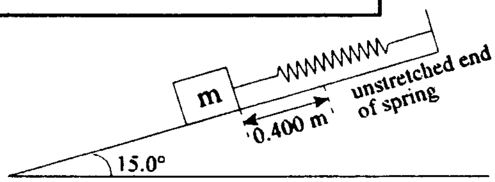
Physics 2010 Fall 2003 Sid Rudolph	**3**

EXAM 4

Name:______________________________ Student ID #:______________________

TA (circle one): Bobela Schrank Shepherd Stoker Tsunoda

A. A spring is attached to a post at the top of a 15.0° frictionless ramp. A 2.00 kg mass is attached to the spring and the mass is slowly allowed to stretch the spring to the equilibrium position of the mass-spring system, the spring stretches by 0.400 m. See figure. The mass is now pulled an additional 10.0 cm and released. The mass-spring system executes simple harmonic motion.



1. *[8 pts.]* What is the spring constant, k, of the spring.

(4PTS) $mg\sin 15^\circ = kx_e \qquad k = \frac{mg\sin 15^\circ}{x_e} = \frac{(2\,kg)(9.8\,m/s^2)\sin 15^\circ}{.4\,m}$

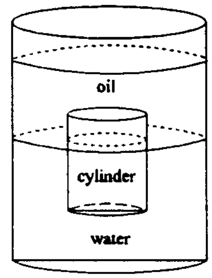
$\boxed{k = 12.7\,N/m}$ (4 PTS)

2. *[8 pts.]* What are the amplitude and period of oscillation of the mass-spring system?

(3PTS) $\boxed{A = 10.0\,cm}$ $\quad \omega = \frac{2\pi}{T} = \sqrt{\frac{k}{m}} \quad T = 2\pi\sqrt{\frac{m}{k}} = (2\pi)\sqrt{\frac{2\,kg}{12.7\,N/m}}$

$\boxed{T = 2.49\,s}$ (5PTS)

B. A solid, uniform cylinder is floating at the interface between water ($\rho_{water} = 1.00 \times 10^3$ kg/m³) and oil ($\rho_{oil} = 8.24 \times 10^2$ kg/m³) with 3/4 of the cylinder in the water region and 1/4 of the cylinder in the oil region. Assume the axis of the cylinder is perfectly vertical. See figure.



1. *[8 pts.]* What is the density of the material out of the which the cylinder is made?

$W_{CYL} = B_{TOT} = B_{OIL} + B_W$

(5PTS) $\rho_{CYL} A h g = \rho_{OIL} \frac{Ah}{4} g + \rho_W \frac{3Ah}{4} g$

$\rho_{CYL} = \frac{\rho_{OIL}}{4} + \frac{3\rho_W}{4} = \frac{8.24\times10^2\,kg/m^3}{4} + \frac{3(1.0\times10^3\,kg/m^3)}{4}$

(3 PTS) $\boxed{\rho_{CYL} = 956\,kg/m^3}$

2. *[8 pts.]* Assume the upper surface of the oil region is open to the atmosphere ($\rho_{atm} = 1.01 \times 10^5$ N/m²) and the oil-water interface is 0.500 m below the upper surface of the oil. Also assume the height of the cylinder is 10.0 cm. What is the gauge pressure on the bottom surface of the cylinder? Recall: $P_{gauge} = P - P_{ATM}$

$P_{GAUGE} = P - P_{ATM} = \rho_{OIL} g h_{OIL} + \rho_W g h_W$ (4PTS)

$= (824\,kg/m^3)(9.8\,m/s^2)(.5\,m) + (10^3\,kg/m^3)(9.8\,m/s^2)(.075\,m)$

$\boxed{P_{GAUGE} = 4.77\times10^3\,N/m^2}$ (4 PTS)