Sample test questions:

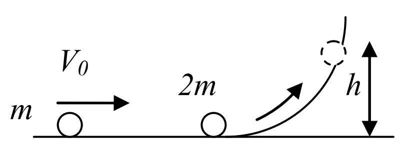
An airplane engine starts from rest; and 2 seconds later, it is rotating with an angular speed of 300 revolution/min. if the angular acceleration is constant, how many revolutions does the propeller undergo during this time?
(a) 5 (b) 10 (c) 50 (d) 300 (e) 600

Key: A ($\omega_f = 300rev/m = 5rev/s = \alpha t$*, t=2s, so,* $\alpha=2.5rev/s^2$*,* $\theta_f=0t+0.5\alpha t^2=5$ *rev)*

Which one of the following is true concerning momentum?
(a) momentum is a force.
(b) momentum is a scalar quantity.
(c) the SI unit of momentum is kg m^2/s
(d) the momentum of an object is always positive.
(e) momentum and angular momentum are measured in different units.

key: E (the unit of linear momentum is kgm/s, while angular momentum is measured in kgm^2/s*)*

A ball of mass *m* moved rightward along a frictionless surface, as shown below, and made an **elastic** collision with another ball, whose mass is *2m* and is initially in rest. After the collision, the bigger ball moved up a curved track, which is also frictionless. What is the maximum height the bigger ball can reach?



Brief solution:
Break this question into two parts. First, a collision happens between two balls. Second, the bigger ball travels along the curved track.

Since the collision happened on the flat frictionless surface, if the two balls were selected as the system, the total external force is zero. Therefore, the linear momentum is conserved. For the elastic collision, the energy is conserved, too .
For the momentum: initially, $p_i=mv_0$ *finally,* $p_f=mv_{f1}+(2m)v_{f2}$
For the kinetic energy: initially, $E_i=0.5mv_0^2$ *finally,* $E_f=0.5mv_{f1}^2+0.5(2m)v_{f2}^2$

Therefore, we have the conservation law for both momentum and energy as:

$$\begin{cases} mv_0 = mv_{f1} + 2mv_{f2} \\ \frac{1}{2}mv_0^2 = \frac{1}{2}mv_{f1}^2 + mv_{f2}^2 \end{cases}$$

Solve this equation set, we get $\begin{cases} v_{f1} = -\frac{1}{3}v_0 \\ v_{f2} = \frac{2}{3}v_0 \end{cases}$

For the second part, the bigger ball travels along the track with an initial velocity of $2/3v_0$ Since the track is frictionless. The total mechanical energy of the bigger ball is conserved. (why)
Initially, the potential energy is zero (if set the reference point as the ground). The kinetic energy is $K=0.5(2m)v_{f2}^2=4/9(mv_0^2)$
Finally,(at the maximum height) the kinetic energy is zero and the potential energy is (2m)gh. Therefore, $2mgh+0=0+\frac{4}{9}mv_0^2$.

We will have $h=2v_0^2/9g$.