Demonstration of Work-Energy Theorem

••16 Figure 7-30 shows an overhead view of three horizontal forces acting on a cargo canister that was initially stationary but now moves across a frictionless floor. The force magnitudes are $F_1 = 3.00$ N, $F_2 = 4.00$ N, and $F_3 = 10.0$ N, and the indicated angles are $\theta_2 = 50.0°$ and $\theta_3 = 35.0°$. What is the net work done on the canister by the three forces during the first 4.00 m of displacement?

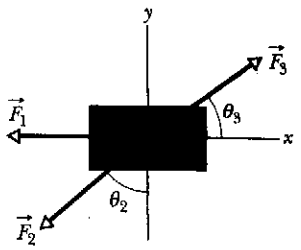


FIG. 7-30 Problem 16.

$$\vec{F}^{net}_{\text{on canister}} = \sum_{i=1}^{3} \vec{F}_i = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = \text{CONSTANT}$$

$$\Rightarrow W^{net}_{\text{on canister}} = \vec{F}^{net}_{\text{on canister}} \cdot \vec{d}_{\text{of canister}}$$

$$\vec{F}^{net} = (F_{1x}+F_{2x}+F_{3x})\hat{x} + (F_{1y}+F_{2y}+F_{3y})\hat{y} = F^{net}_x \hat{x} + F^{net}_y \hat{y}$$

$$\vec{F}^{net}_{on\,c} = m_c \vec{a}_c \Rightarrow \vec{a}_c = \left[\frac{F_{1x}+F_{2x}+F_{3x}}{m_c}\right]\hat{x} + \left[\frac{F_{1y}+F_{2y}+F_{3y}}{m_c}\right]\hat{y} = a_x \hat{x} + a_y \hat{y}$$

$$\vec{d} = (x-x_0)\hat{x} + (y-y_0)\hat{y} = d_x \hat{x} + d_y \hat{y} \quad (\text{let } x_0 = y_0 = z_0 \equiv 0)$$

$$W^{net}_c = \vec{F}^{net}_c \cdot \vec{d}$$

$$= F^{net}_x d_x + F^{net}_y d_y$$

$$= m a_x (x-x_0) + m a_y (y-y_0)$$

CONSTANT FORCE $\Rightarrow$ CONSTANT ACCELERATION

$\Rightarrow$ Eq^{n}s OF UNIFORMLY ACCELERATED MOTION

$$v_{xf}^2 = v_{x0}^2 + 2a_x(x-x_0) \quad \& \quad v_{yf}^2 = v_{y0}^2 + 2a_y(y-y_0)$$

$$W^{net}_c = m\left[\left(v_{xf}^2 - v_{x0}^2\right)/2(x-x_0)\right](x-x_0) + m\left[\left(v_{yf}^2 - v_{y0}^2\right)/2(y-y_0)\right](y-y_0)$$

$$= \frac{1}{2}m\left[v_{xf}^2 + v_{yf}^2\right] - \frac{1}{2}m\left[v_{x0}^2 + v_{y0}^2\right]$$

$$= \frac{1}{2}m v_f^2 - \frac{1}{2}m v_i^2$$

$$= K_f - K_i$$

$$= \Delta K$$

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