

Physics 123

Static Fluids

1. Pressure in a fluid varies linearly with depth.
 - a. What is the absolute pressure at a depth of 1000m in the ocean if the density of seawater is 1024 kg/m^3 ?
 - b. At this depth what force must the frame around a circular submarine porthole having a diameter of 30cm exert to counterbalance the force exerted by the water?
 2. A light balloon can be filled with either 400m^3 of helium ($\rho_{\text{He}} = 0.179 \text{ kg/m}^3$) or 400m^3 of hydrogen ($\rho_{\text{H}} = 0.0899 \text{ kg/m}^3$) and floated to carry a payload.
 - a. If the balloon is nearly in equilibrium (meaning all accelerations are zero), what mass of a payload could a balloon filled with helium support at 0°C ?
 - b. If the balloon is nearly in equilibrium (meaning all accelerations are zero), what mass of a payload could a balloon filled with hydrogen support at 0°C ?
 3. The U.S. Navy has the largest warships in the world, aircraft carriers of the *Nimitz* class (for example, the *USS Ronald Regan* shown on the right.) Suppose that 50, 29,000kg airplanes take off from the flight deck and the ship bobs up to float 11cm higher in the water, in an area where $g = 9.78\text{m/s}^2$. What is the horizontal area enclosed by the waterline of the ship? Compare this to the deck of an aircraft which has an area $18,000 \text{ m}^2$.
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- www.aerospaceweb.org/question/history/q0226.shtml
4. A helium filled balloon is tied to a 2.0m long string where the mass of the string is 0.05kg. The balloon is spherical with radius of 0.40m. When released the balloon lifts a length of string h and then remains in equilibrium. What length of the string is lifted if the balloon has a mass of 0.250kg?
 5. What is the pressure in the ocean at a depth of 2000m assuming that salt water has a constant density of 1002 kg/m^3 and that salt water is incompressible?
 6. What depth of oil, with specific gravity 0.8, will produce a pressure of 120 kN/m^2 ? What would be the corresponding depth of water?
 7. A hydraulic press has a diameter ratio between the two pistons of 8:1. The diameter of the larger piston is 600mm and it is required to support a mass of 3500kg. The piston is filled with hydraulic fluid of specific gravity 0.8.
 - a. What force is required on the smaller piston to provide the required force on the large piston when the two pistons are level?

b. What force is required on the smaller piston to provide the required force on the large piston when the smaller piston is 2.6m below the larger piston?

8. Show that the ratio of the pressures (p_2/p_1) and densities (ρ_2/ρ_1) for altitudes h_2 and h_1 in an isothermal atmosphere is given by

$$\frac{p_2}{p_1} = \frac{\rho_2}{\rho_1} = e^{-\frac{g(h_2-h_1)}{RT}}$$

9. From the results of question 8, what increase in altitude is necessary in the stratosphere to halve the pressure? Assume a constant temperature -56.5°C and the gas constant is $R = 287 \text{ J/kgK}$.