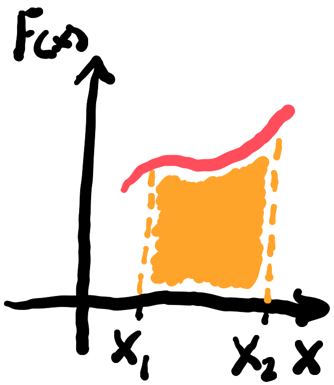
# Work:

## Work done by a constant force




$$W = \vec{F} \cdot \Delta \vec{x}$$

$$F = \frac{GMm}{r}$$

Unit: 1 joule=1Nm=1 Kg m$^2$/s$^2$

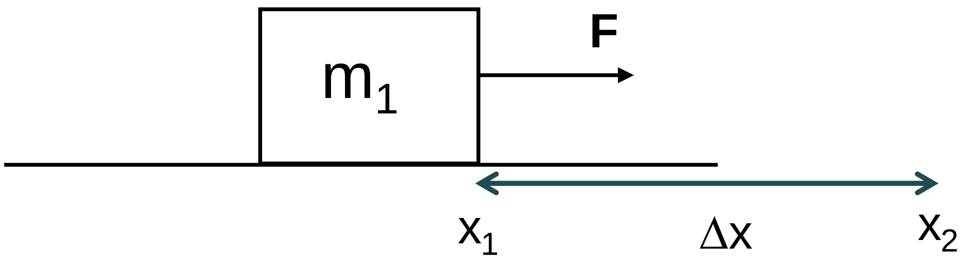

## Work done by a changing force

$$\vec{F} = \vec{F}(\vec{r}), \quad dW = \vec{F} \cdot d\vec{r}$$

$$1-\mathrm{dim}: \quad dW = F(x)dx \quad W = \int_1^2 F(x)dx$$

# ***Work done by constant forces***

The block is being pulled by F.
The block is initially stationary at $x_1$.




$F = 20$ N, $\mu_k = 0$, $m_1 = 5.0$ kg, $\Delta x = 5$ m

What is the work done by *F, N, and $m_1 g$?*

$W_F = F \cdot \Delta x$

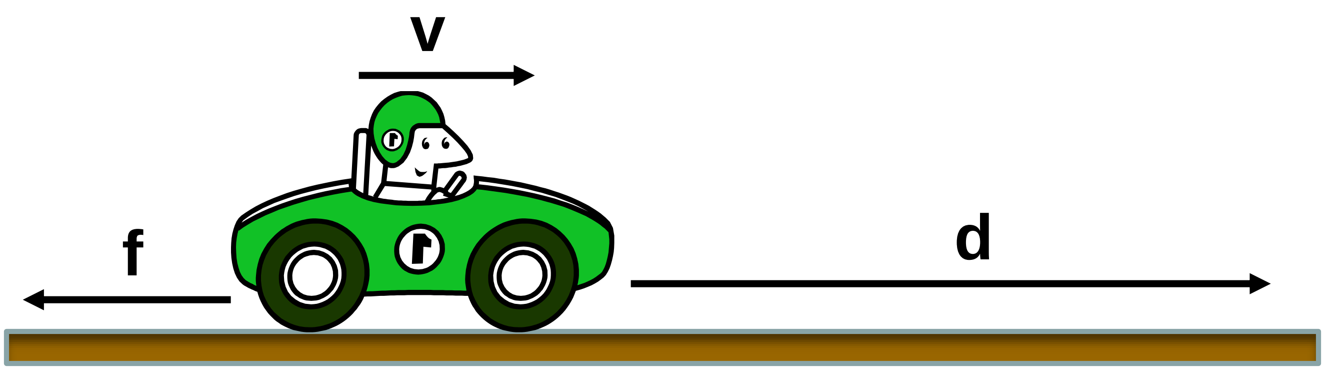
$= 20 \cdot 5$

$W_F = 100$ J

$W_N = N \cdot \Delta x = 0$

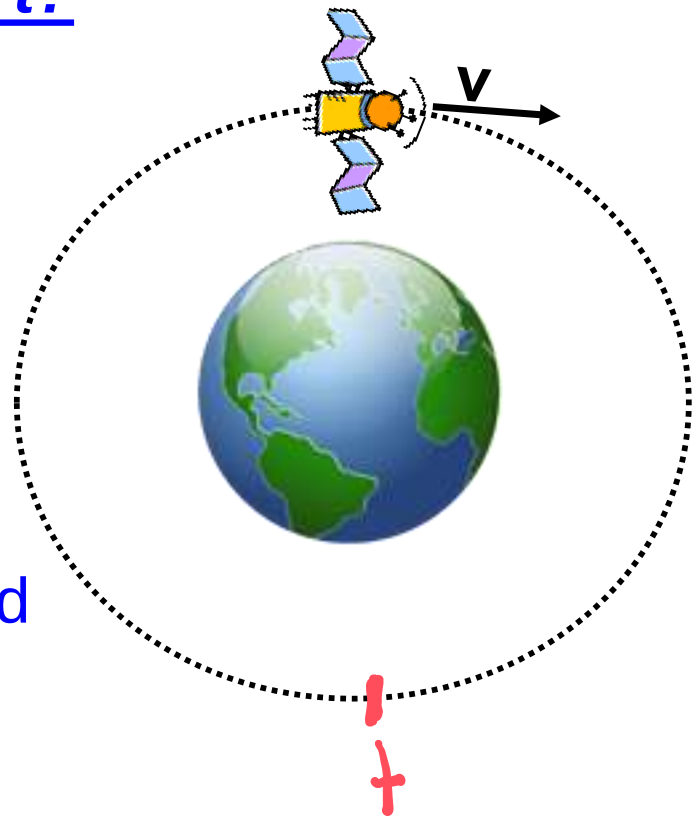
$W_{mg} = w \cdot \Delta x = 0$

A car traveling to the right with a speed v brakes to a stop in a distance d. What is the work done on the car by the frictional force f? (Assume that the frictional force is constant).




1. W = f*d
2. W = -f*d
3. W = 0
4. W = f*v
5. W = -f*v

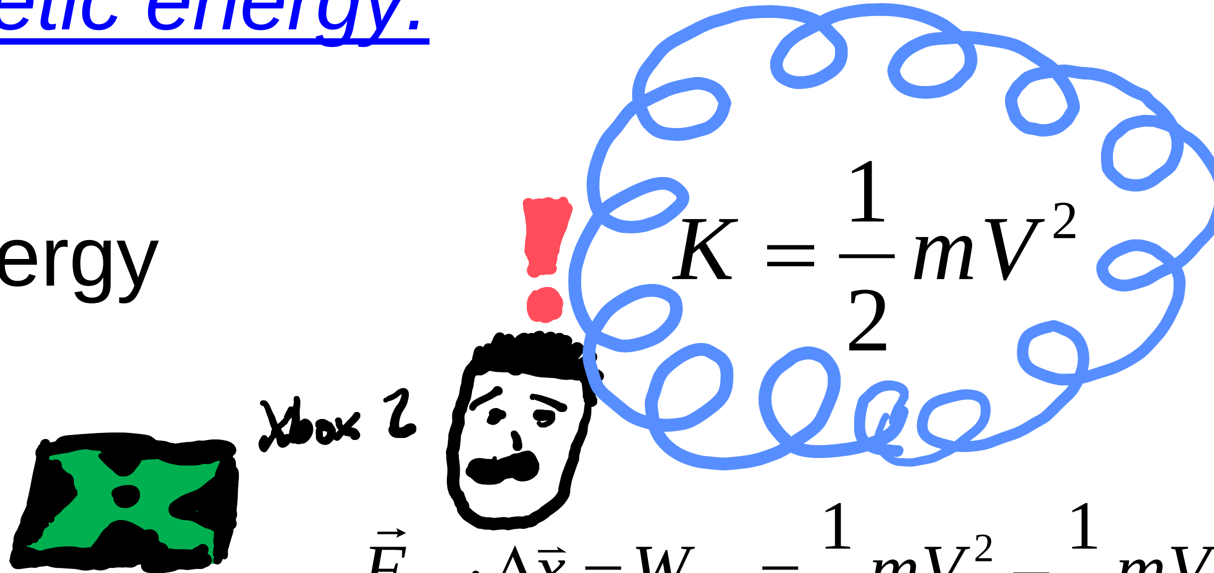
A satellite travels with a constant speed **|v|** as it moves around a circle centered on the earth. How much work is done by the gravitational force F on the satellite ***<u>after it travels half way around the earth in time t?</u>***




1. Cannot be determined
2. W = 0
3. W = F * |v|t
4. W = -F * |v|t

# Work and Kinetic energy:

Kinetic Energy




$$\vec{F}_{net} = m\vec{a}$$

$$V_f^2 - V_0^2 = 2\vec{a} \cdot \Delta\vec{x}$$

$$V_f^2 - V_0^2 = 2\frac{\vec{F}_{net} \cdot \Delta\vec{x}}{m}$$

$$\vec{F}_{net} \cdot \Delta\vec{x} = \frac{1}{2} m (V_f^2 - V_0^2)$$

$$= \frac{1}{2} m V_f^2 - \frac{1}{2} m V_0^2 = K_f - K_0$$

$$\vec{F}_{net} \cdot \Delta\vec{x} = W_{net} = \frac{1}{2} m V_f^2 - \frac{1}{2} m V_0^2$$

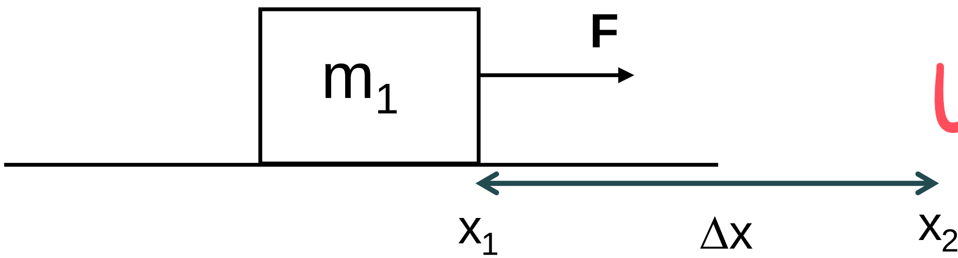
$$= K_f - K_0$$

$$W_{net} = K_f - K_0 = \Delta K$$

Work done by the net force on an object equals the change of its kinetic energy.

# Work done by constant forces

The block is being pulled by F.
The block is initially stationary at $x_1$.




$F=20$ N, $\mu_k=0.2$, $m_1=5.0$kg, $\Delta x=5$ m

What is the work done by *F, f, and* $F_{net}$?

What is the speed at $x_2$

$K = \frac{1}{2} m v^2$

$W_F = Fd = 100\,J$

$W_f = -fd = -\mu N d$

$= -\mu m g d$

$= -0.2 \cdot 5 \cdot 10 \cdot 5$

$= -50\,J$

$W_{net} = W_F - W_f$

$= 100 - 50 = 50\,J$

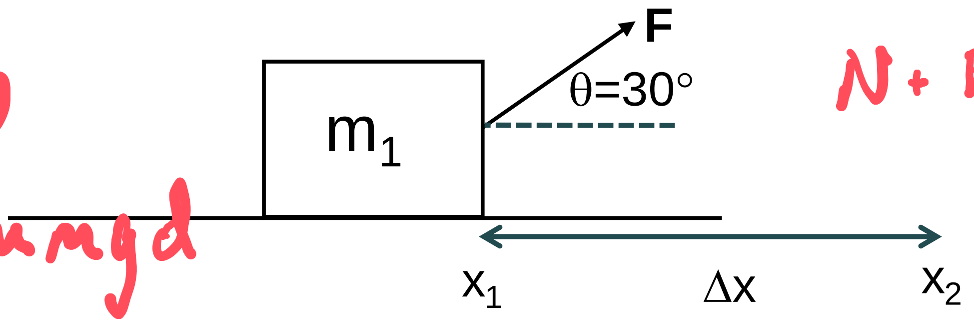
$F_{net} = F - f = 20 - .2 \times 5 \times 10 \times 5$

$= 10\,N$

$W_{net} = F_{net} \cdot d = 10 \cdot 5 = 50 J$

$W_{net} = \frac{1}{2}mv^2 \rightarrow 50 = \frac{1}{2} \times 5 \times v^2 \rightarrow \boxed{v = \sqrt{20}\ m/s}$

The block is being pushed by F.
The block is initially stationary at $x_1$.




$N + F\sin\theta = mg$

$W_F = Fd\cos\theta$

$W_f = -fd = -\mu mgd$

$F_{net} = F - f$

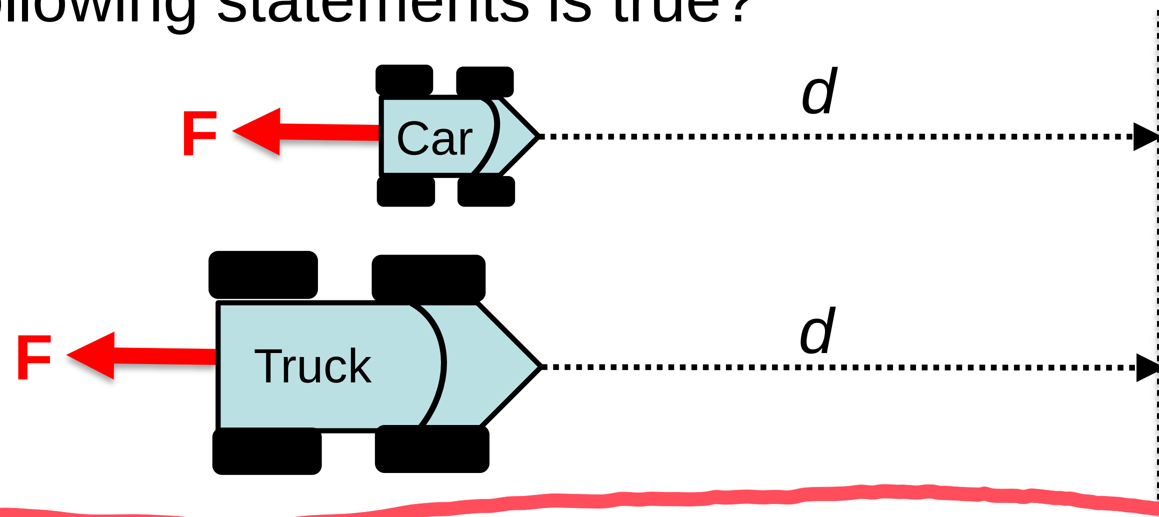
$W_{net} = F_{net} \cdot d$

$F=20$ N, $\mu_k=0.2$, $m_1=5.0$kg, $\Delta x=5$ m

What is the work done by *F, f, and $F_{net}$?*

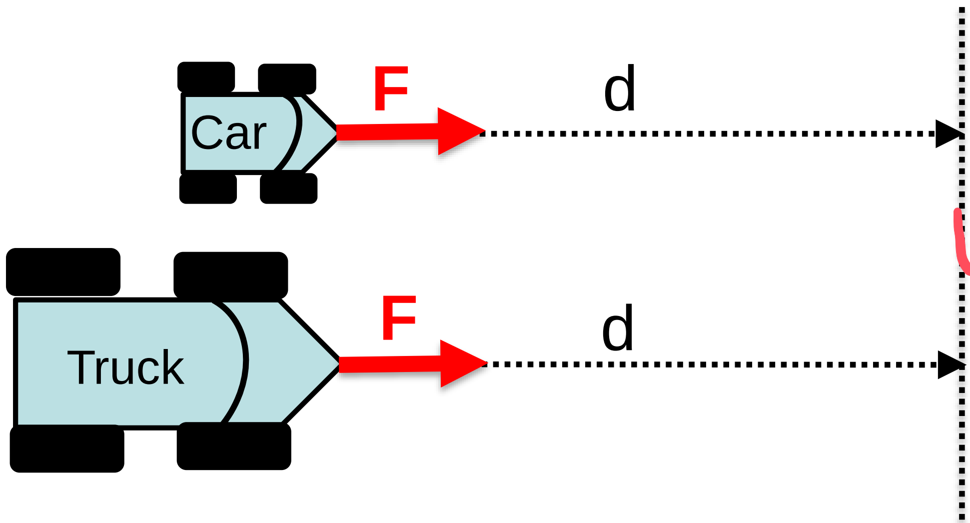
What is the speed at $x_2$

A lighter car and a heavier truck, each traveling to the right with the same speed v, hit the brakes. The retarding frictional force F on both cars turns out to be the same constant. After both vehicles travel a distance *d* (and both are still moving), which of the following statements is true?




1. The work done by F on both vehicles is the same.
2. They will have the same final velocity.
3. They will have the same final kinetic energy
4. They will traverse the distance d in the same time.

A lighter car and a heavier truck, each initially at rest, have the same constant **netforce** F applied on them. After both vehicles travel a distance d, which of the following statements is true? (Ignore friction)




$W_{net} = \Delta K = \frac{1}{2}mv^2$

1. They will traverse the distance d in the same time.
2. They will have the same final velocity.
3. They will have the same final kinetic energy
4. There's not enough information to answer.