

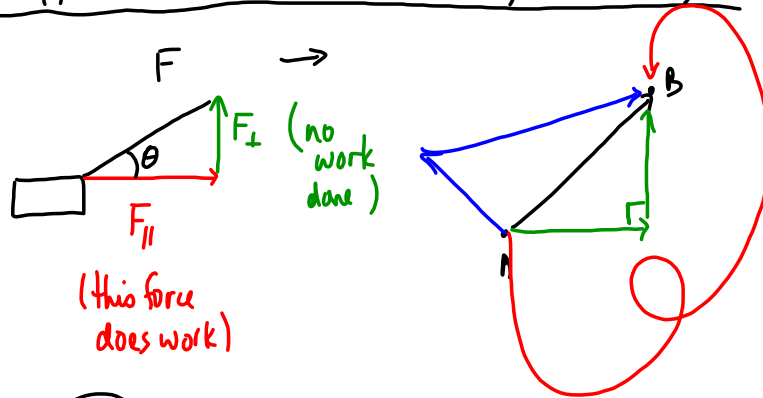
Work

The transfer of energy to an object by applying a force* during the object's movement.

$$W = F_{||} \Delta d$$

* must be in the direction of the displacement.

What happens when the force is acting at an angle?



SOH (CAH) TOA

$$\cos \theta = \frac{\text{adj}}{\text{hyp}}$$

$$\cos \theta = \frac{F_{||}}{F}$$

$$W = F_{||} \Delta d$$

$$W = (F \cos \theta) \Delta d$$

$$W = F \Delta d \cos \theta$$

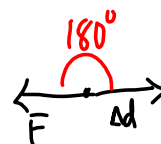
$$F_{||} = F \cos \theta$$

← when $\theta \neq 0^\circ$ (i.e. that F is not parallel to Δd)

$\theta = 0^\circ \rightarrow$ maximum work
($\cos 0^\circ = 1$)

$\theta = 90^\circ \rightarrow$ zero work
($\cos 90^\circ = 0$)

$\theta = 180^\circ \rightarrow$ negative work
($\cos 180^\circ = -1$)



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$$F_g = 6.50 \times 10^2 \text{ N}$$

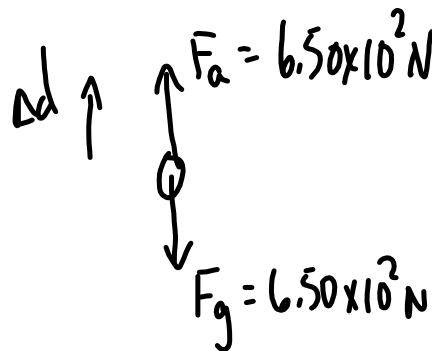
$$\Delta d = 0.55 \text{ m}$$

a) $W = ?$ (lifting)

b) $W = ?$ (lowered)

(assume that the motion is at constant velocity)

a) lifting

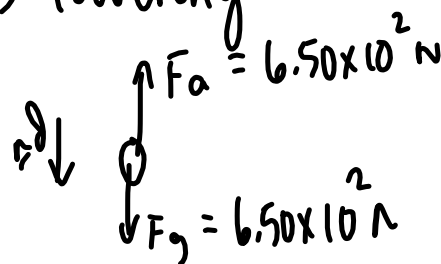


$$W = F_{\parallel} \Delta d$$

$$W = (6.50 \times 10^2 \text{ N})(0.55 \text{ m})$$

$$W = 3.6 \times 10^2 \text{ J}$$

b) lowering



$$W = F \Delta d \cos \theta$$

$$W = (6.50 \times 10^2 \text{ N})(0.55 \text{ m})(\cos 180^\circ)$$

$$W = -3.6 \times 10^2 \text{ J}$$

Example

Calculate the work done by a horse that exerts an applied force of 100N on a sleigh, if the harness makes an angle of 30° with the ground, and the sleigh moves 30m across a flat, level ice surface.

$$F = 100\text{N}$$

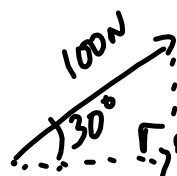
$$\Delta d = 30\text{m}$$

$$\theta = 30^\circ$$

$$W = F \Delta d \cos \theta$$

$$W = (100\text{N})(30\text{m})(\cos 30^\circ)$$

$$W = 2.6 \times 10^3 \text{ J}$$



$$1\text{J} = 1\text{N}\cdot\text{m}$$

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