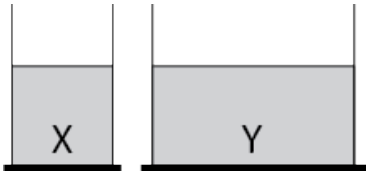
Fluids Worksheet

Part A – Multiple Choice

1. Two containers are filled with the same liquid to the same level. One container has double to cross-sectional area of the other.



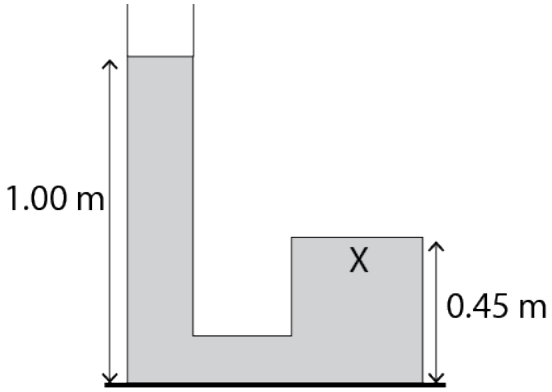
Compare the pressure at points X and Y.

(A) $P_X > P_Y$

(B) $P_X = P_Y$

(C) $P_X < P_Y$

2. The container shown is filled with water $\rho = 1.0\times10^3$ kg/m^3.



The pressure at point X is

(A) 1.07×10^5 kPa

(B) 1.01×10^5 kPa

(C) 5.40×10^3 kPa

(D) 4.41×10^3 kPa

3. A hollow sphere floats exactly half submerged in water of density 1.0×10^3 kg/m^3. The outer radius of the sphere is 15 cm and the inner radius is 14 cm. The density of the material of the sphere is

(A) 3.4×10^6 kg/m^3.

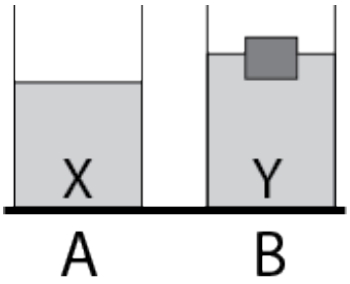
(B) 1.7×10^6 kg/m^3.

(C) 5.4×10^3 kg/m^3.

(D) 2.7×10^3 kg/m^3.

Questions 4 and 5 refer to the following material.

Two identical beakers contain equal amounts of water. In the second beaker, B, a piece of wood is floating in the water.



The beakers are weighed.

4. Which beaker, if any, is heavier?

(A) Beaker A

(B) Beaker B

(C) Both beakers have the same weight.

5. Compare the pressure at points X and Y.

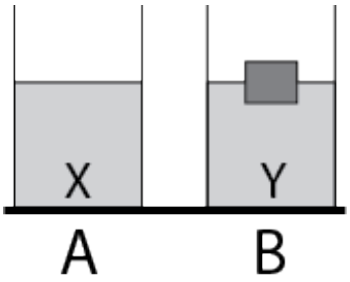
(A) $P_X > P_Y$

(B) $P_X = P_Y$

(C) $P_X < P_Y$

Questions 6 and 7 refer to the following material.

Two identical beakers contain equal amounts of water. In the second beaker, B, a piece of wood is floating in the water.



The beakers are weighed.

6. Which beaker, if any, is heavier?

(A) Beaker A

(B) Beaker B

(C) Both beakers have the same weight.

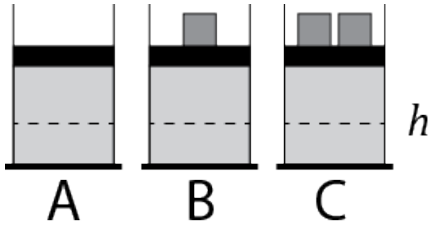
7. Compare the pressure at points X and Y.

(A) $P_X > P_Y$

(B) $P_X = P_Y$

(C) $P_X < P_Y$

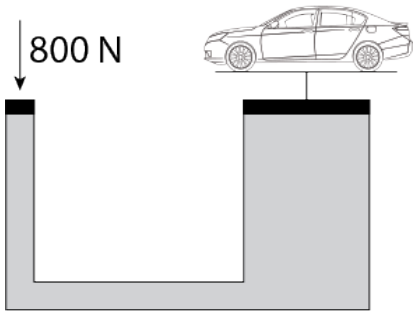
8. A liquid is enclosed in a container with a piston of negligible mass. The pressure at a depth of h is P_A.



A block of weight W is placed on the piston of area A. The pressure at a depth of h is P_B. The weight is then doubled. The pressure at a depth of h is P_C. What are the values of P_B and P_C in terms of P_A.

	P_B	P_C
(A)	$P_A + \frac{W}{A}$	$P_A + \frac{2W}{A}$
(B)	$\frac{P_A W}{A}$	$\frac{2P_A W}{A}$
(C)	$2P_A$	$3P_A$
(D)	P_A	P_A

9. In the hydraulic pump below, a car with a mass of 1400 kg is to be lifted by applying a force of 800 N on a circular piston of diameter d.



The diameter of the circular piston where the car is placed is 1.8 m. The diameter d is

(A) 0.18 m.

(B) 0.43 m.

(C) 0.58 m.

(D) 0.76 m.

10. Water comes out of a tap of cross-sectional area 1.4 cm^2. After falling a vertical distance of 5.0 cm, the cross-sectional area of the water column has been reduced to 0.60 cm^2. Calculate the volume of water per second delivered by the tap.

(A) 6.6×10^{-5} m^3/s

(B) 1.0×10^{-4} m^3/s

(C) 5.6×10^{-3} m^3/s

(D) 6.6×10^{-3} m^3/s

11. Water enters a shower head through a pipe of diameter 1.2 cm at a speed of 1.1 m/s. The shower head has 30 small holes, each of diameter 0.20 cm. What is the speed of the water as it exits one of the small holes.

(A) 0.22 m/s

(B) 1.3 m/s

(C) 6.6 m/s

(D) 40. m/s

12. An aircraft is flying at an altitude where the air density is 0.35 kg/m^3. The pressure of the air outside the aircraft is 12000 Pa lower than the pressure at the same altitude in static air in a Pitot-Prandtl tube. Calculate the speed of the aircraft.

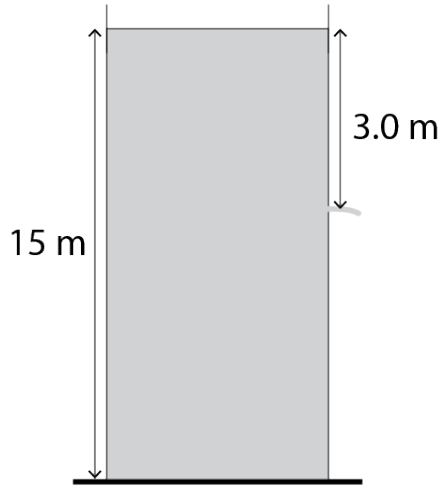
(A) 79 m/s

(B) 83 m/s

(C) 260 m/s

(D) 710 m/s

13. Water leaks out of an open container from a hole 3.0 m below the water surface. The water level in the container is 15 m above the ground, and the container is large enough that the water level can be considered constant.



Calculate the horizontal distance the water travels after leaving the tank.

(A) 38 m

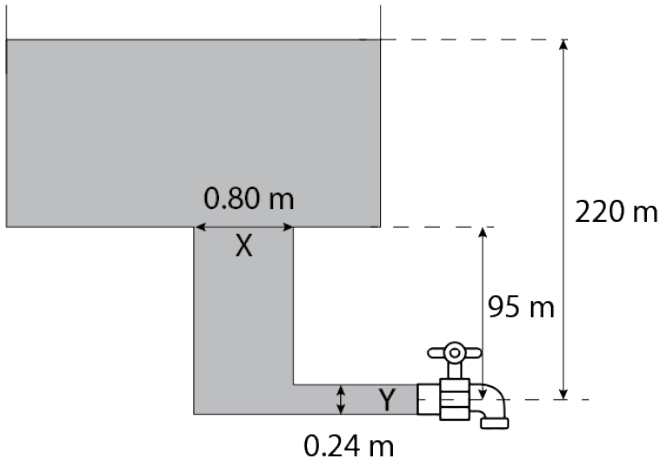
(B) 24 m

(C) 19 m

(D) 12 m

Questions 14 and 15 refer to the following material.

Consider the following tank of water ($\rho = 1.0\times10^3$ kg/m^3).



(diagram is not drawn to scale)

The tap is closed so that no water flows.

14. Calculate the pressure at points X and Y.

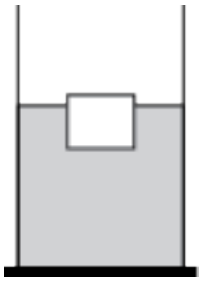
	P_X	P_Y
(A)	1.3×10^6 Pa	2.3×10^6 Pa
(B)	1.2×10^6 Pa	2.2×10^6 Pa
(C)	1.0×10^6 Pa	1.0×10^6 Pa
(D)	1.0×10^5 Pa	1.0×10^5 Pa

15. The tap is now opened such that water flows out of the tank. Calculate the pressure at points X and Y.

	P_X	P_Y
(A)	1.3×10^6 Pa	1.0×10^5 Pa
(B)	1.2×10^6 Pa	1.0×10^5 Pa
(C)	1.0×10^5 Pa	1.0×10^5 Pa
(D)	1.3×10^6 Pa	2.3×10^6 Pa

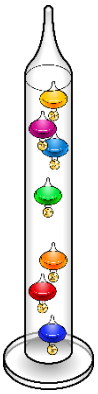
Part B – Free Response

1. An ice cube floats in water.



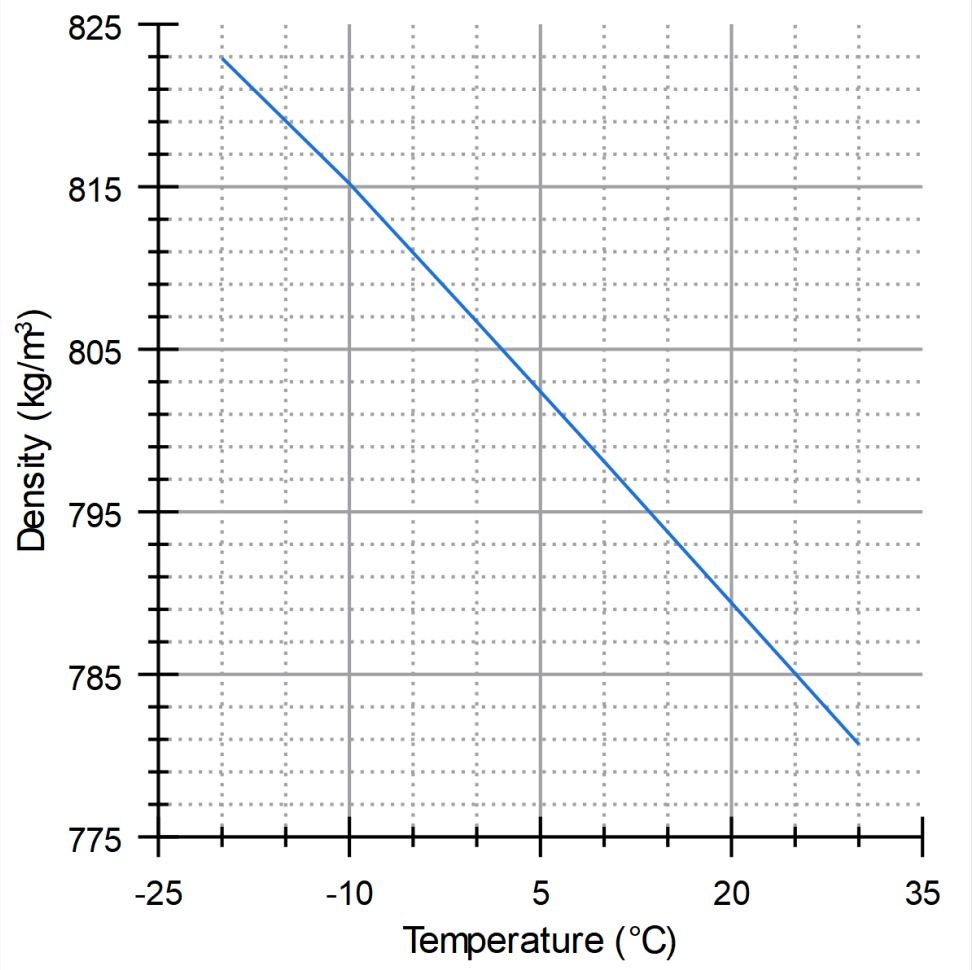
Explain why, after the ice cube melts, the level of water in the container will be the same.

2. A Galilean thermometer consists of glass spheres filled with different amounts of colored water in a sealed glass container of ethanol.



Credit: Zern Liew (Adobe Stock)

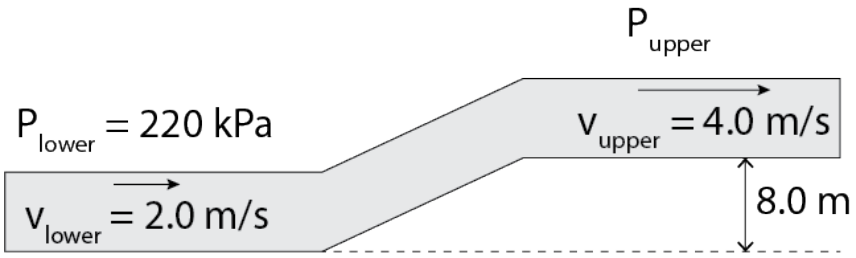
The density of ethanol depends on temperature as shown in the following graph.



(a) Using the graph, determine density of ethanol at 20°C.

(b) At 20°C, one of the glass spheres is at equilibrium. The sphere has a radius of 3.0 cm. Calculate the volume of water ($\rho = 1.0\times10^3$ kg/m^3) in the sphere.

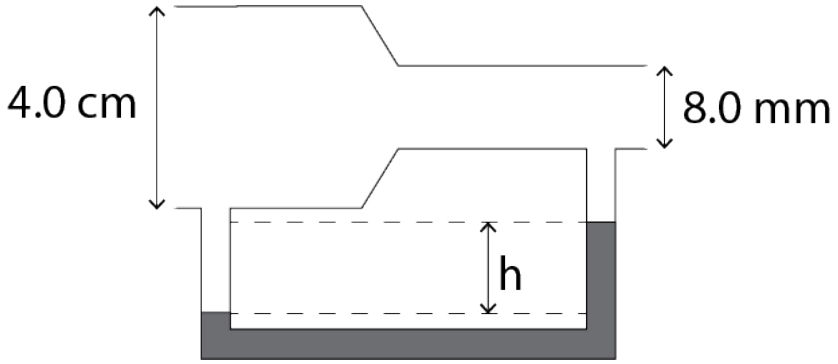
3. Oil of density 850 kg/m^3 flows in the pipe as shown.



Calculate the pressure in the upper end of the pipe.

4. Water exits a tank horizontally from a hole at a depth d. The water level in the tank is H and may be considered constant. Derive an expression for the horizontal distance the water travels after leaving the tank. Express your answer in terms of H, d, and physical constants as appropriate. Begin your derivation by writing an equation from the reference book.

5. Air (ρ = 1.2 kg/m^3) flows through a Venturi tube at a flow rate of 1.8×10^{-3} m^3/s as shown.



Determine the height h of the mercury ($\rho = 1.36\times10^4$ kg/m^3) in the Venturi tube.