1. A straightforward method of finding the density of an object is to measure its mass and then measure its volume by submerging it in a graduated cylinder. What is the density of a 200 g rock that displaces 77.0 cm³ of water? (Note that the accuracy and practical applications of this technique are more limited than a variety of others that are based on Archimedes’ principle.)

2. Since neutron stars consist totally of neutrons, they are extremely massive and have a density that is hard to imagine. A typical radius and mass for a neutron star are 1.55 × 10³ m and 3.50 × 10²⁸ kg respectively.

   (a) Determine the density of a neutron star.

   (b) Determine the weight (in pounds) of a penny (V = 360 mm³) if it were made from this material. (Assume 1 lb = 4.448 N.)

3. Alloys of gold are rated in karats, a dimensionless unit that is used to indicate the proportion of gold by weight in a gold-containing alloy. If an alloy is one part in twenty-four pure gold, then it is classified as one karat gold. The density of gold is 19.3 × 10³ kg/m³. Determine the volume of gold in a 18.0 karat gold necklace that has a weight of 1.43 N.

4. As a woman walks, her entire weight is 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 1.60 cm² and the woman’s mass is 52.0 kg. Express the force in N/m² and lb/in². (In the early days of commercial flight, women were not allowed to wear high-heeled shoes because aircraft floors were too thin to resist such large pressures.)

5. The pressure exerted by a phonograph needle on a record is surprisingly large. If the equivalent of 1.30 g of mass is supported by a needle the tip of which is a circle 0.180 mm in radius, what pressure is exerted on the record in N/m²?

6. A 4.5-kg, three-legged stool supports a 74-kg person. If each leg of the stool has a cross-sectional diameter of 1.4 cm and the weight of the person is evenly distributed, determine the pressure exerted on the floor by each leg.

7. Determine the actual pressure inside an inflated football if it has a gauge pressure of 9.2 lb/in².

8. You inflate the tires of your car to a gauge pressure of 44.0 lb/in². If your car has a mass of 1725 kg and is supported equally by its four tires, determine the following.

   (a) Contact area between each tire and the road

   (b) Will the contact area increase, decrease, or stay the same when the gauge pressure is increased?

   (c) Gauge pressure required to give each tire a contact area of 114 cm²

9. What force must be exerted on the master cylinder of a hydraulic lift to support the weight of a 2200 kg car (a big car) resting on the slave cylinder? The master cylinder has a 2.00 cm diameter, while the slave’s is 24.0 cm.
10. The weight of a hydraulic barber's chair with a client is 2250 N. When the barber steps on the input piston with a force of 46 N, the output plunger of a hydraulic system begins to lift the chair. Determine the ratio of the radius of the output plunger to the radius of the input piston.

\[ \frac{r_{\text{plunger}}}{r_{\text{piston}}} = 0.69 \]

Supporting Materials

Physical Constants

11. A hydraulic system has two pistons of different diameter and uses a liquid of density \( \rho = 850 \text{ kg/m}^3 \). The smaller piston has a diameter of 4.5 cm and a mass of 1.6 kg and the larger piston a diameter of 14 cm and a mass of 3.0 kg. Determine \( h \), the height difference between the two pistons.

\[ h = 0.954 \text{ m} \]

Supporting Materials

Physical Constants

12. The pressure at the bottom of a cylindrical container with a cross-sectional area of 48.0 cm\(^2\) and holding a fluid of density 740 kg/m\(^3\) is 115 kPa. Determine the depth of the fluid.

\[ d = 7.36 \text{ m} \]

(b) Determine the pressure at the bottom of the container if an additional \( 2.40 \times 10^{-3} \text{ m}^3 \) of this fluid is added to the container. (Give your answer to at least 3 significant figures.)

\[ 117 \text{ kPa} \]

Supporting Materials

Physical Constants

13. Mercury is added to a cylindrical container to a depth \( d \) and then the rest of the cylinder is filled with water. If the cylinder is 0.6 m tall and the pressure at the bottom is 1.1 atmospheres, determine the depth of the mercury. (Assume the density of mercury to be \( 1.36 \times 10^4 \text{ mg/m}^3 \).)

\[ d = 0.0344 \text{ m} \]

Supporting Materials

Physical Constants

14. If your body has a density of 990 kg/m\(^3\), what fraction of you will be submerged when floating quietly in the following liquids?

(a) fresh water

\[ 99\% \]

(b) the Great Salt Lake, which has a density of 1030 kg/m\(^3\)

\[ 96.1\% \]

Supporting Materials

Physical Constants

15. A wood block with a volume of \( 6.80 \times 10^{-4} \text{ m}^3 \) is floating in water. When a small steel object of mass \( m = 0.380 \text{ kg} \) is placed on top of the block, the system is in equilibrium, and the top of the block is at the level of the water.

(a) Determine the density of the wood.

\[ 441 \text{ kg/m}^3 \]

(b) What happens to the block if the steel object is replaced by another steel object with half the mass?

- The block rises.
- The block sinks.
- The block stays at the same position.

(c) What happens to the block if the steel object is replaced by yet another steel object with twice the mass?

- The block rises.
- The block sinks.
- The block stays at the same position.
16. **Question Details**

When a solid object is completely submerged in ethyl alcohol, its apparent weight is 20.4 N and when completely submerged in water, its apparent weight is 14.0 N. Determine the volume of the object. Use 790 kg/m³ as the density of the ethyl alcohol and 1000 kg/m³ as the density of water.

**Physical Constants**

When an object is suspended from a spring balance (figure (a)) the reading is 9.40 N. When the suspended object is submerged in water (figure (b)) the reading is 4.50 N. Determine the density of the object.

**Physical Constants**

A spring with a force constant \( k = 135 \) N/m is attached to the bottom of a large beaker which is then filled with water (figure (a)). A block of pine wood with a mass of 4.90 kg and a density of 630 kg/m³ is connected to the spring and the block-spring system comes to equilibrium as shown in figure (b). Determine the elongation \( \Delta L \) of the spring.