Name:___________________________ Instructor:____________ Section:__________

ENGR 121 - Exam 2
March 2, 2015

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:____

Instructions: _Encode your answer to each question by darkening the appropriate circle on your response form. You are also encouraged to work neatly and circle your chosen answers on the exam document so that you are better able to review your work if you find the need. However, the answers you encode on the response form will be taken as your definitive answers, and the entire basis for your grade. Please review your response form carefully before submission._

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1. **_<u>(2 point deduction for failure to complete this problem!)</u>_**

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- 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.

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03	003 - Moller	TR 10-11:50
04	004 - Crittenden	TR 12-1:50
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Notes:

- If your last name is too long, just write the first 10 letters.
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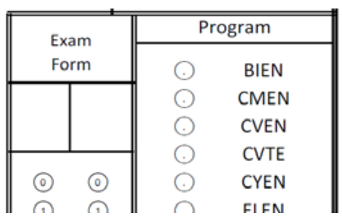

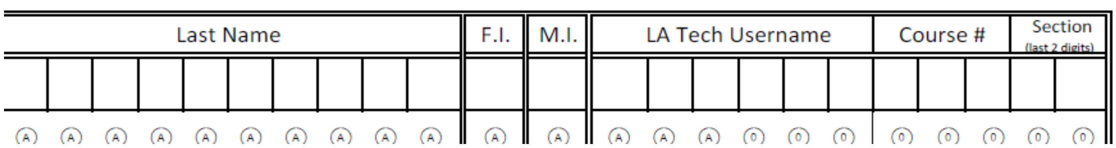

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"I properly completed all required items in problem 1, so I will not lose these points"} \\ \text{"B"} & \text{"I did not properly complete problem 1 because I am fine with losing these points."} \end{pmatrix}$$

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2. (3 points) What do we call the scientific law that is often written as $\Delta E = Q - W$?

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"The Steady-State Law of Energy Systems"} \\ \text{"B"} & \text{"The First Law of Energy Consumption"} \\ \text{"C"} & \text{"The Law of Heat Capacity"} \\ \text{"D"} & \text{"The First Law of Energy Conversion"} \\ \text{"E"} & \text{"The First Law of Fishtank"} \\ \text{"F"} & \text{"The Theory of Everything"} \\ \text{"G"} & \text{"The First Law of Thermodynamics"} \\ \text{"H"} & \text{"The First Law of Work and Heat"} \\ \text{"I"} & \text{"none of these"} \end{pmatrix}$$

3. (3 points) You add 10,000 J of energy to 5kg of a substance, resulting in a 2 degC increase in temperature. The specific heat of the substance is:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"10,000"} \\ \text{"B"} & \text{"1,000"} \\ \text{"C"} & \text{"5,000"} \\ \text{"D"} & \text{"4,000"} \\ \text{"E"} & \text{"20,000"} \\ \text{"F"} & \text{"3,000"} \\ \text{"G"} & \text{"2,000"} \\ \text{"H"} & \text{"25,000"} \\ \text{"I"} & \text{"100,000"} \\ \text{"J"} & \text{"none of these"} \end{pmatrix} \quad \frac{\text{J}}{\text{kg}\cdot\text{degC}}$$

4. (3 points) The Arduino sketch used in temperature calibration is shown below. Which line(s) of this sketch have errors?

`int val = 0;`	line 1
`void setup() {`	line 2
`Serial.begin(9600);`	line 3
`}`	line 4
`void loop {`	line 5
`val = analogRead(4);`	line 6
`Serial.println(val);`	line 7
`}`	line 8

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"line 8"} \\ \text{"B"} & \text{"line 7"} \\ \text{"C"} & \text{"line 1"} \\ \text{"D"} & \text{"line 3"} \\ \text{"E"} & \text{"line 5"} \\ \text{"F"} & \text{"line 6"} \\ \text{"G"} & \text{"line 4"} \\ \text{"H"} & \text{"lines 1 and 7"} \\ \text{"I"} & \text{"lines 1 and 6"} \\ \text{"J"} & \text{"line 2"} \end{pmatrix}$$

5. (3 points) Using the wiring configuration provided in the ENGR121 notes, what source provides the electrical energy that flows through the 20Ω resistor that we used as a heater for our fishtank systems?

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"the USB connection to our computer"} \\ \text{"B"} & \text{"an Arduino pin"} \\ \text{"C"} & \text{"a 12V power supply"} \\ \text{"D"} & \text{"a battery pack plugged into the Arduino board"} \\ \text{"E"} & \text{"the voltage regulator on the Arduino board"} \\ \text{"F"} & \text{"none of these"} \end{pmatrix}$$

6. (3 points) An unknown solid weighing 1 kg and at a temperature of 100 degC is placed in an unknown liquid weighing 1kg and at a temperature of 50 degC. After a long period of time the unknown solid and unknown liquid reach a final temperature of 70 degC. If no heat is transferred to or from the system during the process, then:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"not enough information is provided to determine the relative values of the heat capacities"} \\ \text{"B"} & \text{"the specific heat capacities of the two materials are equal"} \\ \text{"C"} & \text{"the specific heat capacity of the solid material is less than the specific heat capacity of the liquid material"} \\ \text{"D"} & \text{"the specific heat capacity of the solid material is greater than the specific heat capacity of the liquid material"} \\ \text{"E"} & \text{"both substances will get colder"} \\ \text{"F"} & \text{"both substances will get hotter"} \end{pmatrix}$$

7. (3 points) In your fishtank systems, what data type is best for keeping track of the time (in milliseconds) that the last valve closed?

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"double"} \\ \text{"B"} & \text{"Boolean"} \\ \text{"C"} & \text{"unsigned long"} \\ \text{"D"} & \text{"no data type is any better than the others"} \\ \text{"E"} & \text{"char"} \\ \text{"F"} & \text{"word"} \\ \text{"G"} & \text{"int"} \\ \text{"H"} & \text{"float"} \\ \text{"I"} & \text{"byte"} \\ \text{"J"} & \text{"none of these data types will work"} \end{pmatrix}$$

8. (3 points) In your fishtank systems, the term we used to describe the difference between your upper and lower control limits for salinity was:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"hysteresis"} \\ \text{"B"} & \text{"deadtime compensation"} \\ \text{"C"} & \text{"gap"} \\ \text{"D"} & \text{"gain"} \\ \text{"E"} & \text{"random error"} \\ \text{"F"} & \text{"standard deviation"} \\ \text{"G"} & \text{"deadband"} \\ \text{"H"} & \text{"error"} \\ \text{"I"} & \text{"setpoint"} \\ \text{"J"} & \text{"none of these"} \end{pmatrix}$$

9. (3 points) Which of the following are not advantages of using a transistor

```
  i. Can be very small
 ii. Works very fast
iii. Can be controlled mechaninically
 iv. Works slowly
  v. Inexpensive
 vi. Can be controlled electronically
```

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"i, ii, v, \& vi"} \\ \text{"B"} & \text{"ii, v, \& vi"} \\ \text{"C"} & \text{"v \& vi."} \\ \text{"D"} & \text{"i, iii, iv, \& v"} \\ \text{"E"} & \text{"ii \& iv"} \\ \text{"F"} & \text{"i, iv, \& v"} \\ \text{"G"} & \text{"iv * vi"} \\ \text{"H"} & \text{"iii, iv"} \\ \text{"I"} & \text{"i, vi"} \\ \text{"J"} & \text{"none of these"} \end{pmatrix}$$

10. (3 points) Convert the decimal value of 121 into binary.

$$\text{Choices} = \begin{pmatrix} \text{"A"} & \text{"1110111"} \\ \text{"B"} & \text{"1111001"} \\ \text{"C"} & \text{"1100110"} \\ \text{"D"} & \text{"1101011"} \\ \text{"E"} & \text{"1111011"} \\ \text{"F"} & \text{"0101001"} \\ \text{"G"} & \text{"1101001"} \\ \text{"H"} & \text{"none of these"} \end{pmatrix}$$

11. (3 points) Upon completion of your calibration proceedure for your thermistor circuit, you determine that your calibration equation is:

$$\text{analogT}(T) \rightarrow 8.83 \cdot T + 278$$

Where T is the temperature in degC and analogT is the value between 0 and 1023 returned by the Arduino when completing the analogRead() function used to read the appropriate voltage from the thermistor circuit. Upon completion of 20 temperature readings at a constant temperature, you determine that the standard deviation of the random error in analogT is **2**. Using the method recommended in the notes for setting the LCL and UCL for temperature, and assuming a $\text{setpoint} = 25.3 \cdot \text{degC}$, the UCL in degC is should be closest to:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 24.3 \\ \text{"B"} & 24.7 \\ \text{"C"} & 25.1 \\ \text{"D"} & 25.6 \\ \text{"E"} & 26.0 \\ \text{"F"} & 26.4 \\ \text{"G"} & 26.8 \\ \text{"H"} & 27.3 \\ \text{"I"} & 27.6 \\ \text{"J"} & 28.1 \end{pmatrix} \cdot \text{degC}$$

12. (5 points) Beth wants to add enough salt to a $\text{volume} = 3 \cdot \text{gal}$ of DI water to achieve a % weight of 3.5%, roughly the salinity of ocean water. The number of pounds she should add is closest to …

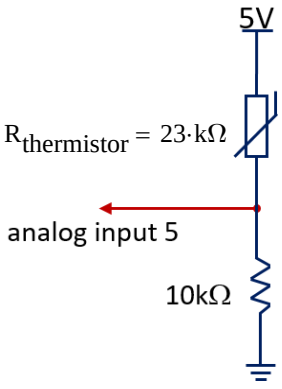
$$\text{Choices} = \begin{pmatrix} \text{"A"} & 0.58 \\ \text{"B"} & 0.63 \\ \text{"C"} & 0.68 \\ \text{"D"} & 0.72 \\ \text{"E"} & 0.77 \\ \text{"F"} & 0.82 \\ \text{"G"} & 0.86 \\ \text{"H"} & 0.91 \\ \text{"I"} & 0.95 \\ \text{"J"} & 1.00 \end{pmatrix} \cdot \text{lb}$$

13. (5 points) A mass of $\text{salt} = 14 \text{grams}$ of NaCl is dissolved in 1,000 grams of DI water. The %wt of NaCl in this solution is closest to . . .

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 1.38 \\ \text{"B"} & 1.59 \\ \text{"C"} & 1.80 \\ \text{"D"} & 2.00 \\ \text{"E"} & 2.21 \\ \text{"F"} & 2.42 \\ \text{"G"} & 2.63 \\ \text{"H"} & 2.84 \\ \text{"I"} & 3.05 \\ \text{"J"} & 3.25 \end{pmatrix} \cdot \%$$

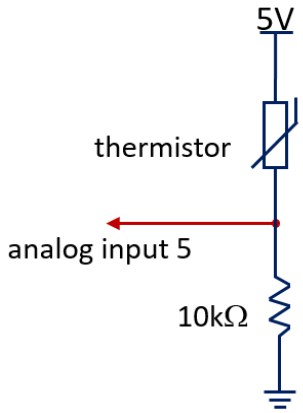
14. (5 points) Given the voltage divider circuit and the temperature calibration equation shown below, the temperature the thermistor is measuring is closest to:

$$\text{Temperature}\,(°\text{C}) = 0.1608 \cdot \text{analog}_{\text{temp}} - 28.062$$



$$\text{Choices} = \begin{pmatrix} \text{"A"} & 18.5 \\ \text{"B"} & 19.6 \\ \text{"C"} & 20.7 \\ \text{"D"} & 21.8 \\ \text{"E"} & 22.9 \\ \text{"F"} & 24.0 \\ \text{"G"} & 25.1 \\ \text{"H"} & 26.2 \\ \text{"I"} & 27.3 \\ \text{"J"} & 28.4 \end{pmatrix} \quad °\text{C}$$

15. (5 points) Given the voltage divider circuit below (where Thermistor $\text{Resistance} = 2190\Omega$), if the Arduino function analogRead(5) is used, the analog input reading would be closest to...



$$\text{Choices} = \begin{pmatrix} \text{"A"} & 306 \\ \text{"B"} & 363 \\ \text{"C"} & 424 \\ \text{"D"} & 483 \\ \text{"E"} & 542 \\ \text{"F"} & 602 \\ \text{"G"} & 661 \\ \text{"H"} & 721 \\ \text{"I"} & 780 \\ \text{"J"} & 839 \end{pmatrix}$$

16. (5 points) A mass of salt (m_{salt}) is added to a vat of salt water, which initially contains salt water with the percentage of salt ($wt\%_{salt}$) listed below. After adding the salt, the final percentage of salt in the vat is 25%. How much water must the vat contain BEFORE adding the salt?

$m_{salt} = 0.75\,\text{kg}$ $wt\%_{salt} = 15\cdot\%$

note: assume all percentages are by weight

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 2.89 \\ \text{"B"} & 3.24 \\ \text{"C"} & 3.58 \\ \text{"D"} & 3.92 \\ \text{"E"} & 4.26 \\ \text{"F"} & 4.60 \\ \text{"G"} & 4.94 \\ \text{"H"} & 5.28 \\ \text{"I"} & 5.63 \\ \text{"J"} & 5.97 \end{pmatrix} \text{kg}$$

17. (5 points) A 300 Watt electric heater is immersed in a container with unknown volume of water. If it takes $\text{time} = 14 \cdot \text{min}$ to heat the water up by 5 degrees Celsius, then the volume of water is closest to

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 8.41 \\ \text{"B"} & 9.13 \\ \text{"C"} & 9.86 \\ \text{"D"} & 10.59 \\ \text{"E"} & 11.32 \\ \text{"F"} & 12.06 \\ \text{"G"} & 12.79 \\ \text{"H"} & 13.52 \\ \text{"I"} & 14.25 \\ \text{"J"} & 14.98 \end{pmatrix} \text{L}$$

18. (5 points) A $\text{resistor} = 24\Omega$ is connected to a 12VDC power supply will be used to heat the water in a small fishtank with a volume of 3 liters. If the initial temperature of the water if 15 degrees Celsius, then the temperature of the water after $\text{time} = 17.5 \cdot \text{min}$ of heating (assuming no heat loss) will be closest to

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 10.781 \\ \text{"B"} & 11.721 \\ \text{"C"} & 12.676 \\ \text{"D"} & 13.619 \\ \text{"E"} & 14.564 \\ \text{"F"} & 15.502 \\ \text{"G"} & 16.445 \\ \text{"H"} & 17.390 \\ \text{"I"} & 18.339 \\ \text{"J"} & 19.265 \end{pmatrix} \text{degC}$$

19. (5 points) If the heater in a fishtank system consumes 12 watts and is immersed in a reservoir containing a $\text{volume} = 225 \cdot \text{cm}^3$ of water for a $\text{time} = 5 \cdot \text{minutes}$, the temperature increase will be closest to:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 3.05 \\ \text{"B"} & 3.24 \\ \text{"C"} & 3.44 \\ \text{"D"} & 3.63 \\ \text{"E"} & 3.83 \\ \text{"F"} & 4.02 \\ \text{"G"} & 4.22 \\ \text{"H"} & 4.41 \\ \text{"I"} & 4.60 \\ \text{"J"} & 4.79 \end{pmatrix} \cdot \text{degC}$$

20. (5 points) You are designing the heating system for your new, improved fishtank system. You are planning to make all of your electrical connections on a breadboard for which current must be limited to 950mA per connection. Since your circuit will be a simple series circuit, this is the maximum current you can supply your heater. You want to heat the water at a $\text{rate} = 3.2 \cdot \frac{\text{degC}}{\text{minute}}$. Your fishtank control volume has an inside diameter of 1.6 inches and holds a $\text{depth} = 1.76 \cdot \text{inches}$ of water. The minimum required voltage of the power supply you need for this design is closest to:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 9.45 \\ \text{"B"} & 10.16 \\ \text{"C"} & 10.84 \\ \text{"D"} & 11.55 \\ \text{"E"} & 12.22 \\ \text{"F"} & 12.92 \\ \text{"G"} & 13.61 \\ \text{"H"} & 14.30 \\ \text{"I"} & 14.99 \\ \text{"J"} & 15.67 \end{pmatrix} \text{V}$$

$$temperature := \begin{pmatrix} 20 \\ 21 \\ 22 \\ 23 \end{pmatrix} degC \qquad temperature := \begin{pmatrix} 28 \\ 30 \\ 32 \\ 34 \end{pmatrix} degC \qquad time := \begin{pmatrix} 143 \\ 158 \\ 172 \\ 191 \end{pmatrix} seconds$$

$m_{sample} := 75gm$

$R_{heater} := 23\Omega$

$V_s := 18V$

$temperature := temperature_{ind} \qquad temperature := temperature_{ind} \qquad time := time_{ind}$

$$Cp_{sample} := \frac{\frac{V_s^{\,2}}{R_{heater}} \cdot time}{m_{sample} \cdot (temperature - temperature)} \qquad \boxed{Cp_{sample} = 3231 \cdot \frac{J}{kg \cdot degC}}$$

$c\_ind := random(2, 9, 1)$

$c\_ind = 7$

$Choices := augment(Letters(10), Answers(Cp_{sample}, c\_ind, 10, .05))$

$Key := stack(Key, Letters(10)_{c\_ind})$

21. (5 points) A 23Ω heater immersed in 75 grams of an unknown liquid is connected to an 18V source, and raises the liquid from a $temperature = 22 \cdot degC$ to a $temperature = 32 \cdot degC$ in a $time = 172 \cdot seconds$. The specific heat capacity of the unknown liquid is closest to:

$$Choices = \begin{pmatrix} "A" & 2246 \\ "B" & 2411 \\ "C" & 2574 \\ "D" & 2739 \\ "E" & 2902 \\ "F" & 3066 \\ "G" & 3231 \\ "H" & 3394 \\ "I" & 3559 \\ "J" & 3723 \end{pmatrix} \cdot \frac{J}{kg \cdot degC}$$

22. (5 points) Dr. Hall loves coffee.He loves it best when it has a $\text{temperature} = 85 \cdot \text{degC}$, but his new Keurig coffee maker makes coffee that has a $\text{temperature} = 81 \cdot \text{degC}$. He wants to make a resistance heater (similar to the one we made for the fishtank project) using a 6V lantern battery as the energy source. He wants to heat an 18oz mug (532.5mL) that comes out of his Keurig to his favorite temperature in a $\text{time} = 6 \cdot \text{minutes}$ (exactly). Assuming that coffee has the same properties as water, the value of the resistor that he must use as his heating element is closest to:

$$\text{Choices} = \begin{pmatrix} \text{"A"} & 1.456 \\ \text{"B"} & 1.530 \\ \text{"C"} & 1.603 \\ \text{"D"} & 1.677 \\ \text{"E"} & 1.752 \\ \text{"F"} & 1.823 \\ \text{"G"} & 1.898 \\ \text{"H"} & 1.974 \\ \text{"I"} & 2.044 \\ \text{"J"} & 2.121 \end{pmatrix} \cdot \Omega$$

23. (5 points) One of our professors likes to add cream to her coffee. One day, the amount of cream she added to the coffee was $m_{cream} = 21 \cdot grams$. The amount of coffee that she added the cream to was $m_{coffee} = 620 \cdot grams$. She knows that the specific heat of cream is 3770 J/(kg degC) and the specific heat of coffee is 4180 J/(kg degC) (same as water). The initial temperature of the coffee was 75 degC and the initial temperature of the cream was 5 degC. If there is no heat loss from the cup, then what was the final equilibrium temperature of both the cream and the coffee?

$$Choices = \begin{pmatrix} "A" & 56.3 \\ "B" & 59.6 \\ "C" & 62.9 \\ "D" & 66.3 \\ "E" & 69.6 \\ "F" & 72.9 \\ "G" & 76.2 \\ "H" & 79.6 \\ "I" & 83.0 \\ "J" & 86.3 \end{pmatrix} \cdot degC$$

24. (5 points) A $mass_{bar} = 200 \cdot gram$ bar of unknown material is dropped into a cup of water. Assume the cup is a cylinder with a diameter of 2.5 inches and a height of 3 inches. Also assume that there are no other sources of heat loss or gain in the system. The temperature of the water started at $T_{water} = 24 \cdot degC$, the temperature of the bar started at $T_{bar} = 145 \cdot degC$. The final equilibrium temperature of the water and the bar is $T_{equal} = 28.8 \cdot degC$. The bar was most likely made from which of these metals?

$$C_{p\_water} = 4180 \cdot \frac{J}{kg \cdot degC}$$

Metals =

"A"	"Aluminum"	910
"B"	"Copper"	390
"C"	"Carbon Steel"	490
"D"	"Cadmium"	230
"E"	"Lead"	130
"F"	"Iron"	450
"G"	"Tin"	210
"H"	"Titanium"	540
"I"	"Magnesium"	1050
"J"	"Zinc"	400

Column 3 is the Specific Heat in J/(kg*degC)

25. (5 points) You want to cool down your swimming pool on a hot day. You measured the temperatue in the water and it is $T_{water} = 29 \cdot degC$. Fortunately you have several iron bars stored in your root cellar. Each bar is 20 kilograms, and your cellar keeps everything at 10 degC. Your pool has a diameter of $dia_{pool} = 8 \cdot ft$ and is 3 feet deep, and you want the final temperature to be $T_{final} = 25 \cdot degC$. The number of bars you should put in the pool is closest to: (round to the closest answer, not necessarily to the next largest answer)

$$C_{p\_water} = 4180 \cdot \frac{J}{kg \cdot degC} \qquad C_{p\_iron} = 1500 \cdot \frac{J}{kg \cdot degC}$$

$$Choices = \begin{pmatrix} "A" & 151 \\ "B" & 159 \\ "C" & 166 \\ "D" & 173 \\ "E" & 180 \\ "F" & 188 \\ "G" & 195 \\ "H" & 202 \\ "I" & 209 \end{pmatrix}$$

26. (5 points) Dr. Crittenden has decided to supplement his professor income by raising alligators. One day, one of his baby alligators gets salmonellosis and is prescribed antibiotics. Since the alligator will not eat the antibiotics by themselves, Dr. Crittenden mixes them into a slurry he makes with a $mass = 800 \cdot grams$ of canned fish added to a $volume = 1.1 \cdot L$ of water. The initial temperature of the water is 21 degC, and the initial temperature of the canned fish is 5 degC. Dr. Crittenden has raised alligators for long enough to know that his baby alligators like to eat food that is no cooler than 19 degC. He looks up the specific heat capacity of canned fish and finds that it is 3350 J/(kg degC). He has a well-insulated resistive heating pot (who doesn't?) with a 23.5Ω heating element that draws 5A of current when plugged in. The amount of time that Dr. Crittenden should heat the slurry with this pot to achieve the minimum food temperature desired by the baby alligator is closest to:

$$Choices = \begin{pmatrix} "A" & 40.9 \\ "B" & 43.3 \\ "C" & 45.8 \\ "D" & 48.2 \\ "E" & 50.7 \\ "F" & 53.1 \\ "G" & 55.5 \\ "H" & 58.0 \\ "I" & 60.4 \\ "J" & 62.9 \end{pmatrix} \cdot seconds$$

ExamForm = 23

1. *(2 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.

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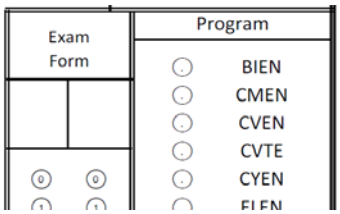

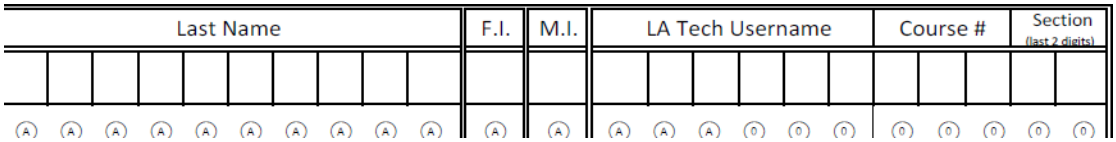

Choices = ("A" "I properly completed all required items in problem 1, so I will not lose these points"; "B" "I did not properly complete problem 1 because I am fine with losing these points.")

1 coulomb = $6.24(10)^{18}$ electrons Avogadro's Number: $6.022(10)^{23}$

Density of water at 4°C (maximum density) = 1 g/mL = 1g/cm³ = 1000 kg/m³ = 8.33 lbs/gal

$$C_{p\,H_2O} = 4180\frac{J}{kg \cdot C}$$

1L = 0.001m³ = 1.0567quarts = 0.264gal = 61.02in³ 1 gal = 0.1337 ft³ = 3.785 L

1 pound = 16 ounces = 453.592 grams 1 inch = 25.4 mm 1 foot = 12 inches

Conductivity Sensor Reactions:

$2Cl^-_{(aq)} \longrightarrow Cl_{2\,(g)} + 2e^-$ and $2H_20_{(l)} + 2e^- \longrightarrow H_{2\,(g)} + 2OH^-_{(aq)}$

Atomic Weights:

Na = 23.0 g/mol, Cl = 35.5 g/mol, C = 12.0 g/mol, H = 1.0 g/mol, O = 16.0 g/mol

$$R = \frac{\rho \cdot L}{A} \qquad \alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)} \qquad V \cdot I \cdot t = \rho \cdot Vol \cdot C_p \cdot \Delta T$$

Volume of Cylinder = $\frac{\pi \cdot diameter^2}{4} \cdot height$ $\Delta E = Q - W$

```
/* mySerial.write(254) - control command must be sent before commands below  */
/*                                                                           */
/* mySerial.write(1)   - clear display and move cursor to top left           */
/* mySerial.write(8)   - turn display off                                    */
/* mySerial.write(12)  - turn display on / hide cursor                       */
/* mySerial.write(13)  - blinking cursor on                                  */
/* mySerial.write(14)  - underline cursor on                                 */
/* mySerial.write(16)  - move cursor left one space                          */
/* mySerial.write(20)  - move cursor right one space                         */
/* mySerial.write(24)  - scroll left one space                               */
/* mySerial.write(28)  - scroll right one space                              */
/*                                                                           */
/* mySerial.write(124) - control command must be sent before commands below  */
/*                                                                           */
/* mySerial.write(128) - backlight off                                       */
/* mySerial.write(157) - backlight fully on                                  */
/*                                                                           */
/* row and position commands are shown below for all 80 character positions  */
/*    ROW 0:   128=(0,0)  129=(0,1)  130=(0,2)  131=(0,3)  132=(0,4)         */
/*             133=(0,5)  134=(0,6)  135=(0,7)  136=(0,8)  137=(0,9)         */
/*             138=(0,10) 139=(0,11) 140=(0,12) 141=(0,13) 142=(0,14)        */
/*             143=(0,15) 144=(0,16) 145=(0,17) 146=(0,18) 147=(0,19)        */
/*    ROW 1:   192=(2,0)  193=(2,1)  194=(2,2)  195=(2,3)  196=(2,4)         */
/*             197=(2,5)  198=(2,6)  199=(2,7)  200=(2,8)  201=(2,9)         */
/*             202=(2,10) 203=(2,11) 204=(2,12) 205=(2,13) 206=(2,14)        */
/*             207=(2,15) 208=(2,16) 209=(2,17) 210=(2,18) 211=(2,19)        */
/*    ROW 2:   148=(1,0)  149=(1,1)  150=(1,2)  151=(1,3)  152=(1,4)         */
/*             153=(1,5)  154=(1,6)  155=(1,7)  156=(1,8)  157=(1,9)         */
/*             158=(1,10) 159=(1,11) 160=(1,12) 161=(1,13) 162=(1,14)        */
/*             163=(1,15) 164=(1,16) 165=(1,17) 166=(1,18) 167=(1,19)        */
/*    ROW 3:   212=(3,0)  213=(3,1)  214=(3,2)  215=(3,3)  216=(3,4)         */
/*             217=(3,5)  218=(3,6)  219=(3,7)  220=(3,8)  221=(3,9)         */
/*             222=(3,10) 223=(3,11) 224=(3,12) 225=(3,13) 226=(3,14)        */
/*             227=(3,15) 228=(3,16) 229=(3,17) 230=(3,18) 231=(3,19)
```

ExamForm = 23

Key =

	1
1	"A"
2	"G"
3	"B"
4	"E"
5	"C"
6	"C"
7	"C"
8	"G"
9	"H"
10	"B"
11	"E"
12	"H"
13	"A"
14	"D"
15	"J"
16	"I"
17	"F"
18	"F"
19	"E"
20	"G"
21	"G"
22	"A"
23	"F"
24	"G"
25	"B"
26	"D"