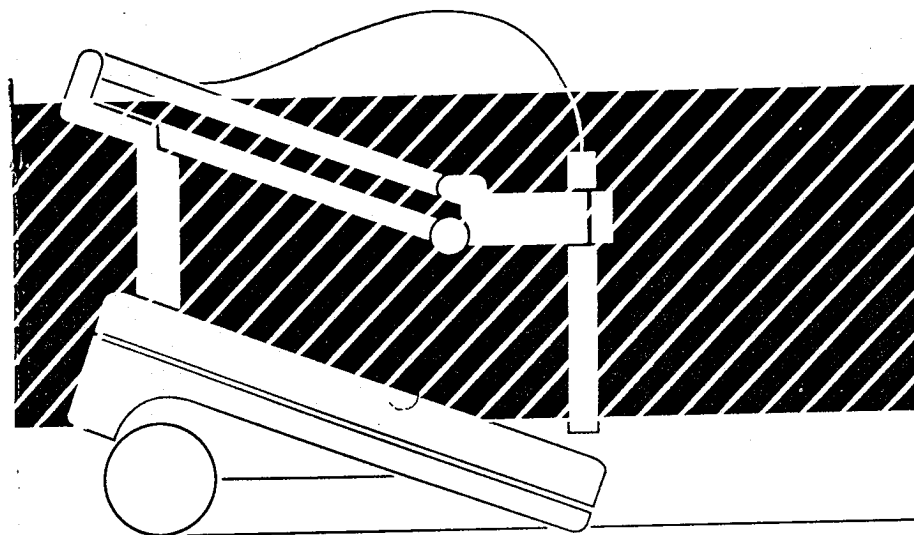


To protect your METTLER TOLEDO product's future:  
METTLER TOLEDO Service assures the quality, measuring accuracy and  
preservation of value of all METTLER TOLEDO products for years to come.  
Please send for full details about our attractive terms of service.  
Thank you.

**METTLER TOLEDO**

## *Delta 320-S pH Meter Instruction Manual*

Subject to technical changes and to the availability of  
the accessories supplied with the instruments.



Mettler-Toledo GmbH,  
Internet: <http://www.mt.com>

12100192 Printed in P. R. China 99/1

**320-S**

## Instruction Manual

This manual contains complete instruction for setting up and using the 320-S pH meter. Application information is also available.

The information contained in this manual was correct at the time of going to print. However, we continue to improve products and reserve the right to change specifications, equipment and maintenance procedures at any time.

This manual is copyrighted, and all rights are reserved. No part of this manual may be reproduced by any means or in any form without prior consent in writing.



The power supply unit is classed as IEC Class II equipment (equipment providing an adequate degree of protection against electric shocks, in which additional safety precautions, for example, double or reinforced insulation, are included). The 320-S is intended for use by persons knowledgeable in safe laboratory practices. If the 320-S is not used in accordance with these instructions for use, the protection provided by the equipment may be impaired.



The 320-S is suitable for direct current only.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference with radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

There are no user replaceable parts in the 320-S or power supply unit. Do not remove the covers.

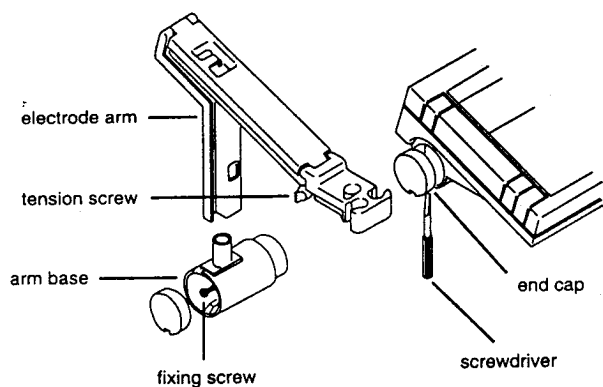
## Contents

<b>1</b>	<b>Setup</b>	
1.1	Unpacking and Installation .....	3
1.2	Input and Output Connection .....	4
1.3	Display and Controls .....	4
<b>2</b>	<b>Operation</b>	
2.1	Inputting Temperature .....	6
2.1.1	Checking and Inputting Temperature .....	6
2.2	pH Measurements .....	7
2.2.1	Setting Calibration Point .....	7
2.2.2	Calibrating a pH Electrode .....	8
2.3	mV Measurements .....	8
2.4	Chart Recorder .....	9
<b>3</b>	<b>Support Information</b>	
3.1	Basic Theory .....	12
3.2	Operating Hints .....	13
3.3	Maintenance .....	15
3.3.1	320-S Maintenance .....	15
3.3.2	Electrode Maintenance .....	15
3.4	Problem Solving .....	16
3.5	Specifications .....	19
	Consumables and Accessories .....	21

## 1.1 Unpacking and Installation

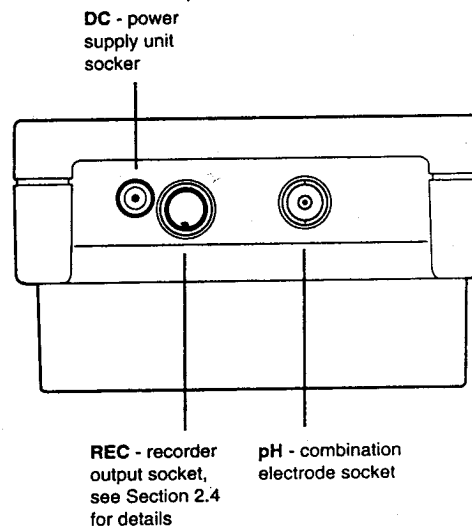
1. Unpack the meter and power supply. If you ordered an electrode, this will also be included.
2. If you ordered the Starter Kit, check the contents:
 

Electrode Arm and Screwdriver	1
Electrode Fill/Storage Solution	1 bottle
Transfer Pipette	1
Electrode Storage Container	1
Guide to pH Measurement	1
3. To attach the electrode arm to the pH meter:
  - a. The electrode arm can be attached to the left or right-hand side. Use the screwdriver supplied to remove the appropriate end cap from the pH meter.
  - b. Slide the arm base into the recess and tighten the fixing screw. Replace the end cap.
  - c. Fit the electrode arm onto the post. Adjust the tension screw as required.



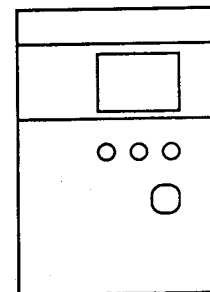
4. Fill in and return the warranty card. For your own record, make a note of the serial number, date of purchase and supplier on page 44.

## 1.2 Input and Output Connections







1. Disconnect the shorting clip from the **pH** socket and retain it by clipping it over the socket. Connect the electrode.
- NOTE** The 320-S will not accept separate reference and pH electrodes.
2. Connect the power supply unit to the **DC** socket.

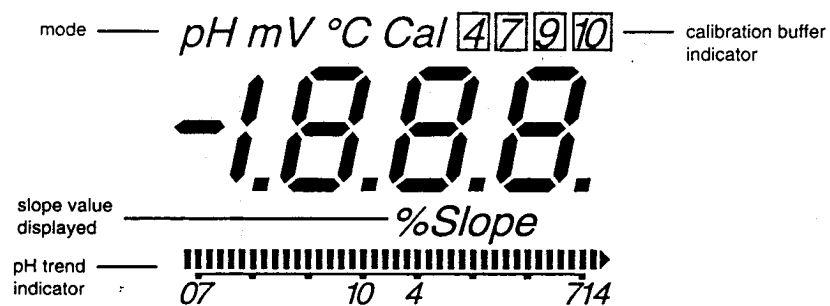
## 1.3 Display and Controls



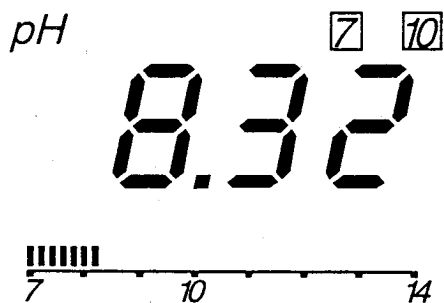
### 1.3 Display and Controls(cont)

-  Select pH, mV, or temperature mode.
-  In the pH mode, start a calibration sequence. But start the temperature inputting procedure in the temperature mode.
-  Turn the display on/off, and place the meter in standby mode when it turns-off.
-  Start a sample measuring sequence in pH and mV mode. Freeze the display with the second press. In the temperature mode, it acts as a shift key between the tens digit, unit digit and the decimal digit.

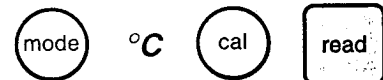
#### 320-S Display



#### Example: pH Reading




### 2.1 Inputting Temperature





We recommend you check the temperature data before each measurement. Input new temperature of the solution if the sample temperature is different from the temperature setting (see Section 2.1.1).



#### 2.1.1 Checking and Inputting Temperature


##### To check the temperature setting:

Enter the temperature mode by pressing the  key once. The '°C' will show on the display together with current temperature data, and the decimal point will flash.


##### To input temperature data:


Press the  key to start a temperature inputting procedure. First, tens digit will flash and the numbers will increase one by one with a fixed time interval. While it reaches the number you want to enter, press the  key.

The unit digit will then start to flash and the number will increase one by one with a fixed time interval. While it reaches the number you want to enter, press the  key. The decimal number will then switch between 0 and 5. Press  key to choose 0 or 5. The display will be frozen after that. It means that all digits

including the decimal point are entered. Press the  key to choose pH mode or mV mode.

The temperature data will be retained even after the power is off or a power failure.

**Note** If you want to make any change in the temperature mode when the display is frozen, just press the  key and the decimal point will flash again. Follow the instruction described above to change the temperature.

**Note** Any time you want to restart during your temperature inputting procedure, just press the  key and follow the instruction described above.

## 2.2 pH Measurements

pH


read


We recommend regular calibration before sample measurement (see Section 2.2.1 and 2.2.2). Check the temperature setting. Make sure to input a new temperature data if needed.

To measure the pH of a sample, proceed as follows:

Place electrode in sample and press  key to start the measurement. The decimal point will flash.

The display simultaneously shows a digital and an analog pH reading. The analog scale shows from 0 to 7 or from 7 to 14. Over or under range readings are indicated by an arrow.

To freeze the display at endpoint press .

To start a new measurement press .


### 2.2.1 Setting Calibration Point




To get the most accurate pH readings you should calibrate regularly. The 320-S allows you to select one of three sets of calibration buffers. For each selected set, you can use two of the three buffers when calibrating.

There are three sets of buffers available:


Set 1(b=1):	pH4.00	7.00	10.01
Set 2(b=2):	pH4.01	7.00	9.21
Set 3(b=3):	pH4.01	6.86	9.18


To set the calibration buffers:

Press  to turn the display off.

Press and hold  and press  again. Release .

The display shows b=3 (or the current buffer set selected).

Press  to display b=1, or b=2.

Press  to select the required buffer set when it is displayed.

The 320-S will retain this setting, even after a power failure.


## 2.2.2 Calibrating a pH Electrode


pH

cal


You must enter the temperature mode and input the buffer solution temperature before calibrating a pH electrode (See Section 2.1.1).

### 1 point calibration


Place the electrode in the first calibration buffer and press . The 320-S

automatically endpoints when calibrating. To manually endpoint press .


At the measurement endpoint the appropriate buffer indicator appears on the display.

To return to sample measurement press .

### 2 point calibration

To continue with a 2 point calibration press .

Place the electrode in the next calibration buffer and continue as before. When the display freezes the electrode slope value will be displayed briefly.

To return to sample measurement press .


## 2.3 mV Measurements

mode


mV


read

To measure the absolute mV of sample:

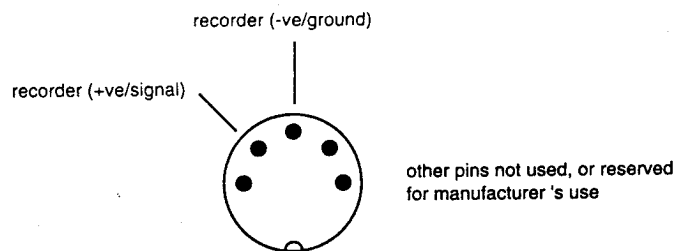
Place electrode in sample and press  to start the measurement.

The display shows the absolute mV of the sample.

To freeze the display at endpoint press .

To start a new measurement press .

## 2.4 Chart Recorder



### REC Socket

The REC socket (5-pin, 180°DIN socket) provides a voltage proportional to the displayed reading in pH and mV modes. The polarity of the output is the same as the polarity of the input signal.

### Approximate Recorder Outputs

pH – Output follows display and provides approximately 60 mV output per pH unit. This value will vary with changes in electrode slope.

mV – Output follows display, i.e. as display varies from -1999 to 1999 mV, output varies from -1999 to +1999 mV.

The recorder output is not available in temperature mode.

## Step-by-step guide to taking pH measurement

**1. Prepare Electrode**

expose fill hole  
check fill solution level  
OR  
remove cap

**2. 1-Point Calibration**

Cal  
pH Cal 7.03  
auto endpoint, or  
read  
pH Cal 7.00  
7 buffer  
swirl, then leave

**3. Rinse Electrode**

**4. 2-Point Calibration**

4 10  
repeat step 2 using 2nd buffer, then rinse

**5. Measure Sample**

read  
pH 5.62  
sample  
swirl, then leave

**6. Rinse Electrode**

**7. Store Electrode**

cover fill hole  
OR  
fill solution  
replace cap

### 3.1 Basic Theory

pH is the unit of measurement of the acidity or alkalinity of a solution, and is expressed as the negative logarithm of the hydrogen ion concentration:

$$\text{pH} = -\log[\text{H}^+]$$

pH 0 is extremely acidic, pH 14 is extremely alkaline and pH 7 is neutral.

To measure a pH value, a sensing electrode and a reference electrode are needed. A combination electrode (sensing and reference electrode in one unit) is commonly used for routine pH measurement.

The sensing (pH) electrode (or sensing element in a combination electrode) has an internal buffer solution with a constant pH value, and develops a potential (difference between inner and outer ionic charge) when placed in solution. This is caused by the activity (concentration) of  $\text{H}^+$  in the solution. The reference electrode (or reference element in a combination electrode) has a defined, stable potential irrespective of the  $\text{H}^+$  activity in the sample. The 320-S measures and converts the resulting minute electrode voltages into a pH reading.

The response of a pH electrode (or its 'slope') is defined by the Nernst equation:

$$\text{Electrode response} = E_0 - \frac{2.3RT}{nF} \cdot \text{pH}$$

Where:

- $E_0$  = a constant factor
- R = the gas constant
- F = the Faraday constant
- T = the temperature (Kelvin)
- n = the ionic charge

For  $\text{H}^+$  (i.e.  $n=+1$ ) at 25°C (298K) the slope value is 59.16 mV. This is the IDEAL SLOPE FACTOR. For one unit change in pH, an ideal system will sense a mV change of 59.16 mV. The measurement of electrode slope is a good indication of the electrode condition and performance.

### 3.1 Basic Theory (cont)

Temperature is an important consideration when making pH measurements. It affects the electrode slope (see Nernst equation), the temperature coefficient of the measured solution, the response time of the electrode and the position of the electrode isothermal intersection (isothermals = calibration lines at different temperature- ideally they should intersect at pH 7/0mV, but in practice this is rarely the case).

Other factors, including the ionic strength of the solution (the degree to which the molecules in a solution dissociate to form ions) also affect pH measurement.

The following section takes account of these factors and provides hints on electrode care and sample measurement.

Further information is included in the booklet "Guide to pH Measurement".

---

### 3.2 Operating Hints

This section gives some brief hints on electrode care and sample measurement. The maintenance section gives some advice on keeping the electrode in good condition. For detailed electrode care refer to the electrode instructions.

1. Remove the electrode wetting cap from the end of the electrode and the rubber cap from the fill hole before using the electrode.
2. New electrode should be conditioned in pH 4 or 7 buffer overnight. Do not use deionized or distilled water.
3. Calibrate the electrode using a buffer solution close to that of the test sample. When you use an electrode for the first time, or after electrode maintenance, we recommend you use a buffer close to pH7 for the first calibration point. After this initial calibration, you can use any of the three calibration buffers you have selected, in any order, for subsequent calibration.

### 3.2 Operating Hints (cont)

4. When transferring the electrode from one solution to another, rinse it with distilled water or a little of the next solution to be measured. Blot dry with tissue paper-do not wipe the electrode as this may cause polarization and slow response.
5. Handle the electrode carefully, do not use it as a stirrer. Avoid handling the electrode membrane. Damage will cause inaccuracy and slow response.
6. For small sample volumes, make sure the liquid junction is covered.
7. Do not allow the electrode fill solution to dry out as this may cause permanent damage. Keep the electrode topped up with the correct filling solution, and change the filling solution completely on a regular basis.
8. Store the electrode short term in electrode filling solution. The Electrode Storage Container, available as an optional accessory, is ideal. For longer term storage, replace the wetting cap, filled with filling solution, and the fill hole cover.
9. Do not use buffer solutions after the expiry date, and do not pour solutions back into bottles.
10. Response time is a function of both the electrode and the solution. Some solutions have very rapid equilibration times, others, particularly those with low ionic strength, may take several minutes.



### 3.3 Maintenance

#### 3.3.1 320-S Maintenance

The 320-S needs no maintenance except for an occasional wipe with a damp cloth. The front panel is made of polycarbonate and is impervious to a wide range of solvents. However, polycarbonate is known to be affected by some organic solvents, including toluene, xylene and methyl - ethyl - ketone. It is good laboratory practice to wipe away any spillages as soon as they occur.

#### 3.3.2 Electrode Maintenance

**CAUTION** Cleaning and filling solutions should be handled with the care accorded to toxic or corrosive substances.

Make sure the electrode is always kept topped up with the appropriate filling solution. For maximum accuracy any filling solution that may have 'crept' and encrusted, the outside of the electrode should be removed with distilled water.

Always store the electrode properly and do not allow it to dry out.


If the electrode slope value falls rapidly, or if the response becomes sluggish or inaccurate, the following procedures may help. Try them one by one, in the order given.

- Degrease the membrane with cotton wool soaked in either acetone or soap solution.
- Soak the tip of the electrode in 0.1 M HCl overnight.
- If a protein build-up has occurred, remove deposits by soaking electrode in 0.1 M HCl + 10% pepsin solution.

### 3.4 Problem Solving


Most problems that arise are caused by electrode faults rather than by the 320-S. Other factors, such as buffer solutions, sample conditions and so on can also cause problems. Carry out the meter test first to eliminate 320-S error.


#### Meter Test


1. Disconnect the power supply unit from the DC socket.
2. Press and hold  and reconnect the power supply unit.


The display shows the test sequence, with all segments showing, and then

displays 1. Release .

3. Press  the display shows 2.

Press  the display shows 3.

Press  the display shows 4.

Press  display repeats the test sequence, with all segments showing,

then returns to normal operation.

4. Disconnect the electrode from the pH socket, and connect the shorting clip (or shorting plug). Select mV mode. The 320-S display 0+1mV. Disconnect the shorting clip(or shorting plug), and the reading changes.
5. Reconnect electrode.

### 3.4 Problem Solving (cont)

**NOTE** Refer to the electrode manufacturer's instructions for full details on cleaning or conditioning electrodes.

#### E1 or E2 Displayed (cal/slope out of range)

1. Carry out meter test.
2. Select mV mode and place electrode in pH 7 buffer. The display should read  $0\text{ mV} \pm 35\text{ mV}$ . If not, clean the electrode, or replace.
3. Select pH mode, and carry out a 2 point calibration using pH 7 buffer as the first buffer, and pH 4 as the second buffer. (If the display still reads pH 7 when measuring pH 4 buffer, the electrode is damaged or broken and should be replaced). Note the % slope value.

Slope Value	Action
>100%	Check calibration buffers.
90-100%	Electrode is in good condition. Check calibration buffers.
85-90%	Electrode needs cleaning.
<85%(E2)	Electrode needs conditioning, or replacing

#### ----- Displayed (measurement out of range)

1. Carry out meter test.
2. Check if electrode is connected.
3. Check if electrode is immersed in the sample.
4. Check if electrode wetting cap is removed.
5. Replace electrode.

#### Unstable Reading

1. Check if electrode fill hole is uncovered.
2. Check if sample covers liquid junction.
3. Check electrode junction for bubbles.
4. Check electrode reference fill solution.
5. Clean or replace electrode junction.
6. Replace electrode.

### 3.4 Problem Solving (cont)

#### Slow Response

1. Check if electrode fill hole is uncovered.
2. Check if solutions are at different temperatures-allow time for temperature equilibration.
3. Check if sample has low ionic strength (i.e. water)-allow time for equilibration.
4. Avoid wiping the electrode between measurements as this can cause slow response.
5. Clean/condition electrode.
6. Replace electrode.

#### Inaccurate Readings

1. Check if you are using correct calibration buffers.
2. Check that buffers are not past their expiry date, or contaminated.

For further help contact your local distributor, or the technical assistance number on the rear cover.

3

3

### 3.5 Specifications

#### Operating Ranges

pH	0.00 to 14.00
mV	±1999
Temp.	0 to 99.5°C

#### Resolution

pH	0.01
mV	1
Temp.	0.5°C

#### Relative Accuracy

pH	±0.01
mV	±1

#### pH Calibration

2 point, auto buffer recognition

#### Isopotential Point

7.00 pH

#### Temperature Compensation

0 to 99.5°C Manual Temperature Compensation

#### Display

LCD display

Digital pH, mV and °C  
Analog trend indicator, pH only,  
0.2 pH increments

#### Outputs

Recorder

#### Input Conditions

Impedance greater than 10<sup>12</sup> ohms

#### Operating Conditions

Operating temperature : 5 to 40°C  
Operating humidity: 5 to 80% (non  
condensing)  
Installation category 2  
Pollution category degree 2

#### Size

6x8x4 inches  
(150X200X100 mm)

#### Weight

1.8lb (0.8 kg)

#### Power Requirements

The 320-S is supplied with an  
appropriate power supply unit, e.g.

UK	240V 50Hz 6.5VA
USA/Japan	100-120V 50/60Hz 9VA
Europe/China	220-230V 50Hz 10VA

320-S Power Rating 0.15VA

Output from PSU 9V DC

**NOTE** The 320-S should only be used  
with the power supply unit provided.

### 3.5 Specifications (cont)

#### Buffer Temperature Correction Table

The 320-S automatically corrects for temperature using the values shown in the table.

	<b>4.00</b>	<b>4.01</b>	<b>6.86</b>	<b>7.00</b>	<b>9.18</b>	<b>9.21</b>	<b>10.01</b>
0°C	4.00	4.01	6.98	7.12	9.46	9.52	10.32
5°C	4.00	4.01	6.95	7.09	9.40	9.45	10.25
10°C	4.00	4.00	6.92	7.06	9.33	9.38	10.18
15°C	4.00	4.00	6.90	7.04	9.28	9.32	10.12
20°C	4.00	4.00	6.88	7.02	9.23	9.26	10.06
<b>25°C</b>	<b>4.00</b>	<b>4.01</b>	<b>6.86</b>	<b>7.00</b>	<b>9.18</b>	<b>9.21</b>	<b>10.01</b>
30°C	4.01	4.01	6.86	6.99	9.14	9.16	9.97
35°C	4.02	4.02	6.84	6.98	9.10	9.11	9.93
40°C	4.03	4.03	6.81	6.98	9.07	9.06	9.89
45°C	4.04	4.04	6.83	6.97	9.04	9.03	9.86
50°C	4.06	4.06	6.83	6.97	9.01	8.99	9.83

#### Environmental Compliance

All the components of the 320-S are marked with the appropriate recycling identification symbol. The packaging is manufactured with recycled cardboard and printed with water based ink. The packaging is recyclable.

**Consumables and Accessories**

Cat.	Description	Quantity
12520001	Combination pH electrode type 405 (BNC)	1
477968M-C	ATC Probe (30K NTC)	1
476380M	'3 IN 1' Combination Electrode (BNC)	1
471024	Starter Kit A	1
32010001E	Electrode Arm	1
001 56 001Z	Electrode Fill/Storage Solution sat. KCl (100mL)	1 bottle
469823250	Electrode Fill/Storage Solution 3M KCl (250mL)	1 bottle
477965	Electrode Storage Container	3
469863250	Standard Buffer pH 4.01 Buffer (250mL)	1 bottle
469865250	Standard Buffer pH 7.00 Buffer (250mL)	1 bottle
469866250	Standard Buffer pH 9.21 Buffer (250mL)	1 bottle
469927025	Electrode Conditioning Solution (25 mL)	1 bottle
469891250	Electrode Cleaning Solution pepsin/HCl (250mL)	1 bottle
471967	Power Supply Unit, 240V/50Hz	1
153393J/C	Power Supply Unit, 220-230V/50Hz	1
471226	Power Supply Unit, 100-120V/50-60Hz	1
471228	In-line Power Supply Unit, 220-240V/50Hz	1
471232	Recorder Cable	1
32005009X/C	BNC Shorting Plug	1
001 92 692K	Guide to pH Measurement	1

For your reference, make a note of the meter serial number, date of purchase and supplier here.

Serial No ..... Date Purchased .....

Supplier .....



**Consumables and Accessories**

Cat.	Description	Quantity
12520001	Combination pH electrode type 405 (BNC)	1
477968M-C	ATC Probe (30K NTC)	1
476380M	'3 IN 1' Combination Electrode (BNC)	1
471024	Starter Kit A	1
32010001E	Electrode Arm	1
001 56 001Z	Electrode Fill/Storage Solution sat. KCl (100mL)	1 bottle
469823250	Electrode Fill/Storage Solution 3M KCl (250mL)	1 bottle
477965	Electrode Storage Container	3
-469863250	Standard Buffer pH 4.01 Buffer (250mL)	1 bottle
-469865250	Standard Buffer pH 7.00 Buffer (250mL)	1 bottle
-469866250	Standard Buffer pH 9.21 Buffer (250mL)	1 bottle
-469927025	Electrode Conditioning Solution (25 mL)	1 bottle
469891250	Electrode Cleaning Solution pepsin/HCl (250mL)	1 bottle
471967	Power Supply Unit, 240V/50Hz	1
153393J/C	Power Supply Unit, 220-230V/50Hz	1
471226	Power Supply Unit, 100-120V/50-60Hz	1
471228	In-line Power Supply Unit, 220-240V/50Hz	1
471232	Recorder Cable	1
32005009X/C	BNC Shorting Plug	1
001 92 692K	Guide to pH Measurement	1

For your reference, make a note of the meter serial number, date of purchase and supplier here.

Serial No ..... Date Purchased .....

Supplier .....

3