Instruction Manual
for

Acid-Base Analyzer
type PHM71

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Acid-Base Analyzer

type PHM71

Section A. Introduction

![The Acid-Base Analyzer, type PHM71.](image)

The Acid-Base Analyzer, type PHM71, is a fully transistorized, line-operated instrument especially developed for the determination of acid-base and blood-gas parameters. A unique feature of this instrument is its modular construction. The basic unit is a high-precision pH meter into which two plug-in modules can be embodied, converting the Analyzer into a three-channel instrument for measuring pH, \( \text{Pco}_2 \) and \( \text{P}_2 \).

The large mirror-backed scale covers both the normal pH range from 0 to 14 pH and, expanded, the typical blood range from 6.6 to 8.0 pH. Utilizing the latter feature, the readable reproducibility is ±0.001 pH. It furthermore offers direct reading of the carbon dioxide tension (\( \text{Pco}_2 \)) from 8 to 200 mm Hg with a readability of 0.5 percent, and also direct reading of the oxygen tension (\( \text{P}_2 \)) in 3 ranges, from 0 to 80, from 0 to 160 and from 0 to...
Section B. Specifications

RANGE

pH:
- Normal: 0 to 14 pH
- Expanded: 6.6 to 8.0 pH

Pco₂:
For Pco₂ measurements, the PHM71 must be equipped with the Pco₂-Module, type PHA931.
8 to 200 mm Hg.

Po₂:
For Po₂ measurements, the PHM71 must be equipped with the Po₂-Module, type PHA930.
0 to 80 mm Hg
0 to 160 mm Hg
0 to 800 mm Hg

ELECTRICAL ZERO POINT
Adjustable from 6.6 to 8.0 pH.

TEMPERATURE COMPENSATION
Adjustable from 14 to 40°C.
Calibrated in 2°C divisions.
Accuracy of calibration: ±2°C.

ELECTRODE SENSITIVITY COMPENSATION
Calibrated in 1% divisions from 85 to 100%.
Accuracy of calibration: ±1%.

pH ADJUSTMENT CONTROL
Adjustable from 0 to 130 mV.
Not calibrated. 6-turn gear with reverse vernier 6:1.

METER
160 mm individually calibrated (linearity ±0.15%), mirror-backed with knife-edge pointer; taut-band-suspended moving coil.

ELECTRODE INPUT TERMINALS
3 pairs of Electrode Input Terminals for pH, Po₂ and Pco₂ electrodes, respectively.
RECORDED OUTPUTS

REC. 1

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>$P_{Ca}^2$</th>
<th>$P_{O_2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLTAGE</td>
<td>500 mV/pH</td>
<td>500 mV/decade</td>
<td>500 mV/100 mm Hg</td>
</tr>
<tr>
<td>OUTPUT IMPEDANCE</td>
<td>235 $\Omega \pm 5%$</td>
<td>235 $\Omega \pm 5%$</td>
<td>235 $\Omega \pm 5%$</td>
</tr>
</tbody>
</table>

REC. 2

<table>
<thead>
<tr>
<th></th>
<th>100 mV for full-scale deflection, independent of scale to be used.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLTAGE</td>
<td></td>
</tr>
<tr>
<td>OUTPUT IMPEDANCE</td>
<td>150 to 200 $\Omega$, dependent on the range.</td>
</tr>
</tbody>
</table>

OPERATING TEMPERATURE.

0 - 50 °C ambient.

POWER REQUIREMENTS

- 115 V ± 15%, 50-60 Hz, 0.10 A
- 220 V ± 15%, 50-60 Hz, 0.05 A

DIMENSIONS AND WEIGHT

- Height: 230 mm (9 1/16")
- Width: 410 mm (16 1/8")
- Depth: 190 mm (7 1/2")
- Weight: 5.7 kilos (13 lbs)

FINISH

Chemically resistant paint on aluminium.
<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>PCO₂</th>
<th>PO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NORMAL EXPANDED</td>
<td>0 to 80</td>
<td>0 to 160</td>
</tr>
<tr>
<td>READING</td>
<td>0 to 14 pH. Direct reading.</td>
<td>8 to 200 mm Hg. Direct reading with increasing values to the left.</td>
<td>0 to 80 mm Hg. Direct reading.</td>
</tr>
<tr>
<td>SMALLEST SCALE DIVISION</td>
<td>0.1 pH</td>
<td>0.01 pH</td>
<td>0.2-5 mm Hg</td>
</tr>
<tr>
<td>READABILITY</td>
<td>±0.01 pH</td>
<td>±0.001 pH</td>
<td>±0.5% of reading</td>
</tr>
<tr>
<td>RELATIVE ACCURACY</td>
<td>±0.02 pH</td>
<td>±0.002 pH</td>
<td>±1% of reading</td>
</tr>
<tr>
<td>(2 point adjustment)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRIFT</td>
<td>&lt;0.004 pH/°C</td>
<td>&lt;0.0007 pH/°C</td>
<td>&lt;0.35% of reading per °C</td>
</tr>
<tr>
<td></td>
<td>&lt;0.002 pH/24 h. non-cumulative.</td>
<td>&lt;0.002 pH/24 h. non-cumulative.</td>
<td></td>
</tr>
<tr>
<td>INPUT IMPEDANCE</td>
<td>&gt;10¹² Ω</td>
<td>&gt;10¹² Ω</td>
<td>&gt;10¹² Ω</td>
</tr>
<tr>
<td>TERMINAL CURRENT</td>
<td>&lt;10⁻¹² A</td>
<td>&lt;10⁻¹² A</td>
<td>&lt;10⁻¹² A</td>
</tr>
<tr>
<td>NOISE</td>
<td>negligible</td>
<td>negligible</td>
<td>negligible</td>
</tr>
</tbody>
</table>
Accessories supplied with the Acid-Base Analyzer, type PHM71:

1 Electrode Holder, type H22  
1 Electrode Adapter, 10 kΩ, type L409

Fig. B1. Accessories for the Acid-Base Analyzer, type PHM71.

Accessories available:

Code 809-153  Support w. 1 screw,  
               code 020-220

Code 809-159  Rod

Type E126  Electrode Holder

Type PHA930  Po₂ Module

Type PHA931  Pco₂ Module

Fig. B2. The Electrode Holder,  
type E126.
Section C. Optional Accessories

A. THE PO₂ MODULE, TYPE PHA930

The PO₂ Module, type PHA930, is a plug-in unit to be used with the Acid-Base Analyzer, type PHM71, for oxygen measurements employing a Clark-type oxygen electrode, for example, a Radiometer PO₂ Electrode, type E5046 or type E5047. The Radiometer PO₂ Electrode is a polarographic platinum cathode and a reference electrode in contact with a solution which is separated from the sample by a gas-permeable membrane and which operates at a polarizing voltage of approx. 630 mV. This voltage is supplied by a mercury cell embodied in the PO₂ Module, type PHA930.

The adjustment controls of the PO₂ Module are designed so as to take into account the important electrical data of the PO₂ electrode, i.e., its zero, which is the electrode current at PO₂ = 0 (residual current), and its sensitivity, which is the current output per mm Hg of PO₂.

The PO₂ electrode requires therefore a standardization against an oxygen-free sample to bring the zero of the instrument in agreement with the zero of the electrode. The zero of the instrument is adjusted with the ZERO knob, which is continuously adjustable from 0 to 700 x 10⁻¹² A.

Fig.C1. The PO₂ Module, type PHA930.

The PO₂ electrode also requires a standardization against a sample of known PO₂ to bring the sensitivity of the instrument in agreement with the sensitivity of the electrode. The sensitivity range is selected by means of the SENSITIVITY dial which covers 5 ranges, and fine adjustment is made with the VERNIER knob which covers the individually selected range. The sensitivity
range to be selected depends upon the sensitivity of the $\text{PO}_2$ electrode. A micro electrode, such as the Radiometer $\text{PO}_2$ Electrode, type E5046 or type E5047, will normally require a sensitivity range of 10 to $30 \times 10^{-12}$ A/mm Hg of $\text{PO}_2$.

However, if an electrode of another make than Radiometer is used, compare its sensitivity with the specifications for the $\text{PO}_2$ Module, type PHA930.

The basic range for $\text{PO}_2$ readings is 0-160 mm Hg (RANGE switch at 0-160), and the scale 0-160 mm Hg of $\text{PO}_2$ is used. This range can be used, for example, in venous and arterial blood measurements, and also for standardizing the electrode at the atmospheric level of $\text{PO}_2$ (about 150 mm Hg).

The range 0-800 mm Hg of $\text{PO}_2$ is applicable in pure oxygen work. When this range is used, standardization should be made in the same range (by using pure oxygen) to prevent a possible, small unlinearity of the electrode response from affecting the accuracy. Readings are made on the scale 0-80 mm Hg with a multiplier of 10.

At low levels of $\text{PO}_2$, the range 0-80 mm Hg can be used; also when the standardization is carried out in the range 0-160 mm Hg, as the above deviation from linearity is far below the measuring accuracy up to 200 mm Hg of $\text{PO}_2$.

The condition of the embodied mercury cell, which supplies the polarizing voltage for the oxygen electrode, is very easily checked by pushing the button BATT. TEST on the PHM71. This test can be made independent of the control settings, and even with the Analyzer disconnected from the power line.

Since the membrane of the $\text{PO}_2$ electrode must be exchanged when it has suffered mechanical damages, the Acid-Base Analyzer is equipped with a LEAK-AGE TEST button by means of which an immediate test on the membrane can be made.

The $\text{PO}_2$ Module, type PHA930, is automatically grounded through the ground terminal of the Analyzer PHM71, when plugged in.

Mounting the Mercury Cell, code 430-114

The cell holder is located at the back of the $\text{PO}_2$ Module, type PHA930.

1) Remove the transparent plate covering the holder (two knurled 4M-nuts).

2) Insert the cell with the insulated pole facing the center pin of the holder.

3) Remount the transparent plate and fasten the nuts.

Mounting the $\text{PO}_2$ Module, type PHA930

1) Remove the left-hand blank panel of the Acid-Base Analyzer, type PHM71, by unscrewing the two fastening screws.

2) Insert the $\text{PO}_2$ Module in the Analyzer by sliding it along the guide rails, and then fasten it by means of the two screws.

Fig. C2. Rear view of the $\text{PO}_2$ Module, type PHA930, showing the position of the Mallory Cell.
Specifications for the \( \text{PO}_2 \) Module, type PHA930

**RANGE:**
- 0 to 80 mm Hg of \( \text{PO}_2 \)
- 0 to 160 mm Hg of \( \text{PO}_2 \)
- 0 to 800 mm Hg of \( \text{PO}_2 \)

**CONTROLS:**

**RESIDUAL CURRENT COMPENSATION**
Adjustable from 0 to \( 700 \times 10^{-12} \) A. Not calibrated.

**SENSITIVITY CONTROL**
Adjustable in 5 ranges from 1 to \( 300 \times 10^{-12} \) A/mm Hg of \( \text{PO}_2 \). Continuously adjustable within any of these ranges.

**POLARIZING VOLTAGE**
630 ± 50 mV, output resistance approx. 5.2 kΩ.

**MERCURY CELL**
Mallory RM-IR or equivalent type

**OPERATING TEMPERATURE**
0 to 50°C ambient

**DIMENSIONS AND WEIGHT**
- **Height:** 192 mm (7 1/2")
- **Width:** 63 mm (2 1/2")
- **Depth:** 130 mm (5 1/2")
- **WEIGHT:** \( \sim 1/2 \) kg (1 lb.)

**FINISH**
Chemically resistant paint on aluminium
B. THE \( \text{Pco}_2 \) MODULE, TYPE PHA931

The \( \text{Pco}_2 \) Module, type PHA931, is a plug-in unit to be used with the Acid-Base Analyzer, type PHM71, for \( \text{Pco}_2 \) measurements employing a Severinghaus electrode, for example the Radiometer \( \text{Pco}_2 \) Electrode, type E5036 or E5037. The Radiometer \( \text{Pco}_2 \) Electrode is a pH electrode pair in contact with a bicarbonate solution which is separated from the sample by a gas-permeable membrane. This means that the electrode response is a potential difference which varies linearly with the pH of the bicarbonate solution which again varies linearly with \( \log (\text{Pco}_2) \) of the sample.

The adjustment controls of the \( \text{Pco}_2 \) Module are designed so as to take into account the important electrical data of the \( \text{Pco}_2 \) electrode. As the sensitive part of the electrode is a pH electrode, these data are the same as those of a pH electrode pair, though converted to \( \text{Pco}_2 \) measurements: the zero of the electrode, which is the \( \text{Pco}_2 \) value at which the potential difference across the electrode is zero, and its sensitivity, which at \( 37^\circ\text{C} \) theoretically is 61.54 mV/decade of \( \text{Pco}_2 \).

The \( \text{Pco}_2 \) electrode requires therefore a standardization with two gases of known \( \text{Pco}_2 \) values to bring the zero and the sensitivity of the instrument in agreement with the zero and the sensitivity of the electrode—this standardization is identical with the "two-buffer adjustment" in pH measurements.

The ADJUSTMENT knob on the PHA931 is used to make the meter read the \( \text{Pco}_2 \) value of a standardizing gas with known \( \text{Pco}_2 \) when the \( \text{Pco}_2 \) electrode is brought into contact with it. The ADJUSTMENT knob covers the range from 0 to 130 mV.

By means of the STANDARD 1 \( \text{Pco}_2 \) knob, it is possible to vary the electrical zero point of the Analyzer from 8 to 200 mm Hg of \( \text{Pco}_2 \), which greatly facilitates the standardizing procedure. To operate the knob during the adjustment, the SET STANDARD 1 pushbutton on the Analyzer must be pushed.

The TEMPERATURE \( ^\circ\text{C} \) dial provides for temperature compensation within the range 14 to \( 46^\circ\text{C} \) when \( \text{Pco}_2 \) measurements are performed. The setting of the dial should correspond to the temperature of the test sample measured in centigrades.

Note: As only the SENSITIVITY \% knob is mechanically coupled to the adjusting potentiometer, it is necessary, when changing to another temperature, first to set the TEMPERATURE \( ^\circ\text{C} \) dial at the actual measuring temperature and then to set the SENSITIVITY \% knob to the sensitivity of the electrode chain (found by a previous two-gas standardization) or if sensitivity correction is not involved, to 100%.

As the sensitivity of the \( \text{Pco}_2 \) electrodes varies from electrode to electrode, and also slowly changes with time, the \( \text{Pco}_2 \) Module is equipped with a SENSITIVITY \% knob by means of which electrode sensitivities can be compensated. The setting of the knob, i.e., the degree
of compensation, should be found through a preliminary two-gas standardization.

Since the membrane of the Pco2 electrode must be exchanged when it has suffered mechanical damages, the Acid-Base Analyzer is equipped with a LEAK-AGE TEST button by means of which an immediate test on the membrane can be made.

The Pco2 Module, type PHA931, is automatically grounded through the ground terminal of the Analyzer, when plugged-in.

Mounting the Pco2 Module, type PHA931

1) Remove the right-hand blank panel of the Acid-Base Analyzer, type PHM71, by unscrewing the two fastening screws.

2) Insert the Pco2 Module in the Analyzer by sliding it along the guide rails, and then fasten it by means of the two screws.
Specifications for the $P_{co2}$ Module, Type PHA931

RANGE: 8 to 200 mm Hg of $P_{co2}$
   Adjustable from 8 to 200 mm Hg.

ELECTRICAL ZERO POINT
   Adjustable from 14 to 46°C.
   Calibrated in 2°C divisions.
   Accuracy of calibration: ±2°C

TEMPERATURE COMPENSATION
   Adjustable from 85 to 100%.
   Calibrated in 1% divisions.
   Accuracy of calibrations: ±1%

ELECTRODE SENSITIVITY COMPENSATION

ADJUSTMENT Control
   Adjustable from 0 to 130 mV.
   Not calibrated.
   6-turn gear with reverse vernier 6:1

OPERATING TEMPERATURE: 0 to 50°C ambient.

DIMENSIONS AND WEIGHT

Height: 192 mm (7 1/2")
Width: 63 mm (2 1/2")
Depth: 130 mm (5 1/2")
Weight: 500 g (1 lb.)

FINISH: Chemically resistant paint on aluminium.
CONTROLS

The large mirror-backed scale covers the pH span in one range from 0 to 14 pH, or, when expanded, the physiological span from 6.6 to 8.0 pH. A second scale, which is logarithmically calibrated and used in PCO₂ measurements, covers the range from 8 to 200 mm Hg of PCO₂. Finally, a scale used in PO₂ measurements covers the ranges 0 to 80, 0 to 160 and 0 to 800 mm Hg of PO₂.

As soon as the power cord is connected to the power line the electrical circuitry including a 5 watt heating element is switched on as indicated by the POWER lamp.

The built-in heating element provides for a higher temperature inside the instrument than ambient, thereby decreasing the relative humidity around the high-impedance circuits. This feature ensures unvarying top-performance of the Analyzer even when particularly damp working conditions exist (exceeding 90% relative humidity).

The scale to be used in the actual measurements is selected by means of the FUNCTION selector which has three positions: PCO₂, pH and PO₂.

With the FUNCTION selector in position PCO₂, the Analyzer, in connection with the PO₂ Module, type PHA931 (available as extra accessory), can be used for PCO₂ measurements. The measurements are taken on the logarithmic scale covering the span from 8 to 200 mm Hg of PCO₂.

With the FUNCTION selector in position pH, the Analyzer works as a pH meter, and the position of the pH RANGE switch determines whether the measurements are to be taken on the scale covering the span from 0 to 14 pH or on the expanded scale from 6.6 to 8.0 pH.

With the FUNCTION selector in position PO₂, the Analyzer, in connection with the PO₂ Module, type PHA930 (available as extra accessory), can be used for PO₂ measurements. The measurements are taken on one of the three scales covering PO₂.

The TEMPERATURE °C dial provides for temperature compensation within the range 14 to 46°C when pH measurements are performed. The setting of the dial should correspond to the temperature of the test sample measured in centigrades.

Note: As only the SENSITIVITY % knob is mechanically coupled to the potentiometer, it is necessary, when changing to another temperature, first to set the TEMPERATURE °C dial at the actual measuring temperature, and then to set the SENSITIVITY % knob to the sensi-
tivity of the electrode chain (found by a previous two-buffer adjustment) or, if sensitivity correction is not desired, to 100%.

The SENSITIVITY % knob provides against decreased sensitivity of the glass electrode. As the sensitivity varies from electrode to electrode and changes slowly with time, the setting of the knob should be found by means of a two-buffer adjustment. (See Section E: pH measurements with increased accuracy.)

By means of the STANDARD 1 pH knob, it is possible to vary the electrical zero point of the Analyzer from 6.6 to 8.0 pH, which greatly facilitates the two-buffer adjustment of the instrument. To operate the knob during the adjustment, the SET STANDARD 1 pushbutton must be pushed.

The pH ADJUSTMENT knob is used to make the meter read the buffer pH when adjustment is made on a well-defined buffer. The pH ADJUSTMENT knob covers the range from 0 to 130 mV. This span makes it possible to adjust the readings on the meter against electrode chains with electrical zero points between 5.6 and 7.1 pH.

The READ/STAND BY pushbutton must be pushed before readings can be taken on the meter. When released, the meter circuit will be switched off in order to prevent the meter from fluctuating while the electrodes are not immersed in a buffer solution or a test solution.

Below the POWER lamp are located the three pushbuttons, the LEAKAGE TEST button, the BATT. TEST button and the SET STANDARD 1 button, which latter already has been mentioned.

The LEAKAGE TEST button is used for a quick check on the membrane electrodes used in Po2 and PCO2 measurements. If it is impossible to carry out the complete or simplified standardization for Po2 or PCO2 measurements in blood as described in section E, and a push on the button causes violent deflection of the meter needle, a leakage exists in the membrane electrode. Probably the leakage has occurred in the membrane which must then be replaced.

The BATT. TEST button is used only when the Analyzer is equipped with the Po2 Module, type PHA930. When pushed, it indicates the condition of the mercury cell which is built into
the Module. If the mercury cell is in good working condition, the meter pointer will fall within the limits given on the meter for the battery test.

The Terminal Board of the Acid-Base Analyzer, type PHM71.

TERMINALS

All terminals for input, output and power supply will be found on the terminal board on the left-hand side of the instrument.

The upper section of the terminal board has three pairs of input terminals for electrodes, i.e., a terminal pair for pH measurements, a terminal pair for $\text{PCO}_2$ measurements and a terminal pair for $\text{PO}_2$ measurements.

The middle section comprises the two Recorder outputs, REC.1 and REC.2, and the ZERO terminal.

The output socket REC.1, for connection to an external recorder or meter, accepts a 5-pole EUROPEAN STANDARD connection plug for radio, DIN 41524 — e.g., the PREH plug, type 8-7506. This socket has an output of 500 mV/pH, 500 mV/100 mm Hg of $\text{PO}_2$, or 500 mV/decade of $\text{PCO}_2$, depending on the position of the FUNCTION selector.

Fig. D3. Preh Plug, type 8-7506.

The plug to be used with this socket must be connected as follows:

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>connected to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Parts of the external instrument that must be grounded — and are not already grounded.</td>
</tr>
<tr>
<td>2 and 5</td>
<td>Terminals of external instrument.</td>
</tr>
<tr>
<td>1 and 4</td>
<td>Not connected.</td>
</tr>
</tbody>
</table>

If a screened cable is used, the screen is connected to the metal part of the multiplug.

A second output socket REC.2, for electronic recorder connection, gives off a voltage of 100 mV for full-scale deflection regardless of the scale used. This socket accepts a 5-pole EUROPEAN STANDARD connection plug for radio, DIN 41524 — e.g., PREH plug, type 8-6082. The plug to be used with this socket must be connected as follows:
Fig. D4. Preh Plug, type 8-6082.

Pin No. connected to:

3 Parts of the external instrument that must be grounded—and are not already grounded.

2 and 5 Terminals of external instrument.

1 and 4 Not connected.

If a screened cable is used, the screen is connected to the metal part of the multiplug.

The lower section of the terminal board comprises the Ground terminal and the power cord.

The Ground terminal, marked $\frac{1}{2}$, is used to ground the instrument. To obtain reliable measurements, it is essential that the instrument is properly grounded. See Section F, Realignment.
Section E. Operating Instructions

EXPLANATION OF PROCEDURES COMMONLY REFERRED TO IN pH MEASUREMENTS

In order to make the following instructions easier to understand, a short explanation is given below of some procedures commonly referred to in this manual:

Preparing the Acid-Base Analyzer, type PHM01:

Check the line voltage and connect the instrument to the power line. Make sure that the pilot lamp POWER goes on and that the pushbutton READ/STAND BY is in position STAND BY.

Preparing the electrodes:

Allow the glass electrode to soak for at least 6 hours in 0.1 N hydrochloric acid. If time is short, the electrodes should be adjusted frequently against a buffer solution as mentioned below. (See also the specific instructions for the electrodes included in the electrode boxes.)

Note: A capillary glass electrode, as used in blood measurements, is soaked, rinsed or otherwise brought into contact with a solution by sucking the solution into the capillary of the electrode.

Rinsing the electrodes:

Dip the electrodes in a beaker filled with distilled water and shake the beaker cautiously. Remove the beaker and detach the drops of water from the tips of the electrodes by wiping them off with filter paper, first touching the tip of the capillary electrode.

As regards the rinsing of capillary glass electrodes used in blood pH measurements, it is imperative, when BLOOD is in the electrode and the measurement is finished, to take care that solution only - and not air - enters the electrode next (as air will cause the creation of films, poisoning of the capillary and disturbances in the measurements). When buffer solution is in the electrode, take care that distilled WATER only - and not air - enters the electrode next (as air will cause the formation of crystals and disturbances in the measurement).

The above mentioned very important rinsing procedure in blood pH measurements may be summarized in what we call the BBW-rule. BLOOD-BUFFER-WATER through the electrode.

Adjusting against buffer:

1. Dip the electrodes in a beaker containing a buffer solution whose pH value is known at the actual temperature.

2. Set the TEMPERATURE °C dial to actual temperature of the buffer.

3. Set the SENSITIVITY % knob at 100%.
4. Push the button READ/STAND BY to position READ.

5. Turn the pH ADJUSTMENT knob to make the meter read the pH of the buffer.

6. Push the button READ/STAND BY to position STAND BY.

When the glass electrode is new or has been stored dry, the buffer adjustment should be repeated quite often during the first two or three days. Later on, experience will show how often an adjustment is necessary according to the accuracy desired. Since the sensitivity of a glass electrode normally falls between 98% and 100% of the theoretical value (~61.54 mV/pH at 37°C), the measurement will be accurate only to about 2% of the difference in pH values of buffer and test solution.

Such an error cannot be tolerated in blood pH measurements, however, but it can be eliminated by increasing the sensitivity of the Analyzer to such a degree that it counteracts the lack in sensitivity of the glass electrode. This is accomplished by the two-buffer adjustment for which the knob SENSITIVITY % is used. The adjustment requires two buffers, A and B, within the physiological range from 6.6 to 8.0 pH, e.g., the Buffer Solution, type S1500 (pH = 6.841 at 37°C), and the Buffer Solution, type S1510 (pH = 7.383 at 37°C).

**pH MEASUREMENTS IN BLOOD**
(for pH measurements in general, see page E6.)

**General remarks on Standardizing in blood pH measurements**

1) The importance of standardizing the pH electrode pair has been discussed above.

2) The instructions below give a complete and a simplified procedure for making a two-buffer adjustment and a one-buffer adjustment, respectively, when the expanded pH scale (6.6–8.0 pH) is used.

3) The intervals at which standardization should be made are suggested only. They should be shortened:

a) When extremely high accuracy is important.
b) When new or recently assembled electrodes are used.
c) When the electrodes have been warmed up to the measuring temperature shortly before the first standardization, or when the electrodes have been exposed to shocks (thermal, mechanical, or electrical).
da) Whenever signs of instability are observed.

4) Instructions for handling or servicing the electrodes, for handling the samples, and for preparing and evaluating solutions or gases for standardization of Pco₂ and Po₂, should be sought in the instruction manual of the electrodes concerned.

**Complete Standardization of the pH Electrode Pair**

The complete standardization should be carried out, for example once a day, to ensure that the zero and the span of the instrument are in agreement with the zero and sensitivity of the electrode. Two buffers, i.e., the type S1500 (pH = 6.841 at 37°C) and the type S1510 (pH = 7.383 at 37°C) must be available. It is assumed that the electrodes are thermostatted to exactly 37°C.

Fig.E1. The Acid-Base Analyzer, type PHM71, with the Pco₂ Module, type PHA930, and the Pco₂ Module, type PHA931.
1) Prepare the Analyzer and the electrodes for measuring.

2) Connect the glass electrode to the pH terminal on the terminal board of the Analyzer.

3) Connect the calomel electrode to the REF terminal (for pH measurements) on the terminal board of the Analyzer.

4) Make the following settings on the Analyzer:
   a) FUNCTION selector in position pH.
   b) pH RANGE switch in position 6.6 - 8.0.
   c) READ/STAND BY button in position READ.
   d) TEMPERATURE °C dial in position 37°C.
   e) SENSITIVITY % knob in position 100%.

5) Rinse the electrodes.

6) Press the button SET STANDARD 1 whilst rotating the knob STANDARD 1 pH to make the meter read 7.383 pH, and then release the button SET STANDARD 1.

7) Adjust against the Buffer, type S1510, to make the meter read 7.383 pH.

8) Rinse the electrodes.

9) Suck the Buffer, type S1500, into the capillary of the glass electrode.

10) Push the button READ/STAND BY to position READ.

11) Rotate the SENSITIVITY % knob to make the meter read 6.841.

12) Push the button READ/STAND BY to position STAND BY.

13) Rinse the electrodes.

Simplified Standardization of the pH Electrode Pair

The simplified standardization should be performed several times a day to ensure that the electrode pair is operative and undisturbed by any drift phenomena.

Proceed as follows:

1) Rinse the electrodes and apply the Buffer, type S1510. Push the button READ/STAND BY to position READ and allow the reading to settle.

2) Check the reading and readjust the pH ADJUSTMENT knob, if necessary, to make the meter read 7.383 pH.

3) Push the button READ/STAND BY to position STAND BY.

4) Rinse the electrodes.

Measuring pH

When the electrodes have been standardized according to the above instructions, the actual pH values in blood are obtained as follows:

1) Rinse the electrodes.

2) Suck the blood sample to be measured into the glass electrode.

Push button READ/STAND BY to position READ and read on the meter the pH of the blood sample.

3) Push button READ/STAND BY to position STAND BY.

4) Rinse the electrodes carefully.

5) In subsequent measurements, the sensitivity adjustment described above should be repeated comparatively often during the first days when the glass electrode is new or has been stored dry. Later on experience will show how often an adjustment is needed for the accuracy desired. However, this adjustment should be made at least once a day, when blood measurements are carried out.

6) After use, do not switch off the Acid-Base Analyzer, type PHM71, as the heating element will protect the instrument against humidity.

7) Store the electrodes according to instructions given in the electrode manuals.

Po2 MEASUREMENTS IN BLOOD

General Remarks on Standardization

1) The reason why Po2 electrodes should
be standardized is given in section C.

2) The instructions below give a complete and a simplified procedure for making a two-buffer adjustment and a one-buffer adjustment, respectively, on the PO2 scale.

3) The intervals at which standardization should be made are suggested only. They should be shortened:
   a) When extremely high accuracy is important.
   b) When a new or recently assembled electrode is used.
   c) When the electrode has been warmed up to the measuring temperature shortly before the first standardization, or when the electrode has been exposed to shocks (thermal, mechanical, or electrical).
   d) Whenever signs of instability are observed.

4) Instructions for handling or servicing the electrode, for handling the samples, and for preparing and evaluating solutions or gases for standardization of PO2, should be sought in the manual for the electrodes concerned.

Complete Standardization of the PO2 Electrode

An oxygen-free sample (solution or gas) and a sample with PO2, say, at atmospheric level must be available (see the electrode manual). The PO2 of the latter sample must be calculated accurately.

Proceed as follows:

1) Mount the PO2 Module, type PHA 930, as described in section C.

2) Prepare the instrument and the electrodes for measuring.

3) Connect the PO2 electrode (type E5046 or E5047) to the PO2 terminal on the terminal board of the Analyzer.

Notes: If a PO2 electrode pair with separate reference electrode is used, the reference electrode should be connected to the REF terminal (for PO2 measurements).

4) Fill the chamber of the PO2 electrode with the oxygen-free sample.

5) Make the following settings:
   a) Set the FUNCTION selector of the Analyzer to PO2.
   b) Set the RANGE switch of the PO2 Module to PO2 0-160 mm.
   c) Set the SENSITIVITY dial of the PO2 Module to the sensitivity range that applies to the electrode concerned. For Radiometer PO2 electrodes (20 μ diameter), use the range (10-30) x 10^-12 A/mm.
   d) If the electrode sensitivity is unknown: Set the SENSITIVITY dial first at the highest level of PO2.
   e) Turn the VERNIER knob to its extreme clockwise position.

   f) Push button READ/STAND BY to position READ.

6) Make a battery test by pushing the button BATT. TEST. Make sure that the pointer falls within the limits for the battery test on the scale.

7) Turn knob ZERO on the PO2 Module until the meter reads 0 mm on the 0 - 160 mm PO2 scale. Allow the reading to settle, and readjust, if necessary.

8) Rinse the electrode and fill it with the sample of a known PO2, generally in the range 140 - 160 mm. Allow the reading to settle.

9) Turn the VERNIER knob until the meter reads actual sample PO2.

10) If the correct reading cannot be obtained by means of the VERNIER knob, reset the SENSITIVITY dial to a higher or lower position. If this must be done, it is necessary to repeat the procedure (4) to (10).

11) Push button READ/STAND-BY to position STAND-BY.

Simplified Standardization of the PO2 Electrode

The simplified standardization should be made several times a day to ensure that the electrode is operative and undisturbed by any drift phenomena.
Proceed as follows:

1) Rinse the electrode and fill it with a sample of known Po2.

Set the RANGE switch of the Po2 Module to 0-160 mm, and allow the reading to settle.

2) Push button READ/STAND BY to READ.

3) Check the reading and readjust the VERNIER knob of the Po2 Module, if necessary.

Note: If at this stage it is required to leave the instrument for a while, the FUNCTION switch of the Analyzer must be set to its pH or Po2 position. In these positions, the polarizing voltage for the Po2 electrode will be constant regardless of whether the pH-meter is operating or not.

4) Push button READ/STAND BY to position STAND BY.

Measuring Po2

Once the electrode has been standardized, the Po2 values of samples tested with the electrode are obtained as follows:

1) Set the FUNCTION selector in position Po2.

2) Set the RANGE switch of the Po2 Module to the range required.

3) Push button READ/STAND BY to position READ, and read Po2 from the meter on the Analyzer.

Note: If at this stage it is required to leave the instrument for a while, the FUNCTION selector of the Analyzer must be set in its pH or Po2 position. In these positions, the polarizing voltage for the Po2 electrode will be constant regardless of whether the pH-meter is operating or not.

Pco2 MEASUREMENTS IN BLOOD

General Remarks on Standardizing

1) The need for standardizing the Pco2 electrode is discussed in Section C.

2) The instructions below give a complete and simplified procedure for adjusting the Pco2 Module to be in agreement with the Pco2 electrode.

3) Intervals at which standardization should be made are suggested only. The period should be shortened:

a) When extremely high accuracy is important.

b) When a new or recently assembled electrode is used.

c) When the electrode has been warmed up to the measuring temperature shortly before the first standardization, or when the electrode has been exposed to shocks (thermal, mechanical, or electrical).

d) Whenever signs of instability are observed.

4) Instructions for handling or servicing the electrode, for handling the samples, and for preparing and evaluating solutions or gases for standardization of Pco2 should be sought in the electrode manual concerned.

Complete Standardization of the Pco2 Electrode

The complete standardization should be carried out, for example, once a day to ensure that the zero and the span of the instrument are in agreement with the zero and the sensitivity of the electrode.

Two gases of accurately known Pco2-values must be available. One, Pco2 (I), is assumed to be near 20 mm Hg (for example, between 15 and 30 mm); the other, Pco2 (II), is assumed to be below 120 mm Hg, (for example, between 40 and 80 mm).

Proceed as follows:

1) Mount the Pco2 Module, type PHA931, as described in Section C.
2) Prepare the instrument and the electrodes for measuring.

3) Connect the Pco2 Electrode, type E5036 or type E5057, to the Pco2 terminal on the terminal board of the Analyzer.

Note: If a Pco2 electrode pair with separate reference electrode is used, the reference electrode should be connected to the REF terminal (for Pco2 measurements).

4) Fill the chamber of the Pco2 electrode with the gas (I) which is close to 20 mm Hg and wait until Pco2 equilibration is obtained.

5) Make the following settings:
   a) The FUNCTION selector on the Analyzer to position Pco2.
   b) The TEMPERATURE °C dial on the Pco2 Module to actual measuring temperature.
   c) The SENSITIVITY % knob on the Pco2 Module to 100%.

6) Push button READ/STAND BY to position READ.

7) Press button SET STANDARD 1 on the Analyzer whilst rotating the STANDARD 1, Pco2 knob on the Pco2 Module to make the meter read the Pco2 of gas 1, and then release button SET STANDARD 1.

8) Turn the ADJUSTMENT knob on the Pco2 Module to make the meter read the Pco2 of gas 1. Allow the reading to settle, and readjust, if necessary.

9) Push button READ/STAND BY to position STAND BY.

10) Fill the Pco2 electrode with gas II and wait until Pco2 equilibration is obtained - approx. 1 minute.

11) Push button READ/STAND BY to position READ.

12) Turn the SENSITIVITY % knob on the Pco2 Module to make the meter read Pco2 of gas II. Allow the reading to settle, and readjust, if necessary.

13) Push button READ/STAND BY to position STAND BY.

Simplified Standardization of the Pco2 Electrode

The simplified standardization should be made several times a day to ensure that the electrode is operative and undisturbed by any drift phenomena.

Proceed as follows:

1) Transfer the gas that is close to the typical sample values to the electrode and allow the meter pointer to settle.

2) Check the reading and readjust the ADJUSTMENT knob on the Pco2 Module, if necessary.

Measuring Pco2

Once the electrode has been standardized according to the instructions above, the Pco2 values of samples tested with the electrode are obtained by using the FUNCTION selector and the scale on the Analyzer:

1) Push button READ/STAND BY to position READ, and read the Pco2 value on the scale. Readings can be taken directly in the range from 8 to 200 mm Hg of Pco2.

2) Push button READ/STAND BY to position STAND BY.

pH MEASUREMENTS IN GENERAL

pH Measurements, simple

1) Prepare the Acid-Base Analyzer, type PHM71, and the electrodes for measuring.

2) Connect the lead of the glass electrode to the pH terminal on the terminal board.
3) Connect the lead of the calomel electrode to the REF terminal for pH measurements on the terminal board.

4) Make the following settings:
   a) READ/STAND BY button in position STAND BY.
   b) FUNCTION selector in position pH.
   c) pH RANGE knob in position 0-14.
   d) TEMPERATURE °C dial to relevant measuring temperature.
   e) SENSITIVITY % knob in position 100%.

5) Rinse the electrodes.

6) Adjust against a well-defined buffer. It is imperative that the temperature of the buffer be the same as that of the solution to be tested. Moreover, the buffer solution should preferably have a pH close to the expected value of the test solution.

7) Rinse the electrodes.

8) Immerse the electrodes in the solution to be tested. Push button READ/STAND BY to position READ, and read the pH of the solution on the meter when the pointer has settled. Release button READ/STAND BY and remove the beaker.

9) Rinse the electrodes.

pH Measurements with increased Accuracy in the Range from 0 to 14 pH (Electrode sensitivity included)

Since the sensitivity of a glass electrode normally falls between 98% and 100% of the theoretical value, the procedures outlined in item “pH Measurements, simple” will be accurate to about 2% of the difference in pH values of buffer and test solution.

It should be borne in mind that the sensitivity of a glass electrode deteriorates with the passage of time. This means that the sensitivity adjustment procedure described below must be repeated (at least once a month to obtain high accuracy, and also whenever the electrode has been stored dry or cleaned with etching reagents).

If a higher measuring accuracy is desired, a decreased electrode sensitivity can be taken into account by adjusting the sensitivity of the pH meter to correct for the decrease. This is accomplished by using the knob, ELECTRODE SENSITIVITY %, and two buffer solutions, of which one should have a pH value within the range from 6.6 to 8.0 pH.

It must be remembered that the pH of the two buffer solutions should be accurately known at the actual temperature, and that all solutions used should have the same temperature.

1) Prepare the Analyzer and the electrodes for measuring.

2) Connect the lead of the glass electrode to the GLASS terminal of the terminal board on the Analyzer.

3) Connect the lead of the calomel electrode to the REF terminal (for pH measurements) on the terminal board of the Analyzer.

4) Make the following settings on the Analyzer:
   a) FUNCTION selector in position pH.
   b) pH RANGE switch in position 0-14.
   c) READ/STAND BY button in position STAND BY.
   d) TEMPERATURE °C dial at actual temperature of test sample measured in centigrades.
   e) SENSITIVITY % knob in position 100%.

5) Rinse the electrodes.

6) Press button SET STANDARD 1 whilst rotating the knob pH STANDARD 1 to make the meter read the pH value of buffer A. After the adjustment, release button SET STANDARD 1.

7) Adjust against buffer A.

8) Rinse the electrodes.
9) Immerse the electrodes in buffer B.
10) Press button READ/STAND BY to position READ.
11) Rotate the SENSITIVITY % knob to make the meter read the pH value of buffer B.
12) Press button READ/STAND BY to position STAND BY.
13) Rinse the electrodes.
14) Immerse the electrodes in the test sample.
15) Press button READ/STAND BY to position READ, and read the pH of the sample when the pointer has settled.
16) Press button READ/STAND BY to position STAND BY.
17) Rinse the electrodes.
18) In subsequent measurements, the sensitivity adjustment described should be repeated comparatively often during the first days when the glass electrode is new or has been stored dry. Later on, experience will show how often an adjustment is needed for the accuracy desired.
19) After use, do not switch off the Acid-Base Analyzer, type PHM71, as the built-in heating element will protect the instrument against humidity.

Store the electrodes according to instructions given in the electrode manuals.

BRIEF OPERATING INSTRUCTIONS FOR THE ACID-BASE ANALYZER, TYPE PHM71

pH Measurements in Blood (Two-Buffer Adjustment included)

This procedure requires two precision buffers with pH values within the physiological range - i.e., the Buffers type S1500 (pH = 6.841 at 37°C) and type S1510 (pH = 7.383 at 37°C). It is also assumed that the electrodes are thermostatted to exactly 37°C.

1) Connect the Acid-Base Analyzer, type PHM71, to the power outlet and push button READ/STAND BY to position STAND BY.
2) Provide proper grounding. Use either the \( \pm \) terminal or the third terminal in the three-pole power cord. Never use both.
3) Mount and prepare the electrodes according to their instruction manuals.
4) Connect the glass electrode (capillary type) to the pH terminal of the Analyzer.
5) Connect the calomel electrode to the REF terminal (for pH measurements) of the Analyzer.
6) Make the following settings:
   a) FUNCTION selector in position pH.
   b) pH RANGE switch in position 6.6-8.0.
   c) TEMPERATURE °C dial at 37°C.
   d) SENSITIVITY % knob at 100%.
7) Rinse the electrodes in distilled water.
8) Press the button SET STANDARD 1 whilst rotating the knob STANDARD 1, pH to make the meter read 7.383 pH, and then release the button SET STANDARD 1.
9) Suck the Buffer, type S1510, into the electrodes, and when temperature equilibration is obtained, push button READ/STAND BY to position READ and adjust the pH ADJUSTMENT knob to make the meter read 7.383 pH.
10) Push button READ/STAND BY to position STAND BY.
11) Rinse the electrodes in distilled water.
12) Suck the Buffer, type S1500, into the electrodes, push button READ/STAND BY to position READ, and rotate the SENSITIVITY % knob to make the meter read 6.841 pH.
13) Push button READ/STAND BY to position STAND BY, and rinse the electrodes in distilled water.
14) Suck the blood sample into the electrodes, push button READ/STAND BY to position READ, and when the pointer has settled, read the pH of the sample.

15) Rinse the glass capillary electrode, recalling the BBW rule.

16) After use, do not switch off the Analyzer unless it is not to be used for a fortnight or more, but store the electrodes according to their instruction manuals.

**PO2 Measurements in Blood**

This procedure requires an oxygen-free sample and a sample with PO2, say, at atmospheric level. The PO2 of the latter must be calculated accurately. It is assumed that the PO2 electrode is thermostatted to exactly 37°C.

1) Connect the Analyzer (with PO2 Module, type PHA930, mounted) to the power outlet and push button READ/STAND BY to position STAND BY.

2) Provide proper grounding. Use either the + terminal or the third terminal in the three-pole power cord. Never use both.

3) Mount and prepare the electrode (type E4056 or type E5047) according to its instruction manual.

4) Connect the electrode to the PO2 terminal of the Analyzer.

5) Make a battery test by pushing button BATT. TEST. Make sure that the pointer falls within the limits given on the scale - if not, the mercury cell must be exchanged with a new one.

6) Transfer the oxygen-free sample to the PO2 electrode.

7) Make the following settings.
   
   a) Set the FUNCTION selector at PO2.

   b) Set the RANGE switch of the PO2 Module to 0-160 mm.

   c) Set the SENSITIVITY dial of the PO2 Module to the sensitivity range that applies to the electrode concerned. For E5046 and E5047, use the range (10-30) x 10-12 A/mm.

   d) Turn the VERNIER knob to its extreme clockwise position.

   e) Push button READ/STAND BY to position READ.

8) Turn the ZERO knob on the PO2 Module until the meter reads 0 mm Hg on the 0 - 160 mm PO2 scale. Readjust if necessary.

9) Rinse the electrode and fill it with the sample of known PO2. Allow the reading to settle.

10) Turn the VERNIER knob until the meter reads the correct PO2 value. If the correct reading cannot be obtained, reset the SENSITIVITY dial on the PO2 Module to a higher or lower position.

11) Push button READ/STAND BY to position STAND BY, and rinse the electrode.

12) Fill it with the blood sample to be measured, push button READ/STAND BY to position READ, and read the PO2 of the sample when the pointer has settled.

13) Push button READ/STAND BY to position STAND BY.

14) After use, set the FUNCTION selector to position pH and store the electrodes according to their instruction manuals. Do not switch off the Analyzer unless it is not to be used for a fortnight or more.

**PCO2 Measurements in Blood**

This procedure requires two gases of accurately known PCO2. One, PO2 (1), is assumed to be near to 20 mm
Hg, the other (2), to be below 120
mm Hg. It is also assumed that the
electrode is thermostatted to exactly
37°C.
1) Connect the Acid-Base Analyzer,
type PHM71 (with Pco2 Module, type
PHA931, mounted) to the power outlet
and push button READ/STAND BY to
position STAND BY.

2) Provide proper grounding. Use either
the ½ terminal or the third terminal in
the three-pole power cord. Never use
both.

3) Mount and prepare the Pco2 electrode
(type E5036 or type E5037) according to
its instruction manual.

4) Connect the Pco2 electrode to the
Pco2 terminal of the Analyzer.

5) Fill it with the gas (1) and wait
until Pco2 equilibration is obtained:

6) Make the following settings:
   a) The FUNCTION selector to position
      Pco2
   b) The TEMPERATURE °C dial on the
      Pco2 Module to 37°C
   c) The SENSITIVITY % knob on the
      Pco2 Module to 100%.

7) Push button READ/STAND BY to
position READ.

8) Make a membrane test by pushing
the LEAKAGE TEST button. If the
pointer during this test is affected,
the membrane of the electrode must be
exchanged.

9) Press button SET STANDARD 1 on
the Analyzer whilst rotating the STAN-
DARD 1, Pco2 knob on the Pco2 Mod-
ule to make the meter read the Pco2
of gas (1).

10) Release the SET STANDARD 1 but-
ton and turn the ADJUSTMENT knob
on the Pco2 Module to make the meter
read the Pco2 of gas (1). Allow the
reading to settle, and readjust if nec-
cessary.

11) Push button READ/STAND BY to
position STAND BY and rinse the elec-
trode.

12) Transfer gas (2) to the electrode
and wait until Pco2 equilibration is
obtained - approx. 1 minute.

13) Push button READ/STAND BY to
position READ, and turn the SENSITIV-
ITY knob on the Pco2 Module to make
the meter read Pco2 of gas (2). Allow
the reading to settle, and readjust, if
necessary.

14) Push button READ/STAND BY to
position STAND BY and rinse the elec-
trode.

15) Transfer the blood sample to be
measured to the electrode, push button
READ/STAND BY to position READ,
and read the Pco2 of the sample when
the pointer has settled.

16) After use, do not switch off the
Analyzer unless it is not to be used
for a fortnight or more. Store the elec-
trode according to its instruction manual.
Section F. Realignment

SHORT ROUTINE CHECK OF THE ACID-BASE ANALYZER, TYPE PHM71

1) Connect the power cord to the power line and make sure that the lamp POWER goes on.

2) Insert the Electrode Holder, type H22, in the pH terminal.

3) Interconnect this holder and the REF terminal (below the pH terminal) with the Polarizing Adapter, type L409/10 kΩ, which is a 10 kΩ resistor with banana plugs.

4) Make the following settings on the PHM71:

   a) Pushbutton READ/STAND BY in position STAND BY.

   b) FUNCTION selector in position pH.

   c) pH RANGE switch in position 6.6-8.0.

   d) TEMPERATURE °C dial at 37°C.

   e) SENSITIVITY % knob at 100%.

5) The meter must read 6.600 pH. If not, the mechanical zero point of the meter must be corrected. This is accomplished by removing the rubber plug on the front plate (see Fig. F1) and adjusting the screw that is accessible through the hole.

6) Push button READ/STAND BY to position READ.

7) Press pushbutton SET STANDARD 1 whilst rotating the knob STANDARD 1, pH from its extreme counterclockwise position to its extreme clockwise position. Verify that the pointer sweeps the entire scale from 6.6 to 8.0 pH. Finally, adjust the STANDARD 1, pH knob to make the meter read 7.300 pH and then release the pushbutton SET STANDARD 1.

8) Rotate the pH ADJUSTMENT knob to make the meter read 7.300 pH, and then check that the pointer does not move when the SENSITIVITY % knob is rotated. Reset the SENSITIVITY % knob to 100%.

9) Press pushbutton SET STANDARD 1 whilst rotating the STANDARD 1, pH knob to make the meter read 7.800 pH.
Release button SET STANDARD 1 and then adjust the pH ADJUSTMENT knob to make the meter read 6.800 pH.

10) Set the SENSITIVITY % knob to 91% – the meter must read 6.70 ± 0.01 pH.

11) Set the pH RANGE switch in position 0-14, and rotate the pH ADJUSTMENT knob to its extreme counterclockwise position and check that the reading is 4.8 ± 0.3 pH.

12) Push button LEAKAGE TEST. During this test, the pointer must not be affected.

If the pointer is affected, the instrument has an electrical leakage in its circuitry and must be repaired by an authorized repairer.

SETTING THE ANALYZER TO OPERATE ON ANOTHER LINE VOLTAGE

The instrument can operate in the intervals 100 V ac to 130 V ac and 190 V ac to 250 V ac.

If the voltage setting is to be changed, proceed as follows.

1) Disconnect the power cord from the wall outlet.

2) Remove the Modules, types PHA930 and PHA931, or corresponding blank panels.

3) Remove the six screws on the front plate shown in Fig. F2.

4) Pull the internal chassis a little to the right so that the terminal board is freed from the outer casing and then withdraw the chassis from the outer casing.

5) Remove the four screws in Fig. F3 and fold out the back cover. The two screws in the left-hand side of the figure are accessible from opposite side to that shown.

Fig. F3. PHM71 with cabinet removed and the rear printed circuit board folded out, showing fastening screws for the board.

6) Move the lead from snap terminal 2 to 3 (changing from 115 V to 220 V) or from snap terminal 3 to 2 (changing from 220 V to 115 V). See Fig. F4.

7) Mark or replace the terminal board.

ELECTROSTATIC DISTURBANCES

Pronounced electrostatic fields may be present, especially in rooms where tables and/or floors are covered with plastic.
mersing the electrode at least 25 mm into the sample which will then act as a shield.

Another disturbance may supervene if the operator, while wiping the electrodes, carries a high electrostatic voltage to the glass electrode. After this kind of disturbance, the zero point of the electrode may have shifted several tenths of a pH unit, and it may not settle again at its original zero for 5 to 10 minutes. Such a disturbance can be avoided by placing a grounded metal plate (for example; stainless steel) under the pH meter and the electrode setup in such a way that the operator must touch it while rinsing the electrodes.

Another efficient precaution is to treat tables, floors, coats, etc., with an antistatic solution.

AC VOLTAGE OF THE INSTALLATION GROUND

In some cases the installation ground may carry an ac voltage of several volts to true ground. This may disturb the functioning of the pH meter, especially if the measuring cell is connected to true ground.

One remedy is to use a cold water pipe for grounding the pH meter; another is to have the local installation ground wired separately or wired with a heavier wire.

The third and best remedy is to use the same grounding for the cell and for the pH meter - in other words, to connect the cell (shield, frame, water jacket, or metal container) to the + terminal of the Acid-Base Analyzer, type PHM71.