CLASS: PHY_____

STUDENT #: ________________

NAME: ______________________

Assignment 4: Forces and Work

Assigned: Sept 30 14:30 Due: Oct 7 18:00

1 An amusement park ride consists of a large vertical cylinder that spins about its axis fast enough that any person inside is held up against the wall when the floor drops away (Fig. P6.65). The coefficient of static friction between person and 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 $T = (4\pi^2 R\mu_s/g)^{1/2}$. (b) Obtain a numerical value for *T* if *R* = 4.00 m and μ_s = 0.400. How many revolutions per minute does the cylinder make?

In the radial direction: $n = \dfrac{mv^2}{R}$

In the vertical direction: $f - mg = 0$

Using the following $f = \mu_s n$ and $v = \dfrac{2\pi R}{T}$ we get:

$$T = \boxed{\sqrt{\frac{4\pi^2 R\mu_s}{g}}}$$

(b) $T = \boxed{2.54\text{ s}}$ 23.6rev/min

2 Using the definition of the scalar product, find the angle between $\mathbf{A} = \hat{\mathbf{i}} - 2\hat{\mathbf{j}} + 2\hat{\mathbf{k}}$ and $\mathbf{B} = 3\hat{\mathbf{j}} + 4\hat{\mathbf{k}}$.

$\vec{A}\cdot\vec{B} = 1\cdot 0 + (-2)\cdot 3 + 2\cdot 4 = 2$ and $\vec{A}\cdot\vec{B} = \left|\vec{A}\right|\left|\vec{B}\right|\cos\theta$

yields: $\dfrac{2}{(9)(25)} = \cos\theta$

so theta= 89.5deg

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Dr. A. Czajkowski

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Assignment 4: Forces Work CONT

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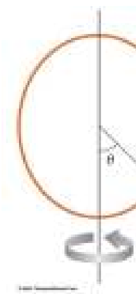
3 A single bead can slide with negligible friction on a wire that is bent into a circular loop of radius 15.0 cm, as in Figure P6.68. The circle is always in a vertical plane and rotates steadily about its vertical diameter with (a) a period of 0.450 s. The position of the bead is described by the angle θ that the radial line, from the center of the loop to the bead, makes with the vertical. At what angle up from the bottom of the circle can the bead stay motionless relative to the turning circle? (b) **What If?** Repeat the problem if the period of the circle's rotation is 0.850 s.



(a) The bead moves in a circle with radius $v = R\sin\theta$ at a speed of

$v = \frac{2\pi r}{T} = \frac{2\pi R\sin\theta}{T}$ The normal force has an inward radial component of $n\sin\theta$ and an upward component of $n\cos\theta$

$\sum F_y = ma_y$: $n\cos\theta - mg = 0$ or $n = \frac{mg}{\cos\theta}$

Then $\sum F_x = n\sin\theta = m\frac{v^2}{r}$ becomes $\frac{mg}{\cos\theta}\sin\theta = \frac{m}{R\sin\theta}\frac{(2\pi R\sin\theta)^2}{T^2}$

which reduces to $\frac{g\sin\theta}{\cos\theta} = \frac{4\pi^2 R\sin\theta}{T^2}$

This has two solutions: $\sin\theta = 0 \Rightarrow \theta = 0°$ and $\cos\theta = \frac{gT^2}{4\pi^2 R}$ If $R = 15.0$ cm and $T = 0.450$ s, the second solution yields $\cos\theta = 0.335$ and $\theta = 70.4°$

Thus, in this case, the bead can ride at two positions $\boxed{\theta = 70.4°}$ and $\boxed{\theta = 0°}$.

(b) At this slower rotation, solution (2) above becomes $\cos\theta = 1.2$ which is impossible. In this case, the bead can ride only at the bottom of the loop, $\boxed{\theta = 0°}$. The loop's rotation must be faster than a certain threshold value in order for the bead to move away from the lowest position.

4 A shopper in a supermarket pushes a cart with a force of 35.0 N directed at an angle of 25.0° downward from the horizontal. Find the work done by the shopper on the cart as he moves down an aisle 50.0 m long.

$$W = \vec{F}\cdot\vec{\Delta r} = |\vec{F}||\vec{\Delta r}|\cos\theta = (35)(50)\cos 25 = 1644.5J$$