EXAM 4

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A. A spring is attached to a post at the top of a 15.0° frictionless ramp. A 3.00 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?

\[
(4 \text{ pts.}) \quad M_g = \text{mass of the pendulum} = 4 \text{ kg}
\]

\[
\theta = 12.7^\circ \quad \text{and} \quad x = \frac{d_2}{2}
\]

\[
(4 \text{ pts.}) \quad k = 12.7 \text{ N/m}
\]

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

\[
(3 \text{ pts.}) \quad A = 10.0 \text{ cm}
\]

\[
\omega = \frac{\sqrt{\frac{g}{2}}} {\sqrt{\text{m}}}
\]

\[
(3 \text{ pts.}) \quad T = 2.49 \text{ s}
\]

B. A solid, uniform cylinder is floating at the interface between water \( (p_{\text{water}} = 1.00 \times 10^3 \text{ kg/m}^3) \) and oil \( (p_{\text{oil}} = 8.24 \times 10^2 \text{ kg/m}^3) \) 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 which the cylinder is made?

\[
(5 \text{ pts.}) \quad \rho_{\text{cyl}} \cdot V_{\text{cyl}} = \rho_{\text{water}} \cdot V_{\text{water}} + \rho_{\text{oil}} \cdot V_{\text{oil}}
\]

\[
(3 \text{ pts.}) \quad \rho_{\text{cyl}} = 9.6 \text{ kg/m}^3
\]

2. [8 pts.] Assume the upper surface of the oil region is open to the atmosphere \( (p_{\text{atm}} = 1.01 \times 10^5 \text{ N/m}^2) \) and the oil-water interface is 0.300 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: \( p_{\text{gauge}} = P - P_{\text{atm}} \)

\[
(4 \text{ pts.}) \quad p_{\text{gauge}} = 12.4 \times 10^5 \text{ N/m}^2
\]

\[
(4 \text{ pts.}) \quad p_{\text{gauge}} = 4.77 \times 10^3 \text{ N/m}^2
\]