

## Arts & Science 2D06

Quiz #5    2008 Jan 25

Name:

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

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1. [2]    Imagine holding two identical bricks in place under water. Brick 1 is just beneath the surface of the water, while brick 2 is held about 2 meters deeper. The force needed to hold brick 2 in place is:

- (a) greater by a factor of 4
- (b) greater by a factor of 2
- (c) the same
- (d) smaller by a factor of 2
- (e) smaller by a factor of 4

*Explain / derive your choice in the space below.*

2. [3] You notice that when a given object is placed in water, it floats with  $\frac{3}{4}$  of its volume submerged. What happens when the object is removed from the water and placed in oil, which has a density half that of water?

- (a) It floats at the same level as in the water
- (b) It floats higher than in the water
- (c) It floats lower than in the water
- (d) It sinks to the bottom
- (e) It sinks to the middle and then returns to the surface

*Explain / derive your choice in the space below.*

3. [3] A trench in the ocean has a depth of 100 km. If sea water has an average density of  $1.04 \text{ g/cm}^3$ , calculate the total (or absolute) pressure at the bottom of the trench.

4. [4] A plastic ball has a radius of 8.0 cm and floats in water with 18 percent of its volume under water.

(a) What force should you apply to the ball to hold it at rest totally below the surface of the water?

(b) If you then let go of the ball, what is its acceleration at the instant you release it?

5. [3] An airplane has a mass of  $2 \times 10^6$  kg, and, when it's flying, the air flows past the lower surface of the wings at 100 m/s. If the wings have a surface area of  $1200 \text{ m}^2$ , how fast must the air flow over the upper surface of the wings if the plane is to stay in the air?

6. [5] Water enters a building through a pipe of diameter of 3.0 cm at an absolute pressure of  $2 \times 10^5 \text{ N/m}^2$ . This entry pipe is at ground level. A pipe of 1.0 cm in diameter leads the water from there to a bathroom on the second floor, located 5.0 m above ground level.

If the flow speed at the entry (ground level) pipe is 2.5 m/s, find (a) the flow speed of the water in the bathroom and (b) the water pressure in the bathroom.