DETECTOR BUILDING C

PRINCETON UNIVERSITY SCIENCE OLYMPIAD INVITATIONAL TOURNAMENT 2020

TEAM ______________________ C - _______		
example: Science Olympiad High School		
NAME(S) ______________ ______________		SCORE _______ / 75

INSTRUCTIONS	
1	You have the duration of this event block (up to 50 minutes) to complete as many questions as you can on this exam.
2	Please limit responses to 1-3 sentences per question. Full sentences are not required. You will not be penalized for writing a lot, but doing so may take time away from answering other questions.
3	Explain and show your work for calculations unless otherwise noted. Units are required.
4	All tiebreaker questions are included in the test score. There are no penalties for incorrect answers.
5	Please write your team number on each page.
6	You will need two specification sheets to complete parts of this test. They are titled “NTE3019 / Light Emitting Diode (LED) / Red Diffused, 5mm” and “NTC Thermistors, Radial Leaded, Standard Precision.”
7	If you brought a laptop for programming your device, only your programming application (IDE) may be open while you are working on this written test.
8	Your total score on this test will be multiplied by (30 / 75) to convert it to a score out of 30 points (as required by rule 6.b.iv.).

QUESTIONS		
1	**What does the initialism LED stand for? What does each word mean about LEDs?**	____ / 3
2	**List an example application for each of the following LED outputs: visible, ultraviolet, and infrared.**	____ / 3
3	**Your partner has snipped the leads/wires on all of your through hole infrared LEDs so that they can all be the same length. How can you still identify the anode and cathode without making any electrical connections?**	____ / 2
4	**<u>Tiebreaker 3</u>: A 9 V battery is connected in series with a resistor and an NTE3019 LED in forward bias. Using the provided specification sheet for NTE's NTE3019 5 mm red diffused LED, calculate the range of resistor values in Ohms that would allow the LED to operate within its specified range.**	____ / 6
5	**Which of the following statements comparing LEDs is correct? Write the letter corresponding to an answer choice here: ______.** a. LEDs, like LASERs, emit monochromatic temporally coherent light due to high Q-resonance of both systems; however, by design light from most LEDs is not spatially coherent. b. LEDs have a relatively longer useful lives, and unlike incandescent lighting their failure is usually gradual. c. Both LEDs and photodiodes are forward-bias components that involve conversions between light and electrical energy (in different directions). d. LEDs emit more lumens per watt than incandescent lighting, but both radiate similar amounts of heat. e. Both a. and b. f. Both a. and c.	____ / 3
6	**Which of the following statements about thermistors is correct? Write the letter corresponding to an answer choice here: ______.** a. Increased resistance is expected when a hot soldering iron is held in close proximity to an NTC thermistor (in its operating temperature range). b. The R_25 value specifies the minimum resistance that can be measured on a PTC thermistor. c. Reversing an NTC thermistor used as an inrush current limiter will make it a PTC thermistor with the opposite function. d. While NTC thermistors decrease in resistance with increasing temperature, PTC thermistors always increase in resistance with increasing temperature. e. Both NTC and PTC thermistors are popular choices for managing current draw by electrical devices. f. None of the above are correct.	____ / 3

7	**<u>Tiebreaker 4</u>: Resistance temperature detectors (RTDs) use a coiled conductive metal wire (commonly made of platinum) to sense temperature changes. Describe what occurs at a molecular level to produce this temperature-resistance relationship.**	____ / 4
8	**What is occurring at a molecular level for temperature detection by both an NTC and PTC semiconductor-based thermistor?**	____ / 3
9	**How do resistance temperature detectors (RTDs) and semiconductor-based thermistors compare in sensitivity to temperature changes?**	____ / 3
10	**An alternative Steinhart-Hart equation with the form T = B / (ln(R) – A) – C is computationally faster for a computer at a slight expense to accuracy. Why might such a tradeoff be acceptable?**	____ / 3
11	**Describe a method for reducing noise in the signal obtained from your temperature measurement device.**	____ / 1
12	**Explain how the low thermal mass of common thermistors affects both responsiveness and accuracy.**	____ / 2
13	**What specification determines whether a 5 mm LED with anode connected to the positive terminal and the cathode to the negative terminal of a 24 V output power supply will breakdown?**	____ / 1
14	**Provide two reasons for adhering to maximum ratings for a component, even if it continues to operate outside of its specified range.**	____ / 2

15	**True or false: A correlation coefficient with magnitude close to 1 indicates that the form of the attempted fit properly explains the underlying relationship of the data in question. Write the letter corresponding to your answer choice here: ______.** a. True. b. False.	____ / 1

Questions 16-24: The remainder of the questions reference the specification sheet for Vishay's NTCLE100E3 NTC thermistors.

16	**Tiebreaker 1: Referencing the B parameter on the provided datasheet, estimate the resistance at 85°C for a thermistor with color code red-red-black.**	____ / 6
17	**Should NTCLE100E3 thermistors be used to measure the temperature of dry ice (which is around -79°C)? Why or why not?**	____ / 2
18	**The specification sheet mentions "zero power." What does this mean and how does it affect operation?**	____ / 2

Your partner has gathered the following temperature and resistance data using an NTCLE100E3 thermistor but has since forgotten which thermistor they used.

Temperature (°C)	Resistance (Ω)
-40.	163.8
-10.	38.0
20.	11.9
50.	4.6
80.	2.1
110.	1.1

19	**Tiebreaker 2: First, linearize the temperature/resistance data, and fill in the table below, making sure to include appropriate units. Very briefly describe what operations you performed to linearize data (to allow for partial credit if your numbers are off).**	____ / 6

20	**Plot the linearized data in the space below.**	____ / 3
21	**Determine an equation that describes your linearized data. Include units and define any variables you use.**	____ / 5
22	**Comment on the slope of your linearized fit and the temperature coefficient for this thermistor.**	____ / 2
23	**Mention one reason for linearizing your experimental data.**	____ / 3
24	**Using the linearized equation for this temperature-resistance relationship, determine the B parameter for this thermistor. What color code does this value correspond to? If more than one color code matches, list all that match.**	____ / 3
25	**Did you return all borrowed materials and dispose of waste? Is your working space dry and clear for the next team?**	____ / 3