PHY2053 Exam 3

Fall 2019

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Abstract

This exam consists of xx multiple choice questions. **You must record your answers on a Scantron sheet.** Don't record your answers on this print-out; I will not accept it as a submission. Fill out the Scantron sheet in with a pencil, not a pen. **Don't forget to include your name, the course, and exam number on the Scantron sheet.**

1. A wheel starts from rest, when a torque applied to it accelerates it at 40 rad/s^2. If allowed to accelerate for 5s, how fast would the wheel be spinning?
   (a) 8 rad/s
   (b) 40 rad/s
   (c) 200 rad/s
   (d) 500 rad/s

2. A wheel starts from rest, when a torque applied to it accelerates it at 40 rad/s^2. If allowed to accelerate for 5s, how much, in radians, would it rotate?
   (a) 100 rad
   (b) 200 rad
   (c) 500 rad
   (d) 1500 rad

3. A car has wheels with a radius of 20cm. If the car is initially driving at 25 m/s, what angular acceleration would be required to stop the car within 75m?
   (a) -0.8 rad/s^2
   (b) -4.2 rad/s^2
   (c) -10.5 rad/s^2
   (d) -20.8 rad/s^2

4. A force, under any circumstance, will produce a torque.
   (a) True
   (b) False

5. 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

6. A hollow sphere, a solid cylinder, and a hollow cylinder are all released from rest at the top of a ramp. Which object has the greatest speed at the bottom of the ramp?

   (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

7. 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) $I = 2MR^2$

8. 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

9. 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? *Hint: think about which point on the wheel acts as the axis when the wheel is rolling.*

   (a) Gravity
   (b) Static friction
   (c) Kinetic friction
   (d) The normal force

10. 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

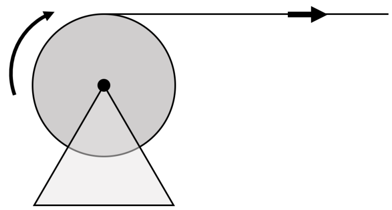


Figure 1: Problems 11 – 12

11. A 2.3kg solid cylinder, with a radius of 15cm, is pulled horizontally by a string with a force of 20N, as shown in the figure above. What is the net torque on the wheel?

    (a) 1.5 Nm
    (b) 3 Nm
    (c) 20 Nm
    (d) 133 Nm

12. A 2.3kg solid cylinder, with a radius of 15cm, is pulled horizontally by a string with a force of 20N, as shown in the figure above. What is the angular acceleration of the cylinder?

    (a) 5.8 rad/s^2
    (b) 17.39 rad/s^2
    (c) 38.6 rad/s^2
    (d) 115.8 rad/s^2

13. A man in a boat undergoes a periodic motion as the water oscillates up and down. If the boat drops from a peak to a trough every 4s, what is the period of the water's oscillation?

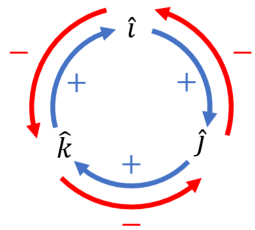
    (a) 2s
    (b) 4s
    (c) 8s
    (d) 12s

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:

$$g = 10\ \mathrm{m/s^2}$$

$$\vec{v}_{av} = \frac{\Delta\vec{x}}{\Delta t};\quad \vec{v}(t) = \frac{d\vec{x}}{dt}$$

$$\vec{a}_{av} = \frac{\Delta\vec{v}}{\Delta t};\quad \vec{a}(t) = \frac{d\vec{v}}{dt}$$

$$\Delta x = v_0 t + \frac{1}{2}at^2$$

$$v = v_0 + at$$

$$v^2 = v_0^2 + 2a\Delta x$$

- Circular motion:

$$a_c = \frac{v^2}{r} = \omega^2 r$$

$$v = \omega r$$

$$\omega = \frac{2\pi}{T}$$

- Forces:

$$\sum \vec{F} = m\vec{a}$$

$$W = mg$$

$$F_{\mathrm{sp}} = kx$$

$$f_{\mathrm{s,max}} = \mu_s N$$

$$f_{\mathrm{k}} = \mu_k N$$

- Work & Energy:

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

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

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

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

$$U_{\text{g}} = mgy$$

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

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

- Momentum & Collisions:

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

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

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

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

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

$$\vec{v}_{1i} + \vec{v}_{1f} = \vec{v}_{2i} + \vec{v}_{2f} \quad \text{(elastic collisions)}$$

- Rotational Kinematics

$$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega = \omega_0 + \alpha t$$

$$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$

$$s = r\theta$$

$$v = r\omega$$

$$a = r\alpha$$

- Torque and Rotational Dynamics

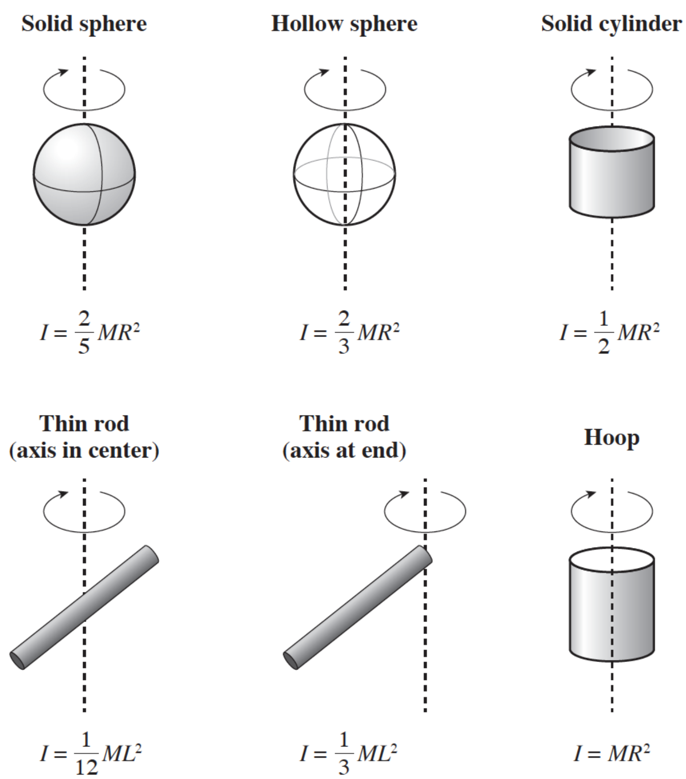
$$\tau = rF\sin\theta$$

$$\sum \tau = I\alpha \quad \text{or} \quad \sum \tau = \frac{dL}{dt}$$

$$K_{rot} = \frac{1}{2}I\omega^2$$

$$I = \int r^2 dm$$

$$I_{new} = I_{cm} + md^2$$



- Oscillations:

$$F_{sp} = kx$$

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

$$T_{sp} = 2\pi\sqrt{\frac{m}{k}}$$

$$T_{pend} = 2\pi\sqrt{\frac{l}{g}}$$

$$f = 1/T$$