

CHAPTER 15 (Knight)

15.1 Fluids. Contains the basic definition of fluids and mass density that we discussed about this week in class.

15.2 Pressure. This is quite lengthy. You could start with the examples and read the section as needed. Make sure you know how to calculate the pressure in a liquid at depth d (equation 15.6). Example 15.2 illustrates an important concept.

15.2 Q1. Looking at Figure 15.3, rank the forces on the water at the location of each hole (with hole 1 being on top and hole 3 being on the bottom).

1. $F_1 = F_2 = F_3$
2. **$F_3 > F_2 > F_1$**
3. $F_1 > F_2 > F_3$
4. $F_2 > F_1 = F_3$

Feedback: review pages:445-450. In a gas, the pressure is nearly the same at all points; however, in a liquid the pressure increases with depth below the surface. Since $F = pA$, the force will also increase with depth.

15.2 Q2. What force is responsible for a suction cup being held on the ceiling?

1. The suction force of the cup. (2.9 %)
2. **The air pressure pushing upward on the cup. (95.2%)**
3. The normal force of the ceiling. (1 %)
4. The force of gravity. (1%)

Feedback: Review pages: 447-448. Pushing the suction cup against the ceiling pushes the air out of the cup. Thus, the air pressure (in the room) pushes upward on the cup.

15.2 Q3. Look at the two containers in Figure 15.13. How would you best describe the pressure at point p_1 and p_2 ?

1. $p_1 > p_2$
2. **$p_1 = p_2$**
3. $p_1 < p_2$

feedback: Review pages: 448 - 450. It is important to look at the weight of the water column above a point. Just because the cone holds more water does NOT mean that the water pressure along the horizontal line changes (as long as the liquid is connected, as is the case here). Look at Figure 15.14.

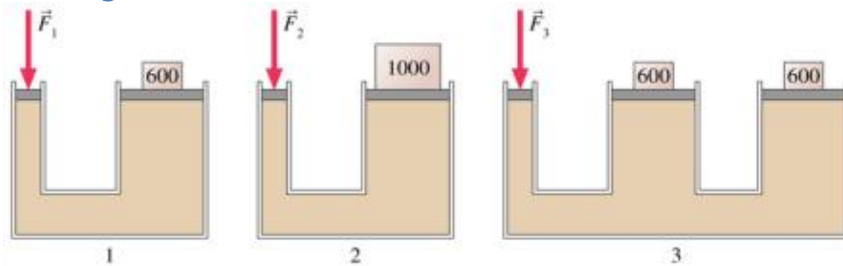
15.3 Measuring and using Pressure. Make sure you understand the difference between gauge pressure and absolute pressure. Look also carefully at the hydraulic lift and make sure you can follow the examples in this section.

15.3 Q1. Is gauge pressure larger, smaller, or the same as true pressure?

1. **smaller**
2. larger
3. same

Feedback: Review pages: 451. The gauge pressure ALWAYS measures pressure in EXCESS of 1 atm.

15.3 Q2. Rank in order, from largest to smallest, the magnitudes of the forces F_1 , F_2 , F_3 required to balance the masses. The masses are in kilograms.



1. $F_2 > F_1 > F_3$
2. **$F_2 > F_1 = F_3$**
3. $F_3 > F_2 > F_1$
4. $F_3 > F_1 > F_2$
5. $F_1 = F_2 = F_3$

Feedback: Review pages: 454-455. The pressure is ONLY under the pistons (the weights in 3 do NOT add).

15.4 Buoyancy - You will look at buoyancy for the labs & tutorials (and we have begun discussing it in class). Focus on Archimedes' principle and the examples. Think about what it means for an object to float or sink, and what the volume of the displaced fluid is in different situations.

15.4 Q1. The buoyant force on an object fully submerged in a liquid depends on (select all that apply)

1. the object's mass.
- 2. the density of the liquid.**
- 3. the object's volume.**
4. the mass of the liquid

Feedback: Review pages: 456 - 459.

15.4 Q2. Chose the statement below that is FALSE about buoyancy:

1. An object on a scale immersed in a fluid has a different apparent weight than it does on a scale in air.
2. An object immersed in a fluid experiences an 'extra' force that makes it appear lighter.
- 3. The mass of an object decreases when it is immersed in a fluid.**
4. The relative density of the fluid as compared to an object will determine if it floats.

Feedback: As we discussed in class, the MASS of an object stays CONSTANT. The mass does not change (and gravity does not change and). However one often thinks of the 'effective weight' of an object in water as 'feeling lighter'. This is because there is an EXTRA force: the buoyant force. It might be easier to refer to the 'net force' on an object to avoid confusion.

15.4 Q3. Looking at figure 15.24 (located in the Example 15.9 Box), what can you say about the relative densities of the unknown liquid (ρ_{unkn}), water (ρ_{water}), and the block (ρ_{block})?

1. $\rho_{\text{water}} > \rho_{\text{unkn}} > \rho_{\text{block}}$
2. $\rho_{\text{block}} > \rho_{\text{water}} = \rho_{\text{unkn}}$
3. $\rho_{\text{block}} > \rho_{\text{unkn}} > \rho_{\text{water}}$
4. $\rho_{\text{block}} > \rho_{\text{water}} > \rho_{\text{unkn}}$
5. $\rho_{\text{unkn}} = \rho_{\text{water}} > \rho_{\text{block}}$
- 6. $\rho_{\text{unkn}} > \rho_{\text{water}} > \rho_{\text{block}}$**

Feedback: Comparing the average density of an object, in this case a block, with the fluid density can tell you if the object will float, sink, or be neutral. The block floats in BOTH the water and the unknown liquid. The block sits HIGHER in the unknown liquid, so it must have a higher density than water.

15.5 Fluid Dynamics - Read this section carefully and focus on the concept of flow rate, the equation of continuity (15.19) and how Bernoulli's equation is applied in the different examples.

15.5 Q1. If you observe water coming out of your kitchen faucet, you notice that the diameter of the streaming water is larger near the faucet than further down. This observation is explained by the

1. Buoyancy of water.
2. Density of water.
3. **Equation of Continuity.**
4. Height of the liquid column.

Feedback: review pages 460-461 for the definition of the Equation of Continuity.

15.5 Q2. What happens if you hold a thin strip of notebook paper at the lower edge of your bottom lip -- just touching your lip -- and blow hard straight over the top of the strip? Hint: Try this yourself! (See Fig. 15.32)

1. Your breath increases the air pressure above the strip, so that the strip of paper is pressed down.
2. Your breath flows over the top of the paper; there is no affect on the paper.
3. **Your breath lowers the air pressure above the strip, so that the strip rises up.**

Feedback: review pages 462-463, Bernoulli's equation. Did you try it? Think about what the pressure difference that occurs when you blow above the paper.

15.5 Q3. Which of the following statements about streamlines is FALSE?

1. The speed is higher where the streamlines are closer together.
2. **A flowtube is defined by a constant cross sectional area.**
3. Steamlines never cross.
4. The fluid particle velocity is tangent to the streamline.

Feedback: review p. 460, the characteristics of streamlines.

15.5 Q4. Replacing the air pump in the 'stop and think 15.6' figure with a fan reverses the air flow direction, i.e., air flows from right to left. Rank in order, from highest to lowest, the liquid heights h_a to h_b in tubes 1 to 4.

1. $h_2 = h_4 > h_3 > h_1$

2. $h_1 > h_2 = h_3 = h_4$

3. $h_1 > h_3 > h_4 > h_2$

4. $h_2 > h_4 > h_3 > h_1$

5. $h_1 = h_2 = h_3 = h_4$

6. $h_2 = h_3 = h_4 > h_1$

Feedback: review p.465. The pressure decreases when the air flow speeds up in the smaller cross-section areas. How does the water columns change? Smaller pressure above means the water column will rise.

15.6 Elasticity. All materials are somewhat elastic and can therefore vibrate or oscillate, similar to springs. While Hooke's law describes the behaviour of springs, Young's modulus describes the elasticity of a material and can therefore be used for all objects. Important to become familiar with the definitions of stress and strain, and see the connection between the spring constant and Young's modulus. Look also at the definition of the bulk modulus.

15.6 Q1. The elasticity of a material is characterized by the value of the...

1. Spring constant
2. Elastic constant
3. Hooke's modulus
4. **Young's modulus**
5. Strain modulus

15.6 Q2. The equation for tensile stress and pressure are almost the same (F/A). Which ONE statement best compares the two?

1. Tensile stress, unlike pressure, is applied in one particular direction and is dimensionless.
2. Tensile stress, unlike pressure, is applied in one particular direction and has the units N/m .
3. **Tensile stress, unlike pressure, is applied in one particular direction and has the units N/m^2 .**
4. Tensile stress, like pressure, is applied equally in all directions and is dimensionless.
5. Tensile stress, like pressure, is applied equally in all directions and is has the units N/m .
6. Tensile stress, like pressure, is applied equally in all directions and has the units N/m^2 .

Feedback: review p. 467-468. The stress is experience ONLY in the direction that the force is applied (consider force as a vector, like in Fig. 15.37(a)). STRAIN is dimensionless not stress. The term $\Delta L/L$ in the top of the stress equation makes the units N/m^2 .

15.6 Q3. The bulk modulus, B , is important for sound waves, as such waves compress the material as they propagate. Sound can travel through air, water, and steel (see table 15.3).

A smaller value of the bulk modulus, B , corresponds to ...

1. a positive pressure value.
- 2. a material that is easier to compress.**
3. the amount of compression possible in a liquid.
4. a material that is harder to compress.

Feedback: review p. 467-468.
