Practice Problems for FE Fluid Mechanics

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NCEES FE REFERENCE HANDBOOK, VERSION 9.5

Example 1

A body that weighs 250 N on earth would weigh how much on the moon where $g \cong 1.6$ m/s^2?

(A) 5030 N

(B) 250 N

(C) 40.77 N

(D) 6.2 N

Example 2

A 4200-N force acts on a 250-cm^2 area at an angle of 30° to the normal. The shear stress acting on the area is:

(A) 84 Pa
(B) 84 mPa
(C) 84 kPa
(D) 84 MPa

Example 3

The velocity distribution in a 4-cm-diameter pipe transporting 20°C water is given by $u(r) = 10(1 - 2500r^2)$ m/s. The shearing stress at the wall is nearest:

(A) 1.0 Pa

(B) 0.1 Pa

(C) 0.01 Pa

(D) 0.001 Pa

Example 4

The distance 20°C water would climb in a long 10-μm-diameter, clean glass tube is nearest:

(A) 50 cm
(B) 100 cm
(C) 200 cm
(D) 300 cm

Example 5

The speed of sound of a dog whistle in the atmosphere at a location where the temperature is 50°C is nearest:

(A) 396 m/s
(B) 360 m/s
(C) 332 m/s
(D) 304 m/s

Example 6

A meteorologist states that the barometric pressure is 28.5 inches of mercury. Convert this pressure to kilopascals.

(A) 98.6 kPa
(B) 97.2 kPa
(C) 96.5 kPa
(D) 95.6 kPa

Example 7

Estimate the pressure in the water pipe shown in Fig. P2.3. The manometer is open to the atmosphere.

(A) 10 kPa **(B)** 9 kPa

(C) 8 kPa **(D)** 7 kPa

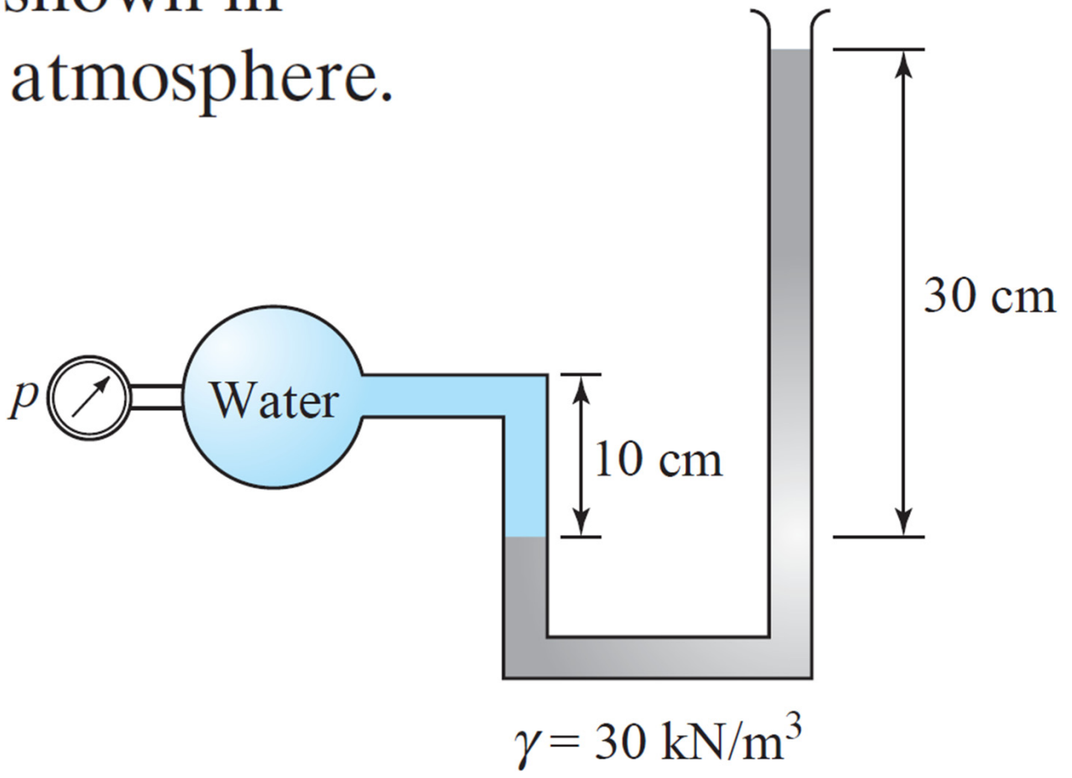


Fig. P2.3

Example 8

The rectangular gate shown in Fig. P2.5 is 3 m wide. The force P needed to hold the gate in the position shown is nearest:

(A) 24.5 kN
(B) 32.7 kN
(C) 98 kN
(D) 147 kN

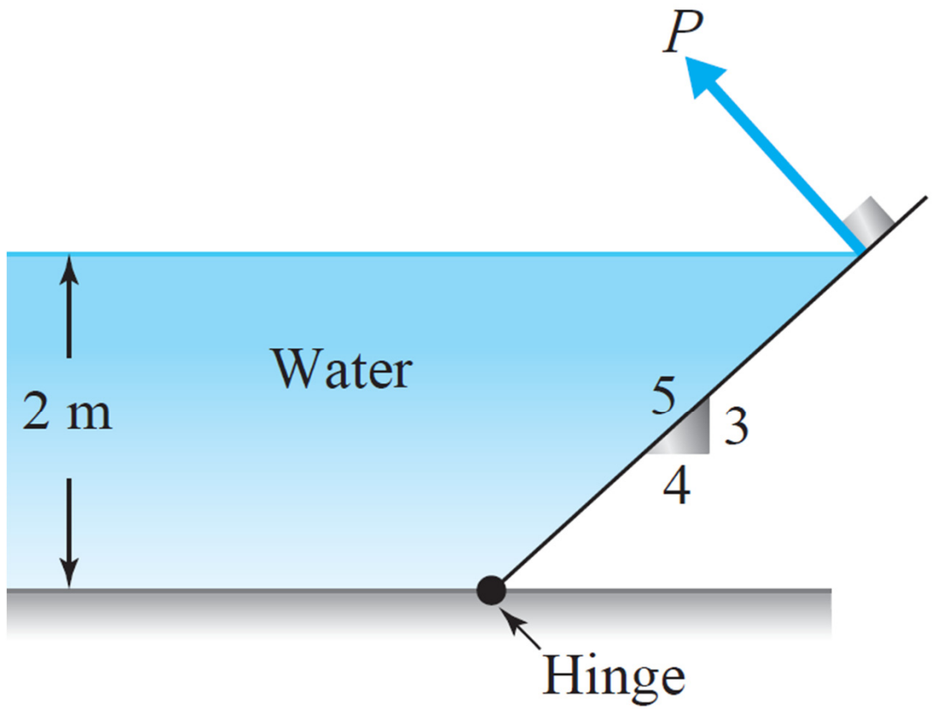


Fig. P2.5

Example 9

A force $P = 300$ kN is needed to just open the gate of Fig. P2.7 with $R = 1.2$ m and $H = 4$ m. How wide is the gate?

(A) 2.98 m
(B) 3.67 m
(C) 4.32 m
(D) 5.16 m

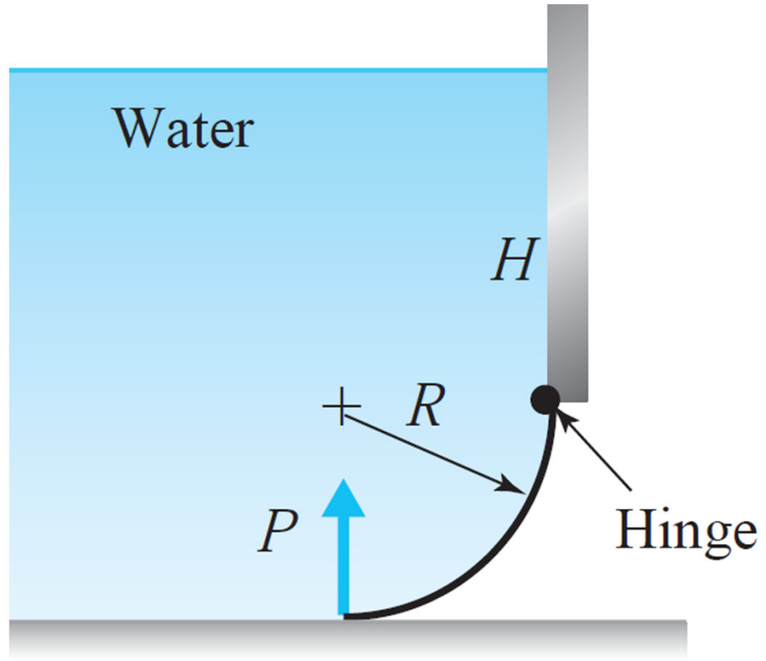


Fig. P2.7

Example 10

The rectangular barge of Fig. P2.8 is known to be 15 m long. A load having a mass of 900 kg is added to the barge causing it to sink 10 mm. How wide is the barge?

(A) 6 m
(B) 9.2 m
(C) 7.5 m
(D) 0.62 m

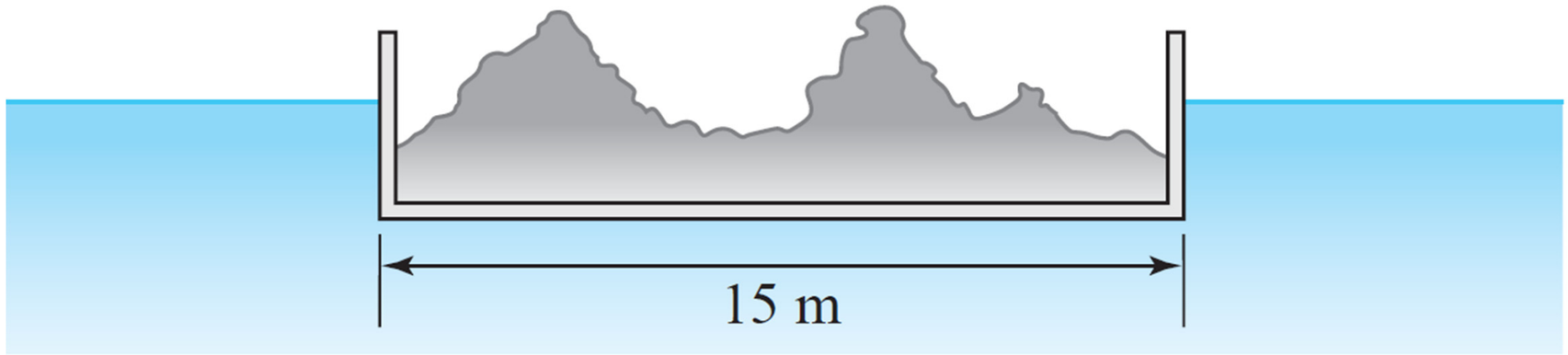


Fig. P2.8

Example 11

The velocity of an airplane is measured with a pitot tube. If the pitot tube measures 800 mm of water, estimate the speed of the airplane. Use $\rho_{air} = 1.23\ kg/m^3$.

(A) 125 m/s

(B) 113 m/s

(C) 80 m/s

(D) 36 m/s

Example 12

A pitot tube measures 600 mm of water in a pipe transporting water. A static pressure probe at the same location measures 200 mm of water. The velocity of water in the pipe is nearest:

(A) 1.10 m/s
(B) 1.98 m/s
(C) 2.8 m/s
(D) 3.43 m/s

Example 13

A water hose is pressurized to 800 kPa with a nozzle in the off position. If the nozzle is opened a small amount, as shown in Fig. P3.8, estimate the exiting velocity of the water. Assume the velocity inside the hose to be negligible.

(A) 40 m/s **(B)** 30 m/s

(C) 20 m/s **(D)** 10 m/s

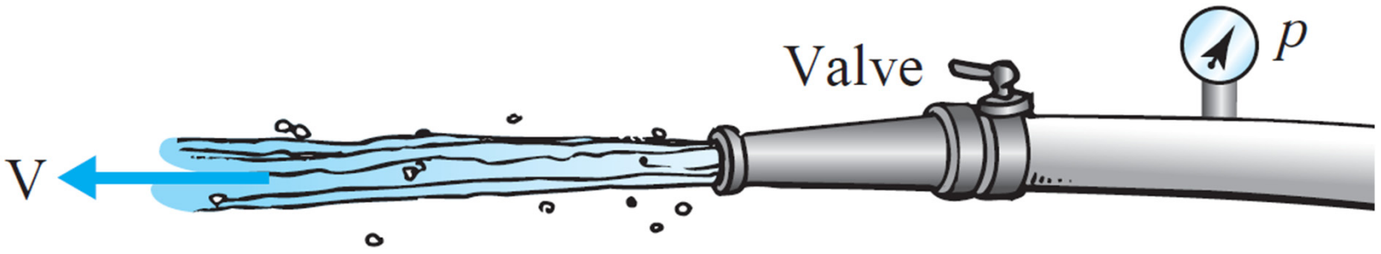


Fig. P3.8

Example 14

What is the energy requirement of an 85% efficient pump that transports 40 L/s of water if the pressure increases from 200 kPa to 1200 kPa?

(A) 4.8 kW

(B) 14.2 kW

(C) 34.0 kW

(D) 47.1 kW

Example 15

A high-speed water jet is used to cut a material. If the velocity issuing from the 2-mm-diameter jet is 120 m/s, the maximum pressure on the material at the point of impact is nearest:

(A) 7200 kPa
(B) 3600 kPa
(C) 735 kPa
(D) 452 kPa

Example 16

Estimate V_1 in Fig. P4.6. Assume the air to be incompressible with $\rho = 1.2$ kg/m^3.

(A) 62 m/s **(B)** 40 m/s

(C) 18 m/s **(D)** 10 m/s

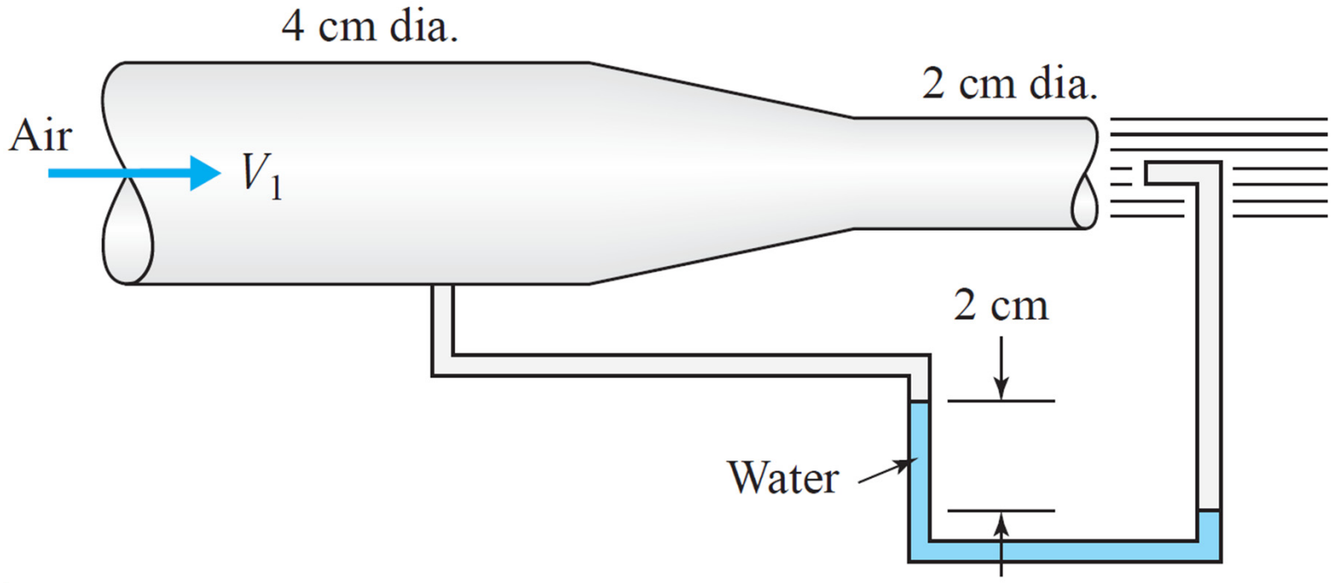


Fig. P4.6

Example 17

The pressure drop across a valve, through which 40 L/s of water flows is measured to be 100 kPa. Estimate the loss coefficient if the nominal diameter of the valve is 8 cm.

(A) 0.79

(B) 3.2

(C) 8.7

(D) 31

Example 18

An 89%-efficient pump is inserted in a 4-cm-diameter line transporting 40 L/s of water. A pressure rise of 400 kPa is desired. The power required by the pump is nearest:

(A) 12 kW
(B) 16 kW
(C) 18 kW
(D) 22 kW

Example 19

A hydroturbine generates power by transporting 0.2 m^3/s of water from a dam. The water surface is 10 m above the turbine outlet. the overall loss co-efficient for the 24-cm-diameter connecting pipe is 3.2. The maximum turbine output is nearest:

(A) 42 kW
(B) 21 kW
(C) 18 kW
(D) 13 kW

Example 20

A 75%-efficient pump delivers 0.1 m^3/s of water from a reservoir to a device at an elevation of 50 m above the reservoir. The pressure at the 8-cm-diameter entrance to the device is 180 kPa. If the piping loss coefficient is 5.6, the necessary power input to the pump is nearest:

(A) 263 kW **(B)** 203 kW

(C) 121 kW **(D)** 91.3 kW

Example 21

A strong wind blows directly against a window on a building. The force on the window can be approximated using:

(A) Bernoulli's equation
(B) The continuity equation
(C) The momentum equation
(D) All of the above

Example 22

A nozzle with an exit diameter of 4 cm is attached to a 10-cm-diameter pipe transporting 0.1 m^3/s of water. The force the water exerts on the nozzle is nearest:

(A) 6.7 kN
(B) 12.2 kN
(C) 17.5 kN
(D) 24.2 kN

Example 23

A 1 cm × 20 cm sheet of water is deflected as shown in Fig. P4.13. The magnitude of the total force acting on the stationary deflector is nearest:

(A) 6830 N **(B)** 5000 N

(C) 4330 N **(D)** 2500 N

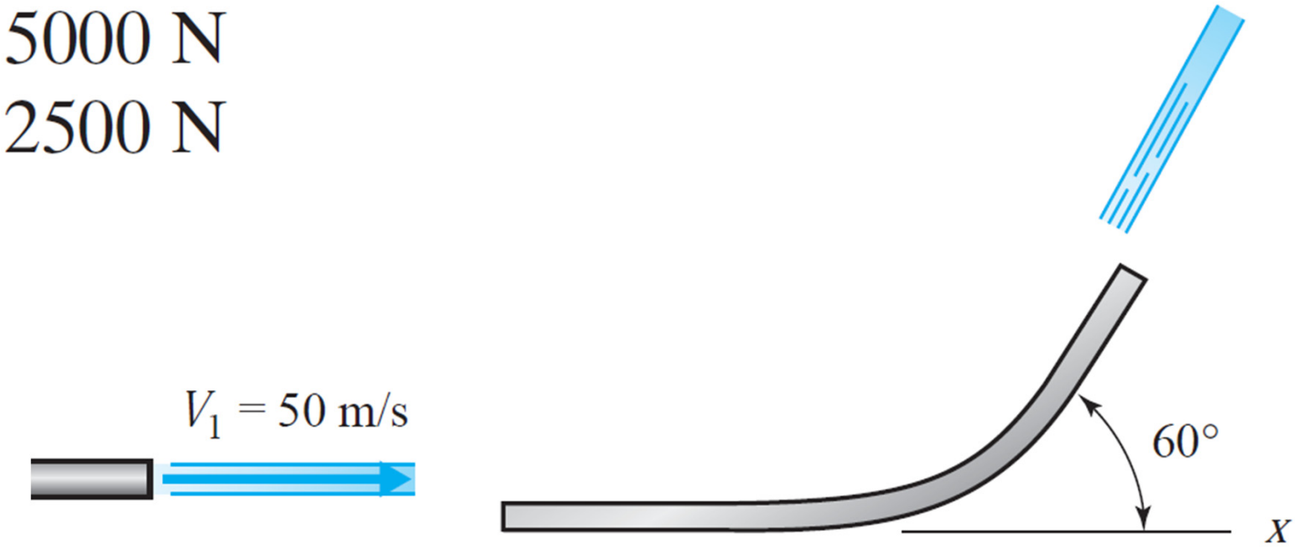


Fig. P4.13

Example 24

A large vehicle in Fig. P4.15 is slowed by lowering a 2-m-wide scoop into a reservoir of water. Estimate the force exerted on the scoop if the vehicle is traveling at 60 m/s and it scoops off 5 cm of water? The scoop diverts the water through 180°.

(A) 720 kN **(B)** 360 kN

(C) 12 kN **(D)** 7.2 kN

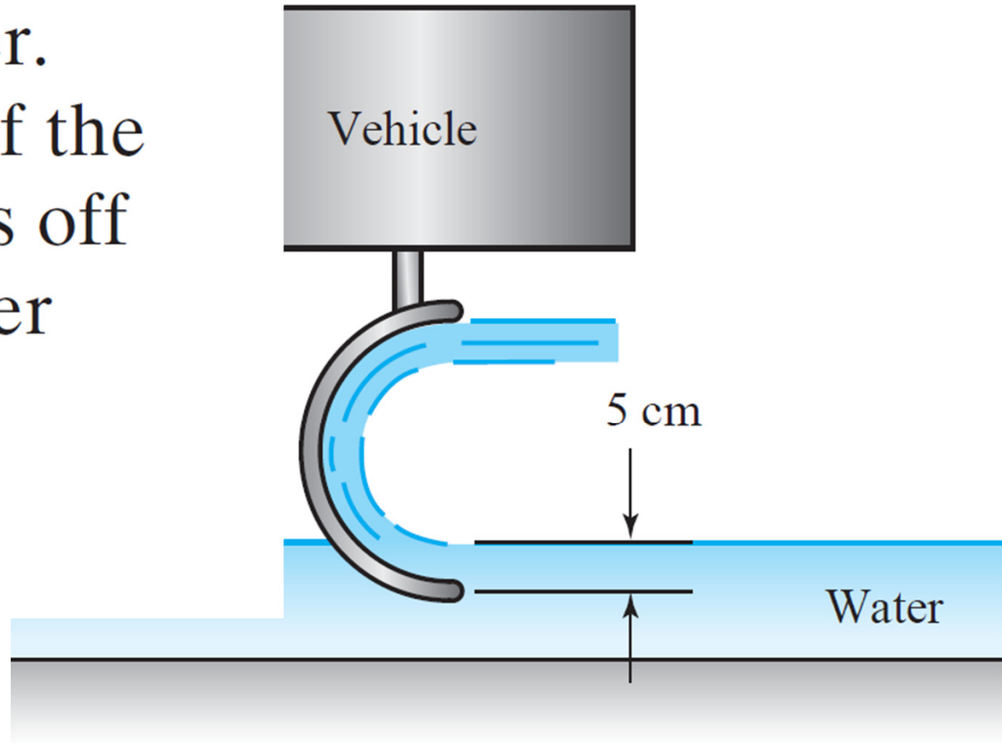


Fig. P4.15

Example 25

What velocity should be selected in a wind tunnel where a 9:1 scale model of an automobile is to simulate a speed of 12 m/s? Neglect compressibility effects.

(A) 108 m/s
(B) 12 m/s
(C) 4 m/s
(D) 1.33 m/s

Example 26

What upstream velocity should be selected in a 16:1 scale model of a levee which has an upstream velocity of 2 m/s?

(A) 2 m/s
(B) 1 m/s
(C) 0.5 m/s
(D) 0.25 m/s

Example 27

A force of 10 N is measured on a 25:1 scale model of a ship tested in a water channel. What force should be expected on the protype ship? Neglect viscous effects.

(A) 156 kN
(B) 62.5 kN
(C) 6250 N
(D) 250 N

Example 28

All of these principles are likely to be applied to determine the flow in a pipeline except:

A) conservation of momentum
B) minor losses
C) Darcy-Weisbach
D) Hazen-Williams
E) energy balance
F) conservation of mass (continuity)

Example 29

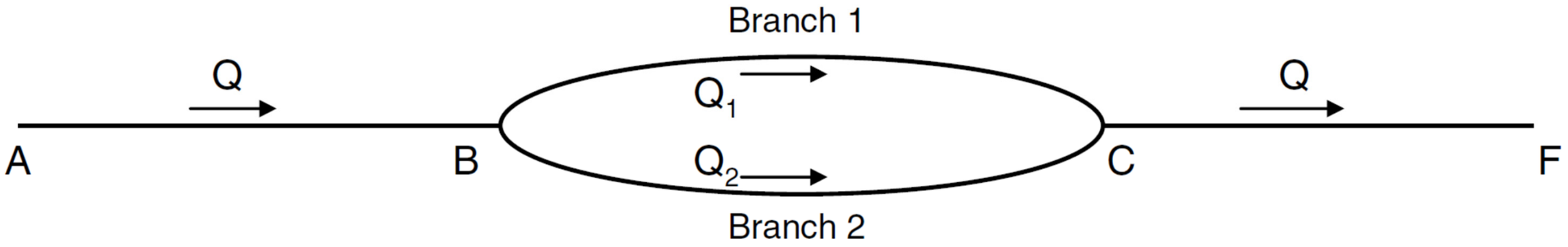
Which of the following methods can be used to determine friction loss in pipelines?

A) Darcy-Weisbach
B) Manning
C) Hazen-Williams
D) A, B, and C
E) A and B only
F) A and C only
G) B and C only
H) none of the above

Example 30

In the pipe system depicted below, the discharge in pipe AB is 100 m^3/sec. Branch 1 is 500 m long, and it has a diameter of 2 m and a friction factor of 0.018. Branch 2 has a length of 400 m, diameter of 3 m, and a friction factor of 0.02. Determine the length of an equivalent pipe to replace branches 1 and 2 assuming the pipe diameter is 3 m and f = 0.02.

A) 222 m B) 432 m C) 832 m D) 112 m



Example 31

To avoid cavitation in a pump, one of the few items that a designer has control over is the

A) vapor pressure
B) velocity head
C) position of the pump
D) suction line head losses

Example 32

The maximum velocity near the tip of impeller vanes is an important parameter in assessing pump cavitation potential. It is normally supplied by the pump manufacturers using the term:

A) total suction head
B) tip velocity
C) cavitation parameter
D) net positive suction head

Example 33

A new design of a valve is to be tested. Which of the following parameters is the most important if liquid benzene flows through the valve?

(A) Froude number
(B) Reynolds number
(C) Mach number
(D) Euler number

Example 34

Water flows in a 2.4-m-wide, rectanglular, finished concrete channel at a depth of 80 cm. If the slope is 0.002, the flow rate is nearest

(A) 2.2 m^3/s

(B) 3.4 m^3/s

(C) 4.6 m^3/s

(D) 6.2 m^3/s

Example 35

Estimate the takeoff speed needed for a 1200-kg aircraft (including payload) if the angle of attack at takeoff is to be 10°. The effective wing area (chord times length) is 16 m^2. The lift coefficient for an angle of attack of 10° is 1.1.

(A) 22 m/s
(B) 33 m/s
(C) 44 m/s
(D) 55 m/s