TEMPERATURE MEASUREMENT

INTRODUCTION

The fundamental meaning of temperature is not given easily. For most purposes the zeroth law of thermodynamics gives a useful concept: For two body to be said to have the same temperature, they must be in thermal equilibrium; this is, when thermal communication is possible between them, no change in the thermodynamic coordinates of either occurs. The zeroth law says that when two bodies are each in thermal equilibrium with a third body, they are in thermal equilibrium with each other.

It is convenient to measure temperature by means of a number and for this purpose temperature scales have been devised. Accordingly, systems in thermal equilibrium with one another have the same number on the adopted scale of temperature and this is the basis for the measurement of the temperature of a system using another system called a thermometer.

The type of the thermometer required to measure temperature depends on many things such as the magnitude and range of temperature, problems of installation and size, nature of the system whose temperature is to be measured, etc.

Important characteristics of thermometers are accuracy, sensitivity, repeatability and response time. Also the thermometer used should not influence significantly with the system being measured.

THERMOELECTRIC SENSORS

If two wires of different materials A and B are connected in a circuit as shown in Fig.1, with one junction at temperature T_1 and the other at T_2, then an infinite resistance voltmeter detects an electromotive force E. The magnitude of the voltage E depends on the materials and temperatures T_1 and T_2.

The overall relation between voltage E and temperatures T_1 and T_2, which is the basis of thermoelectric temperature measurement, is called the ***Seebeck effect***.

To make use of a thermocouple, it must be calibrated. Calibration of a given temperature measuring device is generally accomplished by subjecting it to some established fixed point environment, such as the melting and boiling points of standard substances, or by comparing its readings with those of some more accurate (***Secondary standard***) temperature sensor which itself has been calibrated. The latter , which will be adopted in this experiment, is accomplished by placing the two devices in intimate thermal contact in a constant temperature controlled bath. By varying the temperature of the bath over the desired range (allowing equilibrium at each point), the necessary corrections are determined. Accurate resistance thermometers, liquid-in-glass expansion thermometers, or thermocouples are generally useful as secondary standards.

PROCEDURE

A water bath is used to calibrate a thermocouple. The water bath is provided with a heater to vary its temperature, and a thermometer to measure the temperature. A water proof thermocouple is immersed in the bath. Then at different bath temperatures the EMF of the thermocouple is recorded.

REQUIREMENTS

1. Plot the relation between the recorded EMF and temperature.
2. Comment on the results.
3. What is the fundamental principle of a liquid-in-glass thermometer.

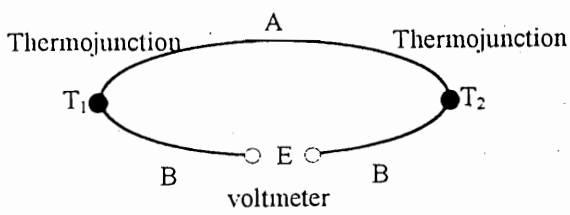

Figure 1 Basic thermocouple.

	Thermometer reading ($^{\circ}$C)	Thermocouple readings		
		Type ( ) μV	Type ( ) μV	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				