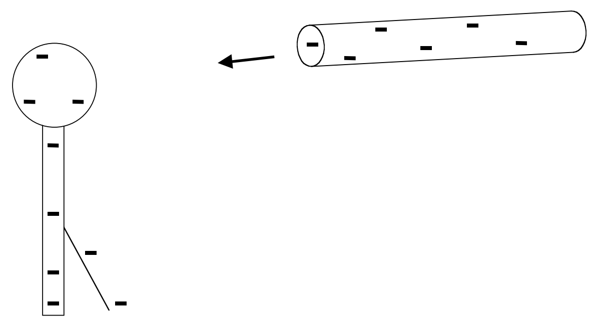
Below are some questions from old 2020 exams, largely from one I gave in Phys 2020 a decade ago! This might give you an idea of the style of questions I ask - although the course (and exam emphasis) are a little different now, 10 years later! So, of course don't expect the same questions (nor should you expect questions exactly the same as any you have seen in class or homeworks)- but I think they'll give you at least some sense for my tests. (Note: The old exam did have more questions on topics we didn't cover this year, some of which I chopped out - so, we will have *more* questions than this practice test)

NOTE: that old test had "written questions" at the end – we will be all multiple choice for our test (but think about how easily I could have taken those written questions and morphed them into a multi-choice question, so they are still good practice for you!)

MULTIPLE CHOICE: All answers *must* be bubbled in on your bubble sheet. (I suggest also circling the answers below, so you can easily check yourself when you get your exam back) There is always *only* one correct answer for each question.

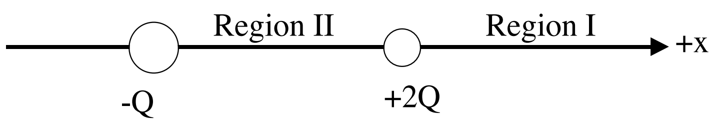
1) Suppose you rub a wool cloth against a rubber rod (both initially neutral), and the rubber acquires a net negative charge of -2 mC. Which statement below MUST be true by conservation of electric charge?(Assume *you* remain neutral)
   A) 2 mC of protons *must* have gone from the cloth to the rod.
   B) 2 mC of protons *must* have gone from the rod to the cloth.
   C) The wool cloth must remain neutral.
   D) The wool cloth aquires a charge of -2 mC.
   E) The wool cloth acquires a charge of +2 mC.

2) An electroscope has been charged up previously, so it has a net negative charge.
A negatively charged rubber rod is brought closer to the electroscope (but does NOT touch it)
What happens as it approaches?



   A) The leaf will rise even more.
   B) The leaf will fall a little.
   C) The leaf will remain where it is.
   D) The leaf will rise for a while, and then fall.

The following two questions refer to this situation: Two particles are fixed on the x axis as shown. The one on the left has non-zero charge -Q. The one on the right has charge +2Q.

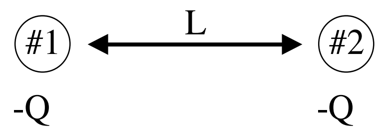


3) In Region I (a finite distance to the right of BOTH charges, on the x axis), the electric field
   A) points to the right, and *must* be non-zero.
   B) points to the left, and *must* be non-zero.
   C) might be zero at some point in that region.

4) In Region II (between the charges, on the x axis), the electric field
   A) points to the right, and *must* be non-zero.
   B) points to the left, and *must* be non-zero.
   C) might be zero at some point in that region.

5) Two charges are 10 cm apart. They are moved so the electrical force on each is now quadrupled (4 times bigger) How far apart are they now?
   A) 40 cm
   B) 5 cm
   C) 2.5 cm
   D) 0.625 cm
   E) Not enough information given

For the next *three* questions, consider two identical negatively charged particles with charge "-Q", and mass "m".
They are initially placed a distance "L" apart in empty space, at rest. (There is no gravity or any other force besides the electrical force between the particles)



(Please look *carefully* at the answers, some of them differ in subtle ways)

6) The particles are both released. What is the magnitude of the initial *acceleration* of the left-hand particle?
   A) $k\,Q^2\,/\,L^2$
   B) $k\,Q\,/\,m\,L$ (note: neither Q nor L are squared in this one)
   C) $k\,Q^2\,/\,m\,L^2$
   D) $k\,Q^2\,/\,m\,L$
   E) None of the above is the correct formula for the magnitude of acceleration of the particle.

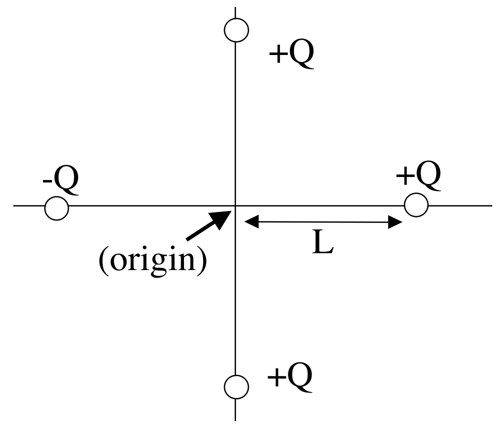
7) What is the potential energy of the system at the moment of release. (Assume PE=0 at infinity)
   A) $+k\,Q^2\,/\,L^2$
   B) $-k\,Q^2\,/\,L^2$
   C) $-k\,Q^2\,/\,L$
   D) $+k\,Q\,/\,L$ (note: neither Q nor L are squared in this one)
   E) None of the above is the correct formula for the potential energy of the system.

8) A few moments *after* they are released, you start to observe the acceleration of one of them. What will happen as time continues to pass?
   A) The acceleration is constant (and non-zero).
   B) The acceleration steadily increases with time.
   C) The acceleration steadily decreases with time.
   D) The acceleration is zero: the particles move with constant non-zero speed forever.
   E) The acceleration is zero: the particles do not ever move.

9) A carbon nucleus consists of 6 protons and 6 neutrons. (There are no electrons present). What is the magnitude of the electric field, a distance 1.0E-10 m away? (Watch units!)

A) 86 N/C
B) 14 J/C
C) 86 N
D) 1.4E-7 J
E) 8.6E11 N/C

The following 3 questions refer to this situation: Four charges are fixed in a square as shown. They are *all* exactly "L" away from the origin.
Three of them have charge +Q, but the one to the left of the origin has charge -Q.



10) What is the electric field at the origin?

A) $k\frac{Q}{L^2}$ to the left
B) $k\frac{Q}{L^2}$ to the right
C) $2k\frac{Q}{L^2}$ to the left
D) $2k\frac{Q}{L^2}$ to the right
E) None of the above is correct.

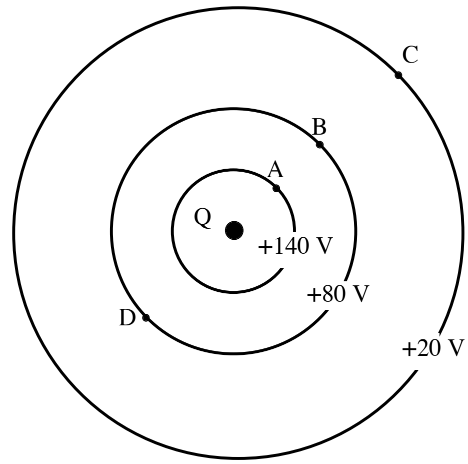
11) If you placed a test charge "-q" at rest, somewhere far to the right of the picture (a distance greater than "L"):

A) it would begin to accelerate in some direction other than towards the origin.
B) it would move towards the origin at constant speed.
C) it would begin to accelerate towards the origin.
D) it would begin to accelerate away from the origin.
E) not enough information given.

12) What is the voltage at the origin? (As usual, we define voltage to be zero at infinity)

A) $+4k\frac{Q}{L}$
B) $+3k\frac{Q}{L}$
C) $+2k\frac{Q}{L}$
D) $+k\frac{Q}{L}$
E) zero

The next *three* problems refer to this situation: a charge Q is at the origin.
The electric potential at points A, B, and C is V=+140 V, +80 V, and +20 V respectively.
(Point D is at +80 V, the same as point B)

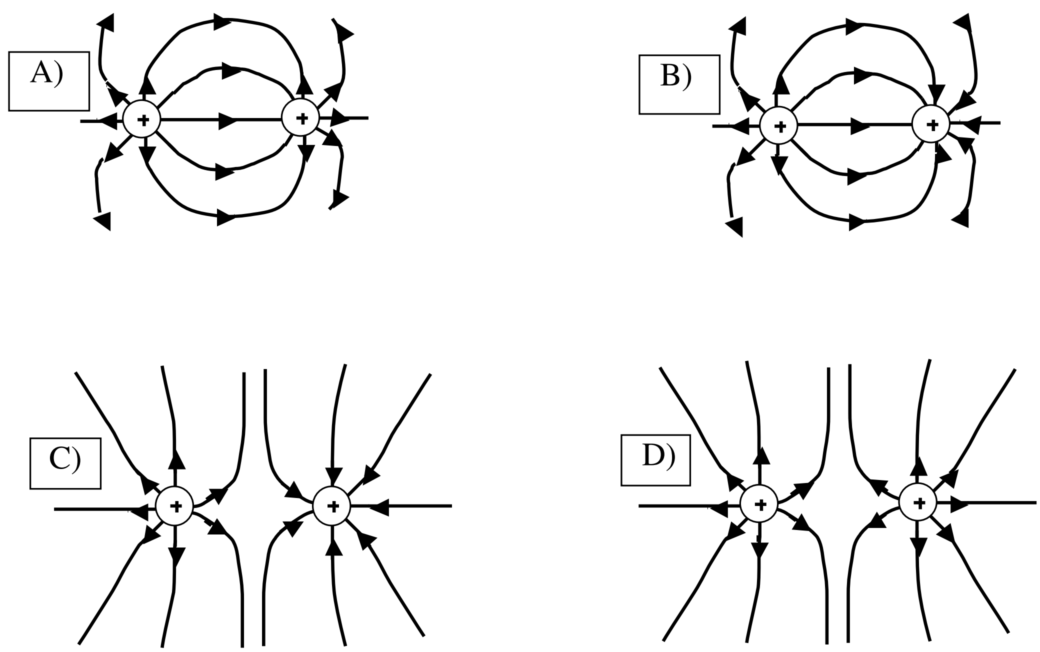


13) An electron placed (initially at rest) at point B will
   A) stay at point B
   B) move towards point A
   C) move towards point C
   D) start to move along the equipotential line V=+80V
   E) oscillate back and forth around the point B

14) If the electron is moved from point B to point D, how much work does the electric field do?
   A) Zero work, no matter what path is taken.
   B) Positive work, no matter what path is taken.
   C) Negative work, no matter what path is taken.
   D) The answer depends on the path taken.

15) If the electron is moved by some external agent from point B to point C (with constant speed), that agent must do a net work (measured in units of eV) of
   A) -9.6E-18 eV
   B) +60 eV
   C) -60 eV
   D) +80 eV
   E) -80 eV

16) Two IDENTICAL positive charges (protons) are fixed in place on the x axis. Which of the following sketches best represents the electric field lines around these protons?



~~**(Expect somewhere between 12 and 24 MC questions, plus 2-4 pages of "long answer" questions, on our midterm...)**~~

Expect about 25 MC questions (and no long-answer ones) on our exam - SJP

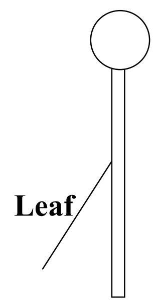
Your Name________________ **Your Student ID #** ____________________

LONG ANSWER QUESTIONS Please write in the space provided. (If you really need more room, use a spare sheet, and indicate clearly in the space provided that you did!)

In ALL problems, show and explain your work <u>briefly but clearly</u>. You may get NO credit for a correct answer, if your thinking is not easy to follow. Try to be neat and organized, so the graders can understand. Please use some English words explaining what you're thinking...

<u>Problem 1:</u> An electroscope starts off neutral, with the leaf hanging straight down.

a) (*4 pts*) We touch the top of the electroscope with a negatively charged rod. The rod is then removed. After this, we notice the electroscope leaf is now hanging at a non-zero angle, as shown to the right.



Is the net charge on the electroscope ***<u>(circle one!)</u>***

positive, negative, or zero.

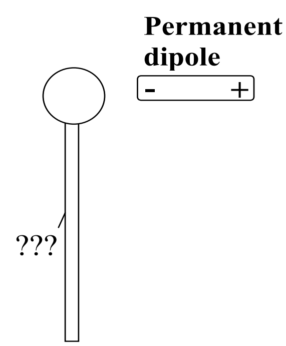
Explain your circled answer, sketch all excess charges in the figure, and explain briefly but clearly, the important features of your sketch:

b) (*6 pts*) We continue our experiment by then bringing a small rod, which is a permanent electric dipole, near the top of the charged electroscope of part a, oriented as shown: (it does not TOUCH). Is the leaf angle ***<u>(circle one!!)</u>***

higher, lower, the same, or is it ambiguous/undetermined

compared to the angle in part a?

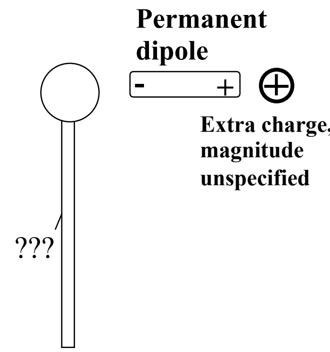
(If you chose ambiguous, what are the different possibilities?)
As always, explain briefly but clearly your answers.



(PROBLEM CONTINUES ON NEXT PAGE!!)

Problem 1 (continued):

c) (*6 pts*) Our experiment from parts a and b continues (the electric dipole in part b is still in the same place) but now we bring in yet ANOTHER object: a strong positive charge, as shown. (You do not know exactly HOW highly charged that new one is, just that it is positive)



Compared to **part b**, is the new leaf angle here (***circle one!!***)

higher, lower, the same, or is it ambiguous/undetermined

(If you chose ambiguous, what are the different possibilities?) As always, explain *briefly* but clearly your answers.