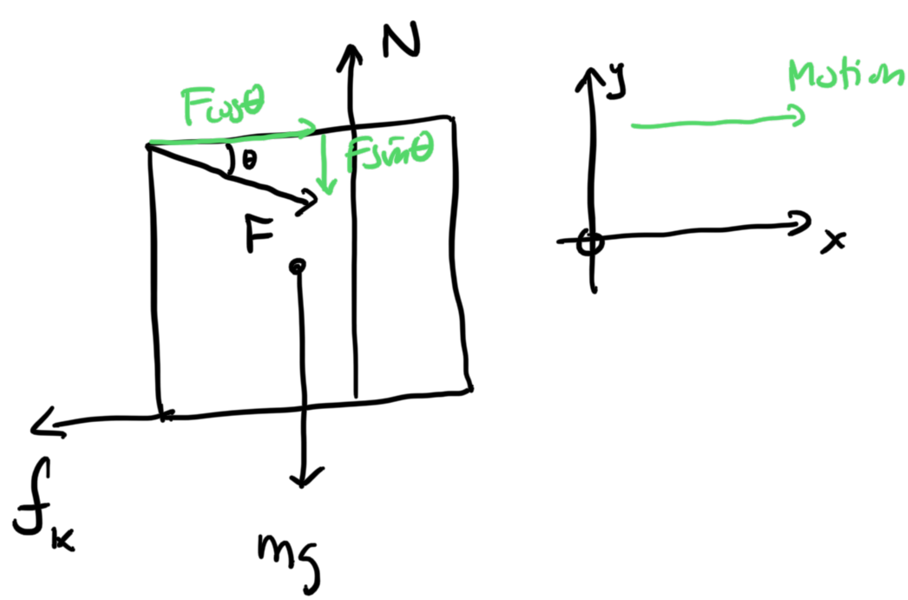
Test 2 Solutions

Question 1 :

My numbers:
- $m = 51$ kg
- $|\vec{F}| = 125$ N
- $28°$ below the horizontal
- in Figure a)
- $\mu_k = 0.068$

Step 1 : Draw a FBD for the block



$\sum F_x = ma_x$

$\sum F_y = ma_y = 0$

$$\boxed{F\cos\theta - f_k = ma_x}$$

$$\boxed{N - mg - F\sin\theta = 0}$$

a) $N = mg + F\sin\theta$

$= (51)(9.8) + (125)(\sin 28^\circ)$

$$\boxed{N = 558\ N}$$

b) $f_k = \mu_k N$

$= (0.068)(558)$

$$\boxed{f_k = 38\ N}$$

c) $F\cos\theta - f_k = ma_x$

$a_x = \frac{1}{m}(F\cos\theta - f_k)$

$$= \frac{1}{51}\left(125\cos 28^\circ - 38\right)$$

$$\boxed{a_x = 1.42\ m/s^2}$$

d) For the situation in figure b) what changes is that the y-component of $\vec{F}$ will be $+F\sin\theta$ instead of $-F\sin\theta$.

$$N = mg - F\sin\theta = \underline{\underline{441\ N}}$$

$$f_k = \mu_k N = \underline{\underline{30\ N}}$$

$$a_x = \frac{1}{m}\left(F\cos\theta - f_k\right) = \underline{\underline{1.58\ m/s^2}}$$

Question 2 :

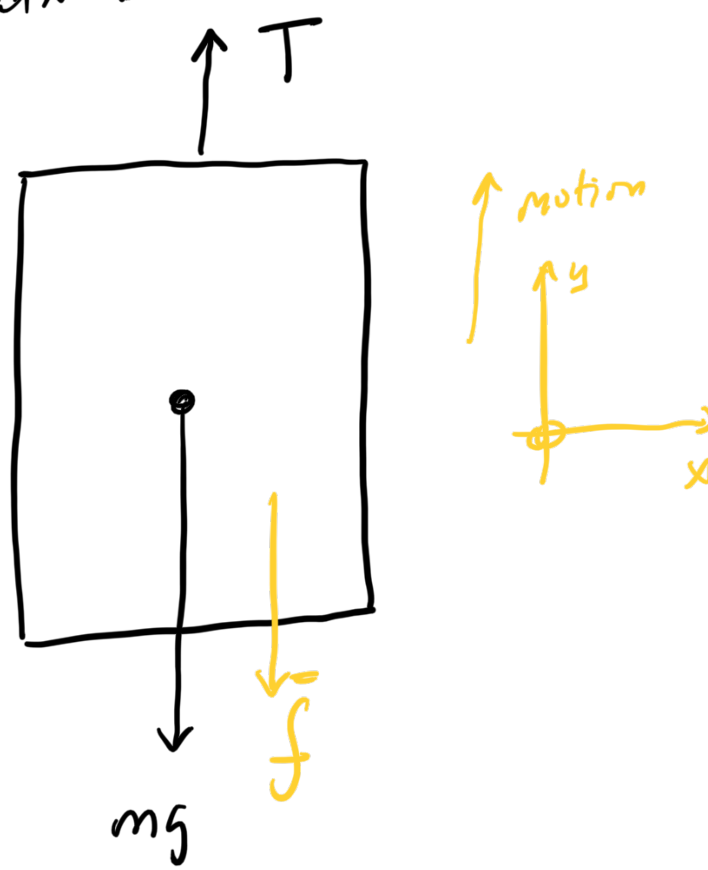
$$m = 1550\ kg$$

My numbers: $m_{elevator}$

$$\Delta y = 42.5 \text{ m}$$

$$\bar{f} = 110 \text{ N}$$

Step 1: Draw a FBD for the elevator:



Constant speed $\rightarrow$ $a_x = a_y = 0$

$\hookrightarrow W_{\text{all forces}} = \Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$= 0$

$$W_{gravity} = -mg\Delta y = -(1550)(9.8) \times (42.5)$$

$$= -645{,}575 \text{ J}$$

$$W_{\bar{f}} = -\bar{f} \cdot \Delta y$$

$$= -(110)(42.5)$$

$$= -4675 \text{ J}$$

$$W_T + W_{gravity} + W_{\bar{f}} = 0$$

$$W_T - 645{,}575 - 4675 = 0$$

$$W_T = 650{,}250 \text{ J}$$

∴

a) $W_T = 650{,}250 \text{ J}$

b) $W_{gravity} = -645{,}575 \text{ J}$

c) $W_{total} = 0$

Question 3:

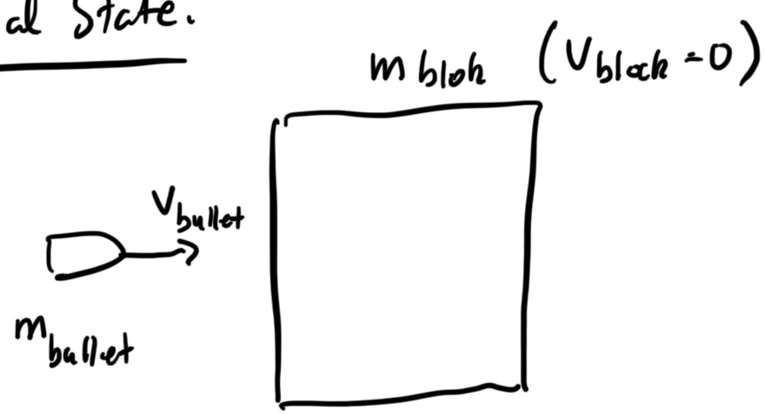
My Numbers:

$m_{bullet} = 250g$
$= 0.25 \text{ kg}$

$v_{bullet} = 410 \text{ m/s}$

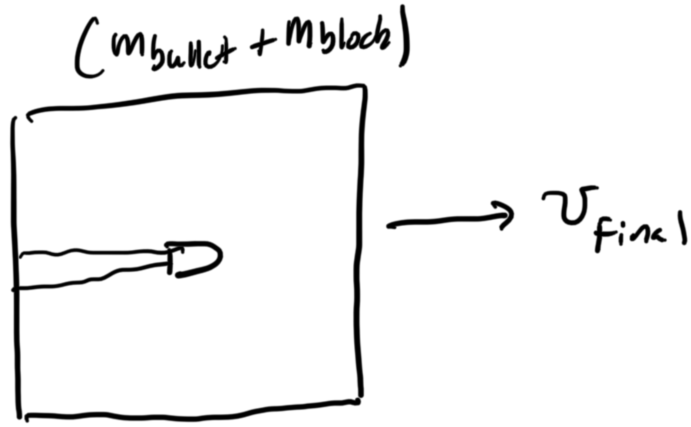
$m_{block} = 6.5 \text{ kg}$

Initial State:



$$\vec{p}_i^{\,system} = m_{bullet} v_{bullet} \hat{i}$$

Final State:



$$\vec{p}_f^{\,system} = (m_{bullet} + m_{block})\, v_F\, \hat{i}$$

Conservation of Momentum:

$$\Delta \vec{P}_{system} = 0$$

$$\vec{p}_i^{\,system} = \vec{P}_f^{\,system}$$

$$m_{bullet}\, v_{bullet}\, \hat{i} = (m_{bullet} + m_{block})\, v_f\, \hat{i}$$

$$\therefore\ v_F = \left(\frac{m_{bullet}}{m_{bullet} + m_{block}} \right) v_{bullet}$$

$m_{bullet} + \ldots$

$$= \left(\frac{.25}{.25 + 6.5} \right) 410$$

$$= 15.2 \text{ m/s}$$

a) $\boxed{\begin{array}{l} |\vec{v}_f| = 15.2 \text{ m/s} \\ \text{Direction} = \hat{i} = \text{East} \end{array}}$

(b) Impulse $\equiv \Delta \vec{p} = \vec{P}_f - \vec{P}_i$

$$\Delta \vec{p}_{bullet} = m_{bullet} \vec{v}_f - m_{bullet} \vec{v}_i$$

$$= 0.25 \left(15.2\,\hat{i} - 410\,\hat{i} \right)$$

$$= -98.7\,\hat{i}$$

$|\Delta \vec{p}_{bullet}| = 98.7$

$\hat{i} = \text{west}$

Direction $= -\hat{i}$ –

c) $$\Delta \vec{p}_{block} = \vec{p}_f^{\,block} - \overset{0}{\vec{p}_i^{\,block}}$$

$$= m_{block}\vec{v}_f - \cancel{m_{block}\vec{v}_i}^{\,0}$$

$$= (6.5)(15.2\,\hat{i}) - 0$$

$$= 98.7\,\hat{i}$$

$$\boxed{\begin{aligned} |\Delta\vec{p}|_{block} &= 98.7 \\ \text{Direction} &= \hat{i} = \text{east} \end{aligned}}$$

d) $$\vec{F}_{net} = \frac{\Delta\vec{p}}{\Delta t} \quad (t = 3\,ms)$$

$$\therefore \vec{F}_{net}^{\,bullet} = \frac{-98.7\,\hat{i}}{0.003\,s}$$

$$= \underline{-32900\,\hat{i}}$$

$$\boxed{\left|\vec{F}_{net}^{\,bullet}\right| = 32900\ N}$$