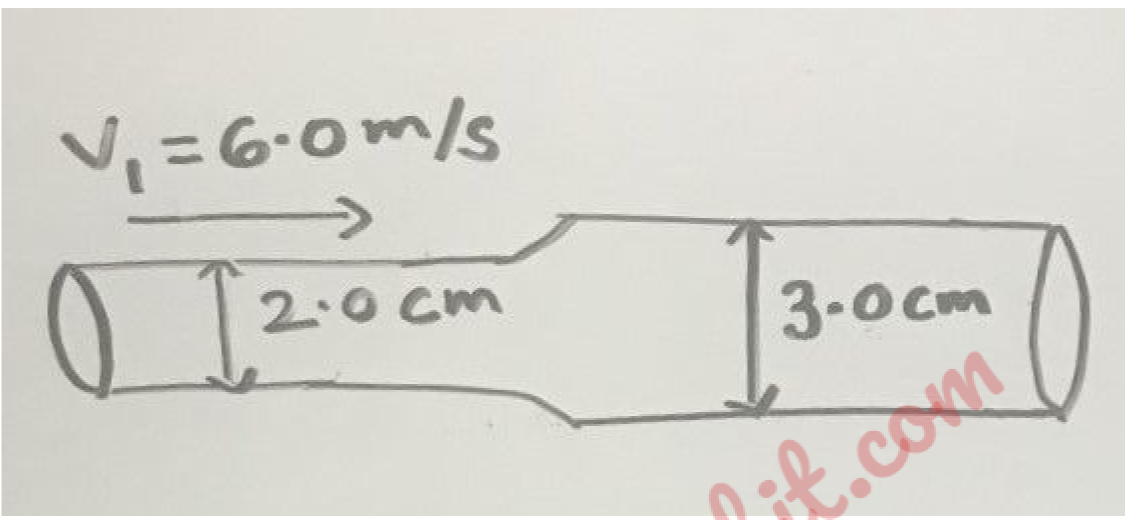
A 2.0-cm-diameter pipe widens to 3.0 cm. Speed of liquid in the first segment is 6.0 m/s.

(a) What is the speed of liquid in the second segment?

(b) Determine the volume flow rate through the pipe?

Given:

Diameter of first segment of pipe:	$d_1 = 2.0\ \text{cm} = 0.02\ \text{m}$
Radius of first segment of pipe:	$r_1 = 1.0\ \text{cm} = 0.01\ \text{m}$
Diameter of second segment of pipe:	$d_2 = 3.0\ \text{cm} = 0.03\ \text{m}$
Radius of second segment of pipe:	$r_2 = 1.5\ \text{cm} = 0.015\ \text{m}$
Speed of liquid in the first segment:	$v_1 = 6.0\ \text{m/s}$



(a) Determine: speed of liquid in the second segment of pipe: v_2

Since volume rate of flow of liquid ($Q = Av$) is a constant throughout the flow in the pipe, use formula:

$$A_1v_1 = A_2v_2 \text{ ----------------------------(1)}$$

A is the area of cross-section of the pipe and v is the speed of the liquid.

Equation (1) is called the " Equation of Continuity".

Area of cross-section of pipe is:

$$A = \pi r^2$$

Substituting for A_1 and A_2 in (1):

$$\pi r_1^2 \times v_1 = \pi r_2^2 \times v_2 \text{ ------------------------(2)}$$

Rearranging & simplifying (2) and substituting for r_1, r_2 and v_1 in (2):

$$\mathbf{v_2 = (0.01^2 \times 6.0) / (0.015^2) = 2.7\ m/s}$$

(b) Determine: Volume flow rate: Q

Use formula:

$$Q = A_1v_1 = \pi r_1^2 \times v_1 \text{ ----------------------------------(3)}$$

Substituting for r_1 & v_1 in (3):

$$\mathbf{Q = A_1v_1 = 3.14 \times 0.01^2 \times 6.0 = 1.9 \times 10^{-3}\ m^3 /s}$$

(Alternatively , $Q = A_2v_2$, can also be used to determine the volume flow rate.)