Work and Energy

Recap

Kinetic energy

- ★ Energy in motion
- ★ K=$\frac{1}{2}mv^2$
    - ○ Scalar not a vector
    - ○ Units: J
    - ○ Never negative always positive

Work

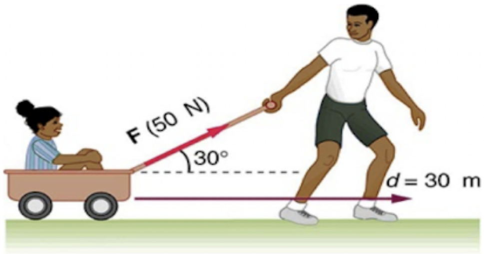
- ★ The product of the component of the forces in the direction of motion
- ★ w=Fdcosθ
    - ○ Units: J
    - ○ Can be negative
    - ○ Centripetal force does not do work

Work Energy Theorem

- ★ Net Work= change in kinetic

Practice

How much work is done by the boy pulling his sister 30.0 m in a wagon as shown in the figure? Assume no friction acts on the wagon.
Link to the Video on how to solve



$d = 30m$ $F = 50$ $\theta = 30°$

$\vec{w} = Fd\cos\theta$

$w = 50 \cdot 30 \cdot \cos 30° = 1299.03$

$\approx 1.30 \times 10^3 J$

Using energy considerations, calculate the average force a 60.0-kg sprinter exerts backward on the track to accelerate from 2.00 to 8.00 m/s in a distance of 25.0 m, if he encounters a headwind that exerts an average force of 30.0 N against him. Link to the video on how to solve

$m = 60kg$ $v_i = 2.00 m/s$ $v_f = 8.0 m/s$ $d = 8m$ $\theta = 0°$

$W = \Delta KE$ $W = Fd\overset{1}{\cancel{\cos\theta}}$

$$F = \frac{W}{d} = \frac{\Delta KE}{d} = \frac{m \Delta v^2}{2} = \frac{60kg(8^2 m/s - 2 m^2/s)}{2 \cdot 25m} = 72N$$

$F_a = ?$

$\sum F_x = F$

$F_a - F_{avg} = F$

$F_a = F + F_{avg} = 72N + 30N = 102N$

A car's bumper is designed to withstand a 4.0 km/h (1.12-m/s) collision with an immovable object without damage to the body of the car. The bumper cushions the shock by absorbing the force over a distance. Calculate the magnitude of the average force on a bumper that collapses 0.200 m while bringing a 900-kg car to rest from an initial speed of 1.12 m/s
Link to the video on how to solve

$m = 900 kg$ $v_0 = 1.12 \, m/s$ $v_f = 0 \, m/s$ $\Delta x = .200 m$

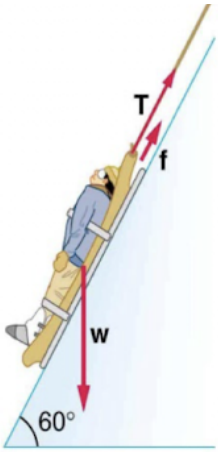
$\Delta KE = \cancel{\frac{1}{2}mv_f^2}^{\,0} - \frac{1}{2}mv_i$

$= -\frac{1}{2}\cdot 900 \cdot 1.12 = -564.48 J$

$F = \frac{\Delta KE}{\Delta x} = \frac{-564.48}{.20}$

$= -2822.4 N$

Suppose the ski patrol lowers a rescue sled and victim, having a total mass of 90.0 kg, down a 60.0º slope at constant speed, as shown in the figure.
The coefficient of friction between the sled and the snow is 0.100. (a) How much work is done by friction as the sled moves 30.0 m along the hill? (b) How much work is done by the rope on the sled in this distance? (c) What is the work done by the gravitational force on the sled? (d) What is the total work done? Link to the video on how to solve



$m = 90.0 kg$ $\theta = 60°$ $f = .100$

ⓐ $f = \mu N \longrightarrow N = mg\cos\theta = 90 \cdot 9.8 \cdot \cos 60° = 441 N$

$f = .1 \cdot 441 = 44.1 N$ $W_f = fd\cos(180) = 44.1 \cdot 30 \cdot \cos(180°) = -1323$

ⓑ $T = ?$ $T + f - mg\sin\theta = 0 \longrightarrow T = mg\sin\theta - f$

$W_T = Td\cos(180°)$ $= 90 \cdot 9.8 \cdot \sin 60° - 44.1N = 719.4 N$

$= 719.4 \cdot 30 \cdot \cos 180° = -21582 J$

ⓒ $W_g = mgd(\cos 90° - \theta) = 90 \cdot 9.8 \cdot 30 \cdot \cos(90-60) = 22905$

ⓓ $W_{tot} = W_f + W_T + W_g = -1323 - 21582 + 22905 = 0 J$