direct the student to look at a relevant band in the spectrum to confirm if a particular group is present or absent (Table 2). The number of errors are listed.

The student now repeats the procedure correcting any mistakes previously made. Further questions may be displayed. When the program is successfully completed, the instrument briefly displays CORRECT then the molecular formula of the compound. At this point the student should have listed all the main functional groups in the compound and may be prepared to suggest a structure or partial structure on the evidence provided by the spectrum.

The instrument may now display the name of the compound.

A student can be assisted by the calculator to analyze the infrared spectra of several different organic compounds.

The teacher can easily alter the program for each new compound or may use several modified programs prerecorded on tape. New functional groups may be added and others deleted as required.

A program makes use of the 'prompt' facility to display a question and to store the response (1 or 0). Conditional steps, especially $x = 0?$ and $x \neq 0?$, enables the answers to be checked and an error will result in the operation of a subprogram which displays first a correct interpretation and then the band (in cm^{-1} or μ units) to be checked in the spectrum. Each error will also result in a number being added to a store, which is recalled to display the error total. When the program is completed and the error store is still zero, the instrument displays ALL CORRECT and allows first the molecular formula, then the name of the compound to be displayed when required.

Chemistry students at the University of Papua New Guinea have found this calculator drill approach interesting and very useful in a logical approach to functional group detection and infrared spectra analysis. No more than two repetitions are necessary to establish the presence of all the major functional groups in the compound. Students who have carried out calculator drill remember the logical approach with subsidiary investigations when analyzing the spectra of organic compounds and have performed more quickly and with more accuracy in later projects and research topics.

Further details and calculator program listings are available. In order to cover airmail postage, handling, and printing costs please send a money order for $5 (US), $4 (Australian) or 2.50 (Sterling) to Dr. D. K. Holdsworth, Chemistry Department, University of Papua New Guinea, Box 4820, University Post Office, Papua New Guinea.

Naming Chemical Compounds: Calculator Drill

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Recent innovations in pocket programmable calculators have included the display of letters and symbols as well as numbers. An alpha-numeric instrument (8), such as the Hewlett-Packard HP-41CV, can store sets of six letters, symbols, numbers, and spaces which may be recalled in a program and compared in the same way that two numbers are compared in numeric calculators. The result of the comparison tests $X = Y?$ and $X \neq Y?$ can result in the use of the subprograms that display statements to indicate results and suggestions for new strategies.

Freshmen students taking introductory organic chemistry courses require constant practice in systematically naming organic compounds. Many students find review more interesting using a programmable calculator. Two methods have recently been developed.

1) *Multiple choice.* The student is shown a number of structural formulae on a sheet, together with multiple choice answers (A–E). A choice is indicated by keying A, B, C, D, or E into the programmed calculator. The use of letter labels enables the instrument to find the appropriate subroutine to display either CORRECT or INCORRECT, pause, then give the correct answer, and finally suggest the next structure to be named.

A correct choice enables one to be added to a memory store. At the end of the exercise the total in this store is processed to display a percentage score.

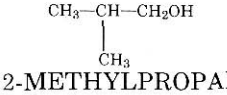
2) *Constructing a Systematic Name.* Operation of an alpha store (ASTO) on a string of 24 letters, numbers, symbols, or spaces results in the first six characters being stored. Operation of an alpha-shift (ASHF) pushes the alpha string to the left losing the first six characters. The next six characters (7–12) may now be stored. Alternate use of an ASTO and ASHF enables the whole alpha string to be stored, six characters at a time, in four alpha stores.

The calculator can also prompt for the input of alpha information and control the mode of the calculator where necessary for alpha input. Thus, the instrument can display a request to the student to key in the complete systematic name of a compound whose structural formula is shown and set to the alpha mode. The student must key in his selected name ensuring that numbers, commas, and hyphens are in the correct order.

The calculator stores each six characters from the left in separate alpha stores. It then compares ($X \neq Y?$) the first alpha store (X) with one prestored in the calculator memory (Y). If the conditional answer is NO (the two alpha stores have identical characters) the second six characters of the name are compared with the six stored ($X \neq Y?$). If all conditional answers are NO, the calculator displays CORRECT, pauses, displays the correct name, then suggests the next structure to be named. Should any conditional answer be YES, the instrument displays INCORRECT, pauses, displays NOT: (the incorrect answer), then displays the first set of six characters which were incorrect to enable the student to reconstruct the correct name. The instrument then invites the student to TRY AGAIN, by means of a prompt function and recommences the program.

Students at the University of Papua New Guinea have used a programmable alpha-numeric calculator to ensure adequate practice in naming organic compounds. They can use the instrument when convenient, and they are able to work at their own speed. The instrument is infinitely patient. Apart from the interest of a novel approach to repetitious tasks, the calculator method is convenient in that in a multiple choice situation the student can find the correct answer immediately after he has made his decision. There is no possibility of noting tabulated letter answers and letting this "influence" a decision. The second method enables a student to build up a complex name by displaying the first six characters in error. Another error could be shown when the name is repeated. Though patient, the calculator is meticulous and will not allow the ommission of a comma, hyphen, or even alphabetical juxtaposition of functional groups.

Papua New Guinean students use the IUPAC rules as recommended by The Association of Science Education (*9*).



would be stored as 2-METHYLPROPAN-1-OL. The calculator could as easily be programmed to include 2-METHYL-1-PROPANOL or even ISOBUTYL ALCOHOL, to accommodate whatever system or common names are taught in a course. However, the calculator compares with what it is given and does not take kindly to alternative suggestions. For this reason its use has been restricted to students learning the names of aliphatic compounds as teachers and textbooks are more flexible with aromatic nomenclature.

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