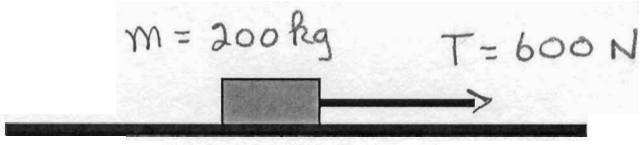
Physics 108.002 Name Key
Test 3
October 22, 2002 Grade _____

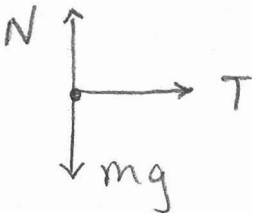
1. A horizontal cable pulls a 200-kg cart along a horizontal track. The tension in the cable is 600 N. Starting from rest, (a) How long will it take the cart to reach a speed of 10.0 m/s? (b) How far will it have gone?

Figure



Friction = 0

Free Body Diagram on m



Theory

(a) $v_{x0} = 0$

$v_x = v_{x0} + a_x t$

$v_x = 10\ m/s$

NSL for m

$\Sigma F_x = m a_x$

$T = m a_x$

$a_x = \frac{T}{m}$

$v_x = v_{x0} + \frac{T}{m} t$

(b) $x = v_{x0} t + \frac{1}{2} a_x t^2$

$x = (0)t + \frac{1}{2} \frac{T}{m} t^2$

Calculation

(a) $v_x = v_{x0} + \frac{T}{m} t$

$t = \frac{(v_x - v_{x0})m}{T} = \frac{(10\ m/s)(200\ kg)}{600\ N}$

$t = 3.33\ s$

(b) $x = \frac{1}{2}\left(\frac{T}{m}\right)t^2 = \frac{1}{2}\left(\frac{600\ N}{200\ kg}\right)(3.33\ s)^2$

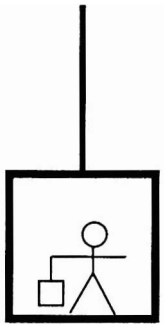
$x = 16.67\ m$

Answers (a) 3.33 s

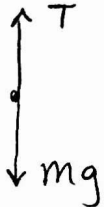
(b) 16.67 m

2. An elevator starts from rest with a constant upward acceleration. It moves 5.0 m in the first 1.6 s. A passenger in the elevator is holding a 4.0-kg package by a vertical string. What is the tension in the string during the accelerating process?

Figure



Free Body Diagram on m



Theory

$y = 5\,m$, $t = 1.6\,s$, $v_{y0} = 0$

$m = 4\,kg$

NSL for m

$\Sigma F_y = ma_y$

$T - mg = ma_y$

$T = mg + ma_y$

$y = v_{y0}t + \frac{1}{2}a_y t^2$

[note m and elevator have same a_y]

$y = \frac{1}{2}a_y t^2$

$a_y = \frac{2y}{t^2}$

$\therefore \quad T = mg + m\frac{2y}{t^2}$

$T = m\left[g + \frac{2y}{t^2}\right]$

Calculation

$T = m\left[g + \frac{2y}{t^2}\right]$

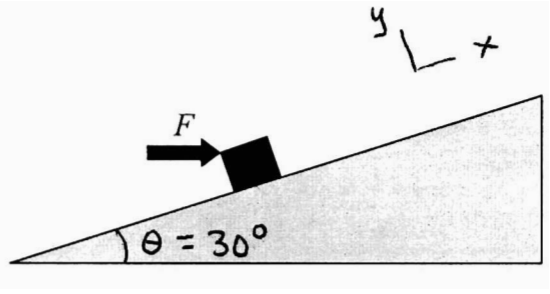
$= 4\,kg\left[9.81\,m/s^2 + \frac{2(5\,m)}{(1.6\,s)^2}\right]$

$T = 54.9\,N$

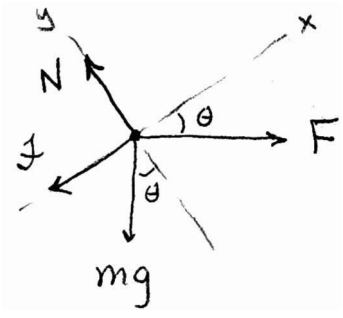
Answer 54.9 N

3. A horizontal force of 400 N is required to cause a 30-kg block to slide up a 30^0 incline with an acceleration of 15 cm/s^2. Find (a) the friction force on the block and (b) the coefficient of friction.

Figure



Free Body Diagram on m



$m = 30\,kg$

$F = 400\,N$

$a_x = 15\,cm/s^2 = 0.15\,m/s^2$

Theory

(a) NSF on m

$\Sigma F_x = ma_x$

$F\cos\theta - f - mg\sin\theta = ma_x$

$f = F\cos\theta - mg\sin\theta - ma_x$

$\Sigma F_y = ma_y$

$N - mg\cos\theta - F\sin\theta = 0$

$N = mg\cos\theta + F\sin\theta$

(b) $f = \mu N$

$\mu = \frac{f}{N}$

Calculation

(a) $f = F\cos\theta - mg\sin\theta - ma_x$

$f = (400\,N)\cos 30° - 30\,kg\,(9.81\,m/s^2)\sin 30° - 30\,kg\,(0.15\,m/s^2)$

$\boxed{f = 194.8\,N}$

$N = mg\cos\theta + F\sin\theta$

$= 30\,kg\,(9.81\,m/s^2)\cos 30° + 400\,N\sin 30°$

$N = 455\,N$

(b) $\mu = \frac{f}{N} = \frac{194.8\,N}{455\,N}$

$\boxed{\mu = 0.428}$

Answers (a) 194.8 N

(b) 0.428