solution to Problem

••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?

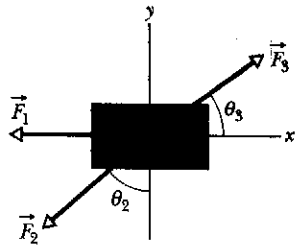


FIG. 7-30 Problem 16.

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

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

The Displacement of the Canister is:

$$\vec{d} = \vec{d}_{oc} + \vec{v}_{oc}t + \frac{1}{2}\vec{a}_c t^2 \quad \text{since by N'2}^{Nd}\text{ Law:}$$

$$\vec{F}^{net}_c = m_c \vec{a}_c \Rightarrow \vec{a}_c = \vec{F}^{net}_c / m_c = \text{constant}$$

take $\vec{d}_{oc} \equiv 0$ & given $\vec{v}_{oc} \equiv 0$ & $\vec{a}_c = \vec{F}^{net}_c / m_c$

$$\vec{d} = \frac{1}{2}\frac{\vec{F}^{net}_c}{m_c} t^2$$

NOTE THAT THE DISPLACEMENT IS IN THE SAME DIRECTION AS THE FORCE

$$\vec{F}^{net}_{on\,c} = (F_{1x} + F_{2x} + F_{3x})\hat{x} + (F_{1y} + F_{2y} + F_{3y})\hat{y}$$

$$= (F_1\cos\theta_1 + F_2\cos\theta_2 + F_3\cos\theta_3)\hat{x} + (F_1\sin\theta_1 + F_2\sin\theta_2 + F_3\cos\theta_3)\hat{y}$$

$$= (3\cos 180 + 4\cos 220 + 10\cos 35)\hat{x} + (3\sin 180 + 4\sin 220 + 10\sin 35)\hat{y}$$

$$= 2.13\hat{x} + 3.16\hat{y} \Rightarrow F = \sqrt{F_x^2 + F_y^2} = 3.81\text{ N}$$

Direction is in the 1ST quadrant $\Rightarrow \theta = \tan^{-1}\frac{F_y}{F_x}$

$$\theta = \arctan\left(3.16/2.13\right) = 56.0°$$

$$W^{net}_{on\,canister} = \vec{F}^{net}_c \cdot \vec{d}_c = F^{net}_c d_c \quad (\cos 0 = 1)$$

$$= (3.81\text{N})4\text{m} = 15.2\,(\text{Nm} = \text{Joules})$$

THIS PROBLEM WAS IN THE SECTION WORK & KINETIC ENERGY

$\Rightarrow$ USE WORK-ENERGY THEOREM: $W_{net} = \Delta K$

$$\Rightarrow 15.2\text{ Joules} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2 - 0$$

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