TH-GP General Physics Week 29 4/25

Elastic Collision

kinetic energy + momentum is conserved.

 particles $m_1 v_1 + m_2 v_2 = m_1 v_{f_1} + m_2 v_{f_2}$

– we do not calculate –

Inelastic collisions

only momentum is conserved — masses must combine.

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v_f$$

A 4,990 (mass) kg Frankie D' Kool Aid (object) traveling 32 m/s (velocity) 45° (degrees) above (above/below) horizonal collides with a 406 kg Bluey traveling 200 m/s 30° (degrees) below (above/below) horizontal. If inelastic, what is the resulting velocity?

① FDKA

$m_1 = 4990\ kg$

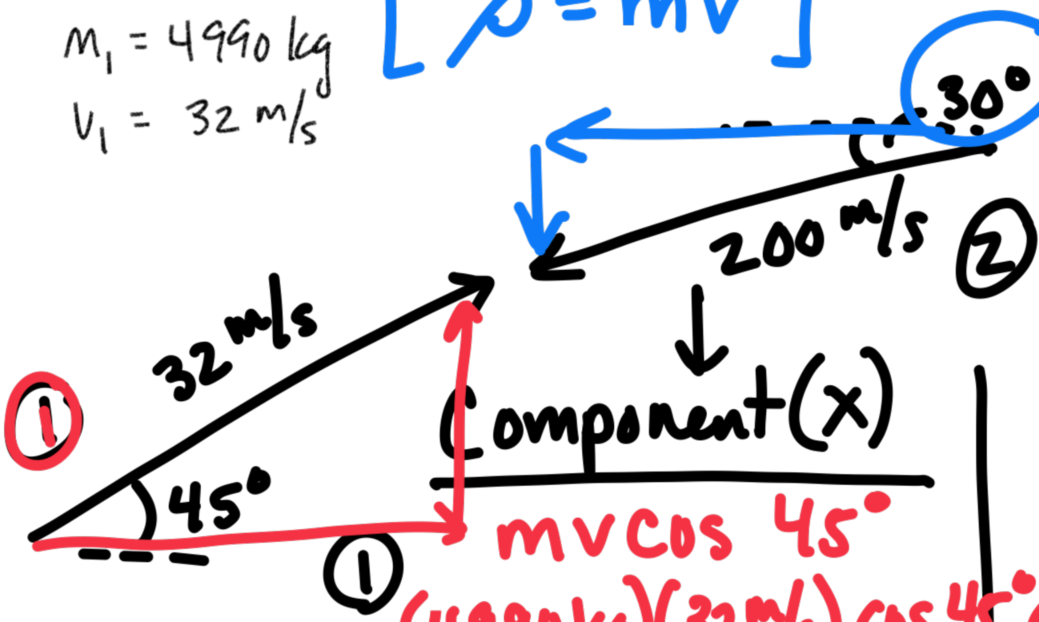
$v_1 = 32\ m/s$

[$p = mv$]

② Bluey

$m_2 = 406\ kg$

$v_2 = 200\ m/s$



	Component (x)	Component (y)
①	$mv\cos 45°$	$mv\sin 45°$
	$(4990\ kg)(32\ m/s)\cos 45°$	$(4990)(32)\sin 45°$
	$+112{,}910.8\ kg\ m/s$	$+112{,}910.8\ kg\ m/s$
②	$mv\cos 30°$	$mv\sin 30$
	$(406\ kg)(200\ m/s)\cos 30$	$(406)(200)\sin 30$
+	$-70{,}321.3\ kg\ m/s$	$-40{,}600$
	tot_x $42{,}589.5\ kg\ m/s$	tot_y $72{,}310.8$

total momentum $r = \sqrt{x^2 + y^2}$

$$r = \sqrt{(42{,}589.5)^2 + (72{,}310.8)^2}$$

total momentum $83{,}921\ kg\ m/s$

Direction $\theta = \tan^{-1}\frac{y}{x}$

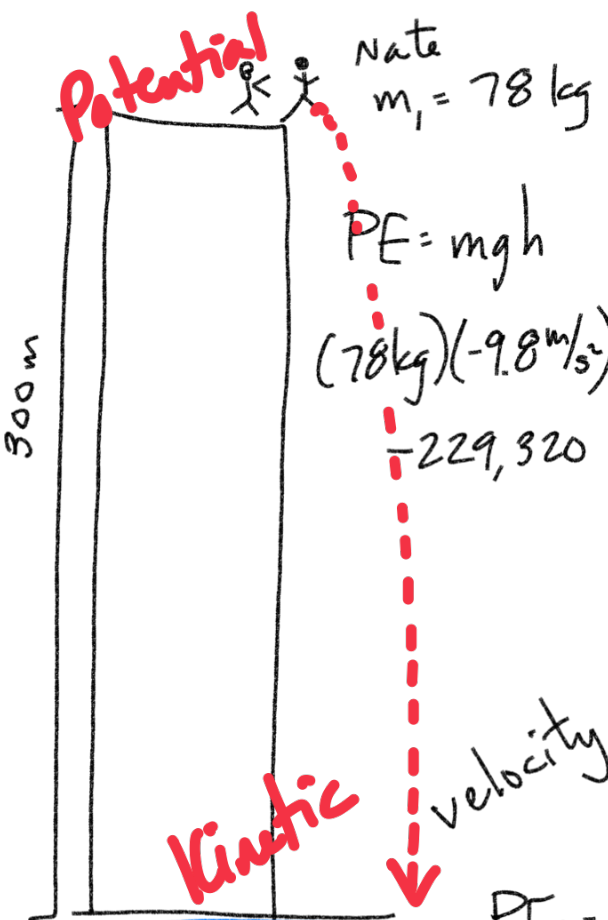
$$\tan^{-1}\left(\frac{72{,}310.8}{42{,}589.5}\right) = 59.5°$$

Total momentum $83{,}921 \text{ kg m/s}, \ 59.5^\circ$

$$\text{final velocity} = \frac{\text{total momentum}}{\text{total mass}}$$

$$\frac{83{,}921 \text{ kg m/s}}{(4990 \text{ kg} + 406 \text{ kg})} = \boxed{15.6 \text{ m/s}, \ 59.5^\circ}$$

Law of conservation of energy – energy cannot be created or destroyed



$PE = mgh$

$(78\text{kg})(-9.8 \text{ m/s}^2)(300\text{m})$

$-229{,}320$ J

Potential energy

Energy based on position

$PE = mgh$

(mass)(gravity)(height)

Kinetic Energy

Energy based on movement

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

$PE = KE$ $\left[mgh = \frac{1}{2}mv^2 \right]$

$2(gh) = 2\left(\frac{1}{2}v^2\right)$ $\sqrt{2gh} = \sqrt{v^2}$

$v = \pm\sqrt{2gh}$

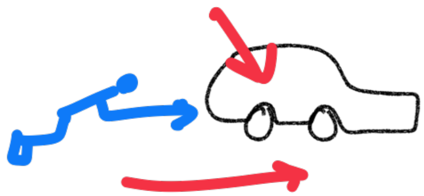
$\pm\sqrt{2(9.8)(300)}$

$\boxed{76.7 \text{ m/s}}$

$KE = PE \quad \frac{1}{2}mv^2 = mgh$

$V = \sqrt{2gh}$?

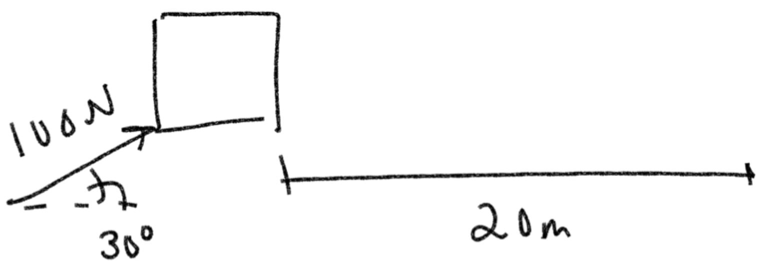
Work = force * displacement
(energy)



x component

$W = F \cdot d \cdot \cos\theta$

$F\cos\theta \cdot d$



$(100\,N)(\cos 30)(20\,m)$

1732 J

Dot Product

$W = F(\cos\theta) * d$

$W = F \cdot d$
"dot"

$W = F_x d_x + F_y d_y$

x y

Displacement: $(8.0\hat{i} + 3.0\hat{j})$

Applied Force: $(2.0\hat{i} + 5.0\hat{j})$

$F \cdot d = (8 * 2) + (3 * 5)$

$16 + 15$

31 J magnitude

Work is a vector → magnitude, direction

magnitude: $F \cdot d$

above problem

$$\cos\theta = \frac{F \cdot d}{|F|\,|d|} = \frac{31}{\sqrt{29}\sqrt{73}}$$

$$|F| = r = \sqrt{x^2+y^2} = \sqrt{2^2+5^2} = \sqrt{4+25}$$

$$\sqrt{29}$$

$$|d| = r = \sqrt{x^2+y^2} = \sqrt{8^2+3^2}$$

$$\sqrt{64+9} = \sqrt{73}$$

$$\cos\theta = \frac{31}{\sqrt{29}\sqrt{73}}$$

$$\theta = \cos^{-1}\left(\frac{31}{\sqrt{29}\sqrt{73}}\right) = 47.6^\circ$$

$$\boxed{W = 31\,J,\ 47.6^\circ}$$