

Detector Building
Test Packet
Captains Tryouts 2019 - 2020
(Montgomery)

Names: _____

School: _____

Team #: _____

Score: _____/80

Multiple Choice Questions

1. Which of the following is the circuit symbol for a thermistor? (___/1)

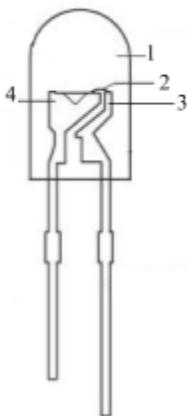


2. In which of these applications are NTC thermistors common? (___/1)

- Resettable fuses
- Overheating protection in motors
- Inrush current limiters
- Multiway switching

3. Match the LED components with their number on the diagram. (___/4)

- Lens:
- Post:
- Anvil:
- Wire bond:



4. Which of the following answers does the shorter lead of an LED correspond to? Choose two. (___/2)

- Positive terminal
- Negative terminal
- Cathode
- Anode

5. Which of these elements is least successful as a semiconducting material for an LED? (___/1)

- Gallium arsenide
- Zinc selenide
- Silicon
- Diamond

6. Which of the following elements serve as a dopant that creates holes in a semiconductor? (___/1)

- Aluminum
- Arsenic
- Germanium
- Antimony

7. In a standard resistor, when temperature increases what happens to the resistivity? (___/1)

- Resistivity decreases
- Resistivity stays the same
- Resistivity increases

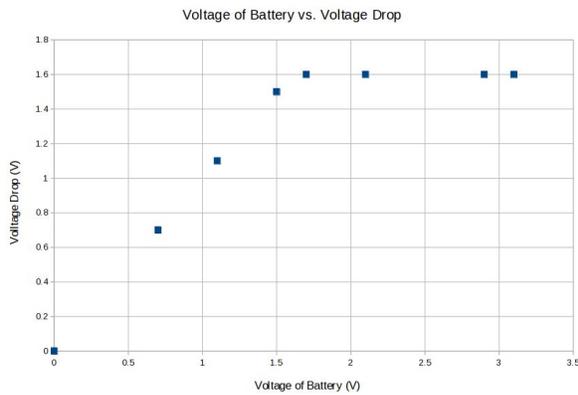
8. Which of the following graphs would be the most conducive to finding the relationship between two quantitative variables? (___/1)

- Bar chart
- Scatterplot
- Dotplot
- Boxplot

9. Which correlation coefficient would indicate a strong negative association? (___/1)

- a. $r = 0.9$
- b. $r = 0.1$
- c. $r = -0.4$
- d. $r = -0.8$

10. A battery is connected in series with a fixed resistor followed by a mystery component. The voltage of the battery is varied and the voltage drop across the mystery component is measured. A scattergram of the data values is given below. What would the mystery component most likely be? (___/1)



- a. Diode
- b. Resistor
- c. Battery
- d. Relay

11. A variable voltage (such as the one generated by a thermistor and a resistor arranged in a voltage divider) is best read in by a microcontroller through what sort of input? (___/1)

- a. Serial
- b. Digital
- c. Parallel
- d. Analog

12. Which of the following does not classify as a microcontroller? (___/1)

- a. Arudino
- b. TI Innovator
- c. Raspberry Pi
- d. 555 Timer IC

13. At 20°C, which of these materials have the highest temperature coefficient of resistivity? (___/1)

- a. Copper
- b. Tungsten
- c. Iron
- d. Lead

Free Response Questions

14. What does “LED” stand for? (___/1)

15. Name three benefits that LEDs have over incandescent bulbs. (___/3)

16. Complete the following statement? (___/2)

LEDs are _____ junctions that emit light when free electrons in the ___-type semiconductor jump across the _____ layer, recombining with the holes in the ___-type semiconductor, releasing energy in the form of photons.

17. Explain what “doping” is in relation to semiconductors. (___/2)

18. Explain the reason behind different colored LEDs. (___/2)

19. The material used to construct a certain LED has a band gap of 2.29×10^{-19} J. Complete the following.

a. Calculate the wavelength of light that the LED emits. (___/3)

b. Name the type of light the LED emits. (___/1)

20. Explain the difference between NTC thermistors and PTC thermistors. (___/2)

21. A thermistor has a resistance of 350Ω at 300K . Find the resistance of the resistor at 320K using a first-order approximation with a temperature coefficient of resistance of $-5 \Omega/\text{K}$. (___/4)

22. An NTC thermistor has a resistance of 1200Ω at 40°C . Find the resistance of the resistor at -20°C using a third order approximation with a β parameter of 200K . (___/4)

23. Explain why resistance in a typical conductor varies with temperature, using arguments about what occurs on the molecular level. (___/3).

24. As the temperature of a conductor increases, thermal expansion may occur. Explain what impact thermal expansion has on the resistance of the conductor and if the phenomenon is significant towards the calculation of its resistance. (___/3)

25. Does the resistance of silicon increase, decrease or stay the same as temperature increases? Explain why this is true. (___/3)

Increase

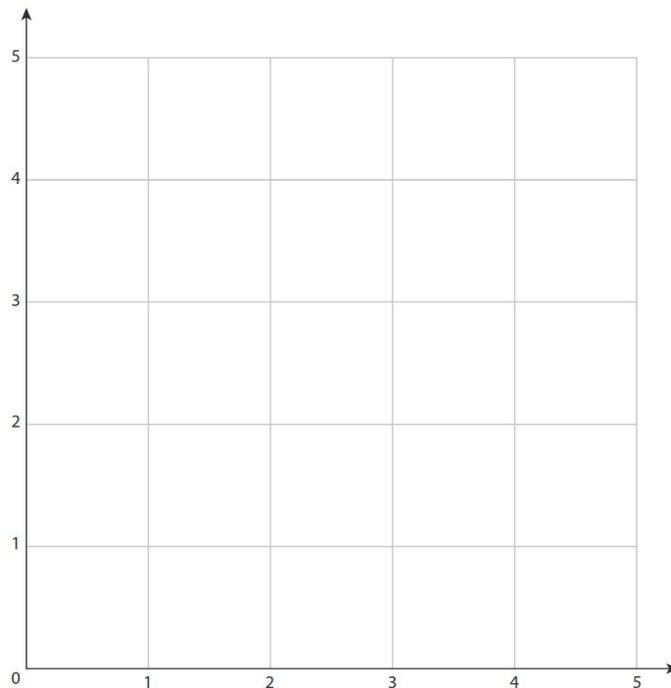
Decrease

Stays the same

26. A certain non-ohmic device increases in resistance as voltage increases and all other factors are held constant. Solve the following tasks using data regarding the device.
- a. Linearize the data below and use the blank data columns to show the linearized data. None, one, or both data columns may be needed. (___/2)

Voltage (V)	Resistance (Ω)		
0.80	1.00		
1.40	1.60		
1.70	2.40		
1.90	2.70		
2.20	3.60		

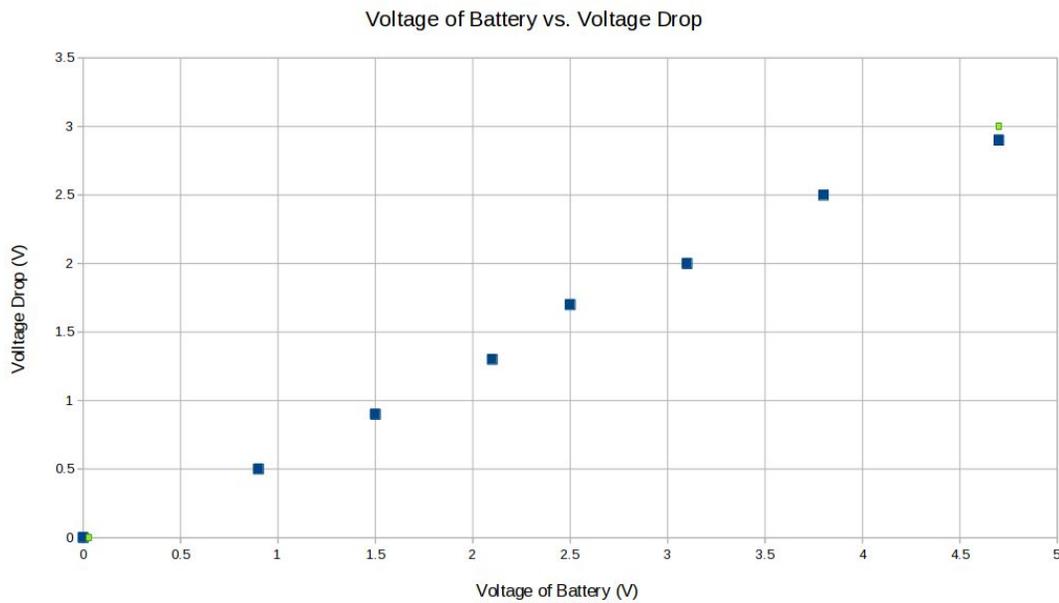
- b. Graph the data and draw a regression line. (___/3)



c. Approximate the slope of the regression line. (___/2)

d. Solve for the resistance of the device when voltage is equal to 3V. (___/2)

27. A battery is connected in series with a fixed resistor followed by a mystery component. The voltage of the battery is varied and the voltage drop across the mystery component is measured. A scattergram of the data is given below. Accomplish the following tasks.



Score: ___/4

a. Write a linear equation modeling the relationship shown in the scattergram. (___/2)

b. Predict the value of the voltage drop when the battery voltage is 6.1V. (___/2)

c. Circle what the mystery component most likely may be. (___/1)

Diode

Resistor

Battery

Relay

28. A thermistor is connected in series with a 1000Ω resistor. The thermistor is attached to the positive terminal of a 9V battery, while the 1000Ω resistor is attached to the negative terminal of the same battery. At the ambient temperature of the environment, the thermistor has a resistance of 1200Ω . Complete the following tasks.

a. Draw a circuit diagram of the described situation. (___/2)

- b. Find the voltage of the circuit between the thermistor and the 1000Ω resistor.
(__/2)

29. The purpose of calibrating a scientific instrument is to measure and adjust the precision and accuracy of the device. Define those two terms.

- a. Precision (__/1)

- b. Accuracy (__/1)