Guide Lines for running Detector Building
(UPDATED 11/26/19)

I. Room Requirements

a. Flat movable tables as compared to fixed student style seats
b. Easy water access and disposal
c. Flooring resistant to water damage in case of an accidental spill.

II. Supplies needed to Run Competition

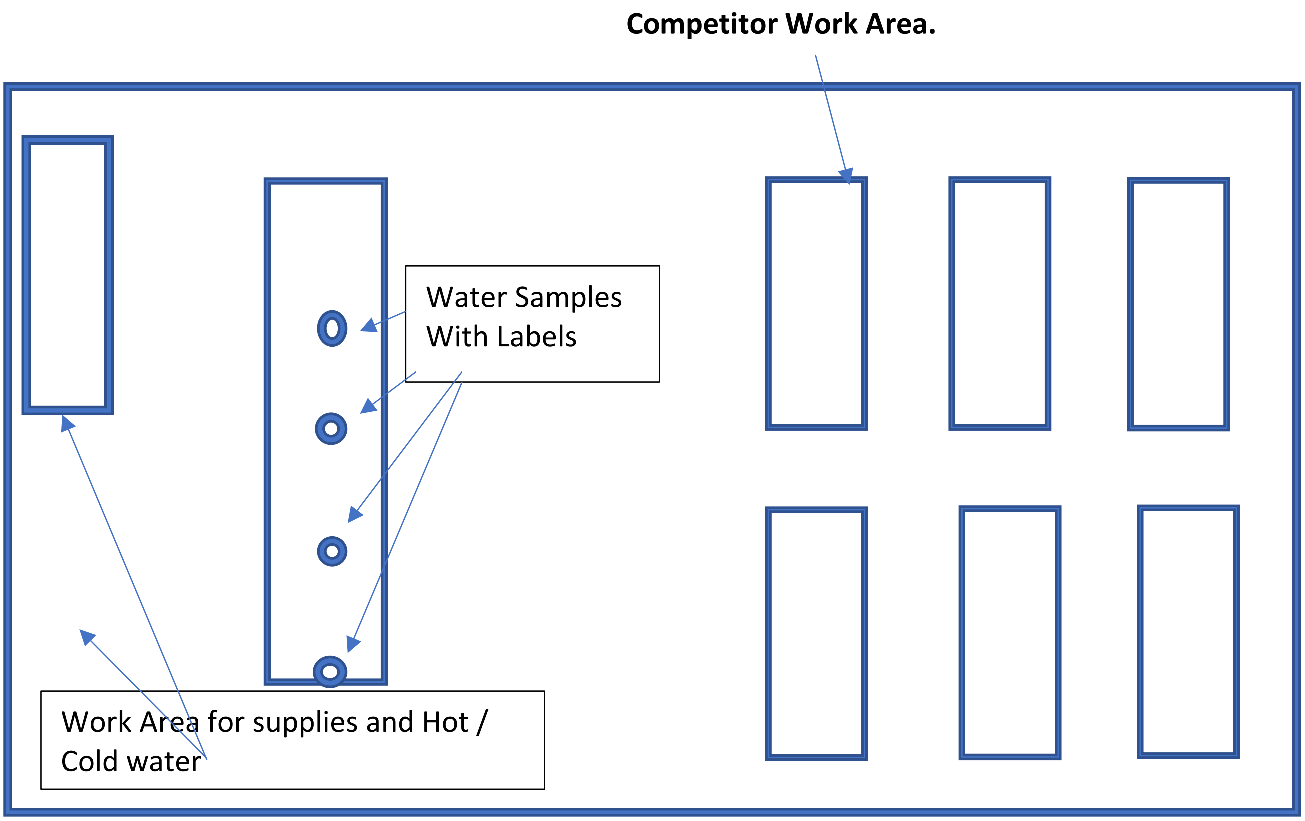
At Regional **l, m, & n** are not required, teams will bring their digital thermometer, which was used to calibrate their probe thus no additional calibration is required.

a. Four insulated cups with lids to hold and help maintain temperature of the 4 Test Samples of water. (YETI style tumblers are ideal)
b. Container to hold extra water to refill containers as needed
c. A few clipboards (minimum of 4 – maximum 10) for judges to hold individual score sheets during competition.
d. Score Sheets, and Quiz.
e. A stapler and staples to attach quiz to the team's score sheet.
f. Dry erase pen to post Temperature ranges for LED Colors.
g. Measuring device to establish a 30 cm probe length requirement.
h. Labels for stations 1-4 identification.
i. Judges will need pens or pencils to record results.
j. Source of hot water (At State and Nationals 2-3 electric coffee pots work area).
k. Source of ice (small cooler with ice work area).
l. One digital thermometer showing resolution to 0.1 Degrees Celsius per team per rotation. (Calculators with a temperature probe or and laboratory-grade digital thermometer will work. It is advisable for an additional one or two thermometers for back-up).
m. Disposable hot cups (~50 -100) and paper towels (~ 3-4 rolls) for participants to use while checking their device calibration.
n. A heavy-duty extension cord and power strip with multiple outlets may be needed depending on room set-up and location of outlets.

III. Room Set-up.

The following drawing is only a suggestion of one possible set-up. The key point is that you need four areas in the room.

1) At States and Nationals, an area for each team to work on coding and recalibration before starting.
2) Area for the actual temperature determination for the competition.
3) A work/storage area for setting up supplies, cups, hot and cold water, and ice.



IV. Competition Guidelines

All construction guidelines must be followed, but the main focus can be summarized in the following three competition goals;

1) Build a durable Temperature sensor. This sensor must be built by the competitor from basic components, and not one purchased already in a waterproof housing.
2) The code must show the conversion of the raw sensor data into a digitally displayed temperature using the Celsius scale. This conversion equation must be derived from the teams' actual data and must be supported with recorded data in the form of a journal and not from a manufactures library or supplied equation (Steinhart and Hart Equation).
3) The assigned temperature ranges (low, medium, and high) must be indicated by either a Red, Green, or Blue LEDs at the regional level and can be multiple colors at the State and National level where more than three ranges may be used. Also, a single RGB LED cannot be used instead of the three individual LEDs. The temperature ranges will not be given until the competition so that the competitors must demonstrate their ability to alter their code to match the assigned temperature ranges and should be continuous. Typical low ranges could be 0-20^{o}C, mid-range from 20-40^{o}C, and high range from 40-60^{o}C.
4) At the State and National level, the teams should be allowed access to hot and cold water, cups, the actual thermometer that will be used to verify their calibration and allowed to make coding adjustments before starting their competition. The calibration verification, code modification, and actual judging must all occur in the assign 50 minutes time rotation.
5) The LED scores will be based on the temperature that the competitors' device indicates and not the calibrating digital thermometer.

V. Suggestions for Running the Event

1. The ideal number of volunteers is 4-5.
2. If time allows, evaluate journals before the team's competition; if not possible, the team may have to retrieve their journal later or leave a copy for the supervisor.
3. Do not post the temperature ranges for the LED colors until the room is secured and the round has begone
4. The State and National Level give each team a digital thermometer and instruct them that when they come to the front tables, bring it, and it will be the thermometer used to evaluate the accuracy of their device, so use it to verify or modify their program before starting their evaluation. Depending on the number of teams in the rotation, give them a minimum of 10 minutes and a maximum of 20 minutes to accomplish this task. Remind them that the digital display will be used to determine the temperatures and not a verbal answer based on a mental temperature modification.
5. Separate the four water samples to be tested on the front table far enough apart to allow one and only one team at each station at a time. If one sample is ice water, be sure to remove any ice before the competition begins. Try to differ the temperature of the samples 15-20 degrees Celsius from each other. The exact temperature is not critical since the score is based on the agreement of their device to a standard thermometer at any temperature within the test range of 0^oC to 100^oC.
6. Limit the time that a team can be allowed at each station to 2 minutes to allow adequate time to judge all the teams.
7. Record the actual temperature as indicated by the thermometer supplied to the team when they entered the room, the temperature as indicated by a digital display on or attached to their device, and the lite LED color at each station. Do not show the team their temperature results until they have completed all four stations. No program modification is allowed once the team starts their evaluation at the front tables. (See attached score sheet)
8. Allow the teams to work on the written question anytime during the rotation. Written questions will focus only on the area identified in the rules.
9. If the device fails during the round, the team's score will be based on the points earned to the point of failure with no more than a 15-point maximum at any one of the four temperature stations. This 15-point maximum deduction includes the multiplication factor.

VI. Sample Score Sheet

Team Name __________ Team Number __________

Design Log (4 pts. each - 28 pts. Max.)

a) Neat, complete, detailed picture with components labeled. __________

b) Data table containing a minimum of 10 trials showing sensor voltage reading and actual measured temperatures ^{0}C. __________

c) Scatter-plot graph of this data with temperature on the Y-axis and voltage on the X-axis. __________

d) Function graph of mathematical model supported by the data overlaid on scatterplot of the data. __________

e) Equation of the above mathematical model used to convert measured voltage to the corresponding temperatures in ^{0}C highlighted for easy identification. __________

f) Printout of program with code highlighted showing this exact mathematical equation converting voltage to temperature ^{0}C. __________

g) Program with the code highlighted that will illuminated the appropriate LED(s) according to their assigned temperature ranges. __________

Temperature Accuracy (60 pts. Max.)

Temp Range 1		**Temp Range 2**		**Temp Range 3**		**Temp Range 4**	
Voltage ___________.		Voltage ___________.		Voltage ___________.		Voltage ___________	
Actual	Experimental	Actual	Experimental	Actual	Experimental	Actual	Experimental
_______	________	_______	________	_______	________	_______	________
Abs. Error ________		Abs. Error _______		Abs. Error ________		Abs. Error ________	

Sum of Absolute Error = _________

Temperature Score ***(60 – (Sum of Abs. Error X Multiplier**)) =*** ____________

***** x2 at Regional*** ***x3 at State*** ***x4 at Nationals***

LED Accuracy (5 pts. Each - 20 pts. Max.)

LED1____ Pts.______ LED2____ Pts.______ LED3____ Pts.______ LED4____ Pts.______

LED Total _________

Test Score _________

Participation Points Only ______________

Total Score __________

VIII. Sample Written Test

Science Olympiad Detector Building Tie Breaker

If a thermo-sensor recorded a reading of 8700 at 20°C and 6400 at 70°C, and using the thermo-sensor's reading as the independent variable and temperature as the dependent variable, calculate the slope and y-intercept of the linear equation that would describe this relationship.

1) Slope = ____________________

2) Y-Intercept = ___________________

Using this equation, determine the temperature in degrees Celsius resulting from a sensor reading of 9230.

3) _______________ °C

4) _______________ °F

5) On the LED pictured to the right, which lead is the anode, A or B?

6) Which lead is the cathode, A or B?

7) Which lead on this LED should be connected to the positive voltage, A or B?

8) Which lead on this LED do you connect to the ground, A or B?

9) Which direction do the electrons move? A→B **or** B→A

10) If the wiring described above is reversed, what would happen?

11) If too much current flows through the LED, what would happen?

12) As temperature increase in a metal, does its' resistance typically go up or down?

13) How are the different colors of an LED created? (Circle the best answer)

a) The color of the plastic used in the construction of the LED housing.

b) The semiconductor compound used in forming the PN junction.

c) The type of gas used in the LED, much like a Neon light.

IX. Key for Sample Written Test

Science Olympiad Detector Building Test

If a thermo-sensor recorded a reading of 8700 at 20°C and 6400 at 70°C and using the thermo-sensor's reading as the independent variable and temperature as the dependent variable, calculate the slope and y-intercept of the linear equation that would describe this relationship.

1) Slope = **-0.0217** **(-46 Half credit)**

2) Y-Intercept = **209** **(9620 Half credit)**

Using this equation, determine the temperature in degrees Celsius resulting from a sensor reading of 9230.

3) **8.48**_ °C

4) **47.3** °F

5) On the LED pictured to the right, which lead is the anode? **A**

6) Which lead is the cathode? **B**

7) Which lead on this LED should be connected to the positive terminal, **A**

8) Which lead on this LED do you connect to the ground, **B**

9) Which direction do the electrons move? **B→A**

10) If the wiring described above is reversed, what would happen?

Would not light up – current is blocked

11) If too much current flows through the LED, what would happen?

LED would burn up

12) As temperature increase in a metal, does its' resistance typically go up or down?

increase

13) How are the different colors of a LED created? (Circle the best answer)

b) The semiconductor compound used in forming the PN junction.