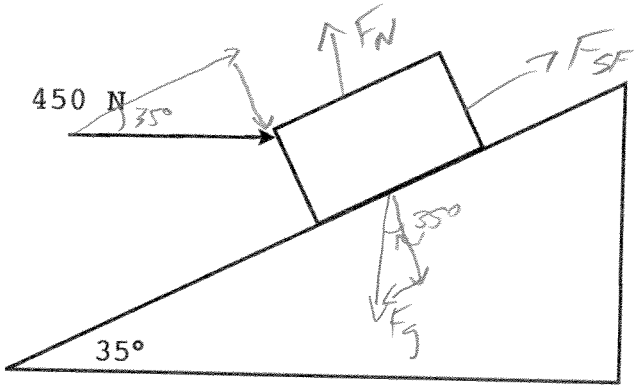
Physics 10154 - Exam #2d

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (35 pts) A person applies a horizontal applied force of 450 Newtons in an attempt to keep an 140 kg crate from sliding down a 35° incline. The coefficient of static friction between the crate and the incline is 0.44. The coefficient of kinetic friction is 0.25. Does the crate move down the incline?

   If no, what is the magnitude and direction of the force of static friction?

   If yes, what is crate's acceleration?



$\Sigma F_\perp = F_N - F_{g,\perp} - F_{App,\perp} = 0$

$F_N - mg\cos 35° - F_{App}\sin 35° = 0$

$F_N = (140)(9.8)\cos 35° + 450\sin 35°$

$= 1381.986$

Assume $a = 0$, find F_{SF}

$F_{SF,MAX} = \mu_s F_N = 608.1\ N$

$\Sigma F_\parallel = F_{SF} - F_{g,\parallel} + F_{App,\parallel} = 0$

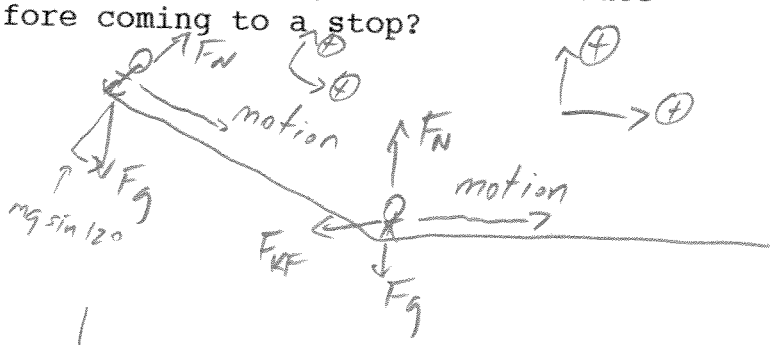
$F_{SF} - mg\sin 35 + F_{App}\cos 35 = 0$

$F_{SF} = (140)(9.8)\sin 35 - 450\cos 35 = 418.3\ N$

Since F_{SF} (418) < $F_{SF,MAX}$ (608), crate doesn't move

$F_{SF} = 420\ N$, up ramp

2. (35 pts) Starting from rest at the top of a 12° frictionless incline, a skier travels 75 meters down the incline, which then turns into a flat, rough surface with a coefficient of kinetic friction of 0.080. How far along the flat surface does the skier travel before coming to a stop?



Ch 4 method

On slope,

$\Sigma F_{\parallel} = F_{g,\parallel} = ma$

$mg \sin 12° = ma$

$a = 2.04 \text{ m/s}^2$

$\Delta s = 75 \text{ m}$
$v_0 = 0$
$v = ?$
$a = 2.04 \text{ m/s}^2$
$t = ?$

$v^2 = v_0^2 + 2a\Delta s$
$= 0 + 2(2.04)(75)$
$v = 17.48 \text{ m/s}$

On flat part

$\Sigma F_{\parallel} = F_{KF} = ma_2$

$-\mu_K F_N = ma_2$

$-\mu_K mg = ma_2$

$a_2 = -0.784$

$\Delta s = ?$
$v_0 = 17.48$
$v = 0$
$a = -0.784$
$t = ?$

$v^2 = v_0^2 + 2a\Delta s$
$0^2 = 17.48^2 + 2(-.784)\Delta s$
$\Delta s = 194.9 \text{ m}$
$\approx 190 \text{ m}$

Ch 5 method

$W_{N,1} = 0$

$W_{g,1} = +mgh$
$= +m(9.8)(75)\sin 12°$
$= 152.8m$

$W_{N,2} = 0$

$W_{g,2} = 0$

$W_{KF,2} = \mu_K F_N \Delta s \cos 180°$
$= -\mu_K mg\Delta s$
$= -(.080)m(9.8)\Delta s$
$= -0.784m\Delta s$

$\Delta K = 0$ (starts + ends at rest)

$0 + 152.8m + 0 + 0 - .784m\Delta s = 0$

$152.8 = .784\Delta s$

$\Delta s = 194.9 \text{ m}$

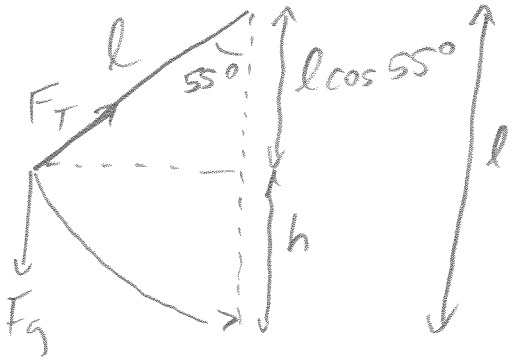
$\approx 190 \text{ m}$

15 kg

3. (30 pts) Kicking off from a ledge with an initial speed of 3.5 m/s, a monkey swings on a pendulum-like 4.5 meter vine that initially makes an angle of 55° with respect to the vertical.

a) How fast is the monkey travelling at the lowest point of his motion, assuming no frictional forces?

b) Suppose the monkey's final speed is only 85% of what you calculated in part a, how much work is done by friction?



$h = 4.5 - 4.5\cos 55°$

$= 1.92\ m$

$W_T = 0$ since $(F_T \perp \Delta s)$ always

$W_g = +mgh = (15)(9.8)(1.92)$

$= 282.2\ J$

a) $\Sigma W_F = W_T + W_g = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$

$282.2 = \frac{1}{2}(15)v^2 - \frac{1}{2}(15)(3.5)^2$

$374.1 = 7.5v^2$

$v = 7.1\ m/s$

b) If $v = 6.0\ m/s$

$W_T + W_g + W_{Fric} = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$

$0 + 282.2 + W_{Fric} = \frac{1}{2}(15)(6.0)^2 - \frac{1}{2}(15)(3.5)^2$

$282.2 + W_{Fric} = 270 - 91.9$

$282.2 + W_{Fric} = 178.1$

$W_{Fric} = -104\ J$ or $-100\ J$