Work-Energy Theorem Notes

https://www.brightstorm.com/science/physics/energy-and-momentum/work-energy-theorem/

Definition:

Work-Energy Theorem- The net work on an object causes a change in the kinetic energy (KE) of the object.

Looking at the formulas:

$$W = \Delta KE$$

① $W = KE_f - KE_i$

② $W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

③ $Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

Looking at the units:

Units for $W = J$ Units for Energy $= J$

$J = J$

$1\ Nm = 1\ J = 1\ \frac{kgm^2}{s^2}$

Practice problems:

1. What is the net work required to accelerate a 3kg object from 2 m/s to 4 m/s?

Formula: $W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

Plug in numbers:

$W = \frac{1}{2}(3kg)(4m/s)^2 - \frac{1}{2}(3kg)(2m/s)^2$

$W = 24\ \frac{kgm^2}{s^2} - 6\ \frac{kgm^2}{s^2}$

Answer:

$W = 18\ \frac{kgm^2}{s^2} = \boxed{18J}$

2. What is the net work required to accelerate a 10 kg object from 8m/s to 14 m/s?

Formula: $W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

Plug in numbers:

$$W = \frac{1}{2}(10\text{kg})(14\text{m/s})^2 - \frac{1}{2}(10\text{kg})(8\text{m/s})^2$$

$$980\frac{\text{kgm}^2}{\text{s}^2} - 320\frac{\text{kgm}^2}{\text{s}^2}$$

Answer: $W = 660\text{ J}$

3. What is the force required to move a 12kg object from 4m/s to 6m/s a distance of 2 meters?

Formula: $Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

Plug in numbers:

$$F(2\text{m}) = \frac{1}{2}(12\text{kg})(6\text{m/s})^2 - \frac{1}{2}(12\text{kg})(4\text{m/s})^2$$

$$216\frac{\text{kgm}^2}{\text{s}^2} - 96\frac{\text{kgm}^2}{\text{s}^2}$$

$$\frac{(F)(2\text{m})}{2} = \frac{120}{2}$$

Answer: $F = 60\text{N}$

4. A 1500 kg car accelerates from rest to a velocity of 25m/s over a distance of 45 meters.

a. What is the change in kinetic energy?

$$\Delta KE = KE_f - KE_i$$

$$\Delta KE = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$\frac{1}{2}(1500\text{kg})(25\text{m/s})^2 - \frac{1}{2}(1500\text{kg})(0\text{m/s})^2$$

$\Delta KE = 468{,}750\text{ J}$

b. What is the work done on the car?

$W = \Delta KE$

$W = 468{,}750\text{ J}$

c. What is the net force applied to the car?

$W = Fd$

$$\frac{468{,}750\text{J}}{45} = \frac{F(45\text{m})}{45}$$

$F = 10{,}417\text{ N}$