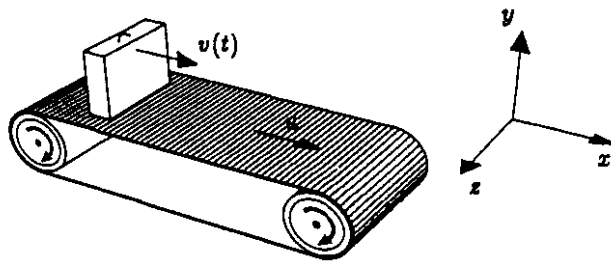


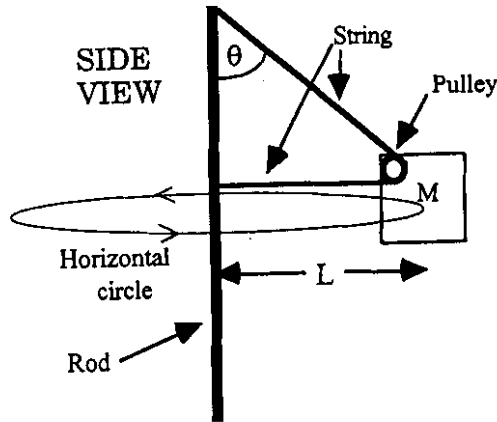
Problem 9 A suitcase placed on a conveyor belt (25 points)

A suitcase of mass M is placed on a level conveyor belt at an airport. The coefficient of static friction between the suitcase and the conveyor belt is μ_s , and the coefficient of kinetic friction is μ_k , with $\mu_k < \mu_s$. The conveyor belt moves with constant speed u , and at time $t = 0$ the suitcase is placed on the conveyor with speed $v = 0$.



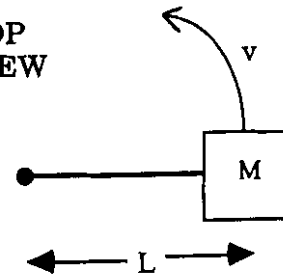
- (6 points) At $t = 0$, what is the total force \vec{F} acting on the suitcase?
- (6 points) How long does the suitcase take to reach the speed of the conveyor belt (i.e. at what time t does $v(t) = u$)?
- (7 points) What is the work done by friction on the suitcase during this time? Be sure that you give the sign as well as the magnitude.
- (6 points) After the suitcase reaches the speed of the conveyor belt, what is the force of friction that acts on it?

Problem 10 (8 points)



Initials _____

TOP VIEW



A block of mass M is attached to a vertical rod by a single string which passes around a pulley attached to the block as shown. The entire system rotates so that the block is moving in a horizontal circle with constant speed, v . Assume that the pulley is very light and has negligible friction and also that the string has very little mass.

- Draw a free-body diagram for the block showing all of the forces acting on it.
- Pick a choice of X and Y axes, show them on your diagram, and write $F=ma$ equations for the two directions. You do not need to solve these equations.

Problem 11 Young & Freedman 7.58 Page 278

Problem 12 Young & Freedman 7.61 Page 279

Problem 13 Young & Freedman 7.65 Page 279

Problem 9

a) ~~The suit case is sliding so it has kinetic friction. Belt is horizontal and no vertical forces other than gravity so $f = \mu_k mg$.~~

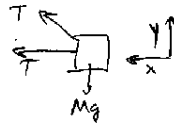
b) ~~$a = \frac{F}{m} = \mu_k g$, $v = at = \mu_k gt = u \Rightarrow t = \frac{u}{\mu_k g}$.~~

c) ~~No PE so $W = \Delta KE = \frac{1}{2}mu^2 - 0 \Rightarrow W_{frict} = \frac{1}{2}mu^2$.~~

d) ~~At this point, the suit case moves at constant velocity, so $f = 0$.~~

Problem 10

a)



b) ~~$\sum F_x = T + T \sin(\theta) = m \frac{v^2}{L}$
 $\sum F_y = T \cos(\theta) - mg = 0$.~~

Problem 11. Young & Freedman 7.58 (pg. 278).

a) ~~Call $h = 0$ the bottom end of the rod when it is vertical. Call the length of the rod L :~~

~~$KE_I = 0$, $KE_F = \frac{1}{2}m_{rat}v^2 + \frac{1}{2}m_{mouse}v^2$.~~

~~The rod pivots around the center so both animals move at the same speed.~~

~~$PE_I = g(m_{rat} + m_{mouse})\frac{L}{2}$, $PE_F = g(m_{rat} - m_{mouse})L$.~~

~~$W = 0$, since no forces other than gravity: $v^2 = \frac{(m_{rat} - m_{mouse})Lg}{m_{rat} + m_{mouse}}$, $v = 1.8m/s$.~~

Problem 12. Young & Freedman 7.61 (pg. 279).

a) ~~Dropping a distance h , no friction: $\frac{1}{2}mv^2 = mgh$, $v^2 = 2gh$.~~

~~Dropping a distance d with friction, but gaining the same KE : $KE_I = 0$, $KE_F = mgh$, $PE_I = mgd$.~~

~~$PE_F = 0$, $W = -fd$, $W = \Delta E$, $-fd = mgh - mgd$~~

~~$f = mg \left(\frac{d-h}{d}\right)$. If $h = d$, $f = 0$, as expected.~~

~~If $h = 0$, no velocity! $f = mg$.~~

b) ~~440 Newtons.~~

c) ~~$KE_I = 0$, $KE_F = \frac{1}{2}mv^2$, $PE_I = mgd$, $PE_F = mgy$, $W = -f(d-y)$~~

~~Using the value of f found in a): $-f(d-y) = -mg \frac{(d-h)(d-y)}{d} = \frac{1}{2}mv^2 + mgy - mgd$~~

~~m drops out $\Rightarrow v^2 = 2g(d-y) - 2g \frac{(d-h)(d-y)}{d} = 2g \frac{(d-y)h}{d}$, $v = \sqrt{2g \frac{(d-y)h}{d}}$~~

Problem 13. Young & Freedman 7.65 (pg. 279).

a) ~~$W = \Delta E$, $KE_I = \frac{1}{2}(m)(4.8)^2$, $KE_F = 0$, $W = -fd$~~

~~$f = \mu N$ and $N = mg$, so: $-\frac{1}{2}m(4.8)^2 = -\mu mgd$, $\mu = 0.39$~~

b) ~~$W = \Delta E$, $PE_I = mg(1.6)$, $PE_F = 0$, $KE_I = 0$, $KE_F = \frac{1}{2}m(4.8)^2$~~

~~$W = \Delta E = \frac{1}{2}m(4.8)^2 - mg(1.6) = -0.83 J$~~