Math Field Day 2012 Short Course Event Names _____CALCS KEY_____

48 points total School _____

Scores
part one: number correct_____ x 4 = _____ minus number wrong _____ = _____(A)

Part one Instructions: Work in teams of two. You should use the formulas, constants, and conversion factors provided and your notes. Record your answers by circling the letter to the right. Each correct answer worth 4 points; one point will be deducted for each wrong answer. (Maximum score on part 1 is 24 points.)

	In problems 1 through 6 you are to **choose the closest answer**.	Circle the letter of the correct answer
1.	Continuity: $Q = AV$ $\Rightarrow \quad Q = \left[(\pi)\left(\frac{3}{12}^2\right)/4 \right] ft^2 \times 10\frac{ft}{s} \times 60\frac{s}{\min} \times 7.48\frac{gal}{ft^3} = 220.3\ gpm$ $(a)\ 22 \quad (b)\ 36 \quad (c)\ 220 \quad (d)\ 361 \quad (e)\ 440$	$a \quad b \quad <c> \quad d \quad e$
2.	Continuity: $500gpm \times \frac{1\min}{60\sec} \times \frac{1ft^3}{7.48gal} = 1.114cfs$ $\Rightarrow \quad V_6 = \frac{A_{12}V_{12}}{A_6} = \frac{Q}{A_6} = \frac{1.114}{\pi/4(1/2)^2} = 5.67\ ^{ft}/_{\sec}$ $(a)\ 1.42 \quad (b)\ 14.2 \quad (c)\ 5.67 \quad (d)\ 9.20 \quad (e)\ 56.7$	$a \quad b \quad <c> \quad d \quad e$
3.	Unit Conversion: $28\frac{mg}{day} \times 10^6\ \frac{gal}{mg} \times \frac{1ft^3}{7.48gal} \times \frac{1day}{24 \times 3600\sec} = 43.33cfs$ $(a)\ 1.55cfs \quad (b)\ 15.5cfs \quad (c)\ 23.7cfs \quad (d)\ 31.5cfs \quad (e)\ 43.4cfs$	$a \quad b \quad c \quad d \quad <e>$
4.	Darcy-Weisbach: $h_L = f\left(\frac{L}{d}\right)\left(\frac{V^2}{2g}\right) = f\left(\frac{L}{d}\right)\frac{(Q/A)^2}{2g} = .0155\left(\frac{1000}{d}\right)\left(\frac{(12/\pi^2/4)^2}{2(32.2)}\right) = 4$ Solve for d or use solver $\Rightarrow \quad d = 1.696\,ft \quad \Rightarrow \quad d = 20.3in$ $(a)\ 12in \quad (b)\ 15in \quad (c)\ 18in \quad (d)\ 21in \quad (e)\ 24in$	$a \quad b \quad c \quad <d> \quad e$
5.	Velocity head and static head: $h_s = \frac{V^2}{2g} \quad \Rightarrow \quad V = \sqrt{2gh_s}$ $\Rightarrow \quad V = \sqrt{2(32.2)10} = \quad 25.38\ ^{ft}/_{\sec}$ $(a)\ 12.2 \quad (b)\ 17.9 \quad (c)\ 25.4 \quad (d)\ 29.2 \quad (e)\ 35.8$	$a \quad b \quad <c> \quad d \quad e$
6.	Unit Conversion: $V = \frac{Q}{A} = \frac{3\frac{gal}{\min} \times \frac{1\min}{60\sec} \times \frac{1ft^3}{7.48gal}}{\pi/4 \times (.5/12)^2\ ft^2} = 4.9\frac{ft}{\sec}$ $(a)\ 1. \quad (b)\ 5. \quad (c)\ 10. \quad (d)\ 20. \quad (e)\ 50.$	$a \quad <b> \quad c \quad d \quad e$

(over)

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part two: number correct_____ x 4 = _____ minus number wrong _____ = _____(B)

Part two Instructions: Work in teams of two. You should use the formulas, constants, and conversion factors provided and your notes. Record your answers by circling the letter to the right. Each correct answer worth 4 points; one point will be deducted for each wrong answer. (Maximum score on part 2 is 24 points.)

	In problems 7 through 12 you are to **choose the closest answer**.	Circle the letter of the correct answer
7.	Energy equation: (Static heads are equal and so cancel; $h_L = 0$.) $v_1 = Q/A_1 = 125.6/\left[(\pi)(2)^2/4\right] = 39.98\ ft/s$ *and* $v_2 = 4.44\ ft/s$ $\frac{p_1}{w} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{w} + \frac{v_2^2}{2g} + z_2 + h_L \Rightarrow$ $\Rightarrow 18 + 39.98^2/(2\times 32.2) + 0 = p_2/w + 4.44^2/(2\times 32.2) + 0 + 0$ $\Rightarrow p_2/w = 42.5\ ft$ $(a)\ 3.5$ $(b)\ 15.0$ $(c)\ 28.5$ $(d)\ 42.5$ $(e)\ 57.5$	a b c $<d>$ e
8.	Hydraulic Jump: $q^2/g = \frac{1}{2}y_1y_2(y_1+y_2) \Rightarrow (192/16)^2/32.2 = 2.10y_1(y_1+4.20)$ $\Rightarrow y_1 = 0.455$ $(a)\ 0.213$ $(b)\ 0.455$ $(c)\ 1.10$ $(d)\ 1.39$ $(e)\ 1.51$	a $<b>$ c d e
9.	Loss of head in Hydraulic Jump = $E_1 - E_2$ $A_1 = 16(0.455) = 7.29\ ft^2$, $V_1 = 192/7.29 = 26.3\ ft/\sec$ $A_2 = 16(4.20) = 67.2\ ft^2$, $V_2 = 192/67.2 = 2.86\ ft/\sec$ $E_1 = (26.3)^2/2g + 0.455 = 11.18\ ft$, $E_2 = (2.86)^2/2g + 4.20 = 4.33\ ft$ $11.18 - 4.33 = 6.85\ ft$ $(a)\ 1.19$ $(b)\ 3.49$ $(c)\ 6.85$ $(d)\ 8.22$ $(e)\ 11.18$	a b $<c>$ d e
10.	Manning formula: $Q = A\frac{1.486}{n}R^{2/3}S^{1/2}$ $6.00 = \frac{\pi}{2}\left(\frac{1.486}{.013}\right)\left(\frac{1}{2}\right)^{2/3}S^{1/2}$ solve for S or use solver $\Rightarrow S = .00281$ $(a)\ .0004$ $(b)\ .0008$ $(c)\ .0009$ $(d)\ .0012$ $(e)\ .0028$	a b c d $<e>$
11.	Manning formula: $Q = A\frac{1.486}{n}R^{2/3}S^{1/2}$ $500 = 6w\left(\frac{1.486}{.010}\right)\left(\frac{6w}{w+12}\right)^{2/3}(.0004)^{1/2}$ use solver $\Rightarrow$ $w = 13.1\ ft$ $(a)\ 6.2\ ft$ $(b)\ 10.1\ ft$ $(c)\ 13.1\ ft$ $(d)\ 15.6\ ft$ $(e)\ 19.2\ ft$	a b $<c>$ d e
12.	Hydraulic Radius: $R = \frac{A}{wp} = \frac{circle - (\text{sec}tor - triangle)}{Arc}$ $R = \frac{A}{wp} = \frac{\pi d^2/4 - \left(d^2/4 \times 2\cos^{-1}(.8)/2\right) - \frac{1}{2}\times .6d \times .4d)}{\pi d - 2\cos^{-1}(.8)\times d/2} = .298d$ $(a)\ 0.298d$ $(b)\ 0.304d$ $(c)\ 0.632d$ $(d)\ 0.98d$ $(e)\ 1.50d$	$<a>$ b c d e