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U4: Homework Questions #1

Conservation of Energy

1. A 60 kg diver jumps from a 10 meter platform into a pool below.

   a. What is her velocity at impact?

   $mgh = \frac{1}{2}mv^2$ $\quad v = \sqrt{2gh}$

   $gh = \frac{1}{2}v^2$ $\quad v = 14\ m/s$

   14 m/s

   b. If she were to come to rest 5.0 meters below the water's surface, how much of a resistance force was present on the diver by the water?

   Assuming force is constant

   $\frac{1}{2}(60)(14)^2 = F(5)$

   $W = F\Delta x$

   ↳ change in energy

   $F = 1176\ N$

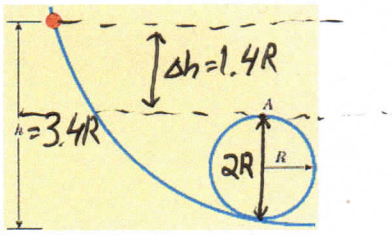
   1176 N

2. A bead slides without friction around a loop-the-loop. If the bead is released from a height $h = 3.40R$, what is its speed at point A?

   a. Solve speed in terms of g and R.

   $mg(1.4R) = \frac{1}{2}mv^2$ $\quad v = 1.673\sqrt{gR}$

   1.673 $\sqrt{(gR)}$



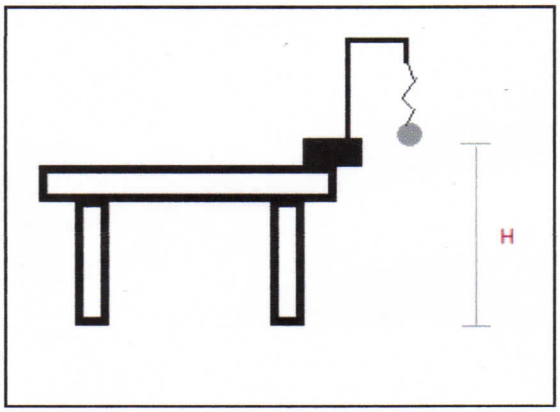
   How large is the normal force on it if its mass is 4.80 g?

   0.132 N (downward)

   $\frac{mv^2}{r} = mg + N$ $\quad N = \frac{(0.0048)(2.8gR)}{R}$

   $N = 0.132\ N$

3. A lab group is tasked with experimentally solving for the spring constant k of a spring at their lab station. Their initial idea is written below:



Hang an object of known mass from a vertical spring and measure both how much the spring is stretched (x) and the height of the object above the floor (h). Set Ug = Us and solve for k!

A - What is incorrect about this lab process? They are using the wrong "h"

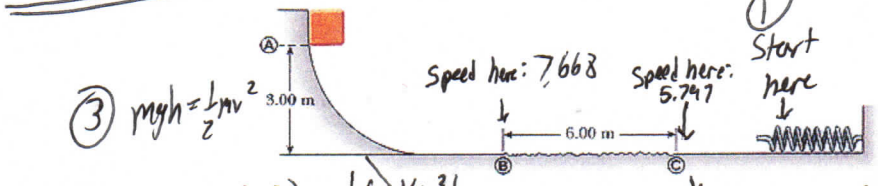
B – Develop your own procedure for experimentally solving for the spring constant of a spring that would work.

Use Hooke's law instead ($F = kx$)

4. A 10.0 kg block is released from point *A*. The track is frictionless except for the portion *BC*, with a length of 6.00 m. The block travels down the track, hits a spring of force constant $k = 2100$ N/m, and compresses it 0.400 m from its equilibrium position before coming to rest momentarily. Determine the coefficient of kinetic friction between surface *BC* and the block.

Follow numbers — Work backwards

0.214



① $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$\frac{1}{2}(2100)(0.4^2) = \frac{1}{2}mv^2$

② $v = \sqrt{33.6} = 5.797$ m/s

③ $mgh = \frac{1}{2}mv^2$

$(10)(g)(3) = \frac{1}{2}(10)(v^2)$

④ $v = 7.668$ m/s

⑤ $v_0 = 7.668$

$v = 5.797$

$(5.797^2) = (7.668)^2 + 2a(6)$

⑥ $a = -2.1$ m/s²

⑦ $F_f = (10)(+2.1)$

$F_f = 21$ N

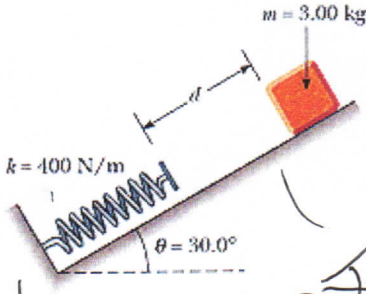
⑧ $F_f = \mu F_N$

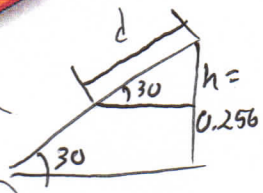
$21\text{N} = \mu(98)$

⑨ $\mu = 0.214$

5. A 3.00 kg block starts from rest and slides a distance *d* down a frictionless 30.0° incline. While sliding, it comes into contact with an unstressed spring of negligible mass. The mass slides an additional 0.194 m as it is brought momentarily to rest by compression of the spring ($k = 400$ N/m). Find the initial separation *d* between mass and spring.

0.512 m





① $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$(400)(.194)^2 = (3)(v^2)$

$v = 2.240$ m/s

② $mgh = \frac{1}{2}mv^2$

$h = \frac{\frac{1}{2}v^2}{g} = 0.256$

③ $\sin 30 = \frac{h}{d}$

$d = \frac{h}{\sin 30}$

④ $d = 0.512$m