USE OF A BUNSEN BURNER

Many chemical experiments require the use of Bunsen burner or similar gas burner to produce heat. The object of this experiment is to familiarize you with the gas burner and teach you how to use it with the aid of thermocouples to explore the temperature at various sites in the burner flame.

In 1821 Thomas Seebeck discovered the principle that lead to thermocouples. He twisted the ends of two dissimilar metal wires together. When he heated the junction between the two wires, a current flowed. The voltage produced by the hot metal junction was a function of its temperature. This junction became known as a thermocouple and the phenomenon the Seebeck effect.

The two dissimilar metals in your thermocouple are chromel and alumel. Both chromel and alumel are alloys with nickel as the major component. Chromel has 10% chromium, and alumel has 5% aluminum with a trace of silicon. When heated, they produce about 0.041 millivolts/°C.

In addition to measuring temperatures, the current generated can also be used power electrical devices. Nuclear thermoelectric generators are used as a source of electrical energy for long term space probes. For example, a grapefruit size plutonium reactor weighing roughly 4 pounds can produce 11.6 kilowatt hours of electricity, enough to operate your television for a thousand years.

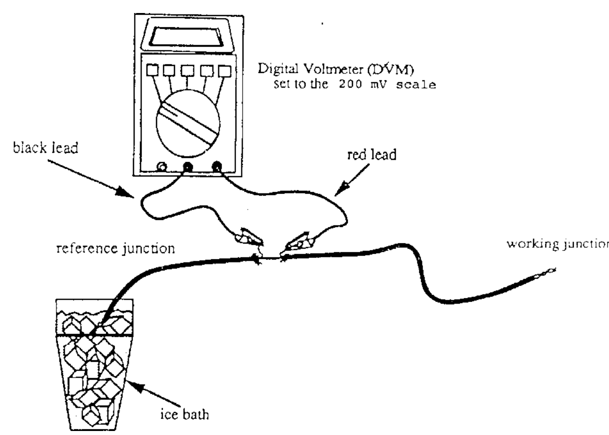
MATERIALS:

Bunsen or Tirrel Burner, thermocouple, digital voltmeter, ice, two styrofoam coffee cups.

PROCEDURE:

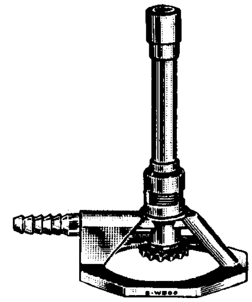
1. Fill two stacked styrofoam coffee cups with cracked ice to act as a reference temperature for the thermocouple. Add a few milliliters of tap water to the ice to insure good thermal contact with the thermocouple. Insert the shorter end of the thermocouple wire into the ice bath and attach the leads to the exposed metal wires. See the drawing on the right.

   Attach the "black" or negative voltmeter lead to the thermocouple wire on the exposed wire closest to the ice and the positive or "red" lead to the other exposed wire.



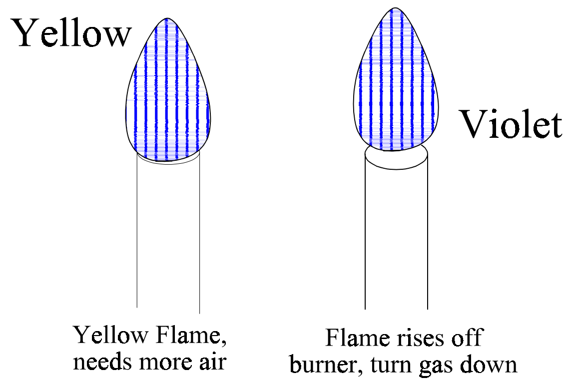
Thermocouple temperature measuring circuit.

2. Set the digital voltmeter on the 200 millivolt scale. Test your apparatus by measuring the room temperature. Your voltmeter should read somewhere between 0.8 mV (20.1°C) and 1.2 mV (30.0°C). Compare your voltmeter readings with the voltage to temperature conversions on Table #1. A 0.0 mV voltmeter reading probably means you have a poor electrical connection or the alligator clips are "shorted" together. Check your voltmeter leads. Record your room temperature to the nearest degree Celsius.



Tirrel Burner

3. Close the air vent and light your Bunsen burner. Open the air vent until you just obtain a sharp blue cone. Make a drawing of your burner flame in your laboratory notebook. Determine the temperature at various parts of the flame by inserting the tip of the thermocouple probe into the flame holding the wire steady until the voltmeter reading is more or less constant over several readings. Record the color of the tip of the thermocouple probe as well as the voltmeter reading on your drawing. Continue the experiment by mapping the various part of the flame to determine the highest temperature. Test the outside edge, the top of the cone, inside the cone, the top of the visible flame, etc. Continue to report both your voltmeter reading and probe color on your drawing for each measurement.



Flames resulting from improper gas-air mixture

Open the air vent completely. Make a drawing of your flame. Determine only the hottest part of the flame recording your voltmeter reading and probe color on your drawing.

4. Close the air vent to produce a luminous (yellow) flame. Make a drawing of your burner flame in your laboratory notebook. Measure both the voltmeter reading and color of the probe at various parts of the flame (middle area, outer edge, top of the flame, etc) until you have completely mapped the flame. If the voltmeter readings drift excessively, report a representative value.

QUESTIONS AND CONCLUSIONS:

Q1. Redraw each of your flames substituting your voltmeter readings with temperatures. The conversions are given on Table #1.

Q2. A general rule is that hot objects do not begin to incandesce until 750°C. Explain how your measurements support or refute this rule ?

Q3. Which type of flame, a blue cone or a luminous flame produced the highest temperature? What was the highest temperature you observed for each type of flame? Why do you think that there was a difference in the two flames?

Q4. Did increasing the amount of air increase the temperature after the blue cone was formed? Explain your answer.

Q5. Assuming a thermocouple probe and voltmeter were not available, how could you use a piece of iron wire to find the hottest part of a Bunsen burner flame?

Q6. A match is attached to a paper clip and placed on top of an unlit Bunsen burner. According to your observations and measurements, what do you predict will happen to the match when the flame is ignited? Explain your reasoning.

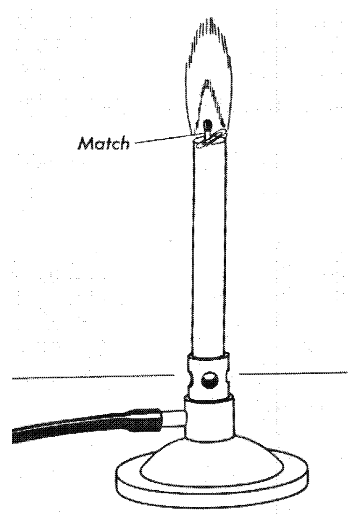


TABLE 1. Digital Voltmeter to Temperature (°C) Conversions

Digital Voltmeter Readings, in millivolts (mv)

	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.0	2.6	5.1	7.6	10.1	12.7	15.2	17.6	20.1	22.6
1	25.1	27.5	30.0	32.4	34.9	37.3	39.7	42.2	44.6	47.0
2	49.4	51.9	54.3	56.7	59.1	61.5	63.9	66.3	68.7	71.1
3	73.5	75.9	78.3	80.7	83.2	85.6	88.0	90.4	92.8	95.2
4	97.7	100.1	102.5	104.9	107.4	109.8	112.2	114.7	117.1	119.6
5	122.0	124.5	126.9	129.4	131.9	134.3	136.8	139.3	141.7	144.2
6	146.7	149.2	151.7	154.1	156.6	159.1	161.6	164.1	166.6	169.1
7	171.6	174.1	176.6	179.1	181.6	184.1	186.6	189.0	191.5	194.0
8	196.5	199.0	201.5	204.0	206.5	209.0	211.5	214.0	216.5	219.0
9	221.5	223.9	226.4	228.9	231.4	233.9	236.3	238.8	241.3	243.8
10	246.2	248.7	251.2	253.6	256.1	258.5	261.0	263.4	265.9	268.3
11	270.8	273.2	275.6	278.1	280.5	282.9	285.4	287.8	290.2	292.6
12	295.1	297.5	299.9	302.3	304.7	307.1	309.5	311.9	314.3	316.7
13	319.1	321.5	323.9	326.3	328.7	331.1	333.5	335.9	338.3	340.7
14	343.0	345.4	347.8	350.2	352.6	355.0	357.3	359.7	362.1	364.5
15	366.9	369.2	371.6	374.0	376.4	378.7	381.1	383.5	385.8	388.2
16	390.6	393.0	395.3	397.7	400.1	402.4	404.8	407.2	409.6	411.9
17	414.3	416.7	419.0	421.4	423.8	426.1	428.5	430.8	433.2	435.6
18	437.9	440.3	442.6	445.0	447.4	449.7	452.1	454.4	456.8	459.1
19	461.5	463.8	466.2	468.5	470.9	473.2	475.6	477.9	480.3	482.6
20	485.0	487.3	489.7	492.0	494.4	496.7	499.1	501.4	503.7	506.1
21	508.4	510.8	513.1	515.5	517.8	520.2	522.5	524.9	527.2	529.5
22	531.9	534.2	536.6	538.9	541.3	543.6	546.0	548.3	550.7	553.0
23	555.3	557.7	560.0	562.4	564.7	567.1	569.4	571.8	574.1	576.5
24	578.8	581.2	583.5	585.9	588.2	590.6	592.9	595.3	597.6	600.0
25	602.3	604.7	607.0	609.4	611.7	614.1	616.4	618.8	621.2	623.5
26	625.9	628.2	630.6	632.9	635.3	637.7	640.0	642.4	644.7	647.1
27	649.5	651.8	654.2	656.6	658.9	661.3	663.7	666.1	668.1	670.8
28	673.2	675.5	677.9	680.3	682.7	685.0	687.4	689.8	692.2	694.6
29	696.9	699.3	701.7	704.1	706.5	708.9	711.3	713.7	716.0	718.4
30	720.8	723.2	725.6	728.0	730.0	732.8	735.2	737.6	740.0	742.4
31	744.8	747.2	749.7	752.1	754.5	756.9	759.3	761.7	764.1	766.6
32	769.0	771.4	773.8	776.2	778.7	781.1	783.5	786.0	788.4	790.8
33	793.3	795.7	798.1	800.6	803.0	805.4	807.9	810.3	812.8	815.2
34	817.7	820.1	822.6	825.0	827.5	829.9	832.4	834.9	837.3	839.8
35	842.2	844.7	847.2	849.7	852.1	854.6	857.1	859.5	862.0	864.5
36	867.0	869.5	871.9	874.4	876.9	879.4	881.9	884.4	886.9	889.4
37	891.9	894.4	896.9	899.4	901.9	904.4	906.9	909.4	911.9	914.4
38	916.9	919.4	922.0	924.5	927.0	929.5	932.0	934.6	937.1	939.6
39	942.2	944.7	947.2	949.8	952.3	954.8	957.4	959.9	962.5	965.0
40	967.5	970.1	972.6	975.2	977.7	980.3	982.9	985.4	988.0	990.5
41	993.1	995.7	998.2	1000.8	1003.4	1005.9	1008.5	1011.1	1013.7	1016.3
42	1018.8	1021.4	1024.0	1026.6	1029.2	1031.8	1034.4	1036.9	1039.5	1042.1
43	1044.7	1047.3	1049.9	1052.6	1055.2	1057.8	1060.4	1063.0	1065.6	1068.2
44	1070.8	1073.5	1076.1	1078.7	1081.3	1084.0	1086.6	1089.2	1091.9	1094.5
45	1097.1	1099.8	1102.4	1105.1	1107.7	1110.4	1113.0	1115.7	1118.3	1121.0
46	1123.7	1126.3	1129.0	1131.7	1134.3	1137.0	1139.7	1142.4	1145.0	1147.7
47	1150.4	1153.1	1155.8	1158.5	1161.2	1163.9	1166.6	1169.3	1172.0	1174.7
48	1177.4	1180.1	1182.9	1185.6	1188.3	1191.0	1193.8	1196.5	1199.2	1202.0
49	1204.7	1207.5	1210.2	1213.0	1215.7	1218.5	1221.3	1224.0	1226.8	1229.6
50	1232.3	1235.1	1237.9	1240.7	1243.5	1246.3	1249.1	1251.9	1254.7	1257.5
51	1260.3	1263.1	1265.9	1268.8	1271.6	1274.4	1277.3	1280.1	1282.9	1285.8
52	1288.6	1291.5	1294.3	1297.2	1300.1	1302.9	1305.8	1308.7	1311.5	1314.4
53	1317.3	1320.2	1323.1	1326.0	1328.9	1331.8	1334.7	1337.6	1340.5	1343.4
54	1346.3	1349.3	1352.2	1355.1	1358.0	1361.0	1363.9	1366.9	1369.8	1372.7

Temperature, in degrees Celsius (°C)

SOURCE OF MATERIALS

OMEGA Engineering, Inc. 1-800-826-6342 (Sales)
P.O. Box 2284
Stamford, CT 06906

High Temperature/Oxidizing Atmosphere Wire

PART # GG-K-26 Type K thermocouple wire, 26 gauge, glass insulated

Prices as of 2/95 + $4.00 shipping/handling

25 ft = $17.06
50 ft = $27.30 ** = 15 meters or enough for 15 groups @ 1 m/group
100 ft = $47.78
200 ft = $82.00
500 ft = $136.50
etc.

Low Temperature/General Purpose Wire

PART #PR-T-24 Type-T thermocouple wire, 24 gauge, Polyvinyl wrap

25 ft = $8.75
50 ft = $14.00
100 ft = $24.50
200 ft = $42.00
500 ft = $70.00
etc.

REFERENCES:

This experiment was developed from "Thermocouple Experiments", by Carl Houtman and Robert Shaner, Instrumentation Workshop, Institute for Chemical Education (ICE), Department of Chemistry, University of Wisconsin-Madison, Madison, WI 53706 - 6/29/92.