THE INTERNATIONAL UNIVERSITY (IU) – VIETNAM NATIONAL UNIVERSITY - HCMC

FINAL EXAMINATION – CLASS

Student Name: ____________________ **Student ID:** ________________

Date: August 2019

Duration: 90 minutes

SUBJECT: PHYSICS 1	
Head of Department of Physics: Signature: Full name: Phan Bao Ngoc	Lecturers: Signature: Full name: Do Xuan Hoi, Dao Ngoc Hanh Tam

INSTRUCTIONS: This is a closed book examination. Use of cell phones, laptops, dictionaries is not allowed.

Q1 (20 pts) A worker pushes a 12-kg block, starting from rest, on a horizontal frictionless plane. His force is 45 N and parallel to the plane. Use the work – kinetic energy theorem to compute the block's speed when its displacement is 10 m. 8.66 m/s.

Q2 (20 pts) An object of mass 0.7 kg is dropped down vertically onto a target at a speed of 13 m/s and comes to a stop. The collision time is 5 ms.

a) Find the magnitude of the impulse exerted on the object during the collision. 9.1

b) What is the average force exerted on the target by the object during the collision? 182

m R

Q3 (20 pts) A 600-g ball is hung from a rope of 0.75 m. The ball is then released from the point where the rope makes an angle of 90° with the vertical (*Fig.1*). At its lowest point, the ball hits a 3-kg brick initially at rest on a frictionless floor and causes an elastic collision. Determine the velocities of the ball and the brick right after the collision. v_1 8.24 $v_2 = 1.65$

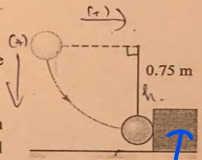

Fig. 1

R v_i

Q4 (20 pts) A wheel of radius 0.25 m, moving initially at 42 m/s along a horizontal plane, rolls smoothly to a stop after a distance of 210 m. d

a) Calculate the magnitudes of its linear and angular accelerations. −4.2 −16.8

b) Find the magnitude of the torque about the central axis due to friction acting on the wheel, knowing that its rotational inertia about this axis is 0.15 kg.m^2. 2.52 N.

Q5 (20 pts) A uniform rod rotates in a horizontal plane about a vertical axis through its center. The rod is 6 m long, weighs 14.7 N, and rotates at 240 rev/min. The rotational inertia of the rod is $\frac{ml^2}{12}$ where m and l are its mass and its length, respectively. Calculate the magnitude of its angular momentum about that axis. 1106.91

- END OF QUESTION PAPER –

Final Exam Physics 1
Unofficial Solutions

by Nguyễn Tiến Đức

August 2019

Q1

$W_{net} = K_f - K_i$

Work-kinetic energy theorem:

$$\Delta K = \sum W$$

$$<=> K_f - K_i = F \cdot \Delta x \cdot cos(\vec{F}, \Delta\vec{x}) \quad (1)$$

Starting from rest: $v_i = 0m/s$ $x_0 = 0$

$$m = 12kg$$

$$F = 45N$$

$$(1) <=> \frac{1}{2} \times 12 \times v_f^2 - 0 = 45 \cdot 10 \cdot cos(0) = 450J$$

$$=> v_f = 5\sqrt{3} = 8.66m/s$$

Q2

a) $I = \Delta p = m \Delta v = \vec{F} \Delta t$

$$\vec{I} = \Delta\vec{p} = m\Delta\vec{v} = m \times (\vec{v_f} - \vec{v_i})$$

$\oplus$

$v_i = 0\ m/s$

$v_f = 13\ m/s$

Choose positive direction upward:

$$v_i = -13m/s$$

$$v_f = 0m/s$$

$$m = 0.7kg$$

$p \sim J$

$=> (kg.m/s)$

$$=> I = 0.7 \times (0 - (-13)) = 9.1kg \cdot m/s$$

Magnitude of impulse is $9.1kg \cdot m/s$ $(N.s)$

$\vec{J} \sim \vec{p}$

$$\vec{F} = \frac{\vec{J}}{\Delta t} = \frac{\Delta \vec{p}}{\Delta t}$$

b)

$$\left\{\begin{array}{l} \vec{I} = \overrightarrow{F_{avg}} \cdot \Delta t \\ 5ms = 5 \times 10^{-3}s \end{array}\right.$$

$$=> |\overrightarrow{F_{avg}}| = \frac{|\vec{I}|}{\Delta t} = \frac{9.1kg \cdot m/s}{5 \times 10^{-3}s} = 1820N$$

Q3

First stage: The ball is released.

Work-Kinetic Energy Theorem on the ball:

$$K_f - K_i = \sum W \quad =$$

Ball is released: $K_i = 0J$ and the only work is from gravity

$$\frac{1}{2} m_{ball} v_{ball_{1f}}^2 - 0 = U_{gi} - U_{gf}$$

$$<=> \frac{1}{2} m_{ball} \times v_{ball_{1f}}^2 = m_{ball} g \times 0.75 - 0$$

$$=> v_{ball_{1f}} = 3.834 m/s$$

Direction of the ball at the bottom is parallel to the horizontal surface.

Second stage: One dimensional collision.

Conservation of momentum right before and after the collision:

$p = p'$

$$m_{ball}\overrightarrow{v_{ball_{2i}}} + m_{brick}\overrightarrow{v_{brick_i}} = m_{ball}\overrightarrow{v_{ball_{2f}}} + m_{brick}\overrightarrow{v_{brick_f}}$$

For the ball, final velocity of the first stage is the initial velocity of the second stage: $\overrightarrow{v_{ball_{1f}}} = \overrightarrow{v_{ball_{2i}}}$
The brick is initially at rest: $\overrightarrow{v_{brick_i}} = \vec{0}$
Choose positive direction to the right: $\xrightarrow{\quad}$ $+$

$$600g = 6 \times 10^{-3} kg = 0.6kg$$

$$0.6 \times 3.834 = 0.6 \times v_{ball_{2f}} + 3 \times v_{brick_f} \tag{1}$$

The collision is elastic: Lost Energy is 0 J

Conservation of energy: $\sum K_i = \sum K_f$

$$<=> \frac{1}{2} \times 0.6 \times 3.834^2 = \frac{1}{2} \times 0.6 \times {v_{ball2_f}}^2 + \frac{1}{2} \times 3 \times {v_{brick_f}}^2 \qquad (2)$$

From (1) and (2):

$$\begin{cases} v_{ball2_f} = 3.834 m/s \\ v_{brick_f} = 0 m/s \end{cases} \text{ or } \begin{cases} v_{ball2_f} = -\frac{7\sqrt{30}}{15} m/s = -2.556 m/s \\ v_{brick_f} = \frac{7}{\sqrt{30}} m/s = 1.278 m/s \end{cases}$$

The floor is frictionless so $v_{brick_f} \neq 0$. Then:

$$\begin{cases} v_{ball2_f} = -\frac{7\sqrt{30}}{15} m/s = -2.556 m/s \\ v_{brick_f} = \frac{7}{\sqrt{30}} m/s = 1.278 m/s \end{cases}$$

Q4

$$R = 0.25m$$

$$v_{cm_i} = 42 m/s$$

Step

$$v_{cm_f} = 0 m/s$$

$$\Delta x_{cm} = 210 m$$

a)

$$v_{cm_f}^2 - v_{cm_i}^2 = 2 a_{cm} \Delta x_{cm}$$

$$=> a_{cm} = -4.2 m/s$$

$$a_{cm} = R\alpha$$

$$=> \alpha = -16.8 rad/s^2$$

b)

$$|\vec{\tau_f}| = I|\vec{\alpha}| = 0.15 kg \cdot m^2 \times |-16.8 rad/s^2| = 2.52 N \cdot m$$

$\tau = I\alpha =$

Q5

$$l = 6m$$

$$mg = |F_g| = 14.7N => m = \frac{14.7N}{9.8} = 1.5kg$$

$$=> I = 4.5kg \cdot m^2 = \frac{ml^2}{12}$$

$$\omega = 240\frac{rev}{min} = 240 \times \frac{2\pi}{60} = 8\pi rad/s$$

Magnitude of angular momentum:

$$|\vec{L}| = I|\vec{\omega}| = 4.5 \times 8\pi = 113kg \cdot m^2/s$$

$$L = I\omega = mRv\sin\theta$$