$$\int_{y_1}^{y_2} mg\,dy = mg(y_2 - y_1)$$

$$W = \int_{y_1}^{y_2} -mg\,dy = \underbrace{-mg(y_2 - y_1)}_{<0} = mg(y_1 - y_2)$$

$$= U_1 - U_2 = -(U_2 - U_1) = -\Delta U$$

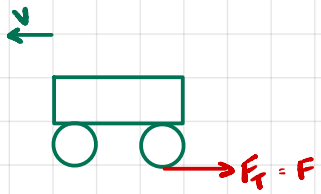
$$= K_2 - K_1$$

$$\Rightarrow U_1 + K_1 = K_2 + U_2$$

$$\int_{x_i}^{x_f} F\,dx = \int_{x_i}^{x_f} m\frac{dv}{dt}\,dx = \int_{v_i}^{v_f} mv\,dv = \frac{mv^2}{2}\Big|_{v_i}^{v_f}$$

$$\downarrow \hat{j} \quad W = \int_{y_1}^{y_2} mg\,dy = mg(y_2 - y_1) = \Delta U$$

$$\int mg\,dy = \int m\frac{dg}{dt}\,dy = \int mv\,dv$$



$$P_T = F_T \cdot v_T = 0$$

$v_T = 0$ because ground doesn't move?