

PHY2048 12PM 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. 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) $I = 2MR^2$
7. 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
8. 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
9. 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

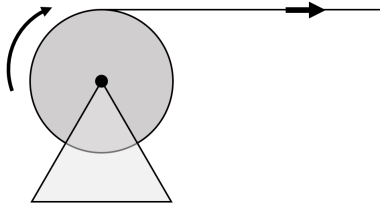


Figure 1: Problems 11 – 12

10. 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
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 angular acceleration of the cylinder?
 - (a) 5.8 rad/s²
 - (b) 17.39 rad/s²
 - (c) 38.6 rad/s²
 - (d) 115.8 rad/s²
12. A distant planet, X, has a mass double that of Earth and a radius triple that of Earth. What would the gravitational acceleration of planet X be at its surface? Assume $g = 9.81 \text{ m/s}^2$, and use Google to look up any constants you feel you might need to solve this problem.
 - (a) 2.18 m/s²
 - (b) 4.37 m/s²
 - (c) 6.54 m/s²
 - (d) 13.1 m/s²
13. A satellite is placed in orbit around the Earth such that it has a period of 90 minutes. What is the altitude of the satellite's orbit? *Use Google to look up any constants you feel you might need to solve this problem.*
 - (a) 282 km
 - (b) 405 km
 - (c) 2,547 km
 - (d) 6,653 km

14. A satellite is placed in orbit around the Earth such that it has a period of 90 minutes. What is the velocity of the satellite? *Use Google to look up any constants you feel you might need to solve this problem.*
- (a) 3.89 km/s
 - (b) 5.55 km/s
 - (c) 7.74 km/s
 - (d) 8.57 km/s
15. 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

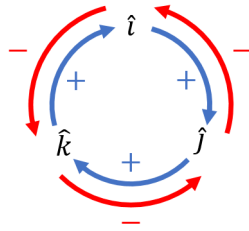
FORMULA SHEET

- Vectors:

$$\vec{A} \cdot \vec{B} = AB \cos \theta$$

$$= A_x B_x + A_y B_y + A_z B_z$$

$$|\vec{A} \times \vec{B}| = AB \sin \theta$$



- Kinematics:

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

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

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

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

$$v = v_0 + a t$$

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

- Circular motion:

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

$$v = \omega r$$

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

- Forces:

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

$$W = mg$$

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

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

$$f_k = \mu_k N$$

- Work & Energy:

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

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

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

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

$$U_g = mgy$$

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

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

- Momentum & Collisions:

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

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

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

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

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

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

- 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

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

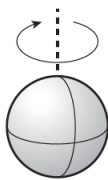
$$\sum \tau = I\alpha \quad \text{or} \quad \sum \tau = \frac{dL}{dt}$$

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

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

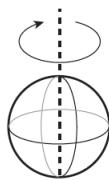
$$I_{new} = I_{cm} + md^2$$

Solid sphere



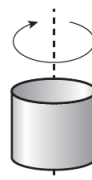
$$I = \frac{2}{5} MR^2$$

Hollow sphere



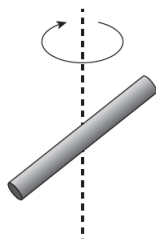
$$I = \frac{2}{3} MR^2$$

Solid cylinder



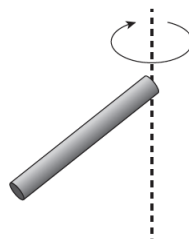
$$I = \frac{1}{2} MR^2$$

**Thin rod
(axis in center)**



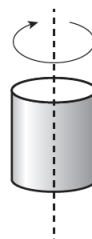
$$I = \frac{1}{12} ML^2$$

**Thin rod
(axis at end)**



$$I = \frac{1}{3} ML^2$$

Hoop



$$I = MR^2$$

- Gravity:

$$G = 6.67 \times 10^{-11} \frac{\text{Nm}^2}{\text{kg}^2}$$

$$F_G = G \frac{mM}{r^2}$$

$$a_G = G \frac{M}{r^2}$$

$$U_G = -G \frac{mM}{r}$$

$$v_{esc} = \sqrt{\frac{2GM}{R}}$$

$$v = \frac{2\pi r}{T}$$

$$T^2 = \frac{4\pi^2}{GM} r^3$$

- Oscillations:

$$F_{sp} = kx$$

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

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

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

$$f = 1/T$$