Buoyancy forces

Question 1

A hydrometer calibrated with specific gravity is made with a cylindrical 20 cm drinking straw that is sealed and weighted at the bottom end. It has an average density of 9 grams per cubic cm, (90% of the density of water). A cm scale has been placed close to the straw.

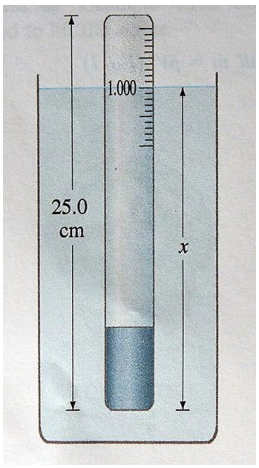
a Show by considering the weight and the buoyancy force that the straw hydrometer floats in water with 2 cm above the water.

b Carefully mark the 1.00 and 0.90 levels (the specific gravity scale) on the straw.

c Find the level at which it will float in salt solution with a specific gravity of 1.20 and mark that level (the 1.20 sg level) on the scale.

d Why is specific gravity not given with units?

e A diagram of a similar hydrometer in Giancoli is shown at below.



In what way could the Giancoli diagram be misleading?

Question 2

A light tethered helium balloon is floating in a breeze blowing left to right.

Take the density of air as 1.2 kg/m^3 and the wind velocity as 5.0 m/s. Drag on a sphere in turbulent flow is given by $\rho A v^2$.

a What forces contribute to the tension in the string?

b Show by drawing a vector diagram that the lift is close to 90 N and find the radius of the balloon.

c "Empty" boxes are shown on a bike. The stack is three layers wide.

d Estimate the mass of the 'empty' boxes by first estimating the mass of one empty box of this size and estimating the number of boxes.

e Estimate the mass of air contained in the boxes if air has a density of 1.2 kg/m^3.

f Why does the air in the boxes not add to the weight on the bike?

g Would the rider notice any difference if all the air were suddenly somehow removed from the boxes?