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A Simple, Automatic Means of Designing a Conversion Table for Expressing Laboratory Results in the International System of Units (SI)

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Summary: A simple, automatic means of designing a conversion table for expressing laboratory results in the international system of units (SI) is described.

The increasing use of the international system of units for expressing the results of clinical chemistry and haematology sets doctors, biologists and paramedical workers the problem of converting the results from the previous confused system of units into the SI system.

We propose a simple method for establishing a conversion scale from one system to the other, irrespective of the parameter.

This is based on a Hewlett-Packard 9830A calculator equipped with a 9862A plotter. The BASIC language is used.

Accordingly we have prepared conversion tables for the most commonly used parameters into the international system of units, on behalf of the Swiss Academy of Medical Sciences.

Ein einfaches, automatisches Verfahren zur Erstellung einer Tabelle für die Umrechnung von Laboratoriumsergebnissen in Einheiten des Internationalen Maßsystems (SI)

Zusammenfassung: Es wird über ein einfaches, automatisches Verfahren zur Erstellung einer Tabelle für die Umrechnung von Laboratoriumsergebnissen in Einheiten des Internationalen Maßsystems (SI) berichtet.

Klinisch-chemische und hämatologische Laboratoriumsergebnisse werden heute mehr und mehr in Einheiten des Internationalen Maßsystems angegeben, so daß sich Ärzte, Biologen und paramedizinische Berufe vor das Problem gestellt sehen, ihre nach dem bisher benutzten konfusen Maßsystem ausgedrückten Ergebnisse in Einheiten des SI-Systems umzurechnen.

Die Autoren schlagen eine einfache Methode vor, eine Tabelle anzulegen, mit der diese Umrechnungen von einem ins andere System für jede Kenngröße möglich sind.

Verwendet wird ein Hewlett-Packard 9830 A Rechengerät, das einen Aufzeichner 9862 A besitzt. Die Programmierung erfolgt in BASIC.

Nach dieser im folgenden beschriebenen Methode wurden für die Schweizerische Akademie der Medizinischen Wissenschaften derartige Umrechnungstabellen für die gebräuchlichsten Kenngrößen angelegt.

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Introduction

The continually increasing use of the international system of units for expressing laboratory results, particularly in clinical chemistry, sets doctors, biologists and paramedical workers the problem of converting the results from the former system (mg/100 ml, g/l, meq/l) into the new one (mol/l). Easily read conversion tables with a dual scale are a valuable asset.

The present article gives a simple method that avoids lengthy calculations and makes use of a desk calculator for automatically tracing a dual scale in the former and in the new system of units. Moreover, linear or logarithmic expression may be chosen, as desired.

Material

This study was made with a Hewlett-Packard type 9830A desk calculator equipped with a 9862 plotter.

The type of programme language was the BASIC language adjusted to the model 30 calculator.

Method

Conversion of a value in the former system of units to the new molar system is reduced to a simple linear relationship without off-set:

$$V' = C \times V$$

V' = value in the new molar system
V = value in the former system
C = conversion coefficient.

For example, for 1.2 mg/100 ml bilirubin, where the coefficient C is 17.1, a value of $17.1 \times 1.2 = 20.52$ μmol/l is obtained.

When a scale in both systems (see Fig. 1) is expressed graphically, adjustment of the curve becomes rather tedious, especially if logarithmic expression has been chosen. It is noteworthy that the latter is coming into increasingly greater use, which is a logical outcome of the frequency distribution of the measurements.

Let D1 and F1 be the initial and final values expressed in the former system and D'2 and F'2 the initial and final values desired in the new system. The absolute minimum of D1 and D2 = $\frac{D'2}{C}$ will be D and the absolute maximum of F1 and F2 = F'2 will be F.

(F and D are the values in the former system). The maximum length of the scale will be determined by the product of (F–D) and an enlargement factor (α).

Linear expression

A value V corresponds to the size shown on the graph: $R(V) = \alpha \cdot V$ (the starting point is fixed by the SCALE instruction of the plotter).

Expression of (V–D) becomes strictly proportional to expression of (F–D) with the factor $\frac{V-D}{F-D}$:

$$R(V-D) = R(F-D) \times \frac{V-D}{F-D}$$

R(F–D) = size fixed by manual adjustment on the plotter and the programme instruction SCALE

$\frac{V-D}{F-D}$ = calculated size.

Therefore each value V may be expressed independently of the initial adjustment of the plotter and the programme instruction SCALE D–E, F+E, . . . (E = margins).

Logarithmic expression

Similarly a value V is given by:

$R(V) = \alpha \cdot \log V$ so that:

$$R(V-D) = R(F-D) \times \frac{\log \frac{V}{D}}{\log \frac{F}{D}}$$

R(F–D) = initially fixed size

$\frac{\log \frac{V}{D}}{\log \frac{F}{D}}$ = calculated size

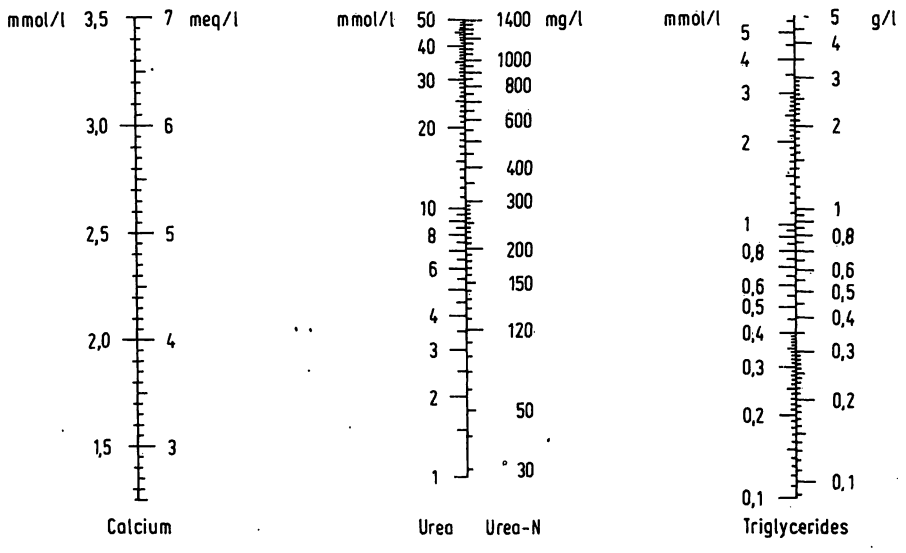

Fig. 1. Conversion scales

Description and Utilization of Programme (see figs. 2 and 3)

We start the programme after manual adjustment of the record sheet on the plotter. The value of the conversion coefficient for the given unit system (former) into the molar system (new) is then inserted (programme line 10 and 20), followed by the areas to be represented in both systems (30 to 60).

The machine then calculates the maximum width of the expression (F–D) that is plotted (70 to 150).

The next step is to choose the expression: linear or logarithmic (160 to 170).

Subsequently we try to express one of the systems (former or new: 180–190) and select how the scale is plotted in it (length of graduations, start and end, spacing) (210–250).

Simultaneously we may or may not choose to record the value corresponding to these graduations (labelling) (290–300).

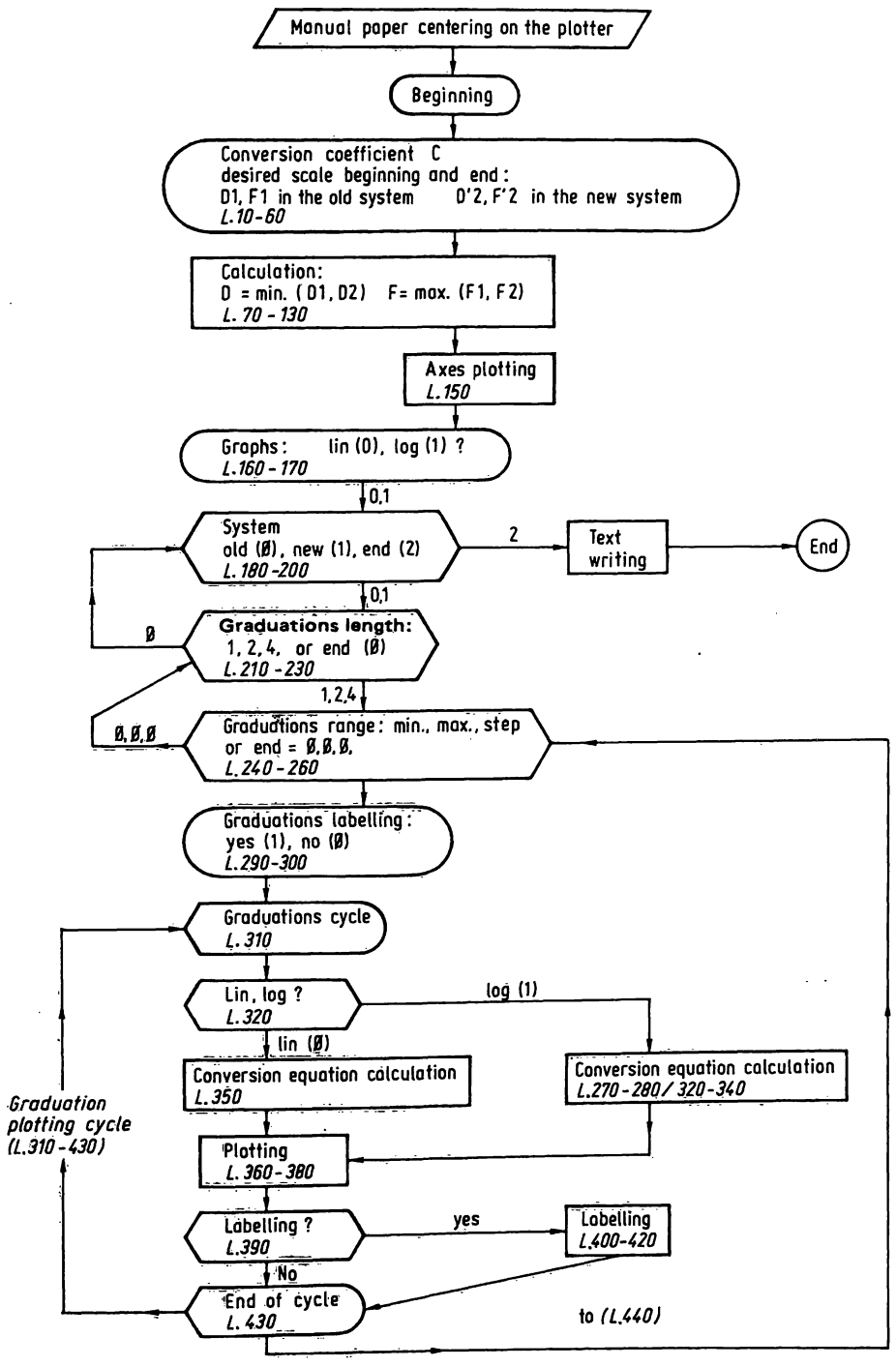

Fig. 2. Flow chart

```
1   REM ---- LINE 10 TO 60: INPUT OF SCALE RANGES AND CONVERSION COEFFICIENT ----
2   REM ------ (NEW VALUE) = C * (OLD VALUE) ------
10   DISP "CONVERSION COEFFICIENT";
20   INPUT C
30   DISP "OLD SCALE: MIN, MAX";
40   INPUT D1,F1
50   DISP "NEW SCALE: MIN, MAX";
60   INPUT D2,F2
65   REM ------ LINE 70 TO 140 CALCULATION OF PLOT LIMITS MIN AND MAX ------
66   REM ------ D = BEGINNING, F = END, E = BLANK SPACE ------
70   D=D1
80   IF D1 <= D2/C THEN 100
90   D=D2/C
100   F=F1
110   IF F1 >= F2/C THEN 130
120   F=F2/C
130   E=(F-D)/10
135   REM ----- 10 = BLANK FRACTION, (-5,5) = LATERAL(YAXIS) SPACING -----
140   SCALE D-E,F+E,-5,5
150   XAXIS 0,F-D,D,F
160   DISP "PLOTTING MODE: LIN=0, LOG=1";
170   INPUT O1
180   DISP "WHICH SCALE: OLD=0,NEW=1,END=2";
190   INPUT O2
200   IF O2=2 THEN 450
205   REM ------ GD=LARGE, MN=MEDIUM, PT=SMALL, ↑= OUT OF CYCLE ------
210   DISP "MARK LENGTH: GD=4,MN=2,PT=1,↑=0";
220   INPUT S1
230   IF S1=0 THEN 180
235   REM ------ PLOTTING RANGE OF THESE MARKS ------
240   DISP "M.RANGE: MIN,MAX,STEP,(↑=0,0,0)";
250   INPUT D3,F3,P3
260   IF D3+F3+P3=0 THEN 210
270   IF O1#1 THEN 290
275   REM ------ SCALE COEFFICIENT FOR LOG-PLOTTING ------
280   X1=(F-D)/LOG(F/D)
290   DISP "MARK LABEL: YES(1),NO(0)";
300   INPUT O3
310   FOR I=D3 TO F3 STEP P3
320   IF O1#1 THEN 350
325   REM ------ EQUATION FOR LOGARITHMICAL CONVERSION ------
330   X2=X1*(LOG(I/(D*(C↑O2))))
340   GOTO 360
345   REM ------ EQUATION FOR LINEAR CONVERSION ------
350   X2=I /(C↑O2)
355   REM ------ MARKS PLOTTING ------
360   PLOT (D*O1)+X2,0,-2
370   PLOT (D*O1)+X2,((-1)↑O2)*(-0.1)*S1
380   PEN
390   IF O3#1 THEN 430
395   REM ------ MARKS LABELLING ------
400   PLOT (D*O1)+X2,-1+(3*O2),-1
410   LABEL (*,1.2+0.5*O2,1.4,-PI/2)I
420   PEN
430   NEXT I
440   GOTO 240
445   REM ------ FREE TEXT ------
450   PLOT D-(E/2),5,-1
460   LABEL (*,1.7,1.4,-PI/2)
470   DISP "LETTER";
480   LETTER
490   END
```

Fig. 3. Program (REM = non-executable remarks)

Processing is automatic according to the selected instructions and the same questions arise once more in an order that allows different types of scales to be chosen in the scale composition. Change to other specifications, or even to expression of another system, is operated through the answers corresponding to the ↑ sign of the calculator.

Applications

This programme has been used to compile a conversion table published by the Size and Units Subcommittee of the Laboratory Committee of the Swiss Academy of Medical Sciences.

In the original version, the reference values are shown by coloured overprinting.

Reference

1. World Health Organization (1977): The SI for the health professions, WHO, Geneva, 76 pp.

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