5 March 2015

Physics 1307 Examination 2

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Spring 2015

Please PRINT your name so that we can read it.

Name: Solutions

BOX your final answers.
SHOW work for maximum credit.

Be Brilliant!

* Note for Q1: Force always points toward the center of the circle. This could be thought of as "always in same direction" or "constantly changing direction". Accepted both (b) and (c) due to ambiguity in answers.

Q1 2 pts You take a seat on a carousel at some Spring Break location (East Dallas for me). The carousel rotates at a steady rate and your chair traces out a circle as you go around and around. If your chair has a constant speed, what can you say, if anything, about the net force acting on you? Circle the one best answer.

a) The net force is zero since the speed is constant.
b) The net force is not zero and its direction constantly changes.
c) The net force is not zero and points in a constant direction
d) None of the above answers is correct.

Q2 2 pts You toss 2 identical tennis balls from a third-story apartment balcony in a completely horizontal direction, one at a time. The second time you throw the ball its initial speed is twice as great as the initial speed of the first. What can you say about the subsequent motion of the two balls? Ignore air friction. Circle the single best answer.

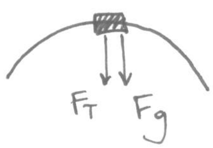
a) The second ball is in the air for twice as long as the first.
b) The first ball is in the air for twice as long as the second.
c) Both balls are in the air for the same amount of time.
d) None of the above answers is correct.

Q3 2 pts You are gazing out a window and notice that a stationary car, after a short while, suddenly begins to coast slowly along the street. What, if anything, can you say about the force or forces acting on this car while you were watching it? Circle the single best answer.

a) You need to know the direction of the car's motion to say anything about possible forces that were or are present.
b) Since you do not know whether or not the car's speed is constant, you cannot say anything about whether any net force acted on the car.

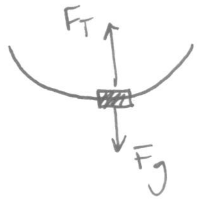
c) There must have been some net force acting on the car while you were watching it.
d) None of the above answers is correct.

Q4 10 pts You are practicing bolo tricks. (A bolo is a rock attached to a strong, flexible string. I demonstrated one with a tennis ball in lecture.) You swing the bolo so that the rock executes uniform circular motion in a vertical plane with a *constant* speed V_0. The tension in the string varies as the rock moves in the vertical circle of radius $r = 1.0\,\mathrm{m}$. When the rock of mass $m = 1.5\,\mathrm{kg}$ is at the bottom of the circle, the tension in the string is T_b. When the rock is at the top of the circle, the tension in the string is T_t. Suppose $T_b = 1.5\,T_t$. What is the speed V_0 of the rock? Hint: Draw a sketch and consider the forces that act on the rock. Do box your answer.



at top of circle:

$$\Sigma F = T_t + mg = ma = \frac{mv^2}{r} \quad ①$$



at bottom of circle:

$$\Sigma F = T_b - mg = ma = \frac{mv^2}{r}$$

$$= 1.5T_t - mg = \frac{mv^2}{r} \quad ②$$

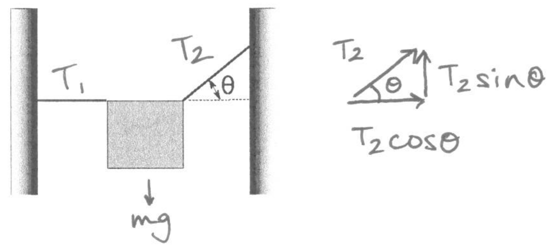
② - ①: $\frac{1}{2}T_t - 2mg = 0$

$\rightarrow T_t = 4mg$, plug into ①: $5mg = \frac{mv^2}{r}$

$$V = \sqrt{5gr} = 7\ \mathrm{m/s}$$

$$\boxed{V = 7\ \mathrm{m/s}}$$

Q5 10 pts Your neighbors dry their clothes in the sun using an old-fashioned clothes line. They hang a sheet of mass $m = 5\,\text{kg}$ by two cords attached to vertical walls. One cord is horizontal while the other makes an angle $\theta = 45°$ with respect to the horizontal. See the figure. Find the tension forces in the two cords. Box your answer.



sheet in equilibrium: $\sum F = 0$

$$\sum F_x = T_1 - T_2 \cos\theta = 0$$

$$\sum F_y = T_2 \sin\theta - mg = 0$$

from y-equation we have: $T_2 \sin\theta = mg$

$$T_2 = \frac{mg}{\sin\theta} = \frac{(5\,\text{kg})(9.8\,\text{m/s}^2)}{\sin(45)}$$

$$\boxed{T_2 = 69.3\,\text{N}}$$

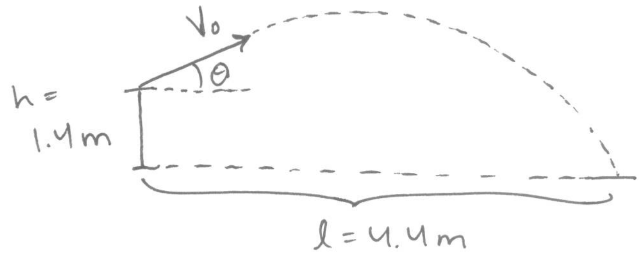
use T_2 in x-equation:

$$T_1 = T_2 \cos\theta = (69.3\,\text{N})\cos(45)$$

$$\boxed{T_1 = 49.0\,\text{N}}$$

* Note: many students used the range equation $\left(R = \frac{V^2}{g}\sin(2\theta_0)\right)$ for this problem; However, this is ONLY valid when the starting and ending heights of the projectile are equal, which is NOT the case here.

Q6 10 pts You decide to annoy your roommate who is sleeping on the grass. You shoot water from a garden hose that is pointed 25 degree above the horizontal onto your roommate lying on the ground $l = 4.4$ m away in the horizontal direction. If you hold the hose $h = 1.4$ m above the ground, what speed V_0 does the water leave the nozzle? Hint: Consider how long is the water in the air and be sure to put on your x-glasses and your y-glasses. Box your answer.



x direction: $a_x = 0$

$$x_f = x_i + V_{0x} t + \frac{1}{2} a_x t^2$$

$$\Delta x = V_{0x} t$$

$$l = V_0 \cos(\theta) t, \quad V_0 = \frac{l}{\cos(25) t}$$

$$t = \frac{l}{V_0 \cos(25)}$$

plug into

y direction:

$$y_f = y_i + V_{0y} t + \frac{1}{2} a_y t^2 \quad (y_f = 0)$$

$$-y_i = V_0 \sin\theta \, t - \frac{1}{2} g t^2$$

$$\frac{1}{2} g t^2 = V_0 \sin\theta \cdot \frac{l}{V_0 \cos\theta} + y_i$$

$$t = \left[\frac{2l}{g}\tan\theta + \frac{2y_i}{g}\right]^{1/2} = \left[\frac{2(4.4\text{m})}{9.8\text{m/s}^2}\tan(25) + \frac{2(1.4\text{m})}{9.8\text{m/s}^2}\right]^{1/2}$$

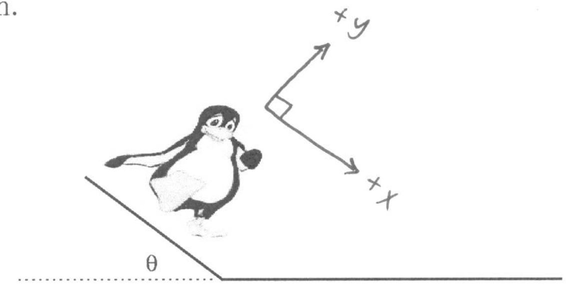
$$\approx 0.84\text{s}$$

use this time in x-direction equation for V_0:

$$V_0 = \frac{l}{\cos\theta \cdot t} = \frac{(4.4\text{m})}{\cos(25)(0.84\text{s})} \approx 5.78 \text{ m/s}$$

$$\boxed{V_0 = 5.78 \text{ m/s}}$$

Q7 10 pts A penguin of mass m slides with *constant* velocity of 1.4 m/s down an icy incline. The incline slopes above the horizontal at $\theta = 6.9°$. See the figure. At the bottom, the penguin slides on a horizontal patch of ice. The coefficient μ of (kinetic) friction is the same for the incline and the horizontal patch.



a) 5 pts What is the coefficient of friction μ? Recall that the magnitude of the frictional force acting on an object is the coefficient of friction times the normal force acting on that object. Box that answer.

constant velocity, so $a = 0$, $\Sigma F = 0$:

$\Sigma F_x = mg\sin\theta - f = 0 = mg\sin\theta - \mu F_N \Rightarrow mg\sin\theta = \mu F_N$

$\Sigma F_y = F_N - mg\cos\theta = 0 \Rightarrow F_N = mg\cos\theta$

$mg\sin\theta = \mu mg\cos\theta$, $\mu = \frac{\sin\theta}{\cos\theta} = \tan\theta = \tan(6.9)$

$\boxed{\mu = 0.12}$

b) 5 pts How much time t is required for the penguin to slide to a stop after entering the horizontal patch? If you could not determine μ from part (a) above, assume $\mu = 0.1$ and proceed. BBBBox your answer.

$$\Sigma F = \mu F_N = ma$$

$$\mu mg = ma \implies a = \mu g \text{ (in negative x-direction)}$$

$$= -\mu g$$

$$\cancel{V_f}^{0} - V_i = at$$

$$t = \frac{-V_i}{-\mu g} = \frac{V_i}{\mu g} = \frac{(1.4\ m/s)}{(.12)(9.8 m/s^2)}$$

$$\boxed{t = 1.19\ s}$$