

**Work each of the following problems. SHOW ALL WORK.**

1. What are four similarities between electrostatic and gravitational forces? What are two differences?

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2. Determine both the mass and the charge of a block of material consisting of  $3 \times 10^{27}$  protons,  $3 \times 10^{37}$  neutrons, and  $3.1 \times 10^{27}$  electrons.

3. A proton is placed  $100 \mu\text{m}$  from a helium nucleus. The gravitational force pulls the proton and nucleus together, while the electric force pushes them apart. Which force is stronger and by how much?

**Work each of the following problems. SHOW ALL WORK.**

4. How far apart are a proton and an electron if they exert an attractive force of 3 N on each other?
5. If the total charge of an atom's nucleus is +3 and the total charge of the surrounding electrons is -3, the atom is which one of the following:
- a. positively charged
  - b. negatively charged
  - c. electrically neutral
  - d. unstable
6. An object with charge  $4.3 \times 10^{-5} \text{ C}$  pushes another object  $0.31 \mu\text{m}$  away with a force of 7 N. What is the total charge of the second object?

**Work each of the following problems. SHOW ALL WORK.**

7. A balloon, which is initially neutral, is rubbed with fur until it acquires a net charge of  $-0.40 \text{ nC}$ .

a. Assuming that only electrons are transferred, were electrons removed from the balloon or added to it?

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b. How many electrons were transferred?

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8. Two  $+1 \text{ C}$  charges are separated by  $3,000 \text{ m}$ . What is the magnitude of the electric force between them?