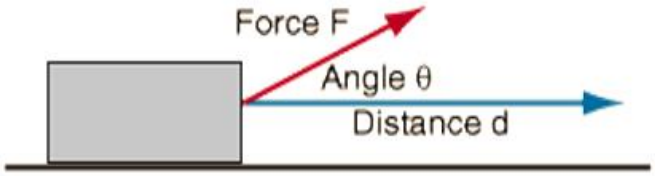
## Answer on Question #43395, Physics, Mechanics | Kinematics | Dynamics

A block is sliding on a horizontal frictionless surface at a velocity of 12.0 m/s (E). A force of 25.0 N(S) acts on the block, causing it to accelerate to a velocity of 45.0 m/s (45 degree S of E). If the mass of the block is 7.50 kg, what is the work done by the force on the block?

**Solution:**

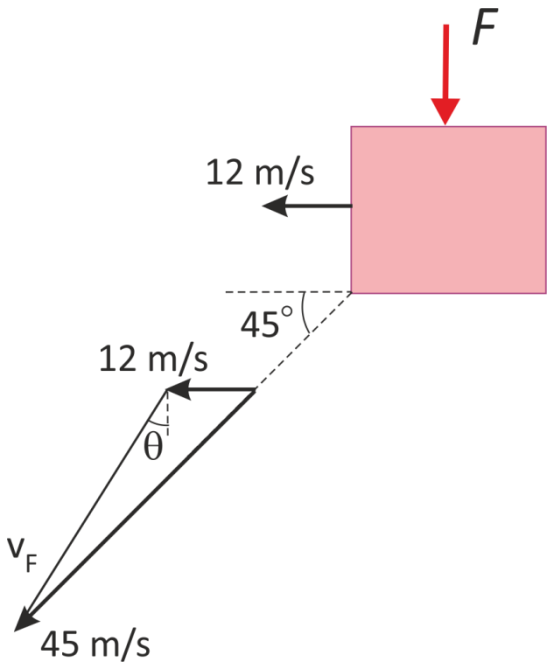
In order to accomplish work on an object there must be a force exerted on the object and it must move in the direction of the force.




Work = Force * distance moved in direction of force

$$W = F \cdot \cos\theta \cdot d$$

In our case:




I give the formula for the Law of Cosines and use it to find the missing side length of a triangle.

$$c^2 = a^2 + b^2 - 2ab\cos\gamma$$

In our notations the final velocity of the block caused of the force action $v_F$ is:

$$v_F^2 = 45^2 + 12^2 - 2 \cdot 45 \cdot 12 \cdot \cos(45°) = 1405$$

$$v_F = \sqrt{1405} = 37.48 \text{ m/s}$$

The force case causes to change the velocity from zero to $37.48\ \mathrm{m/s}$ on direction at angle θ.

To find angle θ we again use the Law of Cosines:

$$45^2 = 37.48^2 + 12^2 - 2 \cdot 37.48 \cdot 12 \cdot \cos(\theta + 90°)$$

$$\cos(\theta + 90°) = \frac{37.48^2 + 12^2 - 45^2}{2 \cdot 37.48 \cdot 12} = -0.52945$$

$$\theta + 90° = \cos^{-1}(-0.52945) = 122°$$

$$\theta = 32°$$

The work is

$$W = F \cdot \cos\theta \cdot d$$

The kinematic equation that describes an object's motion is:

$$v_f^2 = 2ad$$

The symbol *d* stands for the displacement of the object. The symbol *a* stands for the acceleration of the object.

$$a = \frac{F \cdot \cos\theta}{m}$$

$$d = \frac{v_f^2}{2a} = \frac{v_f^2 m}{2F \cdot \cos\theta}$$

Thus,

$$W = \frac{mv_f^2}{2} = \frac{7.50 \cdot 37.48^2}{2} = 5267.8\ \mathrm{J}$$

**Answer:** $W = 5267.8\ \mathrm{J}$.