LEVERS: A COMPUTER-ASSISTED INSTRUCTION

A THESIS

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CHAPTER I

Introduction

As in all other aspects of life, the country's largest industry, education, has been dramatically affected by the rapid technological advancement of the computer. Administrative functions such as class scheduling, record keeping, and payroll calculations have been assumed by computers in virtually all school districts. The potential of computer utilization in instructional enrichment has not yet been realized, however.

In the past, the relatively high cost of computers has made their use prohibitive in most classroom teaching environments. The present trend, however, shows computer costs declining to the point where, in some cases, it is now economically feasible to equip an entire school with adequate computer supplies to provide effective learning opportunities for all students. Indeed, Seidel and Rubin (29) predict that, soon, the cost of storing and transmitting information will be less than that required for print technology. Levien (20) agrees when he says that instructional computing costs will be reduced to "a few cents per student hour." There is more to consider in quality education than cost minimization however.

Ellis (10) warns that we will be tempted to modify current proven educational practices so that our teaching materials will be readily available for computerization. He adds that, as a consequence, we could develop inferior concepts of education.

Another area of concern among potential classroom computer users is the lack of good quality educational software. Jackson (17) has stated that "the figures that go around the [computer] industry are that only 3-5% of the educational programs that are available are worth looking at." He further explains that this void of good software can be attributed to the fact that the programs are either written by programmers who aren't educators or educators who aren't programmers. McGowan and Faust (22) concur when they state that writing and testing new computer assisted instruction (CAI) programs takes a considerable amount of time and talent. An individual must be knowledgeable in the subject matter and must possess skills in instruction design, program writing and CAI.

The emergence and refinement of computer graphics has added a new dimension to CAI increasing potential applications greatly. Graphics, in addition to non-textual displays, can give the illusion of motion making the computer more adaptable in curricula where physical movement is the medium of study. In particular, aspects of physical

education, physical therapy, and occupational therapy instruction can be enhanced. Currently, usage of CAI is minimal in these movement-oriented disciplines when compared to others (33).

It is often difficult for students to fully comprehend some of the concepts relating to principles of movement when they are introduced through traditional teaching methods. Textbook illustrations, because of their static nature, are of limited value in improving understanding. The development of sound and effective CAI software in curricula involving physical activity would not only improve learning in those areas of study but would produce a cornerstone for further development of CAI in other instructional areas.

STATEMENT OF THE PROBLEM

This study entails the development of a computer program to aid in the teaching of a unit on levers and the concept of leverage. Through extensive use of interactive graphics, the effect of lever parameters on subsequent movement potential will be shown. Response-determined branching will be employed when appropriate and program capability will include the recording of student identification and response tracking in a separate file.

PURPOSE OF THE STUDY

The purpose of the investigation is to develop a computer program with graphics to be used as supplemental instruction in the study of the principles of leverage.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The development of quality Computer Assisted Instruction is a very time consuming project. The following review of related literature was undertaken to ascertain the present state of the art in CAI software. In particular, the search will focus on 1) types of CAI, 2) historical CAI development, 3) microcomputers in education, 4) CAI effectiveness, and 5) CAI design techniques.

Types of CAI

Cleary, Mays, and Packham (6) define CAI as "the use of the computer as a sophisticated teaching machine which presents material to the student." They add that CAI can be presented in several types of modes:

1) Drill and Practice - the student is presented opportunities for application of acquired knowledge and allows the user to gain familiarity and competence with the material.
2) Tutorial - the student is presented with material for the first time. Acquisition of new facts and concepts is the main objective.

3) Dialogue - the student can ask the computer questions and carry on fairly sophisticated conversation.

Drill and practice and tutorial modes of instruction appear to dominate present CAI program development. Doerr (8) states that drill and practice techniques are of most value in the educational environment. She elaborates by stating that a human teacher seems to be unnecessary when practice of previously learned material is the major goal.

Tutorial CAI, however, is designed to replace the teacher in presenting new facts. Doerr feels that tutorial CAI can be particularly effective in make-up work or in specialized individual instruction.

Historical CAI Development

Historically, computer software development has occurred at a slower rate than has computer hardware. This is particularly true for CAI. In the late 1950s the first uses of CAI were made almost exclusively by business and industry to train employees. Programming was complicated and tedious but IBM later produced an author language, Courseware 1, which enabled educators to program their ideas more directly (23). The first documented use of CAI in the schools occurred in 1959 when electric typewriters,

interfaced with an IBM 650 computer, presented instructional programs to New York elementary school children (3).

The noted success of IBM's experiment encouraged other major CAI development projects. In 1963 the Institute for Mathematical Studies in the Social Sciences at Stanford University produced a series of tutorial programs in mathematical logic. Additional drill and practice programs later supplemented Stanford's initial effort. Extensive program evaluation occurred during the following years. It was found that, when compared to a control group of students traditionally taught, CAI students performed better on SAT tests. This was true for both the tutorial and drill and practice CAIs. Stanford later instituted a Russian language program. It, too, met with similar success.

During the 1960s, the University of Illinois, working in conjunction with Control Data and the National Science Foundation developed and produced PLATO (Programmed Logic for Automated Teaching Operations). An interesting feature of PLATO is its touch sensitive screen panel which enables a user to touch an option or selection. This eliminates typing ability or, in the graphics mode, reading ability as prerequisites for utilization. Such programs can be used by very young children and by those who don't speak English. PLATO can readily be used in various instructional modes. Magidson (25) surveyed over 2000 students who had used PLATO

for an average of seven hours each and found that, overall, student attitudes were highly positive in their evaluation of PLATO. The only drawback often cited was difficulty with computer or terminal malfunctions. Today, Control Data Education Corporation offers learning and training centers in 50 cities in the United States. Several universities, secondary schools and even prisons also enjoy PLATO instructional opportunities. Presently, there are available volumes of CAI field-tested software in most curricular areas (32).

In 1972 Brigham Young University, funded by the MITRE corporation, began developing and researching an innovative idea called TICCIT (Time-shared, Interactive, Computer-Controlled, Information Television). The project was designed to combine computer and television technologies in presentation of CAI programs in Mathematics and in English. Instructional materials are presented on a television screen. Sequential displays are determined by the student, not the system. This is accomplished through a pad of "learner control" keys located on a keyboard interfaced with a computer. TICCIT is particularly designed for conceptual learning tasks. Evidence (15,26) suggests that, when the student has control over program pathways, learning is accomplished more quickly.

These early efforts in creating effective CAI have

resulted in programs that are still widely used in education, business, and industry. Often these CAI programs are used as a standard in the evaluation of new CAI software.

Microcomputers in Education

The recent marketing of relatively low-cost microcomputers has made the implementation of CAI accessible to most educational institutions. Microcomputers are "stand alone devices with binary data processing capability usually up to 64 thousand bytes." Presently prices vary from $200 to $6000 (13). Often other "peripheral" devices are necessary for educational computing (cathode ray tube, printer, disk drive, etc.). The National Science Foundation estimates that there are about 200,000 units in elementary and secondary schools and projected that, by 1985, one million microcomputers will be in service in these schools (13). Bork (4) estimated that from 1980 to 1985 the percentage of schools with CAI will increase from 54 percent to 74 percent.

This rapid introduction of microcomputers into the schools has manifested several problems. Some schools are purchasing many microcomputer and finding there is no one that can operate them. Teachers have found themselves lacking knowledge about computers and their possible

applications. Some (13) fear that teachers will resist computers much as they have earlier technologies.

Many microcomputers now offer capabilities to display graphics. Skyrme (30) states that "the human brain can quickly assimilate an image more easily than it can decipher text." Hammond (14) adds that software with graphics tends to show rapid learning of a task that would otherwise be difficult. Bork (4) states that graphics tend to separate the important from the trivial, and found student motivation higher with their use. When appropriately used, graphics can also demonstrate motion. This makes it particularly adaptable to motion oriented disciplines. Few applications are reported in subjects where movement or motion is the major medium.

CAI Effectiveness

Regardless of cost reduction, however, most institutions will not make this investment of time and money unless CAI has demonstrated cost-effective advantages over other traditional modes of instruction. Numerous investigations have been performed to compare learning effectiveness of CAI compared to that of other types of instruction. According to Splittgerber (31), the decision to implement CAI should focus on three questions:

1. What are the relative advantages over less

expensive traditional methods?

2. What is the amount of learning gain compared with other methods?
3. Have the identified teaching advantages reduced costs to a point that allows school districts to adopt CAI?

Magidson (24) found that CAI was superior to traditional methods in 45 percent and at least as effective in 55 percent of the surveyed studies. Student attitudes and learning efficiency also favored CAI. Lewellen (21) and Visonhaler and Bass (36) compared standardized test scores in abstract reasoning and scholastic aptitude with those traditionally taught. Results showed that students who used CAI performed better than those who did not. It was concluded that "students are able to learn more material in less time when the computer is properly utilized in the educational process" (35). Gleason (13) summarized CAI research findings and reported a 20 to 40 percent time saving in learning favoring CAI. Those studies surveyed also suggest that retention of learning is often better than that of conventional learning.

CAI Design Techniques

The development of one hour of CAI usually takes a programmer several hundred hours to prepare. In addition,

course objectives must be defined, program content verified and, upon completion, the program should be administered to representatives of the population for whom it was authored.

Gagne, Wager, and Rojas (11) warn that CAI authors must invest a considerable amount of advance planning before initiating actual software programming. Pre-programming procedures do not differ markedly from traditional preliminary planning for classroom instruction; the same principles of learning theory must be employed in both (13,24,27,28). Roblyer (28) offers several essential characteristics of good CAI software:

1. Statement of objectives - should be clearly stated and instructional rather than recreational.
2. Statement of entry skills - should define what preliminary information or abilities are necessary to benefit from the program.
3. Design of learning activities - mode of instruction is defined (i.e. drill and practice), proper learning sequence is determined; each element of presentation is matched to the stated objectives.
4. Design of tests - On line tests (if appropriate) are written and validated.
5. Content integrity - Evaluation of course content

for misspellings, grammatical errors, and misleading statements is performed.

6. Design of presentation - All possible learning distractions (i.e., overuse of flashing text) are identified and eliminated.

Other programming considerations are: learner control, feedback, response format, graphics and animation. Each is described briefly below:

Learner control

The pattern and amount of information in a CAI can be controlled by the system or by the user (learner). Most (11,15,26) studies indicate that when the presentation is learner controlled, the student learns more quickly and has a more positive attitude towards the program.

Feedback

When a student makes a response he/she should be provided information relative to the appropriateness of that response. This is known as feedback. Hanson (15) found that system controlled feedback reduced learner anxiety levels. When feedback was learner controlled, the time to complete a high level reasoning task was reduced.

Response format

Sometimes it is desirable to accept responses expressed

in different ways. Care should be taken to avoid negative feedback for any possible response that is correct. The program must allow for all possible responses to ensure proper program flow.

Graphics and animation

Roblyer (28) states that graphics and animation should be used only when diagram or movement is critical for concept understanding. He suggested that overuse of graphics tends to distract learning. Caldwell (5), however, recommends that graphics and animation be used whenever they might spark an interest in the course content.

SUMMARY

A gleaning of the literature reveals that the early anticipated potential of computer assisted instruction has not yet been realized. The introduction of low cost microcomputers has made CAI accessible to most educational institutions. Unfortunately, CAI software development has not kept pace. Very few programs apply the principles of proven learning theories and, at the same time, make optimum use of the computer as the learning medium.

When quality CAI programs are used, research tends to show favorable results in learning compared to those found with traditional teaching methods. As the number of computer literate people rises, the quality of future CAI

can be expected to improve dramatically. Sophisticated hardware and the development of new instructional programming languages will make CAI authoring easier and less time consuming.

CHAPTER III

PROGRAM DESIGN AND CONSTRUCTION

The purpose of this thesis was to develop a computer assisted instruction to supplement a student's introduction to the concepts of levers. Accomplishment of this task required two major phases: program design and program construction. An attempt was made, at all times, to follow CAI guidelines and recommendations as outlined in the literature review in Chapter II.

Program Design

Regardless of the method or type of knowledge transmission, there are several characteristics of optimally effective teaching. Theories of learning apply to the development of CAI just as they do in more traditional teacher planning.

The initial step in designing a course is to prepare a detailed description of the knowledges or skills that the student will possess upon successful course completion (22). These should always be available to the student and expressed in terms that will enable him to evaluate progress.

The following objectives were prepared for the CAI unit on levers. These objectives are available, on line, to the

student and also appear in a user manual (See Appendix B). Upon completion of all modules the student will:

1. Identify lever parts
2. Classify levers
3. Define lever terms
4. Perform lever calculations
5. Classify simple tools in terms of leverage

Course content and order of presentation were then established to optimally meet the objectives. Concurrently, a test was developed to assist in later program evaluation.

Course content was placed into one of three learning modules according to degree of difficulty and importance in understanding other related concepts. Module descriptions appear in Figure 1. Elaboration of each module's content appears in the user's manual in the Appendix. While the program allows for branching to any of these modules, the recommended learning sequence would be 1) definitions, 2) applications, and 3) quiz.

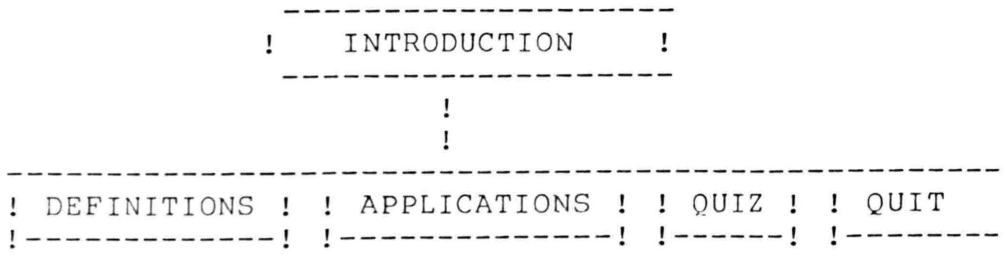

Figure III.-1: Program Branch Options

Upon completion of any module, the student has the option of branching to either of the other modules or of quitting. The learner therefore has some control over material presented.

Program flow is different for each module. In the definitions module, flow is linear; presenting and defining terms. Graphic displays are used to help define each term and demonstrate its relationship to other terms. Sample flow for the definitions module appears in Figure 2.

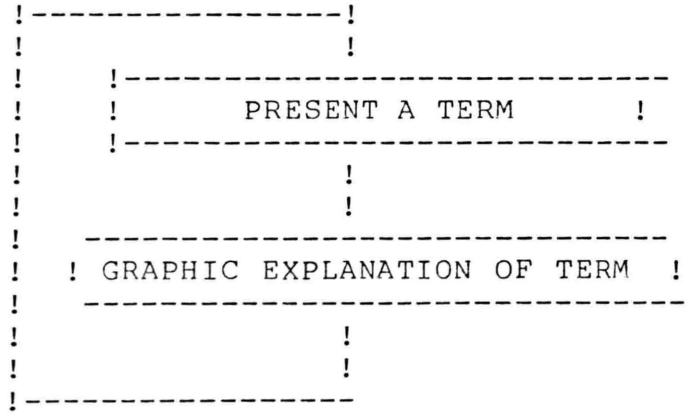

Figure III.-2: Program Flow for Definitions Module

This tutorial mode has little flexibility and is basically system-controlled. The student must progress through the entire program but he can control the speed of presentation. The applications module was designed to provide opportunities to apply knowledge learned in the definitions module.

Program flow is somewhat more sophisticated. An

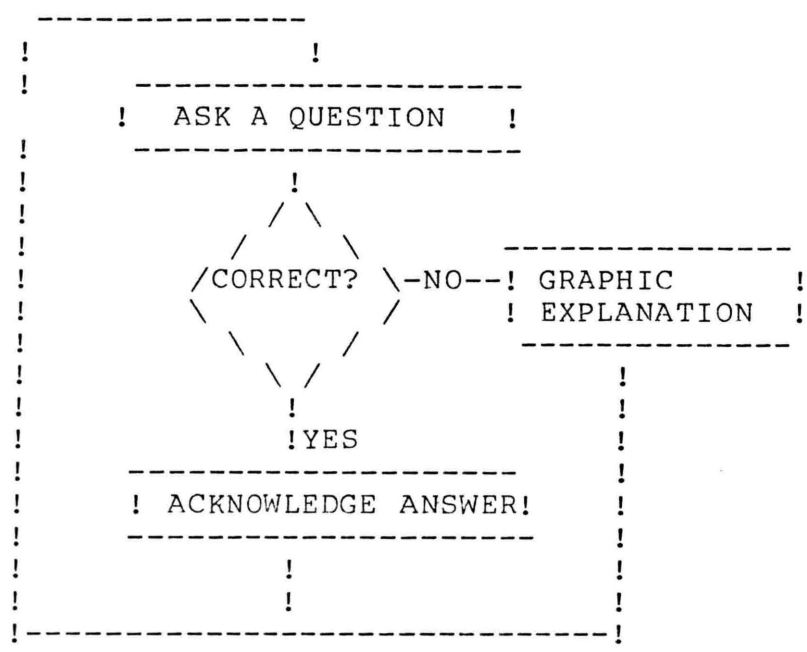

Figure III.-3: Program Control for Applications Module

example is shown in Figure 3.

Again, graphics were used extensively to provide the questions and to enhance explanations.

The quiz module was constructed to be used for either drill and practice or for evaluation of student progress. Questions are presented in order of difficulty and incorrect answers receive a graphic explanation. Quiz questions assume the student has acquainted himself with the course content in the other two modules. Sample program control appears in Figure 4.

Upon completion of the quiz the student is provided with the number of incorrect answers and is given an

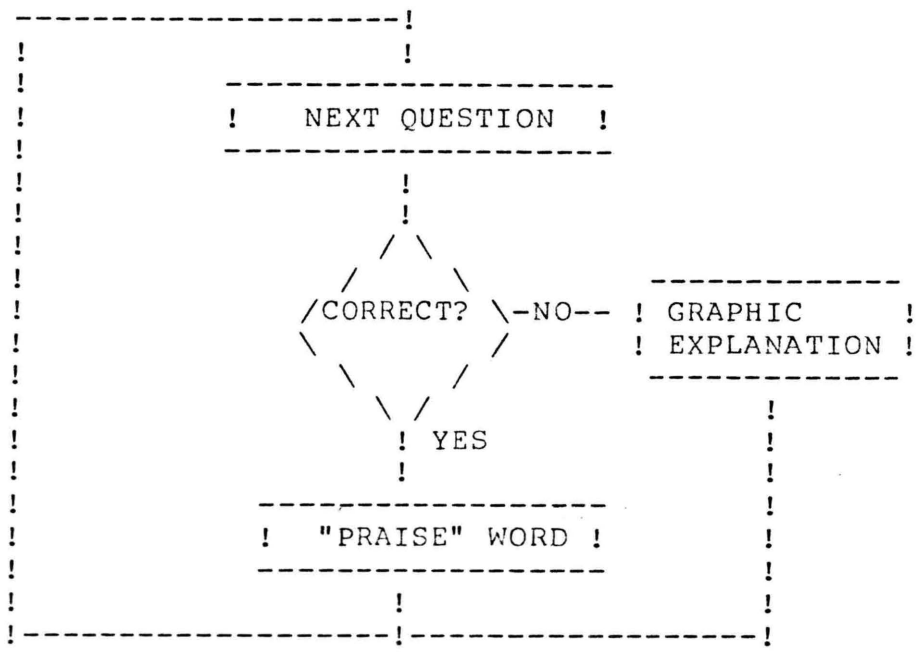

Figure III.-4: Program Flow for Quiz Module

student information along with the questions missed and answers selected can be sent to a record keeping "filewriter" for later analysis by the instructor.

Program Construction

All programming was done in BASIC (Beginners All-purpose Symbolic Instructional Code). BASIC enjoys almost universal use in microcomputers (13). The programs were written for an APPLE II plus with 48K and an interfacing CRT (cathode ray tube). The APPLE is presently the most popular microcomputer in educational institutions (13) and has graphic capabilities superior to its

(13) and has graphic capabilities superior to its competitors.

Shape tables for high resolution graphic displays were prepared with the aid of special software authored by Robert Clardy and marketed by Synergistic Software. Text was formatted on coding forms designed specifically for the APPLE screen dimensions. A short introductory program was written to provide the user with the program title, author, and unit objectives. The shape table which is used in all three modules is loaded from this program. A "relocation" program was written to load each of the modules at an address lower than Apple's standard loading address. This was necessary to prevent the module from overwriting the high resolution screen.

Screen advancing is controlled by the student who can, therefore, take as much time as he needs. A message is flashed for any entry inconsistent with the type requested and the student is given another opportunity to respond.

A program user manual appears in Appendix B. The set of program listings can be found in Appendix A.

APPENDICES

APPENDIX A

PROGRAM LISTINGS

INTRODUCTION PROGRAM

```
 9 D$ =  CHR$ (4): REM  LOAD TITLE CHAR
 10  PRINT  CHR$ (4);"BLOAD LEVERS"
 20  POKE 232,252
 30  POKE 233,29
 35  HOME
 40  HGR
 50  HCOLOR= 3
 60  SCALE= 8
 70  ROT= 0
 80 X = 50
 85 Y = 70
 90  FOR I = 1 TO 3
 95  IF I = 1 THEN  GOSUB 300
 96  IF I = 2 THEN  GOSUB 600
 97  IF I = 3 THEN  GOSUB 300
100  DRAW I AT X,Y
105  GOSUB 700
110 X = X + 30
120  NEXT I
125 I = 2
126  GOSUB 600
```

```
 130  DRAW 2 AT X,Y: REM  USING "E" AGAIN?'
 135  GOSUB 700
 140 X = X + 30
 150  FOR I = 4 TO 5
 155  IF I = 4 THEN  GOSUB 300
 160  IF I = 5 THEN  GOSUB 600
 166  DRAW I AT X,Y
 167  GOSUB 700
 168 X = X + 30
 170  NEXT I
 180  FOR J = 1 TO 3000: NEXT J
 190  TEXT
 200  HOME
 202  INVERSE : FOR I = 2 TO 39: VTAB 2: HTAB I: PRINT " ": N
EXT
 203  FOR I = 2 TO 23: VTAB I: HTAB 39: PRINT " ": NEXT
 204  FOR I = 39 TO 2 STEP  - 1: VTAB 23: HTAB I: PRINT " ":
NEXT
 205  FOR I = 23 TO 2 STEP  - 1: VTAB I: HTAB 2: PRINT " ": N
EXT
 206  NORMAL
 210  VTAB (7): HTAB (19): PRINT "BY"
 211  VTAB (10): HTAB (15): PRINT "JUDY TATE"
 212  VTAB (13): HTAB (7): PRINT "TEXAS WOMAN'S UNIVERSITY"
 213  VTAB (16): HTAB (18): PRINT "1982"?'
```

```
220  FOR J = 1 TO 4000: NEXT J
221  HOME : VTAB 3: HTAB 15: INVERSE : PRINT "OBJECTIVES": N
ORMAL
222  VTAB 6: HTAB 1: PRINT "WHEN YOU FINISH THIS SET OF PROG
RAMS YOU": VTAB 8: HTAB 1: PRINT "SHOULD BE ABLE TO:"
223 : VTAB 11: HTAB 5: PRINT "1. IDENTIFY LEVER PARTS"
224  VTAB 13: HTAB 5: PRINT "2. CLASSIFY LEVERS"
225  VTAB 15: HTAB 5: PRINT "3. DEFINE LEVER TERMS"
226  VTAB 17: HTAB 5: PRINT "4. PERFORM LEVER CALCULATIONS"
227  VTAB 19: HTAB 5: PRINT "5. CLASSIFY SIMPLE COMMON TOOLS
": VTAB 21: HTAB 8: PRINT "IN TERMS OF LEVERAGE": VTAB 24: H
TAB 7: INVERSE : PRINT "PRESS ANY KEY TO CONTINUE";: NORMAL
: GET KEY$
228  HOME : VTAB 8: HTAB 7: PRINT "CHOOSE ONE OF THE FOLLOWI
NG:"
230  VTAB 11: HTAB 7: PRINT "1. DEFINITIONS AND EXAMPLES"
235  VTAB 14: HTAB 7: PRINT "2. TEST"
240  VTAB 17: HTAB 7: PRINT "3. QUIT"
244  INVERSE
245  VTAB 20: HTAB 14: PRINT "CHOOSE 1,2, OR 3";
246  NORMAL
250  GET CHO$: GOSUB 9700
251  IF  PEEK (705) = 1 THEN  POKE 705,0: GOTO 250
252  ON CHO GOTO 255,270,290
253  HOME : VTAB 12: HTAB 14: PRINT "PLEASE WAIT"
```

```
254  ON CHO GOTO 255,270290
255  PRINT " ": PRINT D$;"RUN RELOCATE"
270  PRINT " ": PRINT D$;"RUN MOVEMEM"
290  HOME : END
300  REM  BRINGS LETTERS FROM BOTTOM OF
301  REM  SCREEN
310  FOR Y = 140 TO 80 STEP  - 10
320  DRAW I AT X,Y
325  GOSUB 700
330  FOR J = 1 TO 100: NEXT J
340  XDRAW I AT X,Y
360  NEXT Y
370  RETURN
600  REM  BRINGS LETTERS FROM TOP
601  REM  OF SCREEN
610  FOR Y = 0 TO 70
620  DRAW I AT X,Y
625  GOSUB 700
630  FOR J = 1 TO 100: NEXT J
640  XDRAW I AT X,Y
650 Y = Y + 10
660  NEXT Y
670  RETURN ?'
700  REM  PRODUCES CLICK WITH EACH LETTER DRAW
705 S =  - 16336
```

```
710 SOUND =  PEEK (S) -  PEEK (S) +  PEEK (S) -  PEEK (S) +
 PEEK (S) -  PEEK (S) +  PEEK (S) +  PEEK (S) -  PEEK (S) +
 PEEK (S) -  PEEK (S)
720  RETURN
9700  REM  **CHECKS FOR VALIDITY
9701  REM  **     OF ANSWER    ***
9705  IF  ASC (CHO$) > 48 THEN  IF  ASC (CHO$) < 53 THEN CHO
 =  ASC (CHO$) - 48: RETURN
9710  POKE 705,1: VTAB 23: HTAB 4: PRINT "ENTER THE ";: INVE
RSE : PRINT "NUMBER";: NORMAL : PRINT " OF YOUR CHOICE ";
9715  FOR I = 1 TO 2000: NEXT
9750  RETURN
```

DEFINITIONS PROGRAM

```
 10  REM  ************************
 12  REM   BRANCH TO DEFINITIONS *
 14  REM  ************************
 16 SP = 100
 18  DIM T$(40)
 20  PRINT  CHR$ (4);"BLOAD NEWTAB,A$8000"
 25  POKE 232,0: POKE 233,128
 26 SP = 255: POKE 700,0
 27  POKE 705,0: POKE 702,0
 100  REM  *** PAGE 1 ***
 105  HOME :V = 8:H = 6:T$ = "EVERY LEVER HAS THREE PARTS:"
 110  GOSUB 5000
 111 T = 2000: GOSUB 8000
 115 V = 11:T$ = "1. RESISTANCE (R)"
 117  GOSUB 5000
 118 T = 1000: GOSUB 8000
 120 V = 14:T$ = "2. AXIS (A)"
 121  GOSUB 5000
 122 T = 1000: GOSUB 8000
 125 V = 17:T$ = "3. FORCE (F)"
 126  GOSUB 5000
 127 T = 2000: GOSUB 8000
```

```
128 V = 23:H = 15:T$ = "PRESS ANY KEY TO CONTINUE": INVERSE
: GOSUB 5000: NORMAL
130  GOSUB 9000
200  REM  *** PAGE 2 ***
201  REM
202  HOME
205 V = 8:H = 2:T$ = "THE ARRANGEMENT OF THESE THREE PARTS":
 GOSUB 5000
210 V = 11:H = 8:T$ = "(RESISTANCE, AXIS, FORCE)": GOSUB 500
0
215  VTAB 14: HTAB 4: PRINT "WILL DETERMINE TO WHICH ";: INV
ERSE : PRINT "CLASS";: NORMAL : PRINT " A"
220 V = 17:H = 13:T$ = "LEVER BELONGS.": GOSUB 5000
230  GOSUB 9000
300  REM  *** PAGE 3 ***
301  REM
303  HOME
305 V = 8:H = 4:T$ = "THERE ARE THREE CLASSES OF LEVERS:": G
OSUB 5000
310 T = 1000: GOSUB 8000
315 V = 11:H = 8:T$ = "1. FIRST"
317  GOSUB 5000
318 T = 1000: GOSUB 8000
320 V = 14:T$ = "2. SECOND": GOSUB 5000
325 T = 1000: GOSUB 8000
```

```
330 V = 17:T$ = "3. THIRD": GOSUB 5000
335 T = 1500: GOSUB 8000
340 V = 21:H = 4:T$ = "LET'S LOOK AT EACH ONE SEPARATELY.":
GOSUB 5000
350  GOSUB 9000
360  TEXT : HOME
362  REM  ** INSTRUCTION PAGE **
365  HOME :V = 7:H = 5:T$ = "THE SEQUENCE OF LEVER COMPONENT
S": GOSUB 5000
367 V = 10:H = 13:T$ = "DETERMINES LEVER": GOSUB 5000
369 V = 13:H = 17:T$ = "CLASS.": GOSUB 5000
370  GOSUB 9000: HOME
371 V = 8:H = 6:T$ = "ON THE FOLLOWING DIAGRAM MOVE": GOSUB
5000
373 V = 12:H = 10:T$ = "THE AXIS AND WATCH THE": GOSUB 5000
375 V = 16:H = 6:T$ = "LEVER CLASSIFICATION CHANGE.": GOSUB
5000: GOSUB 9000
376  HOME
377 V = 10:H = 3:T$ = "TO MOVE THE AXIS TO THE LEFT TYPE 'L'
": GOSUB 5000
379 V = 13:T$ = "TO MOVE THE AXIS TO THE RIGHT TYPE 'R'": GO
SUB 5000
381 V = 16:T$ = "TO COME BACK TO THIS PAGE TYPE 'I'": GOSUB
5000
385  GOSUB 9000
```

```
400  REM  *** DISPLAY LEVER SYSTEM ***
401  GOSUB 6100
460 V = 22:H = 10:T$ = "A FIRST CLASS LEVER": GOSUB 5000
470 V = 24:H = 1:T$ = "THE AXIS IS BETWEEN FORCE AND RESISTA
NCE": GOSUB 5000
480 T = 3000: GOSUB 8000: HOME
500 X = 125: GOSUB 6200
505  IF AX$ = "I" THEN  TEXT : GOTO 376
600  REM  *** PAGE 6 ***
601  REM
603  TEXT : HOME
605 V = 8:H = 7:T$ = "LEVERS ENABLE A USER TO GAIN": GOSUB 5
000
610  VTAB 11: HTAB 16: INVERSE : PRINT "EITHER": NORMAL
615  VTAB 15: HTAB 13: PRINT "FORCE ";: INVERSE : PRINT "OR"
;: NORMAL : PRINT " SPEED"
620 V = 19:H = 18:T$ = "BUT...."
621  GOSUB 5000
625  GOSUB 9000
700  REM  ** PAGE 7 **
701  REM
705  HOME :V = 11:H = 13:T$ = "BEFORE CONTINUING": GOSUB 500
0
710 V = 14:H = 6:T$ = "WE NEED TO LEARN SOME NEW TERMS:": GO
SUB 5000
```

```
 711  GOSUB 9000
 712  HOME
 715 V = 8:H = 6:T$ = "FORCE ARM - PERPENDICULAR DISTANCE": G
OSUB 5000
 720 V = 10:H = 18:T$ = "BETWEEN THE AXIS AND": GOSUB 5000
 725 V = 12:T$ = "THE POINT OF APPLICA-": GOSUB 5000
 728 V = 14:T$ = "TION OF FORCE.": GOSUB 5000
 735 V = 22:H = 13:T$ = "FORCE ARM = FA": GOSUB 5000
 740  GOSUB 9000
 800  REM  ** GRAPHICS (FA) **
 801  REM
 805  GOSUB 6100
 808 X = 125:Y = 158
 810  GOSUB 6500
 815  GOSUB 9000
 820  REM  *** PAGE 7B ***
 825  TEXT : HOME :V = 7:H = 6:T$ = "RESISTANCE ARM - PERPEND
ICULAR": GOSUB 5000
 830 V = 9:H = 18:T$ = "DISTANCE BETWEEN THE": GOSUB 5000
 835 V = 11:T$ = "AXIS AND THE POINT OF": GOSUB 5000
 840 V = 13:T$ = "RESISTANCE. (RA)": GOSUB 5000
 845 V = 22:H = 10:T$ = "RESISTANCE ARM = RA": GOSUB 5000
 846  GOSUB 9000
 847  GOSUB 6100
 848 X = 125: DRAW 5 AT X,80:X = 122
```

```
849  POKE 705,1:Z = 92
850  GOSUB 6600
855  GOSUB 9000
860  REM  ** PAGE 10 ***
861  REM
865  TEXT : HOME : SPEED= 255
870  VTAB 6: HTAB 3: PRINT "A ";: INVERSE : PRINT "SECOND";:
 NORMAL : PRINT " CLASS LEVER ALWAYS HAS A"
875 V = 12:H = 7:T$ = "LONGER FORCE ARM AND FAVORS": GOSUB 5
000
880 V = 18:H = 17: INVERSE :T$ = "FORCE": GOSUB 5000: NORMAL

885  GOSUB 9000
887 X = 71: POKE 700,1
890  GOSUB 6100
892 X = 71: DRAW 5 AT X,80
893  GOSUB 6000: VTAB 21: HTAB 1: PRINT "FORCE ARM IS LONGER
 THAN RESISTANCE ARM"
894  GOSUB 7200:Y = 158
895 X = 71: GOSUB 6500
898 T = 300: GOSUB 8000
900 Y = 92:X = 71
901  GOSUB 6900
905  GOSUB 9000
950  REM  *** PAGE 10B ***
```

```
951  REM
952  TEXT : HOME
955  VTAB 6: HTAB 4: PRINT "A ";: INVERSE : PRINT "THIRD";:
NORMAL :60 VT$ = "LONGER RESISTANCE ARM AND FAVORS": GOSUB 5
000
965  INVERSE :V = 18:H = 17:T$ = "SPEED": GOSUB 5000: NORMAL

970  GOSUB 9000
972  GOSUB 6100: DRAW 5 AT 185,80
975  GOSUB 6000: VTAB 21: HTAB 1: PRINT "RESISTANCE ARM IS L
ONGER THAN FORCE ARM"
976 X = 185: GOSUB 7200
977 Y = 92
978 Z = 161
979  POKE 705,0: GOSUB 6600
980  GOSUB 9000
985 X = 183:Y = 92:Z = 161
987  GOSUB 6930
989  GOSUB 9000
1000  REM  ** PAGE 10B **
1001  REM
1005  TEXT : HOME
1010  VTAB 4: HTAB 6: PRINT "A ";: INVERSE : PRINT "FIRST";:
 NORMAL : PRINT " CLASS LEVER MAY HAVE"
1015  VTAB 8: HTAB 17: INVERSE : PRINT "EITHER": NORMAL
```

```
1020 V = 12:H = 11:T$ = "A LONGER FORCE ARM": GOSUB 5000
1025  VTAB 16: HTAB 19: INVERSE : PRINT "OR": NORMAL
1030 V = 20:H = 8:T$ = "A LONGER RESISTANCE ARM": GOSUB 5000
1032  GOSUB 9000
1035  HOME :V = 5:H = 4:T$ = "WHENEVER WE DIVIDE THE LENGTH
OF"
1037  GOSUB 5000
1040 V = 8:H = 10:T$ = "THE FORCE ARM BY THE": GOSUB 5000
1045 V = 11:H = 7:T$ = "LENGTH OF THE RESISTANCE ARM": GOSUB
 5000
1050 V = 14:H = 14:T$ = "WE GET THE": GOSUB 5000
1055 V = 17:H = 10:T$ = "MECHANICAL ADVANTAGE": INVERSE : GO
SUB 5000: NORMAL
1060 V = 20:H = 17:T$ = "SO...": GOSUB 5000
1062  GOSUB 9000: HOME
1065 V = 10:H = 22:T$ = "FA": GOSUB 5000
1070 V = 11:H = 16:T$ = "MA = ---": GOSUB 5000
1075 V = 12:H = 22:T$ = "RA": GOSUB 5000
1080  GOSUB 9000
2060  TEXT : HOME :V = 5:H = 8:T$ = "ON THE FOLLOWING DIAGRA
M": GOSUB 5000
2065 V = 8:H = 13:T$ = "MOVE THE AXIS": GOSUB 5000
2070 V = 11:H = 7:T$ = "AND NOTICE THE CHANGES IN:": GOSUB 5
000
2075 V = 14:H = 15:T$ = "1. CLASS"
```

```
2076  GOSUB 5000
2080 V = 16:T$ = "2. FORCE ARM"
2081  GOSUB 5000
2085 V = 18:T$ = "3. RESISTANCE ARM"
2086  GOSUB 5000
2090 V = 20:T$ = "4. MECHANICAL ADVANTAGE"
2091  GOSUB 5000
2095  GOSUB 9000
3000  POKE 700,0: GOSUB 6100: GOSUB 7100
4000  TEXT : HOME :V = 10:H = 4:T$ = "IT IS IMPORTANT TO UND
ERSTAND THE": GOSUB 5000
4005 V = 14:H = 12:T$ = "PRECEEDING TERMS.": GOSUB 5000: GOS
UB 9000
4008  HOME
4015 V = 9:H = 6:T$ = "FOR NOW, WOULD YOU LIKE TO:": GOSUB 5
000
4020 V = 12:H = 12:T$ = "1. TAKE A QUIZ": GOSUB 5000
4030 V = 15:T$ = "2. QUIT": GOSUB 5000
4040 V = 23:H = 4:T$ = "ENTER THE NUMBER OF YOUR CHOICE": GO
SUB 5000
4050  GET CHO$: GOSUB 9700: NORMAL
4051  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 4050
4055  IF CHO = 1 THEN  HOME :: VTAB 12: HTAB 15: PRINT "PLEA
SE WAIT": PRINT  CHR$ (4)"RUN MOVEMEM"
4070  HOME
```

```
4999  END
5000  REM  **** THIS SUBROUTINE PRINTS
5001  REM  **** LINES ONE AT A TIME ****
5002  REM
5005  SPEED= 255
5010  HTAB H
5015  FOR I = 1 TO  LEN (T$)
5017  VTAB V
5020  PRINT  MID$ (T$,I,1);
5030  NEXT I
5050  RETURN
6000  REM  *** SETS LABEL WINDOW ***
6001  REM
6005  VTAB 24: HTAB 12
6010  CALL  - 958
6050  RETURN
6100  REM  *** DRAWS LEVER SYSTEM ***
6101  REM
6105  HGR : HCOLOR= 3: ROT= 0: SCALE= 1
6110  DRAW 1 AT 100,80
6115  DRAW 2 AT 85,77
6120  DRAW 3 AT 149,84
6125  DRAW 4 AT 146,77
6127  IF  PEEK (700) = 1 THEN  RETURN
6130  DRAW 5 AT 125,80
```

```
6150  RETURN
6200  REM  *** MOVES AXIS ***
6201  REM
6202  HOME
6203 V = 22:H = 12
6204 T$ = "FIRST CLASS LEVER ":G$ = T$
6205  INVERSE : GOSUB 5000: NORMAL : GOSUB 6400
6207 X = 125: REM  SETS AXIS AT ORIGIN
6210  GET AX$
6214  IF AX$ = "C" THEN  RETURN
6215  IF AX$ = "L" THEN  GOTO 6260
6220  IF AX$ = "R" THEN  GOTO 6280
6225  IF AX$ = "I" THEN  RETURN
6230  VTAB 23: HTAB 5: INVERSE : PRINT "ENTER ONLY L,R OR C"
: PRINT "": NORMAL : GOTO 6210
6260  XDRAW 5 AT X,80:X = X - 5: GOSUB 7400: DRAW 5 AT X,80
6265  GOSUB 6300
6270  IF X < 90 THEN G$ = "SECOND CLASS LEVER": POKE 702,1:
GOTO 6290
6271  IF X < 165 THEN G$ = "FIRST CLASS LEVER "
6272  GOTO 6290
6280  XDRAW 5 AT X,80:X = X + 5: GOSUB 7400: DRAW 5 AT X,80:
 GOSUB 6300
6281  IF X > 160 THEN G$ = "THIRD CLASS LEVER": POKE 702,1:
GOTO 6:T$ = G$: INVERSE :V = 22: GOSUB 5000: NORMAL
```

```
6291 V = 22
6295  GOTO 6210
6299  RETURN
6300  REM  ** PRODUCES SOUND WHEN
6301  REM  ** CLASS CHANGES     **
6302  REM
6310 S =  - 16336
6315 SOUND =  PEEK (S) -  PEEK (S) +  PEEK (S) -  PEEK (S) +
  PEEK (S) -  PEEK (S)
6330  RETURN
6400  REM  ** PRINTS DISPLAY INSTRUCTIONS
6401  REM  **     FOR AXIS MOVEMENT     **
6405  VTAB 21: HTAB 2: PRINT "L=LEFT     R=RIGHT     C=CONTI
NUE"
6415  VTAB 23: HTAB  POS (1) + 1
6420  VTAB 23: HTAB 30
6450  RETURN
6500  REM  ** FORCE ARM ***
6502  ROT= 0
6505  DRAW 7 AT X,90
6510  GOSUB 6300: REM  ** SOUND **
6515  FOR I = 1 TO 200: NEXT
6520 X = X + 3
6530  IF X = Y THEN  ROT= 16: DRAW 7 AT X + 3,90: ROT= 0:P =
 8:Q = 9: GOSUB 7300: RETURN
```

```
6545  GOTO 6505
6550  RETURN
6600  REM  ** RESISTANCE ARM **
6610  DRAW 7 AT X - 3,90: GOSUB 6300
6612  ROT= 0
6615 T = 200: GOSUB 8000
6625 X = X - 2
6626 P = 8:Q = 9: IF  PEEK (705) = 1 THEN P = 10
6630  IF X = Z THEN  ROT= 16: DRAW 7 AT X,90: ROT= 0: GOSUB
7300: RETURN
6635  GOTO 6610
6640  POKE 705,0
6650  RETURN
6700  REM  *** MOVES AXIS ***
6701  REM
6705  GET AX$
6710  XDRAW 5 AT X,80
6715  IF AX$ = "C" THEN  RETURN
6720  IF AX$ = "L" THEN X = X - 5: GOTO 6740
6730  IF AX$ = "R" THEN X = X + 5: GOTO 6740
6735  VTAB 21: HTAB 1 PRINT "
      ": VTAB 21: HTAB 11 PRINT "ENTER ONLY L,R, OR C"
6740  DRAW 5 AT X,80: GOSUB 6300
6745  GOSUB 6800
6750  RETURN
```

```
6800  REM  ** CALCULATES AND PRINTS FA,
6801  REM  **       RA, AND MA        **
6805 FA =  ABS (160 - X):RA =  ABS (X - 90)
6815 CL$ = "1ST"
6820  IF X < 90 THEN CL$ = "2ND"
6825  IF X > 164 THEN CL$ = "3RD"
6826  IF RA = 0 THEN RA = 1
6828  IF FA = 0 THEN FA = 1
6829 MA = FA / RA
6830 MA = ( INT (MA * 100)) / 100
6832  INVERSE
6835  VTAB 21: HTAB 21: PRINT CL$
6836  VTAB 22: HTAB 8: PRINT FA
6837  VTAB 22: HTAB 22: PRINT RA
6838  VTAB 22: HTAB 35: PRINT MA
6840  NORMAL
6850  RETURN
6900  REM  ** MAKES DASHED LINES **
6901  GOSUB 9000
6902  DRAW 7 AT X,100
6903  ROT= 0
6905  DRAW 7 AT X - 3,100
6908  GOSUB 6300
6909 T = 300: GOSUB 8000
6910  IF X = Y - 7 THEN  ROT= 16: DRAW 7 AT X + 3,100: ROT=
```

```
0:P = 10:Q = 9: GOSUB 7300: RETURN
6912  IF X = Y - 7 THEN  DRAW 7 AT X + 3,100:P = 10:Q = 9: G
OSUB 7300: RETURN
6916 X = X + 7
6920  GOTO 6905
6925  RETURN
6930  REM  **MAKES DASHED LINES **
6931  REM  **     GOING LEFT      **
6938  DRAW 7 AT X,100
6940  ROT= 0
6950  DRAW 7 AT X - 1,100
6958  GOSUB 6300
6960  FOR I = 1 TO 200: NEXT
6965  IF X = Y - 7 THEN  ROT= 16: DRAW 7 AT X + 1,100: ROT=
0:P = 10:Q = 9: GOSUB 7300: RETURN
6970 X = X - 7
6975  GOTO 6950
6980  RETURN
7000  REM  ** PRINTS LABELS **
7005  GOSUB 6000
7010 V = 21:H = 8
7020  GOSUB 5000
7025  RETURN
7100  REM  DRAWS LEVER SYSTEM
7105 X = 125
```

```
7106  GOSUB 6000: VTAB 21: HTAB 15: PRINT "CLASS "
7108  VTAB 22: HTAB 1: PRINT " FA =          RA =          M
A =     "
7109  GOSUB 6800: VTAB 22: HTAB 39: GET AX$
7110  GET AX$: GOSUB 6300: GOSUB 7500
7111  IF AX$ = "C" THEN  RETURN
7112  IF AX$ = "L" THEN  XDRAW 5 AT X,80:X = X - 5: GOSUB 74
00
7114  IF AX$ = "R" THEN  XDRAW 5 AT X,80:X = X + 5: GOSUB 74
00
7115  IF  PEEK (709) = 0 THEN  VTAB 23: HTAB 2: PRINT "ENTER
 ONLY 'L','R', OR 'C'"
7117  POKE 709,0: DRAW 5 AT X,80
7118  GOSUB 6800
7120  GOTO 7110
7125  RETURN
7200  REM  *** PRINTS CLASS LABELS ***
7205 CL$ = "1ST CLASS LEVER"
7210  IF X < 90 THEN CL$ = "2ND CLASS LEVER"
7215  IF X > 165 THEN CL$ = "3RD CLASS LEVER"
7223  INVERSE
7225  VTAB 23: HTAB 12: PRINT CL$
7230  NORMAL
7250  RETURN
7300  REM  PRINTS RA AND FA ******
```

```
7305  DRAW P AT X - 4,110
7310  DRAW Q AT X + 4,110
7350  RETURN
7400  REM  ** COMPARISON FOR LIMITS
7405  IF X > 180 THEN X = 180
7410  IF X < 70 THEN X = 70
7412  POKE 709,1
7415  RETURN
7500  REM  CLEARS LINE FOR 6800
7510  INVERSE : VTAB 22: HTAB 8: PRINT "   "
7515  VTAB 22: HTAB 22: PRINT "   "
7520  VTAB 22: HTAB 35: PRINT "     "
7525  NORMAL
7530  RETURN
7700  REM  ** DRAWS ARROW **
7705  ROT= 32
7710  IF  PEEK (702) <  > 0 THEN  ROT= 0
7712  XDRAW 6 AT 180,80
7715  DRAW 6 AT 180,80
7720  ROT= 0
7725  RETURN
8000  REM  **** DELAYS PRINTING
8005  FOR I = 1 TO T: NEXT
8050  RETURN
9000  REM   *** WAITS FOR INPUT
```

```
9001  REM
9005  VTAB V: HTAB  POS (2) + 1
9010  FLASH
9012  POKE  - 16368,0
9015  GET KEY$
9020  NORMAL
9050  RETURN
9700  REM  ** TEST FOR VALIDITY **
9701  REM  ************************
9705  IF  ASC (CHO$) > 48 THEN  IF  ASC (CHO$) < 53 THEN CHO
 =  ASC (CHO$) - 48: RETURN
9710  POKE 709,1
9715  VTAB 23: HTAB 4: INVERSE : PRINT "ENTER THE NUMBER OF
YOUR CHOICE"
9750  RETURN
```

APPLICATIONS PROGRAM

```
 6  REM  *************************
 7  REM    BRANCH TO APPLICATIONS
 8  REM  *************************
 9  DIM T$(40)
 10  PRINT  CHR$ (4);"BLOAD NEWTAB,A$8000"
 15  POKE 232,0: POKE 233,128
 18 F = 10:R = 60
 19  POKE 300,0: POKE 700,0: POKE 701,0
 20 SP = 255
 25  HOME :V = 9:H = 7:T$ = "LET'S SEE HOW WELL YOU CAN": GOS
UB 5000
 30 V = 12:H = 10:T$ = "APPLY YOUR KNOWLEDGE": GOSUB 5000
 35 V = 15:H = 15:T$ = "OF LEVERS.": GOSUB 5000
 40  GOSUB 9000
 100  REM  PAGE 2
 105  HOME :V = 6:T$ = "TO MAKE A LEVER BALANCE, THE AMOUNT":
H = 2: GOSUB 5000
 110 V = 9:H = 2:T$ = "OF RESISTANCE TIMES THE LENGTH OF THE"
: GOSUB 5000
 115 V = 12:T$ = "RA MUST EQUAL THE AMOUNT OF THE ":H = 4: GO
SUB 5000
 120 V = 15:T$ = "FORCE TIMES FA.":H = 12: GOSUB 5000
```

```
125 V = 18:H = 18:T$ = "SO...": GOSUB 5000
130  GOSUB 9000
200  REM  PAGE 3
205  GOSUB 4000
210 X = 125: GOSUB 6100
215  GOSUB 6200
220  IF  PEEK (300) = 1 THEN  GOTO 210
300  REM  ** PAGE 4 **
302  REM  ************
305  HOME :V = 8:H = 5:T$ = "OF COURSE, LEVERS ARE USED FOR"
: GOSUB 5000
310 V = 11:H = 6:T$ = "PURPOSES OTHER THAN BALANCE.": GOSUB
5000
315  VTAB 14: HTAB 5: PRINT "MANY ";: INVERSE : PRINT "TOOLS
";: NORMAL : PRINT " APPLY THE PRINCIPLES"
320 V = 17:H = 15:T$ = "OF LEVERAGE": GOSUB 5000: GOSUB 9000
400  REM  ** PAGE 5 **
402  REM  ************
405  HOME :V = 5:H = 5:T$ = "FOR INSTANCE, A WHEELBARROW CAN
": GOSUB 5000
410 V = 8:T$ = "BE CLASSIFIED AS A LEVER WITH": GOSUB 5000
415 V = 11:T$ = "THE FOLLOWING PARTS:": GOSUB 5000
420 V = 14:T$ = "1. AXIS = WHEEL AXLE": GOSUB 5000
425 V = 16:T$ = "2.    R = WEIGHT OF LOAD": GOSUB 5000
430 V = 18:T$ = "3.    F = LIFTING FORCE AT": GOSUB 5000
```

```
435 V = 20:H = 15:T$ = "HANDLES": GOSUB 5000
440  GOSUB 9000
500  REM  ** PAGE 6 **
502  REM  ************
505  HOME :V = 8:H = 4:T$ = "LOOK AT THE FOLLOWING WHEELBARR
OW": GOSUB 5000
510 V = 11:H = 9:T$ = "AND TELL ME WHAT LEVER": GOSUB 5000
515 V = 14:H = 10:T$ = "CLASSIFICATION IT IS.": GOSUB 5000
520  GOSUB 9000
522 X = 100:Y = 110:X2 = 113:Y2 = 87:X3 = 115:Y3 = 72:R = 64
525  GOSUB 9500: GET ANS$: GOSUB 9700
526  IF  PEEK (705) = 1 THEN  POKE 705,0: GOTO 525
528  TEXT : HOME
530  IF ANS = 2 THEN V = 11:H = 2:T$ = "VERY GOOD, A WHEELBA
RROW IS AN EXAMPLE": GOSUB 5000:V = 14:H = 9:T$ = "OF A SECO
ND CLASS LEVER.": GOSUB 5000: GOSUB 9000: GOTO 540
535 V = 11:H = 8:T$ = "WRONG! A WHEELBARROW IS A": GOSUB 500
0
537 V = 14:H = 10:T$ = "SECOND CLASS LEVER": GOSUB 5000: GOS
UB 9000
545  GOSUB 9500
560  HOME : VTAB 23: HTAB 12: INVERSE : PRINT "2ND CLASS LEV
ER": NORMAL
570  GOSUB 9000
600  REM  **START SCISSORS**
```

```
601  REM  ******************
605  TEXT : HOME
610 V = 8:T$ = "ANOTHER TOOL THAT IS A LEVER":H = 7: GOSUB 5
000
615 V = 11:H = 10:T$ = "IS A PAIR OF SCISSORS": GOSUB 5000
620  GOSUB 9000
700  REM  ** PAGE 2 OF SCISSORS **
701  REM  ************************
705  HOME
710 V = 9:H = 4:T$ = "WHAT CLASS OF LEVER DO THINK": GOSUB 5
000
715 V = 12:H = 9:T$ = "A PAIR OF SCISSORS IS?": GOSUB 5000
720  GET ANS$: GOSUB 9700
721  IF  PEEK (705) = 1 THEN  POKE 705,0: GOTO 720
722  TEXT : HOME
725  IF ANS = 1 THEN  GOTO 765
730 V = 11:H = 7:T$ = "NO, A PAIR OF SCISSORS IS A": GOSUB 5
000
735 V = 14:H = 12:T$ = "FIRST CLASS LEVER": GOSUB 5000
740  GOSUB 9000
745  HOME
750 V = 8:H = 2:T$ = "LOOK AT OUR SCISSORS.  WHEN THEY CUT":
 GOSUB 5000
755 V = 11:H = 1:T$ = "PAPER THE RESISTANCE IS THE PAPER AND
": GOSUB 5000
```

```
758 V = 14:T$ = "THE AXIS IS THE CONTACT POINT OF THE TWO":H
 = 1: GOSUB 5000
759 V = 17:T$ = "PARTS AND FORCE IS AT THE HANDLES.":H = 2:
GOSUB 5000
760  GOSUB 9000: GOTO 785
765  HOME
770 V = 12:T$ = "RIGHT! A PAIR OF SCISSCORS IS A 1ST":H = 2:
 GOSUB 5000
772 V = 15:H = 15:T$ = "CLASS LEVER": GOSUB 5000
775  GOSUB 9000
785 X = 144: GOSUB 9400
3999  END
4000  HOME :V = 10:H = 13:T$ = "BALANCE MEANS": GOSUB 5000
4005 V = 13:H = 12:T$ = "F X FA = R X RA": GOSUB 5000
4010  GOSUB 9000
4020  RETURN
5000  REM  **** THIS SUBROUTINE PRINTS
5001  REM  **** LINES ONE AT A TIME ****
5002  REM
5005  SPEED= 255
5010  HTAB H
5015  FOR I = 1 TO  LEN (T$)
5017  VTAB V
5020  PRINT  MID$ (T$,I,1);
5030  NEXT I
```

```
5050  RETURN
6000  REM  *** SETS LABEL WINDOW ***
6001  REM
6005  VTAB 24: HTAB 12
6010  CALL  - 958
6050  RETURN
6100  REM  *** DRAWS LEVER SYSTEM ***
6101  REM
6105  HGR : HCOLOR= 3: ROT= 0: SCALE= 1
6110  DRAW 1 AT 100,80
6115  DRAW 2 AT 85,77
6120  DRAW 3 AT 149,84
6125  DRAW 4 AT 146,77
6130  DRAW 5 AT X,80
6150  RETURN
6200  REM  BALANCE LEVER
6205  VTAB 21: HTAB 1: PRINT "FORCE = ";: INVERSE : PRINT F;
: NORMAL : PRINT "      RESISTANCE = ";: INVERSE : PRINT R:
NORMAL
6207  IF  PEEK (300) = 2 THEN  GOTO 6215
6208  VTAB 23: HTAB 1: PRINT "                                "
6210  VTAB 23: HTAB 5: INVERSE : PRINT "TYPE 'B' WHEN LEVER
WILL BALANCE": NORMAL
6215  GOSUB 9100
6217  IF  PEEK (300) = 2 THEN  RETURN
```

```
6220  VTAB 23: HTAB 39: GET AX$
6225  IF AX$ <  > "R" THEN  IF AX$ <  > "L" THEN  GOTO 6230
6226  XDRAW 5 AT X,80
6230  IF AX$ = "B" THEN  GOSUB 9200: RETURN
6235  IF AX$ = "L" THEN X = X - 5: GOTO 6240
6237  IF AX$ = "R" THEN X = X + 5: GOTO 6240
6238  VTAB 23: HTAB 1: PRINT "
      ": VTAB 23: HTAB 1: PRINT "ENTER ONLY L, R, OR B": FOR
 I = 1 TO 2000: NEXT
6239  GOTO 6205
6240  GOSUB 7400
6245  DRAW 5 AT X,80
6250  GOSUB 6300
6255  GOSUB 9100
6260  GOTO 6220
6270  RETURN
6300  REM  ** PRODUCES SOUND WHEN
6301  REM  ** CLASS CHANGES    **
6302  REM
6310 S =  - 16336
6315 SOUND =  PEEK (S) -  PEEK (S) +  PEEK (S) -  PEEK (S) +
  PEEK (S) -  PEEK (S)
6330  RETURN
6400  REM  ** PRINTS DISPLAY INSTRUCTIONS
6401  REM  **     FOR AXIS MOVEMENT    **
```

```
6405 V = 21:H = 2:T$ = "L=LEFT      R=RIGHT      C=CONTINUE":
 GOSUB 5000
6415 V = 23
6450  RETURN
7000  REM  ** PRINTS LABELS **
7005  GOSUB 6000
7010 V = 21:H = 8
7020  GOSUB 5000
7025  RETURN
7200  REM  *** PRINTS CLASS LABELS ***
7205 CL$ = "1ST CLASS LEVER"
7210  IF X < 90 THEN CL$ = "2ND CLASS LEVER"
7215  IF X > 165 THEN CL$ = "3RD CLASS LEVER"
7223  INVERSE
7225  VTAB 23: HTAB 12: PRINT CL$
7230  NORMAL
7250  RETURN
7300  REM  PRINTS RA AND FA ******
7305  DRAW P AT X - 4,110
7310  DRAW Q AT X + 4,110
7350  RETURN
7400  REM  ** COMPARISON FOR LIMITS
7405  IF X > 180 THEN X = 180
7410  IF X < 70 THEN X = 70
7415  RETURN
```

```
7500  REM  CLEARS LINE FOR 6800
7510  INVERSE : VTAB 23: HTAB 8: PRINT "   "
7515  VTAB 23: HTAB 22: PRINT "   "
7520  VTAB 23: HTAB 35: PRINT "     "
7525  NORMAL
7530  RETURN
7700  REM  ** DRAWS ARROW **
7705  ROT= 32
7710  IF  PEEK (702) <  > 0 THEN  ROT= 0
7712  XDRAW 6 AT 180,80
7715  DRAW 6 AT 180,80
7720  ROT= 0
7725  RETURN
8000  REM  **** DELAYS PRINTING
8005  FOR I = 1 TO T: NEXT
8050  RETURN
9000  REM  *** WAITS FOR INPUT
9001  REM
9005  VTAB 24: HTAB 8
9010  FLASH
9012  POKE  - 16368,0
9015  GET KEY$
9020  NORMAL
9050  RETURN
9100  REM  ** FINDS RA & FA
```

```
9102  VTAB 22: HTAB 9: INVERSE : PRINT "   ": VTAB 22: HTAB 3
0: PRINT "   ": NORMAL
9105 RA = ( ABS (X - 90)) / 5:FA = ( ABS (160 - X)) / 5
9110  VTAB 22: HTAB 1: PRINT "    FA =                    RA =
"
9112 RA$ =  STR$ (RA):FA$ =  STR$ (FA)
9114  INVERSE
9115  VTAB 22: HTAB 11 -  LEN (FA$): PRINT FA
9116  VTAB 22: HTAB 32 -  LEN (RA$): PRINT RA
9117  NORMAL
9120  RETURN
9200  REM  ** CHECKS FOR CORRECT ANSWER
9205  IF FA = 12 THEN  TEXT : HOME :V = 10:H = 1:T$ = "EXCEL
LENT, YOU HAVE CHOSEN THE CORRECT": GOSUB 5000:V = 13:H = 6:
T$ = "AXIS PLACEMENT FOR BALANCE": GOSUB 5000: GOSUB 9000: P
OKE 300,0: RETUR
9215  IF  PEEK (300) = 1 THEN  GOTO 9260
9218  POKE 300,1
9220  TEXT : HOME
9221 V = 10:H = 6
9222  IF FA > 12 THEN T$ = "NO, YOU HAVE PLACED THE AXIS": G
OSUB 5000:V = 13:H = 7:T$ = "TOO FAR FROM THE FORCE": GOSUB
5000: GOSUB 9000: POKE 701,1: GOTO 9250
9228  TEXT : HOME
9230 T$ = "NO, YOU HAVE PLACED THE AXIS": GOSUB 5000:V = 13:
```

```
H = 9:T$ = "TOO CLOSE TO THE FORCE": GOSUB 5000
9240  GOSUB 9000
9250  HOME :V = 10:H = 9:T$ = "REMEMBER, FOR BALANCE,": GOSU
B 5000
9252 V = 13:H = 13:T$ = "F X FA = R X RA": GOSUB 5000
9254 V = 23:H = 15: INVERSE :T$ = "TRY AGAIN": GOSUB 5000: N
ORMAL
9256  GOSUB 9000: HOME : RETURN
9260  TEXT : HOME
9270  IF  PEEK (701) = 1 THEN  IF FA > 12 THEN V = 8:H = 7:T
$ = "AGAIN YOU HAVE PLACED THE": GOSUB 5000:V = 11:H = 4:T$
= "AXIS TOO CLOSE TO THE RESISTANCE": GOSUB 5000: GOSUB 9000
: GOTO 9295
9280  IF FA > 12 THEN V = 10:H = 3:T$ = "THIS TIME YOU HAVE
PLACED THE AXIS": GOSUB 5000:V = 13:H = 6:T$ = "TOO CLOSE TO
 THE RESISTANCE": GOSUB 5000: GOSUB 9000: GOTO 9295
9285  IF  PEEK (701) = 0 THEN  IF FA < 12 THEN V = 10:H = 5:
T$ = "YOUR AXIS PLACEMENT IS STILL TOO": GOSUB 5000:V = 13:H
 = 11:T$ = "CLOSE TO THE FORCE": GOSUB 5000: GOSUB 9000: GOT
O 9295
9290 V = 10:H = 5:T$ = "THIS TIME YOU HAVE PLACED THE": GOSU
B 5000:V = 13:H = 6:T$ = "AXIS TOO CLOSE TO THE FORCE": GOSU
B 5000
9292  GOSUB 9000
9295  HOME :V = 10:H = 12:T$ = "F X FA = R X RA": GOSUB 5000
```

```
9296 V = 13:H = 19:T$ = "SO": GOSUB 5000
9297 V = 16:H = 12:T$ = "12 X 10 = 60 X 2": GOSUB 5000
9298  GOSUB 9000: POKE 300,2
9300  REM  ** BALANCE EXPLANATION
9301  REM  ** AFTER 2 TRYS ******
9302  HOME :V = 11:H = 4:T$ = "FOR THE CORRECT AXIS PLACEMEN
T": GOSUB 5000:V = 14:H = 11:T$ = "LOOK AT THE FOLLOWING": G
OSUB 5000: GOSUB 9000
9303 X = 100
9305  GOSUB 6100: GOSUB 6200
9308  FLASH
9310  VTAB 23: HTAB 8: PRINT "120"
9311  VTAB 23: HTAB 29: PRINT "120"
9315  NORMAL
9320  FOR X = 94 TO 84 STEP  - 2: DRAW 7 AT X,106: NEXT
9325  FOR X = 100 TO 155 STEP 2: DRAW 7 AT X,100: NEXT
9327  ROT= 16: DRAW 7 AT 160,100: DRAW 7 AT 85,106
9329 Y = 118: ROT= 0
9330  DRAW 9 AT 161,Y: DRAW 8 AT 155,Y: DRAW 10 AT 80,Y: DRA
W 9 AT 86,Y
9340  VTAB 23: HTAB 34: GET KEY$
9345  TEXT
9350  RETURN
9400  REM  ** GRAPHICS FOR SCISSORS
9401  REM  ************************
```

```
9405  HGR : HCOLOR= 3: SCALE= 3: ROT= 64
9410  VTAB 22: HTAB 12: INVERSE : PRINT "FIRST CLASS LEVER"
9411  NORMAL
9412  VTAB 23: HTAB 8: PRINT "PRESS ANY KEY TO CONTINUE"
9415  DRAW 22 AT X,73: DRAW 23 AT X,74
9420  FOR I = 1 TO 500: NEXT
9425  XDRAW 22 AT X,73: XDRAW 23 AT X,74
9430  ROT= 72: DRAW 22 AT X,73: ROT= 56: DRAW 23 AT X,74
9435  FOR I = 1 TO 500: NEXT
9440  XDRAW 23 AT X,74: ROT= 72: XDRAW 22 AT X,73
9445  ROT= 64
9450  IF  PEEK ( - 16384) > 128 THEN  POKE  - 16368,0: RETUR
N
9455  GOTO 9415
9460  RETURN
9500  REM  ** GRAPHICS FOR
9502  REM  ** WHEELBARROW
9505  HGR : HCOLOR= 3: SCALE= 2: ROT= R
9510  DRAW 19 AT X,Y
9515  DRAW 20 AT X2,Y2
9520  DRAW 21 AT X3,Y3
9525  VTAB 21: HTAB 11: INVERSE : PRINT "CHOOSE WHICH CLASS"
: NORMAL
9530  VTAB 23: HTAB 5: PRINT " 1 = 1ST      2 = 2ND      3 = 3
RD ";
```

```
9550  RETURN
9700  REM  ** CHECKS FOR ANSWER
9701  REM  ****** VALIDITY *****
9705  IF  ASC (ANS$) > 48 THEN  IF  ASC (ANS$) < 52 THEN ANS
 =  ASC (ANS$) - 48: RETURN
9710  POKE 705,1: VTAB 23: HTAB 4: PRINT "ENTER THE ";: INVE
RSE : PRINT "NUMBER";: NORMAL : PRINT " OF YOUR CHOICE    "
9715  FOR I = 1 TO 2000: NEXT
9750  RETURN
```

QUIZ PROGRAM - 10 QUESTIONS

```
 9  REM  **     SUBPROGRAM     **
 10  REM  ** BRANCH TO QUIZ  **
 15  REM  ****************************
 20 SP = 255
 25  DIM T$(40)
 31  PRINT  CHR$ (4);"BLOAD NEWTAB,A2048"
 32  POKE 232,0: POKE 233,8: POKE 708,0: POKE 707,0
 33  HOME : VTAB 12: HTAB 3: PRINT "PLEASE ENTER YOUR NAME ";
: INPUT NAME$
 34 Z = 768
 35  RESTORE :L = 0
 40  FOR C = 779 TO 789: POKE C,0
 41  NEXT :C = 778
1000  REM  ** INTRODUCTORY PAGE **
1005  HOME :V = 10:H = 9:T$ = "LET'S SEE HOW WELL YOU": GOSU
B 5000
1010 V = 13:T$ = "UNDERSTAND THE CONCEPTS": GOSUB 5000
1015 V = 16:H = 14:T$ = "OF LEVERAGE": GOSUB 5000: GOSUB 900
0
1100  REM  *** QUESTION I **
1102  RESTORE
1105  HOME :V = 6:H = 2:T$ = "IF A LEVER HAS A FORCE ARM OF
5": GOSUB 5000
```

```
1110 V = 8:T$ = "CENTIMETERS AND A RESISTANCE ARM OF 10": GO
SUB 5000
1115 V = 10:T$ = "CENTIMETERS, WHAT IS THE MECHANICAL": GOSU
B 5000
1120 V = 12:T$ = "ADVANTAGE?": GOSUB 5000
1125  INVERSE
1130 V = 15:H = 9:T$ = "1. 1/2": GOSUB 5000
1135 V = 17:T$ = "2. 2": GOSUB 5000
1140 V = 19:T$ = "3. 50": GOSUB 5000
1157  GOSUB 7500
1158  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 1157
1160  GOSUB 7700
1200  REM  ** QUESTION 2 **
1205  HOME :V = 8:H = 2:T$ = "THE FULCRUM (OR AXIS) IN A LEV
ER": GOSUB 5000
1210 V = 10:T$ = "SYSTEM IS THE POINT": GOSUB 5000
1215  INVERSE
1220 V = 13:H = 9:T$ = "1. OF FORCE APPLICATION": GOSUB 5000
1225 V = 15:T$ = "2. OF RESISTANCE": GOSUB 5000
1230 V = 17:T$ = "3. ABOUT WHICH THE LEVER": GOSUB 5000
1235 V = 18:H = 12:T$ = "MOVES.": GOSUB 5000
1252  GOSUB 7500
1253  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 1252?'
1255  GOSUB 7700
1260  TEXT
```

```
1300  REM  ** QUESTION 3 **
1305  HOME :V = 8:H = 2:T$ = "IN WHICH CLASS OF LEVER DO THE
 FORCE": GOSUB 5000
1310 V = 10:T$ = "AND RESISTANCE MOVE IN OPPOSITE": GOSUB 50
00
1315 V = 12:T$ = "DIRECTIONS": GOSUB 5000
1320  GOSUB 7900
1332  GOSUB 7500
1333  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 1332
1335  GOSUB 7700
1400  REM  ** QUESTION 4 **
1405  HOME :V = 9:H = 2:T$ = "MOST EXAMPLES OF HUMAN LEVERS
ARE:": GOSUB 5000
1410  GOSUB 7900
1416  GOSUB 7500
1417  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 1416
1420  GOSUB 7700
1500  REM  ** QUESTION 5 **
1502  HOME
1505 V = 6:H = 2:T$ = "THE EXACT POINT OF RESISTANCE OF A":
GOSUB 5000
1510 V = 8:T$ = "MOVING BODY SEGMENT IS:": GOSUB 5000?'
1512  INVERSE
1515 V = 11:H = 9:T$ = "1. THE CENTER OF GRAVITY OF THE": GO
SUB 5000
```

```
1520 V = 12:H = 12:T$ = "SEGMENT.": GOSUB 5000
1525 V = 14:H = 9:T$ = "2. THE JOINT ABOUT WHICH THE": GOSUB
 5000
1530 V = 15:H = 12:T$ = "MOVEMENT IS OCCURING": GOSUB 5000
1535 V = 17:H = 9:T$ = "3. THE CENTER OF GRAVITY OF THE": GO
SUB 5000
1540 V = 18:H = 12:T$ = "NON-MOVING BONE.": GOSUB 5000
1550  GOSUB 7500
1554  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 1550
1555  GOSUB 7700
1600  REM  ** QUESTION 6 ***
1602  HOME
1605 V = 4:H = 2:T$ = "WHEN A MUSCLE MOVES A BONE,": GOSUB 5
000
1610 V = 6:T$ = "THE AXIS IS THE": GOSUB 5000
1616  INVERSE
1620 V = 9:H = 9:T$ = "1. JOINT FORMED BY THE MOVING": GOSUB
 5000
1625 V = 10:H = 12:T$ = "BONE AND ANOTHER BONE.": GOSUB 5000
1630 V = 12:H = 9:T$ = "2. MUSCLE ATTACHMENT ON THE": GOSUB
5000?'
1635 V = 13:H = 12:T$ = "MOVING BONE.": GOSUB 5000
1640 V = 15:H = 9:T$ = "3. MUSCLE ATTACHMENT ON THE": GOSUB
5000
1645 V = 16:H = 12:T$ = "STATIONARY BONE.": GOSUB 5000
```

```
1660  VTAB V + 3: HTAB 9
1665  NORMAL
1670  GOSUB 7500
1675  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 1670
1680  GOSUB 7700
1690  TEXT
1700  REM  ** QUESTION 7 **
1701  REM  ****************
1705  TEXT : HOME :V = 4:H = 2:T$ = "IF A 10 KILOGRAM WEIGHT
 IS 2 CM FROM": GOSUB 5000
1710 V = 6:T$ = "THE AXIS, HOW FAR MUST A 5 KILOGRAM": GOSUB
 5000
1715 V = 8:T$ = "WEIGHT BE PLACED FROM THE AXIS FOR": GOSUB
5000
1720 V = 10:T$ = "BALANCE?": GOSUB 5000
1725 V = 13:H = 9: INVERSE :T$ = "1. 2 CM"
1726  GOSUB 5000
1730 V = 15:T$ = "2. 4 CM"
1731  GOSUB 5000
1735 V = 17:T$ = "3. 5 CM": GOSUB 5000?'
1740  GOSUB 7500
1745  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 1740
1748  GOSUB 7700
1800  REM  ** QUESTION 8 **
1801  REM  ****************
```

```
1805  HOME :V = 8:H = 2:T$ = "IN WHAT CLASS LEVER WILL THE":
 GOSUB 5000
1810 V = 10:T$ = "RESISTANCE ARM ALWAYS BE SHORTER THAN": GO
SUB 5000
1812 V = 12:T$ = "THE FORCE ARM?": GOSUB 5000
1815  GOSUB 7900
1820  GOSUB 7500
1825  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 1820
1830  GOSUB 7700
1900  REM  ** QUESTION 9 **
1901  REM  ****************
1905  HOME :V = 9:H = 2:T$ = "A DOOR IS ALSO A LEVER.  WHAT
": GOSUB 5000
1908 V = 11:T$ = "CLASS IS IT?": GOSUB 5000
1910  GOSUB 7900
1915  GOSUB 7500
1920  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 1915
1925  GOSUB 7700
2000  REM  ** QUESTION 10 **?'
2001  REM  *****************
2005  HOME :V = 9:H = 2:T$ = "MOST SPORTS IMPLEMENTS ARE LEV
ERS.": GOSUB 5000
2010 V = 11:T$ = "WHAT CLASS ARE THEY USUALLY?": GOSUB 5000
2015  GOSUB 7900
2020  GOSUB 7500
```

```
2025  IF  PEEK (709) = 1 THEN  POKE 709,0: GOTO 2020
2030  GOSUB 7700
3000  DATA   1,3,1,3,1,1,2,2,2,3
3505  HOME
3508  GOSUB 9100
3509  POKE Z,SCR
3510  VTAB 7: HTAB 8: PRINT "YOU MISSED ";: INVERSE : PRINT
10 - SCR;: NORMAL : PRINT " OF10 QUESTIONS."
3515  VTAB 10: HTAB 9: PRINT "NOW WOULD YOU LIKE TO:"
3520  VTAB 13: HTAB 9: PRINT "1. TAKE THE QUIZ OVER"
3530  VTAB 16: HTAB 9: PRINT "2. REVIEW DEFINITIONS"
3540  VTAB 19: HTAB 9: PRINT "3. QUIT"
3545 V = 19
3550  GOSUB 7500
3552  GOSUB 9900
3555  ON ANS GOTO 3560,3570,3580
3560  HOME : GOTO 32
3570  HOME : VTAB 12: HTAB 14: PRINT "PLEASE WAIT": PRINT
HR$ (4);"RUN RELOCATE"
3580  HOME
4999  END
5000  REM  **** THIS SUBROUTINE PRINTS
5001  REM  **** LINES ONE AT A TIME ****
5002  REM
5005  SPEED= 255
```

```
5010  HTAB H
5015  FOR I = 1 TO  LEN (T$)
5017  VTAB V
5020  PRINT  MID$ (T$,I,1);
5030  NEXT I
5050  RETURN
5100  REM  RESPONSE TO INCORRECT
5101  REM        ANSWER
5105  HOME :V = 8:H = 14:T$ = "NO, REMEMBER": GOSUB 5000
5110 V = 11:H = 4:T$ = "THE MECHANICAL ADVANTAGE IS = TO": G
OSUB 5000
5115 V = 14:H = 8:T$ = "THE FORCE ARM DIVIDED BY": GOSUB 500
0
5120 V = 17:H = 11:T$ = "THE RESISTANCE ARM": GOSUB 5000: GO
SUB 9000
5125  HOME :V = 11:H = 18:T$ = "FA      5     1": GOSUB 5000
5130 V = 12:H = 12:T$ = "MA = ---- = ---- = -": GOSUB 5000?'
5135 V = 13:H = 18:T$ = "RA      10     2": GOSUB 5000: GOSUB
9000
5150  RETURN
5200  REM  RESPONSE TO INCORRECT
5201  REM        ANSWER
5205  HOME :V = 8:H = 3:T$ = "NO, MOST DISTAL MUSCLE ATTACHM
ENTS": GOSUB 5000
5210 V = 11:H = 10:T$ = "ARE VERY CLOSE TO THE": GOSUB 5000
```

```
5215 V = 14:H = 11:T$ = "BONE JOINT (AXIS).": GOSUB 5000: GO
SUB 9000
5220  HOME :V = 8:H = 5:T$ = "SO THE FORCE ARM IS QUITE SHOR
T": GOSUB 5000
5225 V = 11:H = 16:T$ = "COMPARED": GOSUB 5000
5230 V = 14:H = 9:T$ = "TO THE RESISTANCE ARM.": GOSUB 5000:
 GOSUB 9000
5235  GOSUB 8300
5240  TEXT
5250  RETURN
5300  REM  RESPONSE TO INCORRECT
5301  REM       ANSWER
5305  HOME :V = 7:H = 3:T$ = "NO, THE FULCRUM IS THE STATION
ARY": GOSUB 5000
5310 V = 10:H = 7:T$ = "POINT ABOUT WHICH A LEVER": GOSUB 50
00?'
5315 V = 13:H = 10:T$ = "CAN ROTATE.  LOOK AT": GOSUB 5000
5320 V = 16:H = 9:T$ = "THE FOLLOWING DIAGRAM:": GOSUB 5000:
 GOSUB 9000
5325 X = 13:M = 139:N = 79: HGR : HCOLOR= 3
5327  SCALE= 1: ROT= 0
5330  DRAW 5 AT M,N - 5: GOSUB 8100
5335  RETURN
5400  REM  RESPONSE TO INCORRECT
5401  REM       ANSWER
```

```
5405  HOME :V = 6:H = 4:T$ = "A FIRST CLASS LEVER IS THE ONL
Y": GOSUB 5000
5410 V = 9:H = 8:T$ = "KIND WHICH REQUIRES THAT": GOSUB 5000
5415 V = 12:T$ = "THE FORCE BE OPPOSITE TO": GOSUB 5000
5420 V = 15:H = 7:T$ = "THE DIRECTION OF MOVEMENT": GOSUB 50
00
5425 V = 18:H = 11:T$ = "OF THE RESISTANCE.": GOSUB 5000
5430  GOSUB 9000
5435 X = 13:M = 139:N = 79
5437  GOSUB 8400
5440  TEXT
5450  RETURN
5500  REM  ** QUESTION 5
5505  HOME :V = 9:H = 3:T$ = "NO, THE POINT OF RESISTANCE OF
 ANY": GOSUB 5000?'
5510 V = 12:H = 13:T$ = "OBJECT IS IT'S": GOSUB 5000
5515 V = 15:H = 11:T$ = "CENTER OF GRAVITY.": GOSUB 5000
5517  GOSUB 9000
5520  GOSUB 8500
5525  TEXT
5550  RETURN
5600  REM  ** QUESTION 6
5603 M = 139:N = 79
5604  HOME :V = 10:H = 3:T$ = "REMEMBER, AN AXIS IS A POINT
ABOUT": GOSUB 5000
```

```
5605 V = 13:H = 9:T$ = "WHICH A LEVER ROTATES.": GOSUB 5000:
 GOSUB 9000
5607  HOME
5608 V = 7:H = 4:T$ = "IF THE LEVER IS A BONE THEN THE": GOS
UB 5000
5610 V = 10:H = 9:T$ = "AXIS IS THE JOINT FORMED BY": GOSUB
5000
5615 V = 13:H = 12:T$ = "THAT BONE AND THE ADJACENT": GOSUB
5000
5620 V = 16:H = 12:T$ = "NONMOVING BONE.": GOSUB 5000: GOSUB
 9000
5650  GOSUB 8200
5660  RETURN
5700  REM  ** INCORRECT ANSWER **?'
5701  REM  **   QUESTION  7    **
5704  HOME : VTAB 11: HTAB 13
5705 V = 11: PRINT "NO, FOR ";: INVERSE : PRINT "BALANCE": N
ORMAL
5709 H = 13
5710 V = 14:T$ = "R X RA = F X FA": GOSUB 5000: GOSUB 9000
5715  HOME :V = 8:T$ = "WE KNOW THE FOLLOWING:":H = 9: GOSUB
 5000
5720 V = 11:H = 6:T$ = "R = 10": GOSUB 5000
5722 V = 13:T$ = "RA = 2": GOSUB 5000
5725 V = 15:T$ = "F = 5": GOSUB 5000
```

```
5727 V = 17:T$ = "FA = ?": GOSUB 5000
5730  GOSUB 9000
5735 V = 12:H = 20:T$ = "2 X 10 = 5 X ?": GOSUB 5000
5737 V = 16:T$ = "20 = 5 X ?": GOSUB 5000
5740  VTAB 18: PRINT "? = ";: FLASH : PRINT "4": NORMAL
5745  GOSUB 9000
5750  HGR : HCOLOR= 3: SCALE= 1: ROT= 0
5751  DRAW 3 AT 166,71: DRAW 1 AT 103,68: DRAW 4 AT 154,64:
DRAW 5 AT 122,66
5755  DRAW 10 AT 99,108: DRAW 9 AT 108,108: DRAW 9 AT 156,91
: DRAW 8 AT 144,91: DRAW 2 AT 87,65
5760  ROT= 32: DRAW 6 AT 184,50
5765  ROT= 16: DRAW 7 AT 184,86: DRAW 7 AT 122,86: DRAW 7 AT
 122,106: DRAW 7 AT 89,106
5768  ROT= 0
5770  FOR X = 121 TO 179 STEP 2
5775  DRAW 7 AT X,92
5780  NEXT
5785  FOR X = 89 TO 117 STEP 2
5788  DRAW 7 AT X,111: NEXT
5790  VTAB 21: HTAB 13: INVERSE : PRINT "LEVER BALANCES": NO
RMAL
5792  VTAB 22: HTAB 12: PRINT "R X RA = F X FA"
5793  VTAB 23: HTAB 11: PRINT "10 X  2 = 5  X 4"
5797  GOSUB 9000
```

```
5798  TEXT
5799  RETURN
5800  REM  ** INCORRECT ANSWER **
5801  REM  **      QUESTION 8    **
5805  HOME :V = 8:H = 5:T$ = "WRONG! IF THE RESISTANCE ARM I
S": GOSUB 5000
5810  VTAB 11: HTAB 3: INVERSE : PRINT "ALWAYS";: NORMAL : P
RINT " SHORTER THAN THE FORCE ARM"
5815 V = 14:H = 1:T$ = "THEN THE AXIS MUST BE ON ONE END AND
...": GOSUB 5000
5818  GOSUB 9000
5820  HOME :V = 8:H = 7:T$ = "THE FORCE ON THE OTHER END.":
GOSUB 5000
5825 V = 11:H = 2:T$ = "SO THE RESISTANCE MUST BE BETWEEN"
5826  GOSUB 5000
5830 V = 14:H = 10:T$ = "THE FORCE AND THE AXIS.": GOSUB 500
0
5832 V = 17:T$ = "REMEMBER, THIS DEFINES A 2ND CLASS LEVER":
H = 1: GOSUB 5000
5835  GOSUB 9000
5850  RETURN
5900  REM  ** WRONG ANSWER **
5905  REM  **  QUESTION 9  **
5910  HOME :V = 8:H = 1:T$ = "MOST DOORS ARE SECOND CLASS LE
VERS."
```

```
5911  GOSUB 5000
5915 V = 11:H = 7:T$ = "THE AXIS IS AT THE HINGES;": GOSUB 5
000
5920 V = 14:H = 2:T$ = "THE RESISTANCE IS THE DOOR'S CENTER"
: GOSUB 5000
5925 V = 17:H = 1:T$ = "OF GRAVITY AND THE FORCE IS AT THE K
NOB": GOSUB 5000
5930  GOSUB 9000
5935  HGR : HCOLOR= 3: ROT= 0: SCALE= 3
5936  DRAW 24 AT 100,128
5937  SCALE= 1: DRAW 19 AT 113,82?'
5938  DRAW 8 AT 110,80
5939  DRAW 10 AT 133,81
5940  DRAW 5 AT 169,66
5941  DRAW 1 AT 148,57
5942  VTAB 23: HTAB 11: INVERSE : PRINT "SECOND CLASS LEVER"
: NORMAL
5943  GOSUB 9000
5944  TEXT
5950  RETURN
6000  REM  *** SETS LABEL WINDOW ***
6001  REM
6005  VTAB 21: HTAB 1
6010  CALL  - 958
6050  RETURN
```

```
6100  REM  ** WRONG ANSWER **
6101  REM  ** QUESTION 10  **
6105  HOME :V = 8:T$ = "NO, ACTUALLY MOST SPORTS IMPLEMENTS"
:H = 2: GOSUB 5000
6110 V = 11:T$ = "(BATS, RACKETS, CLUBS, ETC.)":H = 6: GOSUB
 5000
6115 V = 14:T$ = "ARE 3RD CLASS LEVERS":H = 10: GOSUB 5000
6120  GOSUB 9000
6125  HOME :V = 4:T$ = "ALTHOUGH SOMEWHAT MORE COMPLICATED":
H = 3: GOSUB 5000?'
6130 V = 7:T$ = "THAN OUR PREVIOUS EXAMPLES":H = 7: GOSUB 50
00
6135 V = 10:T$ = "THE LEVER PARTS ARE LISTED BELOW":H = 4: G
OSUB 5000
6140 V = 13:H = 1:T$ = "1. AXIS IS AT THE MAJOR JOINT OF MOT
ION": GOSUB 5000
6142 V = 16:T$ = "2. RESISTANCE IS THE OBJECT BEING STRUCK":
H = 1: GOSUB 5000
6144 V = 19:T$ = "3. FORCE IS AT THE POINT WHERE THE HANDS":
 GOSUB 5000
6145 V = 21:T$ = "GRIP THE HANDLE":H = 4: GOSUB 5000
6148  GOSUB 9000
6150  RETURN
6300  REM  ** PRODUCES SOUND WHEN
6301  REM  ** CLASS CHANGES     **
```

```
6302  REM
6310 S =  - 16336
6315 SOUND =  PEEK (S) -  PEEK (S) +  PEEK (S) -  PEEK (S) +
  PEEK (S) -  PEEK (S)
6330  RETURN
7500  REM  CHECKS FOR RESPONSE VALIDITY
7502  NORMAL
7503  VTAB V + 3: HTAB 9: POKE  - 16368,0: GET ANS$
7505  IF  ASC (ANS$) - 48 < 0 THEN  GOTO 7510?'
7506  IF  ASC (ANS$) - 48 > 3 THEN  GOTO 7510
7507 ANS =  ASC (ANS$) - 48: RETURN
7510  VTAB 23: HTAB 1: PRINT "ENTER THE ";: INVERSE : PRINT
"NUMBER ";: PRINT "OF YOUR CHOICE."
7511  NORMAL
7515  POKE 709,1
7520  RETURN
7600  REM  **CHOOSE POSITIVE
7601  REM  ** REINFORCEMENT **
7602  POKE C,1
7605 N =  INT ( RND (6) * 5) + 1
7610  FOR I = 1 TO 5
7615  IF I = N THEN  GOSUB 7650: RETURN
7620  NEXT
7625  RETURN
7650  REM  ** PRAISE WORDS **
```

```
7655 R$(1) = "RIGHT"
7656 R$(2) = "GOOD!"
7657 R$(3) = "YES, YOU'RE RIGHT"
7658 R$(4) = "EXCELLENT"
7659 R$(5) = "YEP"
7665  HOME :H = (40 -  LEN (R$(N))) / 2
7670  VTAB 12: HTAB H: PRINT R$(N)
7675 T = 2000: GOSUB 8000?'
7677 SCR = SCR + 1
7680  RETURN
7700  REM  ** READ CORRECT ANSWER
7701  REM  ** FROM DATA STATEMENT
7702  REM  ** AND COMPARES WITH
7703  REM  ** INPUT ************
7704  POKE Z,ANS:Z = Z + 1:C = C + 1
7705  READ M
7708 L = L + 1: REM   QUESTION COUNTER
7710  IF ANS = M THEN  GOSUB 7600: RETURN
7712  ON L GOSUB 5100,5300,5400,5200,5500,5600,5700,5800,590
0,6100
7715  RETURN
7800  REM  ** BLANKS ANS SPACE **
7805  FOR J = V + 3 TO V + 9
7810  FOR I = 9 TO 20
7815  VTAB J: HTAB I: PRINT " "
```

```
 7818  NEXT I
 7820  NEXT J
 7825  RETURN
 7900  REM  ** COMMON FOILS ***
 7902  INVERSE
 7905  VTAB V + 3: HTAB 9
 7910  PRINT "1. 1ST CLASS"?'
 7915  VTAB V + 5: HTAB 9: PRINT "2. 2ND CLASS"
 7920  VTAB V + 7: HTAB 9: PRINT "3. 3RD CLASS"
7925 V = V + 7
 7928  NORMAL
 7930  RETURN
 8000  REM  **** DELAYS PRINTING
 8005  FOR I = 1 TO T: NEXT
 8050  RETURN
 8100  REM  ** MOVING LEVER **
8105 R = 56
 8108  ROT= R
 8110  SCALE= 3
 8117  GOSUB 6000
8118 V = 21:H = 7:T$ = "LEVER ROTATES AROUND AXIS": INVERSE
: GOSUB 5000: NORMAL
8119 V = 23:H = 5:T$ = "M = MOVE LEVER       C = CONTINUE": G
OSUB 5000
 8120  ROT= R: DRAW X AT M,N
```

```
8121  GOSUB 6300
8125  GET KEY$: POKE 708,0
8126  IF KEY$ = "C" THEN  RETURN
8127  GOSUB 8900
8128  IF  PEEK (708) = 1 THEN  GOTO 8125
8130  XDRAW X AT M,N?'
8135 R = R + 4
8140  IF R > 72 THEN  GOTO 8150
8145  GOTO 8120
8150 R = R - 8: ROT= R: DRAW X AT M,N
8152  GOSUB 6300
8155  GET KEY$
8158  IF KEY$ = "C" THEN  RETURN
8159  GOSUB 8900: IF  PEEK (708) = 1 THEN  GOTO 8155
8160  XDRAW X AT M,N
8165 R = R - 4: IF R = 56 THEN  GOTO 8120
8170  ROT= R: DRAW X AT M,N
8175  GOSUB 6300
8185  GOTO 8155
8188  SCALE= 1
8190  RETURN
8200  REM  ** MOVING BONE **
8201  REM  ** QUESTION 6 **
8205  HGR : HCOLOR= 3: SCALE= 1: ROT= 0
8206 R = 0
```

```
8210  DRAW 16 AT 100,100
8215  DRAW 17 AT 100,100
8220  DRAW 5 AT 97,98
8221  IF L <  > 6 THEN  RETURN
8222  GOSUB 8230?'
8223 R = 64: ROT= 64
8225  RETURN
8230  REM  ** MOVING BONE **
8231  REM  **   PART II   **
8232 R = 64: ROT= 64
8234  GOSUB 6000
8236  HOME :V = 21:H = 5:T$ = "M = MOVE BONE       C = CONTI
NUE": GOSUB 5000
8238 V = 23:H = 14:T$ = "JOINT = AXIS": INVERSE : GOSUB 5000
: NORMAL
8239 M = 100:N = 100
8240  GET KEY$
8242  IF KEY$ = "C" THEN  RETURN
8245  GOSUB 8900
8246  IF KEY$ <  > "M" THEN  GOTO 8236
8250  XDRAW 17 AT M,N
8255  IF  PEEK (707) = 1 THEN R = R - 8
8256  IF  PEEK (707) = 0 THEN R = R + 8
8258  IF R < 0 THEN R = 0
8260  ROT= R
```

```
8265  DRAW 17 AT M,N
8270  IF R > 72 THEN  POKE 707,1
8275  IF R = 56 THEN  POKE 707,0
8276  ROT= R?'
8280  GOTO 8240
8282  GOSUB 9000
8285  RETURN
8300  REM  ** GRAPHICS FOR Q4
8301  REM  ******************
8305  GOSUB 8200
8310  DRAW 18 AT 100,100
8315  SCALE= 2: DRAW 8 AT 114,119: SCALE= 1
8320  DRAW 2 AT 136,98
8325  GOSUB 6000
8330  HOME :V = 21:H = 12:T$ = "THIRD CLASS LEVER"
8335  INVERSE : GOSUB 5000: NORMAL
8336 V = 23:H = 10:T$ = "RA IS LONGER THAN FA": GOSUB 5000
8340  GOSUB 9000
8350  RETURN
8400  REM  ** GRAPHICS FOR Q3 **
8401  REM  **********************
8405  HGR
8406  HCOLOR= 3
8407  SCALE= 1: ROT= 0
8410  DRAW 1 AT 105,70
```

```
 8411  DRAW 2 AT 90,67
 8412  DRAW 5 AT 139,71
 8413  DRAW 6 AT 115,71?'
 8420  ROT= 32: DRAW 6 AT 191,51: ROT= 0
 8425  SCALE= 3
 8430  DRAW 8 AT 174,67
 8435  DRAW 13 AT 139,79
 8440  GOSUB 6000
8445 V = 21:H = 12:T$ = "FIRST CLASS LEVER": INVERSE : GOSUB
 5000: NORMAL
8450 V = 23:H = 1:T$ = "FORCE MOVES DOWN.  RESISTANCE MOVES
UP.": GOSUB 5000
8455  GOSUB 9000
8460  RETURN
8500  REM  ** GRAPHICS FOR Q5 **
8501  REM  **********************
8505  GOSUB 8200
8512  ROT= 32: DRAW 15 AT 142,89: ROT= 0
8513  DRAW 2 AT 130,98
8514  DRAW 18 AT 100,100
8515  GOSUB 6000
8518 V = 21:H = 12:T$ = "THIRD CLASS LEVER": INVERSE : GOSUB
 5000: NORMAL
8520 V = 23:H = 1:T$ = "R = CENTER OF GRAVITY OF MOVING SEGM
ENT": GOSUB 5000
```

```
 8525  GOSUB 9000
 8550  RETURN ?'
 8900  REM  CHECKS FOR ANSWER
 8901  REM       VALIDITY
 8905  IF KEY$ = "M" THEN  RETURN
 8910  HOME :V = 21:H = 12
 8915 T$ = "ENTER ONLY 'M'  OR 'C'"
 8920  GOSUB 5000
 8922 T = 2000: GOSUB 8000
 8925  POKE 708,1
 8950  RETURN
 9000  REM  *** WAITS FOR INPUT
 9001  REM
 9005  VTAB 24: HTAB 8
 9010  FLASH
 9012  POKE  - 16368,0
 9015  GET KEY$
 9020  NORMAL
 9050  RETURN
 9100  REM  ** PRINTS BORDER **
 9101  REM  ********************
 9105  INVERSE : FOR I = 2 TO 39: VTAB 2: HTAB I: PRINT " ":
NEXT
 9110  FOR I = 2 TO 23: VTAB I: HTAB 39: PRINT " ": NEXT
 9115  FOR I = 39 TO 2 STEP  - 1: VTAB 23: HTAB I: PRINT " ":
```

```
 NEXT ?'
9120  FOR I = 23 TO 2 STEP  - 1: VTAB I: HTAB 2: PRINT " ":
NEXT
9125  NORMAL
9130  RETURN
9900  REM  ** FILE KEEPER **
9901  REM  *****************
9902 D$ =  CHR$ (4): PRINT D$
9905 D$ =  CHR$ (4): PRINT D$;"OPEN FILE" + NAME$
9910  PRINT D$;"WRITE FILE" + NAME$
9912  PRINT NAME$
9913 C = 779
9915  FOR Z = 768 TO 778
9920  PRINT  PEEK (Z);: PRINT  PEEK (C)
9921 C = C + 1
9922  NEXT
9925  PRINT D$;"CLOSE FILE" + NAME$
9930  END
9935  RETURN
```

Appendix B

USER MANUAL FOR LEVER PROGRAM

DESCRIPTION

This program is designed to help students learn and apply the concepts of levers and leverage through a combination of text and graphics. The program should be beneficial to students from high school through university level. Specifically the student will:

* Identify lever parts
* Classify levers
* Define lever terms
* Perform lever calculations
* Classify simple tools in terms of leverage

These objectives are on line in the program's introductory module.

There are three subprogram options that can be selected from the introduction program (INTRODUCTION). These subprograms along with respective program content appear below:

1. Definitions - The interactive graphics for this module allow the user to repeatedly position the axis and note the change in lever classification. A bell rings each time classification changes. In subsequent screens, force arm and resistance arm are drawn and comparisons made for each type

of lever. Finally, the last screen allows the user to move the axis and note changes (provided in text at bottom of screen) in classification, lengths of resistance arm and force arm, and mechanical advantage. Axis placement is continually emphasized as the determining factor in lever classification. The following terms are defined in subprogram DEFINITIONS.

* Lever components
* Lever Classes
* Force arm
* Resistance arm
* Mechanical advantage

2. Applications - This module provides the user an opportunity to apply the F x FA = R x RA formula to balance an object of known weight with a given force. The student moves the axis and notes resulting changes in force arm and resistance arm. The figures required are formatted for easy multiplication. The first incorrect answer will bring an explanation and a chance to try again. A second incorrect response will tell the student if he made the same error or a different one and will provide a detailed explanation followed by a

graphic showing correct axis placement along with formula substitutions. The user is then asked to classify serveral simple tools (wheelbarrow, scissors). Because of the relatively high probability of guessing the correct answer when there are only three choices, a graphic explanation follows correct and incorrect responses. Module content can be summarized as:

* Balance
* Tool classification

3. Quiz - Ten questions from other modules' content are arranged according to anticipated degree of difficulty. Correct answers are rewarded with randomly selected words of positive reinforcement. Incorrect answers result in a branch to an explanation (usually graphic) followed by the next question. Upon completion, the student is provided a score which is sent to a "RECORDS" file that can be later read by the instructor. The student can branch from this point to the DEFINITIONS module or he can quit.

Requirements

The levers program was authored for an APPLE II plus (DOS 3.3) microcomputer with a minimum of 48K RAM. A single

disk drive, CRT and high resolution graphic capabilities are also required. Color is not necessary.

OPERATION

For microcomputers that have automatic booting (turnkey system) the INTRODUCTION program will begin when the computer is powered on. Follow the steps below:

1. Carefully place the disk in the disk drive and shut the door.
2. Turn on the CRT (television).
3. Turn on the APPLE II plus.
4. If the program does not start automatically, type "PR#6" (without the quotes).
5. If the program still does not start, see your computer expert.

The program is initiated with a graphic display of the title, author's name, program objectives and options for selections to enter any of the three subprograms (Definitions, Applications, or Quiz). The user may also choose to quit at this time.

The recommended order of subprogram presentation for learning purposes is:

1. Definitions
2. Applications
3. Quiz

The user also has the option of quitting after any program

execution.

Speed of screen presentation is controlled by the student. Unless otherwise stated, each suceeding screen will be called when the user presses any key. This can be done anytime after the curser starts to flash. Earlier responses will be ignored.

Disk Contents

There are 8 programs on your LEVER disk. All are locked to prevent accidental deletion or modification. Programs are:

* Levers - provides an introduction to the set of learning modules.
* MOVEDEF - Changes Apple's normal loading address for Definitions module.
* MOVEAPP - Changes Apple's normal loading address for Applications module.
* MOVEQUIZ - Changes Apple's normal loading address for Quiz module.
* DEFINITIONS - Learning Module
* APPLICATIONS - Learning Module
* QUIZ - Learning Module
* NEWTAB - Binary shape table for learning modules
* BLEVERS - Shape table for introductory program

In addition, each time the Quiz program is run, a file

with a record of student responses and score will be created. The instructor can read this information by running the RECORDS program. Follow the steps outlined below:

1. type "RUN RECORDS"
2. The program will ask for the name of the file you wish to read. All files will contain the word "FILE" followed immediately (without a space) by the student's name as entered prior to taking the quiz (i.e. FILEJUDY). If the user doesn't know the file name, he can press the RETURN key and a listing of disk programs will appear. Choose from only those files that do not have an "*" next to them. If the file name is spelled incorrectly, the program will ask you to enter it again.
3. Student name, question numbers, and student responses will then be displayed along with total number of correct responses. Incorrect answers will be followed by an "*".
4. Eventually these files will need to be deleted. Once they have been read there is usually no reason to keep them. If the instructor wishes to delete each file as it is read he presses "Y" when prompted by "Do you wish to delete file?"

(Y/N).

5. The program will then ask if there are more files to be read. If there are, it will begin the loop again.
6. Upon program completion, all designated files will be deleted.

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