

Allowed Materials: F.E. approved calculator(s) see syllabus; pencils and/or pens.

ExamForm := 23

Honor Statement: On my honor, I promise that I have not received any unauthorized assistance on this exam (I didn't look at another student's paper, I didn't view any unauthorized written materials, I didn't talk or listen to another student, I didn't use an unauthorized calculator, I didn't use any electronic device, any visual or auditory signals, or any other techniques of exchanging information with others.) I have maintained the highest standards of academic integrity while completing this exam.

Signed: _____

0. (5 point deduction for failure to complete this problem!)

- Write in all of the indicated information in the boxes of your response form.
- Darken the appropriate circles to encode the corresponding information.
- Write your name on this exam and sign the Honor Statement.

Bubble:	For Course	Section:
91	H01 - Cronk	TR 2-3:50
92	H02 - Swanbom	TR 8-9:50
93	H03 - Cronk	MW 2-3:50
94	H04 - Harbour	MW 4-5:50
95	H05 - Reeves	TR10-11:50
96	H06 - Easley	MW10-11:50
97	H07 - Harbour	MW12-1:50
01	001 - Reis	MW10-11:50
02	002 - Orr	MW 2-3:50
03	003 - Hall/Pathak	TR 2-3:50
04	004 - Wallace	MW 8-9:50
05	005 - Reeves	TR 4-5:50
06	006 - Dressel	TR 12-1:50
07	007 - Tranter	MW 12-1:50
08	008 - Reis	MW 4-5:50
09	009 - Wallace	TR 12-1:50

Notes:

- If your last name is too long, just write the first 10 letters.
- "F.I." and "M.I." are your first and middle initials, respectively
- Your "Username" is the first part of your LATech email address
- For "Section" use the guide provided to the right
- Your "Exam Form" is printed on the upper right corner of this page.
- Indicate "ENGR" as the "Program"

Exam Form		Program	
<input type="radio"/>	BIEN	<input type="radio"/>	FIEN
<input type="radio"/>	CMEN	<input type="radio"/>	
<input type="radio"/>	CVEN	<input type="radio"/>	
<input type="radio"/>	CVTE	<input type="radio"/>	
<input type="radio"/>	CYEN	<input type="radio"/>	

Last Name	F.I.	M.I.	LA Tech Username	Course #	Section (last 2 digits)
<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input type="radio"/>

1. (3 points) When measuring the electrical input during the centrifugal pump testing, one multimeter was connected in _____ to measure voltage and another mulimeter was connected in _____ to measure the current.

- Choices =
- "A" "parallel, parallel"
 - "B" "horizontal, vertical"
 - "C" "vertical, series"
 - "D" "series, series"
 - "E" "series, vertical"
 - "F" "series, parallel"
 - "G" "parallel, series"
 - "H" "acute, series"

2. (3 points) The tutorial given on the LWTL website for modeling an impeller employed the _____ tool on the Sketch toolbar to draw the 2D profile of a curved impeller blade.

- Choices =
- "A" "trapezoid"
 - "B" "parallel"
 - "C" "revolve"
 - "D" "spline"
 - "E" "extruded boss"
 - "F" "vertical"
 - "G" "square"
 - "H" "IPS"



3. (3 points) Regarding the pump testing, the units "L/min" refer to which variable?

Choices = $\left(\begin{array}{l} \text{"A"} \quad \text{"v"} \\ \text{"B"} \quad \text{"Q"} \\ \text{"C"} \quad \text{"d"} \\ \text{"D"} \quad \text{"\rho"} \\ \text{"E"} \quad \text{"t"} \\ \text{"F"} \quad \text{"V"} \\ \text{"G"} \quad \text{"I"} \\ \text{"H"} \quad \text{"h"} \end{array} \right)$



4. (3 points) The best description of efficiency in reference to the pump testing, can be described as:

Choices = $\left(\begin{array}{l} \text{"A"} \quad \text{"difference of energy input and energy output"} \\ \text{"B"} \quad \text{"difference of potential and kinetic energy"} \\ \text{"C"} \quad \text{"summation of system energies over electrical energy"} \\ \text{"D"} \quad \text{"summation of electrical input and potential energy divided by kinetic energy"} \\ \text{"E"} \quad \text{"summation of kinetic and potential energies divided by electrical input, times 100\%"} \\ \text{"F"} \quad \text{"summation of system energy divided by output energy, times 100\%"} \\ \text{"G"} \quad \text{"energy output multiplied by the energy input"} \end{array} \right)$



5. (3 points) The r^2 value provides a measure of how well the best-fit line fits the actual data. What is the r^2 value called?

Choices = $\left(\begin{array}{l} \text{"A"} \quad \text{"best fit coefficient"} \\ \text{"B"} \quad \text{"constant of least square"} \\ \text{"C"} \quad \text{"coefficient of error minimization"} \\ \text{"D"} \quad \text{"linear regression"} \\ \text{"E"} \quad \text{"variable of fit"} \\ \text{"F"} \quad \text{"coefficient of regression"} \\ \text{"G"} \quad \text{"constant of determination"} \\ \text{"H"} \quad \text{"least of determination"} \\ \text{"I"} \quad \text{"coefficient of determination"} \\ \text{"J"} \quad \text{"coefficient of best fit"} \end{array} \right)$



6. (3 points) The units corresponding to the variable ρ in the equation given below are:

$$\nu = \frac{m}{\rho \cdot A \cdot t}$$

Choices = $\left(\begin{array}{l} \text{"A"} \quad \text{"kg*m"} \\ \text{"B"} \quad \text{"g"} \\ \text{"C"} \quad \text{"V"} \\ \text{"D"} \quad \text{"N/m^3"} \\ \text{"E"} \quad \text{"kg*m/s"} \\ \text{"F"} \quad \text{"kPa"} \\ \text{"G"} \quad \text{"m/s"} \\ \text{"H"} \quad \text{"kg/m^3"} \\ \text{"I"} \quad \text{"A"} \\ \text{"J"} \quad \text{"m^3"} \end{array} \right)$



7. (3 points) After linear regression was performed, it was determined that the r^2 value equals zero. This means that the experimental data collected has:

- Choices =
- "A" "a trend line that can represent the data perfectly."
 - "B" "no apparent relationship."
 - "C" "a very low minimization error."
 - "D" "zero probability of occurring."
 - "E" "a regression factor that needs to be summed."
 - "F" "drifted into the wrong dimensional space."
 - "G" "an error."

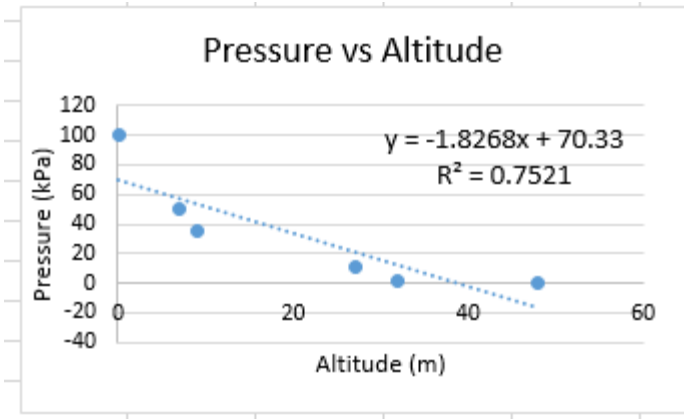


8. (3 points) _____ is a measurement of the energy per electron, of electrons at one location as compared to electrons at another location.

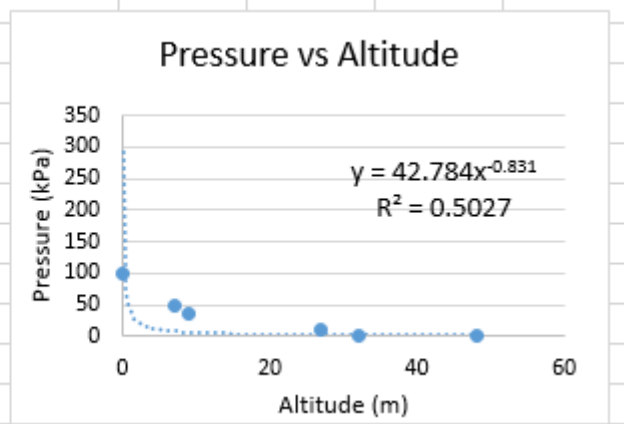
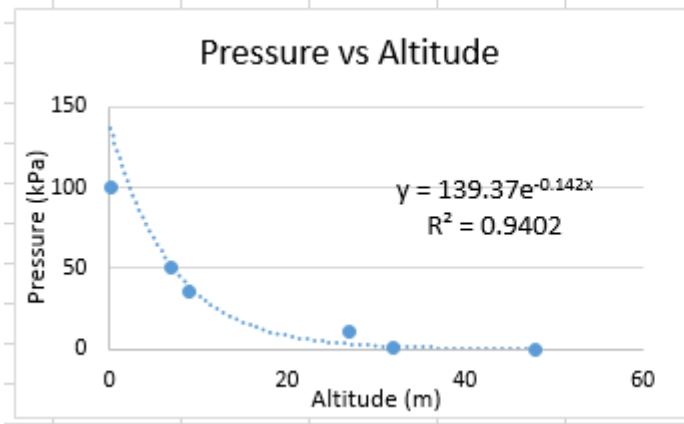
- Choices =
- "A" "Current"
 - "B" "Watts"
 - "C" "Inductance"
 - "D" "Resistance"
 - "E" "Power"
 - "F" "Voltage"
 - "G" "Amperage"



9. (3 points) Consider the plotted data shown. If linear regression is used to determine the best-fit line, which type of equation would prove to be the best model of the data?



- Choices =
- "A" "hyperbolic"
 - "B" "exponential"
 - "C" "trigonometric"
 - "D" "linear"
 - "E" "wave"
 - "F" "Maxwell's"
 - "G" "power"



10. (3 points) Below is a line of code taken from the 'simple left-edge line following program' provided in class. The purpose for this line of code is best described as:

```
int val = analogRead(5);
```

- Choices =
- "A" "read the analog value from a new 8-bit variable named val and write the value to pin 5 "
 - "B" "make the servo connected to pin 5 move "
 - "C" "set the existing variable 'int val' equal to the value read from pin 5"
 - "D" "declare variable val as a long data type and store the digital value at pin 5. "
 - "E" "write the analog value at pin 5 to pin val."
 - "F" "read the analog value at pin 5 and write the value to a new 16-bit variable named val. "
 - "G" "creates a variable int of data type val to store the digital value read at pin 5"

11. (5 points) Given the equation for finding slope using least squares linear regression, what term represents the sum of the dependent variable?

$$m = \frac{n(\sum x_i y_i) - (\sum x_i)(\sum y_i)}{n(\sum x_i^2) - (\sum x_i)^2}$$

II
III
IV
V

VI
VII

- Choices =
- "A" "II"
 - "B" "VI"
 - "C" "VII"
 - "D" "V"
 - "E" "IV"
 - "F" "I"
 - "G" "III"

12. (5 points) If the dataset given below is modeled by the form $y = mx + b$ using linear regression, then m is closest to:

Data_set =

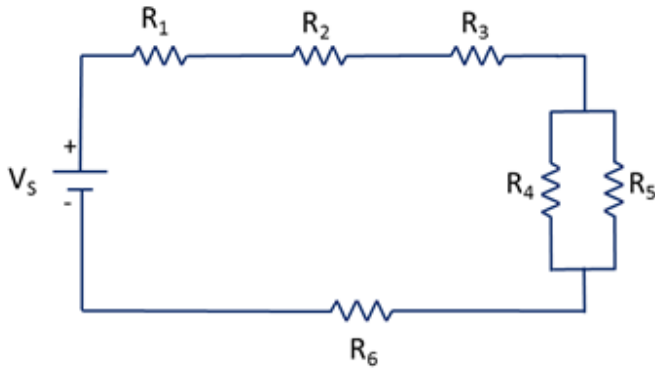
"x"	"y"
5	99
2	51
-1	20

- Choices =
- "A" 11.568
 - "B" 12.366
 - "C" 13.167
 - "D" 13.970
 - "E" 14.766
 - "F" 15.566
 - "G" 16.358
 - "H" 17.182

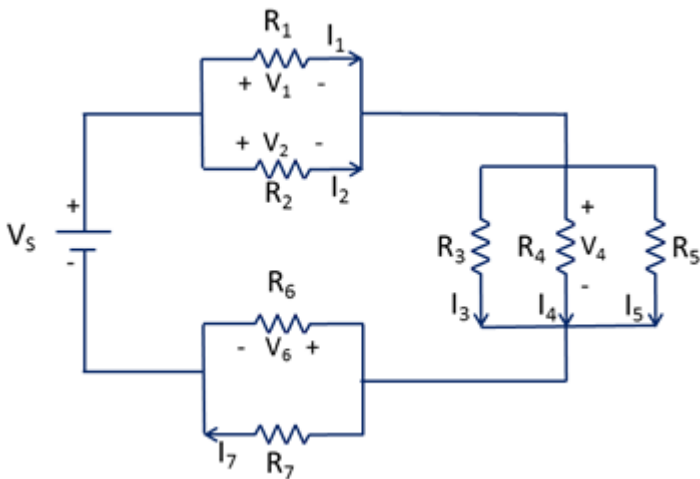
13. (5 points) If $R_1 > R_2 > R_3 > R_4 > R_5 > R_6$, which of the following statements are true?

- I. The current through R_1 is equal to the current through R_6 .
- II. The voltage across R_2 is equal to the voltage across R_3 .
- III. The highest voltage drop across a resistor is across R_1 .
- IV. The current through R_4 is greater than the current through R_5 .
- V. The current through R_3 is greater than the current through R_6 .
- VI. The voltage across R_4 is greater than the voltage across R_5 .
- VII. Without exact values for the resistors nothing can be determined.

- Choices =
- "A" "I and V"
 - "B" "I, III and V"
 - "C" "II, III, IV and VI"
 - "D" "I and III"
 - "E" "VII"
 - "F" "II, IV and VI"
 - "G" "II and VI"



14. (5 points) Find the following, then bubble the appropriate letter: $V_2 = \underline{\hspace{1cm}}$, $V_6 = \underline{\hspace{1cm}}$, $I_4 = \underline{\hspace{1cm}}$, $I_7 = \underline{\hspace{1cm}}$

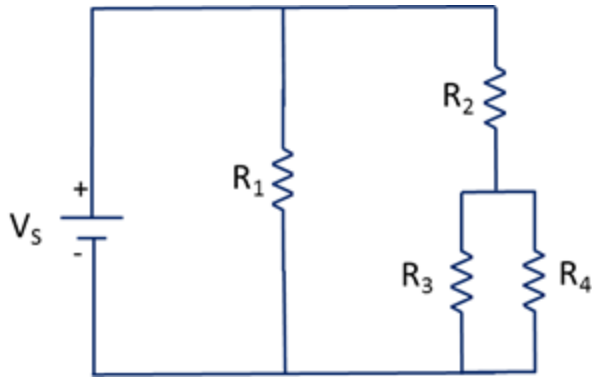


- $R_1 < R_2$
- $R_3 > R_4 > R_5$
- $R_6 = R_7$
- $V_5 = 24 \text{ V}$
- $V_1 = 8 \text{ V}$
- $V_4 = 6 \text{ V}$
- $I_1 = 4 \text{ A}$
- $I_2 = 2 \text{ A}$
- $I_3 = 1 \text{ A}$
- $I_5 = 3 \text{ A}$

- Choices =
- "A" "4 V, 12 V, 1 A, 2 A"
 - "B" "Not enough information given"
 - "C" "4 V, 8 V, 3 A, 6 A"
 - "D" "16 V, 6 V, 2 A, 3 A"
 - "E" "8 V, 10 V, 2 A, 3 A"
 - "F" "24 V, 8 V, 3 A, 3 A"
 - "G" "16 V, 6 V, 1 A, 2 A"
 - "H" "24 V, 12 V, 3 A, 3 A"
 - "I" "8 V, 10 V, 3 A, 6 A"



15. (5 points) The total current leaving V_s is closest to ...



$$R_1 = 7 \Omega \quad R_2 = 4 \Omega \quad R_3 = 18 \Omega$$

$$R_4 = 8 \Omega \quad P_{R4} = 7 \text{ W}$$

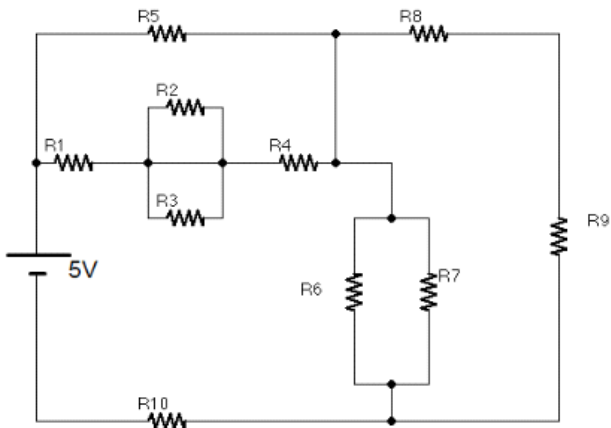
Choices =

"A"	1.84
"B"	2.06
"C"	2.29
"D"	2.52
"E"	2.74
"F"	2.97
"G"	3.19
"H"	3.42

A



16. (5 points) The equivalent resistance of the resistor network shown is closest to:



$$R_1 = 30 \Omega \quad R_6 = 40 \Omega$$

$$R_2 = 30 \Omega \quad R_7 = 40 \Omega$$

$$R_3 = 30 \Omega \quad R_8 = 7 \Omega$$

$$R_4 = 30 \Omega \quad R_9 = 7 \Omega$$

$$R_5 = 30 \Omega \quad R_{10} = 7 \Omega$$

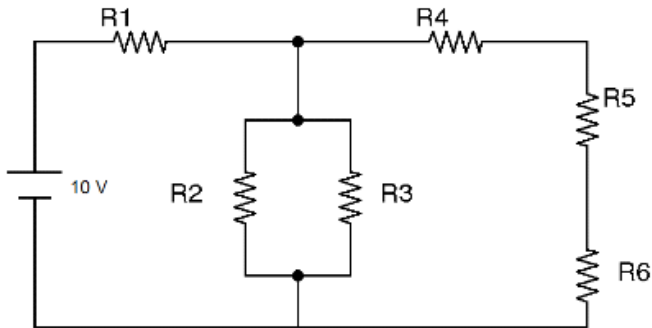
Choices =

"A"	26.286
"B"	28.083
"C"	29.877
"D"	31.671
"E"	33.446
"F"	35.235
"G"	37.016
"H"	38.815
"I"	40.592
"J"	42.353

Ω



17. (5 points) The power dissipated by R_5 is closest to:



$$R_1 = 30\ \Omega \quad R_4 = 7\ \Omega$$

$$R_2 = 40\ \Omega \quad R_5 = 7\ \Omega$$

$$R_3 = 40\ \Omega \quad R_6 = 7\ \Omega$$

Choices = $\left(\begin{array}{l} \text{"A"} \quad 0.0779 \\ \text{"B"} \quad 0.0841 \\ \text{"C"} \quad 0.0904 \\ \text{"D"} \quad 0.0966 \\ \text{"E"} \quad 0.1028 \\ \text{"F"} \quad 0.1091 \\ \text{"G"} \quad 0.1153 \\ \text{"H"} \quad 0.1215 \\ \text{"I"} \quad 0.1279 \\ \text{"J"} \quad 0.1341 \end{array} \right) \cdot \text{W}$



18. (5 points) Assume the 4 data points below are best modeled using $y = mx + b$. The value of "m" is closest to ...

Data_set =

"x"	"y"
5	10
2	13
-1	17
-4	22

Choices = $\left(\begin{array}{l} \text{"A"} \quad -1.171 \\ \text{"B"} \quad -1.252 \\ \text{"C"} \quad -1.333 \\ \text{"D"} \quad -1.414 \\ \text{"E"} \quad -1.495 \\ \text{"F"} \quad -1.575 \\ \text{"G"} \quad -1.657 \\ \text{"H"} \quad -1.739 \\ \text{"I"} \quad -1.821 \\ \text{"J"} \quad -1.901 \end{array} \right)$



19. (5 points) A linear fit is determined to work best for the data set below. Given that $m = -3.1038$, the value of "b" is closest to ...

Data_set =

"x"	"y"
5	-17
3	-10
-1	19
-8	22

Choices =

"A"	2.036
"B"	2.169
"C"	2.309
"D"	2.447
"E"	2.585
"F"	2.724
"G"	2.862
"H"	3.000
"I"	3.141
"J"	3.276



20. (5 points) A system pumps water up to the summit of Mount Bogard (elevation = 3 km) where the ENGR120 professors are competing in the engineering feats of strength. There is a fountain honoring their prowess that pumps a known mass of water (mass = 5 kg) every 20s, and the velocity of the water exiting the fountain is ($v = 5 \frac{m}{s}$). If the games last 3 days, the pump has an efficiency of 25%, and the cost of energy consumption is \$0.01 per kilowatt*hour, then the total cost to operate the fountain for the duration of the games is closest to...

Choices =

"A"	16.89
"B"	17.96
"C"	19.05
"D"	20.13
"E"	21.20
"F"	22.27
"G"	23.35
"H"	24.43
"I"	25.49
"J"	26.59

·dollars



21. (5 points) Dr. Hall is filling an alligator-shaped fountain (volume = 100L) outside his home using a water pump system. There is no elevation change but the water exits the hose at a known velocity ($v = 5 \frac{\text{m}}{\text{s}}$). If the DC pump motor runs on 12 V and 6 A, and has an efficiency of ($\eta = 20\%$), how long will it take to fill the fountain?

Choices = $\left(\begin{array}{l} \text{"A"} \quad 39.18 \\ \text{"B"} \quad 44.68 \\ \text{"C"} \quad 49.92 \\ \text{"D"} \quad 55.09 \\ \text{"E"} \quad 60.49 \\ \text{"F"} \quad 65.78 \\ \text{"G"} \quad 71.01 \\ \text{"H"} \quad 76.25 \\ \text{"I"} \quad 81.53 \\ \text{"J"} \quad 86.81 \end{array} \right) \text{ s}$



22. (5 points) A standard garden hose has an inner diameter of 5/8 in. If it takes a known time to fill a water balloon, the velocity at which the water leaves the hose is closet to...

$$\text{Fill}_{\text{time}} = 6 \text{ s}$$

$$\text{Vol}_{\text{balloon}} = 0.3 \text{ L}$$

Choices = $\left(\begin{array}{l} \text{"A"} \quad 0.175 \\ \text{"B"} \quad 0.188 \\ \text{"C"} \quad 0.201 \\ \text{"D"} \quad 0.214 \\ \text{"E"} \quad 0.227 \\ \text{"F"} \quad 0.240 \\ \text{"G"} \quad 0.253 \\ \text{"H"} \quad 0.265 \\ \text{"I"} \quad 0.278 \\ \text{"J"} \quad 0.291 \end{array} \right) \frac{\text{m}}{\text{s}}$



23. (5 points) A team of ENGR 120 students wants to use their pump and their arduino to keep unwanted visitors out of their dorm. When the door is opened, it flips a switch which starts their program. The regulated 5-volt source is used to power the motor for 10 seconds. If the tube is placed a height of " h_{tube} " above the water source (the toilet), the team finds that this results in a mass of water, " m_{water} ", pumped at a velocity of " v_{water} ". From prior testing, they know that their pump operates at efficiency of " η " at this head. The average current drawn while the pump is running is closest to...

$$h_{\text{tube}} = 1.2 \text{ m}$$

$$m_{\text{water}} = 180 \cdot \text{gram}$$

$$v_{\text{water}} = 0.3 \frac{\text{m}}{\text{s}}$$

$$\eta = 1.1 \cdot \%$$

Choices =	"A" 2.88	A
	"B" 3.09	
	"C" 3.28	
	"D" 3.47	
	"E" 3.67	
	"F" 3.87	
	"G" 4.06	
	"H" 4.26	
	"I" 4.45	
	"J" 4.65	



24. (5 points) Dr. Reeves is using an electric pump to transfer used cooking oil for producing biodiesel. He is pumping the oil from one storage tank in the basement to another tank on the roof, where the oil will be heated by the sun. Assuming the flow rate will be slow enough that the velocity is negligible, use the parameters given to find the pump head.

$$\text{Vol}_{\text{oil}} = 760 \cdot \text{gal}$$

$$V_{\text{motor}} = 120 \text{ V}$$

$$\text{Pumping}_{\text{time}} = 16 \cdot \text{day}$$

$$I_{\text{motor}} = 140 \cdot \text{mA}$$

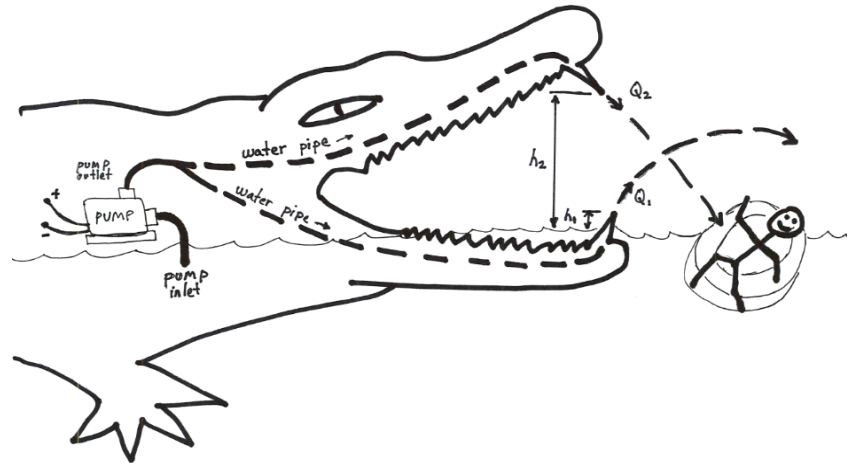
$$\rho_{\text{oil}} = 917 \frac{\text{kg}}{\text{m}^3}$$

$$\eta = 1.2 \cdot \%$$

Choices =	"A" 22.48	.ft
	"B" 24.60	
	"C" 26.78	
	"D" 28.89	
	"E" 31.03	
	"F" 33.19	
	"G" 35.33	
	"H" 37.48	
	"I" 39.61	
	"J" 41.80	



25. (5 points) Suzy the Alligator is a popular attraction at Lazy Swamp Water Park. Suzy has two teeth from which water squirts onto those who float by on tubes. The pump that delivers water to the teeth draws $I = 13 \cdot A$ of current at $V_p = 10 \cdot V$. The flowrates of the two teeth are given below the figure in gallons per minute (gpm). The height of tooth 1 above the water surface, as well as the nozzle diameter of both teeth are also given. The whole system operates at an efficiency of $\eta = 16\%$. The height of tooth 2 is closest to:



$$Q_1 = 4.3 \cdot \text{gpm} \quad h_1 = 1.8 \cdot \text{ft} \quad Q_2 = 2.3 \cdot \text{gpm} \quad d_{\text{nozzles}} = 0.23 \cdot \text{in}$$

- Choices =
- | | |
|-----|------|
| "A" | 6.10 |
| "B" | 6.49 |
| "C" | 6.87 |
| "D" | 7.26 |
| "E" | 7.65 |
| "F" | 8.04 |
| "G" | 8.42 |
| "H" | 8.81 |
| "I" | 9.20 |
| "J" | 9.60 |
- ft

YOUR EXAM FORM IS:

ExamForm = 23

Reference Information:

$$\eta = \frac{\frac{1}{2}mv^2 + Wh}{VIt}$$

$$m = \frac{W}{g}$$

$$Vol = \frac{W}{\rho g}$$

$$v = \frac{Vol}{At} = \frac{W}{\rho g At}$$

$$Q = v \cdot A$$

$$A = \frac{\pi}{4}d^2$$

 Density of water = 1000 kg/m³ = 1 g/cm³

1 kg = 1000 g

1 L = 0.001 m³g = 9.81 m/s²

1 gallon = 3.785 L

1 inch = 2.54 cm

1 coulomb = 6.24(10)¹⁸ electronsAvogadro's Number = 6.022(10)²³ per mol

$$m = \frac{n(\sum x_i y_i) - (\sum x_i)(\sum y_i)}{n(\sum x_i^2) - (\sum x_i)^2}$$

$$b = \frac{\sum y_i - m(\sum x_i)}{n}$$

$$r^2 = \left[\frac{n(\sum x_i y_i) - (\sum x_i)(\sum y_i)}{\sqrt{n(\sum x_i^2) - (\sum x_i)^2} \sqrt{n(\sum y_i^2) - (\sum y_i)^2}} \right]^2$$

color	digit
black	0
brown	1
red	2
orange	3
yellow	4
green	5
blue	6
violet	7
gray	8
white	9