PHY2048 Physics with Calculus I

Section "A", 606222

Prof. Douglas H. Laurence

Exam 3 (Chapters 9, 10, 14, 17)

December 4, 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 not 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. 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) $I = 2MR^2$

4. 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

5. 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

6. A pendulum is built so that its period is 1s on Earth. If it were moved to a planet where the gravitational acceleration is 4 times larger than Earth, what would the period of the pendulum be on the new planet?
   (a) 0.25s
   (b) 0.5s
   (c) 2s
   (d) 4s

7. A spring with a natural length of 7cm and force constant of 200 N/m has a 500g mass attached to the end of it. If the spring is hanged vertically, and the mass allowed to reach equilibrium, how long would the spring be? Use $g = 10$ m/s^2.

   (a) 2.5cm
   (b) 4.5cm
   (c) 7cm
   (d) 9.5cm

8. A 7.5m rod expands by 1.5mm when the temperature is increased from 17^{o}C to 67^{o}C. What is the coefficient of linear thermal expansion for the rod?

   (a) 3.0×10^{-6} K^{-1}
   (b) 4.0×10^{-6} K^{-1}
   (c) 1.2×10^{-5} K^{-1}
   (d) 4.0×10^{-3} K^{-1}

9. Placing a pot of cold water on top of a hot stove will bring the water to a boil. During this process, what mechanism of heat transfer heats up the water?

   (a) Conduction
   (b) Convection
   (c) Radiation
   (d) None of the above

10. An aluminum pot, filled with water at 25^{o}C, is placed on a stove top at 200^{o}C. The base of the pot is circular, with a radius of 10cm and thickness of 1mm. How quickly is heat entering the water? Note that the thermal conductivity of aluminum is 217 W/mK and the thermal conductivity of water is 0.6 W/mK.

   (a) 3.30×10^{3} J/s
   (b) 3.30×10^{5} J/s
   (c) 1.19×10^{6} J/s
   (d) 1.19×10^{7} J/s

FREE-RESPONSE PROBLEMS

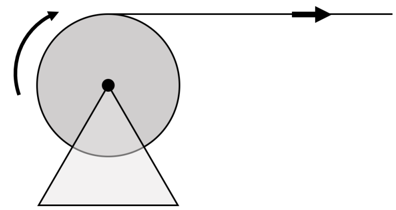
1. A cyclist is riding her bicycle at 15 m/s when she applies the brakes, coming to a stop in 40m. Note that the radius of the bicycle's wheel is 17cm.

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. A 0.6kg mass is attached to a spring, and oscillates with a period of 0.5s and an amplitude of 20cm.

   a) What is the force constant of the spring?

   b) What is the maximum speed of the mass?

   c) What would the speed of the mass be when compressed by 12cm?

4. You want to heat 1.3kg of water, initially at 25^{o}C, to 150^{o}C. Note that for ice, $c = 2090$ J/kgK, for water, $c = 4186$ J/kgK, and for steam, $c = 2010$ J/kgK, and that for freezing, $L = 335$ kJ/kg, and for vaporization, $L = 2260$ kJ/kg.

a) Does the water undergo any phase changes during this heating process? If so, which phase change(s)?

b) How much heat is required **only** to change the temperature of the water?

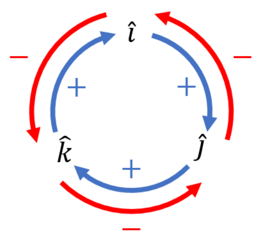
c) How much heat is required to undergo any phase changes, if any are required?

d) How much total heat is required to raise the temperature of the water to 150^{o}C?

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:

$$g = 9.8\text{m/s}^2$$
$$\vec{v}_{av} = \frac{\Delta\vec{x}}{\Delta t}$$
$$\vec{a}_{av} = \frac{\Delta\vec{v}}{\Delta t}$$
$$\Delta x = v_0t + \frac{1}{2}at^2$$
$$v = v_0 + at$$
$$v^2 = v_0^2 + 2a\Delta x$$

- Forces:

$$\sum\vec{F} = m\vec{a}$$
$$W = mg$$
$$f_{s,max} = \mu_sN$$
$$f_k = \mu_kN$$

- Work & Energy:

$$W = \vec{F} \cdot \Delta\vec{x} \quad \text{or} \quad W = \int \vec{F} \cdot d\vec{x}$$

$$W_{tot} = \Delta K$$

$$W_{cons} = -\Delta U$$

$$W_{nc} = \Delta E$$

$$K = \frac{1}{2}mv^2$$

$$U_g = mgy$$

$$U_{sp} = \frac{1}{2}kx^2$$

$$K_i + U_i = K_f + U_f \quad \text{(energy conservation)}$$

$$K_i + U_i + W_{nc} = K_f + U_f \quad \text{(general energy equation)}$$

- Momentum & Collisions:

$$\vec{p} = m\vec{v}$$

$$J = \Delta\vec{p} = \int \vec{F} dt \quad \text{(impulse)}$$

$$\sum \vec{F} = \frac{d\vec{p}}{dt} \quad or \quad \sum \vec{F}_{av} = \frac{\Delta\vec{p}}{\Delta t}$$

$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$$

$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = (m_1 + m_2)\vec{v}_f \quad \text{(when objects stick together)}$$

$$\vec{v}_{1i} + \vec{v}_{1f} = \vec{v}_{2i} + \vec{v}_{2f}$$