Name: _____

Physics 117

Quiz 5 (4/2/2003)

Use as far as possible formula and try to explain your reasoning.

A) A cube of ice with a volume of 10 cm^3 is melted into a measuring cup. What is the volume of liquid water?

(Density of water=D_{Water}=1 gr/cm^3. Density of ice=D_{Ice}=0.92 gr/cm^3.)

The mass does not change during the melting (if you assume that no water evaporates away as a gas). The mass of ice is

$$(10\ cm^3)(.92\ g/cm^3) = 9.2\ g.$$

That much water has a volume of 9.2 cm^3.

B) A solid block of wax has a density of 0.9 gr/cm^3 and a volume of 20 cm^3. If the block is floating in a tank of water, what is the volume of liquid displaced?

(Density of water=D_{Water}=1 gr/cm^3.)

When the block is floating, the gravitational force balances the buoyant force, so the block's mass equals the mass of displaced water. The block has a mass of

$$(20\ cm^3)(.9\ g/cm^3) = 18\ g.$$

18 g of water has a volume of 18 cm^3.

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C) A plastic balloon full of air is immerged completely in ethyl alcohol. The balloon has a volume of 100 cm^3. Calculate:

1) the weight of the balloon
2) the buoyancy force acting on the balloon
3) the force you have to exert on the balloon in order to keep it submerged.

($D_{Balloon}$=Density of air=0.001 gr/cm^3. Density of alcohol=0.80 gr/cm^3.)

The balloon has a mass of

$$(100\ cm^3)(.001\ g/cm^3) = .1\ g = 1 \times 10^{-4}\ kg,$$

so it has a weight of 1×10^{-3} N.

The displaced fluid has a mass of

$$(100\ cm^3)(.80\ g/cm^3) = 80\ g = .08\ kg,$$

so its weight, which equals the buoyant force, is 0.8 N.

To keep the balloon submerged, you have to push against the difference between the buoyant force and the gravitational force.
This is .8 N minus .001 N=.799 N.

Bonus Problem:

D) Two barometers are made with water and mercury, and they are both at sea level. On a normal day, the mercury column would be about 76 cm tall, but for this problem, imagine that it is 100 cm. How tall would the water column be?

(Density of water=D_{Water}=1 gr/cm^3. Density of Mercury=13.6 gr/cm^3.)

In these barometers, atmospheric pressure matches the pressure at the bottom of the column of liquid. That pressure is equal to the weight of fluid divided by cross-sectional area, so

$$P = F/A = (g)(Density)(Volume)/(Area) = (gD)(height).$$

The two barometers measure the same pressure, so

$$(D\ h)_{water} = (D\ h)_{mercury}$$

or

$$h_{water} = h_{mercury}(D_{mercury}/D_{water}).$$
$$= (100\ cm)(13.6)$$
$$= 13.6\ m,$$

or roughly forty feet.