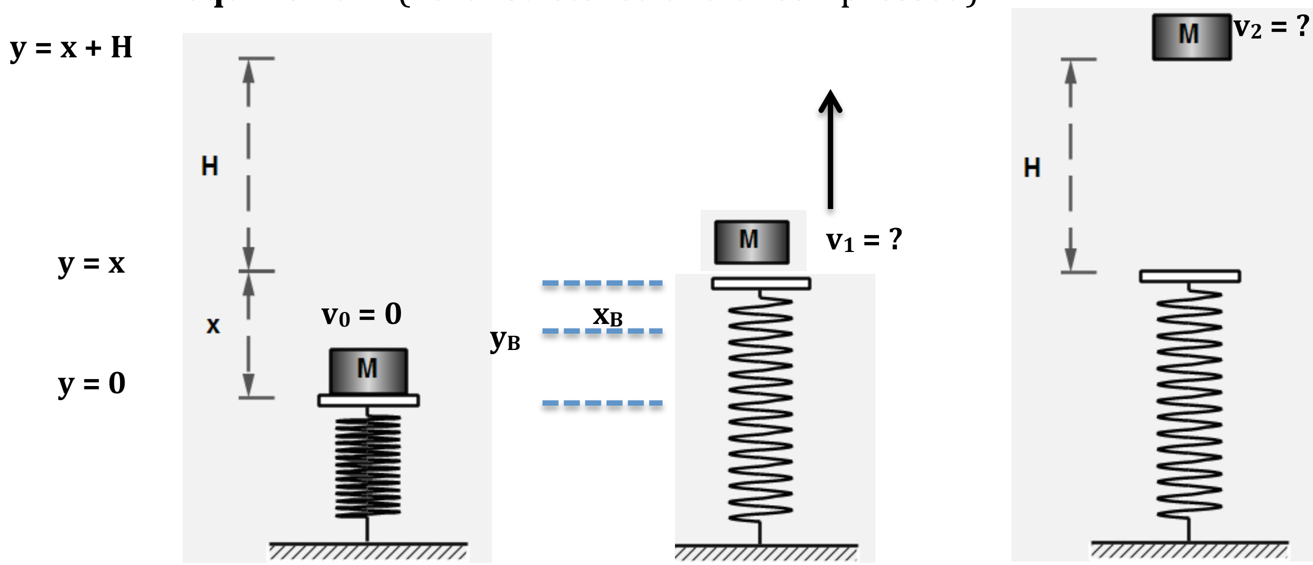
PHYSICS 1211, QUIZ 7, November 10, 2017

In the figure leftmost figure below (0), a block of mass M = 3 kg **compresses** a spring (k = 120 N/m) a distance of **x = 1.25m** from **equilibrium** (i.e. unstretched and uncompressed).



Initial (0) Intermediate(1) Final (2)

A) (**5 points**) Use **conservation** of **mechanical energy** to calculate the speed of the block at **intermediate** position **1**, when it begins to lose contact with the spring.

Initial $U_{s,i}$ + $U_{g,i}$ + K_i $U_{s,f}$ + $U_{g,f}$ + K_f **Final**

$$\frac{1}{2}kx_i^2 + mgy_i + \frac{1}{2}mv_i^2 = \frac{1}{2}kx_f^2 + mgy_f + \frac{1}{2}mv_f^2 ,$$

i = 0 (initial); $y_i = 0$, $v_i = 0$, $x_i = x = 1.25$ m; f = 1 (intermediate) $x_f = 0$, $y_f = x = 1.25$ m

$$\frac{1}{2}kx^2 + mg0 + \frac{1}{2}m0^2 = \frac{1}{2}k0^2 + mgx + \frac{1}{2}mv_f^2 .$$

$$\frac{1}{2}\left(120\frac{N}{m}\right)(1.25m)^2 - (3kg)\left(9.8\frac{m}{s^2}\right)(1.25m) = \frac{1}{2}(3kg)v_1^2 \rightarrow v_1 = 6.16\frac{m}{s} .$$

B) (**5 points**) Use **conservation** of **mechanical energy** to calculate the **maximum height** of the block, shown in **final** position **2**.

At **maximum height** (position 2) the speed is zero, $v_2 = 0$.

Initial $U_{s,i}$ + $U_{g,i}$ + K_i $U_{s,f}$ + $U_{g,f}$ + K_f **Final**

$$\frac{1}{2}kx_i^2 + mgy_i + \frac{1}{2}mv_i^2 = \frac{1}{2}kx_f^2 + mgy_f + \frac{1}{2}mv_f^2 ,$$

i = 0 (initial); $y_i = 0$, $v_i = 0$, $x_i = x = 1.25$ m; f = 2 (final), $v_f = 0$, $x_f = 0$, $y_f = x + H$

$$\frac{1}{2}kx^2 + mg0 + \frac{1}{2}m0^2 = \frac{1}{2}k0^2 + mg(x+H) + \frac{1}{2}m0^2 .$$

$$\frac{1}{2}\left(120\frac{N}{m}\right)(1.25m)^2 = (3kg)\left(9.8\frac{m}{s^2}\right)(x+H) \rightarrow x + H = 3.19m .$$ H = 1.94.

BONUS: (**5 points**) Calculate the **speed** of the block, when the spring is **compressed** from **equilibrium** by **0.5m**.

The final position, in this case, is marked by the middle dashed line in the figure. The compression of the spring is x_B = 0.5 m, and the position is y_B = 0.75 m (Do you see why?). The speed at this position, v_B, is found by conservation of energy,

Position (0) position (B)

$$\frac{1}{2}kx^2 + mg0 + \frac{1}{2}m0^0 = \frac{1}{2}kx_B^2 + mgy_B + \frac{1}{2}mv_B^2$$

$$\frac{1}{2}\left(120\frac{N}{m}\right)(1.25m)^2 = (3kg)\left(9.8\frac{m}{s^2}\right)(0.75m) + \frac{1}{2}\left(120\frac{N}{m}\right)(0.5m)^2 + \frac{1}{2}(3kg)v_B^2$$

v_B = 6.15m/s