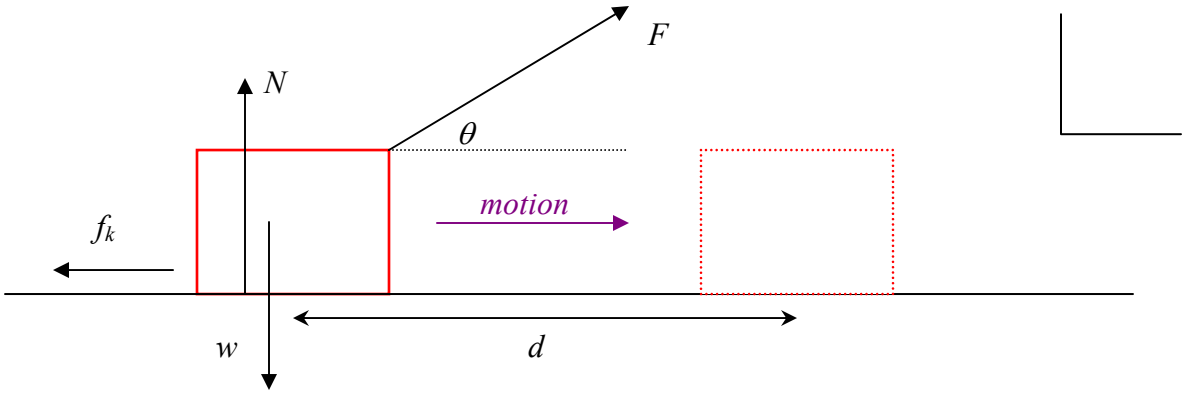
Work done on a box by external forces



* What is the work done on the box by external forces if it moves at a constant speed v_o and:

$d = 250\ m$	$\mu_k = 0.2$
$m = 210\ kg$	$\theta = 10^o$

For this problem, we will find the net force acting on the box in the direction of motion and then use $W = \vec{F}_{net} \cdot \vec{d}$.

To find $\mathbf{F}_{net}$ in the direction of motion, use Newton's Laws:

$\sum F_x = 0$ (*moves @ constant speed → a = 0*)

$F\cos\theta - f_k = 0$

$\sum F_y = 0$ (*no vertical motion*)

$N - w + F\sin\theta = 0$

$N = mg - F\sin\theta$

Using $f_k = \mu_k N$

→ $F\cos\theta - \mu_k(mg - F\sin\theta) = 0$

$$F = \frac{\mu_k mg}{\cos\theta + \mu_k \sin\theta}$$

Now that we know the net force, the work done on the box can be calculated using:
$W = \vec{F}_{net} \cdot \vec{d}$

$$W = Fd\cos\theta$$

$$W = \left(\frac{\mu_k mg}{\cos\theta + \mu_k \sin\theta} \right) d\cos\theta$$

Inserting our numbers:

$$W = \left(\frac{(0.2)(210\ kg)\left(9.8\ \frac{m}{s^2}\right)}{\cos(10) + (0.2)\sin(10)} \right) (250\ m)\cos(10)$$

$$W = 99{,}000J$$