Name_____

Date_____ **Pd**____

Unit II: Worksheet 4

1. Determine how much does the electric force between a pair of charged bodies change when:
   a. their separation is tripled

   b. their separation is reduced to 1/4 the original value

   c. the charge of both objects are doubled *and* their separation is doubled

2. The most common isotope of hydrogen contains a proton and an electron separated by about 5.0×10^{-11} m. The mass of a proton is approximately 1.7×10^{-27} kg. The mass of the electron is approximately 9.0×10^{-31} kg.
   a. Use Newton's law of universal gravitation to calculate the gravitational force between the electron and proton in the hydrogen atom. $G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$.

   b. Use 1.6×10^{-19} C as the elementary unit of charge to calculate the force of attraction between the two particles. $k = 8.99 \times 10^{9}\ N \cdot m^2/C^2$.

   c. Determine how many orders of magnitude greater the electric force between the two particles is than the gravitational force between the two particles. Draw two arrows and label them Fe and Fg. Make the magnitudes of the two arrows of the same size difference in order of magnitude.

3. The four fundamental forces are (1) The nuclear strong force that holds protons and neutrons together in the nuclei of atoms. (2) The electroweak force that is an interaction between quarks confined to a distance of about 1% the diameter of an average atomic nucleus. (3) The gravitational force that pulls all mass, including two protons, together. (4) And the electrostatic force that attracts unlike charges and repels like ones.
   a. Rank the four forces from strongest to weakest. Justify your ranking using the statement above.

   b. A book is pushed horizontally across a table at constant velocity. Draw a force diagram and label the diagram using *only* the four fundamental forces.

4. Two charged spheres are on a friction-less horizontal surface. One has a charge of $+3.0 \times 10^{-6}$ C, the other a $+6.0 \times 10^{-6}$ C charge. Sketch the two spheres, showing all forces on them. Make the length of your force arrows proportional to the strength of the forces.

5. The Earth rotates around the Sun in part because of the gravitational attraction between them. The Earth has a mass of 5.98×10^{24} kg and the Sun has a mass of 1.99×10^{30} kg. The average distance between the sun and the Earth is 1.5×10^{11} m.

   a. Draw a force diagram for each object.

   b. Solve for the magnitude of the gravitational force that each object exerts on the other.

   c. Calculate the magnitude of the gravitational force of one on the other when their separation is reduced by a factor of 10.

6. A 75 kg man is standing on the surface of the Earth. The Earth has a mass of 5.98×10^{24} kg and a radius of 6.38×10^{6} m. Assume all of the mass of the Earth can be concentrated at its center.

   a. Calculate the force of attraction between the man and the Earth.

   b. Divide your answer for part (a) by the mass of the man.

   c. Your answer to part (b) should be interesting. Explain how your answer is <u>not</u> a mathematical coincidence.