Chpt 11 problems: 5, 10, 11, 12, 25. (page 514 of text).

5. Suppose you have a coffee mug with a circular cross section and vertical sides (uniform radius). What is its inside radius if it holds 375 g of coffee when filled to a depth of 7.50 cm? Assume coffee has the same density as water

Solution

$$m = \rho V = \rho\left(\pi R^2 h\right) \Rightarrow R = \left(\frac{m}{\rho\pi h}\right)^{1/2} = \left[\frac{375\text{ g}}{(1.00\text{ g/cm}^3)(\pi)(7.50\text{ cm})}\right]^{1/2} = \underline{3.99\text{ cm}}$$

10. There is relatively little empty space between atoms in solids and liquids,..

(a) What is the approximate density of a nucleus?

(b) One remnant of a supernova, called a neutron star, can have the density of a nucleus. What would be the radius of a neutron star with a mass 10 times that of our Sun

Solution

(a) $\rho_N = \frac{m_N}{V_N}$. Since $m_a \approx m_N$ and $R_N = 10^{-5} R_a$, $\rho_N = \frac{m_a}{(10^{-5})^3 V_a} = \frac{\rho_a}{10^{-15}}$

$$= \frac{10^3\text{ kg/m}^3}{10^{-15}} = \underline{10^{18}\text{ kg/m}^3}$$

$$m = \rho V = \rho\left(\frac{4}{3}\pi R^3\right) = 2.0 \times (\text{mass of sun}) = 3.98 \times 10^{30}\text{ kg}$$

(b) $$R = \left(\frac{3m}{4\pi\rho}\right)^{1/3} = \left[\frac{3(3.98\times10^{30}\text{ kg})}{4\pi(10^{18}\text{ kg/m}^3}\right]^{1/3} = 9.83\times10^3\text{ m} = 9.83\text{ km}$$

The radius of the neutron star would be <u>about 10 km.</u>

(b) One remnant of a supernova, called a neutron star, can have the density of a nucleus. What would be the radius of a neutron star with a mass 10 times that of our Sun

11. As a woman walks, her entire weight is 11 • Problems & Exercises 513 momentarily placed on one heel of her high□heeled shoes. Calculate the pressure exerted on the floor by the heel if it has an area of and the woman's mass is 55.0 kg. Express the pressure in Pa.

Solution

$$P = \frac{F}{A} = \frac{mg}{A} \qquad \left(1.50\ \text{cm}^2 = 1.50 \times 0^{-4}\ \text{m}^2\right)$$

$$P = \frac{(55.0\ \text{kg})(9.80\ \text{m/s}^2)}{1.50 \times 10^{-4}\ \text{m}^2} = \underline{3.59 \times 10^6\ \text{N/m}^2}$$

$$= 3.59 \times 10^6\ \text{N/m}^2 \times \frac{1\ \text{lb}}{4.448\ \text{N}} \times \frac{6.452 \times 10^{-4}\ \text{m}^2}{1\ \text{in.}^2} = \underline{521\ \text{lb/in.}^2}$$

12. The pressure exerted by a phonograph needle on a record is surprisingly large. If the equivalent of 1.00 g is supported by a needle, the tip of which is a circle 0.200 mm in radius, what pressure is exerted on the record in ?

Solution

$$P = \frac{F}{A} = \frac{mg}{\pi r^2} = \frac{(1.00 \times 10^{-3}\ \text{kg})(9.80\ \text{m/s}^2)}{\pi(2.00 \times 10^{-4}\ \text{m})^2} = \underline{7.80 \times 10^4\ \text{Pa}}$$

This pressure is approximately 585 mm Hg.

25. What force must be exerted on the pedal cylinder of a hydraulic lift to support the weight of a 2000-kg car (a large car) resting on the wheel cylinder?

Solution

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \Rightarrow F_2 = \left(\frac{A_2}{A_1}\right)F_1 = \left(\frac{\pi r_2^2}{\pi r_1^2}\right)mg = \left(\frac{r_2^2}{r_1^2}\right)mg$$

$$= \left[\frac{(1.00\ \text{cm})^2}{(12.0\ \text{cm})^2}\right](2000\ \text{kg})(9.80\ \text{m/s}^2) = \underline{136\ \text{N}}$$