Solution:

$$\left(1.828 \times 10^{-4} \frac{\text{g}}{\text{cm·s}}\right)\left(30.48 \frac{\text{cm}}{\text{ft}}\right) \times \left(2.205 \times 10^{-3} \frac{\text{lbm}}{\text{g}}\right) = 1.23 \times 10^{-5} \text{ lbm/ft-sec}$$

Answer is A.

3. At a particular temperature, the surface tension of water is 0.073 N/m. Under ideal conditions, the contact angle between glass and water is zero. A student in a laboratory observes water in a glass capillary tube with a diameter of 0.1 mm. What is the theoretical height of the capillary rise?

(A) 0.00020 m
(B) 0.013 m
(C) 0.045 m
(D) 0.30 m

ATH 2/95

Solution:

$$h = \frac{4\sigma \cos\beta}{\rho g d}$$

$$= \frac{(4)\left(0.073 \frac{\text{N}}{\text{m}}\right)(\cos 0°)}{\left(1000 \frac{\text{kg}}{\text{m}^3}\right)\left(9.81 \frac{\text{m}}{\text{s}^2}\right)(0.0001 \text{ m})}$$

$$= 0.2977 \text{ m}$$

Answer is D.

FE-STYLE EXAM PROBLEMS

1. What is the atmospheric pressure on a planet if the absolute pressure is 100 kPa and the gage pressure is 10 kPa?

(A) 10 kPa
(B) 80 kPa
(C) 90 kPa
(D) 100 kPa

B1P144 6/89

2. 100 g of water are mixed with 150 g of alcohol (ρ = 790 kg/m^3). What is the specific volume of the resulting mixture, assuming that the two fluids mix completely?

(A) 0.63 cm^3/g
(B) 0.82 cm^3/g
(C) 0.88 cm^3/g
(D) 1.20 cm^3/g

ATH 2/95

3. 100 g of water are mixed with 150 g of alcohol (ρ = 790 kg/m^3). What is the specific gravity of the resulting mixture, assuming that the two fluids mix completely?

(A) 0.63
(B) 0.82
(C) 0.86
(D) 0.95

ATH 2/95

4. Kinematic viscosity can be expressed in which of the following units?

(A) ft^2/sec
(B) sec^2/ft
(C) lbm sec^2/ft
(D) lbm/sec

B4P247 6/89

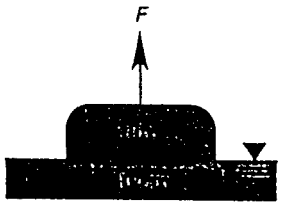
5. Which of the following does not affect the rise or fall of liquid in a small-diameter capillary tube?

(A) adhesive forces
(B) cohesive forces
(C) surface tension
(D) viscosity of the fluid

B1P126 6/89

For the following problems use the *NCEES FE Reference Handbook* as your only reference.

6. The film width in a surface tension experiment is 10 cm. If mercury is the fluid (surface tension = 0.52 N/m), what is the maximum force that can be applied without breaking the membrane? Neglect gravitational force.



(A) 0.1 N
(B) 1.0 N
(C) 2.0 N
(D) 3.4 N

CA5aFMP&S#33 1/94

Problems 7 and 8 refer to the following situation.

The cross section of a concrete dam is shown. The specific weight of concrete is 150 lbf/ft^3. The dam has a constant slope along surface BC and is parabolic according to $y = 0.24x^2$ along surface AD.

FE-STYLE EXAM PROBLEMS

1. What height of mercury column is equivalent to a pressure of 100 psig? The density of mercury is 848 lbm/ft^3.

(A) 2 ft
(B) 4 ft
(C) 11 ft
(D) 17 ft

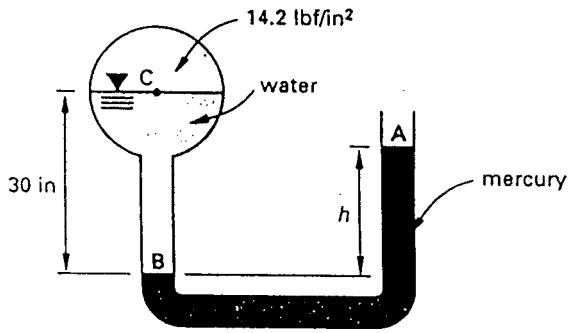
DFMP#2 6/87

2. A fluid with a vapor pressure of 0.2 Pa and a specific gravity of 12 is used in a barometer. If the fluid's column height is 1 m, what is the atmospheric pressure?

(A) 9.80 kPa
(B) 11.76 kPa
(C) 101.3 kPa
(D) 117.7 kPa

CA4FP&S#6 1/93

3. One leg of a mercury U-tube manometer is connected to a pipe containing water under a gage pressure of 14.2 lbf/in^2. The mercury in this leg stands 30 in below the water. What is the height of mercury in the other leg, which is open to the air? The specific gravity of mercury is 13.6.



(A) 0.7 ft
(B) 1.5 ft
(C) 2.6 ft
(D) 3.2 ft

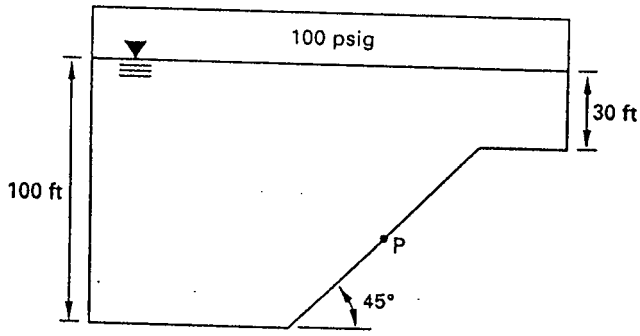
DFMP#3 6/87

4. What is the resultant force on one side of a 10 in diameter vertical circular plate standing at the bottom of a 10 ft pool of water?

(A) 326 lbf
(B) 386 lbf
(C) 451 lbf
(D) 643 lbf

CA5aFMP&S#34 1/94

5. A special closed tank with the dimensions shown contains water. If the pressure of the air is 100 psig, what is the pressure at point P, which is located halfway up the inclined wall?

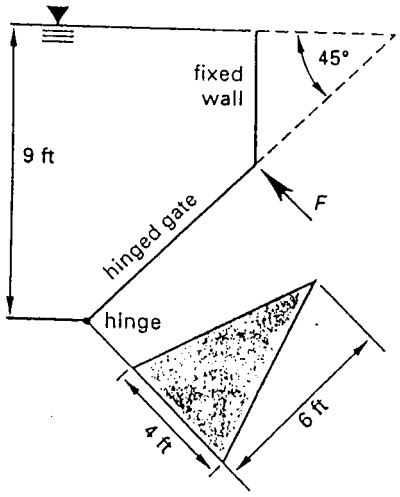


(A) 115 psig
(B) 128 psig
(C) 134 psig
(D) 4060 psig

CA4FP&S#7 1/93

For the following problems use the *NCEES FE Reference Handbook* as your only reference.

6. A triangular gate with a horizontal base 4 ft long and an altitude of 6 ft is inclined 45° from the vertical with the vertex pointing upward. The hinged horizontal base of the gate is 9 ft below the water surface. What normal force must be applied at the vertex of the gate to keep it closed?



(A) 1430 lbf
(B) 1570 lbf
(C) 1670 lbf
(D) 1720 lbf

DFMP#9 6/87

$$v_6 = 1.095v_{10}$$

$$Q_t = Q_6 + Q_{10} = A_6v_6 + A_{10}v_{10}$$
$$= 3 \text{ ft}^3/\text{sec}$$

$$A_6v_6 + A_{10}v_{10} = 3 \text{ ft}^3/\text{sec}$$

$$(0.1963 \text{ ft}^2)(1.095v_{10}) + (0.5454 \text{ ft}^2)(v_{10}) = 3 \text{ ft}^3/\text{sec}$$

$$v_{10} = 3.946 \text{ ft/sec}$$

$$Q_{10} = v_{10}A_{10} = \left(3.946 \frac{\text{ft}}{\text{sec}}\right)(0.5454 \text{ ft}^2)$$
$$= 2.15 \text{ ft}^3/\text{sec}$$

Answer is C.

FE-STYLE EXAM PROBLEMS

1. Water flows through a multisectional pipe placed horizontally on the ground. The velocity is 3.0 m/s at the entrance and 2.1 m/s at the exit. What is the pressure difference between these two points? Neglect friction.

(A) 0.2 kPa
(B) 2.3 kPa
(C) 28 kPa
(D) 110 kPa

CA6aFLP&S#41 7/94

2. What is the mass flow rate of a liquid (ρ = 0.690 g/cm^3) flowing through a 5 cm (inside diameter) pipe at 8.3 m/s?

(A) 11 kg/s
(B) 69 kg/s
(C) 140 kg/s
(D) 340 kg/s

CA6aFLP&S#44 7/94

3. The mean velocity of 100°F water in a 1.76 in (inside diameter) tube is 5 ft/sec. The kinematic viscosity is $\nu = 7.39 \times 10^{-6}$ ft^2/sec. What is the Reynold's number?

(A) 7.9×10^3
(B) 8.3×10^3
(C) 8.8×10^4
(D) 9.9×10^4

CA18aFMP&S#44 3/94

4. What is the head loss for water flowing through a horizontal pipe if the gage pressure at point 1 is 1.03 kPa, the gage pressure at point 2 downstream is 1.00 kPa, and the velocity is constant?

(A) 3.1×10^{-3} m
(B) 3.1×10^{-2} m
(C) 2.3×10^{-2} m
(D) 2.3 m

CA6aFLP&S#42 7/94

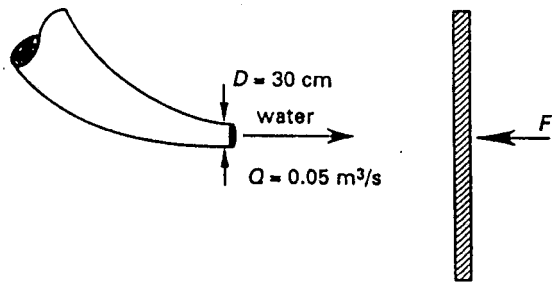
5. The *hydraulic radius* is

(A) the mean radius of the pipe.
(B) the radius of the pipe bend on the line.
(C) the wetted perimeter of a conduit divided by the area of flow.
(D) the cross-sectional fluid area divided by the wetted perimeter.

B1P131 6/89

For the following problems use the *NCEES FE Reference Handbook* as your only reference.

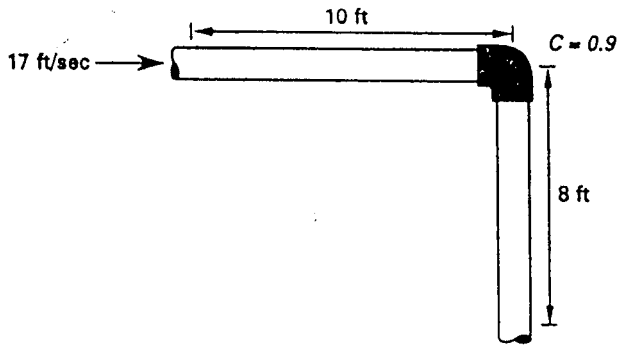
6. What horizontal force is required to hold the plate stationary against the water jet? (All of the water leaves parallel to the plate.)



(A) 17.7 N
(B) 35.4 N
(C) 42.2 N
(D) 67.5 N

B1P139 6/89

7. Water flows with a velocity of 17 ft/sec through 18 ft of cast-iron pipe (specific roughness = 0.00085 ft). The pipe has an inside diameter of 1.7 in. The kinematic viscosity of the water is 5.94×10^{-6} ft^2/sec. The loss coefficient for the standard elbow is 0.9. What percentage of the total head loss is caused by the elbow?



(A) 5.5%
(B) 7.1%
(C) 10%
(D) 18%

CA16FMP&S#6 11/93

FE-STYLE EXAM PROBLEMS

1. A 70% efficient pump pumps 60°C water from ground level to a height of 5 m. How much power is used if the flow rate is 10 m^3/s?

(A) 80 kW
(B) 220 kW
(C) 700 kW
(D) 950 kW

CA6aFLP&S#39 7/94

2. The acoustic velocity in a specific gas depends only on which of the following variables?

(A) c_p, specific heat at constant pressure
(B) k, ratio of specific heats
(C) c_v, specific heat at constant temperature
(D) T, absolute temperature

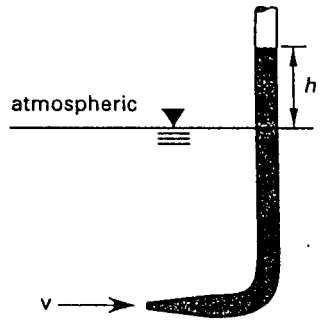
CA6aFLP&S#43 7/94

3. Which of the following cannot be directly determined with the use of a pitot tube?

(A) velocity of a flowing fluid
(B) stagnation pressure
(C) discharge rate
(D) total pressure

B1P135 6/89

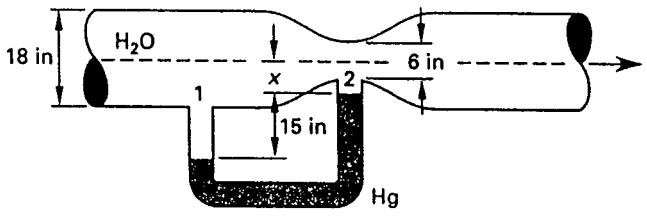
4. The velocity of the water in the stream is 1.2 m/s. What is the height of water in the pitot tube?



(A) 3.7 cm
(B) 4.6 cm
(C) 7.3 cm
(D) 9.2 cm

CA5aFLP&S#32 1/94

5. A venturi meter with a diameter of 6 in at the throat is installed in an 18 in water main. A differential manometer gauge is partly filled with mercury (the remainder of the tube is filled with water) and connected to the meter at the throat and inlet. The mercury column stands 15 in higher in one leg than in the other. Neglecting friction, what is the flow through the meter? The specific gravity of mercury is 13.6.

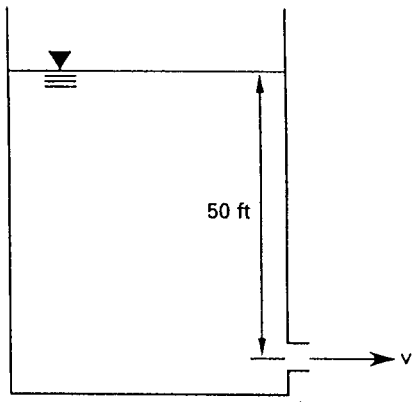


(A) 3.70 ft^3/sec
(B) 6.29 ft^3/sec
(C) 8.62 ft^3/sec
(D) 10.5 ft^3/sec

DFMP#22 6/87

For the following problems use the *NCEES FE Reference Handbook* as your only reference.

6. What is the velocity of water under a 50 ft head discharging through a 1 in diameter round-edged orifice?



(A) 3.6 ft/sec
(B) 9.8 ft/sec
(C) 25 ft/sec
(D) 56 ft/sec

CA18aFMP&S#54 3/94

7. A 1:1 model of a torpedo is tested in a wind tunnel according to the Reynolds number criterion. At the testing temperature, $\nu_{air} = 1.41 \times 10^{-5}$ and $\nu_{water} = 1.31 \times 10^{-6}$. If the velocity of the torpedo in water is 7 m/s, what should be the air velocity in the wind tunnel?

(A) 0.6 m/s
(B) 7.0 m/s
(C) 18 m/s
(D) 75 m/s

NAND 12/94

Problems 8 and 9 refer to the following situation.

A sharp-edged orifice with a 2 in diameter opening is located in the vertical side of a large tank. The coefficient of contraction for the orifice is 0.62, and the coefficient of velocity is 0.98. The orifice discharges under a hydraulic head of 16 ft.

8. What is the minimum diameter of the jet?

(A) 1.24 in
(B) 1.57 in
(C) 2.00 in
(D) 2.54 in

#2989 6/87

9. What is the velocity at the vena contracta?

(A) 5.54 ft/sec
(B) 10.8 ft/sec
(C) 17.4 ft/sec
(D) 31.5 ft/sec

#2990 6/87

Problems 10–13 refer to the following situation.

The bottom of a tall tank sits on level ground. The tank is kept filled to a depth of 15 ft, while water discharges at a constant rate through a 0.5 ft diameter hole in the tank side. The center of the hole is 10 ft from the water surface above. The coefficient of velocity for the hole is essentially 1.0.

10. What horizontal distance will the water jet travel before hitting the ground?

(A) 6.5 ft
(B) 7.1 ft
(C) 7.5 ft
(D) 14 ft

#1161 6/89

11. What is the velocity of the water jet?

(A) 21.9 ft/sec
(B) 25.4 ft/sec
(C) 26.9 ft/sec
(D) 30.6 ft/sec

#1166 6/89

12. If the hole is represented by a sharp-edged orifice with a coefficient of discharge of 0.61, what will be the rate of discharge?

(A) 2.68 ft^3/sec
(B) 3.04 ft^3/sec
(C) 3.27 ft^3/sec
(D) 3.72 ft^3/sec

#1168 6/89

13. Assume the orifice can be moved to any point on the side of the tank. What distance below the water surface should the orifice be located such that the horizontal distance traveled by the jet (before hitting the ground) is the greatest?

(A) 7.5 ft
(B) 8.8 ft
(C) 10 ft
(D) 11 ft

#1160 6/89

14. A 2 m tall, 0.5 m inside diameter tank is filled with water. A 10 cm hole is opened 0.75 m from the bottom of the tank. What is the velocity of the exiting water? Ignore all orifice losses.

(A) 4.75 m/s
(B) 4.80 m/s
(C) 4.85 m/s
(D) 4.95 m/s

#3508 1/94

Problems 15–17 refer to the following situation.

Air flowing through a cylindrical duct encounters a constricted flow area, as shown. The initial flow area is 2.5 m^2. The air entering the constriction has a temperature of 300K and a pressure of 97 kPa. The constricted area is 0.1 m^2. The air in the constriction has a density of 1.416 kg/m^3. The differences in pressures across the constriction is relatively low, and the air velocity through the constriction is 10 m/s.

1. Reynolds number may be calculated from:

(A) diameter, velocity, and absolute viscosity
(B) diameter, velocity, and surface tension
(C) diameter, density, and kinematic viscosity
(D) diameter, density, and absolute viscosity
(E) characteristic length, mass flow rate per unit area, and absolute viscosity

2. Roughening the leading edge of a smooth sphere will reduce its drag coefficient because

(A) the wake width increases
(B) the separation points move to the front of the sphere
(C) the wake eddies increase
(D) the boundary layer becomes turbulent
(E) Stoke's law becomes applicable

3. What is the hydraulic radius of a rectangular flume 2 feet high and 4 feet wide which is running half full?

(A) 1.33 feet
(B) .33
(C) 8.0
(D) .40
(E) .67

4. Water flows at 10 ft/sec in a 1" inside diameter pipe. What is the velocity if the pipe suddenly increases in diameter to 2"?

(A) 5 ft/sec
(B) 2.5
(C) 40
(D) 20
(E) answer depends on the flow direction

5. What pressure differential exists across a perfect venturi with an area reduction ratio of (3:1) if water is flowing through the throat at 40 fps?

(A) .6 feet of water
(B) 17
(C) 22
(D) 27
(E) 1378

6. If 'L' is defined as the characteristic length, what does the quantity (v^2/Lg) represent?

(A) velocity pressure
(B) Reynolds number
(C) Froude number
(D) total pressure
(E) static pressure

7. Minor losses through valves, fittings, diameter changes, and bends are proportional to

(A) total head
(B) dynamic head
(C) static head
(D) wet head
(E) velocity

8. The horsepower of an ideal pump used to move 2 cfs of water into a tank 50 feet above the pump is most nearly

(A) 2
(B) 11
(C) 290
(D) 1213
(E) 6240

9. A horizontal pipe section 1000 feet long has a total energy loss of 26.2 feet. If the inside pipe diameter is 12 inches and the flow velocity is 10 ft/sec, what is the Darcy-Weisbach friction coefficient?

(A) 0.0170
(B) 0.0080
(C) 0.0017
(D) 0.0002
(E) 0.0008

10. The Reynolds number for a 1-foot diameter sphere moving through a fluid (specific gravity of 1.22, absolute viscosity of 0.00122 lb-sec/ft^2) at 10 ft/sec is approximately

(A) 20
(B) 200
(C) 2,000
(D) 20,000
(E) 200,000

11. Water is flowing in a circular pipe between points 1 and 2. The pressure at point 1 is 16.8 psia. The pressure and velocity at point 2 are 17.2 psia and 6.2 ft/sec, respectively. Points 1 and 2 are at the same elevation. Neglecting friction, what is the velocity at point 1?

(A) 97.8 ft/sec
(B) 9.9
(C) 21.0
(D) 1.52
(E) 4.58

12. The critical depth in a rectangular channel 8 feet wide flowing at a critical velocity of 2 ft/sec is approximately

(A) 0.12 feet
(B) 2.00
(C) 4.00
(D) 0.06
(E) 0.08

13. At a certain section of pipe, water is flowing at a pressure of 80 psi and with a linear velocity of 9 ft/sec. What is the total flow work for 1.5 cubic feet of water which pass that section?

(A) 18,000 ft-lb
(B) 36,000
(C) 120
(D) 12,000
(E) 0