

EXPERIMENT

4

The Determination Of Boiling Point

Objective

In this experiment, you will first check your thermometer for errors by determining the temperature of two stable equilibrium systems. You will then use your calibrated thermometer in determining the boiling point of an unknown substance.

Introduction

The most common laboratory device for the measurement of temperature is, of course, the thermometer. The typical thermometer used in the general chemistry laboratory permits the determination of temperatures from -20°C to 120°C . Most laboratory thermometers are constructed of glass, and so they are very fragile. Most general chemistry laboratory thermometers contain a red-colored organic liquid as the temperature-sensing fluid. This liquid is flammable and may be toxic: If a thermometer is broken, you should shut off any flames in the vicinity and consult the instructor. Until recently, many laboratory thermometers contained elemental mercury metal as the temperature-sensing fluid. Mercury, especially its vapor, is very toxic, however, and most labs have replaced mercury thermometers with the red-liquid type. Mercury also presents environmental hazards if it is spilled from a broken thermometer.

The typical laboratory thermometer contains a bulb (reservoir) of temperature-sensing liquid at the bottom; it is this portion of the thermometer that actually senses the temperature. The glass barrel of the thermometer above the liquid bulb contains a fine capillary opening in its center, into which the liquid rises as it expands in volume when heated. The capillary tube in the barrel of the thermometer has been manufactured to very strict tolerances, and it is very regular in cross-section along its length. This ensures that the rise in the level of liquid in the capillary tube as the thermometer is heated will be directly related to the temperature of the thermometer's surroundings.

Although the laboratory thermometer may appear similar to the sort of clinical thermometer used for determination of body temperature, the laboratory thermometer does *not* have to be shaken before use. Medical thermometers are manufactured with a constriction in the capillary tube that is intended to prevent the liquid level from changing once it has risen. The liquid level of a laboratory thermometer, however, changes immediately when removed from the substance whose temperature is being measured. For this reason, temperature readings with the laboratory thermometer must be made while the bulb of the thermometer is actually in the material being determined.

Because the laboratory thermometer is so fragile, it is helpful to check that the thermometer provides reliable readings before any important determinations are made with it. Often, thermometers develop nearly invisible hairline cracks along the barrel, making them unsuitable for further use. This happens especially if you are not careful in opening and closing your laboratory locker: slamming shut a locker drawer can damage the thermometer.

To check whether or not your thermometer is operating correctly, you will *calibrate* the thermometer. To do this, you will determine the reading given by your thermometer in two systems whose temperature is known