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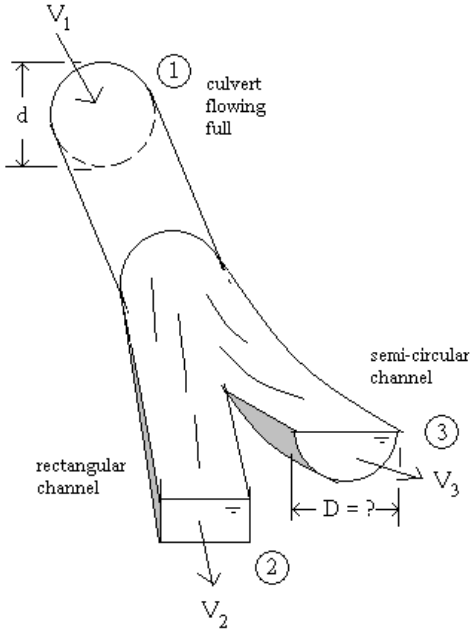
[1]. A culvert with a diameter $d = 2\text{-}ft$, flowing full (section 1), carries water at a speed $V_1 = 2.5\ ft$. The culvert then splits into two open-channel flows. One of the channels is rectangular (section 2) with a width $B = 1.5\ ft$, a depth $y = 0.5\ ft$ and carries water flowing at a speed $V_2 = 1.5\ ft/s$. The second open channel (section 3) has a semi-circular cross-section of diameter D and carries water at a speed $V_3 = 2.0\ ft/s$. Determine the diameter D of the semi-circular cross-section.



Solution: $D =$ _____

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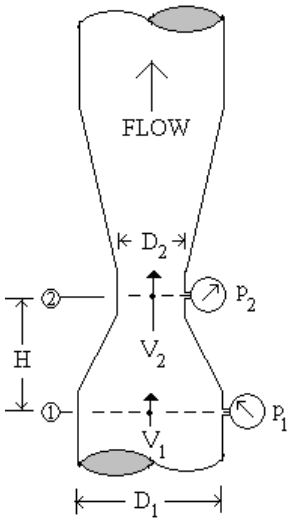
[2]. A Venturi meter is installed in a vertical pipe as shown in the figure below. The flowing fluid is water (specific weight, $\gamma = 62.4\ lb/ft^3$) and the flow is vertically upwards. The diameters of the pipe and of the Venturi meter's throat are $D_1 = 12\ in$, and $D_2 = 9\ in$, respectively. Bourdon manometers attached at sections 1 and 2 show readings of $p_1 = 42\ psi$, and $p_2 = 30\ psi$. The manometers are separated by a vertical distance $H = 36\ in$. Assuming no friction losses in the system, calculate the water discharge through the Venturi meter.



Solution: $Q =$ _____.

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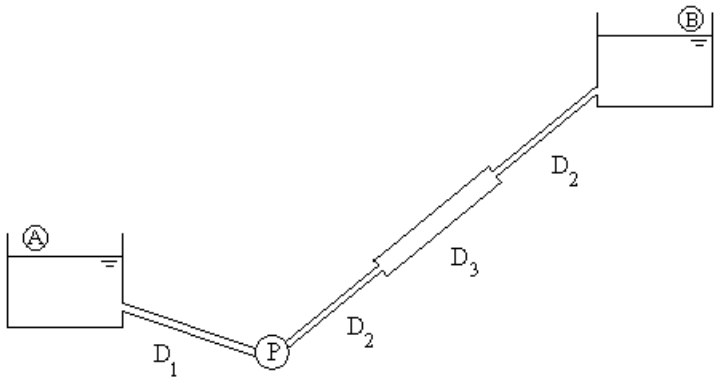
[3]. For the system shown below, with $D_1 = 9$ *in*, $D_2 = 6$ *in*, and $D_3 = 18$ *in*, determine the power provided by the pump (in *hp*) if the elevations of the free surface in reservoirs A and B are *50 ft* and *200 ft*, respectively. The pump is located at elevation *10 ft,* and the discharge through the system is *2.0 cfs*. The friction losses in the pipe upstream of the pump add up to *8 ft* while those in the pipe downstream of the pump add up to *10 ft*. Neglect all minor losses (expansions, contractions, etc.) except the discharge loss into reservoir B. The flowing fluid is water (specific weight $\gamma = 62.4\ lb/ft^3$).



Solution: Pump power, P = _____

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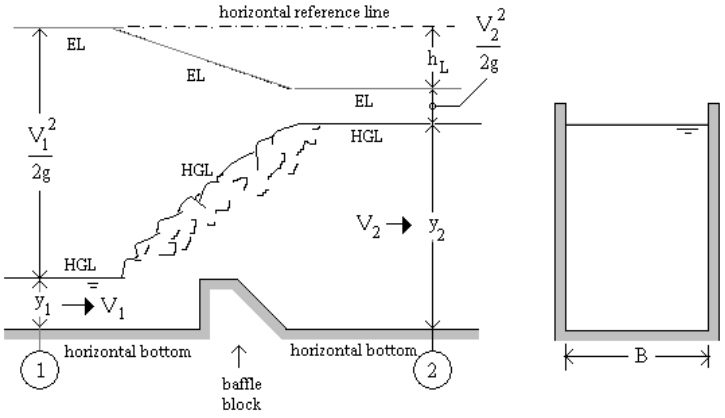
[4]. A hydraulic jump in a rectangular channel of width $B = 3\ ft$ is triggered by a baffle block as shown in the figure below. Determine the force (magnitude and direction) that the flow exerts on the baffle block if the flow depth at sections 1 and 2 are $y_1 = 1\ ft$ and $y_2 = 4\ ft$, respectively, and the energy head lost in the jump is $h_L = 2.5\ ft$. The specific weight of water is $\gamma = 62.4\ lb/ft^3$.

Use page 5 of the exam to complete calculations if needed.



Solution: $F =$ _____

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[5] continued...