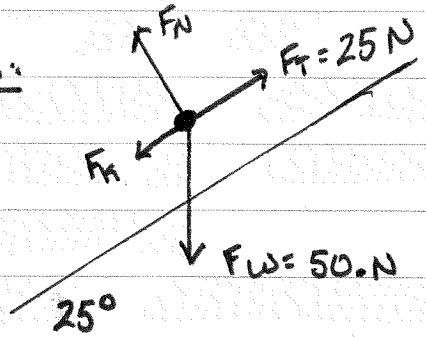
AP Physics - Unit 2

WKst: Inclines with Friction

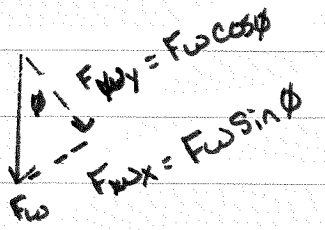
1) Given:



$a = ?$

$\mu_K = 0.10$

$\mu_S = 0.20$



Soln:

$\Sigma F_x = F_T - F_{fK} - F_{Wx} = ma$

$F_{fK} = \mu_K F_N$

$F_T - F_W \sin\phi - \mu_K F_N = ma$

$a = \dfrac{F_T - F_W \sin\phi - \mu_K F_N}{m}$

$= \dfrac{25\,N - 50.\,N \sin 25^\circ - (0.10)45\,N}{5.1\,kg}$

$\boxed{a = -0.098\,m/s^2}$

or East $0.098\,m/s^2$

$\Sigma F_y = F_N - F_{Wy} = ma^0$

$F_N = F_{Wy}$

$= F_W \cos\phi$

$= (50.\,N)\cos 25^\circ$

$F_N = 45\,N$

$F_W = mg$

$m = F_W/g = \dfrac{50.\,N}{9.8\,m/s^2}$

$m = 5.1\,kg$

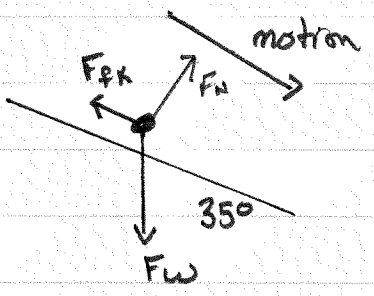
2) Given:

$a = ?$

$m = 20.\text{kg}$

$\mu_K = 0.20$

$\mu_S = 0.40$



$F_{Wy} = F_W \cos\theta$

$F_{Wx} = F_W \sin\theta$

F_W

$F_W = mg$

$= (20.\text{kg})(9.8\,\text{m/s}^2)$

$F_W = 200\,\text{N}$

Soln:

$\Sigma F_x = -F_{fK} + F_W \sin\theta = ma$

$F_{fK} = \mu_K F_N$

$-\mu_K F_N + F_W \sin\theta = ma$

$\Sigma F_y = F_N - F_W \cos\theta = ma^0$

$F_N = F_W \cos\theta$

$= 200.\text{N} \cos 35^\circ$

$F_N = 160\,\text{N}$

$$a = \frac{-\mu_K F_N + F_W \sin\theta}{m}$$

$$= \frac{(-0.20)(160\,\text{N}) + 200 \sin 35^\circ}{20.\text{kg}}$$

$\boxed{a = 3.9\,\text{m/s}^2}$ to Right (west)

3) Given:

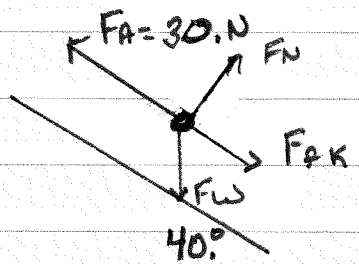
$m = 2.0\,kg$

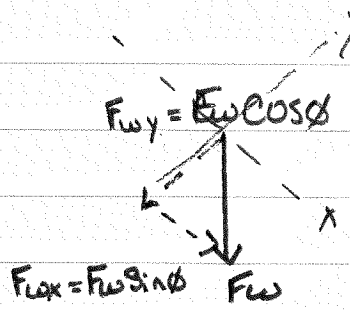
$\mu_K = 0.20$

$\mu_S = 0.30$

$a = ?$

$F_N = ?$





Soln:

$\Sigma F_x = +F_{fK} - F_A + F_w \sin\phi = ma_x$

$F_{fK} = \mu_K F_N$

$\mu_K F_N - F_A + F_w \sin\phi = ma_x$

$\Sigma F_y = F_N - F_w \cos\phi = ma_y^0$

$F_N = F_w \cos\phi$

$F_w = mg$

$F_N = mg\cos\phi$

$= (2.0\,kg)(9.8\,m/s^2)\cos 40.°$

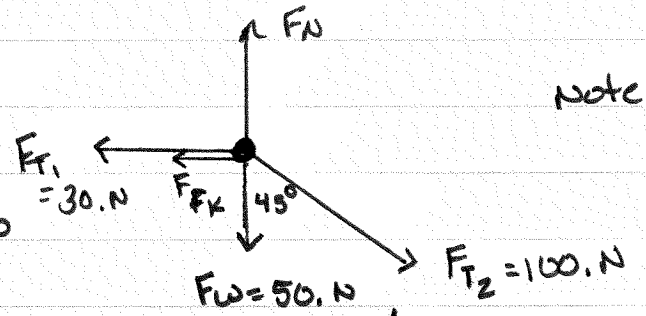
$F_N = 15\,N$

$a = \dfrac{\mu_K F_N - F_A + F_w \sin\phi}{m}$ $\quad F_w = mg$

$= \dfrac{(0.20)(15\,N) - 30.\,N + (2.0\,kg)(9.8\,m/s^2)(\sin 40.°)}{2.0\,kg}$

$a = -7.0\,m/s^2$

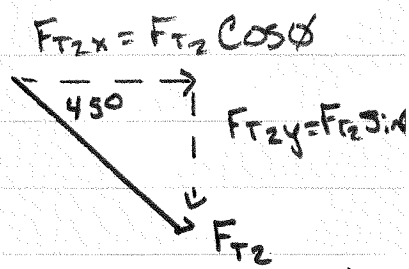
4) Given:



$\mu K = .10$

$a = ?$

Note:



(Reason F_{fK} $100.45° = 71$ which is greater than 30.)

Soln:

$\sum F_x = -F_{T_1} - F_{fK} + F_{T_2}\cos\phi = ma$

$F_{fK} = \mu_K F_N$

$-F_{T_1} - \mu_K F_N + F_{T_2}\cos\phi = ma$

$a = \dfrac{-F_{T_1} - \mu_K F_N + F_{T_2}\cos\phi}{m}$

$= \dfrac{-30.N - 0.10(121N) + 100.N\cos 45^\circ}{5.1\,kg}$

$= \dfrac{-42N + 71N}{5.1\,kg}$

$\boxed{a = 5.7\ m/s^2}$

$\sum F_y = F_N - F_w - F_{T_2}\sin\phi = ma$

$F_N = F_w + F_{T_2}\sin\phi$

$= 50.N + 100.N\sin 45$

$= 50.N + 71N$

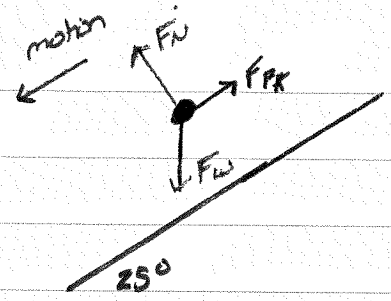
$F_N = 121N$

$F_w = mg$

$m = F_w/g = \dfrac{50.N}{9.8\ m/s^2}$

$m = 5.1\,kg$

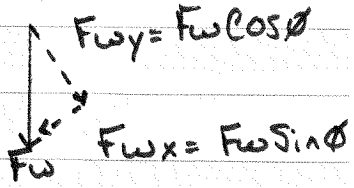
5) Given:



mass = 1000. kg

$\mu_k = 0.10$

$a = ?$



Soln:

$\Sigma F_x = F_{fk} - F_w \sin\phi = ma$ (?)

$F_{fk} = \mu_k F_N$

$\mu_k F_N - F_w \sin\phi = ma$

$F_w = mg$

$\mu_k F_N - mg \sin\phi = ma$

$\Sigma F_y = F_N - F_w \cos\phi = ma$ ($a = 0$)

$F_w = mg$

$F_N - mg\cos\phi = 0$

$F_N = mg\cos\phi$

$= (1000\text{kg})(9.8 \text{m/s}^2)\cos 25$

$F_N = 8900\ \text{N}$

$$a = \frac{\mu_k F_N - mg\sin\phi}{m}$$

$$= \frac{(0.10)(8900\text{N}) - (1000.\text{kg})(9.8\text{m/s}^2)\sin 25^\circ}{1000.\text{kg}}$$

$$= \frac{890\text{N} - 4100\text{N}}{1000.\text{kg}}$$

$$\boxed{a = -3.2\ \text{m/s}^2}$$