1. A

2. D The elastic modulus describes the ratio of the amount of stress to a degree of deformation. The relationship between the stress and the deformation is linear in the same way that the displacement of a spring from equilibrium is proportional in a linear fashion to the force applied. The elastic modulus breaks down at the elastic limit, which is a threshold stress after which a detectable strain will exist after the stress is removed. That the wire began to deform at a greater rate signifies that the relationship between stress and strain posited by the elastic modulus no longer applies. The elastic limit also marks the yield point. It is interesting to note that at the yield point, the strain is no longer only a function of the stress but also of the time.

3. A The key here is watching your units:

$$\text{stress} = \frac{1000\ \text{N}}{1 \times 10^{-6}\ \text{m}^2} = 1 \times 10^{9}\ \frac{\text{N}}{\text{m}^2}$$

$$\text{strain} = \frac{2 \times 10^{-2}\ \text{m}}{2\ \text{m}} = 1 \times 10^{-2}$$

$$\text{Young's modulus} = \frac{\text{stress}}{\text{strain}} = \frac{1 \times 10^{9}\ \frac{\text{N}}{\text{m}^2}}{1 \times 10^{-2}} = 1 \times 10^{11}\ \frac{\text{N}}{\text{m}^2}$$

4. C A buoyant force equal to its weight enables the sample of rubber to float. This occurs when it displaces half of its own volume of water. Material of equal mass but of half the volume would be on the threshold of sinking (being of the densiy of water). This will occur when the rubber cube is submerged to the point that the volume stress produced by the pressure of the water reduces its volume by half. Such a volume strain is expressed:

$$\text{volume strain} = \frac{\Delta V}{V} = \frac{-.5\ \text{m}^3}{1\ \text{m}^3} = -.5$$

We are given the bulk modulus:

$$\text{bulk modulus} = 4 \times 10^{5}\ \frac{\text{N}}{\text{m}^2} = -\frac{F/A}{\Delta V/V} = \frac{F/A}{.5}$$

$$\frac{F/A}{.5} = 4 \times 10^{5}\ \frac{\text{N}}{\text{m}^2}$$

$$F/A = 2 \times 10^{5}\ \frac{\text{N}}{\text{m}^2}$$

The volume stress exerted by a liquid upon a submerged object is simply the pressure, so we can use our formula for the variation of pressure in a liquid with depth + the atmospheric pressure to find the necessary depth:

$$\frac{F}{A} = P = P_a + \rho g h = 2 \times 10^{5}\ \text{Pa}$$

$$1 \times 10^{5}\ \text{Pa} + \left(1000\frac{\text{kg}}{\text{m}^3}\right)\left(10\ \frac{\text{m}}{\text{s}^2}\right)h = 2 \times 10^{5}\ \text{Pa}$$

$$h = 10\ \text{m}$$

5. A Deformation produces oscillations in a solid body much like those produced in a spring. The material is deformed by a stress, and when the stress is removed, it springs back to its initial shape, but at that equilibrium point, the initial potential energy of deformation has been transformed into kinetic energy, and the jello overshoots equilibrium. We thus get oscillations. In this example, the student bumping into the table supplied an itial shearing stress that started the oscillations. In a spring, the frequency of oscillation increases with the magnitude of the spring constant, which by Hooke's law predicts the strength of the restoring force for a given displacement:

An elastic modulus is similar in a fundamental way to Hooke's law. The larger the elastic modulus for a material, the more stress is necessary to produce a given strain, or thinking in one dimension, the greater the restoring force for a given displacement. So in our jello oscillators, the frequency of oscillation will increase with increasing shear modulus.