Review of Major Concepts

Part 1a - Momentum and Impulse

$\vec{p} = m\vec{v}$

- $\vec{p}$: kg m/s
- m: kg
- $\vec{v}$: m/s

$F\Delta t = m\Delta v$

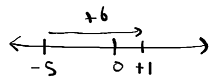
- $F\Delta t$: Impulse, N·s
- m: kg
- Δv: m/s

Impulse causes a change in momentum

Q1: Bob (50kg) travels at 5 m/s [Left]. Force of 100N [Right] is applied for 3sec. Final velocity?

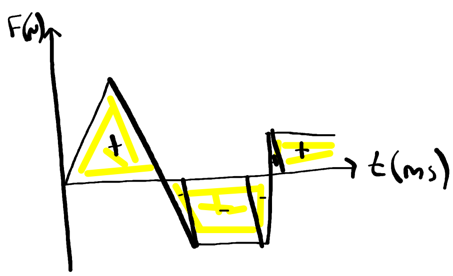
$m = 50\text{ kg}$
$v_i = 5\text{ m/s [L]}$
$v_f = ?$
$\Delta v = ?$
$F = 100\text{ N [R]}$
$t = 3\text{ sec.}$

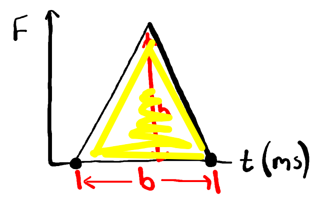
$F\Delta t = m\Delta v$
$(100)(3s) = (50)\Delta v$
$\Delta v = 6\text{ m/s [R]}$



$\Delta v = v_f - v_i$
$+6 = v_f - (-5)$
$6 = v_f + 5$
$-5 \quad -5$
$1\text{ m/s [R]} = v_f$

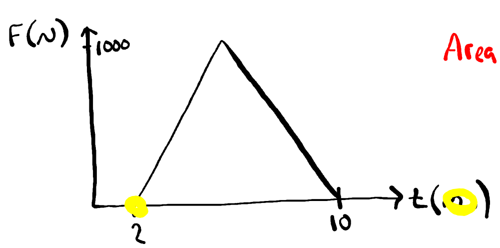
Impulse Graphs





$A = \frac{bh}{2}$

Q2: What is Impulse?



$\text{Area} = \frac{bh}{2} = \frac{(8\times10^{-3})(1000)}{2}$

$= 4\text{ Ns}$

Tricks? → Units
→ Starting Point

Part 1b - Collisions in 1- and 2-Dimensions

Tip! Units? Whatever. Just keep them consistent.

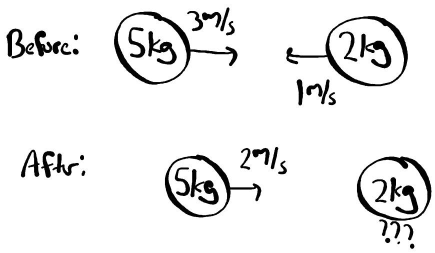
$P_i = P_f$

$kg\,m/s \rightarrow kg\,m/s$
$kg\,\frac{km}{h} \rightarrow kg\,\frac{km}{h}$

$kg\,\frac{km}{h} \rightarrow \frac{kg\,m/s}{3.6}$

$\frac{(P_1)}{3.6} \rightarrow \frac{(P_2 + P_3)}{3.6}$

Type #1 - Unknown final $\vec{p}$ or $\vec{v}$



$- \leftarrow\rightarrow +$ $\quad P_i = P_f$

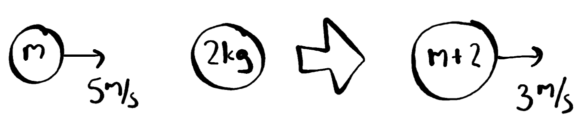
$(5)(3) + (2)(-1) = (5)(2) + (2)(v_f)$

$+15 - 2 = +10 + 2v_f$

$3 = 2v_f$

$v_f = 1.5\ m/s\ [R]$

Type #2 - Unknown Mass (Harder 1-D question)



$P_i = P_f$

$5m + 0 = (m+2)(3)$

$5m = 3m + 6$

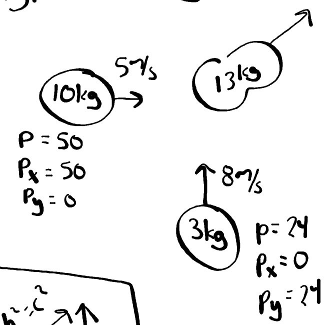
$-3m \quad -3m$

$2m = 6$

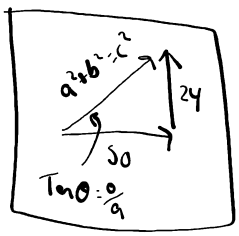
$\div 2 \quad \div 2$

$\boxed{m = 3\,kg}$

Type #3 - 90deg Collision



	x	y
P_1	50	0
P_2	0	24
P_{TOT}	50	24

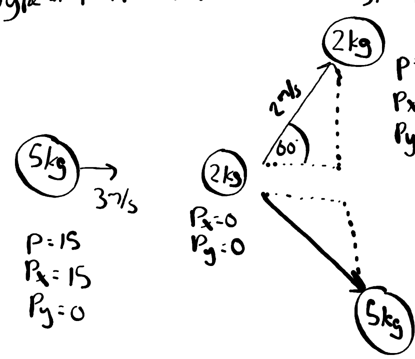


$\vec{p} = 55.46\ kg\,m/s\ [25.64°\ N\ of\ E]$

$p = mv$

$\vec{v} = \frac{\vec{p}}{m} = \frac{55.46\ (25.64°)}{13\ kg}$

Type #4 - Horizontal hits stationary, split at diagonal.



$p = 4\ [60°]$

$P_x = 4\cos 60° = 2$

$P_y = 4\sin 60° = 3.464$

$P_{i_x} = P_{f_x}$

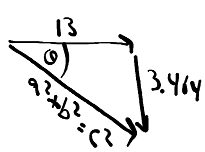
$+15 + 0 = +2 + P_{5_x}$

$P_{5_x} = +13$

$P_{i_y} = P_{f_y}$

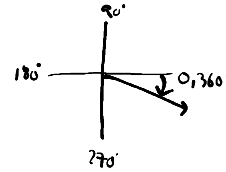
$0 + 0 = +3.464 + P_{5_y}$

$P_{5_y} = -3.464$

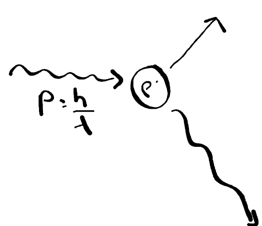


$\vec{P} = 13.45\ kg\,m/s\ [14.92°\ S\ of\ E]$

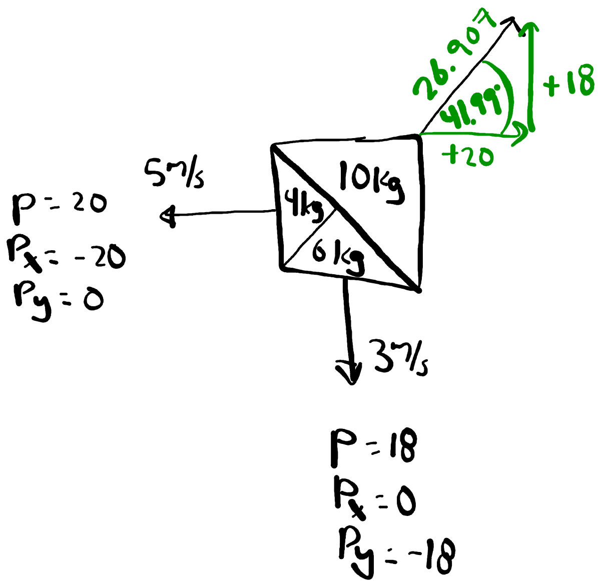
$[345.08°]$



Just like Compton Scattering



Type #5 - Stationary, Split into 3-components



$p_{10kg} = 26.907\ kg\,m/s\ [41.99°]$

$v_{10kg} = \frac{p}{m} = 2.69\ m/s\ [42°]$

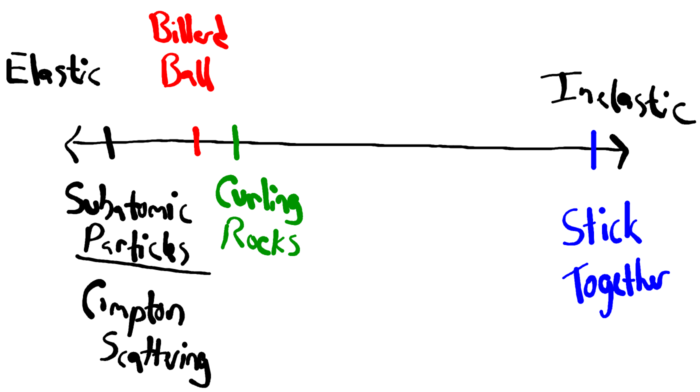
Elastic + Inelastic Collisions

① If no external force (isolated system) → Momentum is conserved.

② Energy will <u>always</u> be conserved, but...

$$E_{K_{Huge}} \rightarrow E_{K_{Small}} + E_{Thermal}$$

Loss of E_K → Inelastic



③ <u>Always</u> $P_i = P_f$

Then compare E_{K_i} to E_{K_f}

Same? Elastic

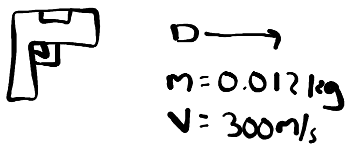
Lost E_K? Inelastic

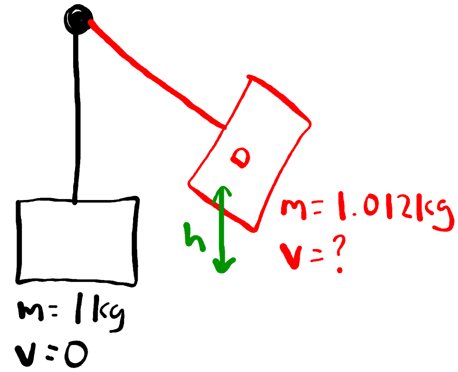
Gained E_K? Error!

$p = mv$

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

Ballistic Pendulum





① Working forward

$P_{bullet} + P_{Block} = P_{system}$

$3.6 + 0 = 3.6$

If $P_{sys} = 3.6 = mv$

$3.6 = (1.012)v$

$v = 3.5573\ m/s$

$E_k \rightarrow E_p$

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

$\frac{1}{2}(1.012)(3.5573)^2 = (1.012)(9.81)h$

$h = 0.64498\ m$

$\approx 64.5\ cm$

② Working backward

Given $h = 0.64498\ m$

$m_{block} = 1\ kg$

$m_{bullet} = 0.012\ kg$

$V_{bullet} = ?$

$E_p \rightarrow E_k \rightarrow v \rightarrow$ Cons. of p

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

$V = 3.5573\ m/s$

$P_i = 3.6\ kg\,m/s$

$V_i = 300\ m/s$