Physics 2010
Fall 2007
Sid Rudolph

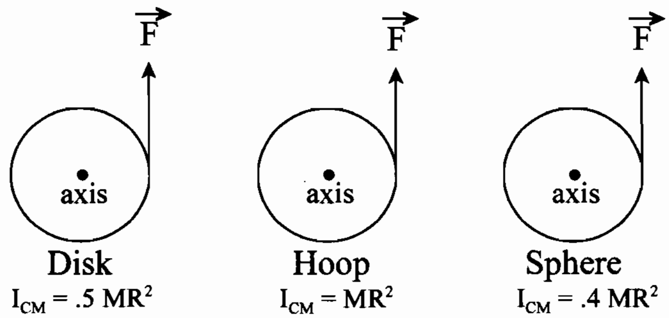
EXAM 4

1

Name:____________________ Student ID #:____________________

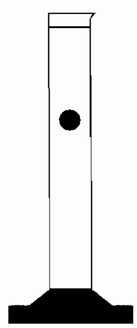
TA (circle one): Golda Kamdem Matthew Michael Paul

A. *[14 pts.]* A uniform disk (D), hoop (H), and sphere (S), all with the <u>same</u> mass and radius, can freely rotate about an axis through the center of mass (CM) of each. A massless string is wrapped around <u>each</u> item. The string is used to apply a <u>constant</u> and <u>equal tangential force</u> to each object. See figure. For the statements below, enter D, H, S, none or the same. Assume all objects start from rest at the same instant.



1. __S__ The one with the smallest moment of inertia about the shown axis.
2. __SAME__ The object experiencing the largest <u>net</u> torque.
3. __H__ The object undergoing the smallest angular acceleration.
4. __S__ The object with the largest angular speed after an elapsed time of 5.0 s.
5. __S__ The object for which the largest amount of string has unraveled in 5.0 s.
6. __H__ The object with the smallest KE_{rot} after 5.0 s.
7. __S__ The object that undergoes the most rotations in 5.0 s.

B. *[14 pts.]* A spherical object is completely immersed in a liquid of density ρ_{liq} some distance above the bottom of the vessel. See figure. The upper surface is initially open to the earth's atmosphere at sea level. Assume the liquid and object are both incompressible. For the items below, indicate whether the object sinks to the bottom (B), rises to the surface (T), or does nothing (N).



1. __N__ The vessel is brought to Salt Lake City.
2. __T__ Salt is dissolved in the liquid in the same way fresh water is turned into salt water.
3. __N__ The top 50 cm^3 of the liquid is removed from the vessel.
4. __N__ The entire apparatus is transported to the surface of the moon.
5. __T__ The volume of the spherical object is increased by heating it without heating the liquid.
6. __N__ The spherical object is moved 10 cm farther down in the vessel and released.
7. __N__ A mass is placed on the top surface of the liquid in the vessel increasing the pressure at the surface. No fluid leaks.

Physics 2010
Fall 2007
Sid Rudolph

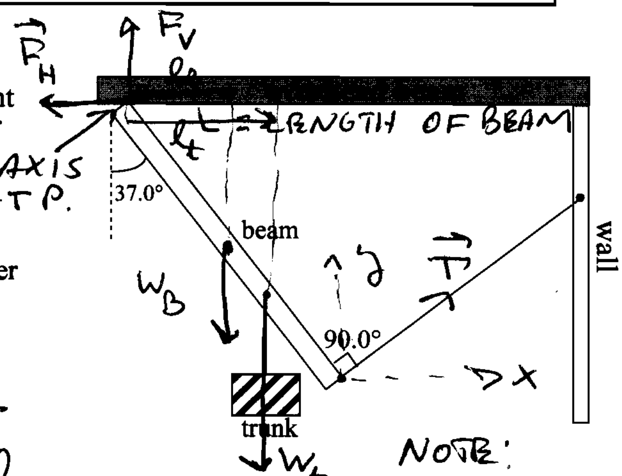
EXAM 4

2

Name:______________________________ Student ID #:______________________

TA (circle one): Golda Kamdem Matthew Michael Paul

A 2.20×10^3 N uniform beam is attached to an overhead beam as shown in the drawing. A 3.60×10^3 N trunk hangs from an attachment to the beam two-thirds of the way down from the upper connection of the beam to the overhead support. A cable is tied to the lower end of the beam and is also attached to the wall on the right. AXIS AT P.



A. [20 pts.] What is the tension in the cable connecting the lower end of the beam to the wall? USE ROT. EQUIL.

$\tau_{NET} = \sum \tau_i = 0$

$= \tau_{F_V} + \tau_{F_H} + \tau_{W_B} + \tau_{W_t} + \tau_T$

$= 0 + 0 - W_B l_B - W_t l_t + T l_T$

$0 = -(2.2\times10^3 N)(\frac{L}{2}\sin 37°) - (3.6\times10^3 N)(\frac{2L}{3}\sin 37°) + TL$

NOTE: $l_T = L$, $l_t = \frac{2}{3}L\sin 37°$, $l_W = \frac{L}{2}\sin 37°$

$T = \frac{(2.2\times10^3 N)(.3) + (3.6\times10^3 N)(.4)}{1}$

$T = 2100 N$

B. [15 pts.] What are the vertical and horizontal components of the force the overhead beam exerts on the upper end of the beam at P? USE TRANSLATIONAL EQUILIBRIUM

$\sum F_x = 0 = T\cos 37° - F_H$

$F_H = (2100 N)(.8)$

$F_H = 1680 N$

NOTE: "+" IN MY CS

$\sum F_y = 0 = F_V + T\sin 37° - W_B - W_t$

$F_V = 2.2\times10^3 N + 3.6\times10^3 N - (2100 N)(.6)$

$F_V = 4540 N$

NOTE: "−" IN MY CS

Physics 2010 Fall 2007 Sid Rudolph	**3**

EXAM 4

Name:______________________________ Student ID #:________________________

TA (circle one): Golda Kamdem Matthew Michael Paul

A. A 12.0 kg block moves back and forth on a frictionless horizontal surface between two springs. The spring on the right has a force constant k = 825 N/m. When the block arrives at the spring on the right, it compresses that spring 0.180 m from its unstretched position.

1. *[9 pts.]* What is the total mechanical energy of the block and two spring system?

ME(SYSTEM) = $\frac{1}{2} k_R A_R^2$ = (.5)(825 N/m)(.18 m)^2

ME(SYSTEM) = 13.4 J

2. *[9 ptsl.]* With what speed does the block travel between the two springs while not in contact with either spring? ME(SYS.) = $\frac{1}{2} m v_{MAX}^2$ v_{MAX} = SPEED OF BLOCK BETWEEN SPRINGS

$v_{MAX} = \sqrt{\frac{(2)(13.4 J)}{12.0 kg}}$

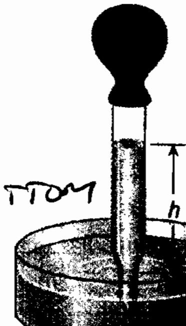
v_{MAX} = 1.49 m/s

3. *[9 pts.]* Suppose the block, after arriving at the left spring, remains in contact with that spring for a total time of 0.650 s, before separating on its way to the right spring? Using the connection between this 0.650 s and the period of oscillation between the block and the left spring, determine the spring constant of the left spring. PERIOD = T = (2)(0.650 s) = 1.30 s

T = 1.30 s = $2\pi\sqrt{m/k_L}$ $k_L = \frac{(2\pi)^2 m}{T^2} = \frac{(2\pi)^2 (12 kg)}{(1.30 s)^2}$

k_L = 280 N/m

B. *[10 pts.]* A turkey baster (see figure) consists of a squeeze bulb attached to a plastic tube. When the bulb is squeezed and released, with the open end of the tube under the surface of the turkey gravy, the gravy rises in the tube to a distance h, as shown in the drawing. It can then be squirted over the turkey. Using $P_{atm} = 1.013 \times 10^5$ N/m^2 for atmospheric pressure and 1.10×10^3 kg/m^3 for the density of the gravy, determine the absolute pressure of the air in the bulb with the distance h = 0.160 m. Give answer to three significant digits. AT THE LEVEL OF THE GRAVY AT THE BOTTOM OF h P = P_{ATM}. THUS,



$P_{ATM} = P_{AIR} + \rho_{GRAVY} g h$

$P_{AIR} = P_{ATM} - \rho_G g h = 1.013 \times 10^5 N/m^2 - (1.1 \times 10^3 kg/m^3)(9.8 m/s^2)(.16 m)$

$P_{AIR} = 9.96 \times 10^4 N/m^2$