What is the "work-energy theorem" and how can we use it to solve problems?

Work is something that is done on an object.

Energy is something that objects have.

\[ W = Fx = (ma) x \]

\[ \frac{V_f^2 - V_o^2}{2a} = \frac{V_f^2 - V_o^2}{2a} \]

\[ W = m(\frac{V_f^2 - V_o^2}{2a})x = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_o^2 \]

Energy of motion, \( KE \), cannot be negative.

The net work done on an object by all the forces acting on it is equal to the change in kinetic energy of the object.

Work is a measure of the transfer of kinetic energy.

A 10.0 kg shopping cart is pushed from rest by a 250.0 N force against a 50.0 N frictional force over a 10.0 m distance.
a) How much work is done by each force on the cart?

\[ W = F \cdot x = 250 \cdot 10 = 2500 \text{ J} \]

\[ W = -50 \cdot 10 = -500 \text{ J} \] (in opposite direction)

\[ \text{net} = 2000 \text{ J} \]

b) How much kinetic energy has the cart gained?

2000 J

c) What is the cart’s final speed?

20 m/s

\[ W = \frac{1}{2} m v_f^2 \]

\[ 2000 = \frac{1}{2} (10) v_f^2 \]

\[ v_f = 20 \]

A 10.0 kg crate is pulled up a rough incline with an initial speed of 1.5 m/s. The pulling force is 100.0 N parallel to the incline, which makes an angle of 15.0 degrees with the horizontal. Assuming the coefficient of friction is 0.40 and the crate is pulled a distance of 7.5 m, find the following:
a.) the work done by the Earth's gravity on the crate.

\[ W_{\text{grav}} = F_g d \cos \theta = mg (\sin 15°) \cdot d \cdot \cos 180° \]

\[ = 10 \text{kg} \cdot 9.8 \text{m/s}^2 \cdot \sin 15° \cdot 2.5 \text{m} \cdot \cos 180° \]

\[ = -190.5 \text{ J} \]

b.) the work done by the force of friction on the crate.

\[ W_f = F_f d \cos \theta = \mu_k F_N d = \mu_k (mg \cos 15°) (7.5 \text{ m}) (\cos 180°) \]

\[ = 0.4 \cdot 10 \text{ kg} \cdot 9.8 \text{ m/s}^2 \cdot \cos 15° \cdot 7.5 \text{ m} \cdot \cos 180° \]

\[ = -284.5 \text{ J} \]

c.) the work done by the puller on the crate:

\[ W_{\text{app}} = F_{\text{app}} d \cos 0° = 1000 \text{ N} \cdot 7.5 \text{ m} \cdot 1 \]

\[ = 7500 \text{ J} \]

d.) The change in kinetic energy of the crate

\[ \Delta KE = 7500 - 284.5 - 190.5 \]

\[ = 6925 \text{ J} \]

e.) the speed of the crate after it is pulled 7.5 m

\[ KE_i = \frac{1}{2} m v_i^2 = \frac{1}{2} \cdot 10 \text{ kg} \cdot (1.5 \text{ m/s})^2 = 11.25 \text{ J} \]

net work = 276.5 J

\[ KE_f = 11.25 + 276.5 = 287.85 \text{ J} \]

\[ v = \frac{1}{\sqrt{m}} \sqrt{\frac{KE_f}{m}} = \sqrt{\frac{287.85}{10}} = 7.58 \text{ m/s} \]
(ME) Mechanical Energy = kinetic energy & all forms of potential energy in a problem

Gravitational elastic

\[
\begin{align*}
\text{initial condition} & \quad \text{final} \\
K + U_g + U_{elas} & = K + U_g + U_{elas} \quad \text{if no work is done}
\end{align*}
\]

3-12-2015

Potential

Work & Energy Quiz tomorrow

~25 pts.

- including "slant on work" & "Spring into Action"

Force:

\[
-\frac{\text{ax}}{\text{Hookes spring}}
\]