# Fluid mechanic / Second Year

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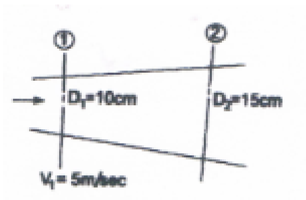
## Problems of chapter Four

**Problem 4.1 /**

**The diameter of the pipe at the section 1 and 2 are 10 cm and 15 cm respectively. Find the discharge through the pipe , if the velocity of water flowing through the pipe at section 1 is 5 m/s. Determine also the velocity at section 2.**




**Solution :**

$$\text{Discharge ( Q )} = A_1 V_1 = \frac{\pi d_1^2}{4} \times V_1 = \frac{\pi (0.1)^2}{4} \times 5 = 0.039 \ m^3/s$$

**Discharge ( Q ) = $A_2 V_2$**

$$V_2 = \frac{Q}{A_2} = \frac{0.039}{\frac{\pi (0.15)^2}{4}} = 2.22 \ m/s$$

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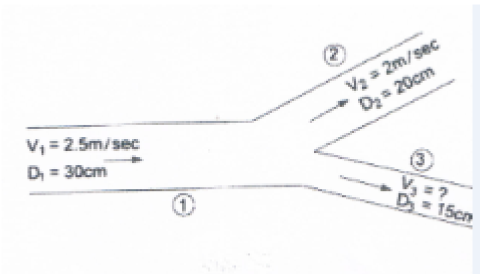
**Problem 4.2 /**

**A 30 cm diameter pipe , conveying water , branches into two pipes of diameters 20 cm and 15 cm respectively. If the average velocity in the 30 cm diameter pipe is 2.5 m/s , find the discharge in this pipe , also determine the velocity in 15 cm pipe if the average velocity in 20 cm diameter pipe is 2 m/s .**



**Solution :**

**Discharge ( $Q_1$ ) in pipe 1 = $A_1 V_1 = \frac{\pi (0.3)^2}{4} \times 2.5 = 0.1767\ m^3/s$**

$Q_2 = A_2 V_2 = \frac{\pi ( 0.2)^2}{4} \times 2 = 0.0628\ m^3 / s$

$Q_1 = Q_2 + Q_3$

$Q_3 = Q_1 - Q_2 = 0.1767 - 0.0628 = 0.1139\ m^2 / s$

$Q_3 = A_3 V_3$

$V_3 = \frac{Q_3}{A_3} = \frac{0.1139}{\frac{\pi ( 0.15)^2}{4}} = 6.44\ m/s$

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**Problem 4.3** /

**A 25 cm diameter pipe carries oil of sp.gr. 0.9 at a velocity of 3 m/s . At another section the diameter is 20 cm. Find the velocity at this section and also mass rate of flow of oil .**

**Solution :**

$Q = A_1 V_1 = A_2 V_2$

$V_2 = \frac{A_1 V_1}{A_2} = \frac{\frac{\pi}{4} \times ( 0.25)^2 \times 3}{\frac{\pi}{4}( 0.2 )^2} = 4.68\ m/s$

**Mass rate of flow of oil ( $\dot{m}$ ) = $\rho A_1 V_1 = 0.9 \times 1000 \times \frac{\pi}{4} \times ( 0.25 )^2 \times 3$**

$= 132.23\ kg / s$

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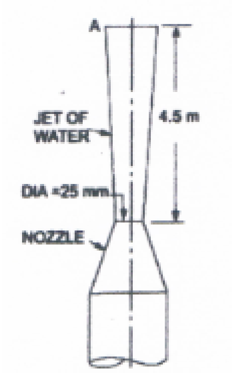
**Problem 4.4/**

**A jet of water from a 25 mm diameter nozzle is directed vertically upwards. Assuming that the jet remains circular and neglecting any loss of energy, that will be the diameter at a point 4.5 m above the nozzle, if the velocity with which the jet leaves the nozzle is 12 m/s .**




**Solution :**

**Initial velocity( $V_1$) = 12 m /s**

**Final velocity ( $V_2$ )**

**But , ( $\Delta V)^2 = 2gh$ ( opposite free fall equation )**

$V_2^2 - V_1^2 = 2gh$

$V_2^2 - 12^2 = 2(-9.81) \times 4.5$

$V_2 = 7.46$ **m /s**

$Q = A_1V_1 = A_2V_2$

$A_2 = \frac{A_1V_1}{V_2} = \frac{\frac{\pi}{4}\times 0.025^2 \times 12}{7.46} = 0.0007896\ m^2$

$A_2 = \frac{\pi D_2^2}{4}$ , $D_2 = \sqrt{\frac{4A_2}{\pi}} = \sqrt{\frac{4 \times 0.0007896}{\pi}} = 31.7$ **mm**

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**Problem 4.5 /**

**Which of the following velocity fields satisfies continuity equation ?**

**( A )** $u = 4xy + y^2$ , $v = 6xy + 3x$

**To satisfy the continuity equation :** $\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$

$\frac{\partial u}{\partial x} = 4y$ , $\frac{\partial v}{\partial y} = 6x$

$4y + 6x = 0$ , Therefore , it does not satisfy continuity equation .

**( B )** $u = 2x^2 + y^2$ , $v = -4xy$

**Solution :**

$\frac{\partial u}{\partial x} = 4x$ , $\frac{\partial v}{\partial y} = -4x$

$4x + (-4x) = 0$ , Therefore , it does satisfy continuity equation .

**( C )** $u = 2x^2 - xy + z^2$ , $v = x^2 - 4xy + y^2$ , $w = -2xy - yz + y^2$

**Solution :**

$\frac{\partial u}{\partial x} = 4x - y$ , $\frac{\partial v}{\partial y} = -4x + 2y$ , $\frac{\partial w}{\partial z} = -y$

$4x - y + (-4x + 2y) + (-y) = 0$

$4x - y - 4x + 2y - y = 0$

$4x - 2y - 4x + 2y = 0$ , Therefore , it does satisfy continuity .

$0 = 0$

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