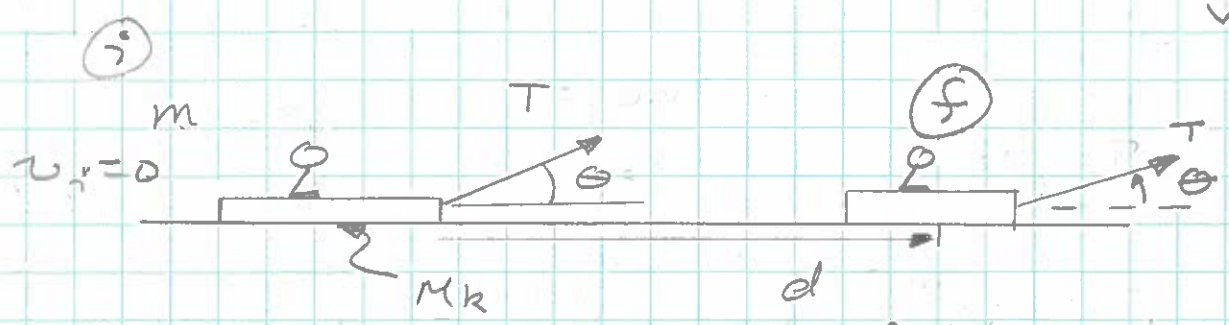


m = mass of child + sled.

Conserve energy i → f:

$$\Delta E_{mech} = \Delta K + \Delta U = W_{nc}$$

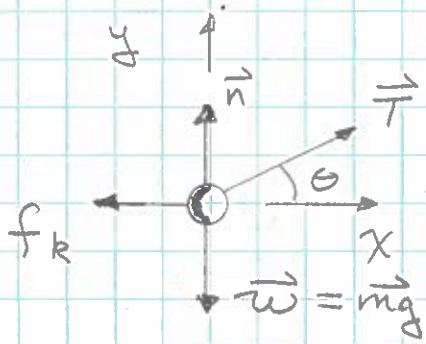
$$\frac{1}{2} m (v_f^2 - v_i^2) = W_T + W_{fric}$$

Now:

$$W_T = \vec{T} \cdot \Delta \vec{r} = T d \cos\theta$$

and for friction:

FBD:



$$\Sigma F_y = T\sin\theta + n - w = ma_y = 0$$

So:

$$n = mg - T\sin\theta$$

and,

$$f_k = \mu_k n$$

$$f_k = \mu_k (mg - T\sin\theta)$$

and

$$W_{fric} = \vec{f}_k \cdot \Delta \vec{r} = f_k d \cos 180^\circ = -f_k d$$

$$= -\mu_k d (mg - T\sin\theta)$$

∴ energy equ'n is:

$$\frac{1}{2} m v_f^2 = T d \cos\theta - \mu_k d (mg - T\sin\theta)$$

or,

$$v_f = \sqrt{\frac{2d}{m}\left\{ T\cos\theta - \mu_k (mg - T\sin\theta)\right\}}$$