

Your Name: _____

PHY203
Final Exam
5/5/08

Part 3

Solutions

1. A 10kg duck is flying North at 5m/s. A second duck of mass 5kg is flying North at 10m/s. Find the velocity of the center of mass:

- a. 0
 b. 3.0 m/s
 c. 5.0 m/s
d. 6.67 m/s
 e. 15.0 m/s

$$v_{cm} = [(10\text{kg})(5\text{m/s}) + (5\text{kg})(10\text{m/s})]/(15\text{kg})$$

2. A wheel is spinning with a constant angular velocity of $\omega = 4 \text{ rad/s}$. Find the number of revolutions the wheel has made after 1 min.:

- a. 0.64 rev
 b. 19.1 rev
c. 38.2 rev
 d. 76.4 rev
 e. none of the above

$$q = 0 + (4\text{rad/s})(60\text{s}) = (240\text{rad})/(2\pi)$$

For problems 3-5:

A wheel is spinning with a constant angular velocity of $\omega = 40 \text{ rad/s}$. A torque is applied to the wheel causing it to slow down to rest in 80 sec. The wheel is a solid disk of mass 2kg and radius 0.5m.

3. Find the moment of inertia of the wheel:

- a. 0.125 kgm^2
b. 0.25 kgm^2
 c. 0.5 kgm^2
 d. 1.0 kgm^2
 e. 25 kgm^2

$$I = \frac{1}{2}mr^2 = \frac{1}{2}(2\text{kg})(0.5\text{m})^2$$

4. Find the angular acceleration of the wheel:

- a. 0.5 rad/s^2**
 b. 1.0 rad/s^2
 c. 2.0 rad/s^2
 d. 5.0 rad/s^2
 e. 20.0 rad/s^2

$$\omega = \omega_0 + at = 0 = 40\text{rad/s} + (a)(80\text{s})$$

5. Find the torque:

- a. 0.0625 Nm
b. 0.125 Nm
 c. 0.625 Nm
 d. 1.25 Nm

$$\tau = I\alpha = (0.25 \text{ kgm}^2)(0.5 \text{ rad/s}^2)$$

e. none of the above

6. Let the vector $\mathbf{A} = 5\mathbf{i} - 4\mathbf{j}$ and $\mathbf{B} = 3\mathbf{i}$. Find the vector $\mathbf{C} = \mathbf{A} \times \mathbf{B}$:

a. $-12\mathbf{k}$ $\mathbf{C} = (5\mathbf{i} - 4\mathbf{j}) \times (3\mathbf{i}) = 15(\mathbf{i} \times \mathbf{i}) - 12(\mathbf{j} \times \mathbf{j}) = 0 - (-12\mathbf{k})$

b. $+12\mathbf{k}$

c. $-15\mathbf{i} - 12\mathbf{k}$

d. $-15\mathbf{i} + 12\mathbf{k}$

e. $15\mathbf{i} - 12\mathbf{k}$

For problems 7-9:

2 bicycles collide and get tangled up so they keep moving together after the collision. Before the collision, one bike (mass=100kg) is traveling East at 10m/s. The second bike (mass=75kg) is traveling West at 20m/s.

7. Find the total momentum of the bikes before the collision:

a. East at 500 kgm/s $p = mv = (100\text{kg})(10\text{m/s}) + 75\text{kg}(-20\text{m/s})$

b. **West at 500 kgm/s**

c. East at 2500 kgm/s

d. West at 2500 kgm/s

e. none of the above

8. Find the total momentum of the bikes after the collision:

a. **Same as in #7** momentum is conserved-same as #7

b. Same magnitude as in #7, opposite direction

c. 1/2 of the answer in #7

d. twice the answer in #7

e. Not enough information is given

9. Find the velocity of the tangled up bikes after the collision:

a. East at 2.9 m/s $v = p_{\text{tot}}/m_{\text{tot}} = (500 \text{ kgm/s})/(175\text{kg})$

b. **West at 2.9 m/s**

c. East at 14.3 m/s

d. West at 14.3 m/s

e. West at 15.0 m/s

10. Young Albert Einstein is playing with a model train set. He gets the train (mass 3kg) going at a speed of 4m/s along a straight section of track. As the train passes by him, he drops a stone (mass 0.5kg) which lands on the train and stays there. Find the speed of the train after the stone has landed:

a. 2.4 m/s $v = p_{\text{tot}}/m_{\text{tot}} = (3\text{kg})(4\text{m/s})/(3.5\text{kg})$

b. **3.4 m/s**

c. 4.0 m/s

d. 4.8 m/s

e. none of the above

11. A ball of mass 2kg traveling at a speed of 5m/s strikes a rod of length 3m and mass 4kg and sticks to it. The rod is hanging from and pivots about an axis at its top end (labeled A).



a. Calculate the momentum of the ball before the collision and express it in vector notation, assuming the ball is initially traveling in the positive x-direction.

$$\mathbf{p}_i = (2\text{kg})(5\text{m/s}) = 10\text{kgm/s}\mathbf{i}$$

b. Calculate the angular momentum of the system about point A just before the collision and express it in vector notation, assuming out-of-the-paper is the positive z-direction.

$$\mathbf{L} = \mathbf{r} \times \mathbf{p} = (3\text{m})(10\text{kgm/s})(\sin 90) = 30\text{kgm}^2/\text{s}\mathbf{k}$$

c. Find the angular momentum of the system after the collision as a vector.

$$\text{same} = 30\text{kgm}^2/\text{s}\mathbf{k}$$

d. Calculate the moment of inertia of the rod about its end before the collision.

$$I = (1/3)ML^2 = (1/3)(4\text{kg})(3.0\text{m})^2 = 12\text{kgm}^2$$

e. Calculate the moment of inertia of the ball+rod system after the collision.

$$I = I_{\text{rod}} + mr^2 = 12\text{kgm}^2 + (2\text{kg})(3\text{m})^2 = 30\text{kgm}^2$$

f. Calculate the angular velocity of the ball+rod system after the collision.

$$L = I\omega = 30\text{kgm}^2/\text{s} = (30\text{kgm}^2)\omega$$

$$\omega = 1\text{rad/s}$$