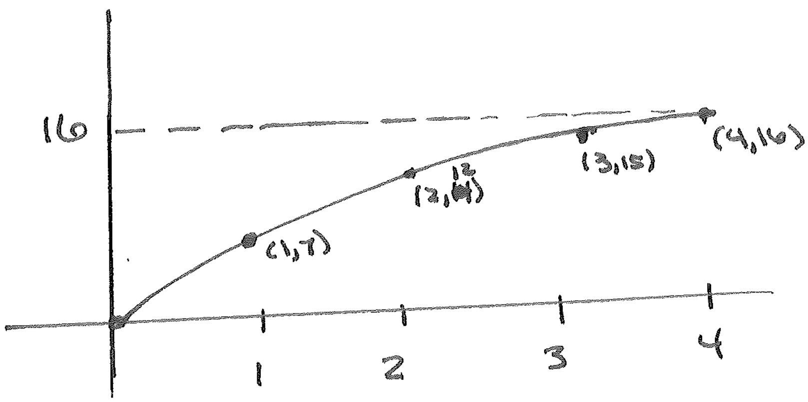
Physics 160

Extra Credit #18

Sketch Kinetic : $E = K + U \Rightarrow K = E - U$

$= E - \frac{1}{2}ks^2$

So start at 0 and end with 16J



Stretching A Spring

a) What interval? $U = \frac{1}{2}ks^2$, $x=0$ is equil. position

So $U = \frac{1}{2}kx^2$

From 0 to d $\Delta U = \frac{1}{2}kd^2 - 0 = \frac{1}{2}kd^2$

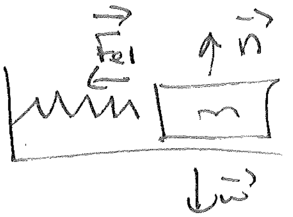
From d to 2d $\Delta U = \frac{1}{2}k(2d)^2 - \frac{1}{2}kd^2 = \frac{1}{2}k(4d^2) - \frac{1}{2}kd^2 = 3(\frac{1}{2}kd^2)$

From 2d to 3d $\Delta U = \frac{1}{2}k(3d)^2 - \frac{1}{2}k(2d)^2 = \frac{1}{2}kd^2(9-4) = 5(\frac{1}{2}kd^2)$

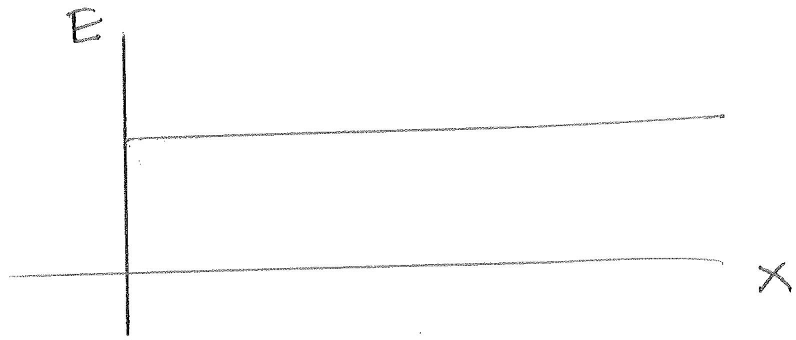
The most

Makes sense since the force is increasing with stretching distance

Energy in a Spring



No Friction, so spring only force doing work so total Energy is Conserved.

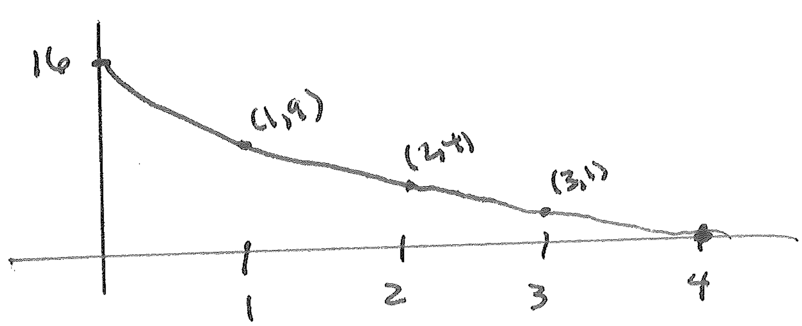


b) Sketch Potential Energy

Spring starts Compressed & at rest $\Rightarrow U_1 = E$, (Note: Mastering makes $E = 16J$, so graph has to start at 16)

$U = \frac{1}{2}ks^2 \Rightarrow$ Parabola with max at $x=0$, & zero at Equilibrium

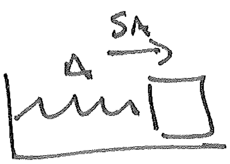
For Convenience I chose to make $U = 0$ at $x = 4$

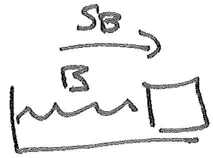


b) From 0 to d vs. 0 to $-d$

$U = \frac{1}{2}ks^2 \Rightarrow$ SAME Energy to stretch OR Compress by AN EQUAL distance

c)



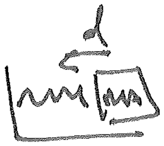


$K_A = 4K_B$

$$U_A = U_B \Rightarrow \cancel{\tfrac{1}{2}} K_A S_A^2 = \cancel{\tfrac{1}{2}} K_B S_B^2 \Rightarrow 4K_B S_A^2 = K_B S_B^2$$

$$\Rightarrow S_B = \sqrt{4S_A^2} = 2S_A$$ ← B stretched twice as far

d)

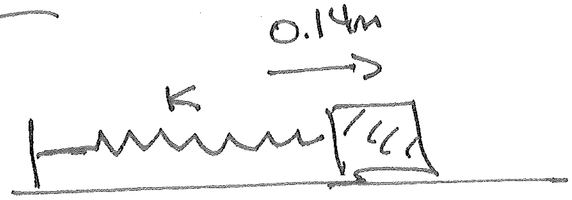


SAME spring Constant but

$M_A \neq M_B$

THE Energy is the SAME for both since $U = \frac{1}{2}ks^2$ Doesn't Depend ON MASS. How <u>fast</u> EACH MASS goes when Released will be different.

7.22



No Friction, $m = 0.24\,kg$

$k = 4.7\,N/m$

$x=0$ is Equilibrium $\Rightarrow S_1 = 0.14\,m$

starts from rest $\Rightarrow V_1 = 0$

How fast at $x=0 \Rightarrow S_2 = 0$

Spring only force doing work $\Rightarrow \cancel{\tfrac{1}{2}mV_1^2} + \tfrac{1}{2}kS_1^2 = \tfrac{1}{2}mV_2^2 + \cancel{\tfrac{1}{2}kS_2^2}$

$$\therefore \quad \cancel{\tfrac{1}{2}}(4.7\,N/m)(0.14\,m)^2 = \cancel{\tfrac{1}{2}}(0.24\,kg)\,V_2^2$$

$$\Rightarrow \quad V_2 = \sqrt{\frac{(4.7\,N/m)(0.14\,m)^2}{(0.24\,kg)}} = 0.6195\,m/s = 0.62\,m/s$$

Unit: $\dfrac{\frac{N}{m}\cdot m^2}{kg} = \dfrac{N\cdot m}{kg} = \dfrac{kg\cdot m^2/s^2}{kg} = m^2/s^2, \quad \sqrt{\dfrac{m^2}{s^2}} = m/s$

b) What S_1 if $V_{max} = 2.2\,m/s$. $V_{max} \Rightarrow$ max Kinetic Energy $\Rightarrow$ Min. Potential $\Rightarrow U_2 = 0 \Rightarrow S_2 = 0$

$$\cancel{\tfrac{1}{2}mV_1^2} + \tfrac{1}{2}kS_1^2 = \tfrac{1}{2}mV_2^2 + \cancel{\tfrac{1}{2}kS_2^2} \Rightarrow \cancel{\tfrac{1}{2}}(4.7\,N/m)\,S_1^2 = \cancel{\tfrac{1}{2}}(0.24\,kg)(2.2\,m/s)^2$$

$$\Rightarrow S_1 = \sqrt{\frac{(0.24\,kg)(2.2\,m/s)^2}{4.7\,N/m}} = 0.497\,m$$

$\Big\{$ Unit: $\dfrac{kg\cdot m^2/s^2}{N/m} = J\cdot\dfrac{m}{N} = \dfrac{N\cdot m\cdot m}{N} = m^2, \ \sqrt{m^2} = m$