* 1. Explain how you first observed the magnetic deflection of electrons on page 125. Also explain how you predicted the *direction* of that deflection. Include magnetic field lines in your illustration.

* 2. Briefly explain how the charge of an electron was measured. Mention the year, the names of the people who first did it, and the best available result. (See #9 on RS IX or page 210 in the book.)

* 3. To measure the path radius, make a careful sketch of the pattern that you see in the vacuum tube. Make it approximately the SAME SIZE as the actual pattern that you see, not enlarged or reduced. Record the measured values of the solenoid current and the plate voltage *clearly* beside your sketch.

* 4. Use a compass or some coins to draw several arcs with different radii for comparison. Find one or two that resemble the arcs that you saw produced by the electron beams. Use them to estimate the path radius *in range form. Use SI units.* Don't kid yourself about the precision of this measurement. It's ok for the GLV and SLV to differ by a factor of two. Better precision only requires more money. Your report must include the sketch with clearly-labelled circular arcs superimposed on it.

* 5. What does the strength of the artificial magnetic field inside a solenoid depend on? How can it be predicted for a standard PSSC solenoid? Please copy *all* the details from #14 on RS XIV. Then illustrate by using the data in #3 to calculate the solenoid's field strength in *range* form.

* 6. Show how those results are used to calculate a GLV & SLV for the electron mass in SI units. (Use the data in #4 & 5 above with the plan that you made in #6 on page 126.) Remember to check units and to calculate by the *range* method. *Adding percent uncertainties is NOT appropriate here because the percentages are not small.* You are welcome to design a better experiment if you care to.

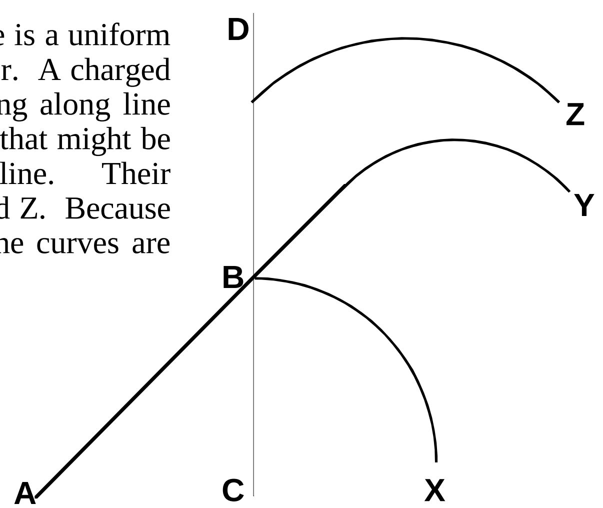
* 7. Suppose we need to find the electron mass with ± 2.0% precision. How precisely must we measure the path radius if all of the other measurements are perfect? (Explain, using #25 on RS II.)

8. Imagine that everywhere to the right of line CD there is a uniform magnetic field perpendicular to the plane of the paper. A charged particle is shot from point A into the field, travelling along line AB. Several students were asked to sketch the path that might be taken by the particle after crossing the boundary line. Their guesses are indicated by the curves marked X, Y, and Z. Because those students chose to guess instead of thinking, the curves are all absurd.

   Curve X is absurd because:

   Curve Y is absurd because:

   Curve Z is absurd because:



9. Copy lines AB and CD onto a another paper. Use a compass and ruler to construct a path that is *not* absurd. Label the final path clearly, label its center of curvature, and show how you found it.

10. Using a compass and ruler, copy path ABY carefully. Then draw a boundary line that could account for such a path. Also describe the direction of the magnetic field, assuming that the particle is negatively charged. Finally, explain how that direction was determined.

11. Problems 8-10 are "physics fairyland" problems to help you develop your thinking muscles. In the real world it is not possible to make a magnetic field with a sharp boundary like CD without having _________ _________ __________ on that boundary. (See pages 282-283 in the textbook.)

12. Did you round off all of your answers properly on this page? ____ If not, please explain.

1. There is some similarity between the cathode ray tube in an oscilloscope and the picture tube in a television set. The main difference between them is the method used to deflect the electron beam. Electrostatic deflection is used in oscilloscopes because it is simple and very fast. Magnetic deflection is used in TV picture tubes because it makes greater deflection angles possible. Both types of tube use an electron gun with a potential difference of 1000 volts or more. Using the "electron gun formula" in #21 on RS XIV, ***show*** how the electron speed can be calculated from that voltage. *Define your symbols*. (See page 246 in PSSC PHYSICS, 5th edition)

2. After emerging from the electron gun in a TV picture tube, electrons pass through an adjustable magnetic field which is perpendicular to the beam. It is produced by a set of coils called a "yoke". The field is confined to a region roughly ten centimeters in diameter, centered on the beam.
   a. Make a full-sized drawing of the circular region within the yoke. Label the field boundary.
   b. Starting from a point outside of that circular boundary, draw a straight line toward the center to represent the beam of electrons entering the magnetic field.
   c. Using a light dotted line, extend that path through the magnetic field and out the other side, showing the path which electrons will follow when there is no yoke current. Label it "undeflected path".

3. When the yoke current is on, electrons can no longer follow that straight path through the field.
   a. What kind of curved path will the electrons follow? (See # 20 on RS XIV.) _______
   b. What drawing instrument is useful for making that kind of curve? ________

4. Use #3 to draw several possible paths through the circular region that you drew for #2:
   a. Sketch one possible electron path with a *SMALL* deflection angle, so that electrons are almost undeflected. Extend it beyond the field boundary. (Use #8 on page 127.) *Label that path clearly*.
   b. Use the instrument mentioned in 3b to construct some other possible paths with somewhat larger deflection angles. Each path corresponds to a different __________ ________ strength.
   c. Extend each one to show where the electrons go after emerging from the magnetic field.
   d. Select one path with a deflection angle of roughly 60 degrees, measured from the dotted line. Label it clearly, measure its path radius, and show that measurement clearly in your diagram.
   e. Paths with smaller deflection angles correspond to _______er magnetic fields. (weaker, stronger)

5. Copy the circular field boundary and the path discussed in 4d. Using a ruler, draw a line tangent to the curved boundary at the entry point and another at the point where that path emerges from the field.
   a. At the entry point the angle between the path and the tangent line is ___ degrees.
      At the exit point the angle between the path and the *other* tangent line is ___ degrees.
   b. Draw straight lines tangent to the curved path at the entry and exit points.
   c. What is special about the point where those tangent lines intersect?
   d. Check to see if 4b and 4c illustrate this rule. (Fix them if necessary.)
   e. How is the angle between the two tangent lines in 5a related to the deflection angle? ______

* 6. Create a general trigonometric formula relating the deflection angle to the path radius. Then combine it with the path radius formula (#20 on RS XIV) to create a new formula for predicting the deflection angle from the magnetic field strength. Check units, define your symbols clearly, & see if 4d agrees.

7. Suppose we shoot some equally-charged particles into a magnetic field, in a direction perpendicular to the field lines. Some of the particles are slightly more massive than others. Which particles will experience the smallest deflection if they all have the same initial velocity? _____ (Use #6.)

8. Suppose instead that the particles in #7 all have equal kinetic energies, as would ions from an "ion gun" similar to the electron gun reviewed above. The more massive ions will then have ______er velocities than the less massive ions, tending to make the path radius smaller for the _____ massive ions. Will this tendency cancel out the separation described in #7? To answer that question recall the relation between speed and kinetic energy. Next, write the relation between path radius and speed. Eliminate speed from this pair of simultaneous equations to create a new equation relating path radius to mass, kinetic energy, and magnetic field strength. The new equation says that particles with 1% greater mass will have __% ______er path radius.

9. Find out what "mass spectrometers" and "calutrons" are. How do they work?
   What are they useful for? -Why do mass spectrometers use 180-degree deflection angles?