ISP209 Fall 2003 **Homework 2** Name: ______________________
Due: Tues., Sept. 16, 10:20 am, in Rm 1410 BPS. ID:__________________________

1. With no forces acting on an ideal spring, its length is called the <u>normal or natural</u> length.

2. To stretch an ideal spring, how many forces must *act on* the spring? <u>two</u>

3. Can forces of different magnitude be applied to opposite sides of an ideal spring? <u>no</u>

4. What are the units of a spring constant? <u>force/unit length (e.g., N/cm)</u>

5. What is the metric unit of force? <u>newton</u> What symbol denotes this unit? <u>N</u>

6. In lbs, what force is equal to 1 N? <u>1/4</u> lb

7. Substitute the values of the spring constant, $k = 5$ N/cm, and a stretch, $x = 15$ cm into Hooke's law to determine the force, F, (with units) needed to maintain this stretch.

(show work here) $\boxed{F = kx = (5\text{ N / cm})(15\text{ cm}) = \underline{75\text{ N}}}$ $F = \underline{75\text{ N}}$

8. A force of 21 N, stretches a spring by 7 cm. What is its spring constant? <u>7</u> N/cm.

$$\boxed{k = \frac{F}{x} = \frac{21\text{ N}}{3\text{ cm}} = \underline{7\text{ N / cm}}}$$

9. What is the maximum force (in lb. & N) that you apply to dental floss when flossing your teeth? Do not guess, use simple logic! For example, imagine lifting something heavy (a box of books, a bicycle, etc.) with dental floss, would it cut your hand? <u>YES</u>

maximum force on dental floss = <u>1 - 5</u> lb,. and <u>4 - 20</u> N

10. An additional 10 N of force will increase the stretch of a spring from 5 cm to 7 cm.
   a) What is the spring constant (w/ units) of this spring? <u>5 N / cm</u>
   b) What force (w/ units) is needed to hold the spring stretched by 7 cm? <u>35 N</u>
   c) What additional force (w/ units) stretches this spring another 3 cm? <u>15 N</u>

$$\boxed{\begin{aligned} \text{a)}\, k &= \frac{\Delta F}{\Delta x}; \quad \Delta F = 10\text{ N},\ \Delta x = (7\text{ - }5)\text{ cm} = 2\text{ cm} \\ &= \frac{10\text{ N}}{2\text{ cm}} = \underline{5\text{ N / cm}} \end{aligned}}$$

$$\boxed{\begin{aligned} &\text{b) } F = kx = (5\text{ N / cm})(7\text{ cm}) = \underline{35\text{ N}} \\ &\text{c) } \Delta F = k\Delta x = (5\text{ N / cm})(3\text{ cm}) = \underline{15\text{ N}} \end{aligned}}$$

11. A rod has a spring constant $k = 2\times10^7$ N/m (note units). How far will it compress (in mm!) under a force of 2×10^3 N? mm

$$\boxed{x = \frac{F}{k} = \frac{2\times10^3\text{ N}}{2\times10^7\text{ N / m}} = 1\times10^{-4}\text{ m} = 1\times10^{-4}\text{ m}\left(\frac{10^3\text{ mm}}{1\text{ m}}\right) = \underline{0.1\text{ mm}}}$$

12. Complete this sentence: Springs *generate* <u>force</u> , and *store* <u>energy</u> .

13. Convert the pressure 1×10^5 N/m^2 to a pressure in lb/in^2 (1 in = 2.54 cm). Use the conversion factors given at the end of the chapter.

$$\boxed{\begin{aligned} 1\times10^5\text{ N / m}^2 &= 1\times10^5\text{ N / m}^2\left(\tfrac{1}{4}\text{lb / N}\right)(1\text{m / 100 cm})^2(2.5\text{ cm / in})^2 \\ &= \underline{1.5\times10^1\text{ lb / in}^2} \end{aligned}}$$

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14. The density of lead is 11 g/cm^3 (1 cm^3 has an 11 g mass). What is the mass (in kg) of 1 m^3 of lead?(convert lead's density to kg/m^3; 1 m^3 is a cube, 100 cm on a side; 1g = 10^{-3} kg.)

$$\boxed{\begin{array}{l} 11\ \mathrm{g/cm^3} = 11\ \mathrm{g/cm^3}\left(1\ \mathrm{kg}/1000\ \mathrm{g}\right)\left(100\ \mathrm{cm}/1\mathrm{m}\right)^3 = 11\times10^3\ \mathrm{kg/m^3} \\ \text{The density indicates that } 1\ \mathrm{m^3} \text{ of lead has a mass of } \underline{11\times10^3\ \mathrm{kg}}. \end{array}}$$

$m = \underline{11\times10^3\ \mathrm{kg}}$.

15. A cubic centimeter of water has a 1 gram mass, i.e., the density is 1g/cm^3. What is the mass of one cubic meter of water? (convert water's density to kg/m^3).
(show work here)

$$\boxed{\begin{array}{l} 1\ \mathrm{g/cm^3} = 1\ \mathrm{g/cm^3}\left(1\ \mathrm{kg}/1000\ \mathrm{g}\right)\left(100\ \mathrm{cm}/1\mathrm{m}\right)^3 = 1\times10^3\ \mathrm{kg/m^3} \\ \text{The density indicates that } 1\ \mathrm{m^3} \text{ of lead has a mass of } \underline{1\times10^3\ \mathrm{kg}}. \end{array}}$$

$m = \underline{1\times10^3\ \mathrm{kg}}$.