PHYS 105 Spring 2018

Quiz 4

A record player is set for 33 1/3 revolutions per minute (rpm). It is found that a penny will stick with the platter as long as its distance from the platter center is less than 15 cm. (A) Draw a free body diagram of the penny sitting on the rotating platter. Show and name all forces acting on the penny. Show the direction of the acceleration (if there is any). (B) Calculate the coefficient of static friction for the penny on the platter.

$\omega = 33\frac{1}{3}\ \frac{rev}{min} \cdot \frac{1\ min}{60\ s} \cdot \frac{2\pi\ rad}{1\ rev} = 3.49\ \frac{rad}{sec}$

$N = mg \qquad f = \mu_s N$ (usually $\leq$ but in this problem at limit)

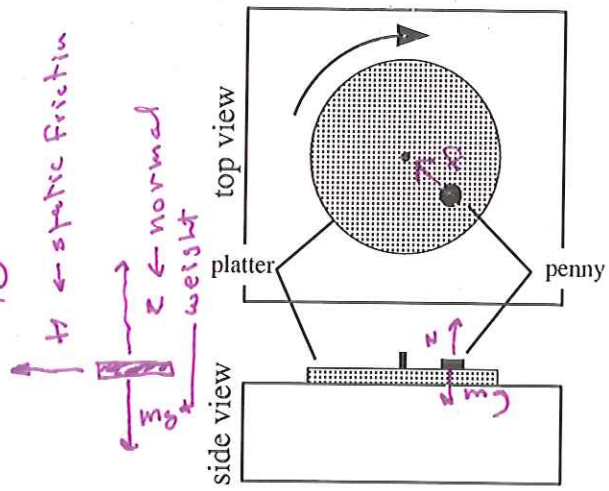
$= ma$

$\mu_s mg = m\omega^2 r \Rightarrow \mu_s = \frac{\omega^2 r}{g}$

$= \frac{(3.49)^2 (.15)}{9.8}$

$= .187$

↑ unitless



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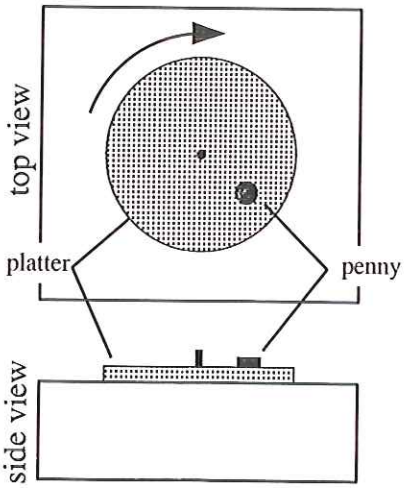

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Quiz 5

Stuntman Rupert has decided his Terminator+bike (mass = 100 kg) should have a horizontal velocity of 14 m/s for the crack-jump scene of Godzilla vs. Terminator. Since he's not really the Terminator, he could not achieve the required speed using his own muscles. So he's decided to build a frictionless ramp out of view of the camera to provide all the required energy. However, the movie frame will include 3 m on the rough surface before the crack (which has a frictional force of 800 N). (A) Calculate the work done by the frictional force as the bike travels over the rough surface. (B) Calculate the bike+rider kinetic energy (at the crack edge) required for a successful jump. (C) Calculate the height h at which Rupert should start.

A: $W = Fd\cos\theta = Fd(-1) = -800 \cdot 3 = -2400\ \text{J}$

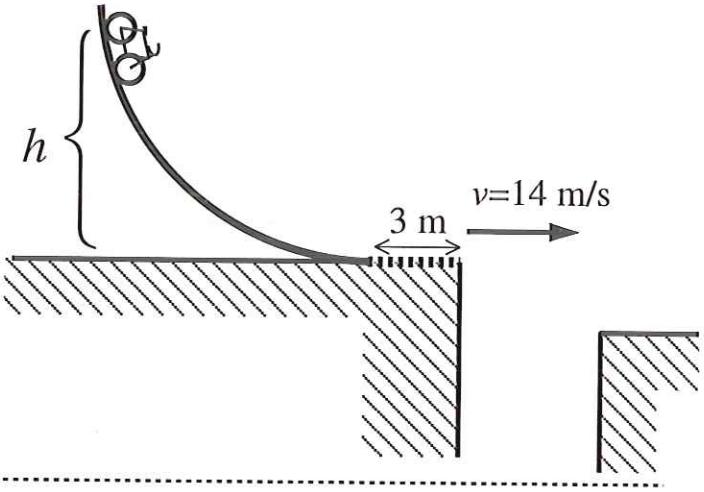
B $KE = \frac{1}{2}mv^2 = \frac{1}{2} \cdot 100 \cdot 14^2 = 9.80 \times 10^3\ \text{J}$

$W_{nc} = (KE_f + PE_f) - (KE_i + PE_i)$

$-2400 \quad 9.8\times10^3 \quad 0 \quad 0 \quad mgh$

$mgh = +2400 + 9.8\times10^3$

$h = \frac{(2400 + 9800)}{100 \cdot 9.8} = 12.5\text{m}$



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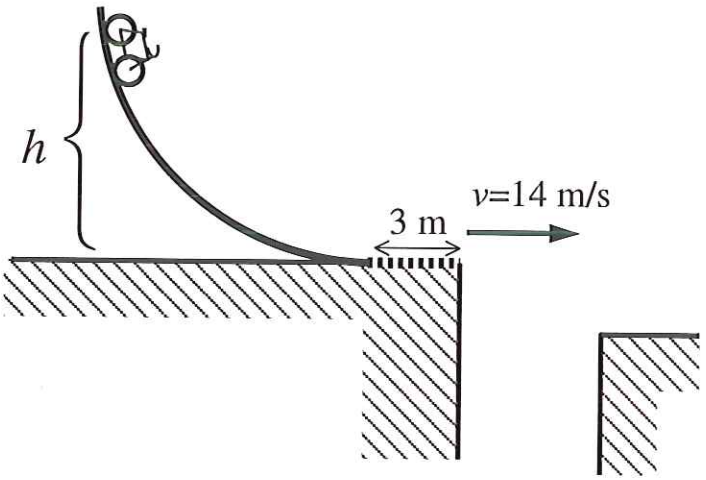

PHYS 105 Spring 2018

Quiz 6

A 5.5 kg bowling ball moving 9 m/s makes an elastic, head-on collision with a .85 kg bowling pin which moves straight ahead (i.e., everything remains in a line). Find the post collision velocities of the bowling ball and bowling pin.

m_1 v_1 m_2 $v_2 = 0$

v_1' v_2'

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2' \quad \text{momentum}$$

$$m_1v_1 = m_1v_1' + m_2v_2'$$

$$m_1v_1 = m_1v_1' + m_2(v_1 + v_1')$$

$$(m_1 - m_2)v_1 = (m_1 + m_2)v_1'$$

$$\frac{(m_1 - m_2)}{(m_1 + m_2)} v_1 = v_1'$$

$$\frac{5.5 - .85}{5.5 + .85} 9 = v_1'$$

$$6.59 \text{ m/s} = v_1'$$

KE conservation is equivalent to

$$(v_1 - v_2) = -(v_1' - v_2')$$

$$v_1 = v_2' - v_1'$$

$$v_1 + v_1' = v_2'$$

$$9 + 6.59 = v_2'$$

$$15.6 \text{ m/s} = v_2'$$

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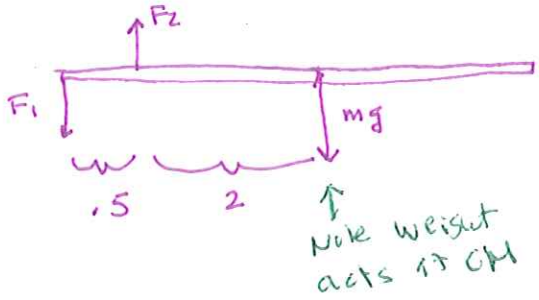
Quiz 7

A straight, uniform pole vault pole is 5 m long and has a mass of 10 kg. A pole vaulter places one hand at the end of the pole and the other hand 50 cm from the pole's end and holds the pole horizontal with no support other than his two hands. Draw a free body diagram showing the pole and where every force is applied. Calculate the force applied by each hand (your diagram should display the direction of these hand forces).



$F_2 - F_1 - mg = 0$

origin F_2 → $F_2 \cdot 0 + F_1(.5) - mg(2) = 0$

$F_1 = \frac{2}{.5} mg = 4 \cdot 10 \cdot g$

$= 392\ N$

origin F_1 $F_1 \cdot 0 + F_2(.5) - mg(2.5) = 0$

$F_2 = \frac{2.5}{.5} mg = 5 \cdot 10 \cdot 9$

$= 490\ N$

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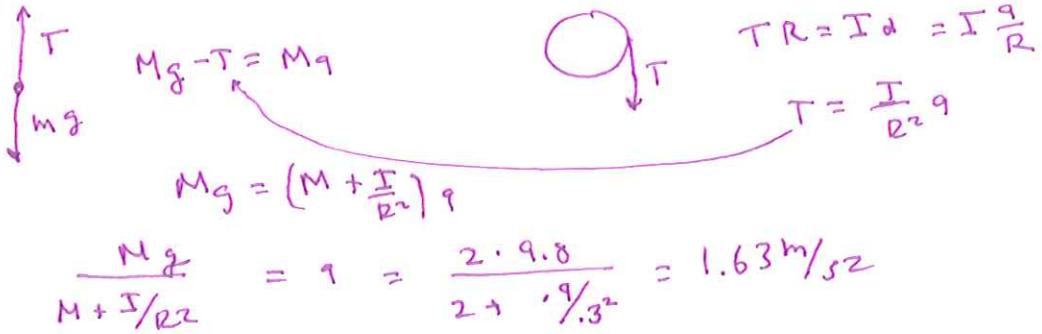
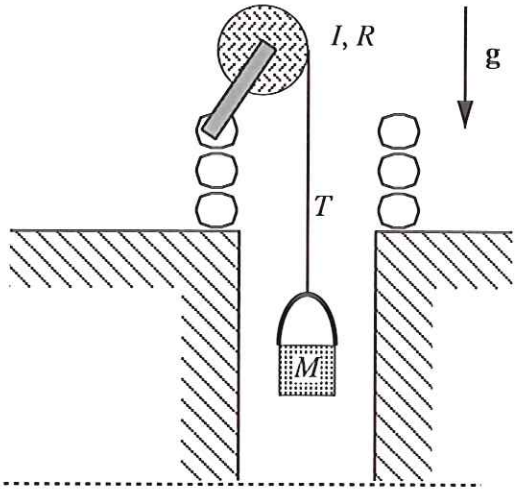
Quiz 8

An old stone well consists of a bucket (mass M=2 kg) and a reel with crank (moment of inertia I= 0.9 kg m^2 and radius R=.3 m) to pull the bucket up. The bucket is released from the top of the well; as it falls it pulls the rope down and, as a result, the crank assembly runs backward. Find the acceleration of the bucket. Of course, your answer will include two free body diagrams: one of the forces on the bucket and one of the torques on the reel.





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