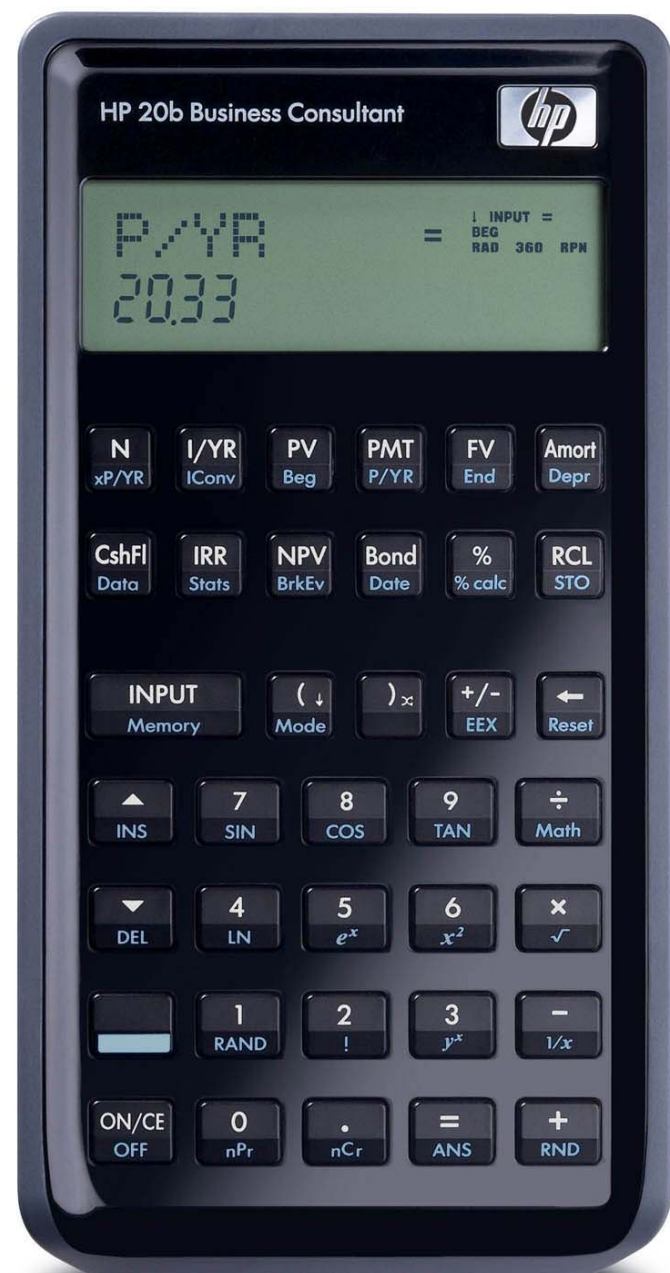**hp calculators**

HP 20b Using chain and algebraic modes to solve problems

The HP 20b chain and algebraic modes

Chain mode and the order of operations

Algebraic mode and the order of operations

Practice solving problems
using chain and algebraic modes

The HP 20b chain and algebraic modes

The HP 20b contains very flexible chain and algebraic modes in addition to its well-known RPN mode. These modes allow for flexible solutions to many problems encountered in business and beyond.

Chain mode and the order of operations

On the HP 20b in chain mode, functions are performed once they have enough arguments. Some functions apply to one number only, others return values from two numbers. One number functions in chain or algebraic mode work like RPN mode functions – they execute as soon as you press the function key. One number functions include [LN] [e^x] [x^2] [√] [1/x] [!] [SIN] [COS] [TAN] and others included in the MATH menu. Functions that operate on one number perform their function on a number just entered or a value already showing in the display.

On the HP 20b, [+], [−], [×], [÷] and [y^x] (and [nPr] and [nCr]) work with two numbers. Enter the first number, press the proper function key, enter the second number and then press the [=] key. For example, the expression 1 + 2 x 3 = will be evaluated by the HP 20b as follows: (1) Entering [1] [+] [2] [×] will cause the HP 20b to solve 1 + 2 (yielding a value of 3) and be ready to multiply this intermediate result by the next number entered. (2) When the [3] [=] keys are pressed, the HP 20b will multiply the previous intermediate result by 3 to provide the answer of 9. If you wish to alter the order of operations, you can use parentheses to force evaluation using whatever order is needed. A total of 10 pending operations are stored by the HP 20b.

Algebraic mode and the order of operations

In algebraic mode, functions are evaluated according to a hierarchy or standard order. One number functions as described in the previous section are evaluated immediately when the key is pressed. For example, multiplication and division are performed before addition and subtraction, but after the power function [y^x]. The entire list of the order of operations is included in the 20b User Guide.

For the expression 1 + 2 x 3 =, the HP 20b would evaluate it as follows in algebraic mode: (1) Entering [1] [+] [2] [×] will cause the HP 20b to store the 1 and the addition as a pending operation until the multiplication is completed. (2) When the [3] [=] keys are pressed, the HP 20b will multiply the 2 by 3 to provide the intermediate answer of 6. (3) The HP 20b will then use this pending result of 6 as the second number for the addition operation by adding 1 to it for a final result of 7. If you wish to alter the order of operations, you can use parentheses to force evaluation using whatever order is needed.

Note: The HP 20b can handle up to 7 pending operations in algebraic (or chain) mode.

Practice solving problems using algebraic mode

Example 1:   What is the most common keystroke sequence to compute the reciprocal of 7.2?

Solution: The most common keystroke sequence to compute the reciprocal of 7.2 is:

[7] [.] [2] [▬] [1/x]

Answer: 0.14.

Example 2: What is the most common keystroke sequence to enter 2.33 and 4.5 and add them to each other? What registers in the stack are used?

Solution: The most common keystroke sequence to add 2.33 to 4.5 is:

| 4 | · | 5 | + | 2 | · | 3 | 3 | = |

Answer: 6.83.

When [=] is pressed, the calculator proceeds with the following operation sequence:

1. take a copy of the X-register contents;
2. take Y-register contents and add to X-register contents;
3. replace actual X-register contents for resulting value;

Example 3: Evaluate: 3 x 4 + 5 =

Solution: | 3 | × | 4 | + | 5 | = |

Answer: 17. In this instance, the order of operations is unimportant, since the multiplication comes before the addition anyway. Chain and Algebraic modes give the same answer.

Example 4: Evaluate: 3 + 4 x 5 =

Solution: | 3 | + | 4 | × | 5 | = |

Answer: In this case, the answer will be different in chain mode compared to algebraic mode. In chain mode, the answer will be 35, while in algebraic mode, the answer will be 23. The difference results from the order in which the operations are evaluated. In chain mode, the addition is evaluated as soon as the HP 20b can, which is when the multiply key is pressed. In algebraic mode, the HP 20b postpones the evaluation of the addition until after the higher priority multiplication is completed.

NOTE: It is very important in chain mode that you know what the order of operations for a calculation is supposed to be. If you are in chain mode but you know the multiplication is supposed to be evaluated first, you <u>must</u> use parentheses to alter the order manually.

Example 5: Evaluate: 5 ÷ (10 – 2)

Solution: | 5 | ÷ | (| 1 | 0 | – | 2 |) | = |

Answer: 0.625.   Figure 5

Example 6: Evaluate: (3 + 4) x (5 + 6) =

Solution: | (| 3 | + | 4 |) | × | (| 5 | + | 6 |) | = |

Answer: 77.

Example 7:   Evaluate: $(5 \times 4) + (6 \div 2) =$

Solution: In algebraic mode, you can type:

$$\boxed{5}\ \boxed{\times}\ \boxed{4}\ \boxed{+}\ \boxed{6}\ \boxed{\div}\ \boxed{2}\ \boxed{=}$$

In chain mode, you need to type:

$$\boxed{5}\ \boxed{\times}\ \boxed{4}\ \boxed{+}\ \boxed{(}\ \boxed{6}\ \boxed{\div}\ \boxed{2}\ \boxed{)}\ \boxed{=}$$

Answer: 23.

Example 8:   Evaluate: $23^2 - (13 \times 9) + \dfrac{1}{7} =$

Solution: In algebraic mode, type

$$\boxed{2}\ \boxed{3}\ \boxed{\blacksquare}\ \boxed{x^2}\ \boxed{-}\ \boxed{1}\ \boxed{3}\ \boxed{\times}\ \boxed{9}\ \boxed{+}\ \boxed{7}\ \boxed{\blacksquare}\ \boxed{1/x}\ \boxed{=}$$

In chain mode, type

$$\boxed{2}\ \boxed{3}\ \boxed{\blacksquare}\ \boxed{x^2}\ \boxed{-}\ \boxed{(}\ \boxed{1}\ \boxed{3}\ \boxed{\times}\ \boxed{9}\ \boxed{)}\ \boxed{+}\ \boxed{7}\ \boxed{\blacksquare}\ \boxed{1/x}\ \boxed{=}$$

Answer: 412.14.