

2018-XE-'40-52'

EE24BTECH11023

- 1) In a capillary tube of radius $R = 0.25$ mm, a fully developed laminar velocity profile is defined as

$$u = \frac{R^2}{4\mu} \left(-\frac{dp}{dx} \right) \left(1 - \frac{r^2}{R^2} \right).$$

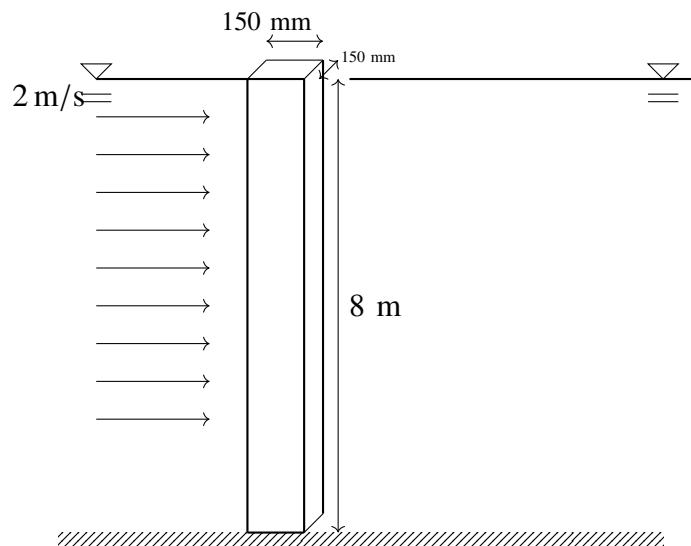
In this expression, $\left(-\frac{dp}{dx} \right) = 1$ MPa/m, μ is the dynamic viscosity of the fluid, and r is the radial position from the centerline of the tube. If the flow rate through the tube is $1000 \text{ mm}^3/\text{s}$, the viscosity of the fluid, in Pa·s is _____.

- 2) The skin friction coefficient for a turbulent pipe flow is defined as

$$C_f = \frac{\tau_w}{0.5\rho V^2},$$

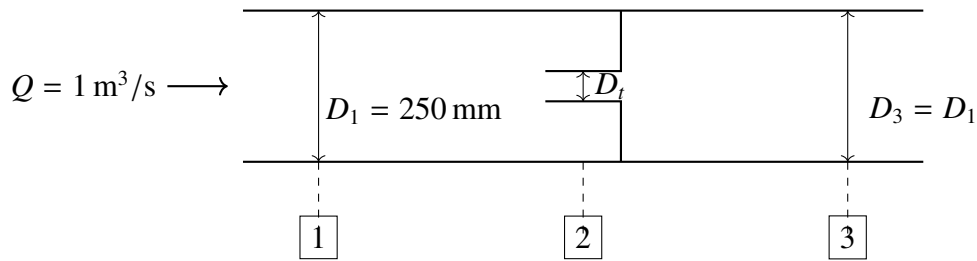
where τ_w is the wall shear stress and V is the average flow velocity. The value of C_f is empirically given by the relation: $C_f = 0.065 \left(\frac{2}{Re} \right)^{0.25}$, where Re is the Reynolds number. If the average flow velocity is 10 m/s , diameter of the pipe is 250 mm , kinematic viscosity of the fluid is $0.25 \times 10^{-6} \text{ m}^2/\text{s}$, and density of the fluid is 700 kg/m^3 , the skin friction drag induced by the flow over 1 m length of the pipe, in N, is _____.

- 3) A $(150 \text{ mm} \times 150 \text{ mm})$ square pillar is located in a river with water flowing at a velocity of 2 m/s , as shown in the figure. The height of the pillar in water is 8 m . Take density of water as 1000 kg/m^3 and kinematic viscosity as $1 \times 10^{-6} \text{ m}^2/\text{s}$. The coefficient of drag of the pillar is 2.0 . The drag force exerted by water on the pillar in N is _____.

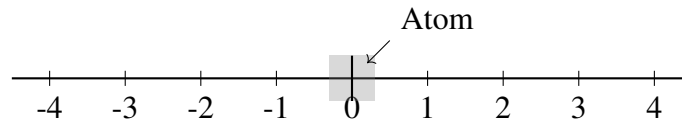


- 4) An orifice plate is used to measure flow rate of air (density = 1.23 kg/m^3) in a duct of 250 mm diameter as shown in figure. The volume flow rate is $1 \text{ m}^3/\text{s}$. Flow at sections 1 and 3 is uniform and section 2 is located at vena contracta. The diameter ratio, D_t/D_1 , is 0.66 .

The flow area at vena contracta, $A_2 = 0.65A_1$, where A_1 is area of the orifice. The pressure difference between locations 2 and 3 in N/m^2 is _____.



- 5) The stress ratio for a completely reversed cyclic loading during a fatigue test is:
 - a) 0
 - b) 1
 - c) -1
 - d) $\frac{-1}{2}$
- 6) Minimum symmetry that a cubic crystal must possess is:
 - a) Four 3-fold rotation axes
 - b) Three 4-fold rotation axes
 - c) Three orthogonal mirror planes
 - d) Centre of symmetry
- 7) If a material is repelled in an external magnetic field, then it is:
 - a) Ferromagnetic
 - b) Diamagnetic
 - c) Paramagnetic
 - d) Antiferromagnetic
- 8) An electron makes a transition from the valence band to the conduction band in an indirect band gap semiconductor. Which one of the following is true?
 - a) Energy of the electron decreases
 - b) A photon is emitted in the process
 - c) A phonon is annihilated in the process
 - d) A photon is created in the process
- 9) Which one of the following is the characteristic of a screw dislocation?
 - a) Dislocation line and Burgers vector are parallel
 - b) Direction of motion of dislocation is parallel to the Burgers vector
 - c) Atomic displacement due to the movement of the dislocation is in the direction of the motion of the dislocation line
 - d) It has a unique slip plane
- 10) The number of vibrational degrees of freedom for a non-linear triatomic molecule are
 - a) 9
 - b) 6
 - c) 4
 - d) 3
- 11) An atom is restricted to move in one dimension by making unit jumps either to the left or right, as shown in figure. Assuming that a jump to the left or right is equally probable, the probability of the atom returning back to the starting point after four jumps is



- a) 0.250 b) 0.333 c) 0.375 d) 0.500

- 12) For a two-dimensional solid, the variation of lattice specific heat as a function of temperature T (in K, at low temperatures) is given as $C_p = bT^n$, where b is a constant. The value of n is _____.
- 13) If the cation (C) to anion (A) radius ratio, $\frac{r_C}{r_A}$, is 0.6, then the coordination number (i.e., number of A ions surrounding a C ion) is likely to be _____.