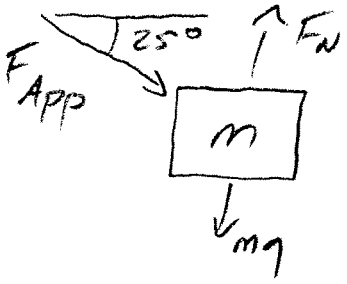
Physics 10154 - Exam #2a

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. (40 pts) A 120 kg crate is initially at rest on a rough horizontal surface. The crate is pushed by an applied force of 950 Newton directed 25° below the horizontal. The coefficient of static friction between the crate on the floor is 0.65. The coefficient of kinetic friction is 0.32.

Does the crate move?
If yes, what is its acceleration?
If no, what is the force of static friction acting on the crate?



Assume $a = 0$

$$\Sigma F_\perp = F_N - mg - F_{App}\sin 25^\circ = 0$$

$$F_N - 1176 - 401.5 \Rightarrow$$

$$F_N = 1577\ N$$

$$F_{SF,MAX} = \mu_S F_N = 1025\ N$$

Now find F_{SF}:

$$\Sigma F_{||} = F_{App}\cos 25^\circ - F_{SF} = 0$$

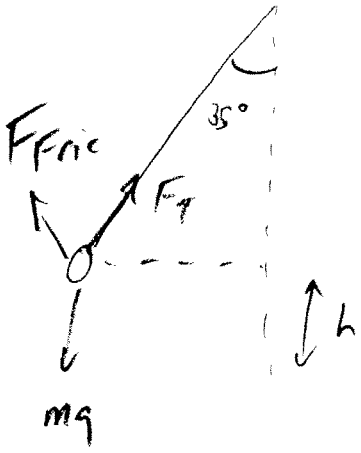
$$950\cos 25^\circ - F_{SF} = 0$$

$$F_{SF} = 860\ N < F_{SF,MAX}$$

So crate does not move

and $F_{SF} = 860\ N$

2. (30 pts) A 3.50-kg mass is attached to a 1.20 meter long string that is held initially at rest at an angle 35.0° from the vertical direction. When the mass passes through the lowest point of its motion, its speed is measured to be 1.80 m/s. How much work is done by the frictional force during this motion?



$$h = \ell - \ell\cos\theta$$

$$= 1.20 - 1.20\cos 35 = 0.217\,m$$

$$\Sigma W_F = W_T + W_{grav} + W_{Fric} = \Delta K$$

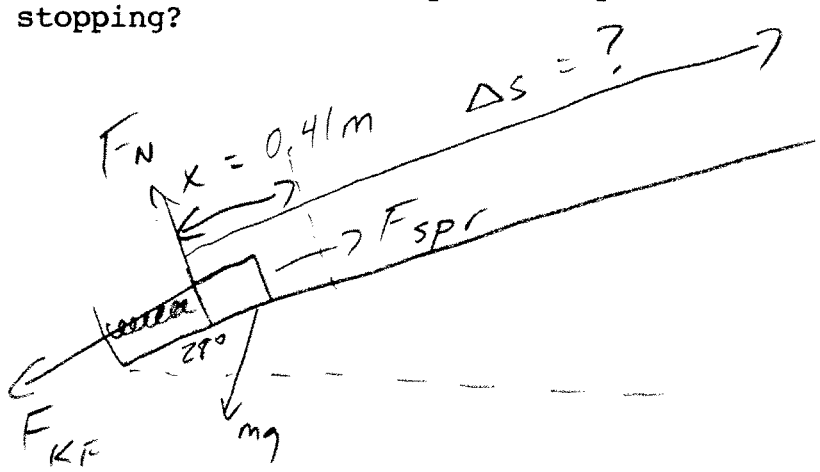
$$0 + mgh + W_{Fric} = \frac{1}{2}mv^2 - 0$$

$$(3.50)(9.8)(0.217) + W_{Fric} = \frac{1}{2}(3.50)(1.80)^2$$

$$7.443 + W_{Fric} = 5.67$$

$$\boxed{W_{Fric} = -1.77\ J}$$

3. (30 pts) A 7.5-kg mass is initially at rest at the bottom of a rough surface inclined 28° above the horizontal. The mass is compressing a spring (k = 450 N/m) that is oriented parallel to the inclined surface. The coefficient of kinetic friction between the mass and surface is 0.22. The mass compresses the spring by 41 cm and then is released. As measured from the point the mass is released, how far up the ramp does the mass slide before stopping?



$W_N = 0$

$W_{grav} = -mgh = -mg\Delta s \sin 28°$

$= -(7.5)(9.8)\Delta s \sin 28° = -34.5\Delta s$

$W_{KF} = -\mu_K F_N \Delta s = -\mu_K mg \cos 28° \Delta s$

$= -(0.22)(7.5)(9.8)\cos 28° \Delta s$

$= -14.3\Delta s$

$W_{spr} = \frac{1}{2}kx^2 = \frac{1}{2}(450)(.41)^2 = 37.8\ J$

$0 - 34.5\Delta s - 14.3\Delta s + 37.8 = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$ (the $\frac{1}{2}mv^2$ and $\frac{1}{2}mv_0^2$ terms are 0)

$37.8 = 48.8\Delta s$

$\boxed{\Delta s = 0.78\ m}$