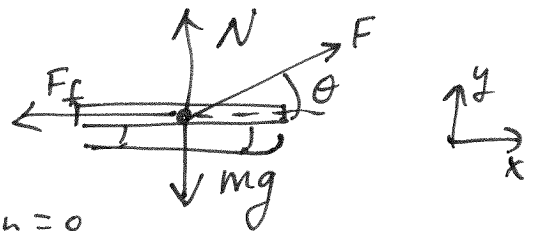
$\mu_k = 0.20$ $\quad d = 20\,m$

$m = 50\,kg$

$\vec{F} = F \angle 25°$

constant velocity $\therefore$ acceleration $= 0$



Using Newton's 2nd law

$$\Sigma \vec{F} = m\vec{a}$$

$$\vec{F}_f + \vec{N} + \vec{F} + \vec{W} = m\vec{a} = 0$$

let horizontal be in the x-direction.

$$-F_f \hat{i} + N\hat{j} + F\cos 25\,\hat{i} + F\sin 25\,\hat{j} - mg\,\hat{j} = 0$$

x-dir) $-F_f + F\cos 25 = 0$ (#1)

y-dir) $N + F\sin 25 - mg = 0$ (#2)

$F_f = \mu N$ (#3)

a) Calculate the applied force & work done by this force

sub (#3) into (#1)

$$-\mu N + F\cos 25 = 0 \longrightarrow N = \frac{F\cos 25}{\mu} \quad (\#4)$$

sub into (#2)

$$\frac{F\cos 25}{\mu} + F\sin 25 - mg = 0$$

$$F\left[\frac{\cos 25}{\mu} + \sin 25\right] = mg \longrightarrow F = \frac{mg}{\frac{\cos 25}{\mu} + \sin 25}$$

$$F = \frac{(50\,kg)(9.8\,m/s^2)}{\frac{\cos 25}{0.20} + \sin 25} = \frac{490\,N}{4.53 + 0.42} = \boxed{99\,N}$$

b) $W_F = \vec{F} \cdot d \cdot \cos\theta = (99N)(20m)\cos(25°) = \boxed{1790\,J}$

~~b) What is work done by friction~~

~~$W_{fric} = -F_f \cdot d \cdot \cos\theta$~~

to 2 sig. figs

$$W_F = 1800\,J$$

b) Find the work done by friction.

start with equation (#4) from part a).

$$N = \frac{F\cos 25}{\mu} = \frac{(99N)\cos(25)}{0.20} = 449\,N$$

Notice this is not equal to the weight of the sled, which is 490N. The upward pull on the sled reduces the normal force.

~~$W = F_f \cdot d = \mu N d$~~

$$W = F_f d\cos\theta = \mu N d\cos\theta$$

In this case θ is not the angle of the applied force, In this case θ is the angle between the direction of motion and the direction of the frictional force.

$$W_{fric} = (0.20)(449N)(20m)\cos(180°) = -1796\,J$$

to 2 sig figs

$$W_{fric} = -1800J$$

c) What is the total work?

$$W_{total} = W_F + W_{Fric} = 1800J - 1800J$$

$$W_{total} = 0\,J$$

Since the total work is zero, the speed of the sled remains constant.