ISP209 Spring 2001 **Homework 3** Name: ____________________
Due: Thurs., Feb. 1, 2:40 pm, in Rm 118PA. ID:______________________

Homework Problems

1. Which force, electromagnetic(E), gravitational(G), weak nuclear(WN) or strong nuclear(SN), is primarily responsible for the following: (all correct for credit)

fusion of Deuterium and Tritium. **SN**
smoking a cigarette **E**
bleaching a shirt. **E**
cutting a piece of paper. **E**
cooking a chicken. **E**
crushing a nut. **E**
pumping water from a well. **E**
beta decay of Tritium to Helium-3. **WN**
sawing wood. **E**
toasting a muffin. **E**
defrosting in a microwave oven. **E**
growing of hair. **E**

2. True or False (all correct for credit)

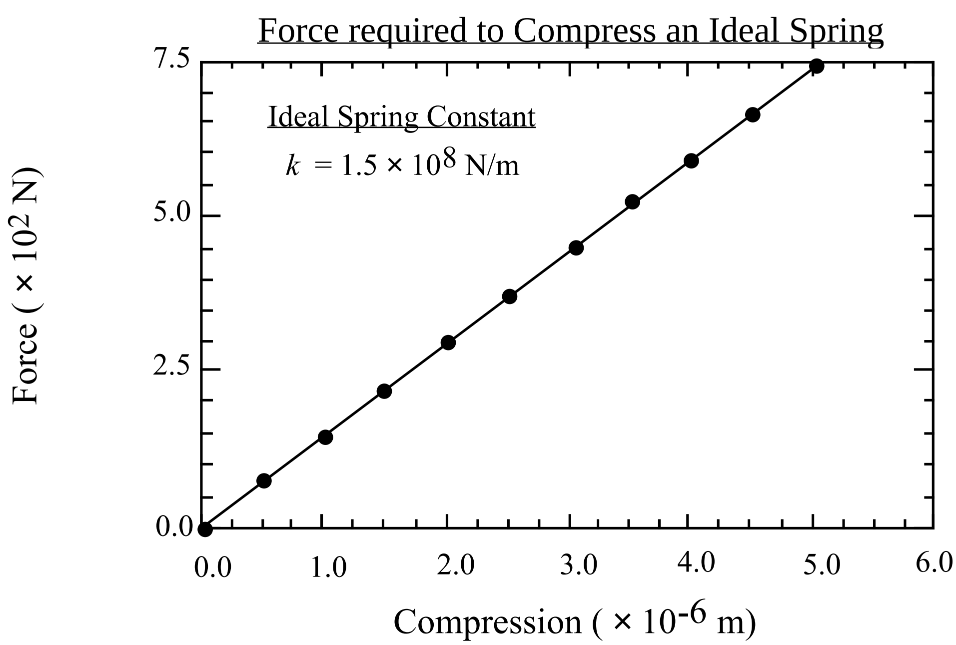
T F Two force vectors are "equal" only if the magnitude and direction are the same.
T **F** Two force vectors can "balance" if the magnitude and direction are the same.
T F Two force vectors cannot "balance" and be "equal" at the same time.
T F Two force vectors with "equal" magnitudes can point in opposite directions.
T F Two force vectors cannot stretch an object if they are "equal".

3. Convert the pressure 1×10^5 N/m^2 to a pressure in lb/in^2 (1 in = 2.54 cm). 14 lb./in.^{2}

$$1\times 10^5\ \text{N/m}^2 = (1\times 10^5\ \text{N/m}^2)(0.22\ \text{lb/N})[(2.54\ \text{cm/1 in.})(1\ \text{m/100cm})]^2$$
$$= (0.22\times 10^5\ \text{lb/m}^2)[.0254\ \text{m/in}]^2 = \underline{14\ \text{lb/in}^2}$$

4. What are the units of a spring constant? Force per unit length (force/unit length)

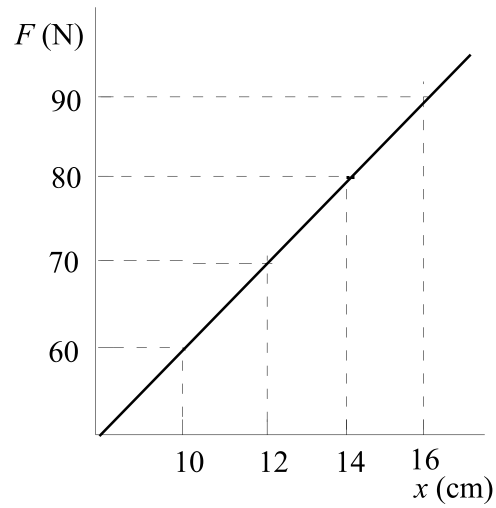
5. On the graph below, plot the applied force vs. compression of a spring, spring constant k=1.5×10^8 N/m, for 11 equally spaced compression values from zero (increasing in 10



steps of 0.5×10^{-6} m) to 5×10^{-6} m. It should look similar to text *Fig. 3.5* .

6. A long spring obeys Hooke's law and can be stretched 10 cm by a force of 20 N.
a) Plot of force vs. stretch of this spring has what slope (w/units)? 2 N/cm
b) Force applied is 50 N. How far does the spring stretch (w/units)? 25 cm

Plotted on the right, is data for a spring following Hooke's law only after an initial force, F_0, is applied; $F = kx + F_0$. (Note: the zero of each scale is not shown.)



Graph for problems 7–8

7. What is the spring constant, k (slope of the line), in the region shown? 5 N/cm

$$k = \text{slope} = \frac{(70-60)\ \text{N}}{(12-10)\ \text{cm}} = 5\ \text{N/cm}$$

8. Use k, and one point, F and x, on the graph to find F_0, force applied to the spring when it begins to stretch; F_0 = 10 N. (assume spring is linear down to $x = 0$).

$$F = kx + F_0$$
$$F_0 = F - kx = (70\ \text{N}) - (5\ \text{N/cm})(12\ \text{cm}) = 10\ \text{N}$$

9. In lbs, what force is equal to 1 N? about 1/4 lb

10. A force of 21 N, stretches a spring by 7 cm. What is its spring constant? 3 N/cm.

11. What force (maximum) do you apply to dental floss in use (in lb. & N)? Do not guess, use logic! For example, tell me how many five pound bags of sugar can you can lift with a piece of dental floss. What will the dental floss do to your hand if you tried to lift 20 bags of sugar? maximum force on dental floss = **about** 10 lb,. or 40 N

12. An additional 10 N of force increases the stretch of a spring from 5 cm to 7 cm.
a) What is the spring constant (w/ units) of this spring? 5 N/cm
b) What additional force (w/ units) stretches this spring another 3 cm? 15 N

$$\Delta F = k\Delta x = (5\ \text{N/cm})(3\ \text{cm}) = 15\ \text{N}$$

13. 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? 0.1 mm

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

14. The density of lead is 11 g/cm^3 (each cubic centimeter of lead has a mass of 11 g). What is the mass (in kg) of 1 m^3 of lead? (1 m^3 is a cube, 100 cm on a side).

$$\text{density} = \left(11\ \text{g/cm}^3\right)\left(1\ \text{kg/1000 g}\right)\left(100\ \text{cm/m}\right)^3 = 1.1\times10^4\ \text{kg/m}^3$$

m = 1.1×10^4 kg.

15. One cubic centimeter of water has a mass of 1 gram (1g = 10^{-3} kg), i.e., the density is 1g/cm^3. What is the mass of one cubic meter of water?

$$\text{density} = \left(1\ \text{g/cm}^3\right)\left(1\ \text{kg/1000 g}\right)\left(100\ \text{cm/m}\right)^3 = 1\times10^3\ \text{kg/m}^3$$

m = 1×10^3 kg