# NYU Physics 1—bouncing

**1** Imagine carefully dropping a basketball and a small rubber ball so that they fall "in a stack" with the basketball immediately underneath the rubber ball. They drop a height $h$ and then the basketball hits the ground, bounces off, and then immediately hits the rubber ball, which bounces off of it. In the limit that the rubber ball is much smaller in mass than the basketball, how high does the rubber ball fly after the double-bounce? *Hint:* Treat the two bounces separately, and remember the example in class of the ball bouncing off of the moving bus.

**2** What happens if there are three balls in a hierarchy? Tiny rubber ball on top of small rubber ball on top of basketball?

**3** Consider a pool shot to be an elastic collision between balls of equal masses. The cue ball is moving before the collision and the object ball is at rest. You may have observed that after the collision, the object ball and the cue ball move at right angles to one another? Prove this, for a general collision, using conservation of kinetic energy. *Hint:* The kinetic energy equation is quadratic, as is what important theorem related to right-angle triangles?

**4** Now imagine the cue ball is heavier than the object ball. Will the cue ball still go on the right-angle path? If not, will it "bounce back more" or "follow on more"?

**5** If a ball bounces off of a wall, the angle of incidence equals the angle of reflection. What do you have to assume to make that true? You have to assume that the collision is elastic, and you have to assume something about the direction of the force from the wall. What is it? In a pool "bank shot" hit hard, the ball reflects *closer* to the normal direction than you would predict from the ideal case. What possible effects are there that might make this happen? Think about what happens physically during the bounce, and what the cushions are made of.