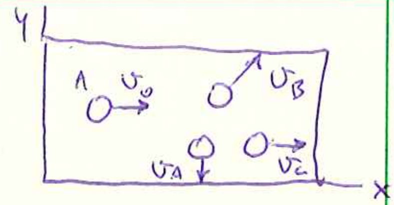
PROB. 14-53



$v_0 = 12\ \frac{ft}{s}$, $v_A = 5.76\ \frac{ft}{s}$, $a = 66$ IN

a) FIND v_B AND v_C

CONSERVE LINEAR MOMENTUM: $m\vec{v}_0 = \Sigma m_i \vec{v}_i$

$$\vec{v}_0 = \vec{v}_A + \vec{v}_B + \vec{v}_C$$

$$(v_0)\hat{i} = (-v_A)\hat{j} + (v_{Bx})\hat{i} + (v_{By})\hat{j} + (v_C)\hat{i}$$

X-DIRECTION: $12 = v_{Bx} + v_C$, $v_{Bx} = 12 - v_C$

Y-DIRECTION: $0 = -5.76 + v_{By} \Rightarrow v_{By} = 5.76\ \frac{ft}{s}$

CONSERVE ANGULAR MOMENTUM ABOUT ORIGIN:

$$(\vec{H}_0)_1 = (\vec{H}_0)_2 = \Sigma(\vec{r}_i \times m_i \vec{v}_i)$$

$$\vec{r}_A \times m_A \vec{v}_0 = \vec{r}_{A'} \times m_A \vec{v}_A + \vec{r}_B \times m_B \vec{v}_B + \vec{r}_C \times m_C \vec{v}_C$$

$$\vec{r}_A \times \vec{v}_0 = \vec{r}_{A'} \times \vec{v}_A + \vec{r}_B \times \vec{v}_B + \vec{r}_C \times \vec{v}_C$$

$$\vec{r}_A \times \vec{v}_0 = -(30\ \text{IN})(12\ \tfrac{ft}{s})\hat{k} = (-360)\hat{k}\ \frac{\text{IN}\cdot ft}{s}$$

$$\vec{r}_{A'} \times \vec{v}_A = -(66\ \text{IN})(5.76\ \tfrac{ft}{s})\hat{k} = (-380.2)\hat{k}\ \frac{\text{IN}\cdot ft}{s}$$

$$\vec{r}_B \times \vec{v}_B = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 72.5 & 60 & 0 \\ (12 - v_C) & 5.76 & 0 \end{vmatrix}$$

$$= [(72.5)(5.76) - (60)(12 - v_C)]\hat{k}$$

$$= (-302.4 + 60 v_C)\hat{k}\ \frac{\text{IN}\cdot ft}{s}$$

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$\vec{r}_C \times \vec{v}_C = [-(60-c)v_C]\hat{k} \ \frac{\text{in}\cdot\text{ft}}{s}$

$-360 = -380.2 - 302.4 + 60v_C - 60v_C + c\cdot v_C$

$c \cdot v_C = 322.6 \ \frac{\text{in}\cdot\text{ft}}{s}$

CONSERVE ENERGY: $\frac{1}{2}m\bar{v}^2 = \sum \frac{1}{2}m_i v_i^2$

$v_0^2 = v_A^2 + v_B^2 + v_C^2$

$v_0^2 = v_A^2 + v_{Bx}^2 + v_{By}^2 + v_C^2$

$(12)^2 = (5.76)^2 + (12-v_C)^2 + (5.76)^2 + v_C^2$

$144 - 24v_C + v_C^2 + v_C^2 - 77.64 = 0$

$2v_C^2 - 24v_C + 66.35 = 0$

$$v_C = \frac{-(-24) \pm \sqrt{24^2 - 4(2)(66.35)}}{2(2)}$$

$v_C = 6 \pm 1.68 = 4.319,\ 7.68 \ \frac{ft}{s}$

$$C = \frac{(322.6)}{v_C} = \frac{(322.6)}{(4.319)} = 74.69\ \text{in} : \text{IMPOSSIBLE}$$

$$C = \frac{(322.6)}{(7.68)} = 42.0\ \text{in} : \text{POSSIBLE} \Rightarrow \boxed{v_C = 7.68\ \frac{ft}{s} \longrightarrow}$$

$v_{Bx} = 12 - 7.68 = 4.32\ \frac{ft}{s}$

$\vec{v}_B = (4.32)\hat{i} + (5.76)\hat{j}\ \frac{ft}{s}$ $\boxed{= 7.20\ \frac{ft}{s} \ \angle 53.13^\circ}$