Hints to Assignment #1 -- 8.022

(10 points) [1] Forces and Work

- Select your system of units. "A" will have different units in different systems. Will "A" have the same *dimensions* in the SI and CGS systems?
- d**r**=dx i^+ dy j^. Form dW=**F**d**r** and integrate over each of the 4 pieces of the square.
  Is this force conservative?

(10 points) [2] Force from potential

As you realized this should actually read force from potential energy. If U were the potential could we come up with the force? (No!).

- Start by reading p.9 and p.10 of your handout#1.
- You may find the definition of the gradient operator in p.15 of your handout#1. Watch out this is in cartesian coordinates (x,y,z).
- The third potential energy is given in polar (or cylindrical?) coordinates. You have three options here:
  - find out the expression for the gradient in polar coordinates in your nearest math handbook,
  - express r and phi in terms of x and y and use your cartesian definition, or
  - work out the general methodology to change variables; we will use MANY TIMES during this course the expression of the gradient in cartesian, polar, cylindrical and spherical coordinates.

(10 points) [3] Relative strength of the Electrostatic and Gravitational force (Purcell 1.1)

- Both force laws are 1/r^2 ... Take their ratios.
- Could gravity account for the stability of nucleus?

(15 points) [4] Two charged volley balls (Purcell 1.3)

- Mr. Coulomb prescribed how to find Q from F_e, thus you have to find F_e.
- Pick one ball and identify all the forces (**vectors**) acting on it. Define a coordinate system and analyze them.

- Can you propose an experiment to verify Coulomb's law based on this idea??

(10 points) [5] Charges on corners of square (Purcell 1.4)

- Let me tell you one thing, the future is in the superposition.
- Each corner charge feels 4 forces as prescribed by Mr. Coulomb.
- Draw a picture, identify the force VECTORS and request to vanish. A bit of trigonometry won't be bad.

(10 points) [6] A charge semicircle (Purcell 1.4)

- Coulomb's law applies to "discrete" charges. Use mathematics to discretize the given continous line charge density: lambda=dq/ds where ds is the infinitesimal length of the arc.
- Draw **E** (vector!) at the center due to an arbitrary dq, this is by definition the d**E** (vector!).
- Superposition=Integration (I told you it is the future).
- Watch out as d**E** changes directions for the various dq.

(10 points) [7] Electric field by two point charges (Purcell 1.11)

- The superposition for discrete charges implies that the field **E** at any point along the axis x will be the vector sum of the fields due to q1 and q2,i.e, **E**=**E1**+**E2**. Notice that if we write **E**(x)=E(x)**i**, E(x) carries also the **sign (+/-)** of the field which we can straightforwardly establish that it lies along **i**.
- You will find two solutions of which only one is accepted... which one and why?
- Can there be a point of E=0 anywhere between two charges of opposite sign? How about between two charges of the same sign?
- Try to plot E(x): identify the three regions in x and study first qualitatively how E(x) behaves at +- infinity or on the charges.

(10 points) [8] Electric field of finite charged rod (Purcell 1.24)

This is the same as problem [6] except the geometry of the continuous charge distribution. Remember, **E** is a vector and in order to perform vector arithmetics you need to introduce a basis system and components of **E** onto it.

(15 points) [9] Electric field of a hairpin (Purcell 1.26)

- Convince yourself that b=(BC)cos(theta) and y=(BC)tan(theta).
- You will need to express dy/d(theta) in terms of theta.
- Express the field at C as the superposition of the fields due to A and B.