

Passage V

A material is a *superconductor* (its electrical resistance, R , is zero) if its temperature, T , is lower than its *critical temperature*, T_C .

Students measured R and T for both a sample of Material X and a sample of Material Y while each sample was cooled. They used an ohmmeter to measure R (in ohms) and a *thermocouple* to measure T . The thermocouple displayed the result of each measurement of T as a voltage (in millivolts, mV). Accordingly, the students plotted R versus voltage (see Figure 1). To convert voltage in mV to T in kelvins (K), they used Table 1.

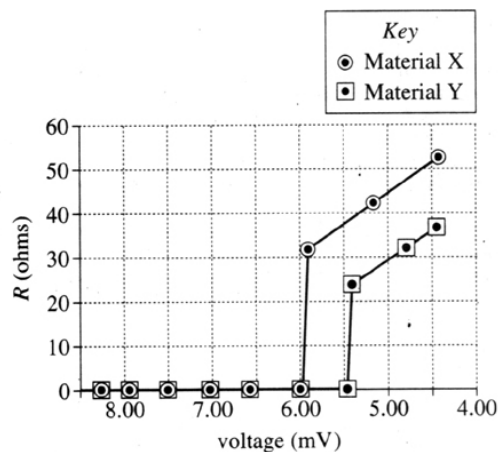


Figure 1

Table 1: Voltage (mV)–Temperature (K) Conversion Chart										
T (K)	0	1	2	3	4	5	6	7	8	9
80	6.29*	6.25 [†]	6.21	6.17	6.13	6.09	6.05	6.01	5.97	5.93
90	5.90	5.86	5.83	5.79	5.75	5.72	5.68	5.64	5.60	5.56
100	5.52	5.48	5.44	5.41	5.37	5.34	5.30	5.27	5.23	5.20
110	5.16	5.13	5.09	5.06	5.02	4.99	4.95	4.91	4.88	4.84
120	4.81	4.77	4.74	4.70	4.67	4.63	4.60	4.56	4.53	4.49
130	4.46	4.42	4.39	4.35	4.32	4.28	4.25	4.21	4.18	4.14
140	4.11	4.07	4.04	4.00	3.97	3.93	3.90	3.86	3.83	3.79
*For example, 6.29 mV converts to 80 K. †For example, 6.25 mV converts to 81 K.										

Figure and table adapted from "Instruction Manual for Superconductor Demonstrations." ©1992 by Colorado Superconductor, Inc.

23. Based on Table 1, if the thermocouple were used to measure the temperature of a sample at 112 K, the voltage displayed would most likely be closest to which of the following?

A. 4.81 mV
B. 5.09 mV
C. 5.44 mV
D. 6.29 mV

24. In Table 1, as voltage decreases, temperature:

F. increases only.
G. decreases only.
H. varies, but with no general trend.
J. remains constant.

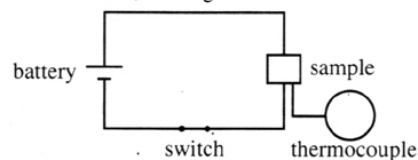
25. Based on Figure 1 and Table 1, the range of temperatures over which Material X is a superconductor is closest to which of the following?

A. 2 K
B. 6 K
C. 88 K
D. 176 K

26. Based on Figure 1 and Table 1, T_C for Material Y is most likely closest to which of the following?

F. 25 K
G. 50 K
H. 75 K
J. 100 K

27. Suppose that the sample of Material Y is included in an electrical circuit, as diagrammed below.



Based on Figure 1 and Table 1, if the sample is kept at 81 K, will the sample generate any heat as a result of the electrical current flowing through the sample?

- A. No, because R of the sample will equal zero.
B. No, because R of the sample will be greater than zero.
C. Yes, because R of the sample will equal zero.
D. Yes, because R of the sample will be greater than zero.