Name__________**KEY**____________ *Using Stress and Strain to Detect Cancer!*

STRESS, STRAIN AND HOOKE'S LAW PROBLEM SET

You will need to SHOW ALL WORK. Useful constants that you will need to know are in a table below. (assume given constants have 3 SF's). Please also note the relationships we've just discussed given below.

Material	Young's Modules, E (Pa)
Steel	200 x 10^9
Cast Iron	100 x 10^9
Concrete	20.0 x 10^9

$$F = m * a \qquad \sigma = \frac{F}{A} \qquad \varepsilon = \frac{\Delta l}{l_0} \qquad \sigma = E * \varepsilon \qquad F = -k * \Delta x$$

1. A 3340 N ball is supported vertically by a 1.90 cm diameter steel cable. Assuming the cable has a length of 10.3 m, determine the stress and the strain in the cable.

$$\sigma = E * \varepsilon \rightarrow \frac{F}{A} = E * \frac{\Delta l}{l_0} \rightarrow \Delta l = \frac{F * l_0}{A * E}$$

$$\Delta l = \frac{3340N * 10.3m}{(\pi * .0095m^2) * (200 * 10^9 N/m^2)} = .000607\ m$$

$$\varepsilon = \frac{.000607\ m}{10.3\ m} = 5.89 * 10^{-5}\ or\ .00589\%$$

2. Consider an iron rod with a cross-sectional area of 3.81 cm^2 that has a force of 66,700 N applied to it. Find the stress in the rod.

$$A = 3.81cm^2 * \frac{1m^2}{(100cm)^2} = .000381m^2$$

$$\sigma = \frac{F}{A} = \frac{66700N}{.000381\ m^2} = 1.75 * 10^8 N/m^2\ \ or\ 175\ MPa$$

3. A concrete post with a 50.8 cm diameter is supporting a compressive load of 8910 Newtons. Determine the stress the post is bearing.

$$d = 50.8cm \frac{1m}{100\ cm} = .508 \quad r = \frac{.508}{2} = .254\ cm$$

$$\sigma = \frac{F}{A} = \frac{8910N}{\pi * (.254m)^2} = 44kPa$$

4. The concrete post in the previous problem has an initial height of 0.55 m. How much shorter is the post once the load is applied (in mm)?

$$\varepsilon = \frac{\sigma}{E} = \frac{44 * 10^3\ N/m^2}{20 * 10^9\ N/m^2} = 2.2 * 10^{-6} = \frac{\Delta l}{l_0}$$

$$\Delta l = 2.2 * 10^{-6} * .55m = 1.2 * 10^{-6} m$$

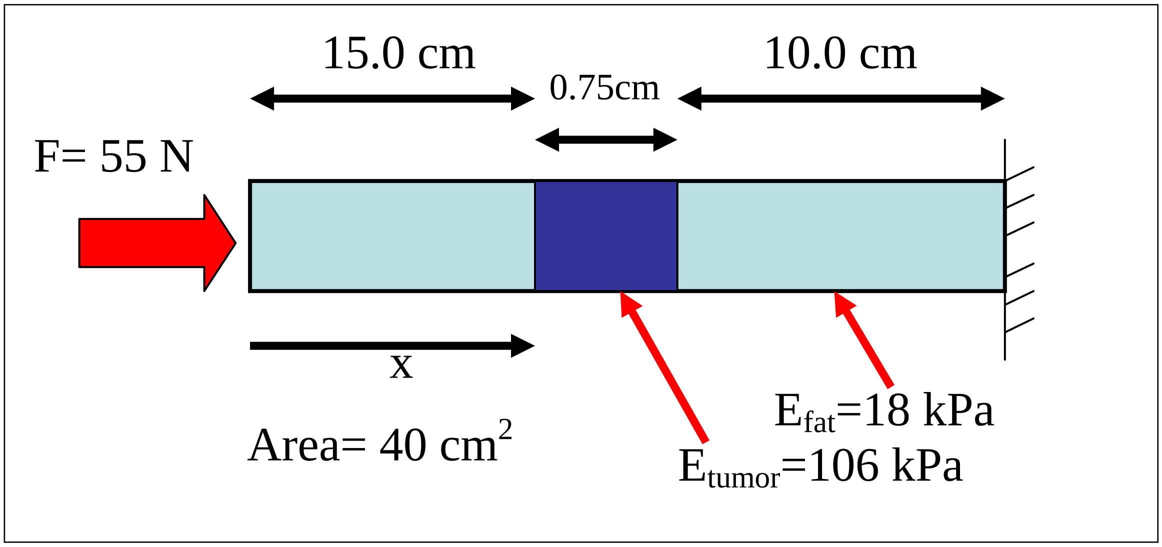
5. A construction crane with a 1.90 cm diameter cable has a maximum functioning stress of 138 MPa. Find the maximum load that the crane can endure.

$$\sigma_{max} = \frac{F_{max}}{A} \rightarrow F_{max} = \sigma_{max} * A \rightarrow 138 * 10^6 Pa * (\pi * (.0095m)^2)$$
$$F_{max} = 39.1 * 10^3 N \text{ or } 39.1\ kN$$

6. Consider Hooke's Law as a simple proportionality where F is directly proportional to delta x. Therefore, we know the force stretching a spring is directly proportional to the distance the spring stretches. If 223 N stretches a spring 12.7 cm, how much stretch can we expect to result from a of 534 N?

$$\frac{223N}{534N} = \frac{12.7cm}{x};\ \ x = 30.4\ cm$$

7. The figure below shows a column of fatty tissue, determine the strain in each of the three regions.



$$A = 40cm^2 * \frac{1m^2}{(100cm)^2} = .004m^2$$

$$FATTY\ TISSUE: \sigma = E * \varepsilon \quad \varepsilon = \frac{\sigma}{E} \quad \varepsilon = \frac{F/A}{E} \quad \varepsilon = \frac{55N/.004m^2}{18 * 10^3 N/m\hat{}2} \quad \varepsilon_{fat} = .76$$

$$TUMOR\ TISSUE: \sigma = E * \varepsilon \quad \varepsilon = \frac{\sigma}{E} \quad \varepsilon = \frac{F/A}{E} \quad \varepsilon = \frac{55N/.004m^2}{106 * 10^3 N/m\hat{}2} \quad \varepsilon_{tumor} = .13$$