Your Name: ________________________ **PHY203**

Final Exam 3
Chapters 8-10
Mon, 5/9/11

Part 3

Solutions

1. Masses are placed on the *x* axis as follows: a 1.0 kilogram uniform sphere at $x = 0$, a 2.0 kilogram uniform sphere at $x = 2.0$ m, and a uniform 2.0 kilogram rod with a length of 1.0 m placed along the *x* axis from $x = 0$ to $x = 1.0$ m. Find the *x* position of the center of mass.

a. 0.25 m
b. 0.50 m
c. 0.75 m
d. 1.0 m
e. 1.25 m

$$\frac{m_1x_1 + m_2x_2 + m_r(L/2)}{m_1 + m_2 + m_r} = \frac{(1.0\text{ kg})(0) + (2.0\text{ kg})(2.0) + (2.0\text{ kg})((1.0\text{ m})/2)}{(1.0\text{ kg}) + (2.0\text{ kg}) + (2.0\text{ kg})}$$

2. A crash test car contains a crash test dummy. If the car is moving at a speed of 75 km/h (20.9 m/s) when it crashes into a wall and stops, calculate the magnitude of the total impulse imparted to the 77.3-kg crash test dummy sitting in the automobile during the collision.

a. $1.62\text{x}10^3$ kg·m/s
b. $3.24\text{x}10^3$ kg·m/s
c. $1.16\text{x}10^4$ kg·m/s
d. $5.8\text{x}10^4$ kg·m/s
e. None of the above

<u>answer</u> = Impulse = mv = (77.3 kg) (20.9 m/s) = $1.62\text{x}10^3$ kg·m/s

3. Point masses are placed as follows along the x-axis: 1kg at x=0, 2kg at x=1m, and 3kg at x=2m, all connected by a massless rod.
Assuming the rod-mass combination is rotating about the y-axis with an angular speed of 5rad/s, find the magnitude of the angular momentum:

a. 1.6 kgm^2/s
b. 2.8 kgm^2/s
c. 40.0 kgm^2/s

d. 70.0 kgm²/s
e. none of the above

$L=Iw = (\sum mr^2)w = [(1kg)(0)^2 + (2kg)(1m)^2 + (3kg)(2m)^2](5rad/s)$

4. Let the vector **A** = – 4**j** and **B** = 3**j**. Find the vector **A** x **B**:
a. 0
b. -12**i**
c. +12**i**
d. -12**k**
e. +12**k**

Ax**B**= (-4**j**) x (3**j**) = -12(**j** x **j**) = 0

5. Let the vector **A** = -4**i** + 5**j** and **B** = 2**i** - 3**k**. Find the vector **A** x **B**:
a. +15**i** -12**j** - 10**k**
b. -15**i** +12**j** - 10**k**
c. -15**i** -12**j** -+10**k**
d. +15**i** -12**j** + 10**k**
e. None of the above

Ax**B**= (-4**i** + 5**j**) x (2**i** -3**k**) = -8(**i** x **i**) + 12(**i** x **k**) +10(**j** x **i**) - 15(**j** x **k**)
= 0 -12**j** - 10**k** – 15**i** = – 15**i** -12**j** - 10**k**

For problems 6-10:
Two pucks collide on a frictionless horizontal surface, as shown below. Before the collision, puck 1 (mass=4kg) is traveling in the positive x-direction with a speed of 3.5m/s and puck 2 (mass=3kg) is traveling in the negative x-direction with a speed of 2.5m/s. After the collision, puck 1 travels off at an angle of 30^0 with respect to the x-axis at a speed of 3m/s.

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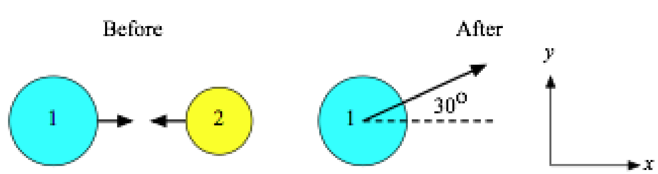


6. Find the momentum of puck #2 before the collision.
a. -7.5i kgm/s
b. -2.5**i** kgm/s
c. +2.5**i** kgm/s
d. +7.5**i** kgm/s
e. none of the above

$\mathbf{p_2}$ = (3kg)(-2.5m/s**i**)

7. Find the total momentum of the system before the collision.
a. +1.0i kgm/s
b. +6.5i kgm/s
c. +15.9**i** kgm/s
d. +21.5**i** kgm/s
e. +15.9 kgm/s

$\mathbf{p_0}$ = (4kg)(3.5m/s**i**)+ (3kg)(-2.5m/s**i**)

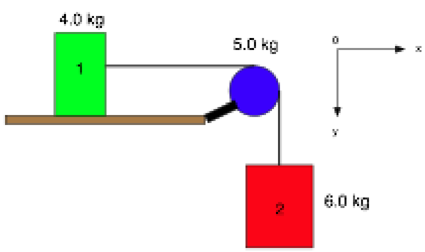
8. What is the total momentum of the system after the collision?
a. less than before the collision
b. the same as before the collision
c. more than before the collision
d. not enough information is given

9. Find the x-component of the velocity of puck #2 after the collision.
a. -5.1m/s
b. -1.3m/s
c. +0.1m/s
d. +1.3m/s
e. +5.6m/s

6.5kgm/s = (4kg)(v_{1x}) + (3kg)(v_{2x})= (4kg)(3m/s)(cos30^o) + (3kg)(v_{2x})
= 10.4kgm/s + (3kg)(v_{2x})

10. Find the y-component of the velocity of puck #2 after the collision.
a. -2.0m/s
b. -1.5m/s
c. +1.5m/s
d. +2.0m/s
e. none of the above

0 = (4kg)(v_{1y}) + (3kg)(v_{2y})= (4kg)(3m/s)(sin30^o) + (3kg)(v_{2y})
= (6.0kgm/s + (3kg)(v_{2y})



11. A 4.0 kg block is resting on a horizontal, frictionless table, as shown. It is attached to a 6.0 kg block with a massless string. The string passes over an M = 5.0 kg pulley which is a solid disk with a radius of R = 0.5 m. The blocks are released. Use g=9.81m/s^2.

a. Calculate the moment of inertia of the pulley.

I = $\frac{1}{2}MR^2 = \frac{1}{2}(5.0\text{kg})(0.5\text{m})^2 = 0.625\ \text{kgm}^2$

b. Using the symbols m_1, T_1, a, and g , and using the given coordinate system, write out Newton's 2nd Law for block 1 in the x direction.

$T_1 = m_1a$

b. Using the symbols m_2, T_2, a, and g , and using the given coordinate system, write out Newton's 2nd Law for block 2 in the y direction.

$m_2g-T_2 = m_2a$

d. Using the symbols T_1, T_2, M, R, and a, write out the torque equation for the pulley.

$(T_2-T_1)R = (\frac{1}{2}MR^2)\alpha$

e. Combine the 3 equations to find the linear acceleration of the blocks <u>and</u> the angular acceleration of the pulley.

$m_2g = (m_1 + m_2)a + (\frac{1}{2}MR)\frac{a}{R} = (m_1 + m_2 + \frac{1}{2}M)a$

$a = \frac{(6.0\,kg)(9.81\,m/s^2)}{4.0\,kg + 6.0\,kg + (0.5)(5.0\,kg)} = 4.71\ m/s^2$

$a = a/R = (4.71\ m/s^2)/(0.5\ m) = 9.42\ rad/s^2$