Problem 16-2: A toy ball is advertised as being able to "bounce perfectly elastically" off hard surfaces. A student decides to test that claim. The hypothesis is that at low velocity, the bounces are close to elastic but that at high velocity, the bounces are not. Additionally, it is supposed that the system deviates more and more from being elastic as the velocity gets larger and larger.

a.) Design an experiment to test the hypothesis about collisions of the ball with a hard surface. Assume you have the equipment that would normally be found in a school physics lab.

i.) What quantities would be measured?

--The initial height of release from rest for freefall (this will vary to generate a range of hit velocities)
--The final height after one bounce (these will tell how much energy is lost after the bounce)
--The mass of the object falling (to determine the kinetic energy and potential energy of the object . . . this is optional as the question could be answered without this data)

ii.) What equipment would be used for the measurements, and how would that equipment be used?

--A meter stick
--A balance

iii.) Describe the procedure used to test the hypothesis. Give enough details so that another students could replicate the experiment.

--Use a relatively massive ball as your object to minimize the effects of air friction.
--Make a table. Record the initial heights of the ball drops. Make them in a range from heights of 2.0 to 0.5 meters above the surface in 0.2 meter intervals.
--Drop the object, allowing it to strike the surface and bounce. Measure the height of rebound for each situation.
--Follow this procedure five times. Average your bounce heights for each initial height.
--As the difference in the initial potential energy and final potential energy will tell you how much energy was lost due to the bounce (assuming no loss to air friction during the fall), you should be able to tell how nearly "elastic" the collision was.

b.) Describe how you might use a graph to draw your conclusions about your hypothesis.

--graphing the final height versus the initial height on a grid that had the same scaling;
--if the bounces were perfectly elastic, you'd get a linear graph whose slope was 1.0;
--for non-elastic collisions, the graph should be linear with a slope less than 1.0;
--if the velocities become less elastic with velocity, then the graph should not be linear but should tail downward as the heights got greater

c.) A student tries the experiment and concludes something went wrong because the collisions appear to be nearly elastic for low velocities, but appears to violate a basic physics principle at higher velocities.

i.) What would the graph alluded to in *Part b* look like for this situation? That is, what anomaly would you notice in the graph that would make you think a physics principle has been violated. Explain how this makes sense?

--if you graphed the bounce height versus the original height and got a graph that tailed upward with that the bounce height being greater than the original height

ii.) What physical principle might be violated? (There may be more than one; just pick one). Explain how it was violated (you don't need to explain how this happened).

--in the case outlined above, conservation of energy would be violated