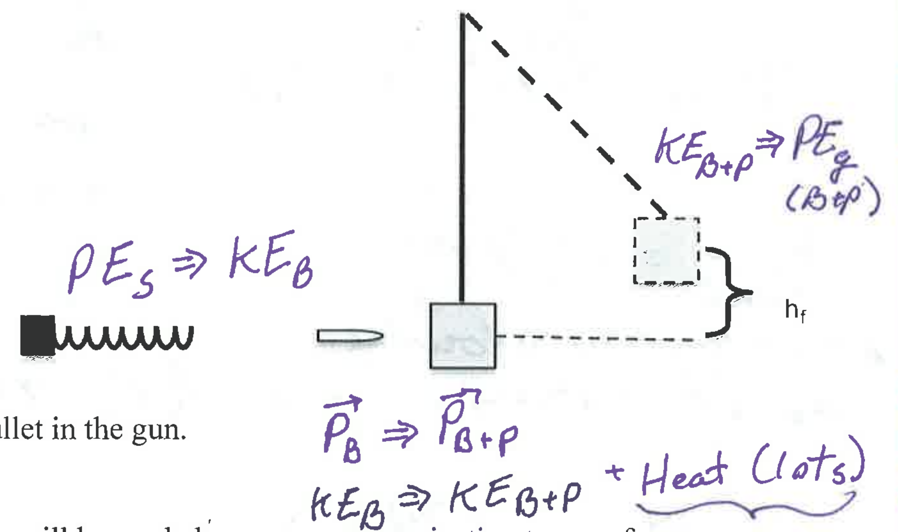
Big Exam #2, Physics 141 Schwartz, F2015, Name ____________________

1) A spring loaded gun is cocked by compressing a spring of $k = 10^3$ N/m. and then releasing it behind a 2 g bullet, sending the bullet off at 70 m/s! The bullet strikes a 0.2 kg ballistics pendulum and swings upward. Presume the spring is massless and there is no friction in the system. Please find:

a) How far the spring was compressed.
b) the height the pendulum swings.
c) The maximum acceleration of the bullet in the gun.



In this process, please be mindful that you will be graded on your communication to me of your understanding of the physics in involved:

a) This is an energy lens because we can see that all the potential energy in the spring is converted to the bullets kenetic energy. (because the spring has no mass)

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

$$x = \sqrt{\frac{m}{k}v^2} = \sqrt{\frac{m}{k}}\,v$$

$$= \left(\frac{0.002\,kg}{10^3\,N/m}\right)^{\frac{1}{2}} 70\,m/s = \left(\frac{2\times10^{-3}\,kg}{10^3\,\frac{kg\,m}{s^2\,m}}\right)^{\frac{1}{2}} \cdot 70\,m/s$$

$$= \sqrt{2}\times10^{-3}\cdot 70\,m/s \cdot s \sim 0.1\,m = 10\,cm$$

~ 1.4 ← ≈ 100

b) This requires 2 lenses #1) conserve momentum in the collision because heat is lost, so mechanical energy isn't conserved, Then #2) conserve what energy you have left as $KE \Rightarrow PE_g$ of the bullet/Pendulum system.

b) $\vec{P}_o = \vec{P}_f$

$m_B \vec{v}_B = (m_B + m_P)\, \vec{v}_{\underline{BP}}$

but $m_B \ll m_P$, so we can say mass ~~go~~ gets multiplied by ~100

$2g \Rightarrow 202g$, so $\vec{v} \Downarrow 100$

$\vec{v}_{Pend} = 0.7\ m/s$

...so it recoils slowly...

as it swings up: $KE_P \Rightarrow PE_{g(P)}$ $\quad m_P \approx m_P + m_B$

$\frac{1}{2} \cancel{m_P} v_P^2 = \cancel{m} g h$

$h = \frac{v_P^2}{2g} \approx \frac{.49\ m^2/s^2}{2 \cdot 10\ m/s^2} \approx \frac{\frac{1}{2}\ m}{20} \approx \frac{1}{40}\ m$

or 2.5 cm

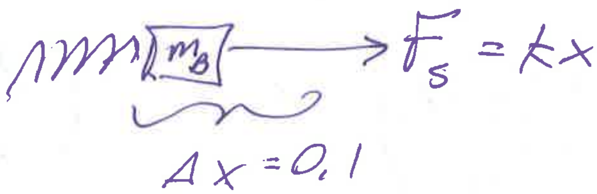
(I could see that happening)

c) We have forces & want acceleration, so we use dynamics...

Oh shit! ....

Wait, I know

$\sum \vec{F} = m\vec{a}$



$F_s = kx = ma$

$a = \frac{kx}{m} = \frac{10^3\ \cancel{N}/\cancel{m}\ 10^{-1}\ \cancel{m}}{2 \times 10^{-3}\ \cancel{kg}} = \frac{1}{2} \cdot 10^5\ m/s^2$ $\quad$ ($N = kg\ m/s^2$)

$= 50{,}000\ m/s^2$

Wow! That's a lot of $\vec{a}$, or 5000 gravities

but it is a gun, so we'd expect that.