PH105 Exam 3

Name___________________________________

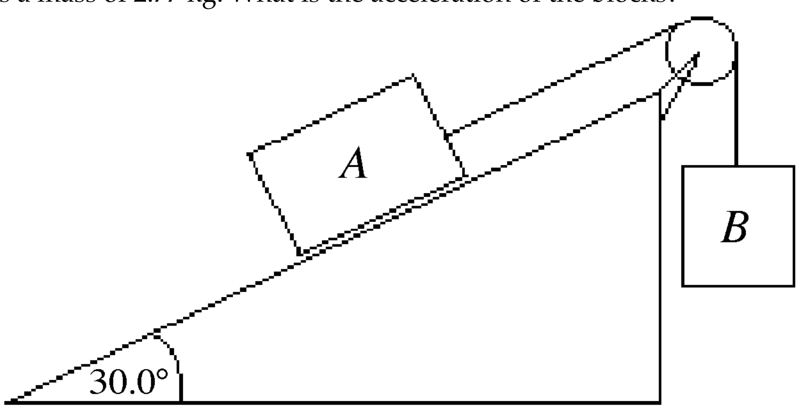
Instructions:
1. Solve 3 of 5 problems below. All problems have equal weight.
2. Do your work on separate sheets rather than on the exam.
3. Do not hesitate to ask if you are unsure what a problem is asking for.
4. Show your work for full credit. Significant partial credit will be given.
5. Symbolic solutions give more partial credit than purely numerical ones.
6. You are allowed 2 sides of a standard 8.5 x 11 in paper and a calculator.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

1) A child throws a ball with an initial speed of 8.00 m/s at an angle of 40.0° above the horizontal. The ball leaves her hand 1.00 m above the ground and experience negligible air resistance. 1) ______________
(a) How far from where the child is standing does the ball hit the ground?
(b) How long is the ball in flight before it hits the ground?

2) A uniform solid sphere of mass M and radius R rotates with an angular speed ω about an axis through its center. A uniform solid cylinder of mass M, radius R, and length $2R$ rotates through an axis running through the central axis of the cylinder. What must be the angular speed of the cylinder so it will have the same rotational kinetic energy as the sphere? 2) ______________

3) Two blocks are connected by a string that goes over an ideal pulley as shown in the figure. Block A has a mass of 3.00 kg and can slide over a rough plane inclined 30.0° to the horizontal. The coefficient of kinetic friction between block A and the plane is 0.400. Block B has a mass of 2.77 kg. What is the acceleration of the blocks? 3) ______________



4) A record is dropped vertically onto a freely rotating (undriven) turntable. Frictional forces act to bring the record and turntable to a common angular speed. If the rotational inertia of the record is 0.54 times that of the turntable, what percentage of the initial kinetic energy is lost? 4) ______________

5) A string is wrapped around a pulley with a radius of 2.0 cm and no appreciable friction in its axle. The pulley is initially not turning. A constant force of 50 N is applied to the string, which does not slip, causing the pulley to rotate and the string to unwind. If the string unwinds 1.2 m in 4.9 s, what is the moment of inertia of the pulley? 5) ______________

Formula sheet

basics

$$g = |\vec{a}_{\text{free fall}}| = 9.81\,\text{m/s}^2 \quad \text{near earth's surface}$$

$$\text{sphere} \quad V = \frac{4}{3}\pi r^3$$

$$ax^2 + bx^2 + c = 0 \Longrightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

1D & 2D motion

$$\text{speed} = v = |\vec{v}| \quad \vec{v}_{av} \equiv \frac{\Delta\vec{r}}{\Delta t} \quad \vec{v} = \lim_{\Delta t \to 0} \frac{\Delta \vec{r}}{\Delta t} \equiv \frac{d\vec{r}}{dt}$$

$$a_x = \lim_{\Delta t \to 0} \frac{\Delta v_x}{\Delta t} \equiv \frac{dv_x}{dt} = \frac{d}{dt}\left(\frac{dx}{dt}\right) = \frac{d^2x}{dt^2}$$

$$v_x(t) = v_{x,i} + a_x t$$

$$x(t) = x_i + v_{x,i} t + \frac{1}{2} a_x t^2$$

$$v_{x,f}^2 = v_{x,i}^2 + 2a_x \Delta x$$

$\downarrow$ launched from origin, level ground

$$y(x) = (\tan\theta_o)\,x - \frac{gx^2}{2v_o^2 \cos^2\theta_o}$$

$$\text{max height } = H = \frac{v_i^2 \sin^2\theta_i}{2g}$$

$$\text{Range } = R = \frac{v_i^2 \sin 2\theta_i}{g}$$

interactions

$$\Delta U^G = mg\Delta x \qquad \frac{a_{1x}}{a_{2x}} = -\frac{m_2}{m_1}$$

$$E_{\text{mech}} = K + U \quad K = \frac{1}{2}mv^2$$

$$\Delta E_{\text{mech}} = \Delta K + \Delta U = 0 \quad \text{non-dissipative, closed}$$

$$\Delta E = W$$

$$\Delta U_{\text{spring}} = \frac{1}{2}k\,(x - x_o)^2$$

$$P = \frac{dE}{dt}\text{general} \qquad P = F_{\text{ext,x}}\,v_x \quad \text{1D const force}$$

Rotation: we use radians

$$s = \theta r \quad \leftarrow \text{arclength}$$

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

$$a_t = \alpha r \quad \text{tangential} \qquad a_r = -\frac{v^2}{r} = -\omega^2 r \quad \text{radial}$$

$$v_t = r\omega \qquad v_r = 0$$

$$\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2 \quad \text{const } \alpha$$

$$\omega_f = \omega_i + \alpha t \quad \text{const } \alpha$$

$$\Delta x = r\theta \quad v = r\omega \quad a = r\alpha \quad \text{no slipping}$$

$$I = \sum_i m_i r_i^2 \Rightarrow \int r^2\,dm = cmr^2 \qquad I = mr^2 \quad \text{point particle}$$

$$I_z = I_{com} + md^2 \quad \text{axis } z \text{ parallel, dist } d$$

$$\vec{L} = \vec{r} \times \vec{p} = I\vec{\omega} \qquad L = I\omega = mvr_\perp$$

$$K = \frac{1}{2}I\omega^2 = L^2/2I$$

$$\Delta K = \frac{1}{2}I\omega_f^2 - \frac{1}{2}I\omega_i^2 = W = \int \tau\,d\theta$$

$$P = \frac{dW}{dt} = \tau\omega$$

$$\tau = rF\sin\theta_{rF} = r_\perp F = rF_\perp$$

$$\tau_{net} = \sum \vec{\tau} = I\vec{\alpha} = \frac{d\vec{L}}{dt}$$

$$K_{\text{tot}} = K_{cm} + K_{rot} = \frac{1}{2}mv_{cm}^2 + \frac{1}{2}I\omega^2$$

work

$$\Delta E_{\text{mech}} = \Delta K + \Delta U = W \quad \leftarrow \text{not closed} \qquad \Delta U_{\text{spring}} = \frac{1}{2}k\,(x - x_o)^2$$

$$P = \frac{dE}{dt} \quad P = F_{\text{ext,x}}\,v_x \quad \text{one dimension}$$

$$W = \left(\sum \vec{F}\right)\Delta x_F \quad \text{constant foce 1D}$$

$$W = \sum_n \left(F_{\text{ext,x}}\,\Delta x_{Fn}\right) \quad \text{const nondiss., many particles, 1D}$$

$$W = \int_{x_i}^{x_f} F_x(x)\,dx \quad \text{nondiss. force, 1D}$$

$$(F_{12}^s)_{\max} = \mu_s F_{12}^n \quad \text{static} \qquad F_{12}^k = \mu_k F_{12}^n \quad \text{kinetic}$$

$$W = \vec{F} \cdot \Delta\vec{r}_F \quad \text{const non-diss force}$$

$$W = \int_{\vec{r}_i}^{\vec{r}_f} \vec{F}(\vec{r}) \cdot d\vec{r} \quad \text{variable nondiss force}$$

Moments of inertia of things of mass M

Object	axis	**dimension**	**I**
solid sphere	central axis	radius R	$\frac{2}{5}MR^2$
hollow sphere	central axis	radius R	$\frac{2}{3}MR^2$
solid disc/cylinder	central axis	radius R	$\frac{1}{2}MR^2$
hoop	central axis	radius R	MR^2
point particle	pivot point	distance R to pivot	MR^2
rod	center	length L	$\frac{1}{12}ML^2$
rod	end	length L	$\frac{1}{3}ML^2$
solid regular octahedron	through vertices	side a	$\frac{1}{10}ma^2$

Derived unit	**Symbol**	**equivalent to**
newton	N	kg·m/s^2
joule	J	kg·m^2/s^2 = N·m
watt	W	J/s=m^2·kg/s^3

Answer Key
Testname: EXAM3

1) (a) 7.46 m (b) 1.22 s
2) $2\omega / \sqrt{5}$
3) 0.392 m/s^2
4) 35%
5) 0.20 $kg \cdot m^2$