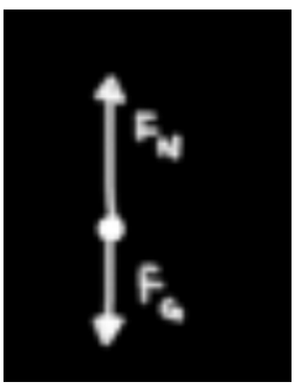
1. A.
   $F = 3mg - mg = 2mg$
   $W = FD = 2mgd$
   $2mgd = \frac{1}{2}Mv^2 = \frac{1}{2}4mv^2 = 2mv^2$
   $gd = v^2$
   $v = \sqrt{gd}$
   B.
   $W = FD = 0d = 0J$
   C.
   a_{com} is less than $g$as the left side is causing negative acceleration to the system. This is the same as throwing a block off a building with a parachute, the block will not fall at g because something is pulling it back, in this case m is pulling it back
2. A.
   I.
   120 seconds
   II.
   $\frac{D}{T} = \frac{2\pi r}{T} = \frac{2\pi 30}{120} = 1.5708$
   B.
   I.
   

   II.
   Up. This is because once the block passes the midway point, the centripetal force starts pulling it up, to prevent it from literally dropping. The centripetal force is then transferred as normal force.
   C.
   $F = F_G + F_C$
   $F_C = ma_R = m\frac{v^2}{r} = m_b\frac{v_b^2}{R}$
   $F = m_b g + m_b\frac{v_b^2}{R} = m_b(g + \frac{v_b^2}{R})$
   D.
   Greater. This is because the force is composed of the normal force and the centripetal force. The normal force is equal to the block's weight. Because of this, the force must be greater.

3. A.

I.

Students designing an experiment can use conservation of energy to test the spring

II.

$kx^2 = mv^2$

B.

Quantity to be Measured	Symbol for Quantity	Equipment for Measurement
Launch velocity	v	Speed Gun
Compression distance	x	Meter Stick
Mass of a block	m	Scale

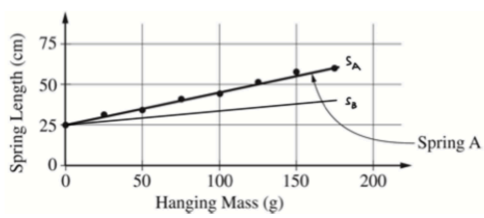
Set up a spring attached to a wall in the horizontal orientation. Point the speed gun at the end of the spring (opposite of the wall). Then, using a block of known mass, push and compress the spring x meters. Once ready, release the block, and record the launch velocity displayed from the speed gun.

C.

Students can analyze if the claim is true by solving for k in the equation written on A.II. You are given object mass, launch velocity, and compression distance. After repeating this test a couple hundred times, check if k, which represents the spring constant, has changed. If the spring constant has changed by a significant amount over a series of tests, then the company's claim is false.

D.

I.



II.

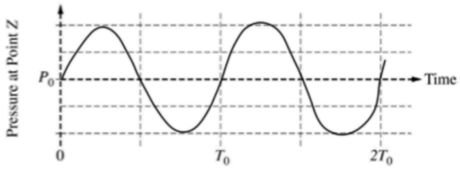
T is the same in both cases. This is because the oscillation period can be determined by the equation $T = 2\pi\sqrt{\frac{m}{k}}$. Because period is only dependent on the two variables mass and spring constant, a change in initial displacement or amplitude will not affect the period.

4. A.

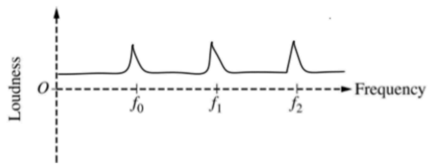
I.

$T_0 = \frac{1}{f_0} = \frac{1}{\frac{v}{\lambda}} = \frac{1}{\frac{340}{2L}} = \frac{1}{\frac{340}{2\times0.3}} = 0.001765s$

II.



B.



C.

Increase. Wavelength remains constant, so if velocity increases then fundamental frequency must also increase.