NAME:.....

POINTS: .....

Dr. Fritz Wilhelm, Diablo Valley College, Physics Department

TEST 130 #1(chapter 1-6, Serway, 1-5 Giancoli); September 19, 2011

NOTE: **TO ENSURE FULL CREDIT EMPHASIZE YOUR ANSWERS AND INCLUDE DIMENSIONS. SPECIFY WHICH PRINCIPLES OR LAWS YOU ARE USING. EXPLAIN BRIEFLY WHAT YOU ARE TRYING TO DO. ORGANIZE YOUR WORK LOGICALLY. USE DRAWINGS! Do not use more than three significant figures, unless required. Use vector arrows where indicated.**

$$G = 6.673\times10^{-11};\ \vec{a}_c = -\frac{v^2}{r}\vec{u}_r = -\omega^2 r\vec{u}_r = -\frac{4\pi^2}{T^2}r\vec{u}_r;\ F_g = \frac{m_1 M}{r^2}G;\ g = 9.80\frac{m}{s^2};\ 1mile = 1610m$$

1. [10] An amusement park ride consists of a large rotating cylinder that spins around its central axis fast enough that any person inside is held up against the wall when the floor drops away. The coefficient between the person and the wall is μ_s and the radius of the cylinder is R. a) Show that the maximum period of revolution necessary to keep the person from falling is $T = 2\pi\sqrt{\frac{R\mu_s}{g}}$

   Draw a sketch of the situation and include all forces acting on the person. Show the radial unit vector. Use Newton's second law!

Find the period T if the radius is 10.0 m, and the coefficient of friction is 0.9.
6.02s

2. [10] A player kicks a football horizontally off the top of a cliff 60.0 m high. The player hears the ball splash into the water after 4.00s. The speed of sound in this situation is 343 m/s. Find the horizontal distance the ball travels and the initial velocity of the football. (Make a sketch to describe the situation, including the approximated path of the football and the path of sound. Indicate the choice of direction for your y-axis.)

$$t_1 = \sqrt{\frac{2y}{g}} = 3.50s;\ z = \mathrm{v}_s \cdot (t_2 - t_1) = 343 \cdot 0.5m = 171.5m$$

$$x = \sqrt{z^2 - y^2} = 161m;\ \mathrm{v}_{0x} = \frac{x}{t_1} = 45.9\frac{m}{s}$$

3. Two particles move in opposite directions, particle A moves with a speed of 0.9000c to the right, particle B moves with speed 0.8000c to the left. Find the relative velocity of particle A with respect to B. (You need relativistic formulas, c is the speed of light.)

0.9884c

4. [10] A projectile is fired in such a way that its horizontal range (maximum horizontal distance) is equal to three times its maximum height. What is the angle of projection? Start with the kinematic equations in the horizontal and vertical directions. Derive the general formula for the range and the maximum height. Draw a sketch with the approximate path of the projectile.

$$R = \frac{2v_0^2 \sin\theta\cos\theta}{g} = 3h = 3\frac{v_0^2 \sin^2\theta}{2g} \Rightarrow \tan\theta = \frac{4}{3} \Rightarrow \theta = 53.1°$$

5. A train is made of 3 cars and a locomotive. The locomotive and the cars are connected by chain, which can be assumed to be mass less. The first car has a mass of 300kg, the second has a mass of 200kg, and the third has a mass of 100kg. The locomotive pulls with a force of 1000 N . The coefficient of kinetic friction between each car and the rails is 0.1. Draw a sketch.

a) [5] Find the acceleration of the train.

Use Newton's second law!

$$-\mu\left(m_1+m_2+m_3\right)g+F=\left(m_1+m_2+m_3\right)a$$

$$a=0.69\frac{m}{s^2}$$

b)[5] Find the tension between the first and the second car.

$$F-\mu m_1 g-T_1=m_1 a\Rightarrow T_1=F-\mu m_1 g-m_1 a=1000-30\cdot 9.8-300\cdot 0.69=500N$$

6. A pilot flies a plane in a vertical circular loop of radius 1,400m. She has a mass of 65kg. a) When she is at the highest point of the loop with a speed of 100m/s find her apparent weight.

Use Newton's second law!

$$N=m(g-\frac{v^2}{R})=173N$$

b) Find her apparent weight at the bottom of the loop when she enters it with the 200m/s.

$N=m(g+\frac{v^2}{R})$=2494N=4 times her weight.

7. [10] You are given two vectors $\vec{A}$ and $\vec{B}$. $\vec{A}=\langle 2,-3,7\rangle$ $\vec{B}=\langle 8,-2,-10\rangle$

a) Find the angle between the two vectors, using the dot product.

$$16+6-70=\sqrt{4+9+49}\cdot\sqrt{64+4+100}\cos\theta$$

$$\cos\theta=\frac{-48}{102}\Rightarrow\theta=118°$$

b) Find the cross product $\vec{A}\times\vec{B}$

$$\begin{vmatrix}\vec{i} & \vec{j} & \vec{k}\\ 2 & -3 & 7\\ 8 & -2 & -10\end{vmatrix}=\vec{i}\,(30+14)-\vec{j}\,(-76)+\vec{k}\,(20)=\langle 44,76,20\rangle$$

8. [10] A particle moves clockwise in a circle of radius 5.50 m. At a certain instant its resultant acceleration is 15.0 m/s^2 and makes an angle of 30˚ with the radius.

Use Newton's second law!

a) Find the radial acceleration, b) the speed of the particle and c) the tangential acceleration at this instant. Make a drawing and show the radial, the tangential, and the resultant acceleration.

$$a_c=a\cos 30°=13\frac{m}{s^2}=\frac{v^2}{r}\Rightarrow v^2=ra_c=71.5\frac{m^2}{s^2}\Rightarrow v=8.46\frac{m}{s}$$

$$a_\theta=a\sin 30°=7.5\frac{m}{s^2}$$

9. [10] A race car pilot enters an embanked curve of radius 275 m. Find the angle of embankment if he is to be able to engage the curve without skidding at a speed of 85.0 mph without the benefit of friction? (Make a clear drawing showing the car, the angle of embankment, and all forces. Show the radial unit vector.) Derive the formula for your answer.

Use Newton's second law!

$$v = 38.0\frac{m}{s}$$

$$-N\sin\theta = -\frac{mv^2}{r}$$

$$N\cos\theta = mg$$

$$\tan\theta = \frac{v^2}{rg} \Rightarrow \theta = 28.2°$$

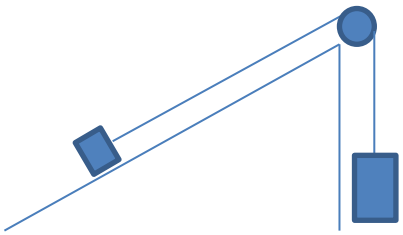
10. [10] A block of 10.0 kg is dragged up an inclined plane by another block of mass 20.0 kg, which is attached to the first one by a string over a pulley. The angle is $35°$.

Use Newton's second law!
The coefficient of kinetic friction of the dragged block is 0.40. If the blocks start from 0 velocity, what is their velocity after the blocks have moved by a distance of 2.00m?

$$-\mu_k m_1 g\cos\theta - m_1 g\sin\theta + T = m_1 a$$

$$-T + m_2 g = m_2 a$$

$$m_2 g - \mu_k m_1 g\cos\theta - m_1 g\sin\theta = m_1 a + m_2 a$$

$$a = g\frac{m_2 - m_1(\mu_k\cos\theta + \sin\theta)}{m_1 + m_2} = 9.8\frac{20 - 10(0.4\cdot 0.82 + 0.5736)}{30} = 3.59\frac{m}{s^2}$$

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