AN INVITATION TO PROGRAMMING™ 3:
INTRODUCTION TO SOUND AND GRAPHICS

Model CX4117
Use with
ATARI® 400™ or ATARI 800™
PERSOINAL COMPUTER SYSTEMS
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AN INVITATION TO PROGRAMMING™ 3 is a course designed to introduce concepts in programming sound and graphics. Introduction to Sound defines the basics of music theory as well as the characteristics of a computer-generated sound. Introduction to Graphics explains the use of color in graphics and introduces the theory of animation.

As this course is the third in a series, effective use of this workbook requires knowledge of ATARI BASIC. Refer to An Invitation to Programming 1 and 2 or the ATARI BASIC Reference Manual for clarification of any BASIC program instructions.

The course has the following components:

- Cassette for Introduction to Sound containing both the computer program and audio material
- Cassette for Introduction to Graphics containing both the computer program and audio material
- This workbook containing both sections of the course to be used as a study guide and reference source
ATARI COMPONENTS REQUIRED

- ATARI® 400™ or ATARI 800™ Personal Computer System with:
  - 8K (minimum) Random Access Memory (RAM)
  - ATARI BASIC Computing Language Cartridge
- ATARI 410™ Program Recorder
- Introduction to Sound Cassette
- Introduction to Graphics Cassette

GENERAL INSTRUCTIONS FOR LOADING THE CASSETTE TAPE

1. Connect the ATARI 400 or ATARI 800 Personal Computer System to your television set and to a wall outlet as instructed in the Operator’s Manual.

2. Make sure that the ATARI 410 Program Recorder is properly connected to the computer console and to a wall outlet (see your ATARI 410 Program Recorder Operator’s Manual for further details, if necessary).

   **Note:** If you have “daisy chained” (connected in series) other ATARI peripherals to your computer console, and do not wish to disconnect them, connect your ATARI 410 Program Recorder to the I/O CONNECTOR of the last unit in the chain.

3. Make sure that at least 8K of RAM is installed in your ATARI Personal Computer System. See the Operator’s Manual for Memory Module™ loading instructions.

   **Note:** If an ATARI Disk Drive is connected to the computer console, the Disk Operating System (DOS) and system software use some of the available Random Access Memory (RAM). The amount of RAM used varies with the version of DOS you are using. Take this overhead into account when calculating the amount of RAM required to run a program.

4. Open the cartridge door and insert the ATARI BASIC Cartridge into the cartridge slot. Use the LEFT CARTRIDGE slot on the ATARI 800 Personal Computer System. Close the cartridge door.

5. Turn on your television set. (You may have to adjust the volume on your television set, since the voice from the audio track comes from the television speaker.)

6. Turn on your ATARI Personal Computer System. The POWER switch is on the right side of the computer console.
7. If all equipment is properly connected and turned on, your television screen should display the READY prompt, with the white cursor just below.

8. Press STOP/EJECT on your ATARI 410 Program Recorder to open the cassette door.

9. Load Lesson One by holding the cassette tape so that the label (Side 1) is up and the tape leader is facing you. Refer to Figure 1.

10. Slide the cassette into the cassette holder and close the door.

11. If necessary, press REWIND and rewind the tape to the beginning. (Set the counter on the Program Recorder to 000.)

12. Type CLOAD on the computer keyboard and press RETURN. The computer will "beep" once to remind you to press PLAY on the Program Recorder.

13. Press PLAY and the RETURN key to start the tape. Through the window in the Program Recorder, note that the tape is turning. The beeps and other sounds you hear coming from the television speaker tell you that Lesson One is being loaded into computer memory.

   Note: If you have problems loading either of the course programs and you have peripherals in addition to the Program Recorder attached to the computer console, try disconnecting the other peripherals and connecting the Program Recorder directly to the computer console to isolate any problem. If problems persist, consult the ATARI 410 Program Recorder Operator's Manual.

14. When the television screen displays the READY prompt, the first program encountered on the cassette, Lesson One, has been loaded into the computer. Make sure that the PLAY button on the Program Recorder is still down (and remains down). On the chart provided, make a note of the number on the Program Recorder's counter. Enter this number in the START AUDIO column for Lesson One. If you want to run Lesson One again, simply rewind the tape to this number. As you proceed with the course, similarly keep track of the START AUDIO numbers of the other lessons.

15. Type RUN and press RETURN to start Lesson One. From now on, follow the instructions given in the lesson. At the end of Lesson One, make a note of the Program Recorder counter number. Enter this number in the END AUDIO column for Lesson One.

16. DO NOT rewind the cassette tape. When you are ready to begin Lesson Two, follow the same procedure as you did to load Lesson One (begin with Step 12). Follow this procedure for all the lessons in the course and for the Final Quiz.

To go to a specific lesson in the course: Completely REWIND the tape. Set the counter at 000. Push FAST FORWARD on the Program Recorder. Advance the tape until you reach the START LOADING number that you entered on the chart.

To repeat a lesson just completed: REWIND the tape to the START AUDIO number on your chart.
Memory in a computer system is divided into two components, ROM and RAM:

**ROM.** Read-Only Memory contains programs permanently stored in your computer by the manufacturer. This information is essential for computer operation. The ROM programs are called read-only because they can be read but not changed.

**RAM.** Random Access Memory temporarily stores programs and data in your computer. You can enter information directly into RAM from the keyboard, which allows you to create new programs or bring stored data into your RAM workspace from diskette, cassette, or cartridge.

Turning off the computer console clears all the information stored in RAM. To write new data without turning your console off and on, use the BASIC instruction **NEW** followed by **RETURN**. A **NEW** command clears any information in RAM.

A **CLOAD** command brings a stored program from the cassette into RAM. To clear out this program and prepare for the practice sessions, you MUST enter the **NEW** command.

The following statement is repeated at the beginning of each practice session because of its importance.

**Note:** To clear RAM computer memory, type **NEW** and press **RETURN** before EVERY practice session and between each example program.
SUMMARY OF LESSONS: INTRODUCTION TO SOUND

Lesson One: Sound Registers
Describes various characteristics of a computer-generated sound. You experiment by changing each characteristic, then listen to the resulting sound.

Lesson Two: Sound Effects
Explains the underlying principles in generating routines for simple sound effects such as thunder or explosions. You also learn how to imitate musical instruments.

Lesson Three: Sound Routines
Explains in logical steps how to develop a routine to play computer music.

Lesson Four: Efficient Sound Programs
Introduces DATA statements and other techniques that extend the program developed in Lesson Three.

Lesson Five: Musical ABC's
Discusses pitch and note representation of sounds. Describes staves and clefs.

Lesson Six: Identifying Notes
Various musical sounds are played and shown on the screen. You identify the sounds and their sound value. At the end of the lesson, you translate written music into a computer program.

Lesson Seven: Sound Routines With More Than One Register
Shows how to create music programs and sound effects using several sound registers at once.

Final Quiz: Sound Quiz covering all of the material taught in this section of the course.

<table>
<thead>
<tr>
<th>INTRO. TO SOUND</th>
<th>LESSON</th>
<th>CASSETTE RECORDER COUNTER VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIDE 1</td>
<td>1</td>
<td>START LOADING 000</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>SIDE 2</td>
<td>5</td>
<td>START LOADING 000</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>FINAL TEST</td>
<td></td>
<td>END AUDIO</td>
</tr>
</tbody>
</table>

Figure 2  Program Recorder Counter Numbers for Lessons in Introduction to Sound
LESSON ONE:  
SOUND REGISTERS

Frame 1: The Sound Register
Three variables determine the quality of a sound produced by a sound register: pitch, purity, and loudness.

• Pitch represents the height of a sound. On the ATARI computer the pitch values range from 1 to 255. The larger the assigned number, the lower the pitch. (Frame 19 gives the pitch values of musical sounds.)

• Purity (distortion), a variable, allows you to create special sound effects. Purity values range from 0 to 15. As an example, an assigned number 10 creates a pure tone while the number 12 will give you an interesting buzzer sound, especially with a pitch number around 200.

• The last variable controls the loudness (volume) of a tone. Values range from 1 to 15 with an assigned number 1 producing a barely audible sound, and the number 15 producing a fairly loud sound. Number 8 is considered “normal.”

Frame 2: Four Sound Registers
The ATARI computer contains four sound registers numbered 0 through 3.

Frame 3: Sound Statement
To produce a sound, enter four variables into a syntax statement: the sound register, pitch value, purity value, and loudness of the sound. Commas must separate the values.

Example:
```
SOUND 0, 100, 10, 12
```
where 0 is the sound register, 100 is the pitch value, 10 is the purity value, and 12 is the loudness value.

Frame 4: Sound Shutoff
You must turn the television set to an audible level in order to hear sound. Once turned on, a sound register stays on until you:

1. Assign a loudness value of 0.
2. Program an END instruction. For example,
```
10 SOUND 1, 50, 10, 8
20 FOR X=1 TO 1000: NEXT X
30 END
```
3. Press the [SYSTEM RESET] key on the right side of the keyboard. ([BREAK] will not stop the sound.)
4. Turn off the sound on your television set.
Frame 5: Practice Session for Lesson One

Note: To clear RAM computer memory, type NEW and press RETURN before EVERY practice session and between each example program.

1. Type this sound instruction into the computer, then press RETURN.
   SOUND 0, 50, 2, 8
   To stop the sound, type END.

2. Change the pitch value in the instructions given in step 1. Repeatedly change the value until you have a general idea of the range of values available to you. (Suggestion: refer to Frame 22 for the pitch values of musical sounds.)

3. Similarly experiment with the purity and loudness values.

When you are ready, load Lesson Two on the cassette by typing CLOAD and pressing RETURN twice. After the READY message appears on the screen, type RUN and press RETURN to start the lesson.

LESSON TWO: SOUND EFFECTS

Frame 6: Summary of Lesson Two

1. Use variables in SOUND instructions.
   SOUND 0, X, Y, Z
   SOUND 0, PITCH, 10, 8
   SOUND 0, 15, 2, LOUD

2. Produce sound effects with the FOR/NEXT loop.
   10 FOR PITCH =1 TO 255
   20 SOUND 0, PITCH, 10, 8
   30 NEXT PITCH

3. Produce a variety of sounds by varying loudness in a FOR/NEXT loop.
   10 REM PIANO
   20 FOR LOUD =15 TO 0 STEP -1
   30 SOUND 0, 15, 0, LOUD
   40 NEXT LOUD

4. Popping sounds, explosions, music produced by tapping, and the like are created by rapid variance between loud and soft.

Frame 7: Practice Session for Lesson Two

Note: To clear RAM computer memory, type NEW and press RETURN before EVERY practice session and between each example program.
Try these sound effects programs.

An organ imitation uses two loudness loops in the following program. The second loop rounds out the sound the way an organ does when the player releases the key.

Line 10 in the program sets the pitch to a random number.
LESSON THREE: SOUND ROUTINES

Frame 8: Sound Routine

A program that produces a series of sounds is called a sound routine. Frames 9 through 17 show the evolution of an efficient way to program a sound routine using only one sound register. (Lesson Seven discusses programs that use more than one register.)
Frame 9: Line Numbers

```
100 SOUND 0,81,10,8
110 SOUND 0,64,10,8
120 SOUND 0,51,10,8
130 SOUND 0,60,10,8
140 SOUND 0,47,10,8
150 SOUND 0,60,10,8
170 END
```

Frame 10: Adding Delay Statements

Each separate sound must have a delay loop.

```
100 SOUND 0,81,10,8
105 FOR D=1 TO 300:NEXT D
110 SOUND 0,64,10,8
115 FOR D=1 TO 300:NEXT D
120 SOUND 0,53,10,8
125 FOR D=1 TO 300:NEXT D
130 SOUND 0,64,10,8
135 FOR D=1 TO 300:NEXT D
140 SOUND 0,60,10,8
145 FOR D=1 TO 300:NEXT D
150 SOUND 0,47,10,8
155 FOR D=1 TO 300:NEXT D
160 SOUND 0,60,10,8
165 FOR D=1 TO 300:NEXT D
170 END
```

Frame 11: Varying Amounts of Delay

```
100 SOUND 0,81,10,8
105 FOR D=1 TO 300:NEXT D
110 SOUND 0,64,10,8
115 FOR D=1 TO 300:NEXT D
120 SOUND 0,53,10,8
125 FOR D=1 TO 300:NEXT D
130 SOUND 0,64,10,8
135 FOR D=1 TO 300:NEXT D
140 SOUND 0,60,10,8
145 FOR D=1 TO 300:NEXT D
150 SOUND 0,47,10,8
155 FOR D=1 TO 300:NEXT D
160 SOUND 0,60,10,8
165 FOR D=1 TO 300:NEXT D
170 END
```
Frame 12: Delay Subroutine

```
1000   SOUND 0, 0.6, 10, 8
1010   T 200:600-60500   1000
1100   SOUND 0, 0.5, 10, 8
1200   T 200:600-60500   1000
1300   SOUND 0, 0.6, 10, 8
1400   T 200:600-60500   1000
1500   SOUND 0, 0.6, 10, 8
1600   T 200:600-60500   1000
1700   T 200:600-60500   1000
1800   T 200:600-60500   1000
1900   T 200:600-60500   1000
1000 FOR D = 1 TO T: NEXT D
1010 RETURN
```

Frame 13: PEEK and POKE

For accurate counts in a music routine, you can use the “clock” built into the computer’s memory. Telling the computer to locate the clock requires a PEEK statement. Resetting the clock to 0 before each use requires a POKE statement. The following routine replaces the less accurate FOR/NEXT loop.

```
1000 POKE 20, 0: REM SET CLOCK TO 0
1010 C: = PEEK(20): REM TAKE TIME COUNT AND
1020 S: = C: IN C:
1030 IF C: THEN GOTO 1010: REM IF COUNT
1040 IF C: THEN LEAVE AT CLOCK AGAIN
1050 RETURN: REM STOP COUNTING WHEN COUNT
1060 TO 7 VALUE
```

Frame 14: Practice Session for Lesson Three

**Note:** To clear RAM computer memory, type NEW and press RETURN before EVERY practice session and between each example program.
Run the following program to hear the sound produced.

```
100 SOUND 0.81, 10.0
110 SOUND 0.04, 10.0
120 SOUND 0.53, 10.0
130 SOUND 0.64, 10.0
140 SOUND 0.60, 10.0
150 SOUND 0.47, 10.0
160 SOUND 0.60, 10.0
70 END
```

Add the following lines and run it again.

```
105 FOR D=1 TO 400: NEXT D
115 FOR D=1 TO 200: NEXT D
125 FOR D=1 TO 400: NEXT D
135 FOR D=1 TO 400: NEXT D
145 FOR D=1 TO 400: NEXT D
155 FOR D=1 TO 200: NEXT D
165 FOR D=1 TO 600: NEXT D
```

Replace the separate FOR/NEXT loops with one FOR/NEXT loop subroutine by adding the following lines to your program. Run the program again.

```
105 T=400: GOSUB 1000
115 T=200: GOSUB 1000
125 T=400: GOSUB 1000
135 T=400: GOSUB 1000
145 T=400: GOSUB 1000
155 T=200: GOSUB 1000
165 T=600: GOSUB 1000
2000 FOR D=1 TO T: NEXT D
2010 RETURN
```
Replace the FOR/NEXT subroutine with the following subroutine, and run the program again.

1000 POKE 20,0
1010 C=PEEK(20)
1020 IF C<T THEN GOTO 1010
1030 IF C>=T THEN RETURN

Note: With T=400, it will take almost seven seconds to play the note! T values should be reduced.

Replace Line 1030 in the above program with the following line and run the program again. Is there any difference? Why?

1030 RETURN

When you are ready, load Lesson Four on the cassette by typing CLOAD and pressing RETURN twice. After the READY message appears on the screen, type RUN and press RETURN to start the lesson.
Frame 17: More Efficient DATA Lines

```
2000 DATA 81,40,64,20,52,40,64,40,60,40
2010 DATA 47,20,60,60,0,0
```

Frame 18: Practice Session for Lesson Four

Note: To clear RAM computer memory, type NEW and press RETURN before EVERY practice session and between each example program.

Our “standard” music program follows. The DATA lines contain the notes from Beethoven's Fifth Symphony. Run the program as written.

```
100 READ PT,T
110 IF PT=0 AND T=0 THEN END
120 GOSUB 1000
130 GOTO 100
1000 SOUND 0,PT,10,8
1010 POKE 20,0
1020 C=PEEK(20)
1030 IF C=0 THEN GOTO 1020
1040 RETURN
2000 DATA 81,30
2010 DATA 81,30
2020 DATA 81,30
2030 DATA 102,70
2040 DATA 0,0
```

Something wrong? There are no breaks between the notes! Here is the simplest remedy—add this line to the program:

```
1040 SOUND 0,0,0,0:RETURN
```

Now each note is automatically shut off before the next is played.
Following are the pitch and time values for "Twinkle, Twinkle, Little Star." Enter these into the above program as DATA lines. Make sure that the last DATA line has a pitch value of 0 and a time value of 0 to stop the program.

<table>
<thead>
<tr>
<th>PT</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>30</td>
</tr>
<tr>
<td>121</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>53</td>
<td>30</td>
</tr>
<tr>
<td>53</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

Here are some songs that you might want to enter into the music program.
LESSON FIVE: MUSICAL ABC's

Frame 19: Staves

Notes, represented by symbols, determine the pitch or frequency of musical sounds. The notes are placed on a staff that consists of five lines and four spaces. Each line and each space represent a different pitch.
The two most important staves are the treble staff and the bass staff. A clef sign appears at the beginning of each staff. Three notes—B, C, and D—fall between the two staves.

Frame 20: Additional Information

Music students often use memory devices to help them remember the names of notes. One device: the notes falling in the spaces on the treble clef spell FACE.

Another device: the first letters of the words, Every Good Boy Does Fine, match the names of the notes on the lines.

When you are ready, load Lesson Six on the cassette by typing CLOAD and pressing RETURN twice. After the READY message appears on the screen, type RUN and press RETURN to start the lesson.

Frame 21: Ledger Lines

Ledger lines are short lines used for pitches above and below a staff. Here are some ledger lines that can be used to extend the treble staff.
Here are some ledger lines above and below the bass staff.

Frame 22: ATARI Values for Musical Notes

<table>
<thead>
<tr>
<th>HIGH NOTES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>29</td>
</tr>
<tr>
<td>B</td>
<td>31</td>
</tr>
<tr>
<td>A# or B♭</td>
<td>33</td>
</tr>
<tr>
<td>A</td>
<td>35</td>
</tr>
<tr>
<td>G# or A♭</td>
<td>37</td>
</tr>
<tr>
<td>G</td>
<td>40</td>
</tr>
<tr>
<td>F# or G♭</td>
<td>42</td>
</tr>
<tr>
<td>F</td>
<td>45</td>
</tr>
<tr>
<td>E</td>
<td>47</td>
</tr>
<tr>
<td>D# or E♭</td>
<td>50</td>
</tr>
<tr>
<td>D</td>
<td>53</td>
</tr>
<tr>
<td>C# or D♭</td>
<td>57</td>
</tr>
<tr>
<td>C</td>
<td>60</td>
</tr>
<tr>
<td>B</td>
<td>64</td>
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<tr>
<td>A# or B♭</td>
<td>68</td>
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<tr>
<td>A</td>
<td>72</td>
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<td>G# or A♭</td>
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<td>81</td>
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<td>F# or G♭</td>
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<td>E</td>
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<td>D# or E♭</td>
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<tr>
<td>D</td>
<td>108</td>
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<tr>
<td>C# or D♭</td>
<td>114</td>
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<tr>
<td>C</td>
<td>121</td>
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<tr>
<td>B</td>
<td>128</td>
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<td>A# or B♭</td>
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<td>G</td>
<td>153</td>
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<td>F# G♭</td>
<td>162</td>
</tr>
<tr>
<td>F</td>
<td>173</td>
</tr>
<tr>
<td>E</td>
<td>182</td>
</tr>
<tr>
<td>D</td>
<td>193</td>
</tr>
<tr>
<td>D# or E♭</td>
<td>204</td>
</tr>
<tr>
<td>D</td>
<td>217</td>
</tr>
<tr>
<td>C# or D♭</td>
<td>230</td>
</tr>
<tr>
<td>C</td>
<td>243</td>
</tr>
</tbody>
</table>
Frame 23: Practice Session for Lesson Six

Note: To clear RAM computer memory, type **NEW** and press **RETURN** before EVERY practice session and between each example program.

Shown below is the music program that we developed in earlier lessons. Use it to play the written music.

```
100 READ PT,T
110 IF PT=0 AND T=0 THEN END
120 GOSUB 1000
130 GOTO 100
1000 SOUND 0,PT,10,8
1010 POKE 20,0
1020 C = PEEK(20)
1030 IF C<T THEN GOTO 1020
1040 SOUND 0,0,0,0:RETURN
2000 DATA
```

Time values for this written music are shown below. Use these time values and translate the written music to your computer program so that it can be played.

\[
\begin{align*}
\text{\(\frac{1}{4}\)} & = 120 \\
\text{\(\frac{1}{8}\)} & = 60 \\
\text{\(\frac{1}{16}\)} & = 30 \\
\text{\(\frac{1}{32}\)} & = 15
\end{align*}
\]

**BILLY BOY**

Lively

```
\begin{array}{c}
\text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \\
\text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \\
\text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \\
\text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}
\end{array}
```

**GO TELL AUNT RHODY**

Slowly

```
\begin{array}{c}
\text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \\
\text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \\
\text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \\
\text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}
\end{array}
```

**LOVE SOMEBODY**

Lively

```
\begin{array}{c}
\text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \\
\text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \text{\(\frac{1}{16}\)}  \\
\text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \text{\(\frac{1}{8}\)}  \\
\text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}  \text{\(\frac{1}{4}\)}
\end{array}
```
When you are ready, load Lesson Seven on the cassette by typing **CLOAD** and pressing **RETURN** twice. After the READY message appears on the screen, type **RUN** and press **RETURN** to start the lesson.

**LESSON SEVEN: SOUND ROUTINES WITH MULTIPLE REGISTERS**

**Frame 24: Single Note Music Routine**

```plaintext
100 READ PT,T
110 IF PT=0 AND T=0 THEN END
120 GOSUB 1000
130 GOTO 100
1000 SOUND O,PT,10,8
1010 POKE 20,0
1020 C=PEEK(20)
1030 IF C=0 THEN GOTO 1020
1040 SOUND O,O,O,O:RETURN
2000 DATA 81,40
2010 DATA 64,20
2020 DATA 53,40
2030 DATA 64,50
2040 DATA 60,40
2050 DATA 47,20
2060 DATA 60,60
2070 DATA 0,0
```

**Frame 25: Summary of Lesson Seven**

You produce sound effects by turning on or off two or more sound registers. However, for several registers to work in combination to produce useful effects, the registers must blend together or “clash.” This usually requires that the sound registers be programmed with pure tones.

Musical notes will blend or clash with other notes depending on the mathematical relationships of the notes’ pitch. Notes that are too close together in sound value tend to clash.

A musical chord consists of two or more notes, from more than one register, that blend together.

**Frame 26: Practice Session for Lesson Seven**

Note: To clear RAM computer memory, type **NEW** and press **RETURN** before EVERY practice session and between each example program.
Try the following sound effects program. This represents two sounds that clash to create a sound effect.

```plaintext
READY
5 REM TRAIN HORN
10 FOR HORN=1 TO 2
15 SOUND 0.190 10.8: SOUND 1.175 10.8
20 FOR DELAY=1 TO 550: NEXT DELAY
30 SOUND 0.0 0.0: SOUND 1.0 0.0
40 FOR DELAY=1 TO 550: NEXT DELAY
50 NEXT HORN
```

Here is another effect that works differently.

```plaintext
READY
5 REM AIR-RAID SIREN
10 FOR PITCH=100 TO 200
20 SOUND 0 PITCH 10.8
30 SOUND 1.5 PITCH 10.8
40 FOR DELAY=1 TO 550: NEXT DELAY
50 NEXT PITCH
60 GOTO 10
```

A program that will play musical chords follows. Enter it and hear the sounds produced. Note that when all four sound registers are turned on, the sound is better if the loudness of each does NOT go over 8.

```plaintext
READY
100 READ PTO,PT1,PT2,PT3,T
110 IF PTO=0 AND PT1=0 AND PT2=0 AND PT3=0 AND T=0 THEN END
120 GOSUB 1000
130 GOTO 100
1000 SOUND 0 PTO,10.8: SOUND 1 PT1,10.8: SOUND 2 PT2,10.8: SOUND 3 PT3,10.8
1010 FORKE 20.0
1020 IF NOT THEN GOTO 1020
1040 SOUND 0 0 0: SOUND 1 0 0: SOUND 2 0 0: SOUND 3 0 0: RETURN
2000 DATA 121,96,64,60,20
3000 DATA 121,96,64,60,20
4000 DATA 121,96,64,60,20
5000 DATA 121,96,64,60,20
6000 DATA 0 0 0,0
```
Now enter the following data into the above program to play a familiar tune.

![Program Listing]

The next program is similar to the last one, except that it sounds more like a piano. You can save time by using the last program for most of the lines and changing only those lines that are different.

```
READY
10 REM PIANO
100 READ PT0,PT1,PT2,PT3,T
110 IF PT0=0 AND PT1=0 AND PT2=0 AND PT3=0 AND T=0 THEN END
120 GOSUB 1000
130 GOTO 100
1000 FOR LOUD=8 TO 0 STEP -0.5
1002 SOUND 0,PT0,10,LOUD;SOUND 1,PT1,10,LOUD:SOUND 2,PT2,10,LOUD:SOUND 3,PT3,10,LOUD
1005 NEXT LOUD
1010 POKE 20,0
1020 C=PEEK(20)
1030 IF C<T THEN GOTO 1020
1040 RETURN:REM SHUT OFF NOT NEEDED
2000 DATA 243,193,162,60,0
2010 DATA 243,193,162,60,0
2020 DATA 243,193,162,60,0
2030 DATA 243,193,162,81,0
2040 DATA 182,144,121,72,0
2050 DATA 182,144,121,72,0
2060 DATA 243,193,162,81,20
2070 DATA 0,0,0,47,0
2080 DATA 0,0,0,47,0
2090 DATA 0,128,108,53,0
2100 DATA 0,128,108,53,0
2110 DATA 243,193,162,60,16
3000 DATA 0,0,0,0,0
```
This program imitates chords on an organ.

READY
10 REM ORGAN
100 READ PT0,PT1,PT2,PT3,T
110 IF PT0=0 AND PT1=0 AND PT2=0 AND P
T3=0 AND T=0 THEN END
120 GOSUB 1000
130 GOTO 100
1000 FOR LOUD=0 TO 8
1002 SOUND 0,PT0,10,LOUD;SOUND 1,PT1,1
0,LOUD;SOUND 2,PT2,10,LOUD;SOUND 3,PT3
,10,LOUD
1005 NEXT LOUD
1010 POKE 20,0
1020 C=PEEK(20)
1030 IF C<T THEN GOTO 1020
1036 FOR LOUD=8 TO 0 STEP -0.5
1037 SOUND 0,PT0,10,LOUD;SOUND 1,PT1,1
0,LOUD;SOUND 2,PT2,10,LOUD;SOUND 3,PT3
,10,LOUD
1038 NEXT LOUD
1040 RETURN :REM SHUT OFF NOT NEEDED
2000 DATA 243,193,162,60,20
2010 DATA 243,193,162,60,20
2020 DATA 243,193,162,60,20
2030 DATA 243,193,162,81,20
2040 DATA 182,144,121,72,20
2050 DATA 182,144,121,72,20
2060 DATA 243,193,162,81,40
2070 DATA 0,0,0,47,20
2080 DATA 0,0,0,47,20
2090 DATA 0,128,108,53,20
2100 DATA 0,128,108,53,20
2110 DATA 243,193,162,60,80
3000 DATA 0,0,0,0,0

CONGRATULATIONS! GO ON TO TAKE THE FINAL QUIZ FOR INTRODUCTION TO SOUND. THERE IS NO AUDIO TRACK IN THIS SECTION.

Frame 27: Use With Final Test

Description of Frames
26 for Introduction to Sound
SUMMARY OF LESSONS: INTRODUCTION TO GRAPHICS

Lesson One: Graphics Demonstration
Brief display of simple effects obtained with graphics.

Lesson Two: Changing Color
Instructions in color coding and use of the color registers.

Lesson Three: Graphics Modes 1 and 2
Introduction to graphics modes and in-depth explanation of color registers.

Lesson Four: Real Graphics
Use of PLOT and DRAWTO instructions as well as color in graphic modes.

Lesson Five: Tricks with Graphics Modes
How to use the entire screen in any graphics mode and go from one mode to another without erasing screen memory.

Lesson Six: Position and Animation
How to position text material and give the appearance of movement.

Lesson Seven: Graphics Characters
How to draw pictures with special symbols.

Final Quiz: Graphics
A review of the material covered in this course. The quiz is scored by section.

<table>
<thead>
<tr>
<th>INTRO. TO GRAPHICS</th>
<th>LESSON</th>
<th>CASSETTE RECORDER COUNTER VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>START LOADING</td>
</tr>
<tr>
<td>SIDE 1</td>
<td>1</td>
<td>000</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>SIDE 2</td>
<td>5</td>
<td>000</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FINAL TEST</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3  Program Recorder Counter Numbers for Lessons in Introduction to Graphics
LESSON ONE: GRAPHICS DEMONSTRATION

When you are ready, load Lesson Two on the cassette by typing **LOAD** and pressing **RETURN** twice. After the READY message appears on the screen, type **RUN** and press **RETURN** to start the lesson.

LESSON TWO: CHANGING COLOR

Frame 1: ATARI BASIC Color Chart

Refer to the following Color Chart for the assigned color number of the approximate color displayed on the screen.

<table>
<thead>
<tr>
<th>Color Number</th>
<th>Approximate Color on the TV Screen</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>gray</td>
</tr>
<tr>
<td>1</td>
<td>gold</td>
</tr>
<tr>
<td>2</td>
<td>orange</td>
</tr>
<tr>
<td>3</td>
<td>red-orange</td>
</tr>
<tr>
<td>4</td>
<td>pink</td>
</tr>
<tr>
<td>5</td>
<td>purple or violet</td>
</tr>
<tr>
<td>6</td>
<td>red-blue</td>
</tr>
<tr>
<td>7</td>
<td>blue</td>
</tr>
<tr>
<td>8</td>
<td>blue</td>
</tr>
<tr>
<td>9</td>
<td>light blue</td>
</tr>
<tr>
<td>10</td>
<td>turquoise</td>
</tr>
<tr>
<td>11</td>
<td>green-blue</td>
</tr>
<tr>
<td>12</td>
<td>green</td>
</tr>
<tr>
<td>13</td>
<td>yellow-green</td>
</tr>
<tr>
<td>14</td>
<td>orange-green</td>
</tr>
<tr>
<td>15</td>
<td>light orange</td>
</tr>
</tbody>
</table>

Frame 2: Color Registers

The ATARI computer has five color registers numbered 0 through 4. Each color register has a specific application; for example, Color Register 4 changes the color of the frame around the screen and Color Register 2 changes the background color of the screen itself. Two numbers, the color number and its shade value, are associated with each color register.
Frame 3: SETCOLOR Statement

Use the SETCOLOR statement to assign specific colors and associated shades to each color register. The syntax of the SETCOLOR statement is as follows:

SETCOLOR x,y,z

where:

x represents the color register
y represents the color number
z represents the luminance number

Frame 4: Additional Information on SETCOLOR

Luminance is changed on every EVEN number: 0, 2, 4, 6, 8, 10, 12, and 14.

Note: Luminance Number 10 will cause a blank screen. To correct this situation, reassign a luminance number or press RETURN.

Variables can be substituted for numbers in the SETCOLOR statement. An example of the convenience this feature provides follows.

Frame 5: Practice Session for Lesson Two

Note: To clear RAM computer memory, type NEW and press RETURN before EVERY practice session and between each example program.

Practice using the SETCOLOR statement with either Color Register 2 or 4. Use the direct command mode or the following program to see all the colors and shades available on your ATARI computer.

```
READY
10 REM PROGRAM TO SHOW ALL OF THE COLOR
20 REM SHADINGS
30 REM USE REGISTER 2
40 FOR X=0 TO 15
50 FOR Y=0 TO 14
60 SETCOLOR 2,X,Y
70 FOR Z=0 TO 100: NEXT Z
80 NEXT Y
90 NEXT X
100 END
```

Experiment with SETCOLOR on Register 1 to determine the shade of the letters on the screen. If the letters disappear while in the direct command mode, press the SYSTEM RESET key.
When you are ready, load Lesson Three on the cassette by typing `CLOAD` and pressing twice. After the READY message appears on the screen, type `RUN` and press twice to start the lesson.

### Frame 6: Graphics Modes

<table>
<thead>
<tr>
<th>COMPUTER INSTRUCTION</th>
<th>OBJECT ON SCREEN</th>
<th>SIZE (No. of objects on screen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRAPHICS 0</td>
<td>regular type</td>
<td>24 lines of 40 characters</td>
</tr>
<tr>
<td>GRAPHICS 1</td>
<td>large type (double width)</td>
<td>20 lines of 20 characters</td>
</tr>
<tr>
<td>GRAPHICS 2</td>
<td>large type (double height and width)</td>
<td>10 lines of 20 characters</td>
</tr>
<tr>
<td>GRAPHICS 3</td>
<td>large graphics squares</td>
<td>20 lines of 40 squares</td>
</tr>
<tr>
<td>GRAPHICS 4</td>
<td>smaller graphics points</td>
<td>40 lines of 80 squares</td>
</tr>
<tr>
<td>GRAPHICS 5</td>
<td>smaller graphics points (more colors)</td>
<td>40 lines of 80 squares</td>
</tr>
</tbody>
</table>
Frame 7: Color in Graphics Mode 1

Color Registers 2 and 4 activate color choice in Graphics Mode 1. Color Register 2 colors the small text window appearing at the bottom of the screen. Color Register 4 colors the graphics window. Use the SETCOLOR statement to place the color and shade of your choice within the appropriate color register.

```
SETCOLOR 4, 10, 8
Color Register 4 colors here
```

```
SETCOLOR 2, 2, 2
Text window colored by Color Register 2
```

Frame 8: Printing to the Screen in Graphics Mode 1 or 2

Regular PRINT statement instructions appear in the text window portion of the screen. Printing to the graphics portion of the screen requires use of a specific PRINT command. The syntax of this statement is as follows:

```
PRINT #6; "the print command string enclosed in quotes"
```

```
PRINT #6; "LARGE TEXT"
```

```
PRINT "SMALL TEXT"
```

Frame 9: Coloring Text in Graphics Window Screen

To have the text characters within the PRINT #6 command appear in assigned colors on the screen, coordinate color registers and character type. As an example:

```
SETCOLOR 0,9,10 sets the color corresponding to 9, turquoise, within Color Register 0.
PRINT #6; "TEST" will cause the word TEST to appear in turquoise on the graphics window screen.
```
COLOR REGISTER | CHARACTER COLORED | SAMPLE COLOR INSTRUCTION
---|---|---
0 | capital letters | SETCOLOR 0,9,10
1 | lowercase letters | SETCOLOR 1,15,0
2 | inverse capitals | SETCOLOR 2,8,6
3 | inverse lowercase | SETCOLOR 3,5,14
4 | no character, only background

Frame 10: Default Colors

If no SETCOLOR commands are given before PRINT #6 instructions are encountered within the program, the character colors will appear in the default color built into the color register.

COLOR REGISTER | CHARACTER COLORED | DEFAULT COLOR
---|---|---
0 | capital letters | orange
1 | lowercase | light green
2 | inverse capital letters | dark blue
3 | inverse lowercase | red
4 | screen background | dark gray (black)

Frame 11: Practice Session for Lesson Three

Note: To clear RAM computer memory, type NEW and press RETURN before EVERY practice session and between each example program.

Enter Graphics Mode 1 by typing GRAPHICS 1 RETURN. Type in various PRINT #6; instructions to see what appears on the screen. Do the same with Graphics 2.

Note: Reverse type is produced by first pressing the ATARI symbol key on the lower right side of the keyboard. To stop producing reverse type, press the key a second time. To get back into the regular type mode, type GRAPHICS 0 RETURN.

Frame 12: Practice With SETCOLOR in Graphics Modes 1 and 2

Run this program:

```
10 GRAPHICS 2
20 PRINT #6;"ONE two THREE four"
100 END
```
Notice the color of the letters on the graphics window screen. Check the color chart and default values color chart. Now type in the following SETCOLOR commands after the above program has run. Do this while still in graphics mode using the direct command status.

```
SETCOLOR 0,8,0
SETCOLOR 1,2,10
SETCOLOR 2,15,14
SETCOLOR 3,0,6
SETCOLOR 4,4,2
```

List the above program. Add the following statement lines and run again:

```
30 FOR X=0 TO 3: REM NUMBER OF COLOR REGISTER
40 FOR Y=1 TO 10: REM NUMBER OF FLASHES
50 SETCOLOR X,0,0
60 FOR TIME=1 TO 100:NEXT TIME: REM DELAY
70 SETCOLOR X,0,14
80 FOR TIME=1 TO 100:NEXT TIME: REM DELAY
90 NEXT Y
95 NEXT X
```

Press the \textit{SYSTEM RESET} key. Add the following statement line and run again:

```
15 SETCOLOR 4,4,10
```

\textbf{Note:} Whenever Graphics 0, 1, or 2 is executed, the screen is cleared and default colors are placed in the color registers.

The abbreviation for Graphics is GR, so, Graphics 1 can be typed GR.1.

When you are ready, load Lesson Four on the cassette by typing CLOAD and pressing \textit{RETURN} twice. After the READY message appears on the screen, type RUN and press \textit{RETURN} to start the lesson.

\textbf{LESSON FOUR: REAL GRAPHICS}

Frame 13: Screen for Graphics Mode 3
Frame 14: PLOT and DRAWTO Commands

To use the PLOT command, visualize a grid pattern on the screen. The PLOT command places a graphics point at the intersection of the x and y coordinates given in the syntax of the command itself. Coordinates can be given from 0 to 39 on the x axis and from 0 to 19 on the y axis.

Frame 15: Sample Program

REMEMBER that the COLOR instruction DOES NOT place a color in any of the registers. The COLOR instruction DOES tell the computer which register will be controlling the color of the graphics point.

Determine the missing instruction from the following program:

```
10 GRAPHICS 3
20 SETCOLOR 3,9,4
30 PLOT 15,6
```

Frame 16: COLOR Command and the Color Registers

A COLOR command directly controls the choice of the color register involved in any following PLOT or DRAWTO commands. The following table illustrates this relationship:

<table>
<thead>
<tr>
<th>COLOR</th>
<th>corresponds to Color Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Frame 17: Sample Program Using COLOR Command

```
10 GRAPHICS 3
20 SETCOLOR 0,6,8
30 SETCOLOR 2,0,6
40 COLOR 1
50 PLOT 15,15
```

Remember that color number 0 = gray and 6 = blue.
Frame 18: Practice Session for Lesson Four Using COLOR

Note: To clear RAM computer memory, type NEW and press RETURN before EVERY practice session and between each example program.

Run the following program:

10 GRAPHICS 3
20 SETCOLOR 0,4,10
30 COLOR 1
40 PLOT 10,10

Change the COLOR and SETCOLOR instruction to get different color squares on the screen. Clear memory and enter the following program.

10 GRAPHICS 3
20 COLOR 1
30 X=INT(RND(1)*40); Y=INT(RND(1)*20)
40 PLOT X,Y
50 GOTO 20

To stop the random graphics display, press the BREAK key. Add these program lines:

20 C=INT(RND(1)*4)
25 COLOR C

Frame 19: Practice Session for Lesson Four Using PLOT and DRAWTO

Enter and run this program:

10 REM FLASHING LIGHTNING PROGRAM
20 GRAPHICS 3
30 COLOR 1
40 PLOT 10,0
42 DRAWTO 20,19

Add these additional program lines:

45 FOR X=1 TO 10
50 SETCOLOR 0,X,8
60 FOR D=1 TO 100: NEXT D: REM DELAY
70 SETCOLOR 0,9,14
80 FOR D=1 TO 100: NEXT D
100 NEXT X

When you are ready, load Lesson Five on the cassette. You must turn over the cassette, Introduction to Graphics, to Side 2. Refer to General Instructions for Loading the Cassette Tape. Remember to reset the Program Recorder counter to 000.
LESSON FIVE: TRICKS WITH GRAPHICS MODES

Frame 20: Appearance of the Screen Using Graphics Modes 3 - 5

<table>
<thead>
<tr>
<th>SCREEN</th>
<th>COLOR REGISTERS</th>
<th>MEMORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Available for plot points 0, 1, and 2</td>
<td>273 bytes</td>
</tr>
<tr>
<td></td>
<td>Background is set by 4</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Plot points by Register 0</td>
<td>537 bytes</td>
</tr>
<tr>
<td></td>
<td>Background by Register 4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Available for plot points 0, 1, and 2</td>
<td>1017 bytes</td>
</tr>
<tr>
<td></td>
<td>Background by Register 4</td>
<td></td>
</tr>
</tbody>
</table>
Frame 21: Graphics Number + 16

Whenever a text window appears in combination with a main graphics window on the screen, four lines of text are reserved at the bottom of the screen. To use the entire screen for a graphics display, enter the graphics mode and increment its number by 16.

Frame 22: Changing Modes Without Clearing the Screen
Frame 23: Practice Session for Lesson Five

*Note:* To clear RAM computer memory, type `NEW` and press `RETURN` before EVERY practice session and between each example program.

Enter this program:

```
10 REM PRINT TO FULL SCREEN
20 GRAPHICS 2+16
30 FOR X=1 TO 12
40 PRINT #6; "LINE";X
50 NEXT X
80 FOR Y=1 TO 1000: NEXT Y: REM TIME DELAY
90 END
```

Add these program lines:

```
60 FOR Y=1 TO 1000: NEXT Y: REM TIME DELAY
70 GRAPHICS 1+16+32
```

*Note:* The computer uses different amounts of memory in accordance with the different graphics modes. If the screen memory displays some unusual characters at the top of the screen when this program is run, the cause of this appearance is the change in memory size between graphics modes.

When you are ready, load Lesson Six on the cassette by typing `LOAD` and pressing `RETURN` twice. After the READY message appears on the screen, type `RUN` and press `RETURN` to start the lesson.

Frame 24: Sample Program Using POSITION

**PLOT** command puts points at the intersection of a grid position on the screen. **POSITION** is similar, except text can now be placed at a specific spot on the screen. Look at the following program:

```
10 GRAPHICS 0
20 SETCOLOR 2,14,10
30 POSITION 12,11
40 PRINT "MIDDLE"
```
Note: POSITION only sets the points where the text will begin on the screen. PRINT, PRINT #6; or DRAWTO commands are necessary before text will actually appear on the screen.

Frame 25: POSITION Instruction

The syntax of the POSITION instruction is:

\[ \text{POSITION } x, y \]

where \( x \) represents the number across
\( y \) represents the number down

Frame 26: Determining Your Program's Accuracy

PROGRAM 1

10 PRINT "TEXT"
20 POSITION 5,5
30 GRAPHICS 0

PROGRAM 2

10 GRAPHICS 2
20 POSITION 8,4
30 PRINT #6; "text"

PROGRAM 3

10 GRAPHICS 1
20 POSITION "TEXT"

Frame 27: Animation Example
Frame 28: Animation Example

Frame 29: Principles of Animating Text

1. Printed word must be positioned and printed on the screen.
2. Image must be registered in the eye by a slight time delay.
3. Image must be blanked out.
4. Text is repositioned and printed in a slightly different location.

Frame 30: Practice Session for Lesson Six

Note: To clear RAM computer memory, type NEW and press \[RETURN\] before EVERY practice session and between each example program.

Demonstration of POSITION in Graphics 0.
Demonstration of Random Positioning.

```
10 REM PROGRAM TO POSITION AT RANDOM
20 GRAPHICS 2
30 POSITION 5,5
40 PRINT #6; "huhhu!
50 X=INT(100*RND)+1
50 Y=INT(100*RND)+1
60 POSITION X,Y; PRINT #6; "O"
70 GOTO 30
```

Movement of an arrow across the screen.

```
10 REM GRAPHICS 2
20 FOR T=1 TO 10
30 POSITION 3,5
40 PRINT #6; "="
50 FOR I=1 TO 100; NEXT T
60 PRINT #6; "+"
70 NEXT X
```

Movement of an arrow across the screen without a print command to blank out the image.

Run this program and determine how the image gets blanked out. Explanation is given on the next page.
By placing a blank space before the arrow, you create the illusion of movement every time a new position is printed on the screen.

When you are ready, load Lesson Seven on the cassette by typing `CLOAD` and pressing `RETURN` twice. After the READY message appears on the screen, type `RUN` and press `RETURN` to start the lesson.

**Frame 31: POKE Command Instruction**

To place lowercase and graphics characters on the screen in Graphics Modes 1 or 2, use a POKE command.

1. Enter a specific graphics mode.
2. Use the `POKE 756,226` command.
3. `PRINT #6; "letters or graphics characters"

**Frame 32: Sample Program With Background of Hearts**

```
10 GRAPHICS 1
20 POKE 756,226
30 PRINT #6; "GRAPHICS \\"
```
Frame 33: Sample Program With “Clean Background”

```
10 GRAPHICS 1
20 POKE 756, 226
30 SETCOLOR 0, 0, 0
40 PRINT #8: "GRAPHICS \-\-
```

Frame 34: Practice Session for Lesson Seven

**Note:** To clear RAM computer memory, type NEW and press RETURN before EVERY practice session and between each example program.

Enter the following program. The graphics are created as follows: top line = Card + 0, bottom line = Card + 10,
left line = Card + 20, right line = Card + 30

```
10 GRAPHICS 2
20 POKE 756, 226
30 SETCOLOR 0, 0, 0
40 PRINT #8: "lower f"
50 PRINT #8: "case f"
60 PRINT #8: "case f"
```

Eliminate Line 20 from the above program and run.
Replace Line 20 and eliminate Line 30 and run again.
Demonstration of program animation.

CONGRATULATIONS! GO ON TO THE FINAL QUIZ ON THE CASSETTE.
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