Numerical PROBLEMS N°4

1/A pipe 40 cm in diameter bifurcates into two pipes of diameter 25 cm and 20 cm respectively. If the flow is incompressible and the velocity of flow in 40 cm and 20 cm pipe is 5.0 m/s and 4.0 m/s respectively.
Find the Discharge through 40 cm and 25 cm diameter pipe.

2/We want to accelerate the circulation of a perfect fluid in a pipe so that its speed is multiplied by 9. For this, the pipe includes a convergent characterized by angle α as shown in Fig. 4–01.

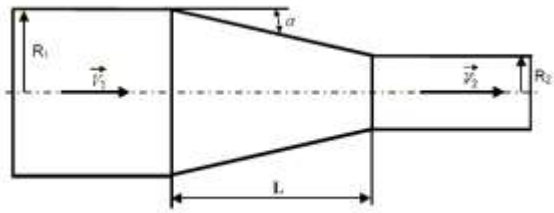

Fig. 4–01

1) Calculate the radius ratio (R_1/R_2)
2) Calculate ($R_1 - R_2$) as a function of L and α deduce the length L.
Data: R_1 = 3cm; $\alpha = 18°$

3/The cylindrical tank shown in Fig. 4–02, open to the air, has a section S_A of diameter D_A = 2 m. It is equipped, at its base, with an S_B section emptying orifice of diameter D_B = 14 mm. The tank is full up to a height H = ($Z_A - Z_B$) = 2.5 m of fuel oil, liquid considered as perfect fluid, of density ρ= 817 kg/m^3.
We note r = (S_B/S_A)

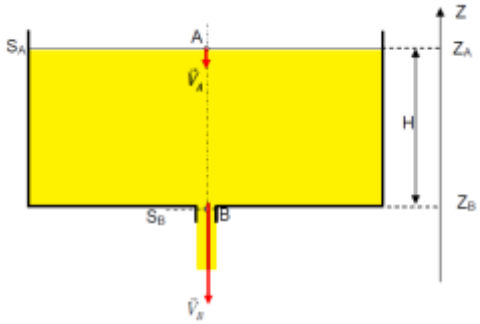

Fig. 4–02

- the atmospheric pressure P_{atm}= 1 bar.
- the acceleration due to gravity g=9.8 m/s^2.

Part 1: The orifice is closed with a plug.
1) By applying the HFE, determine the pressure P_B at point B.
2) Deduce the value of the pressure force F_B which is exerted on the cap.
Part 2: The orifice is open.
Oil flows from the tank. Its average flow velocity at point A is denoted V_A, and its flow velocity at the orifice is denoted V_B.
1) Write the continuity equation. Deduce V_A as a function of V_B and r.
2) By applying Bernoulli's theorem between A and B, establish the literal expression of the speed V_B as a function of g, H and r.
3) Calculate the value of r. The hypothesis of considering a level H of the fluid varies slowly is it true? Justify your answer.
4) Calculate V_B considering the hypothesis that r<<1.
5) Determine the Discharge Q_V of the fluid flowing through the orifice (in l/s).
6) What would be the duration t of the emptying if this flow rate remained constant?

4/The piston of a hypodermic apparatus (fig.4-03) is being withdrawn at 0,75 cm/s; air leaks in around the piston at the rate 0,02 cm^3/s. what is the average speed of blood flow in the needle?
NB: choose as a control volume the region between the piston and the tip of the needle.

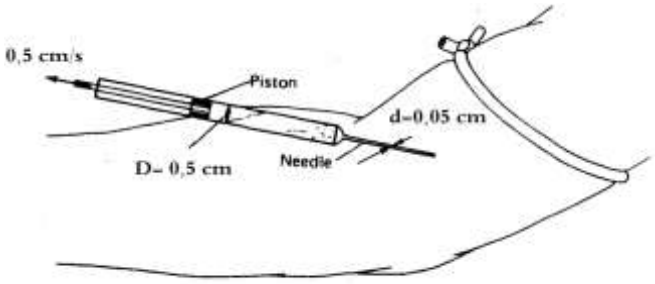

Fig. 4–03

MCQ (Multiple Choice Questions)

1/ The continuity equation is only applicable to incompressible fluid.
a) True
b) False

2/ For incompressible fluid flow, if area reduces then what is the effect on the velocity.
a) increases
b) decreases
c) first increases then decreases
d) first decreases then increases

3/ The diameters of a pipe at the sections 1 and 2 are 8 cm and 13 cm respectively. Find the discharge through pipe if the velocity of water flowing through the pipe at section 1 is 6 m/s. Determine also the velocity at section 2.
a)1.13 m/s
b) 4.54 m/s
c) 2.27 m/s
d) 3.25 m/s