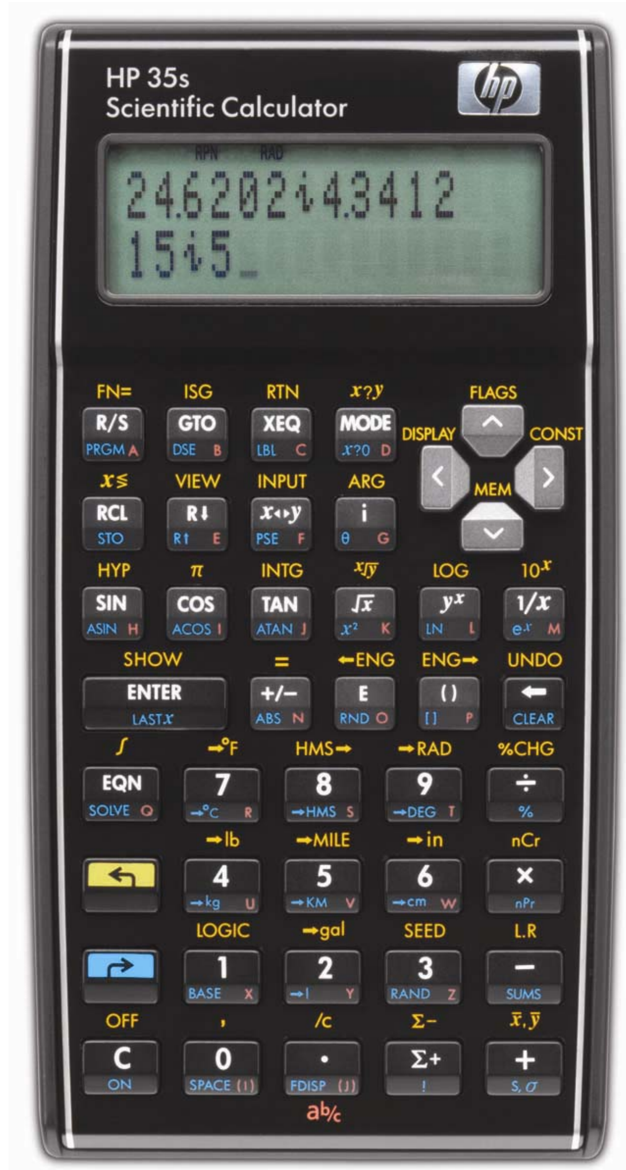
hp calculators

HP 35s Applications in Medicine



Applications in Medicine

Practice solving problems in medicine

- Application 1: Beer's Law
- Application 2: Body Surface Area (BSA)
- Application 3: Schilling Test for Vitamin B_{12} Absorption

Applications in Medicine

This training aid will illustrate the application of the HP 35s calculator to several problems arising in medicine. These examples are far from exhaustive, but do indicate the incredible flexibility of the HP 35s calculator.

Practice solving problems in medicine

Application 1: Beer's Law

Beer's law is a physical law which states that the quantity of light absorbed by a substance dissolved in a non-absorbing solvent is directly related to the concentration of the substance and the path length of the light through the solution. Beer's Law describes how the intensity of light diminishes as it passes through an absorbing media. For many colored materials there is a linear relationship between a property of the materials called optical density and the concentration of the colored species. The linear relationship is called Beer's Law. The formulas needed to solve Beer's Law are shown below.

$$A=2-\mathrm{LOG}(T)$$

Figure 1

$$Cu=Cs\cdot\frac{Au}{As}$$

Figure 2

$$T=10^{(2-A)}$$

Figure 3

In these formulas, T is the percent transmittance, A is the absorbance (optical density) of the substance, Au is the absorbance of the unknown, As is the absorbance of the standard, Cu is the concentration of the unknown substance, and Cs is the concentration of the standard.

<u>Example:</u> A standard solution with a solute concentration of 2 mg/ml is found to have an absorbance of 0.41 at 550 nm. An unknown from a patient is found to show 46% transmittance at the same wavelength. Convert this percent transmission to absorbance. Also find the solute concentration in the unknown.

<u>Solution:</u> Solve for the absorbance of the unknown. Note that T is entered as the percent multiplied by 100.

In RPN mode: [2] [ENTER] [4] [6] [↰] [LOG] [−]

In algebraic mode: [2] [−] [↰] [LOG] [4] [6] [ENTER]

0.0000
0.3372

Figure 4

Then solve for the solute concentration of the unknown. Note that the absorbance of the unknown is available in the calculator's display to continue the calculation.

In RPN mode: [0] [.] [4] [1] [÷] [2] [×]

In algebraic mode: [÷] [0] [.] [4] [1] [×] [2] [ENTER]

Figure 5

Answer: The absorbance of the unknown is 34% and the solute concentration of the unknown is 1.65 mg/ml. Figures 4 and 5 indicate the display in RPN mode.

Application 2: Body Surface Area (BSA)

There are two primary methods used to estimate body surface area, the Dubois method and the Boyd Method. Each method uses inputs of a patient's height and weight in metric units and estimates the patient's BSA.

Dubois' formula is shown below in Figure 6 and requires input of the height in centimeters and the weight in kilograms. Note that Dubois' formula is undefined for children with a BSA less than 0.6 m^2. Boyd's formula should be used in these situations.

$$BSA(m^2) = Ht^{0.725} \times Wt^{0.425} \times 0.007184$$

Figure 6

Boyd's formula is shown below in Figure 7 and requires input of the height in centimeters and the weight in grams.

$$BSA(m^2) = Wt^{(0.7285 - 0.0188 \times LOG(Wt))} \times Ht^{0.3} \times 0.0003207$$

Figure 7

Example 1: A patient is 176 centimeters tall and has a weight of 63.5 kilograms. What is the patient's BSA using the Dubios formula? What is the patient's BSA using Boyd's formula?

Solution: Solve for the BSA using Dubios' formula. Figure 8 shows the answer in algebraic mode.

In RPN mode: [1] [7] [6] [ENTER] [0] [.] [7] [2] [5] [y^x]
[6] [3] [.] [5] [ENTER] [0] [.] [4] [2] [5] [y^x] [×]
[0] [.] [0] [0] [7] [1] [8] [4] [×]

In algebraic mode: [1] [7] [6] [y^x] [0] [.] [7] [2] [5] [×]
[6] [3] [.] [5] [y^x] [0] [.] [4] [2] [5] [×]
[0] [.] [0] [0] [7] [1] [8] [4] [ENTER]

Figure 8

Now solve for the BSA using Boyd's formula. Note that Boyd's formula requires the weight to be input in grams. Figure 9 shows the answer in RPN mode.

In RPN mode: [0] [.] [7] [2] [8] [5] [ENTER] [0] [.] [0] [1] [8] [8] [ENTER]
[6] [3] [5] [0] [0] [↰] [LOG] [↱] [LASTx] [R↓] [×] [−] [y^x]
[1] [7] [6] [ENTER] [0] [.] [3] [y^x] [×] [0] [.] [0] [0] [0] [3] [2] [0] [7] [×]

In algebraic mode: [6] [3] [5] [0] [0] [y^x] [( )] [0] [.] [7] [2] [8] [5] [−]
[0] [.] [0] [1] [8] [8] [×] [↰] [LOG] [6] [3] [5] [0] [0] [>] [>] [×]
[1] [7] [6] [y^x] [0] [.] [3] [×] [0] [.] [0] [0] [0] [3] [2] [0] [7] [ENTER]

Figure 9

Answer: Dubois' method estimates a BSA of 1.78 m^2, while Boyd's method estimates a BSA of 1.76m^2.

Example 2: A patient is 176 centimeters tall and has a weight of 63.5 kilograms. What is the patient's BSA using Boyd's formula? Solve the problem by entering Boyd's formula as an *equation*.

Solution: To enter Boyd's formula into the calculator as an equation, press the following keys on the HP 35s:

[EQN] [RCL] [B] [↰] [=] [RCL] [W] [y^x] [( )] [0] [.] [7] [2] [8] [5] [−] [0] [.] [0] [1] [8] [8] [×] [↰] [LOG]
[RCL] [W] [>] [>] [×] [RCL] [H] [y^x] [0] [.] [3] [×] [0] [.] [0] [0] [0] [3] [2] [0] [7] [ENTER]

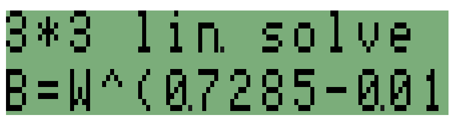


Figure 10

To verify proper entry of the equation, press

[↰] [SHOW]

and hold down the [SHOW] key. This will display the equation's checksum and length. The values displayed should be a checksum of 30D6 and a length of 42, as indicated in Figure 11.

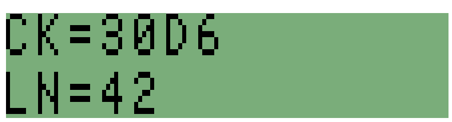


Figure 11

Release the [SHOW] key and the display will return to the one shown in Figure 10. Now press:

[SOLVE] [B]

The HP 35s SOLVER displays the first variable encountered in the equation as it begins its solution, in this case the variable W. The value of 0.0000 is displayed below if this is the first time the equation has been solved on the HP 35s calculator. If any previous equations have used this variable, it will display the value presently held in the variable. Enter the value of W.

Figure 12

In either RPN or algebraic mode, press: 6 3 5 0 0 R/S

Figure 13

In either RPN or algebraic mode, press: 1 7 6 R/S

Figure 14

Answer: Boyd's method estimates a BSA of 1.76m^2. Additional problems can be solved using this equation, if desired. Figure 14 displays the result.

Application 3: Schilling Test for Vitamin B_{12} Absorption

The Schilling Test determines the amount of a radioactive vitamin B_{12} intake that is absorbed. The equation for this calculation is shown in Figure 10.

$$E=\frac{V}{DIL}\cdot\left(\frac{UCPM-BCPM}{SCPM-BCPM}\right)\cdot 100$$

Figure 15

where V is equal to 1 if the urine volume is less than or equal to 1 liter, or equal to the actual urine volume if greater than one liter. If the urine volume is less than 1 liter, it is assumed to have been brought up to 1 liter by the addition of water (and is indicated by DIL, the dilution of the standard). The background (BCPM), standard (SCPM) and urine (UCPM) counts per minute should be of equal volumes counted over equal time intervals (which need not be one minute). The patient being tested should not have received recent prior radioactivity.

Example 1: A capsule of radioactive vitamin B12 is administered orally to a patient. Over the following 24 hours, a volume of 2.54 liters of urine is collected. A 20 milliliter sample of the urine is counted for 10 minutes to give 1923 counts. A 1 milliliter of standard is diluted to 20 milliliters and counted for 10 minutes, giving 1757 counts. 20 milliliters of tap water is used for a background count and over a 10 minute time interval produces 127 counts. Find the percent of the dose excreted.

Solution: V is 2.54 liters, DIL is 20, the Urine CPM is 1923, the standard CPM is 1757, and the background CPM is 127.

In RPN mode: [2] [.] [5] [4] [ENTER] [2] [0] [÷] [1] [9] [2] [3] [ENTER] [1] [2] [7] [−] [1] [7] [5] [7] [ENTER] [1] [2] [7] [−] [÷] [×] [1] [0] [0] [×]

In algebraic mode: [2] [.] [5] [4] [÷] [2] [0] [×]
[( )] [( )] [1] [9] [2] [3] [−] [1] [2] [7] [>] [÷]
[( )] [1] [7] [5] [7] [−] [1] [2] [7] [>] [>] [×] [1] [0] [0] [ENTER]

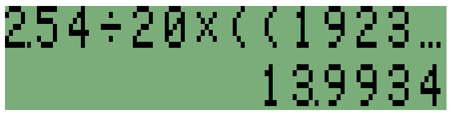


Figure 16

Answer: The amount excreted is 13.99%. The amount absorbed is 86.01%. Figure 16 shows the answer in algebraic mode.

Example 2: A capsule of radioactive vitamin B12 is administered orally to a patient. Over the following 24 hours, a volume of 2.54 liters of urine is collected. A 20 milliliter sample of the urine is counted for 10 minutes to give 1923 counts. A 1 milliliter of standard is diluted to 20 milliliters and counted for 10 minutes, giving 1757 counts. 20 milliliters of tap water is used for a background count and over a 10 minute time interval produces 127 counts. Find the percent of the dose excreted. Solve the problem by entering the formula as an equation.

Solution: V is 2.54 liters, DIL is 20, the Urine CPM is 1923, the standard CPM is 1757, and the background CPM is 127.

To enter the formula into the calculator as an equation, press the following keys on the HP 35s:

[EQN] [RCL] [E] [↰] [=] [RCL] [V] [÷] [RCL] [V] [×] [( )] [( )] [RCL] [U] [−] [RCL] [B] [>] [÷] [( )] [RCL] [S] [−] [RCL] [B] [>] [>] [×] [1] [0] [0] [ENTER]

Figure 17

To verify proper entry of the equation, press

[↰] [SHOW]

and hold down the [SHOW] key. This will display the equation's checksum and length. The values displayed should be a checksum of BF1C and a length of 23, as indicated in Figure 18.

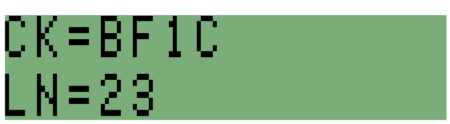


Figure 18

Release the [SHOW] key and the display will return to the one shown in Figure 17. Now press:

[↱] [SOLVE] [E]

The HP 35s SOLVER displays the first variable encountered in the equation as it begins its solution, in this case the variable V. The value of 0.0000 is displayed below if this is the first time the equation has been solved on the HP 35s calculator. If any previous equations have used this variable, it will display the value presently held in the variable. Enter the value of V.

Figure 19

In either RPN or algebraic mode, press: [2] [.] [5] [4] [R/S]

Figure 20

In either RPN or algebraic mode, press: [2] [0] [R/S]

Figure 21

In either RPN or algebraic mode, press: [1] [9] [2] [3] [R/S]

Figure 22

Note that the value displayed for B results from the reuse of variable B from the earlier example in this training aid.

In either RPN or algebraic mode, press: [1] [2] [7] [R/S]

Figure 23

In either RPN or algebraic mode, press: 1 7 5 7 R/S

Figure 24

Answer: The amount excreted is 13.99%.