Name: [redacted] Lab section: 16

Exam 1: Physics 50, Section 1 7 October 2014.

Please keep this exam closed until given the signal to start. The exam will end promptly at 1:10, at which time you will send your papers to the end of the row to be collected. If you finish early, please wait until 1:10.

There are 5 pages with problems, each page is worth 10 points, for a total of 50 points on this exam.

You may use a calculator, but no other materials are allowed during this exam. Also, show all of your work because unsupported work will not receive credit.

Here are the equations that you may find useful:

$$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2 \qquad v_x = v_{0x} + a_x t \qquad v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$$

$$x - x_0 = \left(\frac{v_{0x} + v_x}{2}\right)t \qquad a_{\text{rad}} = \frac{v^2}{r} \qquad C = 2\pi r$$

$$\sum \vec{F} = m\vec{a} \qquad w = mg \qquad f_s \le \mu_s N \qquad f_k = \mu_k N$$

For grading use only:

PM 8

N1L 10

N2L 10

CM 10

CA 10

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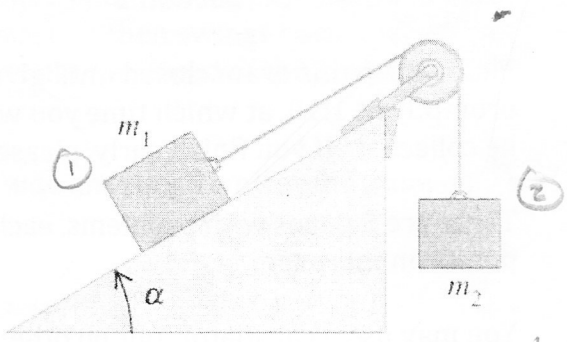
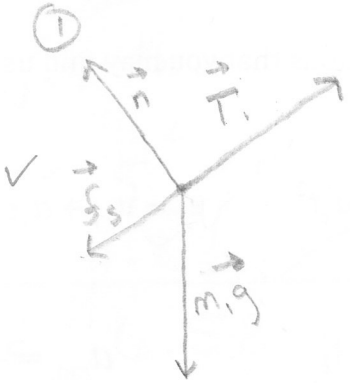
Total 48

Name: [redacted]

Two masses are connected by a thin, light string over a frictionless, massless pulley. The coefficient of static friction between mass 1 and the ramp is 0.400. The coefficient of kinetic friction between mass 1 and the ramp is 0.250. m_1 = 20.0 kg and α = 52.0°.
What is the largest mass, m_2, that can be hung from the string without mass 1 being pulled up the ramp?



good chart!



	x	y
$\vec{T}_1$	T_1	0
$\vec{n}$	0	n
$\vec{f}_s$	$-f_s$	0
$m_1\vec{g}$	$-\sin\theta m_1 g$	$\cos\theta m_1 g$
	0	0

$\mu_s = .4$

$\mu_K = .25$

$m_1 = 20\ kg$

$\theta = 52°$

$m_1 g$

$f_s = .4(n)$

$\Sigma F_x = 0$ $\quad \Sigma F_y = 0$

$\Sigma F_x = \vec{T}_1 + \vec{f}_s + \sin\theta m_1 \vec{g} = 0$ $\quad \Sigma F_y = \vec{n} + \cos\theta m_1 g = 0$

$T_1 - f_s - \sin\theta m_1 g = 0$ $\quad n - \cos\theta m_1 g = 0$

$n = \cos\theta m_1 g$

$f_s = .4(\cos\theta m_1 g)$

$m_2 g - .4\cos\theta m_1 g - \sin\theta m_1 g = 0$

$m_2 9.8 - (\cos\theta 78.4) - 154.45 = 0$

$m_2 9.8 = 154.45 + 48.27$

$m_2 = \frac{202.72}{9.8}$

$m_2 = 20.68\ kg$ ✓

$m_2 = 20.7\ kg$

	x	y
$\vec{T}_1$	0	T_1
$m_2\vec{g}$	0	$M_2 g$
	0	0

$\Sigma \vec{F} = 0$

$\vec{T}_1 + m_2\vec{g} = 0$

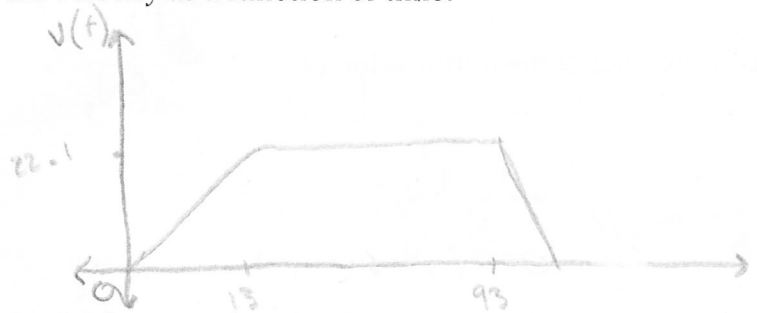
$T_1 - m_2 g = 0$

10

Name: [redacted]

The light rail train starts from rest and speeds up at a rate of 1.70 m/s² for 13.0 seconds. It moves along a long, straight track. It goes at a constant speed for 80.0 s, and then slows down at a rate of 3.40 m/s² until it stops at the next station.

a) Sketch the velocity as a function of time.



b) Find the total distance that the train moves during this time.

$x - x_0 = V_0 t + \frac{1}{2} a t^2$

$V_0 = 0$

$a = 1.7 \text{ m/s}^2$ | $a = 0$ | $a = -3.4$

13 s | 80 s | ? s

① ② ③

$x - x_0 = \frac{1.7}{2}(13^2)$

$x - x_0 = 143.65 \text{ m}$

$V_1 = 22.1 \text{ m/s}$

$V_2 = V_1 + 0 = 22.1 \text{ m/s}$

$V_1 = V_0 + at$

$x - x_0 = V_0(t) + \frac{1}{2} a t^2$

$x - x_0 = 22.1(80) + 0$

$x - x_0 = 1768$

$V^2 = V_0^2 + 2a(x - x_0)$

$0 = (22.1)^2 + 2(-3.4)(x - x_0)$

$-488.41 = -6.8(x - x_0)$

$x - x_0 = 71.825 \text{ m}$

143.65 m + 1768 m + 71.825 m

Total: 1768 + 143.65 + 71.825 = 1983.5 m

Total distance = 1,983.5 m

10

Name [redacted]

A cannon ball is fired with an initial velocity that is unknown. It strikes the castle wall 20.0 seconds later. The castle is a horizontal distance of 3000.0 m away, and sits on top of a cliff, so that the impact of the cannon ball is 450.0 m higher than where it was fired.

a) Find the x and y components of the initial velocity.

"x" comp

$V_{0x} = 150\ m/s$ ✓

y comp

$V_{0y} = 118.5\ m/s$ $(120.5\ m/s)$

b) What was its maximum height above its starting point?

at max height, $V_y = 0$ ✓

$V_y^2 = V_{0y}^2 + 2a(y - y_0)$

$0 = (118.5)^2 + 2a(y - y_0)$

$-14042.25 = -19.6(y - y_0)$

$= 716.44\ m$ wall

max height = 716.4 m

741 m

+2

c) Find the speed at which the cannon ball hit the ground.

x comp

$V_y = V_{0y} + at$

$V_y = 118.5 - 9.8(20)$

$V_y = -77.5\ m/s$ ✓

$V_0 = \sqrt{(V_{0x})^2 + (V_{0y})^2}$

$V_0 = \sqrt{22500 + 6006.25}$

$V_0 = \sqrt{28506.25}$

$|\vec{V_0}| = 168.8\ m/s$

x comp

$V_x = V_{0x} + at$

$V_x = 150\ m/s$

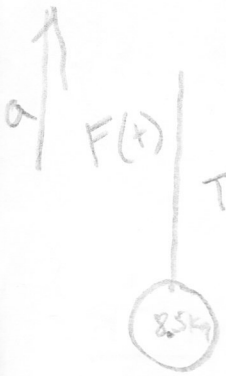
150 m/s, V_0, -77.5

+3

+8

Name: [redacted]

A bowling ball of mass 8.50 kg is attached to the end of a long nylon string. An upward force F(t) is applied to the end of the string, such that the bowling ball's height is given by $y(t) = 3.40t + 0.200t^4$. Find the force F(t) at t = 6.00 seconds.



(derive

$v(t) = 3.4 + .8t^3$

↳ derivation

$a(t) = 2.4t^2$

(a) 6 sec

$a(6) = 2.4(6)^2$

(a 6 sec) $a = 86.4\ m/s^2$ ✓

F(t) = Tension

$\Sigma \vec{F} = m\vec{a}$

$mg = 83.3\ N$

$T - mg = ma$

$T - 83.3\ N = 8.5\ kg\ (86.4\ m/s^2)$

$T = 734.4\ N + 83.3\ N$

$T = 817.7\ N$

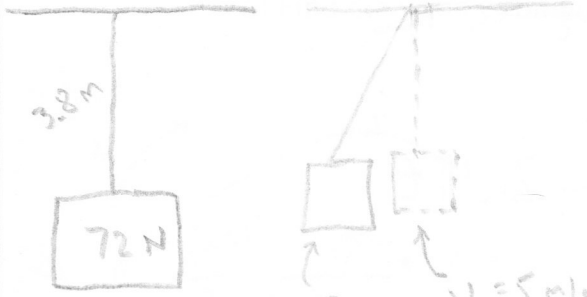
Force @ 6 sec is 817.7 N ✓

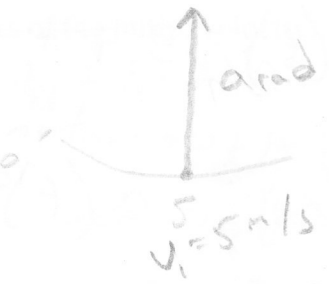
Name: [redacted]

10

A wooden block with a weight of 72.0 N is attached to the ceiling by a rope of length 3.80 m. The block is pulled to one side and released; it then swings back and forth as a pendulum. As the rope swings through the vertical, the speed of the block is 5.00m/s .

a) What is the acceleration of the block (magnitude and direction), at the moment that the rope is vertical?





$R = 3.8$ m

$a_{rad} = \frac{v^2}{R}$

$a_{rad} = \frac{4\pi^2 R}{T^2}$

$a_{rad} = \frac{5^2}{3.8}$

$v = \frac{d}{t}$

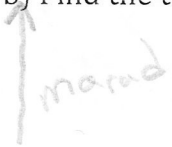
$C = 2\pi r$

$C = 7.6\pi$

$a_{rad} = 6.58\ m/s^2$

$\frac{7.6\pi}{360^\circ}$ $\frac{2\pi r}{1\ rev}$ $\frac{7.6\pi}{1\ rev}$

b) Find the tension in the rope at the moment it is vertical.



$\Sigma \vec{F} = m\vec{a}_{rad}$

$\Sigma \vec{F} = \vec{T} + m\vec{g} = m\vec{a}_{rad}$

$T - mg = ma_{rad}$

$T - 72 = 7.34\ kg\ (6.58\ m/s^2)$

$T = 48.34\ N + 72\ N$

$T = 120.3\ N$

when rope's vertical, the tension is 120 N