PHY2053 General Physics I

Section 606232

Prof. Douglas H. Laurence

Exam 3 (Chapters 10, 11)

December 5, 2018

Name: ______________________________

Instructions:

This exam is composed of **10 multiple choice questions** and **4 free-response problems**. To receive a perfect score (100) on this exam, 3 of the 4 free-response problems must be completed. The fourth free-response problem **may <u>not</u> be answered for extra credit**. Each multiple choice question is worth 2.5 points, for a total of 25 points, and each free-response problem is worth 25 points, for a total of 75 points. This means that your exam will be scored out of 100 total points, which will be presented in the rubric below. **Please do not write in the rubric below; it is for grading purposes only.**

Only scientific calculators are allowed – do not use any graphing or programmable calculators.

For multiple choice questions, no work must be shown to justify your answer and no partial credit will be given for any work. However, for the free response questions, **work must be shown to justify your answers.** The clearer the logic and presentation of your work, the easier it will be for the instructor to follow your logic and assign partial credit accordingly.

The exam begins on the next page. **The formula sheet is attached to the end of the exam.**

Exam Grade:

Multiple Choice	
Problem 1	
Problem 2	
Problem 3	
Problem 4	
Total	

MULTIPLE CHOICE QUESTIONS

1. A wheel spinning at 15 rad/s has a brake applied to it, stopping the wheel in 2 revolutions. What angular acceleration did the brake apply on the wheel?
   (a) -0.60 rad/s
   (b) -8.95 rad/s
   (c) -17.9 rad/s
   (d) -56.2 rad/s
2. A hollow sphere, a solid cylinder, and a hollow cylinder are all released from rest at the top of a ramp. Which object reaches the bottom of the ramp first?
   (a) The hollow sphere
   (b) The solid cylinder
   (c) The hollow cylinder
   (d) They all reach the bottom of the ramp at the same time
3. A hollow sphere, a solid cylinder, and a hollow cylinder are all released from rest at the top of a ramp. Which object reaches the bottom of the ramp with the largest velocity?
   (a) The hollow sphere
   (b) The solid cylinder
   (c) The hollow cylinder
   (d) They all reach the bottom of the ramp with the same velocity
4. What is the formula for the moment of inertia of a hollow cylinder rotating about an axis at its edge?
   (a) $I = \frac{1}{2}MR^2$
   (b) $I = MR^2$
   (c) $I = \frac{3}{2}MR^2$
   (d) $I = 2MR^2$
5. A meter stick is held such that it rotates at its end. If the meter stick has a mass of 100g, how much torque does gravity produce?
   (a) 0 Nm
   (b) 0.5 Nm
   (c) 0.75 Nm
   (d) 1 Nm
6. A wheel is placed at the top of an incline. What force acting on the wheel produces the torque responsible for rolling the wheel down the incline?
   (a) Gravity
   (b) Friction
   (c) The normal force
   (d) It depends on which point on the wheel you consider to the be the axis
7. An ice skater with her hands pulled in towards her body is going to have a smaller moment of inertia than with her hands outstretched.
   (a) True
   (b) False

8. An ice skater has a moment of inertia of 3.5 kgm^2 with her arms outstretched and 1.3 kgm^2 with her arms tucked in. If she spins at 200 rpm with her arms tucked in, how fast does she spin with her arms outstretched?

   (a) 44 rpm
   (b) 74 rpm
   (c) 538 rpm
   (d) 910 rpm

9. The angular momentum of a system will be conserved if what condition is satisfied?

   (a) The net external force on the system is zero
   (b) The net external torque on the system is zero
   (c) The net internal force on the system is zero
   (d) The net internal torque on the system is zero

10. Two children sit on a seesaw. One child, 35kg, sits 50cm from the seesaw's pivot. If the second child is 25kg in mass, how far must the child sit from the pivot for the seesaw to be balanced?

   (a) 25cm
   (b) 36cm
   (c) 44cm
   (d) 70cm

FREE-RESPONSE PROBLEMS

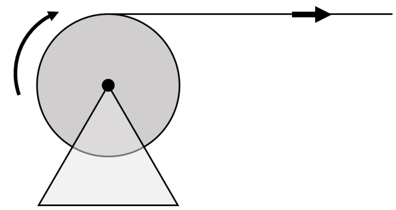
1. A cyclist is riding her bicycle at 15 m/s when she applies the brakes, coming to a stop in 40m. Note that the radius of the bicycle's wheel is 17cm.

a) What was the initial angular velocity of the wheel?

b) What is the angular acceleration of the wheel during the breaking process?

c) What is the linear acceleration of the bicycle during the breaking process?

d) How long does it take the cyclist to stop?

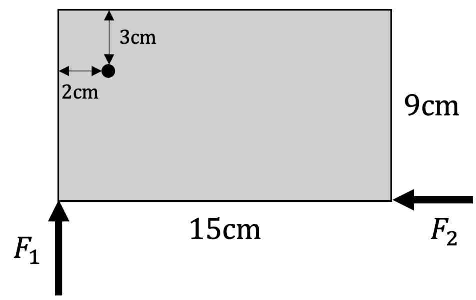


2. A light string, wound tightly around a solid cylinder, is pulled with a force of 20N as shown in the figure above. The cylinder has a mass of 2.3kg and a radius of 15cm, and has a frictionless axle placed through its center to allow the cylinder to spin.

a) What is the angular acceleration of the wheel?

b) After the string is pulled 25cm, what is the angular velocity of the wheel?

c) How much work was done on the wheel during the 25cm pull?



3. Two forces, $F_1 = 10\text{N}$ and $F_2 = 15\text{N}$, act on a 15cm by 9cm rectangle, as shown above. The rectangle rotates about an axis 2cm to the left and 3cm below the upper-left corner of the rectangle, as shown in the figure.

a) What is the net torque on the rectangle?

b) What is the moment of inertia of the rectangle?

c) If the net torque is constant, what angular velocity will the rectangle have after 3s?

4. A 100g disk, with a radius of 10cm, spins at a rate of 15 rad/s. At the center of this disk is a 5g bug. As the disk spins, the bug travels from the center of the disk to the edge of the disk. For this problem, treat the bug as a point mass.

a) Is the angular momentum of the bug-disk system conserved? If so, why?

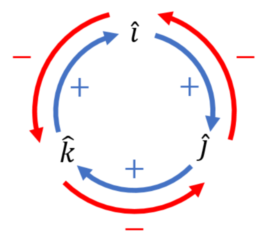
b) What would the angular velocity of the disk be when the bug reached the edge of the disk?

c) How much work is done by the bug walking across the disk?

FORMULA SHEET

- Vectors:

$$\vec{A}\cdot\vec{B} = AB\cos\theta$$
$$= A_xB_x + A_yB_y + A_zB_z$$
$$\left|\vec{A}\times\vec{B}\right| = AB\sin\theta$$



- Kinematics:

$$g = 9.8\mathrm{m/s}^2$$
$$\vec{v}_{av} = \frac{\Delta\vec{x}}{\Delta t}$$
$$\vec{a}_{av} = \frac{\Delta\vec{v}}{\Delta t}$$
$$\Delta x = v_0 t + \frac{1}{2}at^2$$
$$v = v_0 + at$$
$$v^2 = v_0^2 + 2a\Delta x$$

- Forces:

$$\sum\vec{F} = m\vec{a}$$
$$W = mg$$
$$f_{s,max} = \mu_s N$$
$$f_k = \mu_k N$$

- Work & Energy:

$$W = \vec{F} \cdot \Delta\vec{x}$$
$$W_{tot} = \Delta K$$
$$W_{cons} = -\Delta U$$
$$W_{nc} = \Delta E$$
$$K = \frac{1}{2}mv^2$$
$$U_g = mgy$$
$$U_{sp} = \frac{1}{2}kx^2$$
$$K_i + U_i = K_f + U_f \qquad \text{(energy conservation)}$$
$$K_i + U_i + W_{nc} = K_f + U_f \qquad \text{(general energy equation)}$$

- Momentum & Collisions:

$$\vec{p} = m\vec{v}$$
$$J = \Delta\vec{p} \qquad \text{(impulse)}$$
$$\sum \vec{F} = \frac{\Delta\vec{p}}{\Delta t}$$
$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$$
$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = (m_1 + m_2)\vec{v}_f \qquad \text{(when objects stick together)}$$
$$\vec{v}_{1i} + \vec{v}_{1f} = \vec{v}_{2i} + \vec{v}_{2f}$$