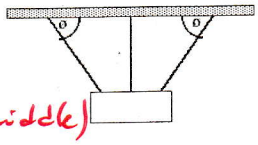
Key (new) Feb. 2015

Physics 122/121

Force Problems: Type I, II and III

1. A block is pulled by a string that makes an angle of 25° to the horizontal. If the mass of the block is 12.0 kg and the coefficient of friction is 0.25, what force would keep the block moving at a constant velocity? (29 N, 25° ↑ horizontal)

2. A 10-kg sign is suspended by three ropes, each supporting an equal portion of the sign's weight. The two end ropes make an angle of 70° to the horizontal. What is the magnitude of the tensions in each of the ropes? (35 N in two end ropes, 33 N in middle)



3. A wooden block slides directly down an inclined plane, at a constant velocity of 6.0 m/s.
   a) How large is the coefficient of kinetic friction if the plane makes an angle of 25° with the horizontal? (0.47)
   b) If the angle of incline is changed to 10°, how far will the block slide before coming to a stop? (6.4m)

4. A 10 N block is held motionless on a frictionless inclined plane which makes an angle of 30° with the horizontal. What force would be needed to hold the block in position? (5.0 N, up the incline)

5. A 32.53 N light hangs at equilibrium from two cables at angles 78.3° and 60.2° with respect to the ceiling. What is the tension in the first cable? (24.4 N, 78.3° ↑ horizontal)

6. An object is being pulled up a 15° incline against a frictional coefficient of 0.15, and requires a force of 835 N parallel to the surface of the ramp to move it at a constant speed. What is the weight of the object? (2.1×10^3 N, down)

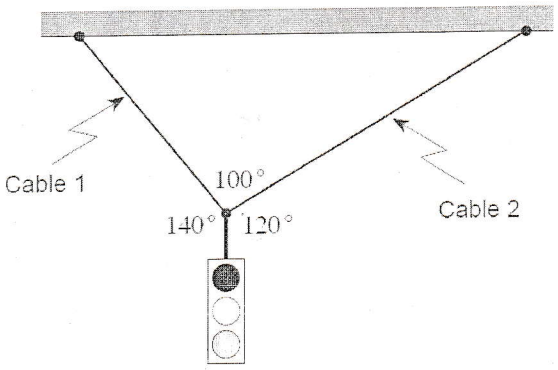
7. A 4.58 kg crate is at rest on a level icy surface. A cord suddenly exerts a force, F = 13.0 N, at an angle of 15.5° above the horizontal. At 3.3 seconds what is the crate's speed? (9.0 m/s)

8. A person pushes a 14.0 kg lawn mower at constant speed with a force of F = 88.0 N directed along the handle, which is at an angle of 45.0° to the horizontal. Calculate
   a) the horizontal frictional force on the mower (62.2 N, left)
   b) the normal force exerted vertically upward on the mower by the ground. (199 N, up)

9. A package slides down a 135 m long ramp with no friction. If the package starts from rest at the top and is to have a speed no faster than 19 m/s at the bottom, what should be the maximum angle of inclination? (7.9°)

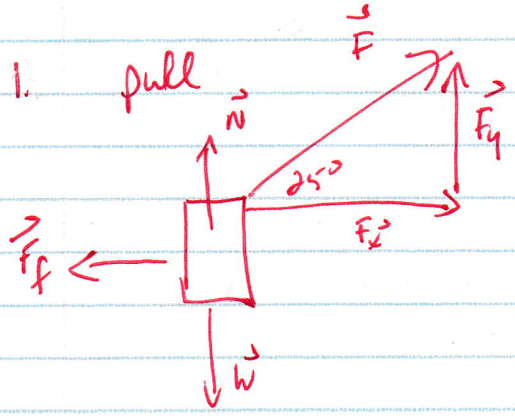
10. A rope attached to a 35.0 kg box makes an angle of 25.0° with the horizontal. A force of 185 N is applied to the rope, and the coefficient of kinetic friction between the box and floor is 0.450. Find the acceleration of the box. (1.39 m/s², right)

11. A 35 kg traffic light is suspended from two cables as shown in the diagram. Find the tension in Cable 1 and Cable 2. (3.0×10^2 N, 50° ↑ horiz., 2.2×10^2 N, 30° ↑ horizontal).



Physics 122/121
Force Problems: Types I, II and III

1. pull



$m = 12.0\ kg$
$\mu = 0.25$
Constant vel, $a = 0\ m/s^2$
$\vec{F} = ?$

$+F_x - F_f = 0$
$F\cos 25° - \mu N = 0$
$F\cos 25° - \mu(W - F_y) = 0$
$F\cos 25° - \mu(mg - F\sin 25°) = 0$
$F\cos 25° - \mu mg + \mu F\sin 25° = 0$
$F\cos 25° + \mu F \sin 25° = \mu mg$

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

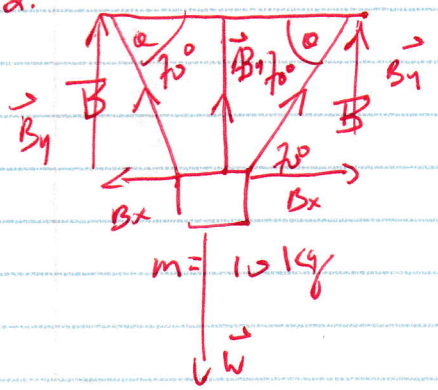
$$F = \frac{(0.25)(12.0)(9.80)}{\cos 25° + (0.25)\sin 25°}$$

$F = 29\ N$

$N - W + F_y = 0$
$N = W - F_y$

The force is 29 N, 25° NofE (to horizontal)

2.



$3B_y - W = 0$
$3B\sin 70° = mg$

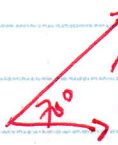
$$B = \frac{mg}{3\sin 70°}$$

$$B = \frac{(10)(9.80)}{3\sin 70°}$$

$B = 35\ N$

$B_y = B\sin 70°$
$B_y = (35)\sin 70°$
$B_y = 33\ N$

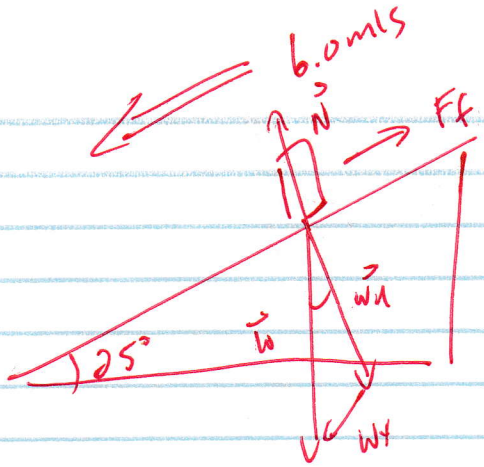
B = 35 N in end ropes
B_y = 33 N in middle rope



$\frac{33}{B_y}\sin 70° =$

$B_y =$

3.



$N = W_y$

$\mu = ?$
constant vel.

a) $+F_f - W_x = 0$

$\mu N - W\sin\theta = 0$

$\mu W_y - W\sin\theta = 0$

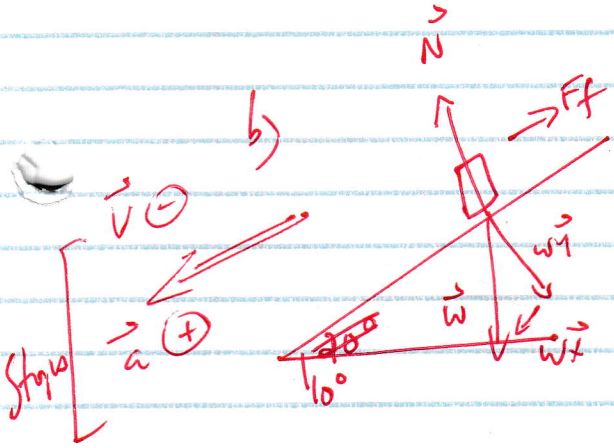
$\mu mg\cos\theta - mg\sin\theta = 0$

$\mu = \frac{\sin\theta}{\cos\theta}$

$\mu = \tan\theta$

$\mu = \tan 25^\circ$

$\mu = 0.47$



$+F_f - W_x = +ma$

$\mu N - mg\sin\theta = ma$

$\mu mg\cos\theta - mg\sin\theta = ma$

$a = 0.47(9.80)\cos 25^{\circ} - (9.80)(\sin 25^{\circ})$

$a = 0.0328\ m/s^2$ ~~2.83 m/s²~~

$v_i = -6.0$ m/s

$v_f = 0$

$d = ?$

$a = ?$

$v_f^2 = v_i^2 + 2ad$

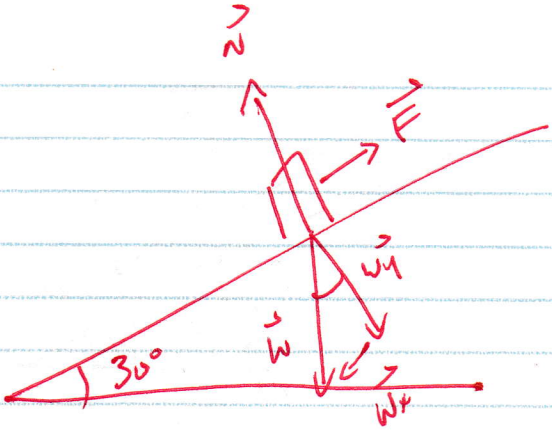
$d = \frac{-v_i^2}{2a}$

$d = \frac{-(-6.0\ m/s)^2}{2(0.0328)}$ ~~2.83~~

~~$d = 5505.5 \times 10$ m~~

$d = -6.4$ m.

4.



frictionless inclined plane

$W = 10\,N$

$\vec{F} = ?$

$+F - W_x = 0$

$F = W_x$

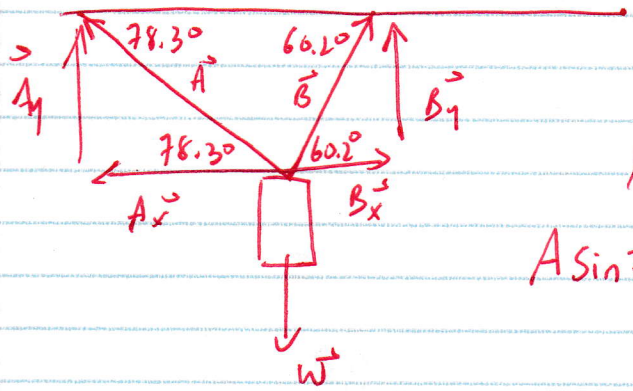
$F = W\sin\theta$

$F = 10\sin 30°$

$F = 5.0\,N$

$\vec{F} = 5.0\,N$, up the inclined plane.

5.



$A_y + B_y - W = 0$

$A\sin 78.3° + B\sin 60.2° = W$

$A\sin 78.3° + \left(\frac{A\cos 78.3°}{\cos 60.2°}\right)\sin 60.2° = W$

$A\sin 78.3° + A\cos 78.3°\tan 60.2° = W$

$+B_x - A_x = 0$

$B_x = A_x$

$B\cos 60.2° = A\cos 78.3°$

$A = \frac{W}{\sin 78.3° + \cos 78.3°\tan 60.2°}$

$A = \frac{32.53}{\sin 78.3 + \cos 78.3°\tan 60.2°}$

$W = 32.53\,N$

$A = 24.4\,N$

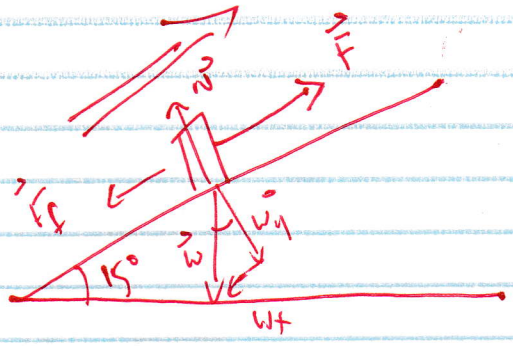
$B = \frac{A\cos 78.3°}{\cos 60.2°}$

$B = \frac{24.4\cos 78.3°}{\cos 60.2°} = 9.96\,N$

$\Rightarrow \vec{A} = 24.4\,N,\ 78.3°$ ↑ hor.

$\left(\vec{B} = 9.96\,N,\ 60.2°\ \uparrow\ \text{hor.}\right)$

6.

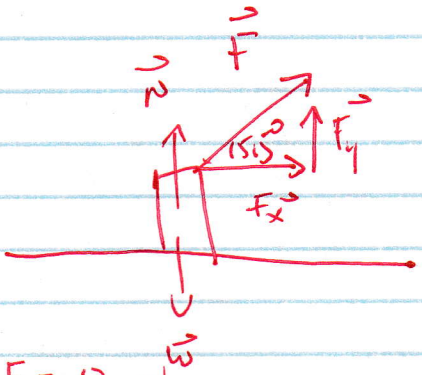


$\mu = 0.15$
$F = 835\ N$
(mint speed
$\vec{W} = ?$

$F - F_f - Wx = 0$
$F - \mu N - W\sin\theta = 0$
$F - \mu W_y - W\sin\theta = 0$
$F - \mu W\cos\theta - W\sin\theta = 0$
$F = \mu W\cos\theta + W\sin\theta$
$W = \dfrac{F}{\mu\cos\theta + \sin\theta}$
$W = \dfrac{835}{0.15\cos 15^\circ + \sin 15^\circ}$
$W = 2.1 \times 10^3\ N$

$\vec{W} = -2.1 \times 10^3\ N$

7.

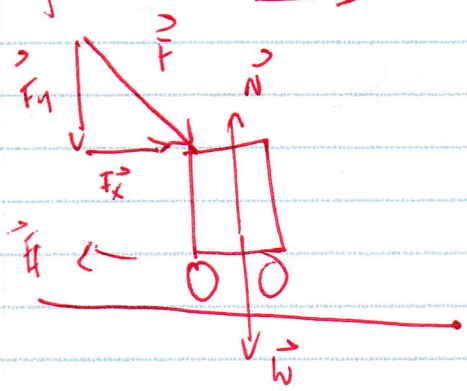


$F = 13.0\ N$
icy surface
$\vec{v_i} = 0\ m/s$
$t = 3.3\ s$
$v_f = ?$ (speed)
$m = 4.58\ kg$

$F_x = ma$
$F\cos 15.5^\circ = ma$
$a = \dfrac{F\cos 15.5^\circ}{m}$
$a = \dfrac{13.0\cos 15.5^\circ}{4.58}$
$a = 2.74\ m/s^2$ ✓

$\vec{a} = \dfrac{\vec{v_f} - \vec{v_i}}{t}$
$\vec{v_f} = \vec{v_i} + \vec{a}t = (2.74)(3.3)$
$\vec{v_f} = 9.0\ m/s$, $v_f = 9.0\ m/s$.

8. push. ⟹



m = 14.0 kg
constant speed
F = 88.0 N
θ = 45.0°

a) $\vec{F}_f = ?$

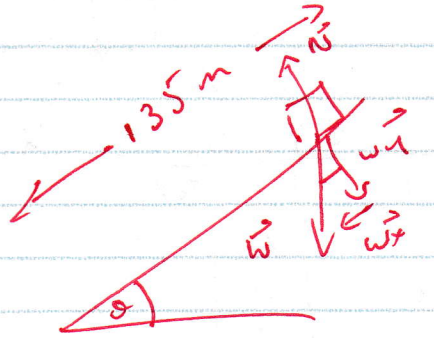
$+F_x - F_f = 0$
$F_f = F_x$
$F_f = F\cos 45.0°$
$F_f = 88.0\cos 45.0°$
$F_f = 62.2\ N$

$\vec{F}_f = 62.2\ N$, left

b) $N - w - F_y = 0$
$N = w + F_y$
$N = mg + F\sin\theta$
$N = 14.0(9.80) + (88.0)\sin 45.0°$
$N = 199\ N$

$\vec{N} = 199\ N$, up.

9.

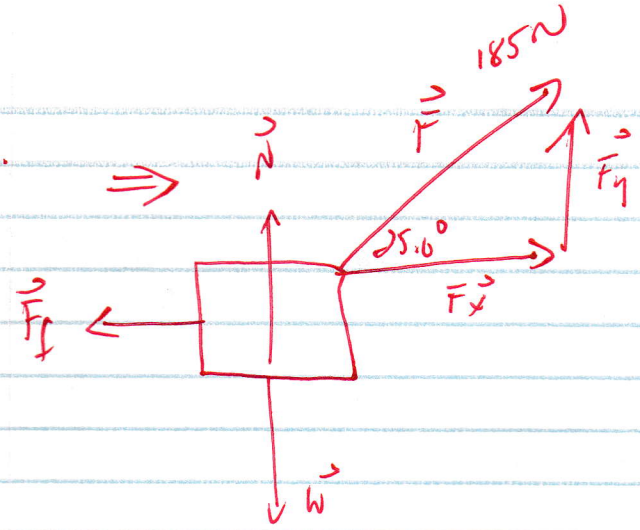


no friction
$v_i = 0\ m/s$
$v_f = -19\ m/s$
$\theta = ?$
$\Delta = -135\ m$.

$v_f^2 = v_i^2 + 2a\Delta$
$a = \frac{v_f^2}{2\Delta}$
$a = \frac{(-19)^2}{2(-135)}$
$a = -1.34\ m/s^2$

$-wx = -ma$
$+mg\sin\theta = +ma$
$\sin\theta = \frac{a}{g} = \frac{1.34}{9.80}$
$\theta = 7.9°$

10.



$+F_x - F_f = +ma$

$F\cos 25.0^\circ - \mu N = ma$

$F\cos 25.0^\circ - \mu(w - F_y) = ma$

$F\cos 25.0^\circ - \mu(mg - F\sin 25.0^\circ) = ma$

$m = 35.0\ kg$

$\mu = 0.450$

$\vec{a} = ?$

$a = \dfrac{F\cos 25.0^\circ - \mu(mg - F\sin 25.0^\circ)}{m}$

$a = \dfrac{185\cos 25.0^\circ - (0.450)(35.0)(9.80) - 185\sin 25.0^\circ)}{35.0}$

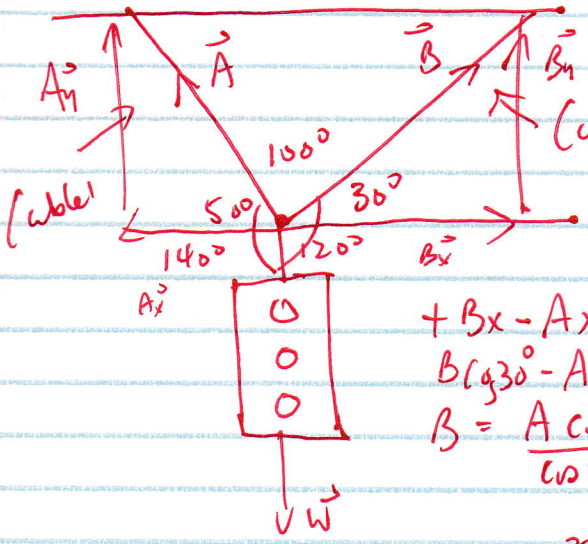
$N + F_y - w = 0$

$N = w - F_y$

$a = 1.39\ m/s^2$

$\vec{a} = 1.39\ m/s^2$, right.

11.



$m = 35\ kg$

$A_y + B_y - w = 0$

$A\sin 50^\circ + B\sin 30^\circ = mg$

$A\sin 50^\circ + \left(\dfrac{A\cos 50^\circ}{\cos 30^\circ}\right)\sin 30^\circ = mg$

$+B_x - A_x = 0$

$B\cos 30^\circ - A\cos 50^\circ = 0$

$B = \dfrac{A\cos 50^\circ}{\cos 30^\circ}$

$A\sin 50^\circ + A\cos 50^\circ \tan 30^\circ = mg$

$A = \dfrac{mg}{\sin 50^\circ + \cos 50^\circ \tan 30^\circ}$

$B = \dfrac{3.0\times10^2\cos 50^\circ}{\cos 30^\circ}$

$A = \dfrac{35(9.80)}{\sin 50^\circ + \cos 50^\circ \tan 30^\circ}$

$B = 2.2\times10^2\ N$

$A = 3.0\times10^2\ N$

$\vec{A} = 3.0\times10^2\ N$, 50° w hor. || $\vec{B} = 2.2\times10^2$, 30° w hor.