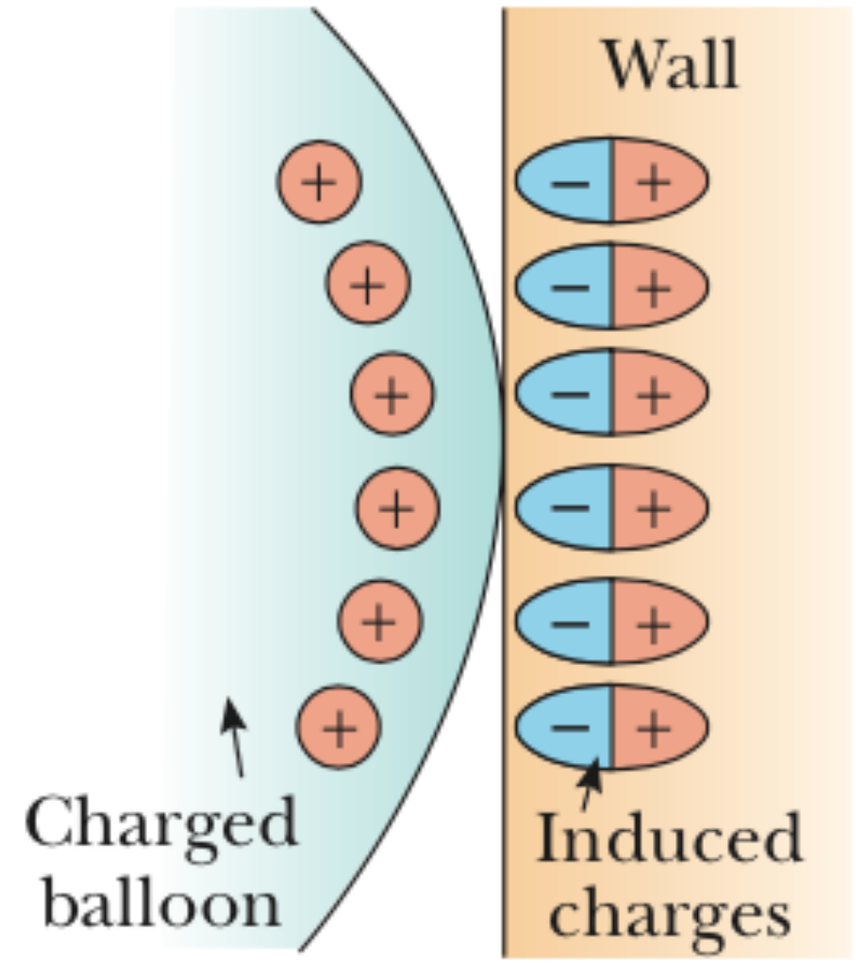


What if I only rub one of the rods?

What if I exchange the plastic rod for a glass rod?

Why didn't the electrons detach from the protons?





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Why di

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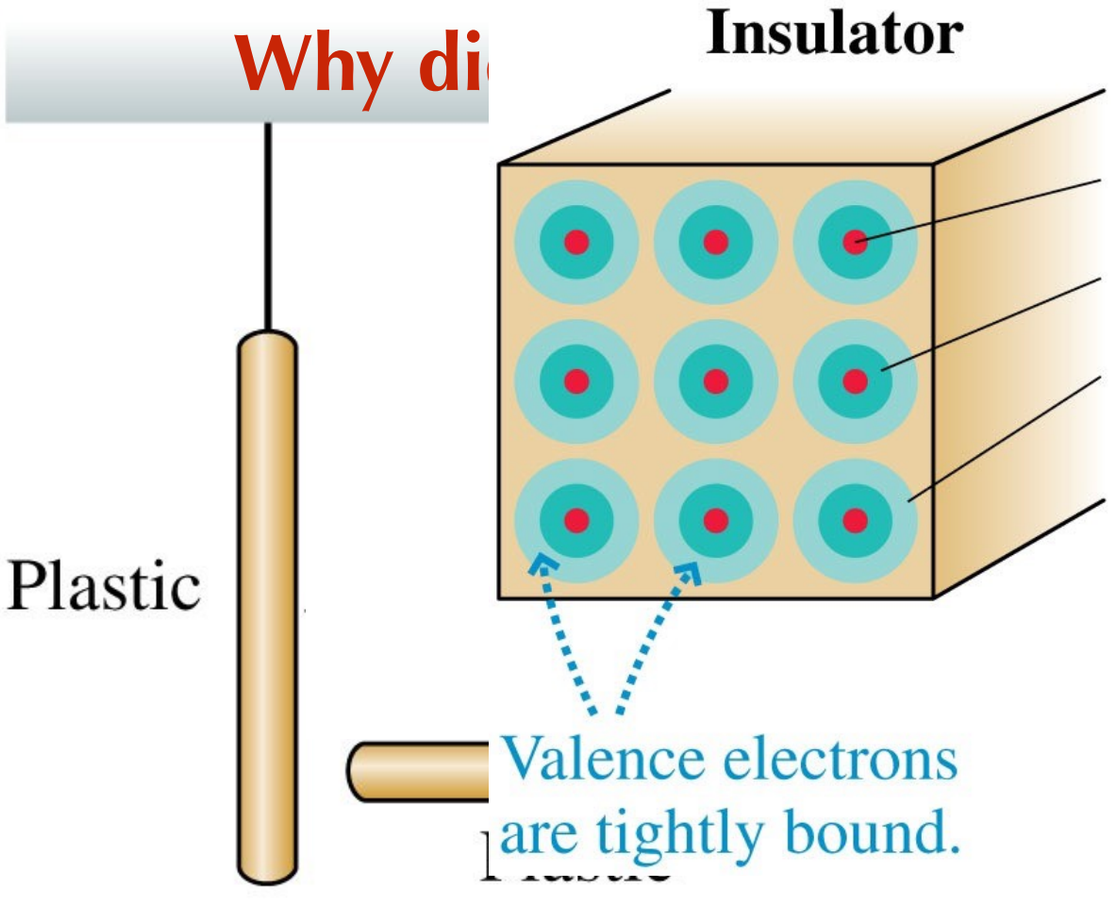
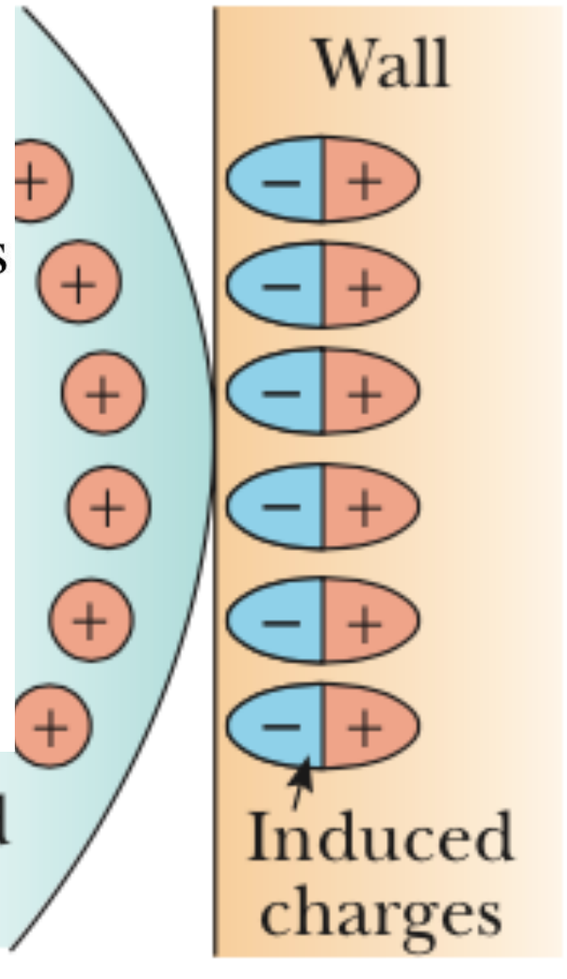
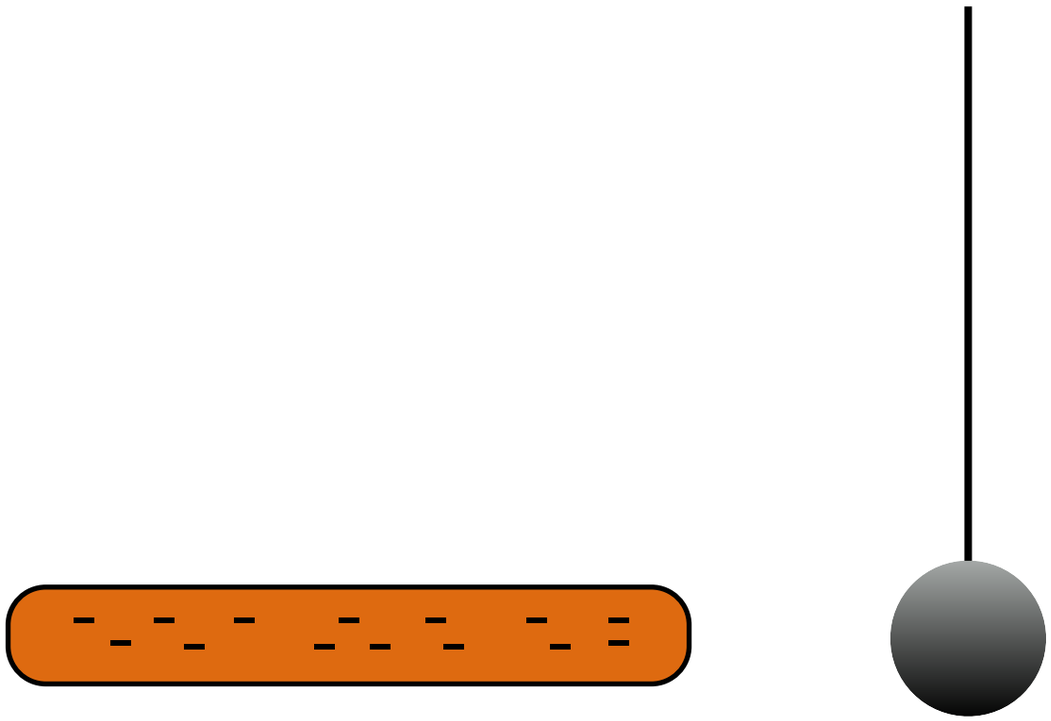
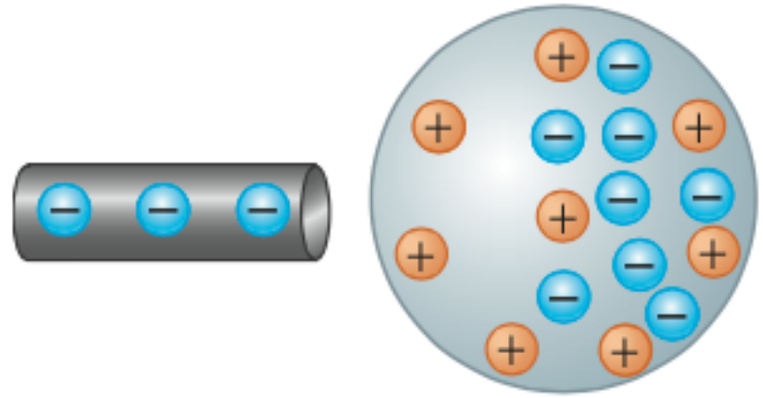
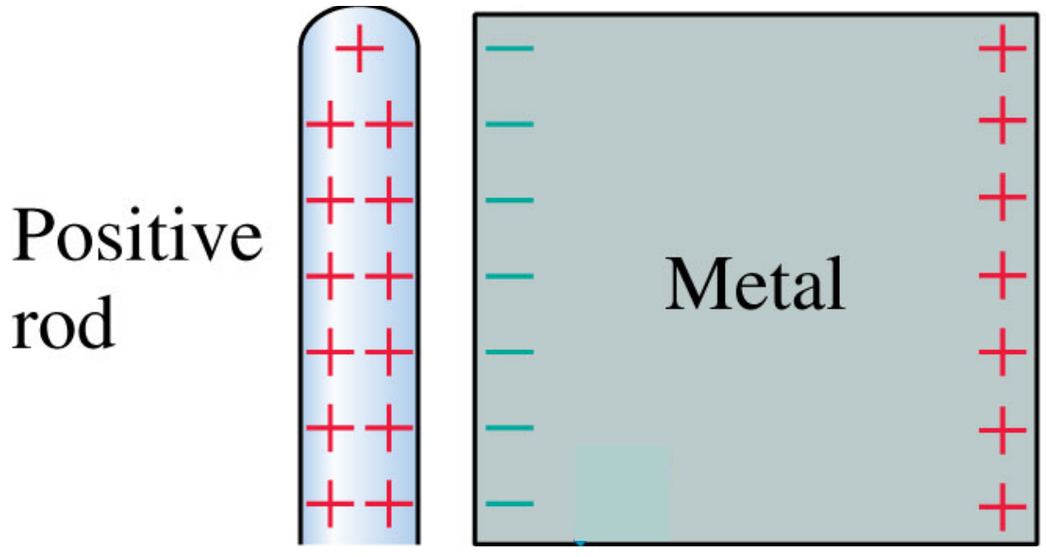
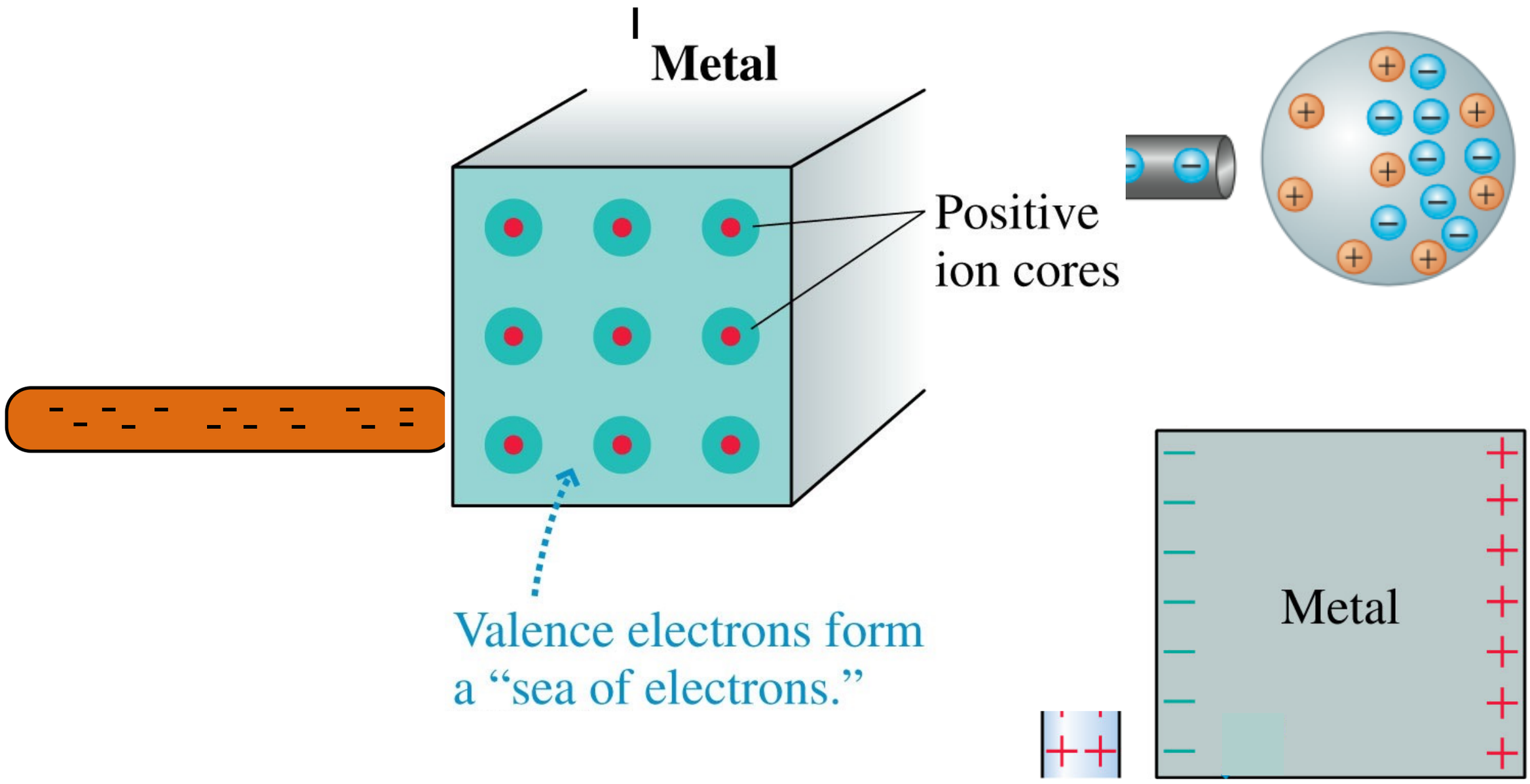









Positive
rod
Metal

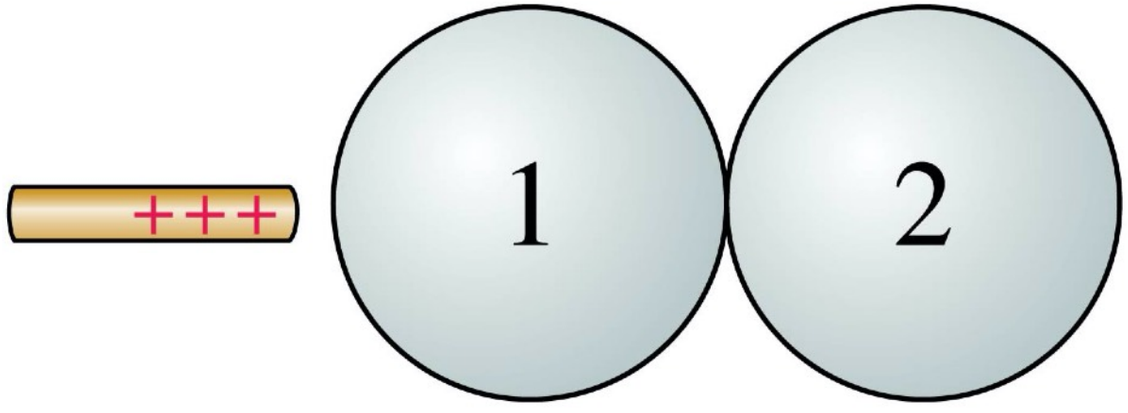

Metal
Positive
ion cores
Valence electrons form
a “sea of electrons.”
Metal

Question #19

Metal spheres 1 and 2 are touching. Both are initially neutral.

a. The charged rod is brought near.
b. The spheres are separated.
c.The charged rod is then removed.

Afterward, the charges on the sphere are:

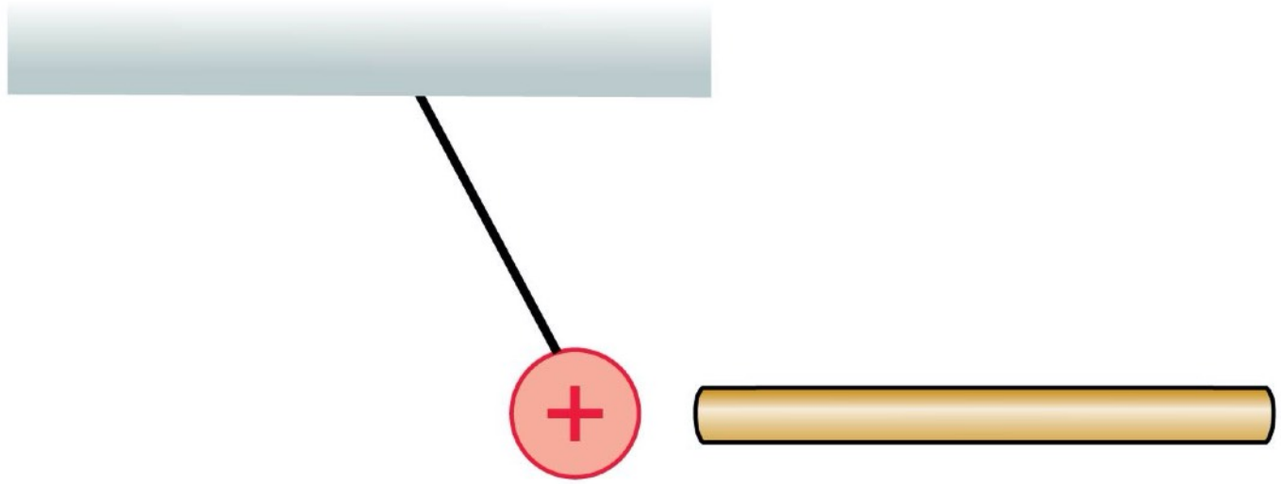


A. Q_1 is + and Q_2 is +.
B. Q_1 is – and Q_2 is +.
C. Q_1 is + and Q_2 is –.
D. Q_1 is – and Q_2 is –.
E. Q_1 is 0 and Q_2 is 0.

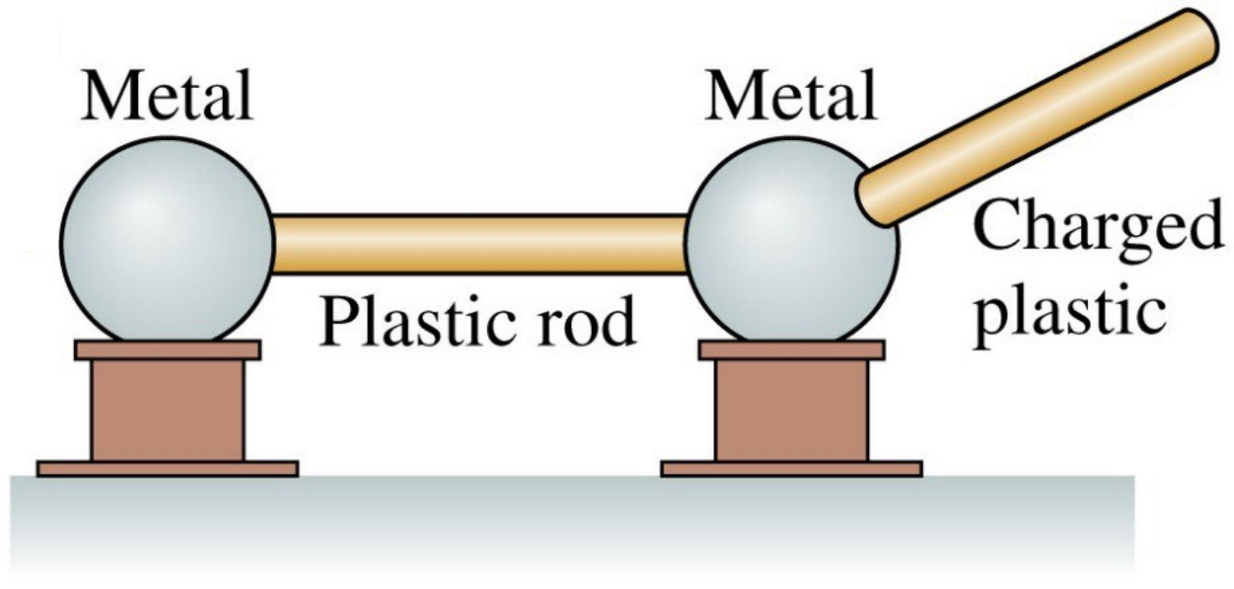
Question #20

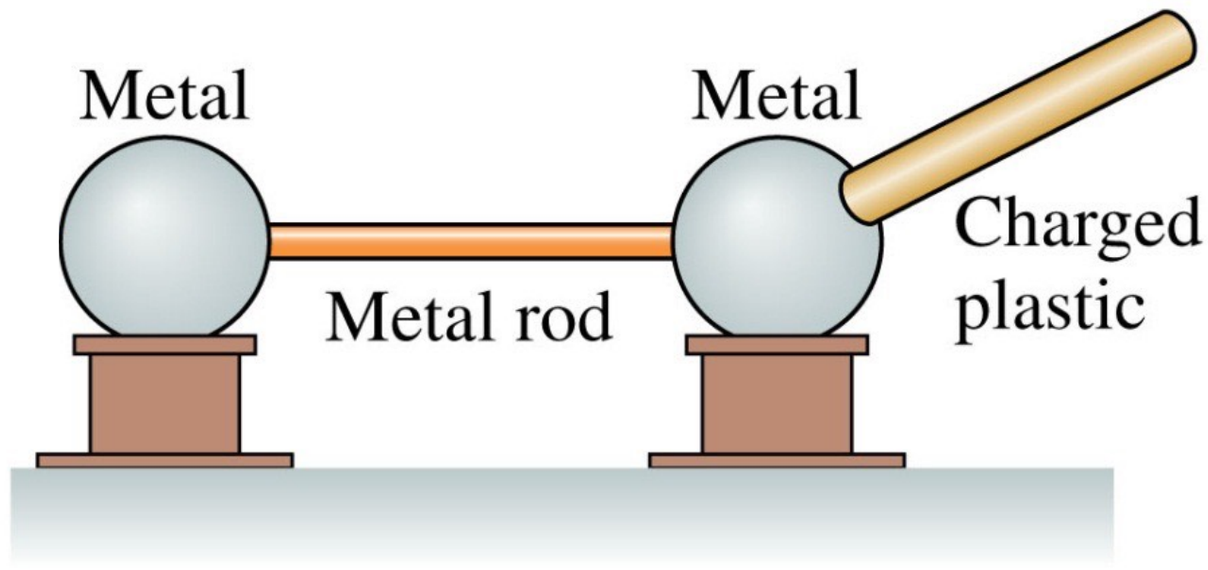
A rod attracts a positively charged hanging ball. The rod is

A. Positive.
B. Negative.
C. Neutral.
D. Either B or C.
E. Either A or C.

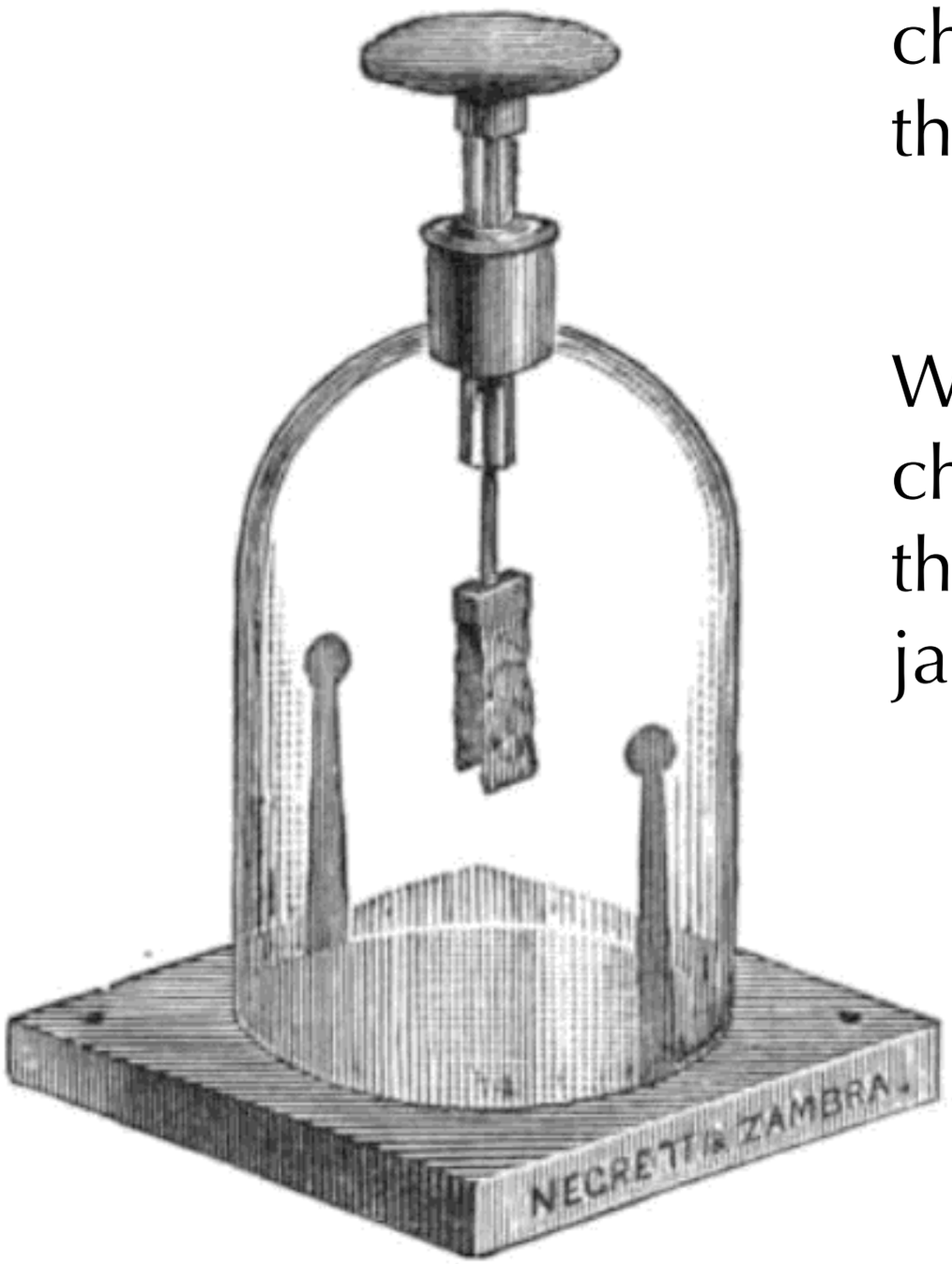


What will be charge state of the metal spheres?





Electroscope

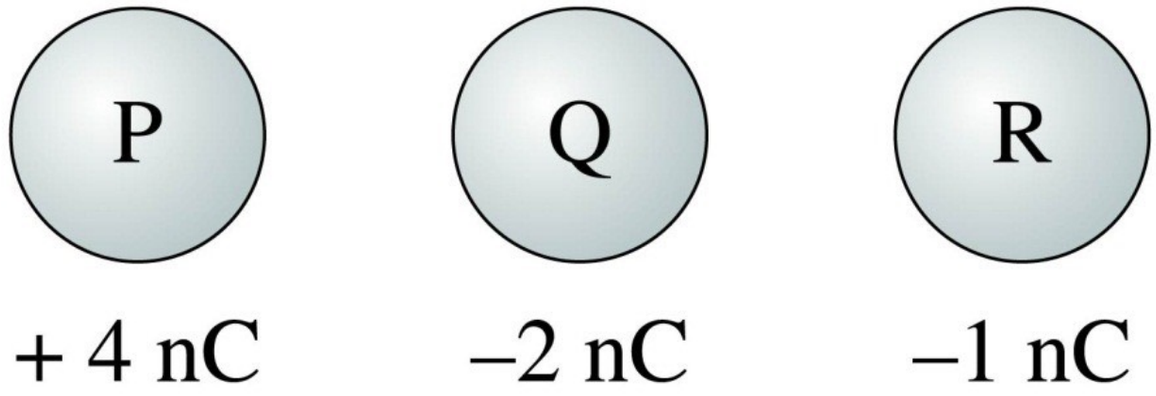


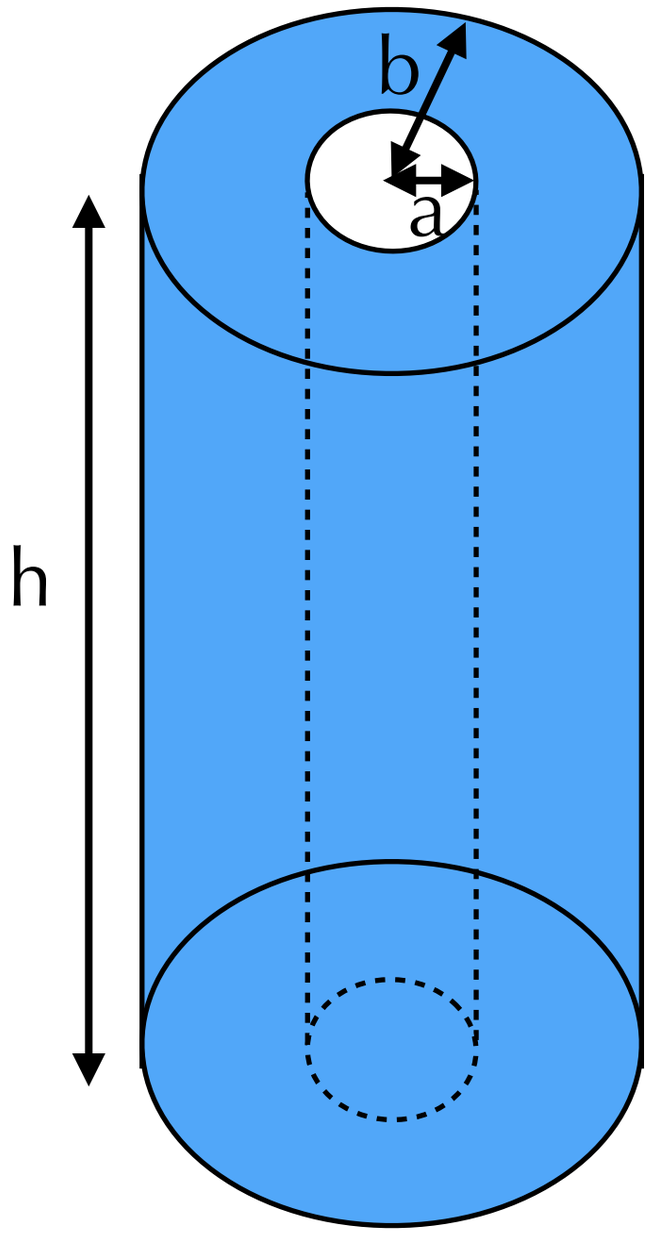
What will happen if I bring a charged object close to the top of the jar?

What will happen if I bring a charged object close to the top of the jar while touching the top of the jar?

Identical metal spheres are initially charged as shown. Question #21
Spheres P and Q are touched together and then separated.
Then spheres Q and R are touched together and separated.
Afterward the charge on
sphere R is

A. 0 nC.
B. –1 nC or less.
C. –0.5 nC.
D. +0.5 nC.
E. +1.0 nC or more.





A right cylindrical shell of inner radius a, outer radius b, and height h is shown in the figure. The mass density of the object varies according to the function:

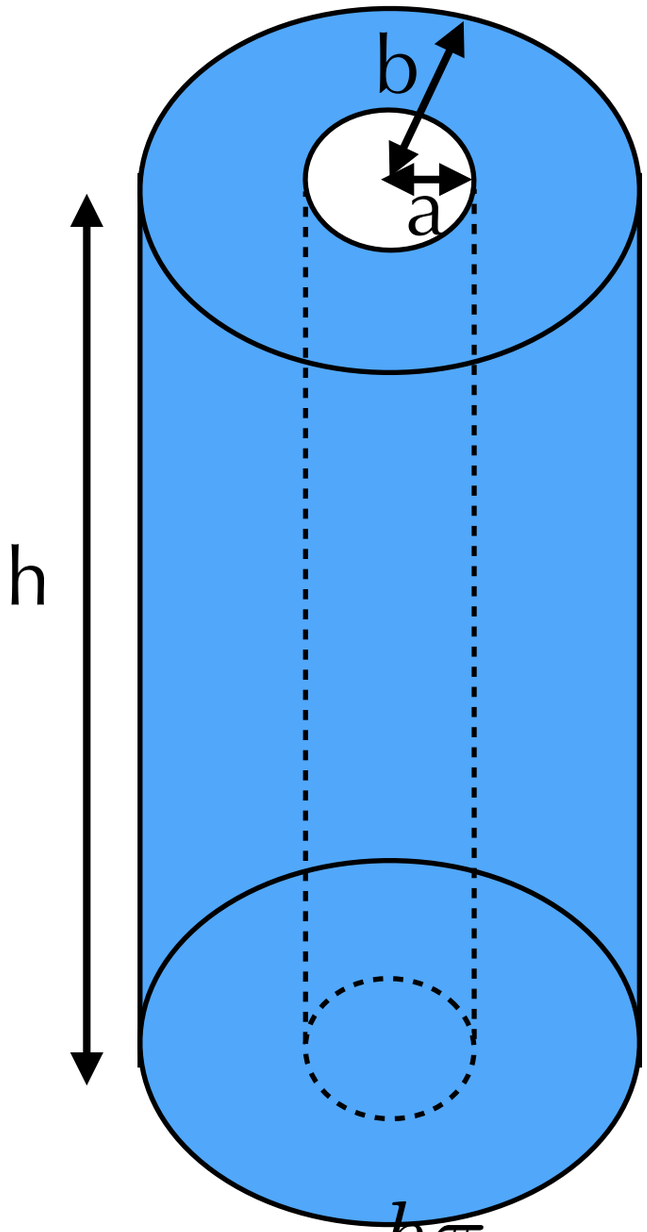
$$\sigma(\rho, \phi) = \rho^2 \sin^2 \phi$$

Find an expression for the mass of the object.

The following trig identity may be useful

$$\sin^2 u = \frac{1 - \cos 2u}{2}$$

Try solving using Mathematica



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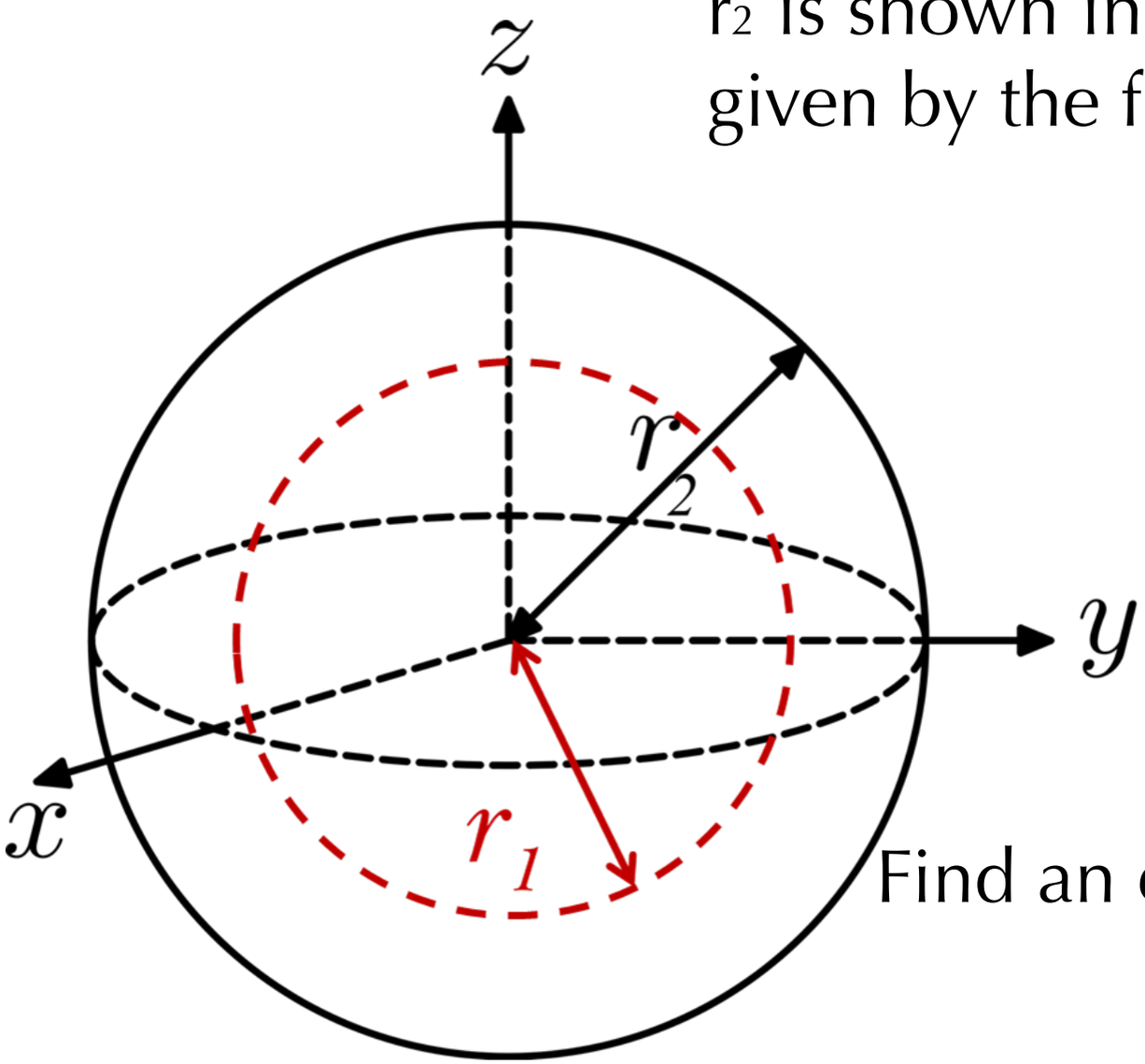
Try solving using Mathematica

$$m = \frac{h\pi}{4}(b^4 - a^4)$$

A spherical shell of inner radius r_1 and outer radius r_2 is shown in the figure. Its density varies and is given by the function:

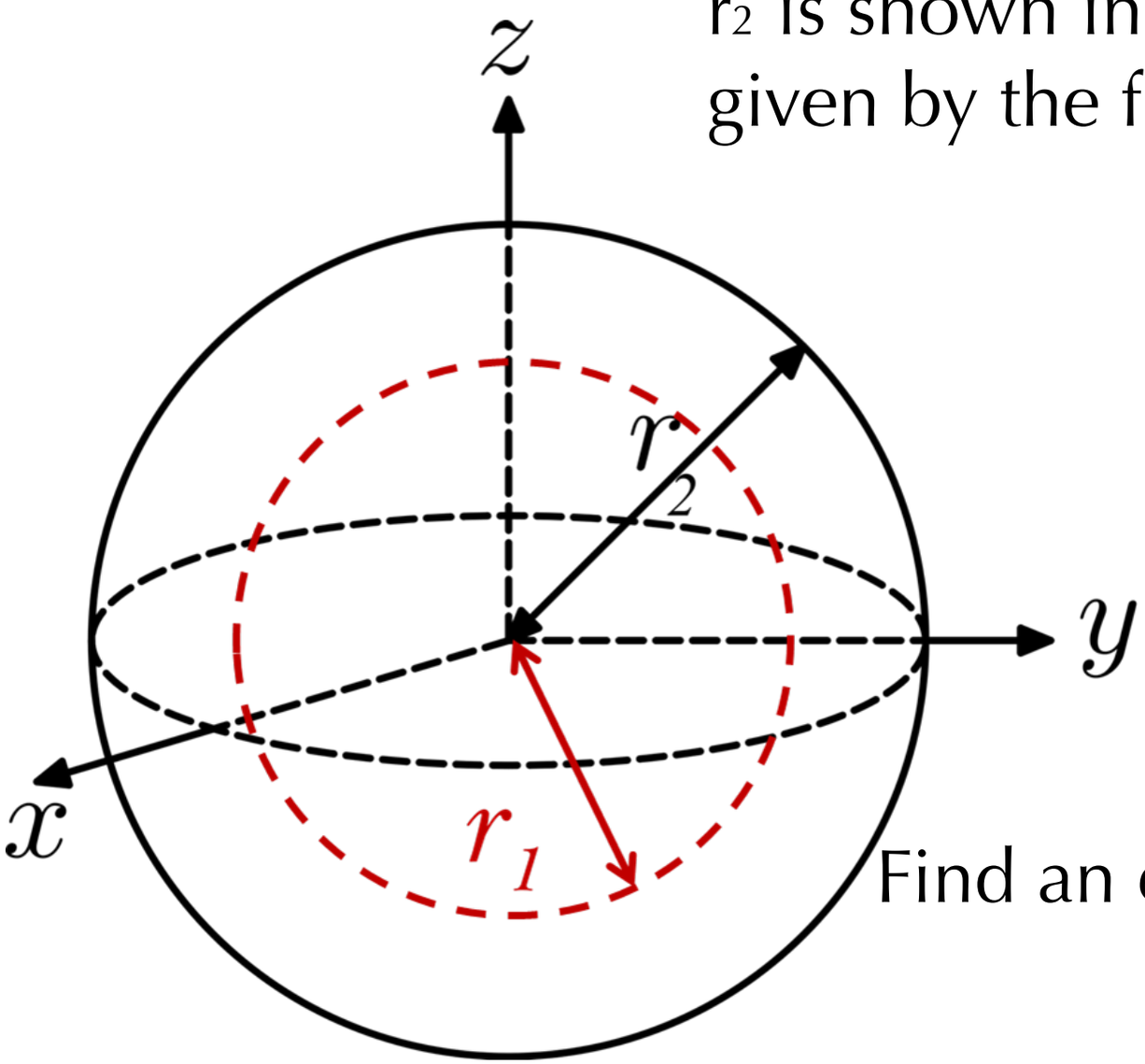


$$\rho(r, \theta, \phi) = \sqrt{r} \sin^2 \phi$$

Find an expression for the mass of the object.

to ponder: what is a differential volume element in spherical coordinates.

A spherical shell of inner radius r_1 and outer radius r_2 is shown in the figure. Its density varies and is given by the function:



$$\rho(r, \theta, \phi) = \sqrt{r} \sin^2 \phi$$

Find an expression for the mass of the object.

$$m = \frac{4\pi}{7}(r_2^{7/2} - r_1^{7/2})$$

to ponder: what is a differential volume element in spherical coordinates.