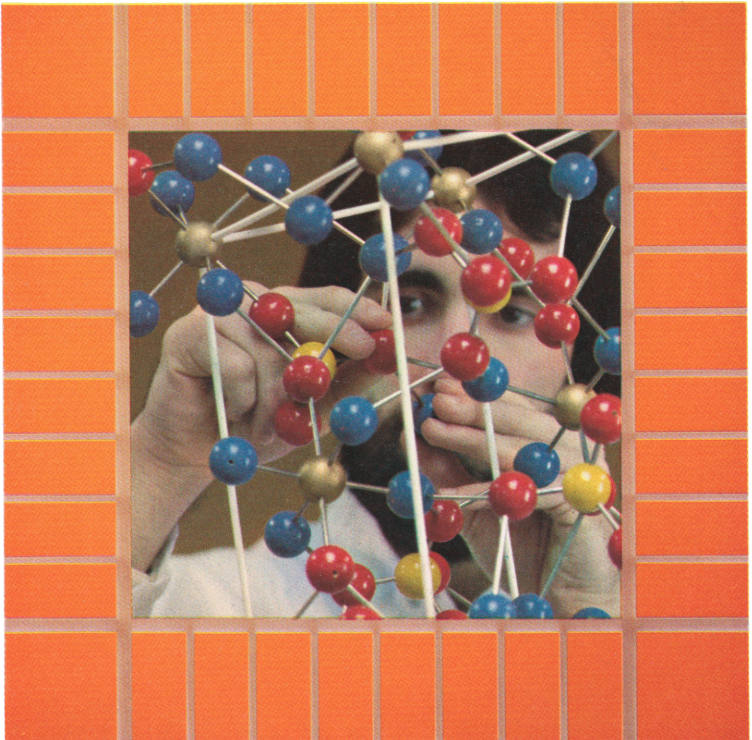


HEWLETT-PACKARD

# HP-31E

## OWNER'S HANDBOOK



"The success and prosperity of our company will be assured only if we offer our customers superior products that fill real needs and provide lasting value, and that are supported by a wide variety of useful services, both before and after sale."

Statement of Corporate Objectives.  
Hewlett-Packard

When Messrs. Hewlett and Packard founded our company in 1939, we offered one superior product, an audio oscillator. Today, we offer over 3500 quality products, designed and built for some of the world's most discerning customers.

Since we introduced our first scientific calculator in 1967, we've sold millions world-wide, both pocket and desktop models. Their owners include Nobel laureates, astronauts, mountain climbers, businessmen, doctors, students, and housewives.

Each of our calculators is precision crafted and designed to solve the problems its owner can expect to encounter throughout a working lifetime.

HP calculators fill real needs. And they provide lasting value.



# **The HP-31E Scientific Calculator Owner's Handbook**

**July 1978**

00031-90001 Rev. B 7/78

# Your HP-31E

Congratulations!

Your HP-31E is another professional-quality personal product from the Hewlett-Packard line of calculators—calculators whose durability, size, and ease of operation have made them the choice for use by climbers on Mt. Everest and astronauts in outer space. Doctors, engineers, scientists, and other people who require instant answers to complex and highly technical problems use Hewlett-Packard calculators. You're in good company with HP!

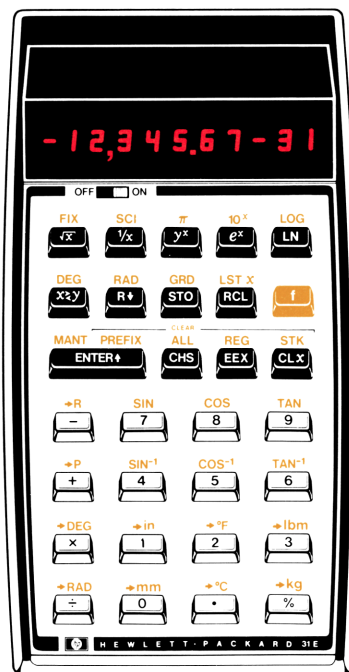
This handbook has been designed to be used in conjunction with *Solving Problems With Your Hewlett-Packard Calculator*. These two books will help you get the most from your HP-31E. In their pages you'll find a reference guide to every basic operation your calculator can perform.

If you are new to HP calculators and their RPN logic system, you will want to use the *Solving Problems* book before reading your owner's handbook. Even if you already own another HP calculator, glance through *Solving Problems With Your Hewlett-Packard Calculator*. You may find some new features you're not familiar with.

Get to know your HP-31E. It's easy.

# HP-31E

## Scientific Calculator



### Automatic Memory Stack

T ..... 0.0000

Z ..... 0.0000

Y ..... 0.0000

Display

X ..... 0.0000

LAST X

0.0000

### Storage Registers

R<sub>0</sub> 0.0000


R<sub>1</sub> 0.0000







R<sub>2</sub> 0.0000

R<sub>3</sub> 0.0000


# Function Key Index


OFF  ON  
OFF-ON Switch.


 Pressed before function key, selects gold function printed above key.

**CLEAR**   
After , ,  
, , ,  
cancels that key-stroke or sequence of keystrokes.

## Digit Entry

 Enters a copy of number displayed in X-register into Y-register. Used to separate numbers.


 Changes sign of mantissa or exponent in displayed X-register.


 Enter exponent. After pressing, next digits keyed in comprise the exponent.


0 through 9  
Digit keys.


- Decimal point.


## Number Manipulation

 Rolls down contents of stack for viewing in displayed X-register.


 Exchanges contents of X- and Y-registers of stack.


 Clears contents of displayed X-register to zero.

**CLEAR**  Clears contents of stack (X, Y, Z, T) and all storage registers.


**CLEAR**  Clears contents of stack (X, Y, Z, T).


## Metric Conversions


 Converts millimeters to inches.

 Converts inches to millimeters.


 Converts degrees Celsius to degrees Fahrenheit


 Converts degrees Fahrenheit to degrees Celsius.


 Converts kilograms to pounds (mass).




 Converts pounds (mass) to kilograms.




## Trigonometry

 Sets decimal degrees mode for argument of trigonometric functions.


 Sets radians mode for argument of trigonometric functions.

 Sets grads mode for argument of trigonometric functions.

    
Computes sine, cosine, or tangent of value in displayed X-register.

    
Computes arc sine, arc cosine, or arc tangent of number in displayed X-register.

## Percentages

 Computes x % of y.

## Display Control

**FIX** Fixed point display. Followed by a digit key, selects fixed point notation display.

**SCI** Scientific display. Followed by a digit key, selects scientific notation display.

**MANT** Mantissa. Temporarily displays all 10 digits of the mantissa of the number in the X-register.

## Storage

**STO** Store. Followed by 0, 1, 2, 3 key, stores displayed number in specified storage register. Also used to perform storage register arithmetic.

**RCL** Recall. Followed by 0, 1, 2, 3 key, recalls value from storage register specified into the displayed X-register.

**CLEAR** **REG** Clears contents of all storage registers.

**LST X** Recalls number displayed before previous operation back into displayed X-register.

## Mathematics

**$\sqrt{x}$**  Computes square root of number in displayed X-register.

**$1/x$**  Computes reciprocal of number in displayed X-register.

**$\rightarrow \text{RAD}$**  Converts decimal degrees to radians.

**$\rightarrow \text{DEG}$**  Converts radians to decimal degrees.

**$\pi$**  Places value of pi (3.141592654) into X-register.

**$+$   $-$   $\times$   $\div$**   
Arithmetic operators.

## Polar/Rectangular Conversions

**$\rightarrow \text{P}$**  Converts rectangular (x, y) coordinates in X- and Y-registers to polar (r,  $\theta$ ) coordinates.

**$\rightarrow \text{R}$**  Converts polar (r,  $\theta$ ) coordinates in X- and Y-registers to rectangular (x, y) coordinates.

## Logarithmic and Exponential Functions

**$y^x$**  Raises number in Y-register to power of number in displayed X-register.

**$10^x$**  Common anti-logarithm. Raises 10 to power of number in displayed X-register.

**$e^x$**  Natural anti-logarithm. Raises e (2.718281828) to power of number in displayed X-register.

**LOG** Computes common logarithm (base 10) of number in displayed X-register.

**LN** Computes natural logarithm (base e, 2.718281828) of number in displayed X-register.

## Specific Features of the HP-31E

Most of the features found on the HP-31E are discussed in *Solving Problems With Your Hewlett-Packard Calculator*. However several features unique to the HP-31E (or new to HP calculators) are discussed in the following pages.

### Self Check Routine

Your new Hewlett-Packard calculator is loaded with features that make it easy to use and give you confidence that the answers you calculate are right, every time. The self check routine, a feature found on many sophisticated electronic instruments and computers, was designed for just those reasons. We don't expect you to ever have a problem with your calculator, but if you think that it isn't operating properly, try this:

#### Keystrokes

**STO** **ENTER**



#### Display

**-8,8,8,8,8,8,8,8,**

The display shown above will appear if your calculator is operating properly. Press any key to clear the display back to zero. If your calculator is not operating properly, your display will show **Error 9** or an erroneous display. This tells you that a problem exists in the calculator's circuitry and you should send it in for service (refer to Shipping Instructions, in this owner's handbook). Pressing any key will replace the **Error 9** in the display with a number that tells a Hewlett-Packard Service Engineer which circuit in the calculator is at fault. That's right, the calculator not only tells you it's having problems, it tells us where the problem is, so we can fix it as quickly and inexpensively as possible and return it to you without delay.







**Note:** Using the self check causes all memory to be cleared, including the stack and data registers.

## Mantissa

When in any display format, you wish to view the contents of the true mantissa (all 10 digits) press   and hold down the key. This operation displays all the digits of the mantissa held internally. Release the key and the display will revert back to its original contents. For more information on display formatting refer to Display Control in *Solving Problems With Your Hewlett-Packard Calculator*.



## Metric Conversions

The six functions provided for converting English measurements and System International measurements are:

	(millimeters to inches)
	(inches to millimeters)
	(degrees Celsius to degrees Fahrenheit)
	(degrees Fahrenheit to degrees Celsius)
	(kilograms to pounds mass)
	(pounds mass to kilograms)

All measurement conversion functions are one-number functions. To use them, key in the number, then press the function key.



**Example:** Convert 98.6 degrees Fahrenheit to degrees Celsius.

Keystrokes	Display
98.6	98.6
 	37.0000 °C.

**Example:** Convert 7 pounds (mass) to kilograms.

Keystrokes	Display
7	7.
 	3.1751 Kilograms.

**Example:** Convert 843 millimeters to inches.

Keystrokes	Display
843	843.
 	33.1890 Inches.

## 8 Specific Features of the HP-31E

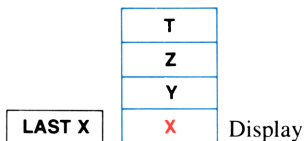
Conversions  $\boxed{\leftrightarrow^{\circ}\text{F}}$ ,  $\boxed{\leftrightarrow\text{mm}}$ , and  $\boxed{\leftrightarrow\text{lbm}}$  work in the same way as those shown above.

### Storage Registers

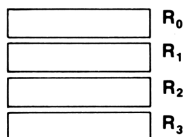
In addition to the power that exists in the four-register automatic memory stack and LAST X register, your HP-31E contains four addressable data storage registers that are unaffected by operations within the stack.

These registers allow you to manually store and recall constants or to set aside numbers for use in later calculations. Refer to *Storing and Recalling Numbers* in *Solving Problems With Your Hewlett-Packard Calculator* for further information.

#### Automatic Memory Stack



#### Storage Registers



# Service and Maintenance

## Your Hewlett-Packard Calculator

Your calculator is another example of the award-winning design, superior quality, and attention to detail in engineering and construction that have marked Hewlett-Packard electronic instruments for more than 30 years. Each Hewlett-Packard calculator is precision crafted by people who are dedicated to giving you the best possible product at any price.

After construction, every calculator is thoroughly inspected for electrical or mechanical flaws.

When you purchase a Hewlett-Packard calculator, you deal with a company that stands behind its products.

## AC Line Operation

Your calculator contains a rechargeable battery pack consisting of nickel-cadmium batteries. When you receive your calculator, the battery pack inside may be discharged, but you can operate the calculator immediately by using the ac adapter/recharger.

**Note:** Do not attempt to operate the calculator from the ac line with the battery pack removed.

The procedure for using the ac adapter/recharger is as follows:

1. You need *not* turn the calculator off.
2. Insert the ac adapter/recharger plug into the connector on top of the calculator, with the snap release tab on the plug facing toward the right side of the calculator.
3. Insert the power plug into a live ac power outlet.

**Note:** It is normal for the ac adapter/recharger to be warm to the touch when it is plugged into an ac outlet.

### CAUTION

The use of a charger other than the HP recharger supplied with the calculator may result in damage to your calculator.

## Battery Charging

The rechargeable batteries in the battery pack are charged while you operate the calculator from the ac adapter/recharger. Batteries will charge with the calculator on or off, provided batteries are in place and recharger is connected. Normal charging times between the fully discharged state and the fully charged state are (depending on ac line voltage value):

Calculator off: 5 to 9 hours

Calculator on: 17 hours

Shorter charging periods will reduce the operating time you can expect from a single battery charge. Whether the calculator is off or on, the calculator battery pack is never in danger of becoming overcharged.

**Note:** The ac adapter/recharger is a sealed unit and is not repairable. Return it to Hewlett-Packard if service is required.

## Battery Operation

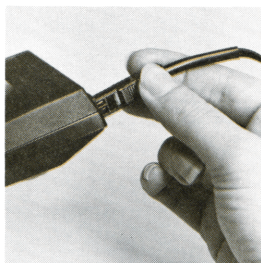
To operate the calculator from battery power alone, simply disconnect the recharger plug from the calculator by grasping the plug between thumb and forefinger, squeezing to depress the snap release tab, and pulling gently. (Even when not connected to the calculator, the ac adapter/recharger may be left plugged into the ac outlet.)

Using the calculator on battery power gives the calculator full portability, allowing you to carry it nearly anywhere. A fully charged battery pack typically provides 3 hours of continuous operation. By turning the power off when the calculator is not in use, the charge on the battery pack should easily last throughout a normal working day.

## Battery Pack Replacement

To replace the battery pack use the following procedure:

1. Set calculator ON-OFF switch to OFF and disconnect the battery ac adapter / recharger from the calculator.



2. Press down on the battery door where indicated until the door release snaps open. Slide the door open.



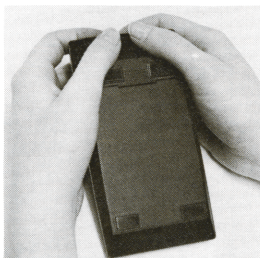
3. When door is removed, turn calculator over and gently shake, allowing the battery pack to fall into the palm of your hand.



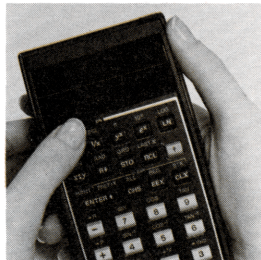
4. Place the new battery pack into the calculator. Your calculator will only turn on if the battery pack is inserted correctly.



5. Insert battery door and slide door back into place.



6. Turn calculator over and turn power on to assure proper battery installation. If the display does not light make sure the battery pack is correctly placed in calculator.



## Battery Care

When not being used, the batteries in your calculator have a self-discharge rate of approximately 1 percent of available charge per day. After 30 days, a battery pack might have only 50 to 75 percent of its charge remaining, and the calculator might not even turn on. If a calculator fails to turn on, you should substitute a charged battery pack, if available, for the one in the calculator or plug into ac adapter/recharger. The discharged battery pack should be charged for at least 12 hours.

If a battery pack will not hold a charge and seems to discharge very quickly in use, it may be defective. If the one-year warranty on the battery pack has not expired, return the defective pack to Hewlett-Packard according to the shipping instructions. (If you are in doubt about the cause of the problem, return the complete calculator along with its battery pack and ac adapter/recharger.) If the battery pack is out of warranty, see your nearest dealer to order a replacement.

### WARNING

Do not attempt to incinerate or mutilate the battery pack—the pack may burst or release toxic materials.

Do not connect together or otherwise short-circuit the battery terminals—the pack may melt or cause serious burns.

## Service

### Low Power

When you are operating from battery power and the batteries get low, a raised decimal is turned on at the far left of the display to warn you that you have between 1 minute and 25 minutes of operating time left.

**•1.23                      49**

If the display contains the low power indication, a negative number looks like half a divide sign.

**-1.23                      49**

To return to full power either connect the ac adapter/recharger to the calculator as described under AC Line Operation, or substitute a fully charged battery pack for the one in the calculator.

### Blank Display

If the display blanks out, turn the calculator off, then on. If a display of numbers does not appear in the display, check the following:

1. If the ac adapter/recharger is attached to the calculator, make sure it is plugged into an ac outlet.
2. Examine the battery pack to see if the contacts are dirty.
3. Substitute a fully charged battery pack, if available, for the one that was in the calculator.
4. If the display is still blank, try operating the calculator using the ac adapter/recharger (with the batteries in the calculator).
5. If, after step 4, the display is still blank, service is required. (Refer to Warranty.)

## Temperature Range

Temperature ranges for the calculator are:

Operating	0° to 45°C	32° to 113°F
Charging	15° to 40°C	59° to 104°F
Storage	-40° to 55°C	-40° to 131°F

## Limited One-Year Warranty

### What We Will Do

The HP-31E and its accessories are warranted by Hewlett-Packard against defects in materials and workmanship for one year from date of original purchase. If you sell your calculator or give it as a gift, the warranty is automatically transferred to the new owner and remains in effect for the original one-year period. During the warranty period we will repair or, at our option, replace at no charge a product that proves to be defective provided that you return the product, shipping prepaid, to a Hewlett-Packard repair center.

### How to Obtain Repair Service

Hewlett-Packard maintains repair centers in most major countries throughout the world. You may have your calculator repaired at a Hewlett-Packard repair center anytime it needs service, whether the unit is under warranty or not. There is a charge for repairs after the one-year warranty period. Please refer to the Shipping Instructions in this handbook.

The Hewlett-Packard United States Repair Center for handheld and portable printing calculators is located at Corvallis, Oregon. The mailing address is:

**HEWLETT-PACKARD COMPANY  
CORVALLIS DIVISION, SERVICE DEPT.  
P.O. BOX 999  
CORVALLIS, OREGON 97330**

### What Is Not Covered

This warranty does not apply if the product has been damaged by accident or misuse, or as a result of service or modification by other than an authorized Hewlett-Packard repair center.

No other express warranty is given. The repair or replacement of a product is your exclusive remedy. **ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS IS LIMITED TO THE ONE-YEAR DURATION OF THIS WRITTEN WARRANTY.** Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. **IN NO EVENT SHALL HEWLETT-PACKARD COMPANY BE LIABLE FOR CONSEQUENTIAL DAMAGES.** Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

### **Obligation to Make Changes**

Products are sold on the basis of specifications applicable at the time of sale. Hewlett-Packard shall have no obligation to modify or update products once sold.

### **Warranty Information Toll-Free Number**

If you have any questions concerning this warranty please call **800/648-4711**. (In Nevada call 800/992-5710.)

### **Repair Policy**

Hewlett-Packard calculators are normally repaired and reshipped within five (5) working days of receipt at any repair center. This is an average time and could possibly vary depending upon time of year and work load at the repair center.

### **Shipping Instructions**

The calculator should be returned, along with completed Service Card, in its shipping case (or other protective package) to avoid in-transit damage. Such damage is not covered by warranty and Hewlett-Packard suggests that the customer insure shipments to the repair center. A calculator returned for repair should include the ac adapter/recharger and the battery pack. Send these items to the address shown on the Service Card. *Remember to include a sales slip or other proof of purchase with your unit.*

Whether the unit is under warranty or not, it is your responsibility to pay shipping charges for delivery to the Hewlett-Packard repair center.

After warranty repairs are completed, the repair center returns the unit with postage prepaid. On out-of-warranty repairs, the unit is returned C.O.D. (covering shipping costs and the service charge).

### **Further Information**

Service contracts are not available. Calculator circuitry and design are proprietary to Hewlett-Packard, and service manuals are not available to customers.

Should other problems or questions arise regarding repairs, please call your nearest Hewlett-Packard repair center.

**Note:** Not all Hewlett-Packard repair centers offer service for all models of HP calculators. However, you can be sure that service may be obtained in the country where you bought your calculator.

If you happen to be outside of the country where you bought your calculator, you can contact the local Hewlett-Packard repair center to see if service capability is available for your model. If service is unavailable, please ship your calculator to the following address:

Hewlett-Packard  
1000 N.E. Circle Boulevard  
Corvallis, Oregon 97330  
U.S.A.

All shipping and reimportation arrangements are your responsibility.

## Error Indications

If you attempt a calculation containing an improper operation—say, division by zero—the display will show **Error** and a number. To clear, press any key.

The following operations display **Error** plus a number:

### Error 0

- $\boxed{\div}$ , where  $x = 0$ .
- $\boxed{y^x}$ , where  $y = 0$  &  $x \leq 0$ .
- $\boxed{y^x}$ , where  $y < 0$  &  $x$  is non-integer.
- $\boxed{\sqrt{x}}$ , where  $x < 0$ .
- $\boxed{1/x}$ , where  $x = 0$ .
- $\boxed{\text{LOG}}$ , where  $x \leq 0$ .
- $\boxed{\text{LN}}$ , where  $x \leq 0$ .
- $\boxed{\text{SIN}^{-1}}$ , where  $|x|$  is  $> 1$ .
- $\boxed{\text{COS}^{-1}}$ , where  $|x|$  is  $> 1$ .
- $\boxed{\text{STO}} \boxed{\div}$ , where  $x = 0$ .

### Error 1

Storage register overflow.

### Error 2

$\boxed{\text{STO}}$ ,  $\boxed{\text{STO}} \boxed{+}$ ,  $\boxed{\text{STO}} \boxed{\times}$ ,  $\boxed{\text{STO}} \boxed{-}$ ,  $\boxed{\text{STO}} \boxed{\div}$ ,  $\boxed{\text{RCL}}$ ,  
where next digit entered is  $\geq 4$ .

### Error 9

Self-check failure. When **Error 9** is displayed, press any key and another number will show in the display. This number indicates to service personnel what is wrong with your calculator.



# Service Card

The warranty period for your calculator and/or accessory is one year from date of purchase. Hewlett-Packard will assume that any unit returned without a copy of proof of purchase (sales slip or validation) is out of warranty. Should service be required, please return your calculator, charger, batteries and this card protectively packaged to avoid in-transit damage. Such damage is not covered under warranty.

## Inside the U.S.A.

Return items safely packaged directly to:

**Hewlett-Packard**  
**Corvallis Division • Service Department**  
**P.O. Box 999**  
**Corvallis, Oregon 97330**

We advise that you insure your calculator and use priority (AIR) mail for distances greater than 300 miles to minimize transit times. All units will be returned by fastest practical means.

## Outside the U.S.A.

Where required please fill in the validation below and return your unit to the nearest designated Hewlett-Packard Sales and Service Office. Your warranty will be considered invalid if this completed card is not returned with the calculator.

Model No. \_\_\_\_\_

Serial No. \_\_\_\_\_

Date Received \_\_\_\_\_

Invoice No./Delivery Note No. \_\_\_\_\_

**Sold by:**

# Information

This card must be **completed** and **returned** with your calculator and/or recharger, and batteries. Return of this card is considered authorization for Hewlett-Packard to make all repairs necessary to return the calculator to normal working order and to charge the cost of those repairs to the owner for units out of warranty.

Owner's Name \_\_\_\_\_

Date \_\_\_\_\_

Street Address \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_

Zip Code \_\_\_\_\_

Home Phone \_\_\_\_\_

Work Phone \_\_\_\_\_

Date Purchased \_\_\_\_\_

## What Is The Problem Area?

☐ Intermittent Problem

☐ Display

☐ Printer (Enclose sample)

☐ Recharger/Battery

☐ Keyboard

☐ Prerecorded Program/Reader

☐ Programming

**Describe Problem:** \_\_\_\_\_

\_\_\_\_\_

Model No. \_\_\_\_\_

Serial No. \_\_\_\_\_

Preferred method of payment for out-of-warranty repairs.

**If not specified, unit will be returned C.O.D.**

☐ VISA

☐ Master Charge

Card No. \_\_\_\_\_

Expiration Date \_\_\_\_\_

Name appearing on credit card \_\_\_\_\_

☐ Purchase Order. Companies with established Hewlett-Packard credit only. (Include copy of purchase order with shipment.)

P.O. Number \_\_\_\_\_

Authorized Signature \_\_\_\_\_





## Calculator Catalog and Buying Guide Request Card

Thank you for your order.

A friend or associate might also want to know about Hewlett-Packard calculators. If you would like us to send the current issue of the *Hewlett-Packard Personal Calculator Digest* (The HP Magazine and Product Catalog), please write his/her name and address on this postage-paid Request Card.

### **Primary Interest:**

- ☐ Scientific Calculators
- ☐ Fully-Programmable Calculators
- ☐ Business Calculators
- ☐ All

Name \_\_\_\_\_

Title \_\_\_\_\_

Company \_\_\_\_\_

Street \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Valid in U.S. only

**430M**

FIRST CLASS
Permit No.
33
Corvallis, Oregon

**BUSINESS REPLY MAIL**

No postage stamp necessary if mailed in the United States

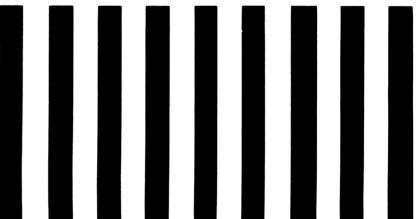
*Postage will be paid by:*

**Hewlett-Packard**

Corvallis Division

1000 N.E. Circle Boulevard

Corvallis, Oregon 97330



# HP-31E Registration Card

Please complete and return this postage-paid card. Owners with a U.S. address will have their name added to the Hewlett-Packard Personal Calculator Digest mailing list, and will automatically receive future product information.

Name \_\_\_\_\_ Date Product Received \_\_\_\_\_ Month \_\_\_\_\_ Day \_\_\_\_\_ Year \_\_\_\_\_  
 Company \_\_\_\_\_ Initial \_\_\_\_\_ Last \_\_\_\_\_  
 (Include Bldg., Division, Room No., etc.)  
 Street/Box/Route \_\_\_\_\_  
 City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_

1. Where was your calculator purchased?

- 101 ☐ Directly from an HP sales office or factory  
 102 ☐ By mail from HP  
 103 ☐ From any retail store

2. Check the ONE category best describing your job function

- 201 ☐ Top Management  
 202 ☐ Middle Management/Supervisory  
 203 ☐ Professional/Technical  
 204 ☐ Student  
 205 ☐ Other (Specify) \_\_\_\_\_

3. Rank TWO categories of applications for which your calculator will be used. (1 for most important, 2 for second.)

- 301 ☐ Engineering  
 302 ☐ Physical Science  
 303 ☐ Natural Science  
 304 ☐ Computer Science/Data Processing  
 305 ☐ Aviation/Marine Navigation  
 306 ☐ Statistics/Mathematics  
 307 ☐ Financial Analysis  
 308 ☐ Real Estate/Lending  
 309 ☐ Budgeting/Forecasting

If you are outside the United States please mail this card to the nearest Hewlett-Packard Sales Office.

FIRST CLASS
Permit No.
33
Corvallis, Oregon

**BUSINESS REPLY MAIL**

No postage stamp necessary if mailed in the United States

*Postage will be paid by:*

**Hewlett-Packard**

Corvallis Division

1000 N.E. Circle Boulevard

Corvallis, Oregon 97330



# Useful Conversion Factors

The following factors are provided to 10 digits of accuracy where possible. Exact values are marked with an asterisk. For more complete information on conversion factors, refer to *Metric Practice Guide E380-74* by the American Society for Testing and Materials (ASTM).

## Length

1 inch	= 25.4 millimeters*
1 foot	= 0.304 8 meter*
1 mile (statute)†	= 1.609 344 kilometers*
1 mile (nautical)†	= 1.852 kilometers*
1 mile (nautical)†	= 1.150 779 448 miles (statute)†

## Area

1 square inch	= 6.451 6 square centimeters*
1 square foot	= 0.092 903 04 square meter*
1 acre	= 43 560 square feet
1 square mile†	= 640 acres

## Volume

1 cubic inch	= 16.387 064 cubic centimeters*
1 cubic foot	= 0.028 316 847 cubic meter
1 ounce (fluid)†	= 29.573 529 56 cubic centimeters
1 ounce (fluid)†	= 0.029 573 530 liter
1 gallon (fluid)†	= 3.785 411 784 liters*

## Mass

1 ounce (mass)	= 28.349 523 12 grams
1 pound (mass)	= 0.453 592 37 kilogram*
1 ton (short)	= 0.907 184 74 metric ton*

## Energy

1 British thermal unit	= 1 055.055 853 joules
1 kilocalorie (mean)	= 4 190.02 joules
1 watt-hour	= 3 600 joules*

## Force

1 ounce (force)	= 0.278 013 85 newton
1 pound (force)	= 4.448 221 615 newtons

## Power

1 horsepower (electric)	= 746 watts*
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## Pressure

1 atmosphere	= 760 mm Hg at sea level
1 atmosphere	= 14.7 pounds per square inch
1 atmosphere	= 101 325 pascals

## Temperature

Fahrenheit	= 1.8 Celsius + 32
Celsius	= 5/9 (Fahrenheit - 32)
kelvin	= Celsius + 273.15
kelvin	= 5/9 (Fahrenheit + 459.67)
kelvin	= 5/9 Rankine

† U.S. values chosen.

\* Exact values.



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