Homework 1

1. In a process known as beta decay, a neutron in an unstable atomic nucleus becomes a proton, in the process ejecting an electron and an antineutrino. (a) Use conservation of charge to determine the charge of an antineutrino. (b) Sixty billion neutrinos (mostly from the Sun) pass through every square centimeter on Earth every second. They are hardly noticeable due to their negligible mass and weak interaction with matter. When a neutrino and an antineutrino collide, however, they annihilate each other and produce two (electrically neutral) gamma rays traveling in opposite directions. What is the charge of a neutrino?

2. The Sun generates most of its light through a series of nuclear reactions called the proton-proton chain. The overall process of these nuclear reactions can be summarized as $4\ {}_1\mathrm{H} \rightarrow {}_2\mathrm{He} + 2\ \nu + 2\ \gamma + 2?$ where ν is a small neutral particle called a neutrino, and γ is a photon (a particle of light), which is also neutral. The pre-subscripts on the element symbols H (hydrogen) and He (helium) indicate the number of protons in the nucleus of each element. What is the charge of the unknown entity "?" ?
☐$+2e$ ☐$+e$ ☐0 ☐$-e$ ☐$-2e$

3. You are locked in a rubber room and given a pair of rubber gloves along with a positively charged bar of gold (marked with a "+") and two electrically neutral bars of gold. You will be released if you can produce a negatively charged bar of gold, and you get to keep the gold. Explain how you might accomplish this.

4. A cloud that is about to unleash a lightning bolt has a charge of +24 coulombs. In stormy weather, powerful updrafts of air carry electrons from one place in the storm system to another. If the cloud started out electrically neutral, how many electrons were removed from it to give it this positive charge?

5. Two 2.0 kg plastic garbage cans are sitting 2.6 meters apart on a sticky classroom floor (coefficient of static friction $\mu_s = 0.40$). They are not moving. If the first one has a charge of 10 μC, find (a) the most negative possible charge and (b) the most positive possible charge for the other garbage can. Assume that the charges can be represented as point charges located at the cans' centers.

6. A bicycle wheel with radius 35 cm has 73 charges (1.0 μC each) spaced at regular intervals along its edge. A flea with charge –0.010 μC lands in the center of the wheel. (a) What is the net electric force on the flea? (b) One of the charges is removed. Find the magnitude of the new net electric force on the flea.