İZMİR UNIVERSITY
OF ECONOMICS

IZMIR UNIVERSITY OF ECONOMICS
Faculty of Arts and Sciences

Term	**: 2024-2025 Fall**
Course ID	**: PHYS 100 – General Physics I**
Exam	**: Final Exam**
Date	**: 06.01.2025**
Duration	**: 75 minutes**
Instructor	**: ....**

Answer Key

Full Name : ....

Student ID : ....

Classroom : .... **Section** : ....

Information on exam rules

Electronic devices such as laptops, mobile phones, and smartwatches are generally prohibited in the examination room. However, exceptions can be made for individuals with special needs, provided they have valid medical documentation. Requests for exceptions must be submitted with prior written approval from the academic advisor, and they should include details on the necessary measures to maintain the integrity and security of the examination.

Please refrain from engaging in cheating or any other prohibited activities during the examination. Suspected cheating may result in a score of zero on your exam, and any students found cheating may face disciplinary actions in accordance with law #2547. This includes actions such as using unauthorized electronic devices, communicating with classmates, exchanging exam or formula sheets, or using unauthorized written materials during the exam, all of which qualify as attempted cheating.

Students can use only simple calculators during the exam.

Declaration

I affirm that the activities and assessments completed as part of this examination are entirely my own work and comply with all relevant rules regarding copyright, plagiarism, and cheating. I acknowledge that if there is any question regarding the authenticity of any portion of my assessment, I may be subject to oral examination. The signatory of evidence records may also be contacted, or a disciplinary process may be initiated as per law #2547.

Signature of Student:

Problem	**1**	**2**	**3**	**4**	**5**
Score	**/20**	**/20**	**/20**	**/20**	**/20**
Total	**/100**				

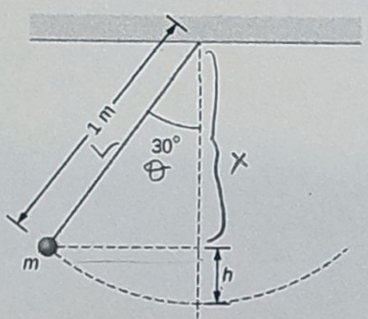
Problem 1. Neptune is an average distance of 4.5×10^9 km from the Sun. Estimate the length of the Neptunian year using the fact that the Earth is 1.50×10^8 km from the Sun on the average.

Use Kepler's third law for objects orbiting the sun.

$$\left(\frac{T_{Neptune}}{T_{Earth}}\right)^2 = \left(\frac{r_{Neptune}}{r_{Earth}}\right)^3 \Rightarrow T_{Neptune} = T_{Earth}\left(\frac{r_{Neptune}}{r_{Earth}}\right)^{3/2}$$

$$T_{Neptune} = (1 \text{ year}) \cdot \left(\frac{4.5 \times 10^9 \text{ km}}{1.50 \times 10^8 \text{ km}}\right)^{3/2} \cong 160 \text{ years}$$

Problem 2. A particle of mass m is hung from the ceiling by a massless string of length 1.0 m, as shown in Figure. The particle is released from rest, when the angle between the string and the downward vertical direction is 30°. What is its speed when it reaches the lowest point of its arc?



$$K_i + U_i = K_f + U_f$$

$$0 + mgh = \frac{1}{2} m v^2 + 0$$

$$v = \sqrt{2gh}$$

$$x + h = L$$

$$L \cdot \cos\theta + h = L$$

$$h = L - L\cos\theta$$

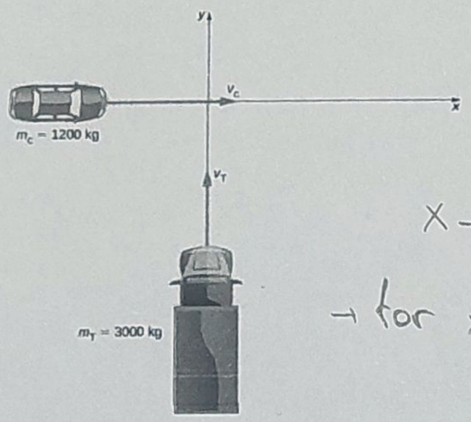
$$h = L(1 - \cos\theta)$$

$$v = \sqrt{2gL(1-\cos\theta)}$$

$$v = \sqrt{2 \cdot (9.8 \text{ m/s}^2)(1 \text{ m})(1 - \cos 30)}$$

$$v = 1.62 \text{ m/s}$$

Problem 3. A small car of mass 1200 kg traveling east at 60 km/hr collides at an intersection with a truck of mass 3000 kg that is traveling due north at 40 km/hr. The two vehicles are locked together. What is the velocity of the combined wreckage?



$$P_i = P_f$$

$$m_c \vec{v}_c + m_T \vec{v}_T = (m_c + m_T) v_w$$

x-axis → east, y axis → north

→ for x-axis → $m_c v_c = (m_c + m_T) v_{w,x}$

$$v_{w,x} = \left(\frac{m_c}{m_c + m_T}\right) v_c$$

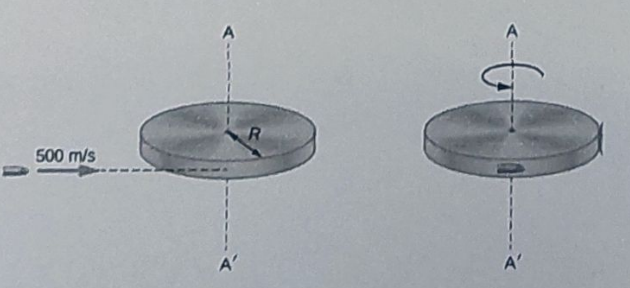
for y-axis → $m_T v_T = (m_c + m_T) v_{w,y} \Rightarrow v_{w,y} = \left(\frac{m_T}{m_c + m_T}\right) v_T$

$$|\vec{v}_w| = \sqrt{(v_{w,x})^2 + (v_{w,y})^2} = \sqrt{\left[\left(\frac{1200\,kg}{4200\,kg}\right)\left(16{,}67\,\frac{m}{s}\right)\right]^2 + \left\{\left(\frac{3000\,kg}{4200\,kg}\right)\left(11{,}1\,\frac{m}{s}\right)\right\}^2}$$

$$|\vec{v}_w| = 9{,}25\ m/s \simeq 33{,}3\ \frac{km}{hr}$$

$\theta = \tan^{-1}\left(\frac{7{,}93\ m/s}{4{,}76\ m/s}\right) = 59°$ → This angle is east of north, or 31° counter-clokwise from the +x-direction.

Problem 4. A bullet of mass m=2.0 g is moving horizontally with a speed of 500.0 m/s. The bullet strikes and becomes embedded in the edge of solid disk of mass M = 3.2 kg and radius R = 0.5 m. The cylinder is free to rotate around its axis and is initially at rest (Fig.). What is the angular velocity of the disk immediately after the bullet is embedded?



→ $L_i = m v R$

$$I = mR^2 + \frac{1}{2}MR^2 = \left(m + \frac{M}{2}\right)R^2$$

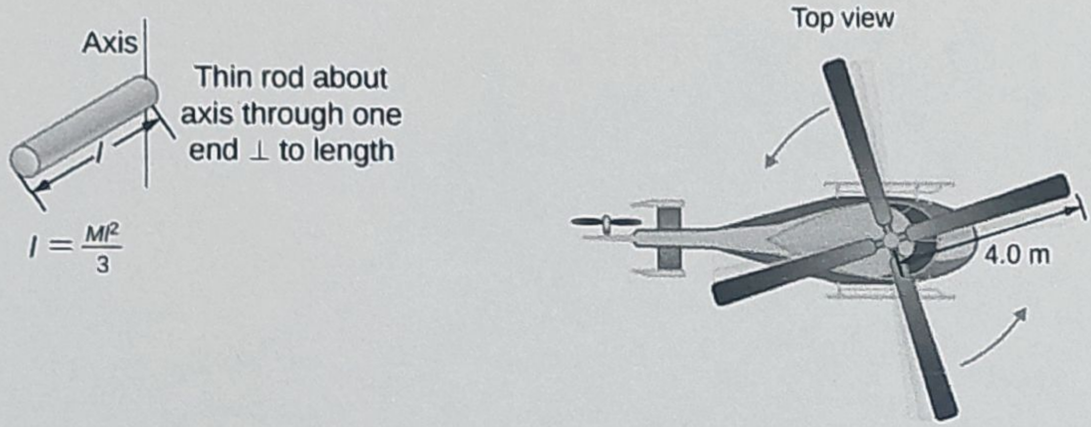
→ $L_f = I\omega_f$

$$L_i = L_f$$

$$m v R = \left(m + \frac{M}{2}\right)R^2 \omega_f \Rightarrow \omega_f = \frac{m v \cancel{R}}{\left(m + \frac{M}{2}\right)R^{\cancel{2}}}$$

$$\omega_f = \frac{(2 \times 10^{-3}\,kg)(500\ m/s)}{(2 \times 10^{-3}\,kg + 1{,}6\,kg)(0{,}50\,m)} = 1{,}2\ rad/s$$

Problem 5. A typical small rescue helicopter has four blades: Each is 4.00 m long and has a mass of 50.0 kg (**Figure**). The blades can be approximated as thin rods that rotate about one end of an axis perpendicular to their length. The helicopter has a total loaded mass of 1000 kg. (a) Calculate the rotational kinetic energy in the blades when they rotate at 300 rpm. (b) Calculate the translational kinetic energy of the helicopter when it flies at 20.0 m/s, and compare it with the rotational energy in the blades.



a) The rotational kinetic energy → $K = \frac{1}{2} I \omega^2$

$$\omega = \frac{300\,rev}{1\,min} \cdot \frac{2\pi\,rad}{1\,rev} \cdot \frac{1\,min}{60\,s} = 31{,}4\ \frac{rad}{s}$$

The total I is four times this moment of inertia because there are four blades. Thus,

$$I = 4 \cdot \frac{M l^2}{3} = 4 \cdot \frac{(50\,kg)(4\,m)^2}{3} = 1067\ kg \cdot m^2$$

$$K = \frac{1}{2} I \omega^2 = \frac{1}{2}(1067\ kg \cdot m^2)(31{,}4\ rad/s)^2 = 5{,}26 \times 10^5\ J$$

b) Entering the given values into the equation for translational kinetic energy, we obtain

$$K = \frac{1}{2} m v^2 = \frac{1}{2}(1000\ kg)(20\ m/s)^2 = 2 \times 10^5\ J$$

To compare k. energy → $\frac{2 \times 10^5\ J}{5{,}26 \times 10^5\ J} = 0{,}380$