

DO NOT OPEN YOUR EXAM UNTIL TOLD

Exam 3, Phys 172, Fall 2010

EXAM # 01

1. Record your two-digit exam version number on **scantron** form in the field "Test/Quiz number". Please do not omit leading zero.

2. Write your name in the top-right corner here and on the **scantron** form

3. Record your PUID number in the respective field on your **scantron** form

Do not use other paper. Write on the back of this test if needed.

The page with major equations is provided with this exam (in the back)

*Circle your answers here and on **scantron** form. At the end of the exam, you will place:*

- *the **scantron** form and this printout with circled answers in the box labeled according to your recitation day – Wed, Thurs, or Fri.*
- *the hand-graded portion of the exam in the box labeled according to your recitation day – Wed, Thurs, or Fri.*

USEFUL INFORMATION

$$\Delta \vec{p} = \vec{F}_{net} \Delta t$$

$$\Delta \vec{r} = \vec{v}_{avg} \Delta t$$

$$|\vec{F}_{grav}| = G \frac{Mm}{|\vec{r}|^2}; \text{ approx. } mg \text{ near surface of Earth}$$

$$|\vec{F}_{spring}| = k_s |s|, \text{ opposite the stretch}$$

$$G = 6.7 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$$

$$g = 9.8 \text{ N/kg}$$

$$c = 3 \times 10^8 \text{ m/s}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$$

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

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\vec{p} \approx m\vec{v}, \text{ if } |\vec{v}| \text{ is small compared to } c$$

$$U_{electric} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r}$$

$$U_{gravity} = \frac{-GMm}{r}$$

$$\Delta E_{system} = W_{surroundings} + Q$$

$$|\vec{F}_{net \perp}| = \frac{mv^2}{R} = m\omega^2 R$$

$$E = m\gamma c^2 \text{ for a single particle}$$

$$E = mc^2 + \frac{1}{2}mv^2 \text{ for a single particle if } v \ll c$$

$$f = \mu N$$

$$F_{air} = \frac{1}{2} C \rho_{air} A v^2$$

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

$$F_{buoyancy} = \frac{\rho_{air}}{\rho_{object}} mg$$

$$K_{trans} = \frac{1}{2} mv^2$$

$$W = \vec{F} \cdot \Delta \vec{r}$$

$$\Delta \vec{L}_A = \vec{\tau}_A \Delta t$$

$$\Delta E_{thermal} = mC_v \Delta T$$

$$I_{disk} = I_{cylinder \text{ about long axis}} = \frac{1}{2} MR^2$$

$$I_{sphere} = \frac{2}{5} MR^2$$

Moment of inertia if a thin cylinder rotating about an axis perpendicular to the cylinder, through the center of the cylinder $I_{cylinder} = \frac{1}{12} ML^2$

$$\vec{\tau}_A = \vec{r}_A \times \vec{F}$$

$$I = \sum m_i r_i^2$$

$$K_{total} = K_{trans} + K_{rot} + K_{vib}$$

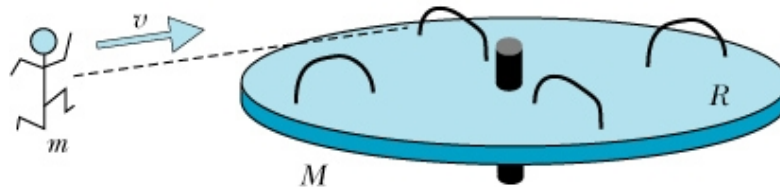
$$K_{rot} = \frac{L_{rot}^2}{2I} = \frac{1}{2} I \omega^2$$

mass of earth = 5.97×10^{24} kg

radius of earth = 6.4×10^6 m

PHYS 172 – Fall 2010 Exam 3 **Machine Graded Portion (70 points total)**

1. A playground ride consists of a disk of mass M and radius R mounted on a low-friction, vertical axle. The ride is initially at rest. A child of mass m runs in the x direction at speed v along a line tangent to the disk, jumps onto its outer edge and holds onto one of the railings shown. The disk plus child system begins to rotate.



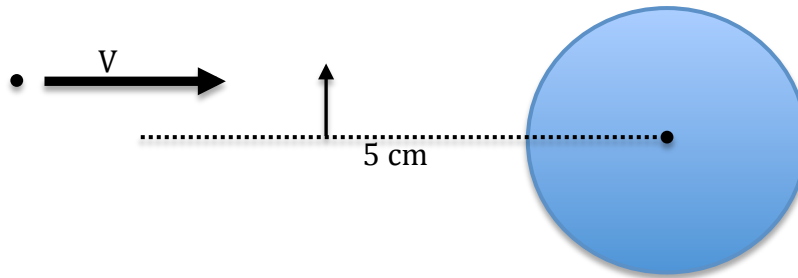
Which statement below is incorrect?

- The linear momentum of the system is constant throughout this process.
- The angular momentum of the system is constant throughout this process.
- The child's translational kinetic energy is not constant throughout this process.
- The angular momentum of the child about the vertical axle is not constant throughout this process.

2. Tarzan, whose mass is 100 kg, is hanging at rest from a tree limb. Then he lets go and falls to the ground. Just before he lets go, his center of mass is at a height 2.9 m above the ground and the bottom of his dangling feet are at a height 2.1 m above the ground. When he first hits the ground he has dropped a distance 2.1 m so his center of mass is 0.8 m above the ground. Then his knees bend and he ends up at rest in a crouched position with his center of mass a height 0.5 m above the ground. From the instant Tarzan's feet touch the ground to when he is in the crouched position, what is the average force exerted by the ground on his feet?

- a) 7840 N
- b) 3553 N
- c) 2058 N
- d) 980 N
- e) 5096 N

3. A bullet of mass 30 g is fired horizontally and at a distance 5 cm above the axis of a cylinder of mass 10 kg, radius 10 cm and length 20 cm. The cylinder is initially at rest and is free to rotate on a massless axle through its long axis. The bullet adheres to the cylinder surface as it hits it. The cylinder begins to rotate at an angular speed such that it completes one complete revolution in 0.209 s after catching the bullet. Calculate the initial speed of the bullet prior to impact.



- a) 1008 m/s
b) 2016 m/s
c) 3 m/s
d) 3000 m/s
e) 55 m/s
4. A 6 kg bowling ball moves across a floor with a speed of 5 m/s. The ball (rolling while slipping on the waxed floor) also rotates at a rate of 4 complete revolutions per second. The moment of inertia of the ball is 0.03 kg m^2 . What is the total kinetic energy of the bowling ball?
- a) 84.5 J
b) 30 J
c) 9.5 J
d) 75 J
e) 65.5 J

5. A thin rod of length 1 meter and mass 500 grams lies on ice. A constant force of 5 N is applied to one end of the stick, initially at right angles to the stick. What is the translational kinetic energy of the stick after .5 seconds?

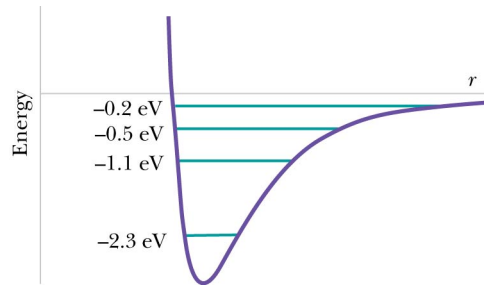


- a) 6.25 J
- b) 2.5 J
- c) 5.0 J
- d) 3.63 J

6. It is sometimes claimed that friction forces always slow an object down, but this is not true. If you place a box of mass M on a moving horizontal conveyor belt, the friction force of the belt acting on the bottom of the box speeds up the box. At first, there is some slipping, until the speed of the box catches up to the speed, v , of the belt. The coefficient of friction between the box and the belt is μ . How much time does it take for the box to reach its final speed?

- a) $v/\mu g$
- b) $\mu v/g$
- c) $Mv/\mu g$
- d) $M\mu v/g$

7. The figure below shows all of the quantized energies for a molecule. The energy for each state is given on the graph, in electron volts ($1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$). At high enough temperatures, in a collection of these molecules, there will be at all times some molecules in each of these states, and light will be emitted. What are the energies in electron volts of the emitted light?



- a. 0.3, 0.6, 0.9, 1.2, 1.8, 2.1 eV
- b. 0.2, 0.5, 1.1, 2.3 eV
- c. 0.3, 0.9, 2.1 eV
- d. 0.3, 0.6, 1.2 eV