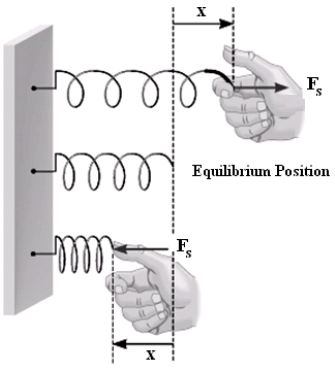
d) How efficient is this process?

1. Does the force needed to stretch or compress a spring remain constant? Explain.



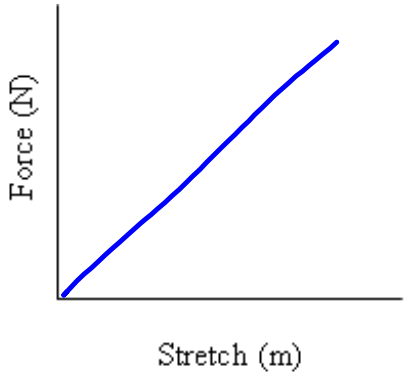
No. As the amount of stretch or compression increases, so does the amount of force.

2. Sketch the expected relationship on the axes at right.

Hooke's Law

$\vec{F}_s \propto \vec{x}$

$F_s = -k\,x$



3. What is the significance of the slope of the graph?

Spring constant: a constant describing the stiffness of a spring

4. Sketch on the graph the relationship for a stiffer spring.

F_s	k	x
Force on a spring	Spring Constant	Change in spring length from the equilibrium position
[N]	[N/m]	[m]
vector	scalar	vector

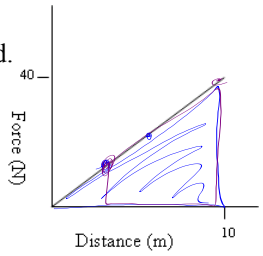
5. If it takes 20. newtons of force to compress a spring 8.0 cm, what is its spring constant?

$K = \frac{F}{x} = \frac{20\,N}{.08\,m} = 250\,N/m$

6. The graph at right shows the amount of force needed to stretch a bungee cord a certain distance. Calculate:

a) the spring constant of the bungee cord.

$4\ N/m$



b) the amount of work needed to stretch the bungee cord 10. meters.

$W = F \cdot d$

$= F_{avg} \cdot d$

$20\ N\ (10\ m) = 200\ J$

$\left(\frac{1}{2} F_{max}\right) \cdot d$

NOTE:

W = F d cosθ (use average force)

F = kx (use instantaneous force)

c) the area under the curve.

$200\ J$

NOTE:

area under curve of force vs. distance (displacement) graph equals the work done

7. How much work is done stretching a spring 0.50 meter if the spring constant is 40. N/m?

$F = kx = 20\ N$

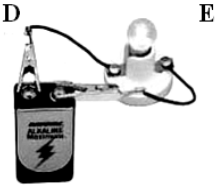
$W = F_{avg} \cdot d = 5\ J$

Energy

A 

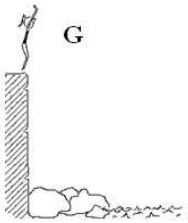
B 

C 

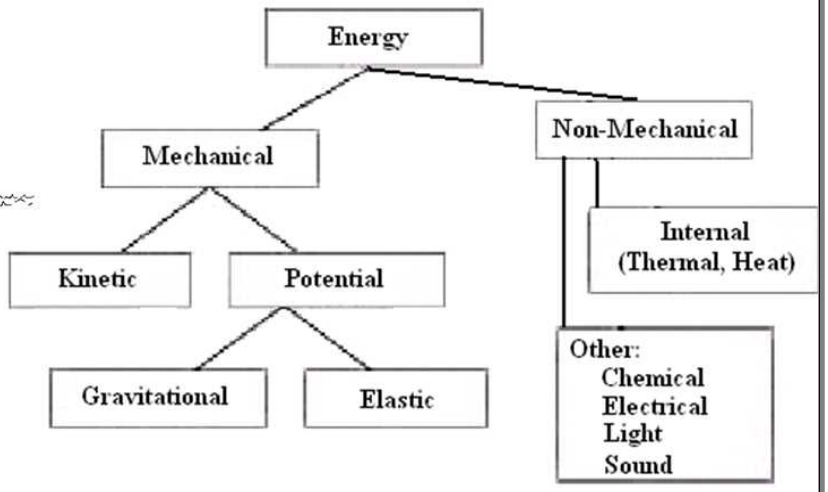
D 

E 

F 

G 

H 



KE	PE_g	PE_S	Q
Kinetic energy	Gravitational potential energy	Potential energy stored in a spring (elastic)	Internal energy (thermal energy, heat)
Object in motion	Object above ground level	Stretched or compressed	Friction, heat
$KE = \frac{1}{2} mv^2$	$PE_g = mgh$	$PE_S = \frac{1}{2} kx^2$	$F_f \cdot d$ $Q = mc\Delta T$ $Q = mL$
Joules (J)	Joules (J)	Joules (J)	Joules (J)
scalar	scalar	scalar	scalar

Mechanical Energy:

$KE + PE_g + PE_S$

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

Total Energy:

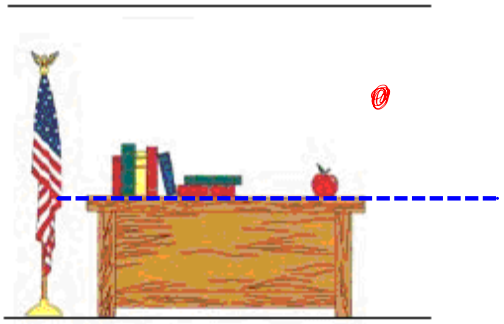
$KE + PE_g + PE_S + Q$

$\frac{1}{2}mv^2 + mgh + \frac{1}{2}kx^2 + (F_f \cdot d)$

1. a) Estimate the gravitational potential energy of this apple.

mgh

$.1kg \cdot 10 m/s^2 \cdot 1m = 1J$



Base level (Reference Level, Zero Level):

Level from which height is measured for grav PE

Level of 0 PE

b) Does PE_g depend on the choice of a base level?

yes

c) When does an object have:

i) Positive PE_g? above base level

ii) Zero PE_g? at base level

iii) Negative PE_g? below base level

d) Does the change in potential energy (ΔPE_g)depend on the choice of a base level? No

2. A 900. kilogram car drives off the edge of a 45 meter high cliff at a speed of 25 meters per second. How much energy does the car have at this point?

$KE + mgh$

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

$\frac{1}{2} \cdot 900\,kg\,(25\,m/s)^2 + 900\,kg \cdot 10\,m/s^2 \cdot 45\,m$

$= 6.8 \times 10^5\,J$

3. A runner has 800 joules of kinetic energy. If he doubles his speed, how much kinetic energy does he now have?

$KE = \frac{1}{2}m(2v)^2 = 800J \times 4$

$\Rightarrow 3200J$

4. A spring whose spring constant is 125 newtons per meter is compressed 0.50 meter.

a) Determine how much energy is stored in the spring.

PE_s

$\frac{1}{2}kx^2$

$\frac{1}{2}(125N/m)(.5m)^2$

$= 16J$

b) How much force was needed to compress the spring?

$F = kx$

$= 125N/m \cdot .5m$

$= 63N$