**057:20 TEST # 2 Fall 2003**

**Prob. 1**

**Information and assumptions**

Provided in problem statement

**Find**

Deflection of manometer

**Solution**

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Continuity equation

$$V_1 A_1 = V_2 A_2$$ (Eqn. = 2)

$$V_2 = V_1 \left( A_1 / A_2 \right)$$

$$= 100 \times (2)$$

$$= 200 \; ft/s$$ (Inter. + Ans. = 1)

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Bernoulli equation from 1 to 2

$$p_1 + \rho V_1^2/2 = p_2 + \rho V_2^2/2$$ (Eqn. = 4)

$$p_1 - p_2 = (1/2)\rho\left(V_2^2 - V_1^2\right)$$

$$= (1/2)(0.0644/32.2)\left(200^2 - 100^2\right)$$

$$= 30 \, psf$$ (Inter. + Ans. = 1)

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Manometer equation for deflection

$$p_1 - p_2 = \Delta h\left(\gamma_{liquid} - \gamma_{air}\right)$$ (Eqn. = 1)

$$30 = \Delta h(120 - 0.0644)$$

$$\Delta h = 0.25 \, ft$$ (Inter. + Ans. = 1)

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**057:**20 **TEST # 2** **Fall 2003**

**Prob. 2**

**Information and assumptions**

Provided in problem statement

**Find**

Vertical component of force exerted by anchor on bend

**Solution**

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Velocity calculation

$$v = Q/A$$ (Eqn. = 3)

$$= 31.4/(\pi \times 1 \times 1)$$

$$= 9.995\ ft/s$$ (Inter. + Ans. = 1)

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Y-momentum

$$\sum F_y = \rho Q\left(v_{2y} - v_{1y}\right)$$ (Eqn. = 3)

$$F_a - W_{water} - W_{bend} - p_2 A_2 \sin 30^o = \rho Q\left(v \sin 30^o - v \sin 0^o\right)$$ (Eqn. = 2)

$$F_a = (\pi \times 1 \times 1 \times 4 \times 62.4) + (300) + 8.5 \times 144 \times \pi \times 1 \times 1 \times 0.5$$

$$+ \left[1.94 \times 31.4 \times (9.995 \times 0.5 - 0)\right]$$

$$F_a = 3{,}310 lbf$$ (Inter. + Ans. = 1)

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**Prob. 3**

**Information and assumptions**

Provided in problem statement

**Find**

Power supplied to water pump

**Solution**

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Velocity calculation

$$V = Q/A$$ (Eqn. = 1)

$$= 3.0 / \left( (\pi/4) \times (2/3)^2 \right)$$

$$= 8.59 \ ft/s$$ (Inter. + Ans. = 1)

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Loss calculation

$$h_L = 0.015 \times (3000/(2/3)) \times (8.59)^2 / (2 \times 32.2)$$

$$+ (8.59)^2 / (2 \times 32.2)$$ (Eqn. = 1)

$$= 78.5 \, ft$$ (Inter. + Ans. = 1)

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Energy equation from water surface to water surface

$$p_1/\gamma_1 + V_1^2/2g + z_1 + h_p = p_2/\gamma_2 + V_2^2/2g + z_2 + h_L$$ (Eqn. = 3)

$$0 + 0 + 90 + h_p = 0 + 0 + 140 + 78.5$$

$$h_p = 128.5 \, ft$$ (Inter. + Ans. = 1)

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Power supplied to water pump

$$P = Q\gamma h_p$$

$$= 3.0 \times 62.4 \times 128.5$$

$$= 24{,}055 \ ft\text{-}lbf/s$$

$$P = 24{,}055/550 = 43.7 \, hp$$ (Eqn.+ Ans. = 1)

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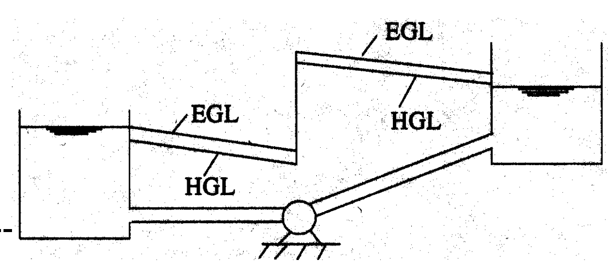
HGL and EGL figure




(Ans. = 1)

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**Prob. 4**

**Information and assumptions**

Provided in problem statement

**Find**

The $\pi$-groups

**Solution**

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Using the step-by-step method: $n - m = 5 - 3 = 2$ $\pi$-groups

$$\begin{array}{|lll||lll||lll||lll|}
n & \frac{1}{T} & & n & \frac{1}{T} & & n & \frac{1}{T} & & \frac{nd}{V} & 0 & (+1) \\
V & \frac{L}{T} & (+1) & \frac{V}{d} & \frac{1}{T} & (+1) & \frac{V}{d} & \frac{1}{T} & (+1) & & & \\
d & L & (+1) & & & & & & & & & \\
\rho & \frac{M}{L^3} & (+1) & \rho d^3 & M & (+1) & & & & & & \\
\mu & \frac{M}{LT} & & \mu d & \frac{M}{T} & (+1) & \frac{\mu}{\rho d^2} & \frac{1}{T} & (+1) & \frac{\mu}{\rho V d} & 0 & (+1)
\end{array}$$

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There are other possible solutions.
The final functional form is

$$\frac{nd}{V} = f\left(\frac{\mu}{Vd\rho}\right)$$

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