Your Name: _____

PHY203
Exam #3
Chapters 9-11,15
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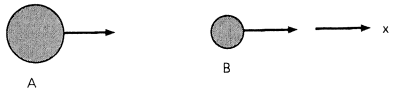
Wed, April 30, 2025

Solutions

S25

PHY203Exam3Makeup F24



1. A disk (A) of mass 9.50 kg is traveling on a frictionless surface in the +x direction with a speed of 15.5 m/s. It collides with a disk (B) of mass 8.00 kg that had been traveling in the +x direction with a speed of 10.5 m/s. The disks stick together.

a. List the known quantities before the collision:

Parameter	Known Value
M_A	9.50 kg
v_A	15.5 m/s
M_B	8.00 kg
v_B	10.5 m/s

b. Find the linear momentum of each disk before the collision and write them in vector notation. **10**

$\vec{p_A} = (9.50)(15.5) = 147\,\hat{i}$ kg m/s

$\vec{p_B} = (8.00)(10.5) = 84.0\,\hat{i}$ kg m/s

c. Draw a sketch of the situation just after the collision. **5**

d. Find the total momentum of disk AB in vector notation after the collision: **10**

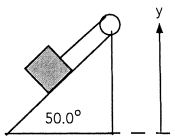
$\mathbf{p_{AB}} =$ $147 + 84 = 231\,\hat{i}$ kg m/s

e. Find the velocity of disk AB after the collision and write it in vector notation. **10**

$231 = (m_A + m_B) v_f$

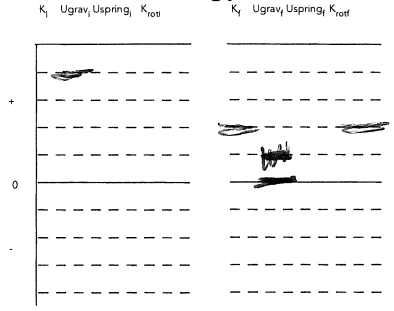
$v_f = \frac{231}{17.5} = 13.2$

$\vec{v_f} = 13.2\,\hat{i}$ m/s



2. A block on a frictionless ramp is attached to a light string wrapped around a pulley. Given m for the block and M and R for the pulley (a solid disk). Assume the block starts from rest at a height of 5.00 m. We want to find the speed of the block when it has reached the bottom of the ramp.

a. Create energy bar charts. **5**



Given m=5.50 kg, M=4.00 kg, and R=0.500 m.

b. Find the initial energy of the block. ~~10~~ 5

$$U_{grav} = mgh = (5.5)g(5) = 270\,J$$

c. Using Conservation of Energy, find the speed of the block when it has just reached the bottom of the ramp. ~~20~~ 25

$$270 = \frac{1}{2}mv^2 + \frac{1}{2}Iw^2$$

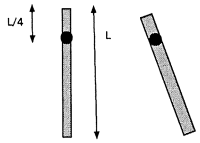
$$= \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{1}{2}MR^2\right)\left(\frac{v}{R}\right)^2$$

$$= \frac{1}{2}v^2\left(m + \frac{M}{2}\right)$$

$$= \frac{1}{2}v^2\left(5.5 + \frac{4}{2}\right) = \frac{7.5}{2}v^2$$

$$v^2 = 270\left(\frac{2}{7.5}\right) = 71.94$$

$$v = 8.48\ m/s$$



3. A thin rod of mass 2.50 kg and length L = 3.00 m is pinned through a point ¼ of the way from its end, as shown above. The rod is set into small oscillation about that pivot point at t=0 with an amplitude of 12.0°.

a. Identify and list the known quantities (in SI units) (these could include m,A,x,t,v,a,E,T,f,ω, …)

$m = 2.50\ kg,\ L = 3.00\ m,\ \theta_0 = 12.0^\circ$

b. Find the moment of inertia of the rod <u>about its center</u>. ~~10~~ 5

$I = \frac{1}{12} M L^2 = \frac{1}{12}(2.50)(3.00)^2 = 1.88\ kg\,m^2$

c. Find the moment of inertia of the rod about its pivot point.(<u>Hint:</u> you must use the parallel axis theorem.) **10**

$I = I_{CM} + Mh^2 = 1.88 + 2.5\left(\frac{L}{4}\right)^2$

$= 1.88 + 2.5\left(\frac{3}{4}\right)^2 = 3.29$

d. Find the period of the rod. **10**

$T = 2\pi\sqrt{\frac{I}{Mgd}} = 2\pi\sqrt{\frac{3.29}{2.50g(1/4)}}$

$= 2.46\ s$

e. Write an equation of motion of the rod, θ vs. t. **5**

$\omega = \frac{2\pi}{T} = \frac{2\pi}{2.46} = 2.37\ rad/s$

$\theta = 12.0^\circ \cos 2.37t$