NYU General Physics 1—Problem set 12

Problem 1: *(a)* Look up the pressure corresponding to one atmosphere in kPa. Starting at sea level, under what depth h of water will the pressure be 2 atmospheres? That is, what depth leads to a pressure increase of one atmosphere?

(b) Same but for mercury. What is the conversion between mm of Hg and kPa?

(c) Imagine that the air was incompressible (that is, constant density). What height of atmosphere corresponds to one atmosphere of pressure? Use the STP density for air.

(d) The air is *not* incompressible, so what really is the meaning of the height computed in part *(c)* (no, the answer is not "no meaning at all")? Can you think of any industrial activity on Earth that makes use of the altitude or height computed in part *(c)*?

Problem 2: A cube of ice 2 cm on a side floats in a glass of water. The water is at 0 deg C and the glass is in a room at STP. Look up or assume what you need in order to solve these problems.

(a) What is the pressure *difference* ΔP between the atmospheric pressure and the pressure at the bottom surface of the ice cube?

(b) If the ice cube melts, does the water level go up or down? Why?

(c) If you submerge the ice cube, and hold it at rest under water, there is a pressure difference ΔP between the top and bottom face of the cube. Is this larger than, smaller than, or the same as the pressure difference you calculated in part *(a)*?

(d) If you release the submerged cube, it will accelerate upwards. Immediately after release, what is the net force F on the ice cube? Can you think of two different ways of calculating this?

Problem 3: Everything submerged in the Earth's atmosphere is subject to a buoyant force from the air. In the following, use a sensible (reasonably accurate) measure of the density of air at STP.

(a) When you measure your weight on a standard bathroom scale, you are measuring the *normal force* between yourself and the floor. This normal force opposes the *combination* of gravity and buoyancy. What is the correction to your weight coming from buoyancy, roughly? Express it as a *fraction* of the

gravitational force. Is this correction positive or negative—that is, does it increase or decrease the weight measured by the scale?

(b) Look up the "volume" of the Goodyear blimp model GZ-22. Imagine that it is floating in an air atmosphere at STP, and that the gas inside the blimp is *also* at STP. What is the approximate buoyant force on the blimp if it is filled with helium? What about if it were filled with hydrogen (molecular hydrogen)? Compare these numbers with the gross weight and capacity of the blimp.

(c) Will the bouyant force increase, decrease, or stay the same as you change the altitude (atmospheric density) or temperature? Assume that the blimp contents are always at the same pressure as the exterior air.