Part H Problems

1. A sixty-kilogram person is wearing stiletto high-heel shoes. The circular base of a stiletto of each heel has a radius of 0.5 cm (0.005 m). If the wearer of these shoes rocks back onto his heels, and raises one foot off the floor, what would be the pressure exerted by the heel on the floor?

2. Using the atmospheric pressure versus height equation, $P = P_o(1 - 2.3 \times 10^{-5} h)^5$, where h is in meters, determine the height at which P is only one percent of P_o. How many miles is this? (3.28 feet per meter, 5280 feet per mile)

3. Another unit of air pressure is the "millibar" (mb): 1.0 mb = 100 Pa.

Suppose a windowless flattop building's roof is rectangular, 20 meters long and 15 meters wide. If the air pressure outside drops to a pressure 20 mb below the pressure inside the building, what will be the net air pressure force on the roof?

4. A gram of gold sells for approximately $40. What is the radius of a solid gold ball that's worth $100,000?

5. Humans can withstand water pressures no greater than about four atmospheric pressure--three "atmospheres" more than the pressure humans are subject to above water. To what depth could humans dive without a pressurized diving suit?

6. Modern nuclear attack submarine hulls are designed to withstand water pressures no greater than about 7,000,000 newtons per square meter. How far below the surface may such submarines dive without being crushed?

7. At an untapered place in a pipe the radius is $r_1 = 0.20$ m, and in a tapered portion the radius is $r_2 = 0.10$ m. The volume flow rate R_1 of water in the un-tapered portion is 0.005 m^3/s. (a) What is the volume flow rate R_2 in the tapered portion of the pipe? (b) What is the speed v_1 the fluid in the un-tapered portion of the pipe? (c) What is the speed v_2 in the tapered portion?

8. A 100-kg object is *floating* in water. What is the buoyant force acting on the object?

9. An object weighing 100 N and having a volume of 0.002 m^3 is placed under water and released. What is its acceleration?

10. The mass of a basketball held under water is 1.6 kg. The ball is then released and accelerates upward at 0.20 m/s^2. (a) What is the buoyant force (in newtons) acting on the ball? (b) What is the radius of the basketball?

11. An object whose density is 300 kg/m^3 is floating in water. The volume of the object is 5.2 m^3. What volume of water is displaced?

12. A solid object weighing 500 N consists of a certain metal whose density is 5000 kg/m^3. The object is dropped into a tank of water and sinks to the bottom. What is the contact force between the object and the bottom of the tank?

Solutions

1. $F = 60(9.8)$ N $= 588.00$ N $A = \pi(0.005)^2$ $= 7.85 \times 10^{-5}$ m^2 $P = F/A$ $= 588.00/7.85 \times 10^{-5}$ $= 7.49 \times 10^{6}$ Pa	**2.** $P = 0.01\ P_o$ $P = P_o\ (1 - 2.3 \times 10^{-5}\ h^5)$ $0.01 = (1 - 2.3 \times 10^{-5}\ h)^5$ $h = 26169$ m $= 26169$ m (3.28 ft/m)/5280 ft/mile $= 16.3$ miles
3. Roof Area = (20 m) (15 m) $= 300$ m^2 Outside: $F_1 = P_1\ A$ (force downward) Inside: $F_2 = P_2\ A$ (force upward) Net Force $= F_2 - F_1$ $= P_2A - P_1A$ $= (P_2 - P_1)\ A$ $P_2 - P_1 = 20$ mb $= 20\ (100)$ $= 2000$ Pa $= 2000$ N/m^2 Net Force = (2000 N/m^2) (300 m^2) $= 600{,}000$ N	**4.** 100,000/40 = 2500 grams $m = \rho V$ $2500 = 19.3\ [(4/3)\ \pi\ r^3]$ $r = 3.14$ cm

5. $\rho gh = 4P_o$

$1000\ (9.8)\ h = 4\ (101{,}000)$

$h = 41.2$ m

6.

$7 \times 10^6 = \rho gh$

$= (1000)(9.8)h$

$= 9800\ h$

$h = 7 \times 10^6 / 9800$

$= 714$ m

7.

(a) $A_1v_1 = A_2v_2$

$= 0.005\ m^3/s$

The volume flow rates are the same everywhere. The rate in the tapered portion is the same as in the untapered portion: $0.005\ m^3/s$

(b) $A_1v_1 = 0.005$

$\pi\ (0.20)^2\ v_1 = 0.005$

$v_1 = 3.98 \times 10^{-2}$ m/s

(c) $A_2v_2 = 0.005$

$\pi\ (0.10)^2\ v_2 = 0.005$

$v_2 = 15.92 \times 10^{-2}$ m/s

8. $a = 0$

$F = 0$

$B - w = 0$

$B = w$

$= (100)\ (9.8)$

$= 980$ N

The buoyant force acting on a floating object equals its weight.

9. $m = w/g$

$= 100/9.8$

$= 10.20$ kg (mass of object)

Water mass = 1000 (0.002)

= 2.0 kg

$B = mg$

$= 2.0(9.8)$

$= 19.6$ N

$F = ma$

$B - w = ma$

$19.6 - 100 = 10.2\ a$

$a = -7.88\ m/s^2$

10. $F = ma$

$B - mg = ma$

$B - 1.6(9.8) = 1.6\ (0.2)$

$B = 16.00$ N

$(1000)(4\pi/3)r^3\ (9.8) = 16.00$

$r = 0.073$ m

11. Fraction of the volume under equals the ratio of densities:

density of object / density of water

fraction under = 300/1000

= 0.300

$0.300\ (5.2) = 1.56\ m^3$

12. w = 500 N (weight of object) m = w/g = 500/9.8 = 51.02 kg V = m/ρ = 51.02/5000 = 0.0102 m^3 mass of water = 1000 (0.0102) = 10.2 kg B = mg = 10.2 (9.8) = 100 N F = ma C + B - w = m (0) C + 100 - 500 = 0 C = 400 N	