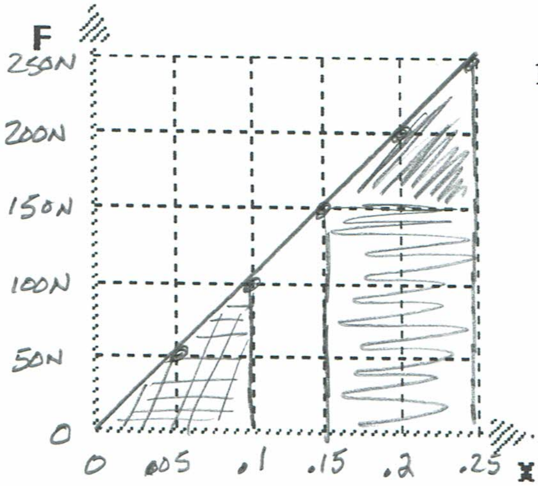
Name KEY   /43   Date __________ Pd____

PreQuiz Unit 6: Work and Energy Hooke's Law and Us

Suppose in the lab one group found that $F = 1000\frac{N}{m}(\Delta x)$. Construct a graphical representation of force vs. displacement. (Hint: make the maximum displacement 0.25 m.)



1. Graphically determine the amount of energy stored while stretching the spring described above from x = 0 to x = 10 cm (3 pts)

$F = -kx$ $\quad F = 1000\frac{N}{m}(.25m) = 250\ N$

$= 1000\frac{N}{m}(.2m) = 200\ N$

$= 1000\frac{N}{m}(.15m) = 150\ N$

- SEE Triangle under the line Between X = 0cm to X = .1m & Force 0N to 100N
- Area = $\bar{F} \cdot D$ = work(energy) = $\frac{1}{2} b \cdot h$

$= \frac{1}{2}(.1m)(100N) = \boxed{5J}$

- Double check $U = \frac{1}{2}kx^2 = \frac{1}{2}1000(.1)^2 = 5J$

2. Graphically determine the amount of energy stored while stretching the spring described above from x = 15 to x = 25 cm. (3 pts)

Find area under slope between X = .15m to X = .25m

SEE ABOVE

- Area of Square + Triangle = Energy stored

$(b \cdot h) + (\frac{1}{2} b \cdot h) =$

$(.1m \times 150N) + (\frac{1}{2}(.1m) \times 100N) =$

$15J + 5J = \boxed{20J}$

(OR)

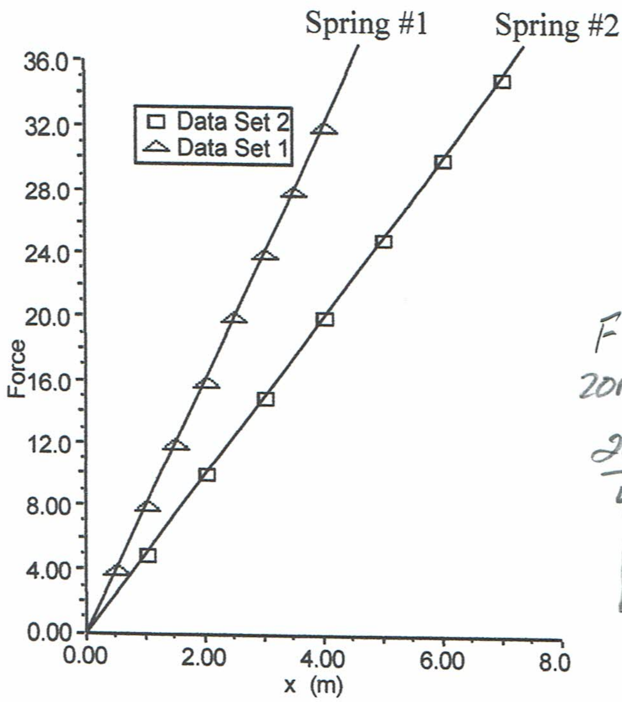
$U_{(0-.25)} = \frac{1}{2}kx^2 = \frac{1}{2}(1000)(.25)^2 = 31.25J$

$U_{(0-.15)} = \frac{1}{2}kx^2 = \frac{1}{2}(1000)(.15)^2 = 11.25J$

$\boxed{20J}$

Subtract the area Not included From the Total.

The graph at left was made from data collected during an investigation of the relationship between the amount two different springs stretched, when different forces were applied.



3. For each spring determine the spring constant. (3pts)

Spring #2

$F = -Kx$

$20N = -K \cdot 4m$

$\frac{20N}{4m} = -K$

$K_2 = \frac{5N}{m}$

Spring #1

$F = -Kx$

$32N = -K \cdot 4m$

$\frac{32N}{4m} = -K$

$K_1 = 8\frac{N}{m}$

4. For each spring, compare:

a. the amount of force required to stretch the spring 3.0 m. (3pts)

SPRING #2

$F = -KX$

$F = -5\frac{N}{m} \times 3m = -15N$

SPRING #1

$F = -KX$

$F = -8 \times 3m = -24N$

b. the U_s stored in each spring when stretched 3.0 m. (3pts)

SPRING #2

$U_s = \frac{1}{2} Kx^2$

$U_s = \frac{1}{2} 5(3)^2 = 22.5J$

SPRING #1

$U_s = \frac{1}{2} Kx^2$

$U_s = \frac{1}{2} 8(3)^2 = 36J$

5. Determine the amount that spring 2 needs to be stretched in order to store 24 joules of energy. (2pts)

SPRING #2

$U = \frac{1}{2} KX^2$

$24J = \frac{1}{2} 5\frac{N}{m} X^2$

$X = 3.10m$ ✓

SPRING #1

$U = \frac{1}{2} KX^2$

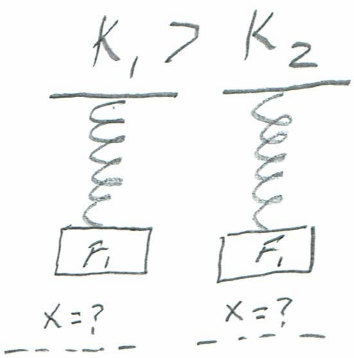
$24J = \frac{1}{2} 8 X^2$

$48J = 8X^2$

$X = 2.5m$

6. You have two springs that are identical except that spring #1 is stiffer than spring #2 ($k_1>k_2$). On which spring is more work done? Explain!

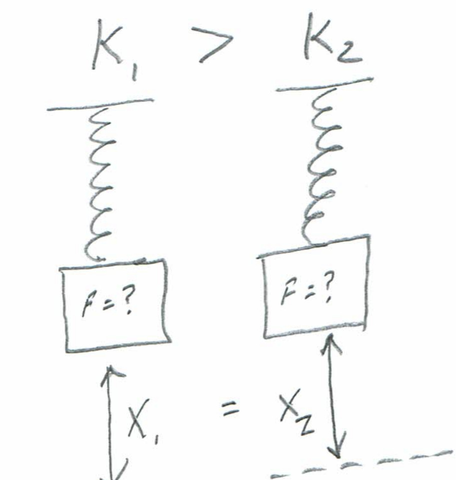
a) if they are stretched using the same force? (5pts)



	Spring 1		Spring 2
Hooke's Law	$F = K_1 x_1$		$F = K_2 X_2$
Rearrange for "x"	$X_1 = \frac{F}{K_1}$		$X_2 = \frac{F}{K_2}$
Energy	$u_1 = \frac{1}{2} K_1 x_1^2$		$u_2 = \frac{1}{2} K_2 X_2^2$
Substitute	$u_1 = \frac{1}{2} K_1 \left(\frac{F}{K_1}\right)^2$		$u_2 = \frac{1}{2} K_2 \left(\frac{F}{K_2}\right)^2$
	$u_1 = \frac{1}{2} K_1 \left(\frac{F^2}{K_1^2}\right)$		$u_2 = \frac{1}{2} K_2 \left(\frac{F^2}{K_2^2}\right)$
	$u_1 = \frac{F^2}{2K_1}$		$u_2 = \frac{F^2}{2K_2}$

- Since Force is the same for both springs so Force is Not a factor and Since distance stretched (x) is No longer considered we can compare u_1 & u_2. LARGER "K" yields smaller work done ∴ Spring 2 does more work.

b) if they are stretched the same distance? (3 pts)



Spring 1

$u = \frac{1}{2} K_1 X_1^2$

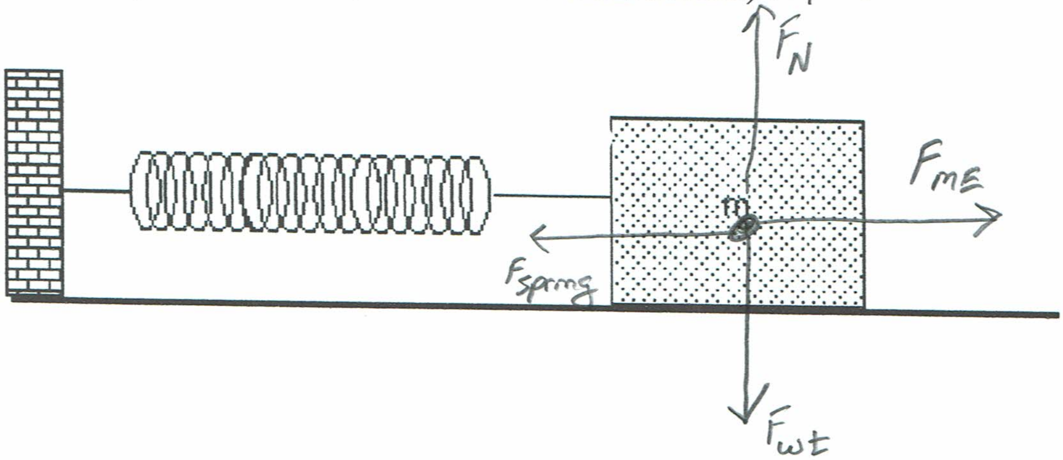
Spring 2

$u = \frac{1}{2} K_2 X_2^2$

Since the stretch (x) is the same for Both springs, determination of the work done i.e, energy (u) is directly related to the "K" value. $K_1 > K_2$ ∴ more work is done stretching Spring 1 than Spring 2

Force is Not a factor as it is Not directly in the energy Formula

7. The spring below has a spring constant of 10. N/m. If the block is pulled 0.30 m horizontally to the right, and held motionless, what force does the spring exert on the block? Sketch a force diagram for the mass as you hold it still. (Assume a frictionless surface.) (3pts)

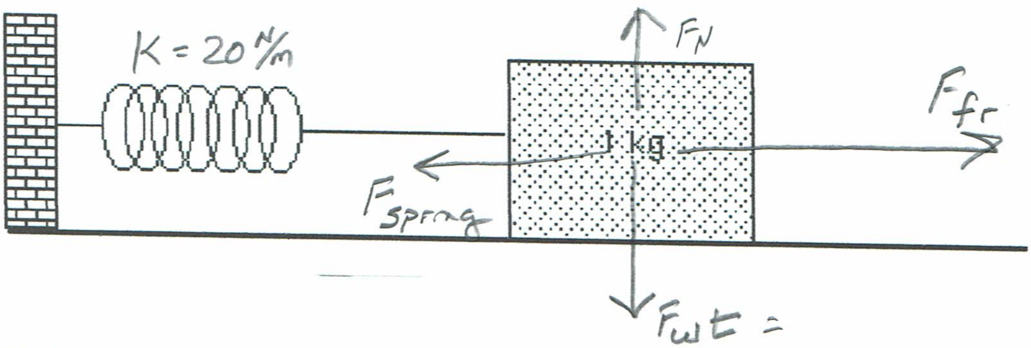


$F = -kx$

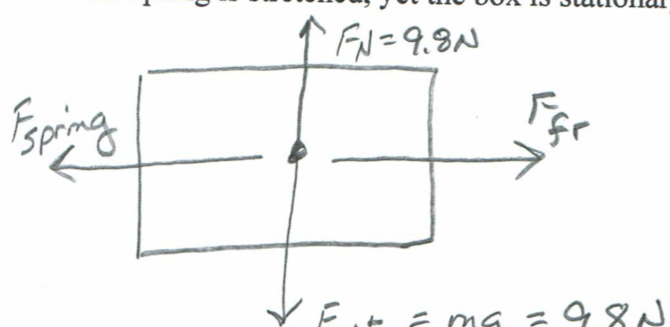
$F = -10\frac{N}{m}(.3m)$

$\boxed{F_{sp} = -3N}$

8. The spring below has a spring constant of 20. N/m. The μ_s between the box and the surface is 0.40.



a. The box is pushed to the right, then released. Once released, the box remains in place; in other words, it doesn't return to the equilibrium position where the force of the spring is zero. Draw a force diagram for the box above when the spring is stretched, yet the box is stationary. (2pts)



b. What is the maximum distance that the spring can be stretched from equilibrium before the box begins to slide back? (3pts)

The maximum distance would be where the spring force increases to equal the force of friction.

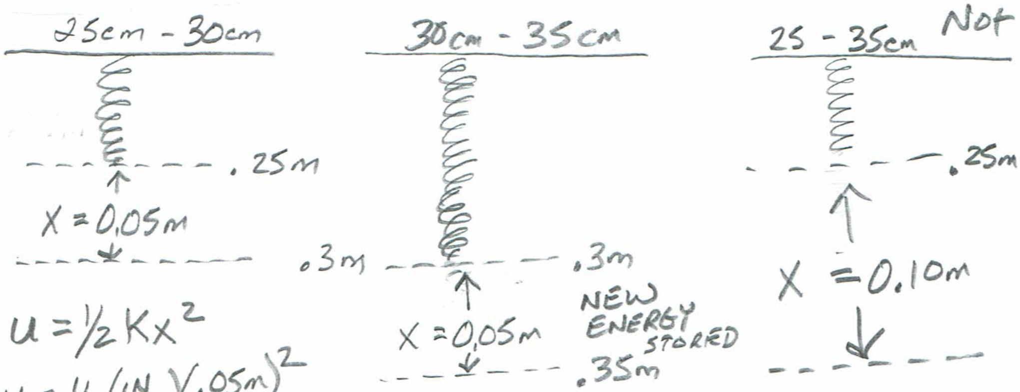
$F_{fr} = \mu F_N = .4(9.8N)$

$F_{fr} = 3.92N$

$F = -kx \qquad 3.92N = -20\frac{N}{m}(x) \qquad \boxed{x = 0.196m}$

9.

a) A spring is stretched from a rest length of 25 cm to a length of 30 cm. A certain amount of energy, U_{S1}, is stored. The spring is then stretched from 30 to 35 cm. How does the new amount of energy stored compare to U_{S1}? (4pt) ($-W_S = \Delta U_S$ so $U_S = 1/2kx^2$) Assume $K = 1\ N/m$ as it does Not change



$U = \frac{1}{2}Kx^2$

$U = \frac{1}{2}(1\frac{N}{m})(.05m)^2$

$U = 0.00125J$

Initial Energy STORED STEP 1

Common mistake is to get the Answer of 0.00125J at This point. STEP 2.

$U = \frac{1}{2}Kx^2$

$U = \frac{1}{2}(1\ N/m)(.1)^2$

$U = 0.005J$

Total Energy

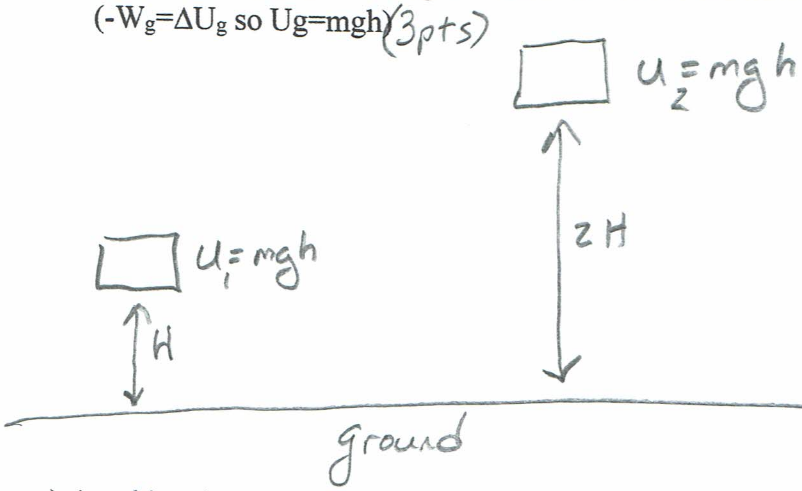
To Find Energy Stored in Step 2 Find Total and Subtract STEP 1

$0.005J - 0.00125J = 0.00375J$ STEP 2

How does this Compare to U_{s_1}?

$$\frac{0.00375J}{0.00125J} = \boxed{3x}$$

b) A block is raised from the ground to a height H and now contains a certain amount of energy U_{g1}. The box is then raised to a height of 2H. How does the new amount of energy stored compare to U_{g1}? ($-W_g = \Delta U_g$ so $U_g = mgh$) (3pts)



How do they Compare?

$$\frac{U_2}{U_1} = \frac{mgh}{mgh} = \frac{m_1 g_1 2H}{m_1 g_1 H} = \boxed{\frac{2}{1}}$$

c) An object is moving with speed v and contains a certain amount of energy K1. The speed is increased to 2v. How does the new amount of energy stored compare to K1? (3pts) K2

Compare?

$$\frac{K_2}{K_1} = \frac{\frac{1}{2}m_1 v_2^2}{\frac{1}{2}m_1 v_1^2} = \frac{\frac{1}{2}m_1(2v_1)^2}{\frac{1}{2}m_1 v_1^2} = \frac{\frac{1}{2}m_1 4v_1^2}{\frac{1}{2}m_1 v_1^2} = \boxed{\frac{4}{1}}$$

Answers

1) 5J 2) 20 J 3) $k_1 = 5$ N/m, $k_2 = 5$ N/m 4a) 24 N/ 15 N b) 36J / 22.5J 5) 3.10m/2.5m

7) -3N 8b) 0.20m 9a) 3 x more b) 2x more c) 4x more