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Handout 6.1.1.1: Pressure Investigation

Directions:

1. Explore the *Under Pressure* PhET simulation to find out how pressure changes in air and water.
2. Describe your findings and include specific data from your explorations to support your ideas.
3. Test your ideas by predicting what the air pressure would be 2 meters above sea level and 2 meters under water.
   a. Predict what the pressure would be 2 meters above sea level and 2 meters under water.
   b. Use the sim to check your predictions.
      i. Was your prediction correct?
      ii. If not, what was incorrect? Why?
   c. Investigate what happens when you change the shape of the pool.
      i. How does the shape of the pool affect your values?
      ii. Why do you think this is true?

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4. Discover how you can change pressure in the simulation.
   a. Describe your findings and include specific examples.

   b. Check to see how your answers to #3 change as you change the things that affect pressure. Describe qualitatively.

   c. Are there things that could affect pressure that were not included in the sim? Cite references for your ideas.

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Handout 6.1.2.1: Continuity Equation

Open the *Fluid Pressure and Flow* PhET simulation. Go to the second tab – "Flow"

1. Explore how you can change the flow rate by moving the slider. What are you changing when you change the flow rate? Explain in words.

2. What do you think happens to the flow rate as the fluid moves throughout the pipe?

3. Drag the arms on the side of the pipe to create three different shaped pipes. Draw your three unique designs below –

Design	Picture
1	
2	
3	

4. Use the tools available to study what happens to the pressure and speed of the fluid as it moves along the pipe. What conclusions can you make regarding how the properties of the pipe affect the speed of the fluid in the pipe? *Use one of your examples from above as your evidence*

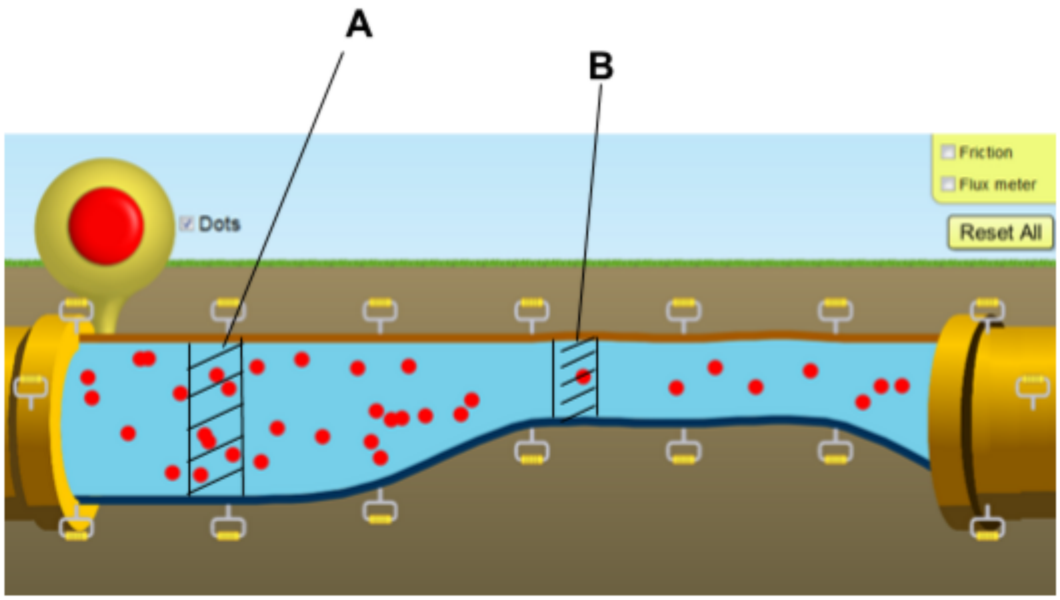
5. How does velocity of the fluid change as –
   a. The pipe becomes smaller

   b. The pipe becomes larger

6. What physical property of the pipe are you changing by making the pipe larger or smaller?

7. What is the mathematical term that describes this property?

8. Consider the following image -



a) How does the flow rate at A compare to B?

b) How does the velocity of the fluid at A compare to B? *Use the simulation to confirm your prediction*

c) What is different about the pipe at A compared to B?

d) If you were to write in words a rule for how the fluid compares at A to B that includes the properties of the pipe and the velocity of the fluid what would it say?

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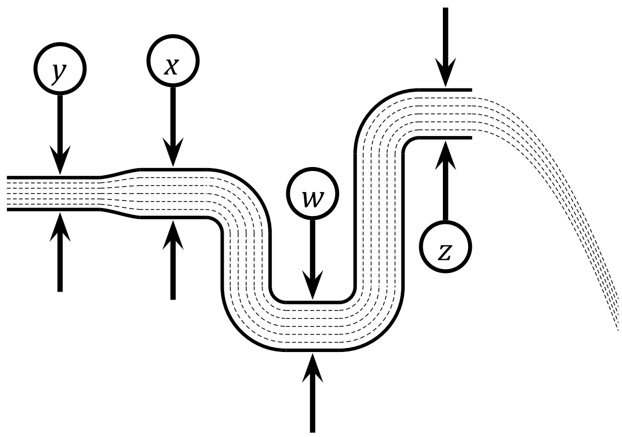
6.1.2.2 Handout: Bernoulli's Equation Practice

This print-out should have 15 questions. Multiple-choice questions may continue on the next page – find all choices before answering.

Bernoulli Principle

1. Shown below is a cross-section of a vertical view of a pipe discharging a fluid into the atmosphere at its highest elevation. The pipe diameter increases and then remains constant. P_i is the pressure and $||\vec{v_i}||$ is the speed of the fluid, at locations *i* = *y*, *x*, *w*, and *z*.

   If the fluid is incompressible and nonviscous, what is the relationship between the magnitude of the velocity $v = ||\vec{v}||$ at position y and x?

   A. Indeterminable; not enough information is available
   B. $||\vec{v_x}|| < ||\vec{v_y}||$
   C. $||\vec{v_x}|| > ||\vec{v_y}||$
   D. $||\vec{v_x}|| = ||\vec{v_y}||$

2. What is the relationship between the pressure P at position x and w?

   A. $P_w = P_x$
   B. $P_w > P_x$
   C. Indeterminable; not enough information is available
   D. $P_w < P_x$

3. What is the relationship between the pressure P at position y and z?

   A. Indeterminable; not enough information is available
   B. $P_z = P_y$
   C. $P_z < P_y$
   D. $P_z > P_y$

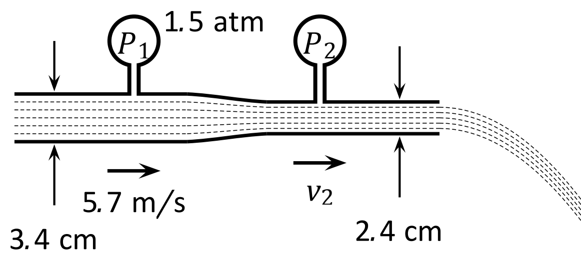
4. What is the relationship between the pressure P at position x and y?

   A. $P_x = P_y$
   B. Indeterminable; not enough information is available
   C. $P_x > P_y$
   D. $P_x < P_y$

Constructed Pipe

5. Water flows at speed of 5.7 m/s through a horizontal pipe of diameter 3.4 cm. The gauge pressure P_1 of the water in the pipe is 1.5 atm. A short segment of the pipe is constricted to a smaller diameter of 2.4 cm.

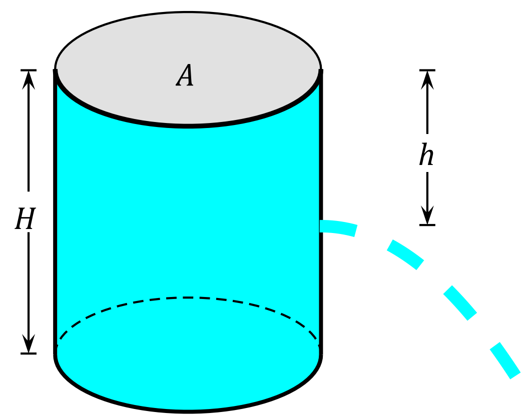
   What is the gauge pressure of the water flowing through the constricted segment? Atmospheric pressure is 1.013×10^5 Pa. The density of water is 1000 kg/m^3 . The viscosity of water is negligible. Answer in units of atm.



Escaping Liquid

6. A container of liquid of density ρ has a surface area A exposed to normal atmospheric pressure. A distance h below the surface of the liquid is a tiny hole of area A_0. The depth of the liquid in the container is H.

   If $A_0 \ll A$, which expression correctly gives the velocity v_0 (in terms of only g, h, H, A_0, and A) at which the fluid escapes through the hole of area A_0? $\frac{1}{(1-x)^n} \approx 1 + nx \; if \; x \ll 1$



   A. $\sqrt{2gh}\left[1+\frac{1}{2}\left(\frac{A_0}{A}\right)^2\right]$
   B. $\sqrt{2g(H-h)}$
   C. Not enough information is provided to produce an answer
   D. $\sqrt{gh}$
   E. $\sqrt{2gh}\left[1-\frac{1}{2}\left(\frac{A_0}{A}\right)^2\right]$
   F. $\sqrt{2gh}\left[1+\frac{1}{2}(A_o)^2\right]$
   G. $\sqrt{2gh}\left[1+2\left(\frac{A_0}{A}\right)^2\right]$
   H. $\sqrt{2gh}$
   I. $(A-A_0)\rho gh$
   J. $\sqrt{2g(H+h)}$

Hole in Water Container

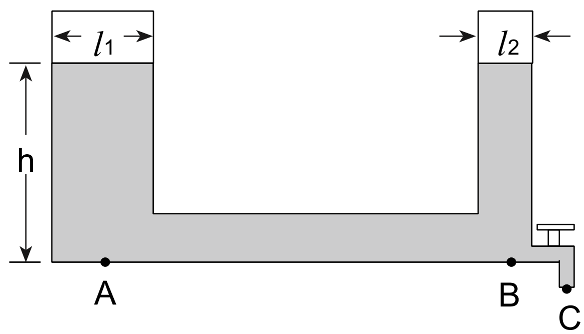
7. A hole is punched in the side of a 29.8 cm tall container, full of water. If the water is to shoot as far as possible horizontally, how far from the bottom of the container should the hole be punched? Answer in units of cm.

8. Neglecting friction losses, how far from the side of the container will the water land? Answer in units of cm.

Pressure in an Odd Container

9. Water is placed in the container shown. It is open to the atmosphere at the top. The diameter l_1 = 0.2 m, diameter l_2 = 0.07 m, and height is 0.47 m.

   What is the gauge pressure at point A when spigot C is closed. The density of water is ρ = 1 g/cm^3 and g = 9.8 m/s^2. Atmospheric pressure is 1.013 × 10^5 Pa. The acceleration of gravity is 9.8 m/s^2. Answer in units of N/m^2.



10. What is the absolute pressure at point B when spigot C is closed? Answer in units of N/m^2.

11. Spigot C is opened. What is the velocity of water upon leaving the spigot? Neglect the slow drop in height of water in the container. The figure is misleading; assume C is at the same level as A and B. Answer in units of m/s.

12. After the water has fallen through an additional height h_2 = 1 m, what is its new velocity? Answer in units of m/s.

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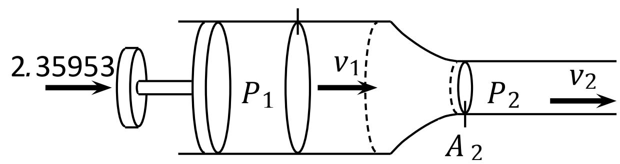
Serway

13. The hypodermic syringe contains a medicine with the same density of water. The barrel of the syringe has a cross-sectional area of 3.59813 × 10^{-5} m^2. The cross-sectional area of the needle is 2.72634 × 10^{-8} m^2. In the absence of a force on the plunger, the pressure everywhere is 1.0 atm. A force of magnitude 2.35953 N is exerted on the plunger, making medicine squirt from the needle.

    Find the medicine's flow speed through the needle. Assume that the pressure in the needle remains at atmospheric pressure, that the syringe is horizontal, and that the speed of the emerging fluid is the same as the speed of the fluid in the needle. Answer in units of m/s.



Tripler

14. Water flows at 0.54 m/s through a hose with diameter 4 cm. At the end of the hose is a nozzle with diameter 0.4 cm.

    At what speed does the water pass through the nozzle? 1 atm = 1.01325 × 10^5 Pa. Answer in units of m/s.

15. If the pump at one end of the hose and the nozzle at the other end are at the same height, and if the pressure at the nozzle is 1.3 atm, what is the pressure at the pump? Assume laminar nonviscous flow. Answer in units of atm.