Worksheet 3.3 – Fluid Flow

Show ALL WORK including knowns and steps taken to solve the problem!

Substance	ρ(kg/m³)	Substance	ρ(kg/m³)
Ice	0.917×10^3	Water	1.00×10^3
Aluminum	2.70×10^3	Salt Water	1.025×10^3
Iron	7.86×10^3	Glycerin	1.26×10^3
Copper	8.92×10^3	Ethyl Alcohol	0.806×10^3
Silver	10.5×10^3	Benzene	0.879×10^3
Lead	11.3×10^3	Mercury	13.6×10^3
Gold	19.3×10^3	Air	1.29
Platinum	21.4×10^3	Oxygen	1.43
Uranium	18.7×10^3	Hydrogen	8.99×10^{-2}
Brass	8.7×10^3	Helium	1.79×10^{-1}

"I'm afraid we can't accept your grant proposal. You can't predict the way water flows from a faucet!"

1. A river gets narrower and shallower in a 'rapids' section. Suppose that in a certain rapids the river narrows to half the width and the depth is cut in half. What happens to the speed of the water when it gets to the rapids?
   a) The water slows down to half the original speed.
   b) The water speed stays the same.
   c) The water speed increases by a factor of two.
   d) The water speed increases by a factor of four.

2. Two horizontal pipes are the same length, but pipe *B* has twice the diameter of pipe *A*. Water undergoes viscous flow in both pipes, subject to the same pressure difference across the lengths of the pipes. If the flow rate in pipe *A* is *Q*, what is the flow rate in pipe *B*?

   a. *Q* b. *2Q* c. *4Q* d. *8Q* b. *16Q*

3. A 2.0 m diameter pipe narrows to 0.50 m and then widens to 1.0 m. Water flows through the first section of the pipe at a speed of 5.0 m/s.
   a. Find the volume flow rate (in m^3/s) through the pipe.
   b. Find the speed of the water in the second and third segments.

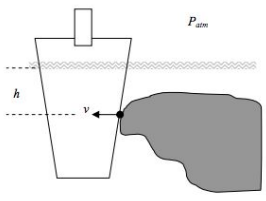
4. Water comes out a 2.5 cm diameter faucet opening at a speed of 4.0 m/s. How long does it take to fill a 0.60 m x 1.6 m x 0.40 m bathtub?

5. At one point in a pipeline, the water's speed is 3.0 m/s and the gauge pressure is 4.0×10^4 Pa. Find the gauge pressure at a second point in the line 11 m lower than the first if the pipe diameter at the second point is twice that of the first.

6. Modern airplane design calls for a lift, due to the net force of the moving air on the wing, of about 2000 N per square meter of wing area. Assume that air flows past the wing of an aircraft with streamline flow. If the speed of flow past the lower wing surface is 120 m/s, what is the required speed over the upper surface to give a lift of 2000 N/m^2? Assume the density of the air is 1.2 kg/m^3.

7. A plane is flying at an altitude of 1000 m above the ground. The density of the air is 1.123 kg/m^3, the velocity of the air on the top of the wing is 60 m/s, the velocity on the bottom of the wing is 30 m/s, and the pressure on top of the wing is 88,600 Pa. Find the pressure on the bottom of the wing.

8. A boat on a lake crashes into a submerged rock, ripping a 0.0040 m^2 hole in its hull 1.75 m below P_{atm}. Calculate the flow speed in which water pours into the boat. How many liters enter the hull per minute?



Answers:

1. D
2. A (Flow rate is constant… $A_1v_1 = A_2v_2$ ***Velocities would be different!)***
3. a. $Q = 15.7\ m^3/s$ b. $v_2 = 80.0$ m/s ; $v_3 = 20.0$ m/s
4. t = 196 s
5. $v_2 = 0.75$ m/s ; $P_2 = 1.5 \times 10^5$ Pa
6. $v_2 = 132$ m/s
7. 90112 Pa
8. v = 5.86 m/s ; V/s = 1400 L/min