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General Physics I, Quiz 4
PHYS10400, Class year 99
11-18-2010

SN:_______________, Name:________________

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.

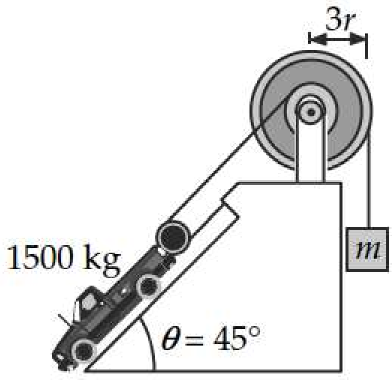
$$\sum \tau = 0 = mg(3r) - Tr$$

$$2T - Mg\sin 45.0° = 0$$

$$T = \frac{Mg\sin 45.0°}{2} = \frac{1\,500\text{ kg}(g)\sin 45.0°}{2}$$

$$= (530)(9.80)\text{ N}$$

$$m = \frac{T}{3g} = \frac{530g}{3g} = \boxed{177\text{ kg}}$$



ANS FIG. P12.9

2.

$$E_{\text{tot}} = -\frac{GMm}{2r}$$

$$\Delta E = \frac{GMm}{2}\left(\frac{1}{r_i} - \frac{1}{r_f}\right) = \frac{(6.67\times10^{-11})(5.98\times10^{24})}{2}\frac{10^3\text{ kg}}{10^3\text{ m}}\left(\frac{1}{6\,370+100} - \frac{1}{6\,370+200}\right)$$

$$\Delta E = 4.69\times10^8\text{ J} = \boxed{469\text{ MJ}}$$

3.

The air outside and water inside both exert atmospheric pressure, so only the excess water pressure ρgh counts for the net force. Take a strip of hatch between depth h and $h + dh$. It feels force

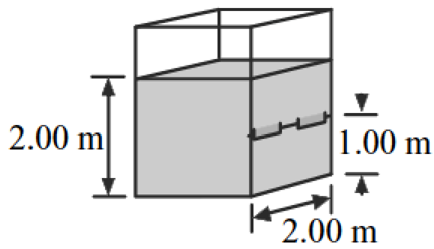
$$dF = PdA = \rho gh(2.00\text{ m})dh$$

The total force is

$$F = \int dF = \int_{h=1.00\text{ m}}^{2.00\text{ m}} \rho gh(2.00\text{ m})dh$$

$$F = \rho g(2.00\text{ m})\frac{h^2}{2}\Bigg|_{1.00\text{ m}}^{2.00\text{ m}} = (1000\text{ kg/m}^3)(9.80\text{ m/s}^2)\frac{(2.00\text{ m})}{2}\left[(2.00\text{ m})^2 - (1.00\text{ m})^2\right]$$

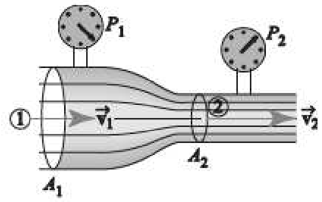
$$F = \boxed{29.4\text{ kN (to the right)}}$$



ANS FIG. P14.13

4.

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



ANS FIG. P14.47

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

or

$$v_2^2 - v_1^2 = \frac{2(P_1 - P_2)}{\rho} = \frac{2(1.20 \times 10^3 \text{ Pa})}{7.00 \times 10^2 \text{ kg/m}^3}$$

and

$$v_2^2 - v_1^2 = 3.43 \text{ m}^2/\text{s}^2 \qquad [1]$$

From the continuity equation, $A_1 v_1 = A_2 v_2$, we find

$$v_2 = \left(\frac{A_1}{A_2}\right) v_1 = \left(\frac{r_1}{r_2}\right)^2 v_1 = \left(\frac{2.40 \text{ cm}}{1.20 \text{ cm}}\right)^2 v_1$$

or

$$v_2 = 4v_1 \qquad [2]$$

Substituting Equation [2] into [1] yields $15v_1^2 = 3.43 \text{ m}^2/\text{s}^2$ and $v_1 = 0.478$ m/s. Then, Equation [2] gives $v_2 = 4(0.478 \text{ m/s}) = \boxed{1.91 \text{ m/s}}$.

(b) The volume flow rate is

$A_1 v_1 = A_2 v_2 = (\pi r_2^2)\, v_2 = \pi\,(1.20 \times 10^{-2} \text{ m})^2\,(1.91 \text{ m/s}) = \boxed{8.64 \times 10^{-4} \text{ m}^3/\text{s}}$