Question

- How many electrons are there in one coulomb of charge?
- Number = $1/1.6022 \times 10^{-19}$ coulombs/electron
- $N = 6.241 \times 10^{18}$ electrons/coulomb

Question

- The mass of one electron is 9.11×10^{-31} kg. What is the mass of one coulomb of electrons?
- $m = (6.241 \times 10^{18}\ e/C)(9.11 \times 10^{-31}\ kg/e) =$
  $= 5.69 \times 10^{-12}\ kg/C$

Question

A uranium atom has 92 electrons orbiting around its nucleus. How many coulombs of charge do they have?

$92 \times 1.6022 \times 10^{-19}$ coulombs

$= 1.47 \times 10^{-17}$ coulombs

Problem 22-1

Compare the gravitational force between an electron and a proton with the electrical force between them. $d = 10^{-10}$ m

$e = 1.6022 \times 10^{-19}$ coulombs (same for proton!)

$k = 9 \times 10^{9}\ N \cdot m^2/C^2$

$m_{electron} = 9.1094 \times 10^{-31}$ kg
$m_{proton} = 1.6726 \times 10^{-27}$ kg

$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$

Answers!

- F_{grav} 1.02×10^{-47} N
- $F_{elec} = 2.3 \times 10^{-8}$ N
- The electrical force is 2.3 x 10^{39} times stronger!

An oil drop of mass 10^{-6} kg enters a region between two parallel plates. The potential difference between the plates is 120 V. (The plates are .1 m apart.) The oil drop has a charge of 3 μC. Find the change in kinetic energy of the oil drop and its final velocity (Assume it starts from rest).

1. ΔKE = Work done.
2. $W = qV$, so $\Delta KE = (3 \times 10^{-6}\ C) \times (120V)$
   $= 3.6 \times 10^{-4}\ J$
3. $\frac{1}{2}mv^2 = \Delta KE$, so $v = (2\ \Delta KE/m)^{\frac{1}{2}}$
   $= 26.8\ m/s$

In an x-ray machine, electrons are accelerated by an electric field and then strike a target that emits x-ray energy. The potential difference through which the electrons are accelerated is 10^4 V. Find the energy of the electrons in joules, and their velocity.

$m_e = 9.11 \times 10^{-31}$ kg

$q = e = 1.602 \times 10^{-19}$ coulombs

1. $V = 10^4$ V
2. W = qV, so
   $W = (1.602 \times 10^{-19}\ C) \times (10^4\ V)$
   $= 1.602 \times 10^{-15}$ J
3. $\frac{1}{2}mv^2 = \Delta KE$, so $v = (2\ \Delta KE/m)^{\frac{1}{2}}$
   $= 5.93 \times 10^7$ m/s (which is less than the speed of light!)

Electron Volt (eV)

$W = (1e) \times (10^4\ V) = 10^4\ eV = 10\ keV$

$1\ eV = 1.602 \times 10^{-19}\ J$

Example

- How many coulombs of charge pass a given point in a wire in 2 minutes if it carries a current of 3 amperes?
- q = (I)(t)
- = (3 A)(120 sec)
- = (3 coulombs/sec)(120 sec)
- = 360 coulombs

Example

- How much current is drawn by a 60 watt, 120 volt light bulb?
- I = P/V
- = (60 watts)/(120 volts)
- = 0.5 watt/volt
- = 0.5 amperes

Example

- How many 100 watt light bulbs can be plugged into a 15 ampere, 120 volt residential circuit which is already operating a 1000 watt toaster?
- P = VI
- = (120 volts)(15 amperes)
- = 1800 watts.
- 1800 W – 1000 W = 800 W
- 8 Bulbs

Example

- A small flashlight bulb runs on 6V, draws .15 amps, and has a resistance of 40 ohms. How much power does it use?
- $P = I^2R$
- $P = (.15 \text{ amps})^2 \times (40 \text{ ohms})$
- $P = .9 \text{ W}$