

Arts & Science 2D06

Quiz #5 2007 Jan 19

Name:

NB: Mark values are given in brackets [] beside each problem. Write all your answers on the quiz paper. No books or notes allowed. Time to write quiz: 50 minutes.

Solution for quadratic equation: $x = (-b \pm \sqrt{b^2 - 4ac})/2a$

Area of sphere: $A = 4\pi r^2$ Volume of sphere: $V = \frac{4}{3}\pi r^3$

Bernoulli's equation: $P + \rho gy + \frac{1}{2}\rho v^2 = \text{const}$

Air pressure at sea level $P_0 = 1.013 \times 10^5 \text{ N/m}^2$

Density of air at sea level $\rho_{air} = 1.29 \text{ kg/m}^3$

Density of water $\rho_{H_2O} = 1000 \text{ kg/m}^3$

1. [2] Think of an open container of liquid mercury ($\rho = 13600 \text{ kg/m}^3$). The pressure at the bottom of the container is 3 times as large as the atmospheric pressure P_0 . What is the height of the column of mercury in the container?

2. [2] You put a block of wood ($\rho = 0.75 \text{ gram/cm}^3$) in a container of water. What fraction of the volume of the wood is submerged?

3. [4] A 100-kg payload hangs from a hot-air balloon. The balloon itself (fabric plus enclosed air) has a mass of 60 kg. When it is released from rest, it moves upward at an initial acceleration of 2.0 m/s^2 , carrying the payload with it. Calculate the radius of the balloon assuming it is spherical. Make reasonable estimates for any quantity that you have to.

4. [3] The pressure at the center of a tornado is $0.5P_0$. If the tornado suddenly passes by a house in which all the doors and windows are closed, what is the wind speed in the tornado?

5. [5] Water flows at 2.4 m/s through a garden hose of diameter 1.6 cm. It then comes out through a nozzle of diameter 0.64 cm.

(a) At what speed does the water come out of the nozzle?

(b) What is the water pressure in the hose?

6. [4] A small rowboat floats in a swimming pool. The boat has a heavy rock in it. Now, the rock is lifted out of the boat and put in the water, and the rock sinks to the bottom of the pool. What happens to the water level of the pool? After the rock is dropped into the water, is the water level (a) higher (b) lower or (c) just the same as when the rock was sitting in the boat? (NB: the boat itself continues to float on the surface – it is there both before and after.) Give a reason for your answer.