Week 7 Challenge Homework Solutions

You are a world-famous physicist-lawyer defending a client who has been charged with murder. It is alleged that your client, Mr. Lawton, shot the victim, Mr. Cray. The detective who investigated the scene of the crime, Mr. Dibny, found a second bullet, from a shot that missed Mr. Cray, that had embedded itself into a chair. You arise to cross-examine the detective.

You: In what type of chair did you find the bullet?
Dibny: A **wooden** chair.
You: How massive was this chair?
Dibny: It had a mass of 20 kg.
You: How did the chair respond to being struck with a bullet?
Dibny: It slid across the floor.
You: How far?
Dibny: Three centimeters. The slide marks on the dusty floor are quite distinct.
You: What kind of floor was it?
Dibny: A **wood** floor.
You: What was the mass of the bullet you retrieved from the chair?
Dibny: Its mass was 10 g.
You: Have you tested the gun you found in Mr. Lawton's possession?
Dibny: I have.
You: What is the muzzle velocity of bullets fired from that gun?
Dibny: The muzzle velocity is 450 m/s.

With only slight hesitation, you turn confidently to the jury and proclaim, "My client's gun did not fire those shots!"

(a) (a) How are you going to convince the jury and judge?
(b) (b) Choose one part of your solution and perform a sense-making analysis. Clearly state which sense-making analysis you've chosen and why.

FEW DIFFERENT WAYS TO PROVE ....

... ONE WAY IS TO FIND INITIAL VELOCITY OF A BULLET SUCH THAT THE CHAIR THEN MOVES 3 cm .... THEN COMPARE W/ GIVEN 450 m/s

THIS CAN BE DONE IN 2 STAGES...

... 3 STAGES

I] C.O.M.

II] FORCES

III] KINEMATICS

KNOWNS

$M_{CHAIR} = M_C = 20\ kg$

$|\Delta \vec{r}_{CHAIR}| = d = 0.03\ m$

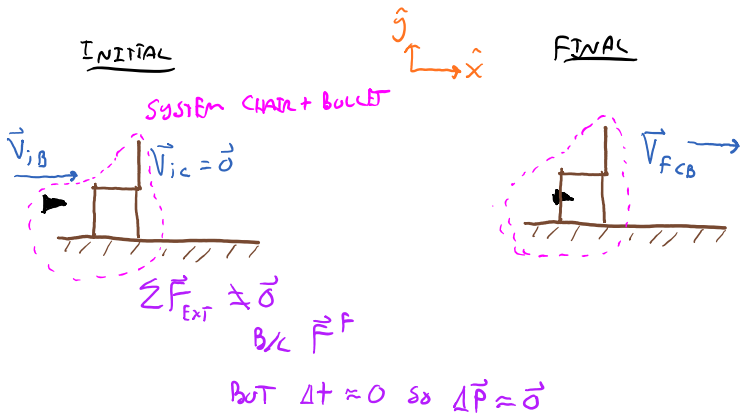
$M_{BULLET} = M_B = 0.010\ kg$

CHAIR TYPE: WOOD
FLOOR TYPE: WOOD
} $\mu_K \approx 0.20$

GOOGLE COMMON WOOD ON WOOD μ_K

$V_B = 450\ m/s$

STAGE I



$$\Delta \vec{P}_{sys} = \vec{0}$$

$$\Sigma \vec{P}_i = \Sigma \vec{P}_f$$

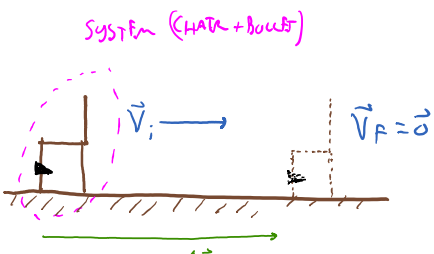
$$\Sigma P_{ix} = \Sigma P_{fx}$$

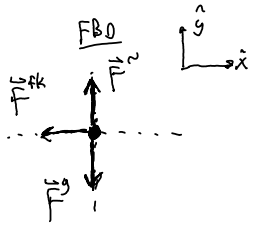
$$P_{Bix} + \cancel{P_{Cix}}^{0} = P_{f\langle BC\rangle x}$$

$$m_B \, v_{iBx} = (m_B + m_C) \, v_{f\langle BC\rangle}$$

$$v_{f\langle BC\rangle} = \frac{m_B}{(m_B + m_C)} v_{iBx}$$

STAGE II + III





$\Sigma F_x = ma_x$ $\quad$ $\Sigma F_y = ma_y^{\,0}$

$-F^{fk} = ma_x$ $\quad$ $F^N - mg = 0$

$-\mu_k F^N = ma_x$ $\quad$ $F^N = mg$

$-\mu_k mg = ma_x$

$a_x = -\mu_k g$

	k	uk
$\Delta x = \frac{3}{100}$ m		v_{ix}
$v_{fx} = 0$		
$a_x = -\mu_k g$		Δt

$v_{fx}^{\,2\,0} = v_{ix}^2 + 2a_x \Delta x$

$0 = v_{ix}^2 - 2(\mu_k g)\Delta x$

$v_{ix} = \sqrt{2\mu_k g \Delta x}$

$v_{f\langle B\rangle} = \sqrt{2\mu_k g \Delta x}$

$$\frac{m_B}{(m_B + m_C)} v_{iBx} = \sqrt{2\mu_k g \Delta x}$$

$$v_{iBx} = \frac{(m_B + m_C)\sqrt{2\mu_k g \Delta x}}{m_B}$$

$$v_{iBx} = \sqrt{\frac{2\mu_k g \Delta x \, (m_B + m_C)^2}{m_B^2}} = \boxed{687 \text{ m/s}}$$

COMPARE 687 m/s > 450 m/s

SO NOT THE SAME GUN.

(b) $v_{i,Bx} = \sqrt{\dfrac{2\mu_k g \Delta x (m_B + m_L)^2}{m_B^2}}$

$\frac{m}{s}$

* DIMENSIONALITY CHECK...

$g \rightarrow \frac{m}{s^2}$

$\Delta x \rightarrow m$

$m_B \rightarrow kg$

$m_L \rightarrow kg$

$2, \mu_k \rightarrow$ UNITLESS

$$\sqrt{\frac{\frac{m}{s^2} \cdot m \left(kg\right)^2}{kg^2}}$$

$$\sqrt{\frac{m^2}{s^2}}$$

$\frac{m}{s}$:)

I DID THIS SENSE MAKES B/C I USED VARIABLES AND HAD AN ODD LOOKING FINAL EXPRESSION FOR A SPEED.