24.3: Case II- Constant force at an angle to the direction of motion

Now let's look at a more general case. Suppose the applied force $\mathbf{F}$ is still constant, but not necessarily in the direction of motion. Then the work W done by the force is equal to the component of $\mathbf{F}$ that's in the direction of motion times the distance over which the force is applied. We can write this using the dot product:

$$W = \mathbf{F} \cdot \mathbf{r} \tag{24.3.1}$$

where $\mathbf{r}$ is a vector in the direction of motion, whose magnitude is equal to the distance over which the force is applied.

Example 24.3.1

Suppose a constant force $\mathbf{F}$ of magnitude $F = 60\ \text{N}$ acting 30° from the horizontal is applied to a box sitting on the floor for a horizontal distance of $12\ \text{m}$. How much work is done?

Solution

Then the work done by the force is $W = \mathbf{F} \cdot \mathbf{r} = Fr\cos\theta = (60\ \text{N})(12\ \text{m})\,(\cos 30^\circ) = 623.5\ \text{J}$.