PHY101 HW6 Solutions Fall 2017

(1) This is a Young's modulus situation with a changing length in the direction of the applied force, or $Y\left(\frac{\Delta L}{L}\right) = \frac{F}{A}$

$$\Delta L = \frac{FL}{YA} = \frac{\left(\frac{1}{2} mg\right) L}{YA} = \frac{\frac{1}{2}(91\,kg)(9.8\,m/s^2)(.5\,m)}{\left(1.1\times 10^{10}\,\frac{N}{m^2}\right)(7\times 10^{-4}\,m^2)}$$

$$\Delta L = 29\times 10^{-6}\,m$$

(2) A Bulk modulus situation with $\Delta P = -B\frac{\Delta V}{V}$. Therefore, $\frac{\Delta V}{V} = \frac{-\Delta P}{B}$

$$= \frac{-1\times 10^{8}\,N/m^2}{130\times 10^{9}\,Pa} = -7.7\times 10^{-4} \rightarrow \text{a decrease in volume fraction.}$$

To compute the fractional change in the radius, we begin with $V = \frac{4}{3}\pi r^3$ for a sphere, or $r = \left(\frac{3V}{4\pi}\right)^{\frac{1}{3}}$. To compute $\frac{r_f - r_i}{r_i} = \frac{\Delta r}{r_i}$,

$$\frac{r_f}{r_i} - 1 = \frac{\left(\frac{3V_f}{4\pi}\right)^{\frac{1}{3}}}{\left(\frac{3V_i}{4\pi}\right)^{\frac{1}{3}}} - 1 = \left(\frac{V_f}{V_i}\right)^{\frac{1}{3}} - 1 = \left(\frac{(\Delta V + V_i)}{V_i}\right)^{\frac{1}{3}} - 1.$$

$$= \left(\frac{\Delta V}{V_i} + 1\right)^{\frac{1}{3}} = \left(-7.7\times10^{-4} + 1\right)^{\frac{1}{3}} - 1 = -2.6\times10^{-4}$$

(3) (a) Starting with $\omega = \sqrt{\frac{k}{m}} = 2\pi f$, then $k = (2\pi f)^2 m = (2\pi)^2 (3\,\text{Hz})^2 (.17\,\text{kg})$

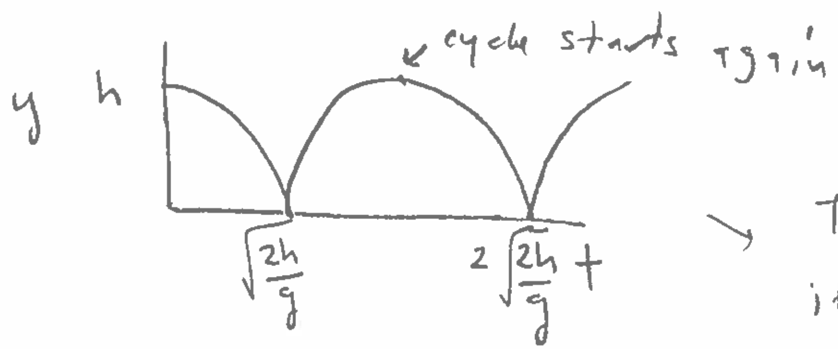
$$K = 60\ \text{N/m}.$$

(b) The amplitude A is given by $0.12\,\text{m}$ (the initial stretch), and

$$x(t) = A\cos(\omega t) = 0.12\,\text{m}\cos\left((2\pi)(3\,\text{Hz})t\right)$$
$$= 0.12\,\text{m}\cos\left((6\pi\ \text{Hz})t\right).$$

We use the cosine here because $\sin(0) = 0$ when $t = 0$.

(4) How long does it take the ball to drop? $0 = h - \frac{1}{2}g(\Delta t)^2$



$$\Rightarrow \Delta t = t_f - \underset{0}{t_i} = \sqrt{\frac{2h}{g}}.$$

This graph is <u>not</u> SHM because it is not a sine or cosine graph.

Here, $y(t)$ decreases parabolically with time.

When $y=0$, all K and $U_{grav}=0$, so an "initial" velocity of $\sqrt{2gh}$ which then allows the ball to return to its original height again in the absence of friction/dissipation.

(5) In equilibrium, $\sum F_y = 0 = mg - k\ell = 0 \Rightarrow \frac{k}{m} = \frac{g}{\ell}$.

For a spring, $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}} = \frac{1}{2\pi}\sqrt{\frac{9.8\,m/s^2}{3\times10^{-5}\,m}} = 91\ Hz.$