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General Physics I, Quiz 5
PHYS10400, Class year100
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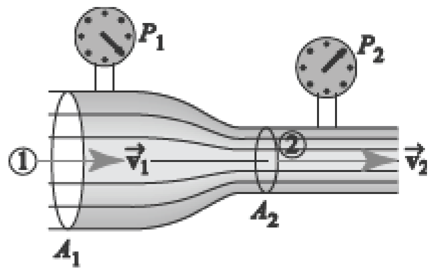
Solution Q5

Chapter 12-14, Serway; ABSOLUTELY NO CHEATING!
Please write the answers on the blank space or on the back of this paper to save resources.

1. (a) Since the tube is horizontal, $y_1 = y_2$ and the gravity terms in Bernoulli's equation cancel, leaving



ANS FIG. P14.47

$$P_1 + \frac{1}{2}\rho\upsilon_1^2 = P_2 + \frac{1}{2}\rho\upsilon_2^2$$

or

$$\upsilon_2^2 - \upsilon_1^2 = \frac{2(P_1 - P_2)}{\rho} = \frac{2(1.20\times10^3\,\text{Pa})}{7.00\times10^2\ \text{kg/m}^3}$$

and

$$\upsilon_2^2 - \upsilon_1^2 = 3.43\ \text{m}^2/\text{s}^2 \qquad [1]$$

From the continuity equation, $A_1\upsilon_1 = A_2\upsilon_2$, we find

$$\upsilon^2 = \left(\frac{A_1}{A_2}\right)\upsilon_1 = \left(\frac{r_1}{r_2}\right)^2 \upsilon_1 = \left(\frac{2.40\,\text{cm}}{1.20\,\text{cm}}\right)^2 \upsilon_1$$

or

$$\upsilon_2 = 4\upsilon_1 \qquad [2]$$

Substitution Equation [2] into [1] yields $15\upsilon_1^2 = 3.43\text{m}^2/\text{s}^2$ and $\upsilon_1 = 0.478\,\text{m/s}$.

Then, Equation [2] gives $\upsilon_2 = 4(0.478\,\text{m/s}) = 1.91\,\text{m/s}$.

(b) The volume flow rate is

$$A_1\upsilon_1 = A_2\upsilon_2 = (\pi r_2^2)\upsilon_2 = \pi(1.20\times10^{-2}\ \text{m})^2(1.91\,\text{m/s}) = 8.64\times10^{-4}\ \text{m}^3/\text{s}$$

2.

Find the mass of the space station from its weight at the surface of the Earth:

$$m = \frac{F_g}{g} = \frac{4.22\times10^6\ \text{N}}{9.80\ \text{m/s}^2} = 4.31\times10^5\ \text{kg}$$

Use Equation 13.6 with h = 350 km to find g at the orbital location:

$$g = \frac{GM_E}{(R_E + h)^2}$$

$$= \frac{(6.67\times10^{-11}\,\text{N}\cdot\text{m}^2/\text{kg}^2)(5.97\times10^{24}\ \text{kg})}{(6.37\times10^6\,\text{m}+0.350\times10^6\,\text{m})^2} = 8.82\ \text{m/s}^2$$

Use this value of g to find the space station's weight in orbit:

$$mg = (4.31\times10^5\ \text{kg})(8.82\ \text{m/s}^2) = 3.80\times10^6\,\text{N}$$

3.

(a)
Vertical forces on one-half of the chain:

$$T_e \sin 42.0° = 20.0\ \text{N} \qquad \boxed{T_e = 29.9\ \text{N}}$$

(b)
Horizontal forces on one-half of the chain:

$$T_e \cos 42.0° = T_m \qquad \boxed{T_m = 22.2\ \text{N}}$$