M-GP General Physics Week 29/30 5/6

Elastic Collision

<u>kinetic energy</u> and <u>momentum</u> are conserved.

particles $m_1 v_1 + m_2 v_2 = m_1 v_{1f} + m_2 v_{2f}$

we do <u>not</u> calculate this!

Inelastic collision

Only momentum is conserved — masses must combine.

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

A 9000 kg (mass) F-16 (object) traveling 610 m/s

_____ ° 20° above/below horizontal collides with a

648 kg (mass) Chunkiest Dude (Godspeed) traveling 6,667 m/s

_____ ° 45° above/below horizontal. If inelastic, find the final velocity.

F-16 vs Chunky Boy

$m_1 = 9000\,kg$

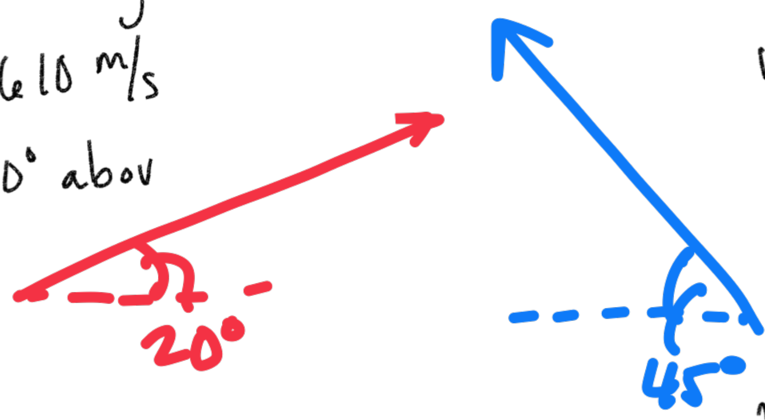
$V_1 = 610\,m/s$

20° abov

$m_2 = 648\,kg$

$v_2 = 6{,}667\,m/s$

45° above



$p = mv$

	component x	component y
F-16	$mv\cos\theta$	$mv\sin\theta$
	$(9000\,kg)(610\,m/s)(\cos 20)$	$(9000\,kg)(610\,m/s)(\sin 20)$
	$5{,}158{,}912\,kg\,m/s$	$1{,}877{,}691\,kg\,m/s$
ChunkyBoy	$mv\cos\theta$	$mv\cos\theta$
	$(648\,kg)(6{,}667\,m/s)\cos 45°$	$(648)(6667\,m/s)\sin 45°$
	$-3{,}054{,}854\,kg\,m/s$	$3{,}054{,}854\,kg\,m/s$
	$2{,}104{,}058\,kg\,m/s$	$4{,}932{,}545\,kg\,m/s$

total momentum

$$r = \sqrt{x^2+y^2} = \sqrt{(2{,}104{,}058)^2 + (4{,}932{,}545)^2}$$

$$= 5{,}362{,}560\,kg\,m/s$$

$$\text{velocity} = \frac{\text{total momentum}}{\text{total mass}} \quad \frac{5{,}362{,}560\,kg\,m/s}{648\,kg + 9000\,kg} = 556\,m/s$$

$\theta = \tan^{-1} \frac{y}{x} = \tan^{-1} \left(\frac{4,932,545}{2,104,058} \right) = 67°$

$\boxed{556 \text{ m/s}, 67°}$

Law of conservation of energy - energy cannot be created or destroyed.

Max PE

$PE = mgh$

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

$\boxed{229,320 \text{ J}}$

Max. Potential Energy

Based on position

$PE = mgh$

(mass)(gravity)(height)

Kinetic Energy

Energy based on movement

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

terminal velocity

$PE = KE$

$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$

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

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

$v = \sqrt{2gh}$

$\sqrt{2(9.8 \text{ m/s}^2)(300 \text{ m})}$

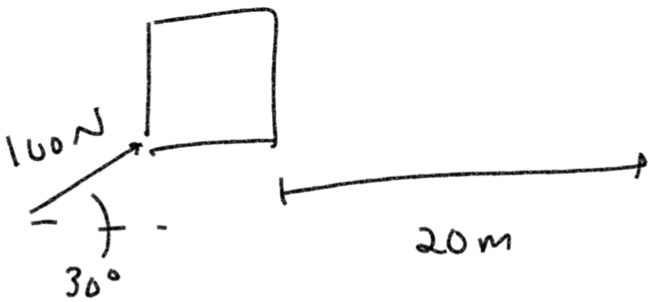
$\boxed{76.7 \text{ m/s}}$

Work = force * displacement

(energy)

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

$F\cos\theta * d$



$100N \cos 30 * 20$

$\boxed{1732\ J}$

Dot Product

$W = F_x d_x + f_y * d_y$

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

$F \cdot d$

dot

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

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

$F \cdot d$

$(8 * 2) + (3 * 5)$

$16 + 15 = \boxed{31\ J}$

magnitude

Work is a <u>vector</u> → has magnitude & <u>direction</u>.

Magnitude = $F \cdot d$

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

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

$$\theta = \cos^{-1}\left(\frac{F \cdot d}{|F|\,|d|}\right)$$

$$\left[\cos^{-1}\left(\frac{31}{\sqrt{29}\sqrt{73}}\right)\right] = \boxed{48^\circ}$$

magnitude

$$|F| = \sqrt{(F_x)^2 + (F_y)^2}$$

$$\sqrt{2^2 + 5^2} = \sqrt{4+25} = \sqrt{29}$$

$$|d| = \sqrt{(d_x)^2 + (d_y)^2}$$

$$\sqrt{8^2 + 3^2}$$

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

Having impacted gracefully on ground, Nate's mangled, lifeless body is dragged away.

His body is dragged with a force of $\langle 500N, 40N \rangle$ and a displacement of $\langle 2000m, 60m \rangle$

Find the work done, include the angle.

$$F \cdot d = (500 * 2000) + (40 * 60)$$

$$1000000 + 2400 = 1002400 \text{ J}$$

$$\theta = \cos^{-1} \frac{F \cdot d}{|F||d|} = \cos^{-1}\left(\frac{1002400}{(501)(2001)}\right) = \approx 3^\circ$$

$$\boxed{1002400 \text{ J}, 3^\circ}$$

$$|F| = \sqrt{(500)^2 + (40)^2} = 501$$

$$|d| = \sqrt{(2000)^2 + (60)^2} = 2001$$