37. (III) Four bricks are to be stacked at the edge of a table, each brick overhanging the one below it, so that the top brick extends as far as possible beyond the edge of the table. (*a*) To achieve this, show that successive bricks must extend no more than (starting at the top) $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{6}$, and $\frac{1}{8}$ of their length beyond the one below (Fig. 9–67a). (*b*) Is the top brick completely beyond the base? (*c*) Determine a general formula for the maximum total distance spanned by n bricks if they are to remain stable. (*d*) A builder wants to construct a corbeled arch (Fig. 9–67b) based on the principle of stability discussed in (*a*) and (*c*) above. What minimum number of bricks, each 0.30 m long, is needed if the arch is to span 1.0 m?

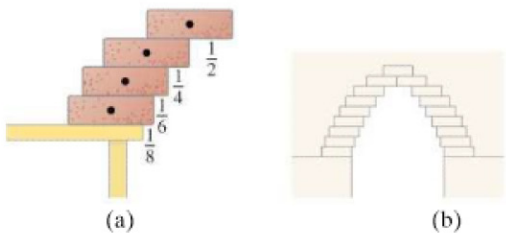

FIGURE 9–67 Problem 37.

* 9–5 Elasticity; Stress and Strain

* 38. (I) A nylon string on a tennis racket is under a tension of 275 N. If its diameter is 1.00 mm, by how much is it lengthened from its untensioned length of 30.0 cm?

* 39. (I) A marble column of cross-sectional area $1.2\,\text{m}^2$ supports a mass of 25,000 kg. (*a*) What is the stress within the column? (*b*) What is the strain?

* 40. (I) By how much is the column in Problem 39 shortened if it is 9.6 m high?

* 41. (I) A sign (mass 2100 kg) hangs from the end of a vertical steel girder with a cross-sectional area of $0.15\,\text{m}^2$. (*a*) What is the stress within the girder? (*b*) What is the strain on the girder? (*c*) If the girder is 9.50 m long, how much is it lengthened? (Ignore the mass of the girder itself.)

* 42. (II) One liter of alcohol $(1000\,\text{cm}^3)$ in a flexible container is carried to the bottom of the sea, where the pressure is $2.6 \times 10^6\,\text{N/m}^2$. What will be its volume there?

* 43. (II) A 15-cm-long tendon was found to stretch 3.7 mm by a force of 13.4 N. The tendon was approximately round with an average diameter of 8.5 mm. Calculate the Young's modulus of this tendon.

* 44. (II) How much pressure is needed to compress the volume of an iron block by 0.10%? Express your answer in N/m^2, and compare it to atmospheric pressure $(1.0 \times 10^5\,\text{N/m}^2)$.

* 45. (II) At depths of 2000 m in the sea, the pressure is about 200 times atmospheric pressure $(1\,\text{atm} = 1.0 \times 10^5\,\text{N/m}^2)$. By what percentage does the interior space of an iron bathysphere's volume change at this depth?

* 46. (III) A scallop forces open its shell with an elastic material called abductin, whose Young's modulus is about $2.0 \times 10^6\,\text{N/m}^2$. If this piece of abductin is 3.0 mm thick and has a cross-sectional area of $0.50\,\text{cm}^2$, how much potential energy does it store when compressed 1.0 mm?

* 47. (III) A pole projects horizontally from the front wall of a shop. A 5.1-kg sign hangs from the pole at a point 2.2 m from the wall (Fig. 9–68). (*a*) What is the torque due to this sign calculated about the point where the pole meets the wall? (*b*) If the pole is not to fall off, there must be another torque exerted to balance it. What exerts this torque? Use a diagram to show how this torque must act. (*c*) Discuss whether compression, tension, and/or shear play a role in part (*b*).

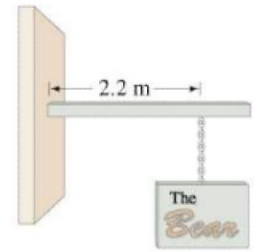

FIGURE 9–68 Problem 47.

* 9–6 Fracture

* 48. (I) The femur bone in the human leg has a minimum effective cross section of about $3.0\,\text{cm}^2$ $(= 3.0 \times 10^{-4}\,\text{m}^2)$. How much compressive force can it withstand before breaking?

* 49. (II) (*a*) What is the maximum tension possible in a 1.00-mm-diameter nylon tennis racket string? (*b*) If you want tighter strings, what do you do to prevent breakage: use thinner or thicker strings? Why? What causes strings to break when they are hit by the ball?

* 50. (II) If a compressive force of 3.6×10^4 N is exerted on the end of a 22-cm-long bone of cross-sectional area $3.6\,\text{cm}^2$, (*a*) will the bone break, and (*b*) if not, by how much does it shorten?

* 51. (II) (*a*) What is the minimum cross-sectional area required of a vertical steel cable from which is suspended a 320-kg chandelier? Assume a safety factor of 7.0 (*b*) If the cable is 7.5 m long, how much does it elongate?

* 52. (II) Assume the supports of the uniform cantilever shown in Fig. 9–69 (mass = 2600 kg) are made of wood. Calculate the minimum cross-sectional area required of each, assuming a safety factor of 8.5.

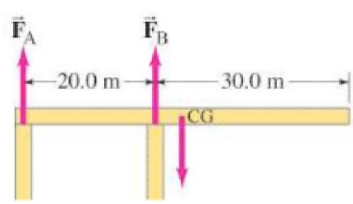

FIGURE 9–69 Problem 52.

* 53. (II) An iron bolt is used to connect two iron plates together. The bolt must withstand shear forces up to about 3200 N. Calculate the minimum diameter for the bolt, based on a safety factor of 6.0.

* 54. (III) A steel cable is to support an elevator whose total (loaded) mass is not to exceed 3100 kg. If the maximum acceleration of the elevator is $1.2\,\text{m/s}^2$, calculate the diameter of cable required. Assume a safety factor of 7.0.

* 9–7 Arches and Domes

* 55. (II) How high must a pointed arch be if it is to span a space 8.0 m wide and exert one-third the horizontal force at its base that a round arch would?