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General Physics I, Quiz 4
PHYS1000AA, Class year102
12-12-2013

SN:_____, Name:_____

Chapter 14-15 Serway; ABSOLUTELY NO CHEATING!
Please write the answers on the blank space or on the back of this paper to save resources.

1. Assuming the spring obeys Hooke's law, the increase in force on the piston required to compress the spring an additional amount Δx is

$$\Delta F = F - F_0 = (P - P_0)A = k(\Delta x)$$

The gauge pressure at depth h beneath the surface of a fluid is

$$P - P_0 = \rho g h$$

so we have

$$\rho g h A = k\,(\Delta x)$$

or the required depth is

$$h = k\,(\Delta x)\,\rho g A$$

If $k = 1250$ N/m, $A = \pi d^2/4$, $d = 1.20 \times 10^{-2}$ m, and the fluid is water ($\rho = 1.00 \times 10^3$ kg/m^3), the depth required to compress the spring an additional $\Delta x = 0.750 \times 10^{-2}$ m is $h = 8.46$ m

$\boxed{h=8.46\text{ m}}$

2. (a) Energy is conserved for the block-spring system between the maximum-displacement and the half-maximum points:

$$(K+U)_i = (K+U)_f$$

$$0 + \frac{1}{2}kA^2 = \frac{1}{2}mv^2 + \frac{1}{2}kx^2$$

$$\frac{1}{2}(6.50\,\text{N/m})(0.100\,\text{m})^2 = \frac{1}{2}m(0.300\,\text{m/s})^2 + \frac{1}{2}(6.50\,\text{N/m})(5.00\times10^{-2}\,\text{m})^2$$

$$3.25\times10^{-2}\,\text{J} = \frac{1}{2}m(0.300\,\text{m/s})^2 + 8.12\times10^{-3}\,\text{J}$$

giving $m = \dfrac{2(2.44\times10^{-2}\,\text{J})}{9.0\times10^{-2}\,\text{m}^2/\text{s}^2} = \boxed{0.542\,\text{kg}}$

(b) $\omega = \sqrt{\dfrac{k}{m}} = \sqrt{\dfrac{6.50\,\text{N/m}}{0.542\,kg}} = 3.46\,\text{rad/s}$

Then, $T = \dfrac{2\pi}{\omega} = \dfrac{2\pi\,\text{rad}}{3.46\,\text{rad/s}} = \boxed{1.81\,\text{s}}$

(c) $a_{\max} = A\omega^2 = (0.100\text{ m})(3.46\text{ rad/s})^2 = \boxed{1.20\text{ m/s}^2}$

so $\omega = \sqrt{\dfrac{GM_s}{R_s^3}} = \sqrt{\dfrac{(6.67\times10^{-11}\,\text{N}\cdot\text{m}^2/\text{kg}^2)[2(1.99\times10^{30}\,\text{kg})]}{(10.0\times10^3\,\text{m})^3}}$

$\omega = \boxed{1.63\times10^4\text{ rad/s}}$