Jan 25 Momentum

$\vec{p} = m\vec{v}$ units: $[kg][m/s] = kgm/s$

- describes the difficulty of changing motion

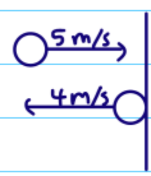
If $F = ma$

$F = m\frac{\Delta v}{\Delta t}$

$F\Delta t = m\Delta v$

$F\Delta t = \Delta p$ ← impulse $[N \cdot s]$

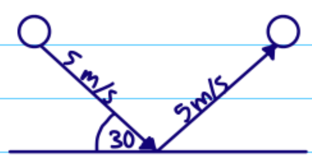
Ex① What is the impulse in each case?

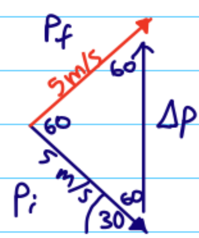


$m = 0.10$ kg

$\Delta p = mv_f - mv_i$

$= 0.10(-4-5) = -0.9$ Ns





$\Delta p = (0.1)(5)$

$= 0.5$ Ns ↑

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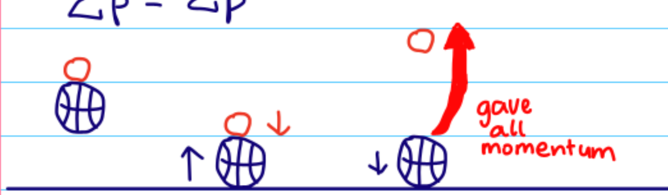
Law of conservation of Momentum

The total momentum of a closed system of bodies remains constant

- no external forces, no objects leave

$\Sigma p = \Sigma p'$

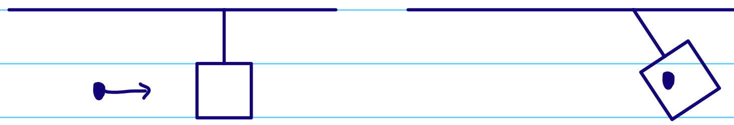


Perfect collisions where both energy & momentum are conserved, are called elastic collisions

$\Sigma p = \Sigma p'$ $\Sigma E_k = \Sigma E_k'$

Inelastic Collisions

consider a bullet shot at a block of wood



If momentum is conserved after impact:

$m_1 v_1 = (m_1 + m_2) v'$

$$v' = \frac{m_1 v_1}{m_1 + m_2}$$

In terms of energy before and after

$$\frac{1}{2} m_1 v_1^2 = (m_1 + m_2) gh$$

$$h = \frac{m_1 v_1^2}{2g(m_1 + m_2)}$$

However look at energy after the collision

$$\frac{1}{2}(m_1 + m_2) v'^2 = (m_1 + m_2) gh$$

$$v'^2 = 2gh$$

$$h = \frac{v'^2}{2g} \quad \text{sub with} \quad v' = \frac{m_1 v_1}{m_1 + m_2}$$

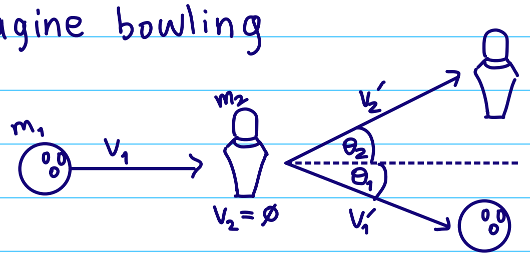
$$h' = \frac{(m_1 v_1)^2}{2g(m_1 + m_2)^2}$$

h and h' are different values
h compares beginning and end
h' compares middle and end

During an elastic collision, momentum is conserved but the kinetic energy is not

Assignment Matthewson p.188 # 3-11 odd (worksheet)

Jan 31 Imagine bowling



$m_1 = 2.0$ kg $\quad V_1 = 5.0$ m/s

$m_2 = 0.3$ kg

After collision $\theta_2 = 37°$ $\quad V_2' = 6.5$ m/s

Find V_1' and θ_1

use COMPONENTS

x: $m_1 V_1 = m_1 V_1' \cos\theta_1 + m_2 V_2' \cos\theta_2$

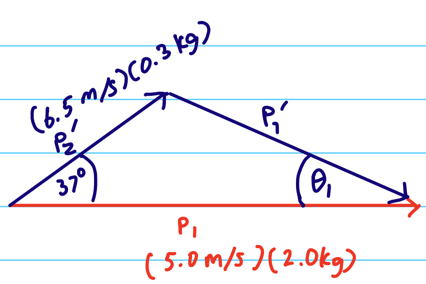
y: $0 = -m_1 V_1' \sin\theta_1 + m_2 V_2' \sin\theta_2$

$$m_1 V_1 = m_1 V_1' \cos\theta_1 + m_2 V_2' \cos\theta_2$$
$$10 = 2 V_1' \cos\theta_1 + 1.557$$

$$0 = -m_1 V_1' \sin\theta_1 + m_2 V_2' \sin\theta_2$$
$$0 = -2 V_1' \sin\theta_1 + 1.173$$
$$V_1' = \frac{1.173}{2\sin\theta_1}$$

$$10 = 1.173 \cot\theta_1 + 1.557$$
$$\theta_1 = 7.91°$$

use VECTOR ADDITION



using COSINE LAW

$$c^2 = a^2 + b^2 - 2ab\cos C$$
$$P_1'^2 = P_2'^2 + P_1^2 - 2(P_2')(P_1)\cos(\theta_2)$$
$$P_1'^2 = 1.95^2 + 10^2 - 2(10)(1.95)\cos(37)$$
$$P_1' = 8.524 \text{ kgm/s}$$

$p_1' = mv$

$v_1' = 4.26\ m/s$

Solve θ with sine law

$$\frac{a}{\sin A} = \frac{b}{\sin B}$$

$$\frac{p_2'}{\sin\theta_1} = \frac{p_1'}{\sin 37}$$

$$\frac{1.95}{\sin\theta_1} = \frac{8.524}{\sin 37}$$

$$\theta = 7.913$$

Assignment Giancoli p. 205 # 37-45 odd

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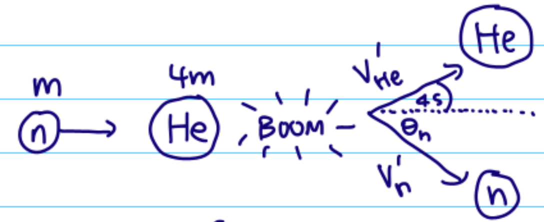
Feb 2

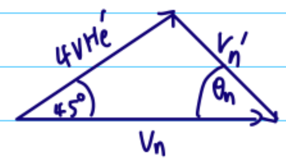
43.



elastically → energy is conserved

$V_n = 6.2 \times 10^5$ m/s

$V_{He} = 0$ m/s



$$E = E'$$

$$\frac{1}{2} m v_n^2 = \frac{1}{2}(4m)(V_{He}')^2 + \frac{1}{2} m (V_n')^2$$

$$V_n^2 = 4(V_{He}')^2 + (V_n')^2$$

$$(V_n')^2 = (4V_{He}')^2 + (V_n)^2 - 2(4V_{He}')(V_n)\cos(45)$$

$$(V_n')^2 = (4V_{He}')^2 + 4(V_{He}')^2 + (V_n')^2 - 2(4V_{He}')(V_n)\cos(45)$$

$$0 = 20(V_{He}')^2 - 8(V_{He}')(6.2 \times 10^5)\cos 45$$

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