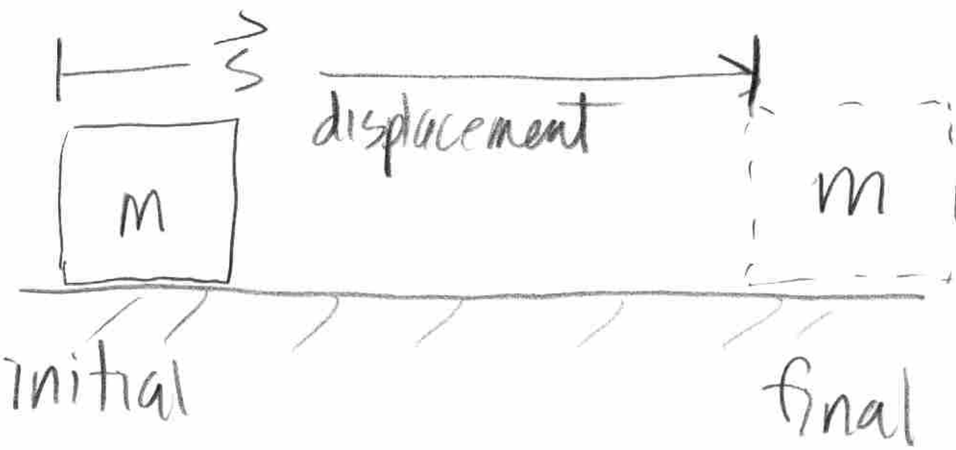
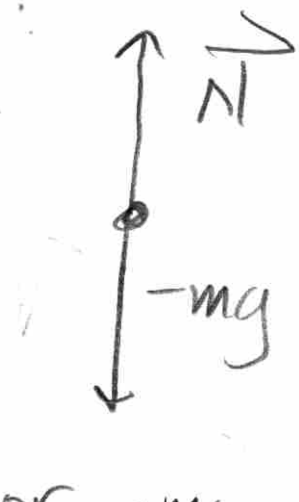
Work W in physics

Need: • force acting on a body
• displacement of that body IN THE DIRECTION OF THAT FORCE.



Force diagram:



$$N - mg = 0$$
$$N = mg$$

Neither $\vec{N}$ nor $-mg$ do any work, because the displacement $\vec{s}$ is $\perp$ to these forces.

IF a <u>horizontal</u> force $\vec{F}$ did act on the mass,

$W = Fs \Rightarrow$ units? $N \cdot m$

assume: F constant

or $\frac{kg\, m^2}{s^2}$

or mass × (velocity)^2

⇒ "Energy"

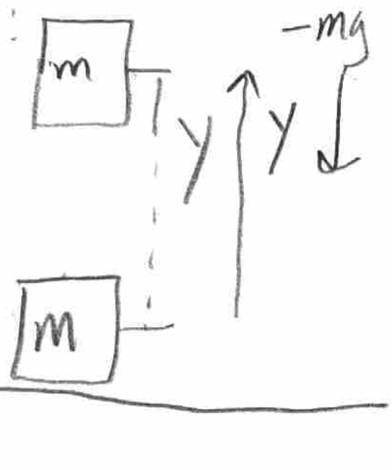
$1 \frac{kg \cdot m^2}{s^2} = 1$ Joule

What good is W? <u>Change</u> in Energy

Impulse $\vec{I}$? <u>Change</u> in Momentum

Focus on calculating W

<u>Vertical</u>:

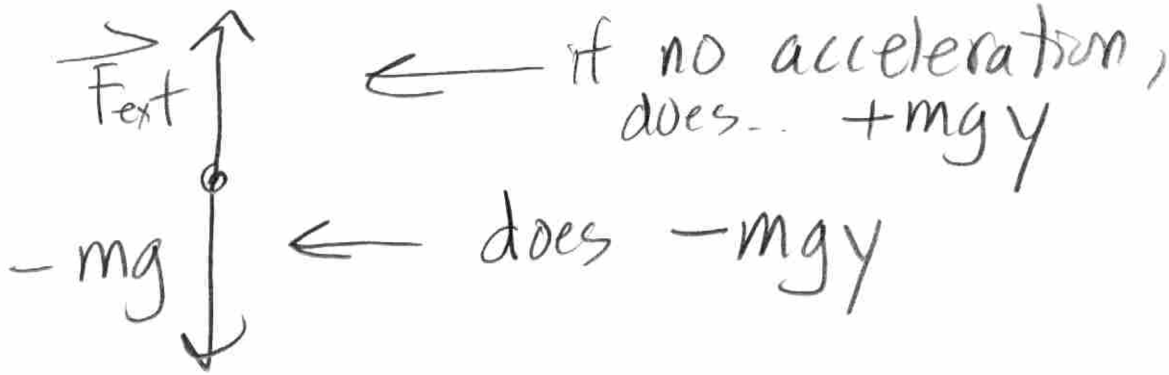


gravity...

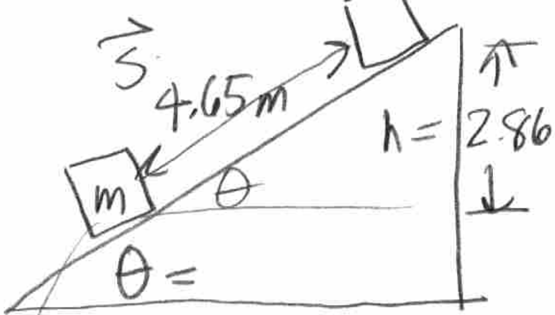
<u>gravity</u>:

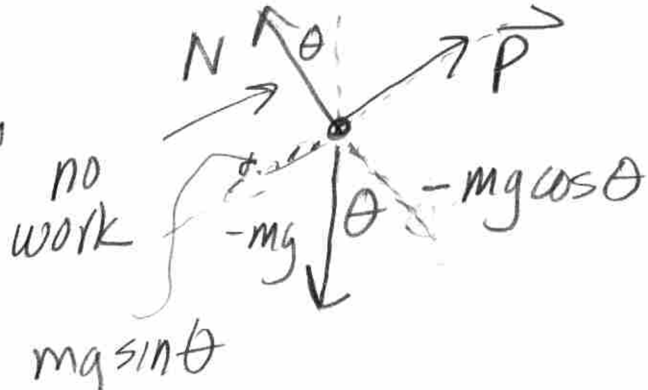
$W = -mgy$

<u>other</u> <u>entity</u> <u>moved it</u>



Up a frictionless incline (p.133 RHK4)





$m = 11.7\,kg$

$$P - mg\sin\theta = 0$$

$$P = mg\sin\theta \qquad \sin\theta = h/s$$

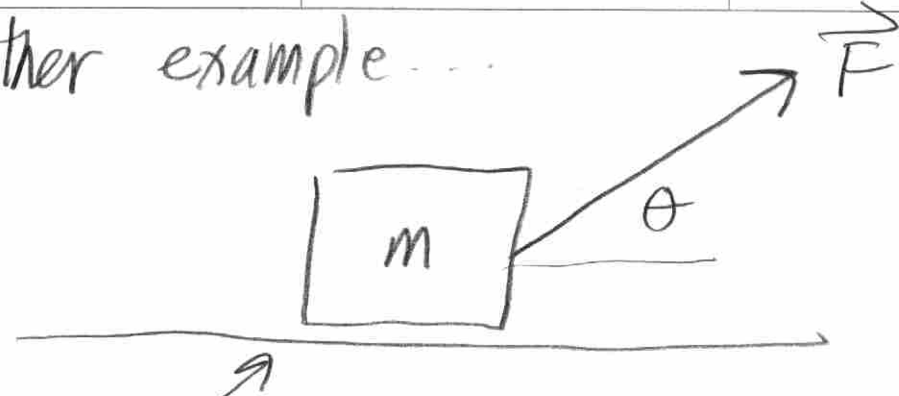
$$W = Ps = mgs\sin\theta = mgh$$

$$= 11.7 \cdot 9.8 \cdot 4.65 \cdot \left(\frac{2.86}{4.65}\right)$$

$$= 11.7 \cdot 9.8 \cdot 2.86 = 328\,J$$

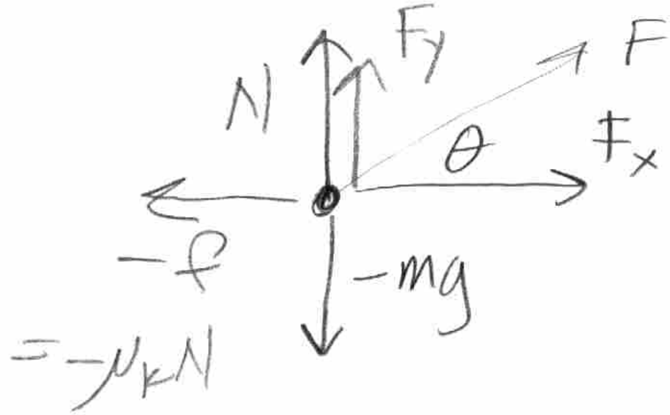
...hmm... mgh reappeared! Like lifting block... first appearance of path independence! ⌋ = ✓

Another example...



friction: μ_k

trick: $\vec{F}$ in this case reduces $\vec{N}$!



No acceleration...

$$F_x - f = 0 \qquad F_x = F\cos\theta$$

$$N + F_y - mg = 0 \qquad F_y = F\sin\theta$$

$$F\cos\theta = \mu_k N \Rightarrow F = \frac{\mu_k N}{\cos\theta}$$

$$N + N\mu_k \tan\theta - mg = 0$$

$$N = \frac{mg}{1 + \mu_k \tan\theta} \quad \begin{array}{l} = mg \ (\theta = 0) \\ < mg \ (\theta > 0 \end{array}$$

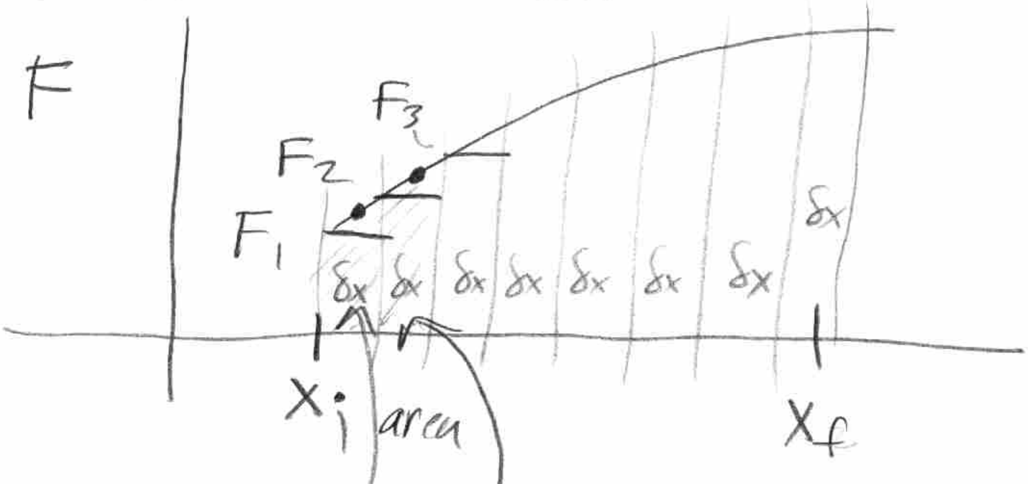
$$F_x = F\cos\theta = \left(\frac{\mu_k N}{\cos\theta}\right)\cos\theta = \mu_k N$$

$$F_x = \frac{\mu_k mg}{1 + \mu_k \tan\theta}$$

$$W = F_x s = \frac{\mu_k mgs}{1 + \mu_k \tan\theta}$$

When F is not constant

One Dimension



$$W = \delta W_1 + \delta W_2 + \delta W_3 + \ldots$$

$$= F_1 \delta x + F_2 \delta x + \ldots$$

$$= \left(\sum_{n=1}^{N} F_n\right)\delta x \quad \text{take limit}$$

$$W = \int_{x_i}^{x_f} F(x)\,dx$$