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Computer Program for Calculation of Oxygen Uptake

B. L. Castle, G. Castle, and J. E. Greenleaf

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Computer Program for Calculation of Oxygen Uptake

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GENERAL PROGRAM DESCRIPTION

This program, written in Super Basic, can be used to calculate \( O_2 \) uptake and \( CO_2 \) production in resting and exercising human test subjects. The set of data from which these calculations are made is entered into the program; included are measurements of \( O_2 \) and \( CO_2 \) in inspired air and expired respiratory gas, and various gas volumes, temperature, and pressure measurements. A flow diagram of the program is presented in Fig. 1.

The program will accommodate readings from two types of \( O_2 \) and \( CO_2 \) analyzers: indirect readout analyzers (Steps 10.1 and 12.1) which require the use of calibration curves to convert numerical readings of \( O_2 \) and \( CO_2 \) concentrations into percent, and direct readout analyzers (Steps 10, 11, 12, 13) which read directly in percent. For the indirect readout analyzers, the slopes and intercepts of the calibration curves must be entered as constants (Steps 2, 3, 4).

The program begins with a prompt (Step 5) that allows the operator to either print a set of instructions for running the program, or to go directly to the data input section of the program. The data can be entered "conversationally" through a series of prompts (Steps 6, 6.1, and 6.2), or they can be entered all at once, according to a specified format, without interruption (Steps 7, 8). Expired water vapor pressure is calculated in either Step 6.2A or 8.1, depending on which option for data input is selected.

Direct or indirect measurements of the concentrations of inspired \( CO_2 \) and \( O_2 \) can be entered in the program (Steps 14-19, excluding 14.1), to be used later in the ventilation calculations. However, if they are not measured, constant values for inspired \( CO_2 \) and \( O_2 \) concentrations can be used; 0.03% and 20.93%, respectively, are commonly used. These values have been incorporated into the program.
The major ventilation measurements in the $O_2$ uptake equation are printed out in Step 20; oxygen uptake, expressed in ml/kg/min, is printed in Step 22.2. The basic equations used to calculate these ventilation measurements were taken from Consolazio et al. (1).

A "no" input in response to the query "are you finished?" (Step 23) recycles the program to Step 6 for the next set of input data. One run through the program without use of the conversational queries takes less than 2 min. Run-time with the conversational queries requires less than 3 min. The run-time is partly dependent on the speed of the printer.

**PROGRAM PRINTOUT AND EQUATIONS**

The complete program is presented in Fig. 2; the statement numbers, description, and symbols for each function are given in Fig. 3. The basic equations used are as follows (1):

Water vapor pressure ($P_{8}$) = $P_{7}/10^{Z_{8}}$ (760) (Ref. 2) (Step 6.2A or 8.1)

where: $Z_{8} = \left( \frac{X_{8}}{Y_{8}} \right) \left[ \frac{A_{7}+(B_{7} \cdot X_{8})+(C_{7} \cdot X_{8}^{3})}{1+(D_{7} \cdot X_{8})} \right]$

Expired $O_2 (Z) = B_{2}+(M_{2} \cdot F)$ (Step 10.2)

Expired $CO_2 (Y) = B_{1}+(M_{1} \cdot C)$ (Step 12.2)

Inspired $CO_2 (H) = B+(M \cdot H_{1})$ (Step 16.1)

Inspired $O_2 (J) = B_{2}+(M_{2} \cdot J_{1})$ (Step 17.2)

$\dot{V}_{E_{ATPS}} (W) = \left( \frac{(V_{2}-V_{1})}{T} \right) \left( V_{3} \right)$ (Step 20)

STPD FACTOR ($U$) = $(P-P_{8})/760(1+0.00367G)$ (Step 20)

$\dot{V}_{E_{STPD}} (V) = W-U \quad$ (Step 20)

$\dot{V}_{E_{BTPS}} (O_{3}) = \left[ W-(R_{S} \cdot D_{S}) \right] \left[ \left( P-P_{8} \right) \left( \frac{273+38}{273+G} \right) \right]$ (Step 20)

where: 49.7 = $H_{2}O$ vapor tension in expired air at $T_{b}$ of 38°C.
\[ R_E (R) = \frac{(Y$)}{[k(100-(Y+Z))-Z]} \] (Step 20)

True \( O_2 \) (X) = \( \frac{(Y$)}{R} \) (Step 20)

\( O_2 \) uptake (0) = \( \frac{(V-X)}{100} \) (Step 20)

\( CO_2 \) production (C4) = R*0 (Step 20)

The printout of a sample calculation is presented in Fig. 4.

A comparison was made between 22 measurements of oxygen uptake, that ranged from 1.79 to 4.50 l/min, calculated from the nomogram of Consolazio et al. (1) and from the computer program (Fig. 5). The mean (±SD) of the nomogram values was 3.44 ±0.89 l/min versus 3.42 ±0.88 for the program data. The correlation coefficient was 1.00.

REFERENCES


FIG. 1. Flow diagram of program.
THIS PROGRAM CALCULATES OXYGEN CONSUMPTION

PRINT 1
AS="NO"
B=-0.014287 !INTERCEPT FOR INSPIRED CO2 CURVE. SEE STATEMENT 830"
M= 0.00850467 !SLOPE FOR INSPIRED CO2 CURVE.

B1=-0.01066 !INTERCEPT FOR EXPIRED CO2 CURVE. SEE STATEMENT 670
M1= 0.03494 !SLOPE FOR EXPIRED CO2 CURVE.

B2=-0.002167 !INTERCEPT FOR INSPIRED AND EXPIRED O2 CURVE
M2= 0.02501 !SLOPE FOR INSPIRED AND EXPIRED O2 CURVE
PRINT "DO YOU NEED INSTRUCTIONS? TYPE YES OR NO:" ";
INPUT IN IMAGE ":I$";
IF I$=A9 THEN 100 ELSE 35
PRINT 40
PRINT "THIS PROGRAM CALCULATES OXYGEN CONSUMPTION. IT CAN BE USED"
PRINT "WHEN EITHER OF TWO TYPES OF O2/CO2 ANALYZERS ARE AVAILABLE."
PRINT "THEY ARE: 1) DIRECT READOUT ANALYZERS (READINGS IN PERCENT OF"
PRINT "GAS COMPOSITION), AND 2) INDIRECT READOUT ANALYZERS (WHICH"
PRINT "REQUIRE USE OF A CALIBRATION CURVE)."
PRINT "THE SLOPES AND INTERCEPTS OF THE CALIBRATION CURVES MUST BE"
PRINT "ENTERED INTO THIS PROGRAM AT STATEMENT NUMBERS 11 TO 18.""
PRINT 47
PRINT 60 PRINT "WHEN REQUESTED TO TYPE (NO), DO NOT TYPE THE ENCLOSING ()"
PRINT
PRINT "TO INTERRUPT THE EXECUTION OF THIS PROGRAM AT ANY POINT,"
PRINT "DEPRESS THE ALT MODE/ESCAPE KEY SEVERAL TIMES."
PRINT "THE PRIMARY EQUATIONS USED IN THIS PROGRAM PLUS THEIR"
PRINT "ASSOCIATED MNEMONICS CAN BE FOUND IN STATEMENTS 580,"
PRINT "590 THROUGH 1090, AND 1325."
PRINT 75
PRINT 80 PRINT "DATA CAN BE ENTERED IN TWO WAYS: 1) CONVERSATIONALLY AS A"
PRINT "STRING OF VARIABLES IN A SPECIFIED FORMAT, OR 2) CONVERSATIONAL,"
PRINT "IN RESPONSE TO COMPUTER-GENERATED QUESTIONS."
PRINT "CONVERSATIONAL? YES OR NO? GIVES YOU THE CHOICE OF HOW YOU"
PRINT "WANT TO INPUT THE DATA."
PRINT 85
PRINT 100 PRINT 110 PRINT "CONVERSATIONAL? TYPE YES OR NO: ";
INPUT IN IMAGE "":C$"
111 PRINT
112 IF C$=A9 THEN 126 ELSE 200
116 PRINT "DO YOU NEED THE INPUT FORMAT? TYPE YES OR NO: ";
117 INPUT IN IMAGE "":F$"
118 IF F$=A9 THEN 158 ELSE 129
125 PRINT 130 PRINT "INSTRUCTIONS FOR ENTERING DATA ARE:";
131 PRINT 132 PRINT "1) SEPARATE EACH VARIABLE WITH A COMMA"
133 PRINT "2) PUSH THE LINE FEED KEY IF THE RIGHT-HAND EDGE OF THE"
134 PRINT "PAPER IS REACHED BEFORE ALL VARIABLES ARE ENTERED"
135 PRINT "3) TYPE (NO) IF BODY WT., ERGOMETER LOAD, OR TREADMILL"
136 PRINT "SPEED ARE NOT MEASURED."
138 PRINT 139 PRINT "THE FORMAT FOR ENTERING DATA IS AS FOLLOWS:";
140 PRINT 141 PRINT "COLUMN 1 COLUMN 2"
142 PRINT "D = DATE (ENCLOSE IN QUOTES) V1 = VOL. METER READ. INITIAL (L)"
144 PRINT "SS = SUBJECT'S NAME V3 = VOL. METER CORRECTION"
146 PRINT "MS = BODY WT. (KG) P = BAROMETRIC PRESS. (MM HG)"
148 PRINT "ES = ERGOMETER LOAD (WATTS) G = GAS TEMPERATURE (CELSIUS)"
150 PRINT "TS = TREADMILL SPEED (MPH) P = BAROMETRIC PRESS. (MM HG)"
152 PRINT "S = TIME, GAS COLLECT. (SEC) RS = RESPIRATORY RATE (BR/MIN)"
154 PRINT "V2 = VOL. METER READ. FINAL (L)"
156 PRINT 160 PRINT "ENTER THE COLUMN 1 VARIABLES FIRST";
162 INPUT D,SS,WS,ES,TS,S,V2,V1,V3,DS,G,P,RS;
164 PRINT

FIG. 2. Printout of complete program.

ORIGINAL PAGE IS OF POOR QUALITY
166 PRINT
170 PRINT "DATE "":"D
171 PRINT
172 PRINT "SUBJECT "":"S$
173 PRINT
174 PRINT "BODY WEIGHT (KG) W$= "":W$
175 PRINT "ERGOMETER LOAD (WATTS) E$= "":E$
176 PRINT "TREADMILL SPEED (MPH) TS= "":TS
177 PRINT
178 PRINT "TIME, GAS COLLECTION (SECONDS) S=":S;"SECONDS"
179 PRINT "RESP. GAS METER READING, FINAL V2=":V2;"LITERS"
180 PRINT "RESP. GAS METER READING, INITIAL V1=":V1;"LITERS"
181 PRINT "RESP. GAS METER CORRECTION V3=":V3;"LITERS"
182 PRINT "RESP. VALVE DEAD SPACE DS=":DS;"LITERS"
183 PRINT "GAS TEMPERATURE G=":G;"CELSIUS"
184 PRINT "BAROMETRIC PRESSURE P=":P;"MM HG"
185 PRINT "RESP. VALVE DEAD SPACE. DS="":DS;"LITERS"
186 PRINT "RESP. VALVE DEAD SPACE.

189 GO TO 500
200 PRINT "DATE (FORMAT = MONTH DAY, YEAR):%"
210 INPUT IN IMAGE "#":D
215 PRINT
220 PRINT "SUBJECT'S NAME:%"
230 INPUT IN IMAGE "#":S$
250 PRINT
260 PRINT "BODY WT. (KG) (TYPE (NO) IF NOT MEASURED) W$:"
280 PRINT "ERGOMETER LOAD, (WATTS) (TYPE (NO) IF NOT MEASURED): ":
300 PRINT "TREADMILL SPEED, (MPH) (TYPE (NO) IF NOT MEASURED): ":
320 PRINT "TIME, GAS COLLECTION (SEC.) S=":S
340 PRINT "RESP. GAS METER READING, FINAL (LITERS) V2=":V2
360 PRINT "RESP. GAS METER READING, INITIAL (LITERS) V1=":V1
380 PRINT "RESP. GAS METER READING, INITIAL (LITERS) V1=":V1
400 PRINT "RESP. GAS METER CORRECTION V3=":V3
410 PRINT "RESP. VALVE DEAD SPACE DS=":DS
420 PRINT "GAS TEMPERATURE (CELSIUS) G=":G
440 PRINT "GAS TEMPERATURE (CELSIUS) G=":G
460 PRINT "BAROMETRIC PRESSURE (MM HG) P=":P
480 PRINT "RESP. VALVE DEAD SPACE. DS="":DS;"LITERS"
500 PRINT "RESP. VALVE DEAD SPACE.

510 A7=3.2437814
520 B7=5.86826E-03
530 C7=1.1702379E-08
540 D7=2.1878462E-03
550 P1=218.167
560 TH=G+273.16
570 X8=(X8/18)+((A7+B7*X8+C7*X8^3)/(1+D7*X8))
580 P8=(P7/10^2)+670.161P8-PH2O SATURATED AT DBT
600 PRINT "WATER VAPOR PRESSURE P8="":P8;" MM HG"
610 PRINT
620 PRINT "EXPIRED CO2, AS %, FROM DIRECT READOUT ANALYZER"
630 PRINT "EXPIRED CO2, AS %, FROM DIRECT READOUT ANALYZER"
631 PRINT " (TYPE (NO) IF NOT MEASURED) FC02 Y=":Y
650 PRINT "INPUT IN IMAGE "":"Y
660 IF Y=9 THEN 690 ELSE 690
670 PRINT "EXPIRED CO2 (READING FROM INDIRECT READOUT ANALYZER) C=":C
680 PRINT "INPUT IN IMAGE "":"C
690 IF Y=9 THEN 690 ELSE 690
691 PRINT "EXPIRED O2, AS %, FROM DIRECT READOUT ANALYZER"
700 PRINT "EXPIRED O2, AS %, FROM DIRECT READOUT ANALYZER"
701 PRINT " (TYPE (NO) IF NOT MEASURED) F02 Z=":Z

Fig. 2.—Continued
110 INPUT IN IMAGE "I":Z
120 IF Z=A9 THEN 130 ELSE 140
130 PRINT "EXPIRED 02 (READING FROM INDIRECT READOUT ANALYZER)"
140 INPUT IN IMAGE "F"
150 IF F=A9 THEN 160 ELSE 170
160 PRINT "INSPIRED CO2 AND O2 MEASURED? TYPE YES OR NO:"
170 INPUT IN IMAGE "N":N
180 IF N=A9 THEN 190 ELSE 200
190 H=0.03
200 J=20.93
210 GOTO 220
220 PRINT "INSPIRED CO2 (READING FROM INDIRECT READOUT ANALYZER)
230 INPUT IN IMAGE "N":H1
240 Z=Z+M*H1
250 PRINT "INSPIRED CO2, AS %, FROM DIRECT READOUT ANALYZER"
260 PRINT "TYPE (NO) IF NOT MEASURED"
270 INPUT IN IMAGE "N":J
280 IF J=A9 THEN 290 ELSE 300
290 PRINT "INSPIRED O2, AS %, FROM DIRECT READOUT ANALYZER"
300 PRINT "TYPE (NO) IF NOT MEASURED"
310 INPUT IN IMAGE "N":J1
320 J=J+M*J1
330 PRINT
340 Q="%%%%%%%%%%%%%%%% %%%%%%%%%%"
350 PRINT IN IMAGE Q: "INSPIRED CO2: H=",H,"%"
360 PRINT "INSPIRED O2: J=",J,"%"
370 PRINT "EXPIRED CO2: Y=",Y,"%"
380 PRINT "EXPIRED O2: Z=",Z,"%"
390 K=J/(100-(J+H))
400 T=S/60
410 YE=Y-H
420 W=(V2-V1)/T*V3
430 U=(P-P8)/(760*(1+0.00367*G))
440 V=W*U
450 U3=(W-(R*DE))*(((P-P8)/(P-49.7))*(273+38)/(273+G))
460 R=YE/(100-(Y+Z))*K-Z
470 X=Y3/R
480 O=(V*X)/100
490 C4=R*O
500 PRINT
510 PRINT "TIME =",T,"MINUTES"
520 PRINT "VE ATPS =",W,"L/MIN"
530 PRINT "STPD FACTOR =",U
540 PRINT "VE STPD =",V,"L/MIN"
550 PRINT "VE BTPS =",W,"L/MIN"
560 PRINT "FCO2 MINUS INSPIRED CO2 =",Y5,"%"
570 PRINT "FCO2 =",Z,"%"
580 PRINT "RE =",R
590 PRINT "TRUE O2 =",X,"%"
600 PRINT "CO2 PRODUCTION =",C4,"LITERS PER MINUTE"
610 PRINT "OXYGEN UPTAKE =",O,"LITERS PER MINUTE"
620 PRINT "ARE YOU FINISHED? TYPE YES OR NO:"
630 IF F=A9 THEN 640 ELSE 650
640 END
650 Q=""
SYMBOLS AND CONSTANTS USED IN O₂/UPTAKE PROGRAM

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Statement No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A7</td>
<td>500</td>
<td>Water Vapor Pressure Constant (3.2437814)</td>
</tr>
<tr>
<td>A9</td>
<td>10</td>
<td>&quot;No&quot;</td>
</tr>
<tr>
<td>B</td>
<td>11</td>
<td>Intercept for Inspired CO₂ Curve</td>
</tr>
<tr>
<td>B1</td>
<td>14</td>
<td>Intercept for Expired CO₂ Curve</td>
</tr>
<tr>
<td>B2</td>
<td>17</td>
<td>Intercept for Inspired &amp; Expired O₂ Curve</td>
</tr>
<tr>
<td>C5</td>
<td>510</td>
<td>Water Vapor Pressure Constant (5.88826x10⁻³)</td>
</tr>
<tr>
<td>C7</td>
<td>1090</td>
<td>Water Vapor Pressure Constant (1.170239x10⁻⁸)</td>
</tr>
<tr>
<td>C9</td>
<td>120, 122</td>
<td>Prompt for Conversational Mode of Input</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>Date</td>
</tr>
<tr>
<td>D7</td>
<td>162, 200, 210</td>
<td>Water Vapor Pressure Constant (2.1878462x10⁻³)</td>
</tr>
<tr>
<td>D5</td>
<td>162, 410, 420</td>
<td>Respiratory Valve Dead Space (LITERS)</td>
</tr>
<tr>
<td>D3</td>
<td>162, 280, 290</td>
<td>Ergometer Load (Watts)</td>
</tr>
<tr>
<td>F</td>
<td>126, 127</td>
<td>Branch in Program for Format Instructions</td>
</tr>
<tr>
<td>F8</td>
<td>1400, 1410</td>
<td>Branch in Program for Exiting</td>
</tr>
<tr>
<td>G</td>
<td>162, 430, 440</td>
<td>Gas Temperature (CELSIUS)</td>
</tr>
<tr>
<td>H</td>
<td>770, 801, 810</td>
<td>Inspired CO₂ Constant or Direct Reading (%)</td>
</tr>
<tr>
<td>H1</td>
<td>830, 840</td>
<td>Inspired CO₂ Reading from Indirect Readout Analyzer</td>
</tr>
<tr>
<td>J</td>
<td>780, 861, 870</td>
<td>Inspired O₂ Constant or Direct Reading</td>
</tr>
<tr>
<td>J1</td>
<td>890, 900</td>
<td>Inspired O₂ Reading from Indirect Readout Analyzer</td>
</tr>
<tr>
<td>K</td>
<td>1000</td>
<td>Inspired O₂/N₂ (%)</td>
</tr>
<tr>
<td>M</td>
<td>12</td>
<td>Slope for Inspired CO₂ Curve</td>
</tr>
<tr>
<td>M1</td>
<td>15</td>
<td>Slope for Expired CO₂ Curve</td>
</tr>
<tr>
<td>M2</td>
<td>18</td>
<td>Slope for Inspired and Expired O₂ Curve</td>
</tr>
<tr>
<td>N</td>
<td>750, 755</td>
<td>Branch in Program for Inspired Air Measurements</td>
</tr>
<tr>
<td>O</td>
<td>1080</td>
<td>Oxygen Uptake (L/Min)</td>
</tr>
<tr>
<td>O1</td>
<td>1325</td>
<td>Oxygen Uptake (ML/KG/Min)</td>
</tr>
<tr>
<td>O3</td>
<td>1050</td>
<td>VE BTPS (L/Min)</td>
</tr>
<tr>
<td>P</td>
<td>162, 460, 470</td>
<td>Barometric Pressure (TORR)</td>
</tr>
<tr>
<td>P7</td>
<td>540</td>
<td>Water Vapor Pressure Constant (218.167 INT. ATM)</td>
</tr>
<tr>
<td>P6</td>
<td>580</td>
<td>Water Vapor Pressure (INT. ATMOSPHERES)</td>
</tr>
<tr>
<td>Q</td>
<td>911</td>
<td>Print in Image Statement</td>
</tr>
<tr>
<td>R</td>
<td>1060</td>
<td>RE</td>
</tr>
<tr>
<td>R5</td>
<td>162, 480, 490</td>
<td>Respiratory Rate (BREATHS/MIN)</td>
</tr>
<tr>
<td>S</td>
<td>162, 330, 340</td>
<td>Time (Seconds)</td>
</tr>
<tr>
<td>S5</td>
<td>162, 220, 230</td>
<td>Subject's Name</td>
</tr>
<tr>
<td>T</td>
<td>1005</td>
<td>Time (Minutes)</td>
</tr>
<tr>
<td>T8</td>
<td>550</td>
<td>Gas Temperature, KELVIN (G., °C &lt; 273.16)</td>
</tr>
<tr>
<td>T5</td>
<td>162, 300, 310</td>
<td>Speed</td>
</tr>
<tr>
<td>U</td>
<td>1030</td>
<td>STPD Factor</td>
</tr>
<tr>
<td>V</td>
<td>1040</td>
<td>VE STPD (L/Min)</td>
</tr>
<tr>
<td>V1</td>
<td>162, 370, 380</td>
<td>Respiratory Gas Meter Reading, Initial (LITERS)</td>
</tr>
<tr>
<td>V2</td>
<td>162, 350, 360</td>
<td>Respiratory Gas Meter Reading, Final (LITERS)</td>
</tr>
<tr>
<td>V3</td>
<td>162, 390, 400</td>
<td>Respiratory Gas Meter Correction (LITERS)</td>
</tr>
<tr>
<td>W</td>
<td>1020</td>
<td>VE ATPS (L/Min)</td>
</tr>
<tr>
<td>W5</td>
<td>162, 260, 270</td>
<td>Body Weight (kg)</td>
</tr>
<tr>
<td>X</td>
<td>1070</td>
<td>True O₂ (%)</td>
</tr>
<tr>
<td>X8</td>
<td>561</td>
<td>647.27-T8</td>
</tr>
<tr>
<td>Y</td>
<td>631, 650</td>
<td>Expired CO₂ from Direct Readout Analyzer</td>
</tr>
<tr>
<td>Y5</td>
<td>10.0</td>
<td>Net CO₂ (%)</td>
</tr>
<tr>
<td>Z</td>
<td>561, 700</td>
<td>Expired O₂ from Direct Readout Analyzer</td>
</tr>
<tr>
<td>Z8</td>
<td>570</td>
<td>LOG₁₀ P7/P8</td>
</tr>
</tbody>
</table>

FIG. 3. Symbols and constants used in the program.
**ENTER THE COLUMN 1 VARIABLES FIRST**

? "3/30/77", SUBJECT, 66.42, 175, NO, 60, 76.5, 0, 1.066, 0, 27.3, 765.3, 40

**DATE = 3/30/77**

**SUBJECT =**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BODY WEIGHT (KG)</td>
<td>W$=66.42</td>
</tr>
<tr>
<td>ERGOMETER LOAD (WATTS)</td>
<td>E$=175</td>
</tr>
<tr>
<td>TREADMILL SPEED (MPH)</td>
<td>T$=NO</td>
</tr>
<tr>
<td>TIME, GAS COLLECTION (SECONDS)</td>
<td>S=60</td>
</tr>
<tr>
<td>RESP. GAS METER READING, FINAL</td>
<td>V2=76.5</td>
</tr>
<tr>
<td>RESP. GAS METER READING, INITIAL</td>
<td>V1=0</td>
</tr>
<tr>
<td>RESP. GAS METER CORRECTION</td>
<td>V3=1.066</td>
</tr>
<tr>
<td>RESP. VALVE DEAD SPACE</td>
<td>D$=0</td>
</tr>
<tr>
<td>GAS TEMPERATURE</td>
<td>G=27.3</td>
</tr>
<tr>
<td>BAROMETRIC PRESSURE</td>
<td>P=765.3</td>
</tr>
<tr>
<td>RESPIRATION RATE</td>
<td>R$=40</td>
</tr>
<tr>
<td>WATER VAPOR PRESSURE</td>
<td>PB=27.208617</td>
</tr>
</tbody>
</table>

**EXPIRED CO2, AS %, FROM DIRECT READOUT ANALYZER** (TYPE (NO) IF NOT MEASURED)

| FCO2 | Y=3.99 |

**EXPIRED O2, AS %, FROM DIRECT READOUT ANALYZER** (TYPE (NO) IF NOT MEASURED)

| FO2  | Z=NO   |

**EXPIRED O2 (READING FROM INDIRECT READOUT ANALYZER)** F= 657

**WERE INSPIRED CO2 AND O2 MEASURED? TYPE YES OR NO:** NO

**INSPIRED CO2 H= 0.03%**

**INSPIRED O2 J= 20.93%**

**EXPIRED CO2 Y= 3.99%**

**EXPIRED O2 Z= 16.429403%**

**TIME = 1 MINUTES**

<table>
<thead>
<tr>
<th>VE ATPS</th>
<th>81.549 L/MIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>STPD FACTOR</td>
<td>0.88273116</td>
</tr>
<tr>
<td>VE STPD</td>
<td>71.985843 L/MIN</td>
</tr>
<tr>
<td>VE BTPS</td>
<td>87.199095 L/MIN</td>
</tr>
</tbody>
</table>

**FCO2 MINUS INSPIRED CO2 = 3.96%**

**FO2 = 16.429403%**

**RE = 0.85275936**

**TRUE O2 = 4.6437485%**

**CO2 PRODUCTION = 2.8506394 LITERS PER MINUTE**

**OXYGEN UPTAKE = 3.3428415 LITERS PER MINUTE**

**OXYGEN UPTAKE = 59.328839 ML/KG/MIN**

**ARE YOU FINISHED? TYPE YES OR NO:**

**FIG. 4. Sample printout of O2 uptake computation.**
Fig. 5. Comparison of oxygen uptake calculated with the computer program and the nomograph method.