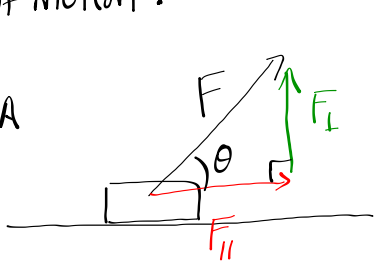
Work

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

F and Δd are in the same direction.

What happens if the force does not act in the direction of motion?



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

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

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

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

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

$\boxed{W = F\Delta d\cos\theta}$

Work is a maximum for $\theta = 0^\circ$ $(\cos 0^\circ = 1)$

Work is zero for $\theta = 90^\circ$ $(\cos 90^\circ = 0)$

Work is negative is $\theta = 180^\circ$ $(\cos 180^\circ = -1)$

MP/233

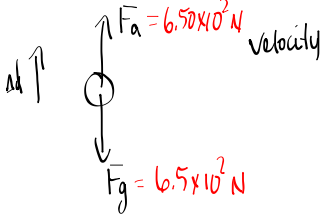
$F_g = 6.50 \times 10^2 N$

$\Delta d = 0.55m$

a) $W = ?$ (when lifting)

b) $W = ?$ (when lowering)

Draw a FBD (lifting) - constant velocity



Since F_a is in the same direction as Δd:

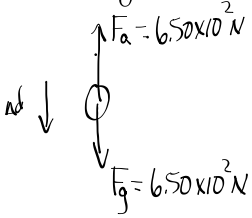
$W = F_{||} \Delta d$

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

$W = +3.6 \times 10^2 J$

↑ positive

Lowering:



Since F_a and Δd are NOT in the same direction!

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

$W = (6.50 \times 10^2 N)(0.55m)\cos 180^\circ$ ← -1

$W = -3.6 \times 10^2 J$

↑ negative work.

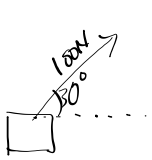
Example

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.

$F = 100N$

$\theta = 30^\circ$

$\Delta d = 30m$



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

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

$W = 2.6 \times 10^3 J$

TODO

① PP/235

② See Webpage