HAWAI'I PACIFIC UNIVERSITY

PHYS 2050: SECOND PRACTICE EXAMINATION

Campus/Centre:	( ) Downtown campus (x) Loa Campus

Examination Day:	**TBD**	**Examination Date:**	**TBD**
Examination Time:	**TBD**	**Duration:**	**75 min**

Course Abbreviation & Number:	**PHYS 2050**
Course Title:	**General Physics I**

Name of Student: ____

Student Number: ____

INSTRUCTIONS TO CANDIDATES

1. This examination consists of 5 pages.
2. There are 8 conceptual and 8 quantitative (+1 extra credit) questions in this examination.
3. **All working must be shown.**
4. **Units must be shown.**
5. A list of selected formulae is provided below.

LIST OF SELECTED FORMULAE

Kinematics equations

$$v = \frac{dx}{dt} \qquad a = \frac{dv}{dt}$$

Center-of-mass

$$\vec{r} = \frac{1}{M}\sum_{i=1}^{N} \vec{r}_i m_i$$

Conservation of energy

$$W_{\text{ext}} = \Delta K_{\text{rot}} + \Delta K_{\text{trans}} + \sum \Delta U$$

Work

$$W = \int \vec{F} \cdot d\vec{s}$$

Newton's 2nd law

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

Centripetal acceleration

$$a_{rad} = \frac{v^2}{r}$$

Conservation of momentum

$$\vec{p}_i = \vec{p}_f \qquad m\vec{v}_i = m\vec{v}_f$$

Rotational kinematics

$$\omega = \frac{d\theta}{dt} \qquad \alpha = \frac{d\omega}{dt}$$

Kinetic energies

$$K_{\text{trans}} = \frac{1}{2}mv^2 \qquad K_{\text{rot}} = \frac{1}{2}I\omega^2$$

Gravitational potential energy

$$\Delta U_g = mg(y - y_0)$$

Conservation of kinetic energy in an elastic collision (1 dim)

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

Spring potential energy for $x_{eq} = 0$

$$\Delta U_s = \frac{1}{2}k(x^2 - x_0^2)$$

Work-kinetic energy theorem

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

Momentum and impulse

$$\vec{p} = m\vec{v} \qquad \vec{J} = \int \vec{F} dt = \Delta\vec{p}$$

Volume density

$$\rho = \frac{dm}{dV}$$

Pressure

$$p = \frac{dF_\perp}{dA}$$

Simple fluid eqs.

$$p = p_0 + \rho g h \qquad A_1 v_1 = A_2 v_2 \qquad \frac{dV}{dt} = Av$$

Torque

$$\vec{\tau} = \vec{r} \times \vec{F} \qquad \Sigma\vec{\tau} = I\vec{\alpha}$$

Surface density

$$\sigma = \frac{dm}{dA}$$

Line density

$$\lambda = \frac{dm}{d\ell}$$

Conservation of angular momentum

$$\vec{L}_i = \vec{L}_f \qquad I_i\omega_i = I_f\omega_f$$

Moment-of-inertia

$$I = \sum m_i r_i^2 \qquad I = \int r^2 dm$$

Small angle pendulum

$$\theta(t) \approx \theta_{max}\cos(\omega t - \phi)$$

Physical pend.

$$\omega = \sqrt{\frac{mgd}{I}}$$

Bernoulli's equation

$$p_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = p_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$$

Rotation to linear

$$a = \alpha r \qquad v = \omega r$$

SHM parameters

$$\omega_{\text{spring}} = \sqrt{\frac{k}{m}} \qquad \omega_{\text{pend}} = \sqrt{\frac{g}{\ell}}$$

Simple Harmonic Motion (SHM)

$$x(t) = x_{max}\cos(\omega t - \phi)$$

Gravitation between 2 point masses

$$F_g = G\frac{m_1 m_2}{r^2} \qquad U_g = -G\frac{m_1 m_2}{r}$$

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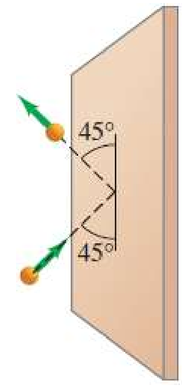
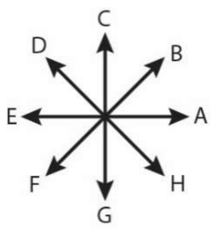
Conceptual Section (Circle the correct answer)

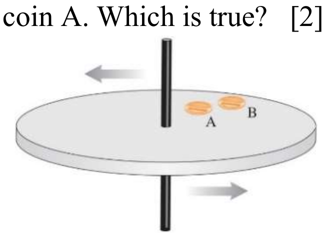


1. A ball hits a wall as shown in the figure on the right. Circle the direction of the impulse on the ball caused by the wall using the figure on the left? [2]

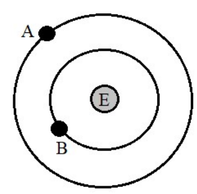


2. A disk ($I_{disk} = \frac{1}{2}mR^2$) and a sphere ($I_{sphere} = \frac{2}{5}mR^2$) both have the same radius and mass. They roll without slipping at the same speed along the horizontal before reaching a ramp. Which is true? [2]
   A. The disk rolls farther up the ramp than the sphere.
   B. The sphere rolls farther up the ramp than the disk.
   C. They both roll to the same height up the ramp.

3. Two coins rotate on a turntable. Coin B is twice as far from the axis of rotation as coin A. Which is true? [2]
   A. The angular speed of A is four times that of B.
   B. The angular speed of A is twice that of B.
   C. The angular speed of A is half that of B.
   D. The angular speed of A is the same as that of B.



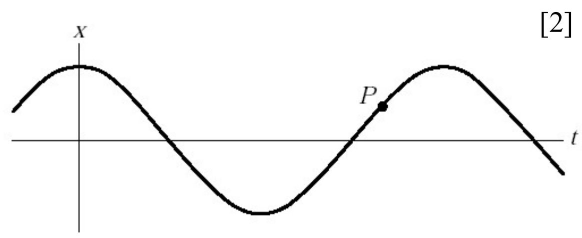
4. Both satellites have the same mass. Which satellite has the larger gravitational potential energy U_g? [2]
   A. Satellite A.
   B. Satellite B.
   C. Both satellites have the same potential energy.
   D. Not enough information to tell.



5. Finish the following sentence for a uniform, hollow, spherical shell. The gravitational force on an object inside the shell [2]
   A. pulls the object towards the center.
   B. is zero.
   C. pulls the object towards the edge of the shell.

6. If you drive an oscillator, it will have the largest amplitude if you drive it at its ________ frequency. [2]
   A. special
   B. positive
   C. resonant
   D. damped

7. A mass attached to a spring oscillates back and forth as indicated in the position vs. time plot below. At point P, the mass has [2]
   A. positive velocity and positive acceleration.
   B. positive velocity and negative acceleration.
   C. negative velocity and positive acceleration.
   D. negative velocity and negative acceleration.



8. A person swings on a swing. When the person sits still, the swing oscillates back and forth at its natural frequency. If, instead, the person stands on the swing, the natural frequency of the swing is [2]
   A. greater.
   B. the same.
   C. smaller.
   D. Not enough information.

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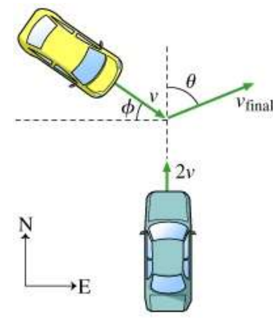
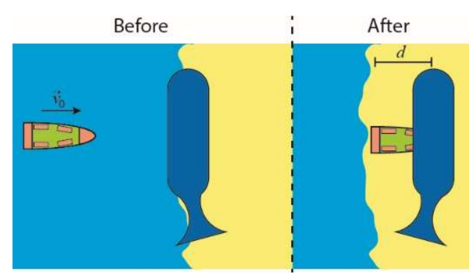
Quantitative Section



1. Two cars, both of mass $m = 2300$ kg, collide and stick together. Prior to the collision, one car traveled north at speed $2v$, while the second traveled with speed v at an angle $\phi = 18.0°$ south of east. Let the speed $v = 42.0$ m/s. After the collision, the two-car system travels at speed v_{final} at an angle θ east of north.

   (a) Find the speed v_{final} of the joined cars after the collision. [4]

   (b) What is the angle θ made by the velocity vector of the two cars after the collision? [3]



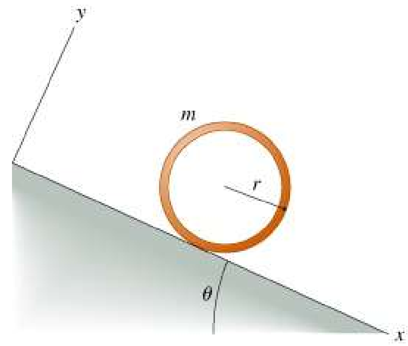
2. The Deep convinces a small sperm whale of mass $M = 18{,}000$ kg to beach itself in an attempt to stop some vigilantes. The speed boat and people inside have a combined mass of $m = 2500$ kg. Instead of slowing down, the boat increases its speed and rams into the whale. After the collision, the combined mass of objects slides across the beach a distance of $d = 2.2$ m. Assume a coefficient of kinetic friction to be $\mu_k = 0.200$ when sliding over the beach. Determine the speed of the boat just before impact with the whale. [6]

3. A barrel contains a 0.110 m layer of oil floating on water that is 0.230 m deep. The density of the oil is 570 kg/m^3 and the density of water is 1000 kg/m^3.

   (a) What is the gauge pressure, $p - p_{\text{atm}}$, at the oil-water interface? [3]

   (b) What is the gauge pressure at the bottom of the barrel? [3]

4. A circular hoop ($I_{\text{hoop}} = mR^2$) of mass $m = 5.00$ kg, radius $r = 2.00$ m, and infinitesimal thickness rolls without slipping down a ramp inclined at an angle $\theta = 32.0°$ with the horizontal.



(a) Draw a free body diagram of the hoop. [1]

(b) Determine the magnitude of the hoop's acceleration down the ramp. [4]

(c) Determine the force of static friction on the hoop. [3]

5. A primitive robot named Geometrus Prime could only transform between a solid cylinder ($I_{cyl} = \frac{1}{2}MR_{cyl}^2$) and a solid sphere ($I_{sph} = \frac{2}{5}MR_{sph}^2$). The ratio of radii between the two shapes was $\frac{R_{sp}}{R_{cyl}} = 2.30$. One day Geometrus Prime was floating through space in the shape of a cylinder and rotating with an angular speed of 6.50 rad/s. Determine the angular speed of Geometrus Prime when he transformed into a sphere. [5]

6. A spacecraft is placed in an orbit $h = 100$ km above the Earth's surface in a circular orbit. The distance of the spacecraft above the center of Earth is $r = R_E + h$. [Gravitational constant $G = 6.64\times10^{-11}$ N m^{2}kg^2, radius of the Earth $R_E = 6{,}380{,}000$ m, and mass of Earth $M_E = 5.97\times10^{24}$ kg]

(a) How fast is the craft moving when in orbit? [4]

(b) How many minutes does it take this craft to make one orbit? [3]

7. A hanging mass of $M = 0.350$ kg is attached to an ideal spring as shown in the above diagram. The mass is held above the equilibrium position until it is finally dropped at $t = 0$. The vertical position as a function of time is given by $y = y_{max}\cos(2\pi f t)$, where $y_{max} = 7.00$ cm and $f = 8.00\ \text{s}^{-1}$.

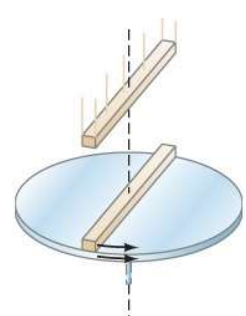
   (a) Determine the spring constant k. [4]

   (b) Find the distance between the hanging mass's position and the equilibrium position at $t = 1.40$ s. [3]

   (c) Determine the speed of the hanging mass at $t = 1.60$ s. [3]

   (d) Determine the magnitude of the hanging mass's acceleration at $t = 1.80$ s. [3]

8. On a distant planet, a rod of uniform mass density ($I = \frac{1}{12}mL^2$) hangs from the ceiling by a cord of negligible mass and oscillates at low angles. The length of the cord is $\ell = 0.350$ m and the length of the rod is $L = 0.750$ m. The oscillating system has a period of 1.80 s. Determine the acceleration due to gravity on the surface of the distant planet. [4]



Extra Credit Problem: A uniform disk ($I_{disk} = \frac{1}{2}mR^2$) turns at an angular speed of 25.0 rad/s around a frictionless central axis. An initially stationary rod ($I_{rod} = \frac{1}{12}mL^2$) of the same mass as the disk and length equal to the disk's diameter, is dropped onto the freely spinning disk as shown in the diagram. They then turn around the spindle with their centers superposed. Determine the angular speed of the pair as they rotate after the collision. [7]

END OF EXAMINATION