Spring Energy
Class Practice

(A8)

Hook's Law is $F = -kd$

1. Why is there a "-" in the equation for Hook's law?

spring always pushes againt Pressure

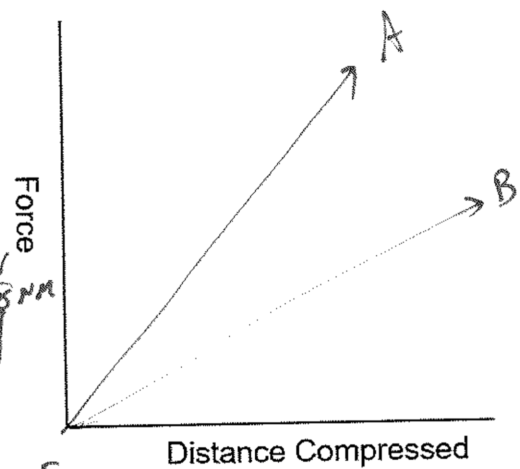
2. If you exert 5N of pressure on a spring to compress it 0.1m, how far would you compress the spring if you exerted 10N of pressure.

$F = -kx \quad \frac{F}{K} = x \quad \frac{5}{.1} = K = 50\ N/M$

$\frac{F}{K} = d \quad \frac{10}{50} = \boxed{.2}$ ← Note this, is linear.

3. A common graph involving springs is below. In the graph below we are going to sketch 2 lines one line for each different spring. Label the lines below.

- line "A" for a stiff spring
- line "B" for a loser spring



4. A spring is pushed 25cm requiring a force of 2N.

a. What is the spring constant of this spring? $\frac{F}{x} = K \quad \frac{2}{.25} \Rightarrow 8\ N/M$

b. How much energy is stored in the spring?

$U_s = \frac{1}{2}kx^2 = 0.5 \cdot 8 \cdot (.25)^2 = \boxed{0.25N}$

c. The spring is tipped vertical and a 0.5kg block is placed on the spring and launched vertically. How high would the block go up?

$PE = mgH \quad \frac{PE}{mg} = h \quad \frac{.25}{10 \cdot .5} = 0.05m$ (50cm)

5. A 10kg block is set on top of a vertical spring and it compresses 20cm.

a. What is the spring constant? $F = kx \quad \frac{F}{x} = k$

$F = F_w \quad \frac{mg}{x} = K \quad \frac{10 \cdot 10}{.02} = \boxed{500\ N/m}$

b. How much energy is being stored in the spring?

$U_{spring} = \frac{1}{2}kx^2 = \frac{1}{2}(500)(.2)^2 = \boxed{10J}$

c. The spring system is tipped sideways launching the block horizontally on to a frictionless surface, what is the maximum speed of the block?

$KE = \frac{1}{2}mv^2$

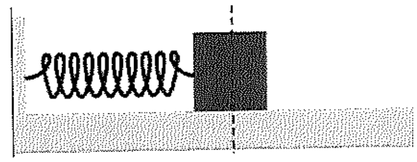
$10 = .5 \cdot 10 \cdot v^2$

$\sqrt{\frac{KE \cdot 2}{m}} = v \quad \sqrt{\frac{10 \cdot 2}{10}} = \boxed{1.4\ m/s}$

Spring Energy
Student Practice

1. A spring with a mass of 50g is compressed from its equilibrium point 10cm. At this point a force of 2.5N is required to hold the spring at this position.

   a. What is the spring stiffness constant?



   $F = kx$ $\frac{2.5}{.1m} = 25 Nm$

   $\frac{F}{x} = k$

   b. How much energy is the spring storing? (U_{spring})

   $U_s = \frac{1}{2}kx^2 = .5 \cdot 25 \cdot .1^2 = 0.125 J$

   c. The massless ideal spring is released and pushes the block horizontally where it starts to slide on a frictionless surface. How fast is the block moving?

   $U_s = KE = \frac{1}{2}mv^2$ $\frac{1}{2} \cdot 50 \cdot v^2 = 0.125J$ $v = 0.07 m/s$

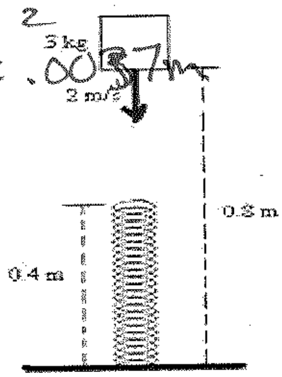
   d. The block slides until it reaches a surface with a $U_k = 0.15$. How far will it slide before stopping?

   $KE = TE$

   $\frac{1}{2}mv^2 = mgud = \frac{v^2 gu}{2} = d$ $\frac{(.07)^2 \cdot 10 \cdot .15}{2} =$

   $d = .0037 m$

2. A metal block of mass 3 kg is moving downward with speed 2m/s when the bottom of the block is 0.8 m above the floor (Figure B1). When the bottom of the block is 0.4 m above the floor, it strikes the top of a relaxed vertical spring 0.4 m in length. The stiffness of the spring is 2000 N/m.



   a. What is the total energy of the block at 0.8m?

   $PE + KE = Total$

   $mgh + \frac{1}{2}mv^2$

   $3 \cdot 10 \cdot .4 + \frac{1}{2}(3)(2)^2 = 12 + 6 = 18 J$

   b. How far will the spring be compressed?

   $U = U_s$ $18 = \frac{1}{2}kx^2$ $x = \sqrt{\frac{18 \cdot 2}{2000}} = .13m$

   c. At the moment of maximum compression, how much force is being placed on the spring?

   $F = -kx$

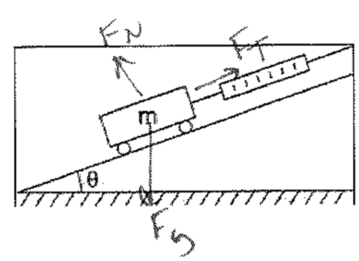
   $2000 \cdot .13 = 268 N$

   d. The spring then pushes the block back up into the air, how high can the spring go?

   $18J = mgh$ $\frac{18}{10 \cdot 3} = .6m$

3. a. Add the forces acting on the "m".

   b. Derive a formula for the distance M will fall on the ramp.

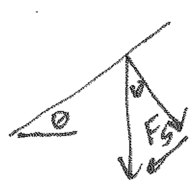


$F_T = F_r$

$F_T = \sin\theta \cdot F_g$

$kx = \sin\theta Mg$

$x = \frac{\sin\theta Mg}{k}$



$\sin\theta \cdot F_g = F_r$