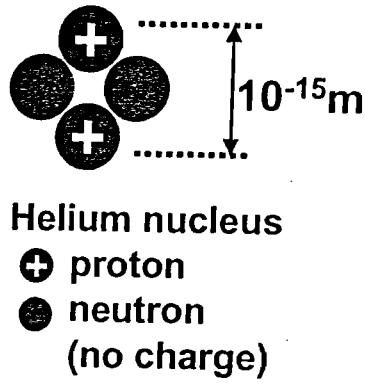
Physics 100 HW 7 (Due 3/2/07) **Friday** Name_____

1. The nucleus of a helium atom contains two protons that are typically about $10^{-15}m$ apart. Since protons have the same charge, the electrical force between them is repulsive. The gravitational force between them is attractive. The proton mass is $m_p = 1.7 \times 10^{-27}$ kg and its electric charge is $q_p = +1.6 \times 10^{-19}$ C. (The helium nucleus also contains two particles called neutrons, but since they have no electric charge, you can ignore them for now.)

   a) What is the *repulsive* electrical force between the two protons in the helium atom?

   b) What is the *attractive* gravitational force between the two protons?



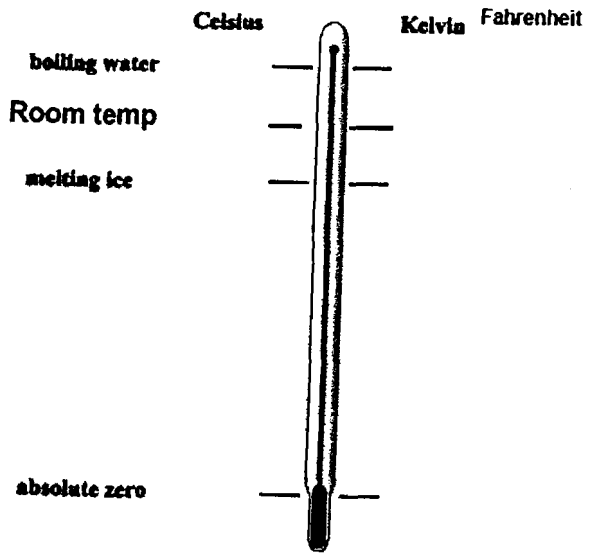
   c) Is the attraction provided by the gravitational force sufficient to counteract the repulsion of the electrical force?

2. Emmy Noether proved that every symmetry of a physical law implied a conservation law and vice versa. In the left-hand column below are listed three quantities that are conserved according to Newton's laws of motion; in the right-hand column are three symmetry properties of Newton's laws. Indicate which symmetries go with which conservation laws.

A) Conserved quantity	(answer)	**B)** Symmetry
a) Energy	_____	1. Same laws apply everywhere
b) Momentum	_____	2. All directions are equivalent
c) Angular momentum	_____	3. Laws are constant in time

3. List some differences between gravitational, electrical and magnetic forces.

4. Indicate the numerical values for the C, F, and K scale thermometers for the conditions indicated in the sketch below.



5. Sketch what the magnetic field lines look like for the arrangement of magnets shown below.

6. The arrangement of charges sketched at the right produce the pattern of $\vec{E}$-field lines as shown.

   a) Indicate the sign of each charge i.e. positive (+) or negative (-).

   b) Which charge is bigger?