quantity $A$ in Eq. (11) has the value $0.509 \ \text{kg}^{1/2} \ \text{mol}^{-1/2}$ and the quantity $B$ is found to be close to unity for many salts.\(^4\) Furthermore, the difference between molarity and molality is sufficiently small in dilute aqueous solutions that one can approximate $m_i$ by the molar concentration $c_i$ in $\text{mol L}^{-1}$.

For dilute solutions of HAc, $I = ac$ has a very small value and Eq. (10) is well approximated by

$$\log K_e = \log K_a + 2(0.509) \sqrt{ac}$$ \hspace{1cm} (13)

Thus, if $K_e$ has been determined from conductance measurements at a number of low HAc concentrations, one can plot $\log K_e$ against $\sqrt{ac}$ and make a linear extrapolation to $c = 0$ to obtain $K_a$.

**METHOD**

The use of dc circuitry is impractical for determining ionic conductance from measurements of the resistance of the solution in a conductivity cell, since the electrodes quickly become polarized: that is, electrode reactions take place that set up an emf (electromotive force) opposing the applied emf, leading to a spuriously high apparent cell resistance. Polarization can be prevented by (1) using a high (audio)-frequency *alternating current*, so that the quantity of electricity carried during one half-cycle is insufficient to produce any measurable polarization, and at the same time by (2) employing platinum electrodes covered with a colloidal deposit of "platinum black," having an extremely large surface area, to facilitate the adsorption of the tiny quantities of electrode reaction products produced in one half-cycle so that no measurable chemical emf is produced.\(^5\)

Although conductance/resistance meters are available commercially (e.g., YSI Yellow Springs Instruments, and others), the simple ac Wheatstone bridge of Fig. 1 is adequate and better illustrates some of the principles for accurate conductivity measurements. Here the ionic solution is placed in the conductivity cell, which is part of a bridge subjected to a small ac voltage from a 1-kHz oscillator. The condition of balance for the bridge is detected with an oscilloscope and requires that the alternating potential at points $B$ and $D$ be of equal amplitude and exactly in phase. This corresponds to a balance condition

$$\frac{Z_1}{Z_2} = \frac{Z_3}{Z_4}$$ \hspace{1cm} (14)

**FIGURE 1**

Conductance bridge. The slide-wire reading $X$ is on a scale from 0 to 1000. The oscillator should be isolated from the bridge circuit by a good-quality transformer, and another transformer should be used to isolate the bridge from the oscilloscope. The oscillator and cables should be well shielded.