MCQ Part 1

1. A solid wooden block is placed in a container of water and floats with one-third of its volume submerged. The density of the wood is most nearly:
   (a) 1000 kg/m^3
   (b) 667 kg/m^3
   (c) 500 kg/m^3
   (d) 333 kg/m^3
   (e) 100 kg/m^3

2. A hydraulic press has a small piston of area A and a large piston of area $4A$. A force F is applied to the small piston. What force is exerted by the large piston?
   (a) $F/4$
   (b) $F/2$
   (c) F
   (d) $2F$
   (e) $4F$

3. Water flows through a horizontal pipe that narrows from a large cross-sectional area to a smaller one. Compared to the wide section, the fluid in the narrow section has:
   (a) lower speed and higher pressure.
   (b) higher speed and higher pressure.
   (c) higher speed and lower pressure.
   (d) lower speed and lower pressure.
   (e) the same speed and the same pressure.

4. An object is fully submerged in a fluid and released from rest. It accelerates upward. Which of the following must be true?
   (a) The object is less dense than the fluid.
   (b) The object is more dense than the fluid.
   (c) The buoyant force equals the object's weight.
   (d) The net force on the object is zero.
   (e) The fluid pressure is uniform throughout.

MCQ Part 2

A large open tank is filled with water to a height H above a small hole near the bottom of the tank. Water flows out of the hole into the atmosphere. Assume the tank is large enough that the water level drops negligibly slowly.

5. The speed of the water exiting the hole is
   (a) $v = gH$
   (b) $v = \sqrt{gH}$
   (c) $v = \sqrt{2gH}$
   (d) $v = 2\sqrt{gH}$
   (e) $v = 2gH$

6. The hole is now plugged and a second hole is drilled at a height $H/2$ above the bottom of the tank. The exit speed of water from this new hole, compared to the original, is
   (a) the same.
   (b) $\sqrt{2}$ times greater.
   (c) half as large.
   (d) $1/\sqrt{2}$ times as large.
   (e) twice as large.

7. A second identical tank is filled with a fluid of density 2ρ (twice that of water) to the same height H. A hole identical in size to the original is drilled at the bottom. Compared to the water tank, the volume flow rate out of this tank is
   (a) twice as large.
   (b) $\sqrt{2}$ times as large.
   (c) the same.
   (d) $1/\sqrt{2}$ times as large.
   (e) half as large.

Fun Problems

8. A large cylindrical tank of cross-sectional area $A_T = 2.00$ m^2 is filled with water to a height of $H = 3.60$ m. A circular drain hole of radius $r = 1.50$ cm is opened at the base of the tank.
   (a) Find the initial speed of the water exiting the drain.
   (b) Find the initial volume flow rate out of the tank.
   (c) Determine the initial rate at which the water level in the tank is dropping (i.e., find dH/dt at $t = 0$).

9. A U-tube manometer is open to the atmosphere on both sides. Oil of density $\rho_o = 800$ kg/m^3 is poured into the left arm until it reaches a height of $h_o = 15.0$ cm. Water ($\rho_w = 1000$ kg/m^3) is then carefully poured into the right arm.
   (a) Find the height of water h_w that must be added to the right arm so that the fluid levels in both arms are at the same height.

(b) Now suppose extra water is poured until the water column in the right arm is $h_w = 20.0$ cm tall. By how much does the oil surface in the left arm rise above the water surface in the right arm?

10. A wooden raft of mass $m = 120$ kg and volume $V = 0.250$ m^3 floats on a freshwater lake ($\rho_w = 1000$ kg/m^3). A person of mass $M = 80.0$ kg steps onto the raft.

(a) Find the fraction of the raft's volume that is submerged when the person is standing on it.

(b) The person now holds a dense iron anchor of mass $m_a = 20.0$ kg and volume $V_a = 2.55 \times 10^{-3}$ m^3. By how much does the waterline on the raft rise compared to part (a)?

(c) The person throws the anchor overboard. Once the anchor sinks to the bottom of the lake and the raft returns to equilibrium, is the water level of the lake higher, lower, or the same as when the anchor was on the raft? Justify your answer.