CEng 230 Introduction to C Programming

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Web Pages

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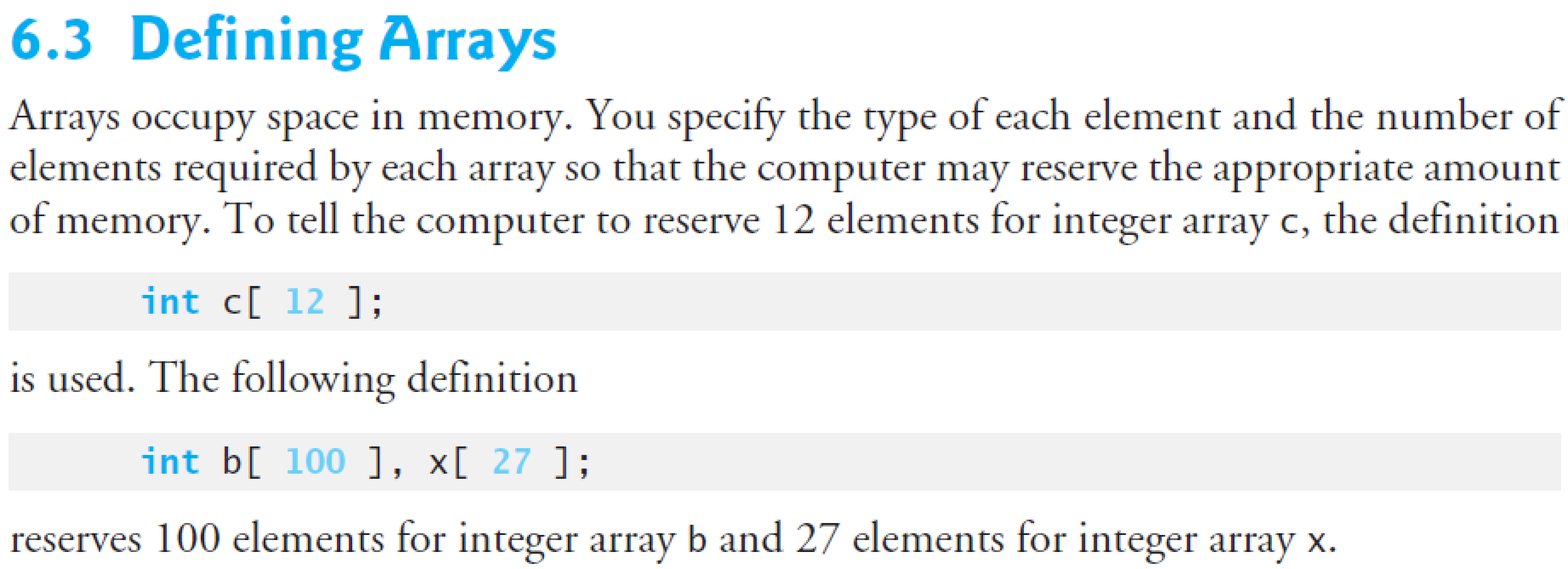
Arrays

Declaring and Referencing Arrays
Array Subscripts
Using for Loops for Sequential Access
Using Array Elements as Function Arguments
Arrays Arguments
Multidimensional Arrays



6.3 Defining Arrays

Arrays occupy space in memory. You specify the type of each element and the number of elements required by each array so that the computer may reserve the appropriate amount of memory. To tell the computer to reserve 12 elements for integer array c, the definition

```
      int c[ 12 ];
```

is used. The following definition

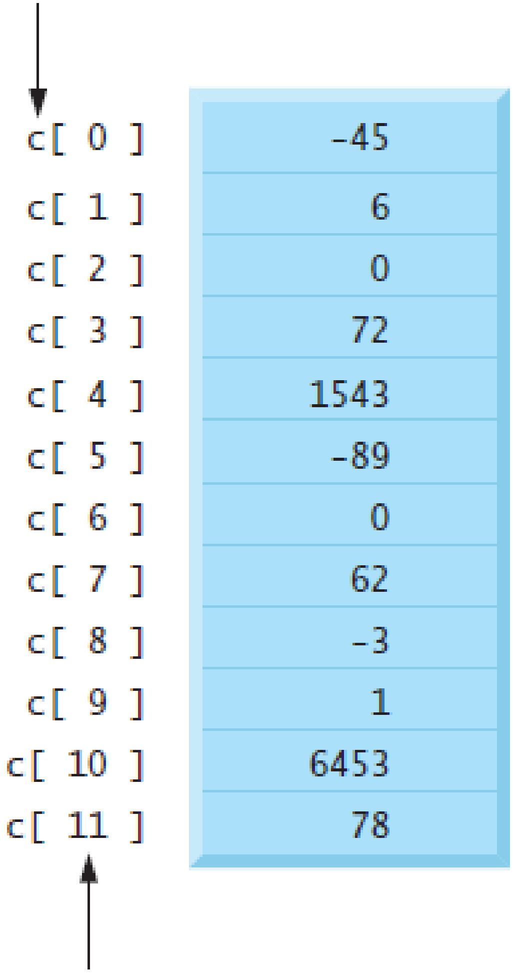
```
      int b[ 100 ], x[ 27 ];
```

reserves 100 elements for integer array b and 27 elements for integer array x.

```
char    chr_arr[100];
float    flt_arry[100];
double     dbl_arry[20];
```

An array is a group of memory locations related by the fact that they all have the same name and the same type. To refer to a particular location or element in the array, we specify the name of the array and the position number of the particular element in the array.

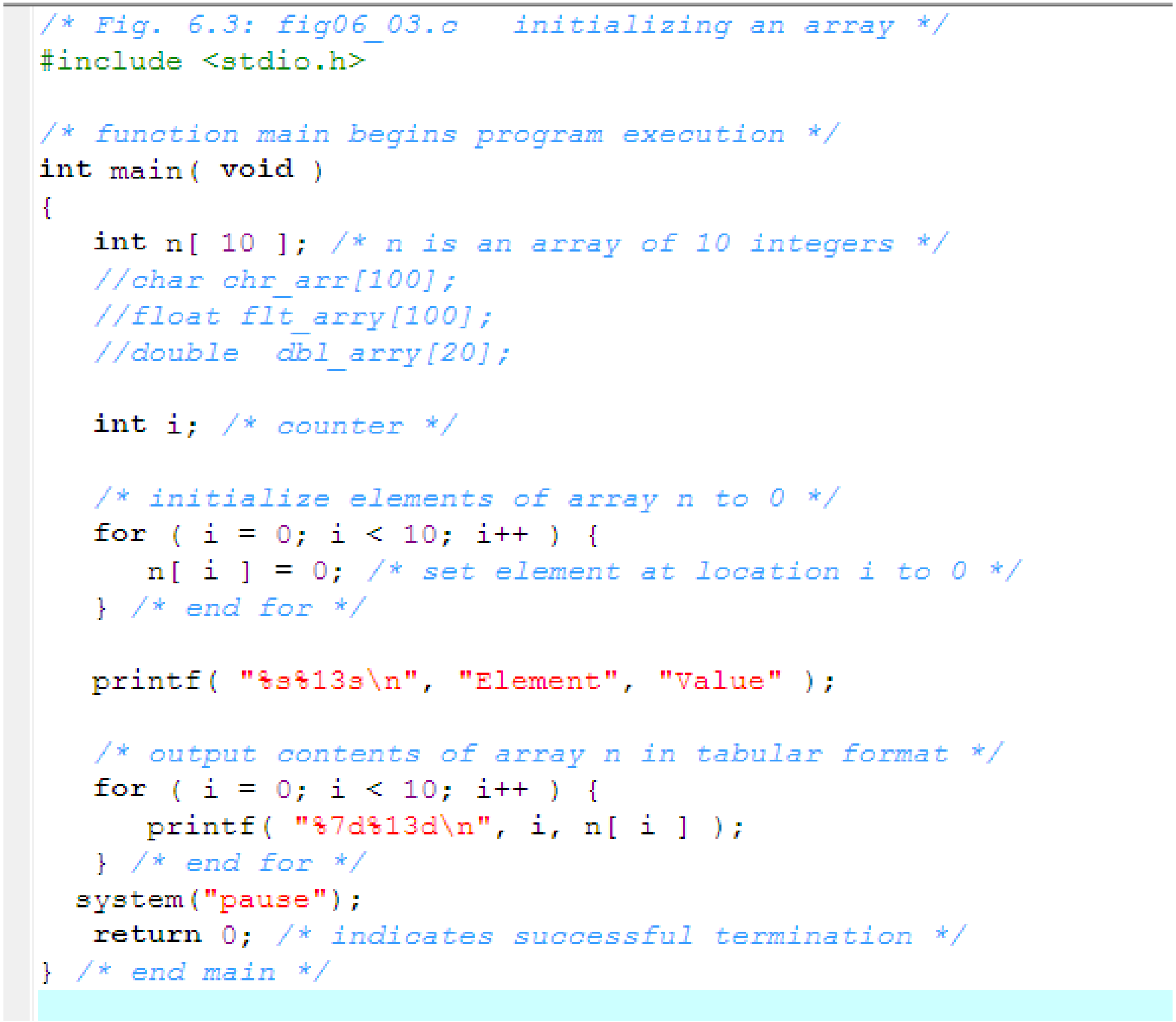
Name of array (note that all elements of this array have the same name, c)



c[0]	-45
c[1]	6
c[2]	0
c[3]	72
c[4]	1543
c[5]	-89
c[6]	0
c[7]	62
c[8]	-3
c[9]	1
c[10]	6453
c[11]	78

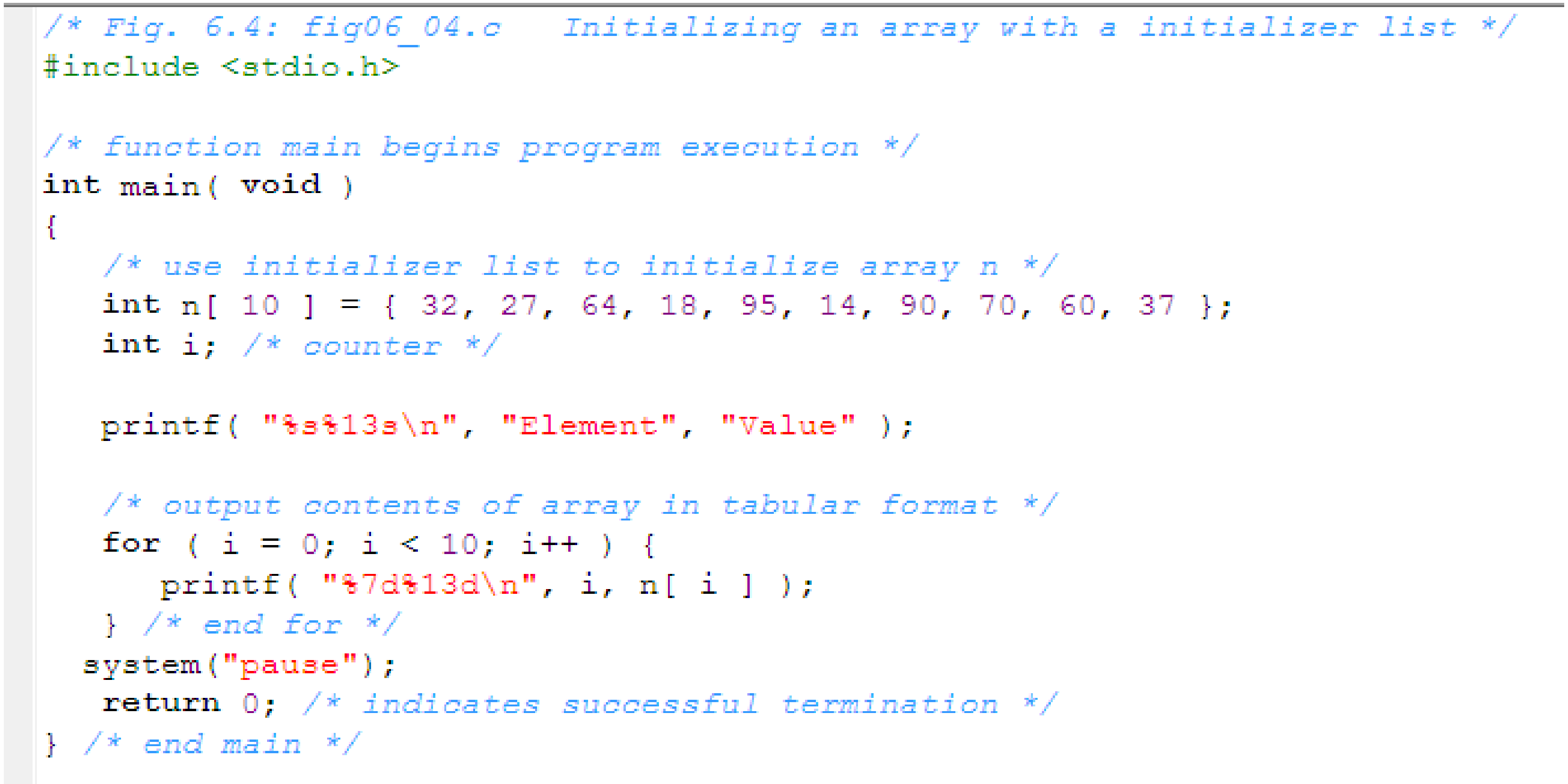
Position number of the element within array c

Defining an Array and Using a Loop to Initialize the Array's Elements

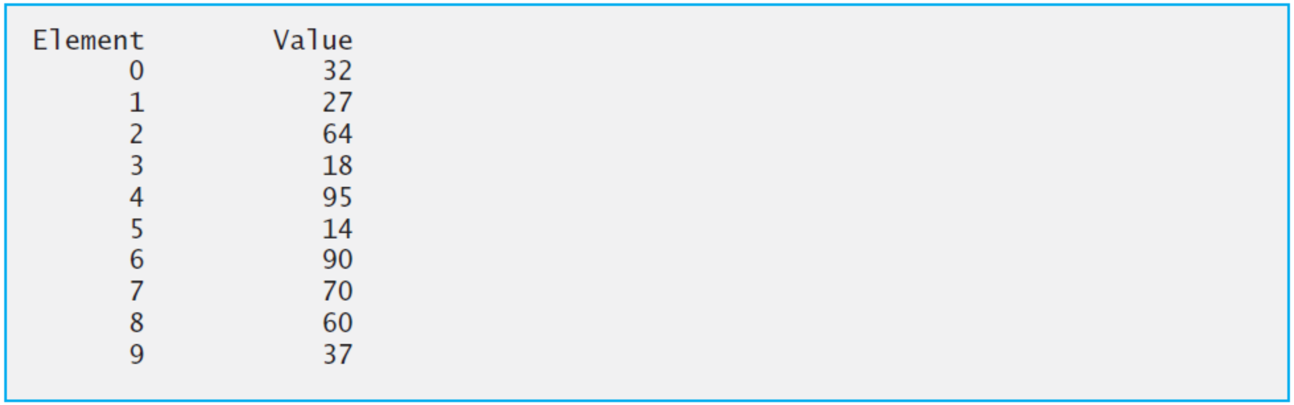


```
/* Fig. 6.3: fig06_03.c   initializing an array */
#include <stdio.h>

/* function main begins program execution */
int main( void )
{
   int n[ 10 ]; /* n is an array of 10 integers */
   //char chr_arr[100];
   //float flt_arry[100];
   //double  dbl_arry[20];

   int i; /* counter */

   /* initialize elements of array n to 0 */
   for ( i = 0; i < 10; i++ ) {
      n[ i ] = 0; /* set element at location i to 0 */
   } /* end for */

   printf( "%s%13s\n", "Element", "Value" );

   /* output contents of array n in tabular format */
   for ( i = 0; i < 10; i++ ) {
      printf( "%7d%13d\n", i, n[ i ] );
   } /* end for */
  system("pause");
   return 0; /* indicates successful termination */
} /* end main */
```

Initializing an Array in a Definition with an initializer List



```c
/* Fig. 6.4: fig06_04.c   Initializing an array with a initializer list */
#include <stdio.h>

/* function main begins program execution */
int main( void )
{
    /* use initializer list to initialize array n */
    int n[ 10 ] = { 32, 27, 64, 18, 95, 14, 90, 70, 60, 37 };
    int i; /* counter */

    printf( "%s%13s\n", "Element", "Value" );

    /* output contents of array in tabular format */
    for ( i = 0; i < 10; i++ ) {
        printf( "%7d%13d\n", i, n[ i ] );
    } /* end for */
   system("pause");
    return 0; /* indicates successful termination */
} /* end main */
```



```
Element        Value
      0           32
      1           27
      2           64
      3           18
      4           95
      5           14
      6           90
      7           70
      8           60
      9           37
```

TABLE 7.1 Statements That Manipulate Array x

Statement	Explanation
`printf("%.1f", x[0]);`	Displays the value of `x[0]`, which is `16.0`.
`x[3] = 25.0;`	Stores the value `25.0` in `x[3]`.
`sum = x[0] + x[1];`	Stores the sum of `x[0]` and `x[1]`, which is `28.0` in the variable `sum`.
`sum += x[2];`	Adds `x[2]` to `sum`. The new `sum` is `34.0`.
`x[3] += 1.0;`	Adds `1.0` to `x[3]`. The new `x[3]` is `26.0`.
`x[2] = x[0] + x[1];`	Stores the sum of `x[0]` and `x[1]` in `x[2]`. The new `x[2]` is `28.0`.

For example, if a = 5 and b = 6, then the statement

```
      c[ a + b ] += 2;
```

adds 2 to array element c[11]. A subscripted array name is an *lvalue*—it can be used on the left side of an assignment.

```
      printf( "%d", c[ 0 ] + c[ 1 ] + c[ 2 ] );
```

```
      x = c[ 6 ] / 2;
```

7.2 Array Subscripts

We use a subscript to differentiate between the individual array elements and to specify which array element is to be manipulated. We can use any expression of type `int` as an array subscript. However, to create a valid reference, the value of this subscript must lie between 0 and one less than the declared size of the array.

EXAMPLE 7.3

Understanding the distinction between an array subscript value and an array element value is essential. The original array `x` from Fig. 7.1 follows. The subscripted variable `x[i]` references a particular element of this array. If `i` has the value `0`, the subscript value is `0`, and `x[0]` is referenced. The value of `x[0]` in this case is `16.0`. If `i` has the value `2`, the subscript value is `2`, and the value of `x[i]` is `6.0`. If `i` has the value `8`, the subscript value is `8`, and we cannot predict the value of `x[i]` because the subscript value is out of the allowable range.

Array x

x[0]	x[1]	x[2]	x[3]	x[4]	x[5]	x[6]	x[7]
16.0	12.0	6.0	8.0	2.5	12.0	14.0	–54.5

TABLE 7.2 Code Fragment That Manipulates Array x

Statement	Explanation
`i = 5;`	
`printf("%d %.1f", 4, x[4]);`	Displays `4` and `2.5` (value of `x[4]`)
`printf("%d %.1f", i, x[i]);`	Displays `5` and `12.0` (value of `x[5]`)
`printf("%.1f", x[i] + 1);`	Displays `13.0` (value of `x[5]` plus `1`)
`printf("%.1f", x[i] + i);`	Displays `17.0` (value of `x[5]` plus `5`)
`printf("%.1f", x[i + 1]);`	Displays `14.0` (value of `x[6]`)
`printf("%.1f", x[i + i]);`	Invalid. Attempt to display `x[10]`
`printf("%.1f", x[2 * i]);`	Invalid. Attempt to display `x[10]`
`printf("%.1f", x[2 * i - 3]);`	Displays `-54.5` (value of `x[7]`)
`printf("%.1f", x[(int)x[4]]);`	Displays `6.0` (value of `x[2]`)
`printf("%.1f", x[i++]);`	Displays `12.0` (value of `x[5]);` then assigns `6` to `i`
`printf("%.1f", x[--i]);`	Assigns `5` (`6 - 1`) to `i` and then displays `12.0` (value of `x[5]`)
`x[i - 1] = x[i];`	Assigns `12.0` (value of `x[5]`) to `x[4]`
`x[i] = x[i + 1];`	Assigns `14.0` (value of `x[6]`) to `x[5]`
`x[i] - 1 = x[i];`	Illegal assignment statement

If there are fewer initializers than elements in the array, the remaining elements are initialized to zero. For example, the elements of the array n in Fig. 6.3 could have been initialized to zero as follows:

```
int n[ 10 ] = { 0 };
```

The array definition

```
int n[ 5 ] = { 32, 27, 64, 18, 95, 14 };
```

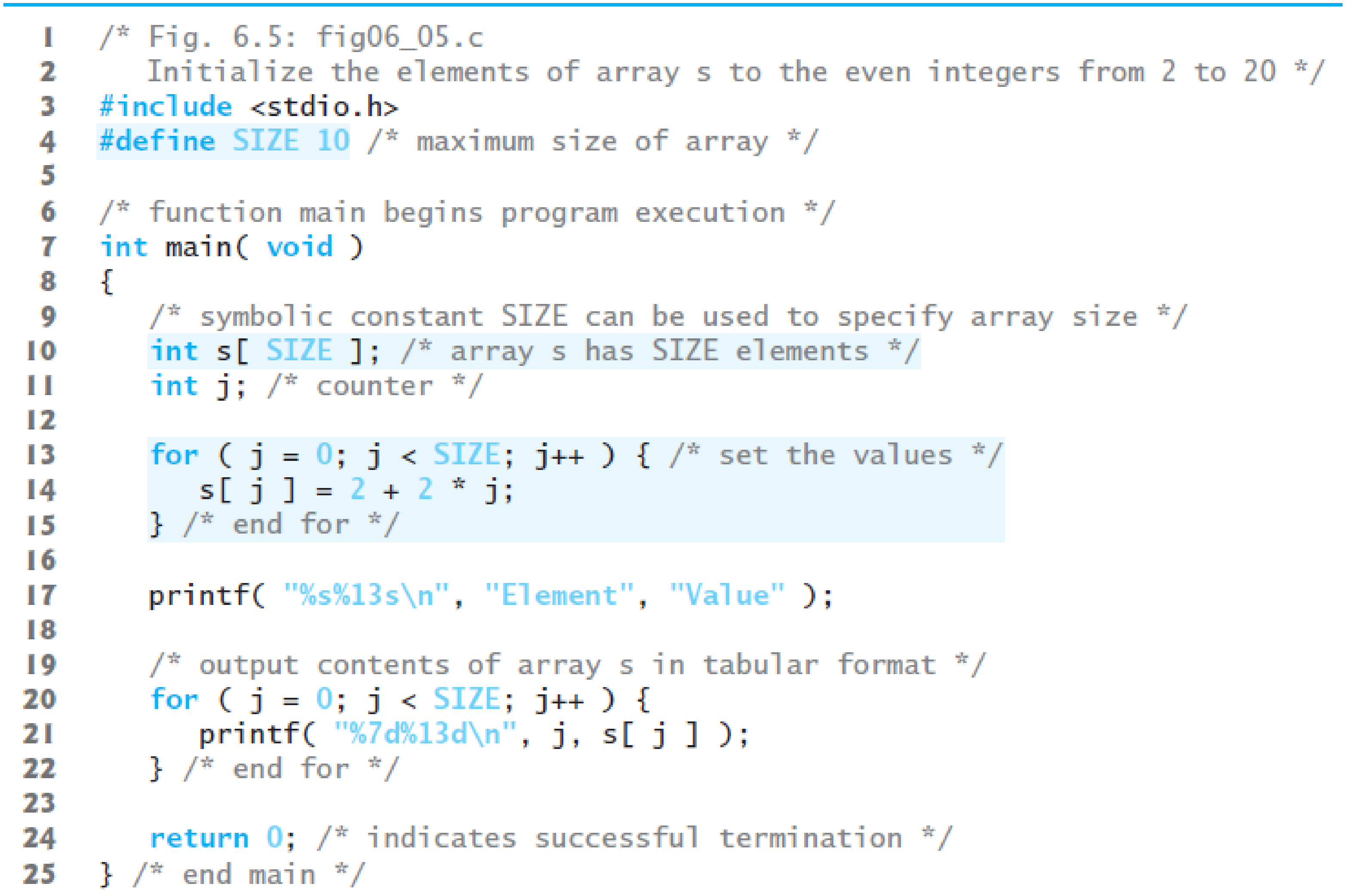
causes a syntax error because there are six initializers and only five array elements.

If the array size is omitted from a definition with an initializer list, the number of elements in the array will be the number of elements in the initializer list. For example,

```
int n[] = { 1, 2, 3, 4, 5 };
```

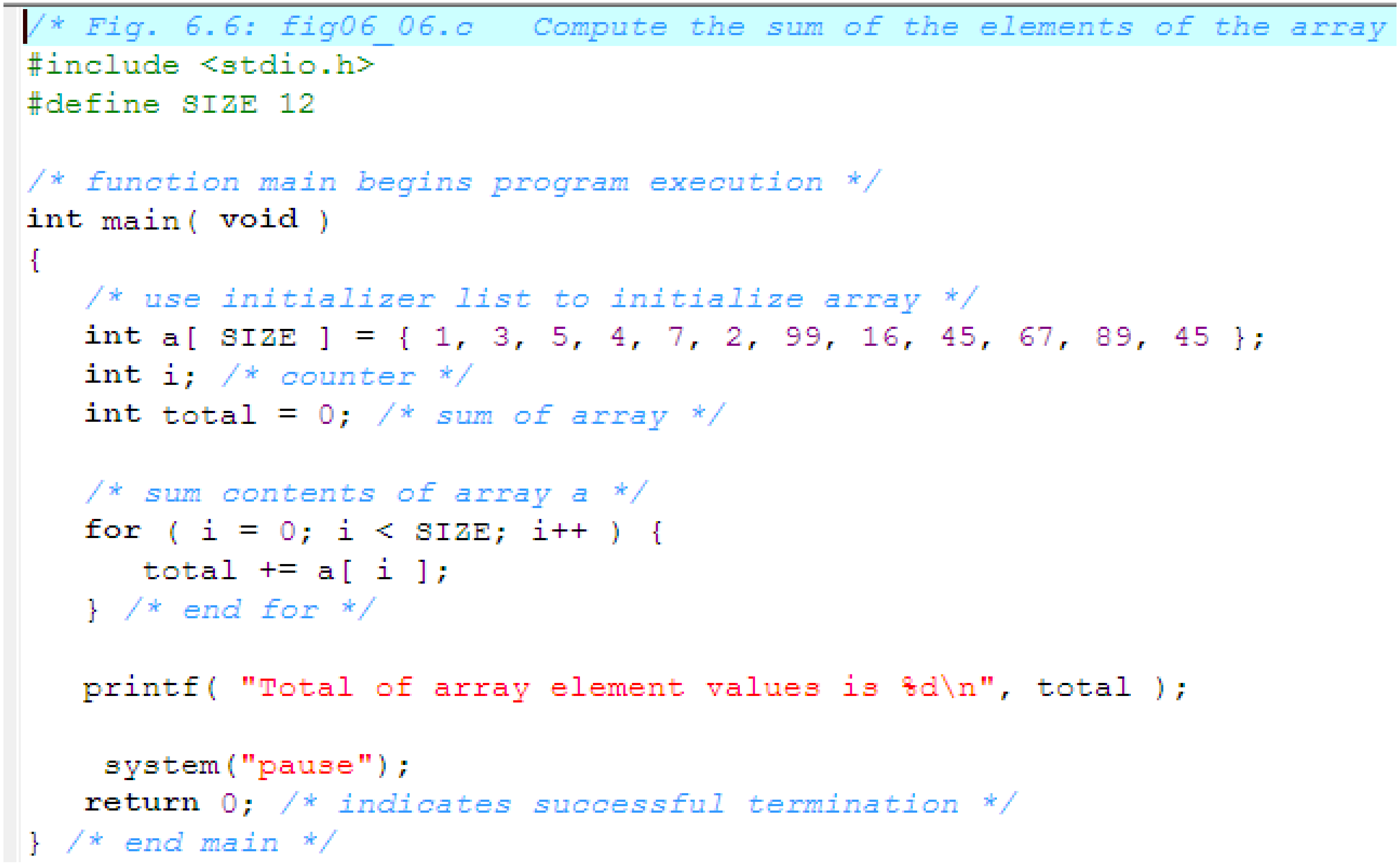
would create a five-element array.

Specifying an Array's Size with a Symbolic Constant and Initializing Array Elements with Calculations



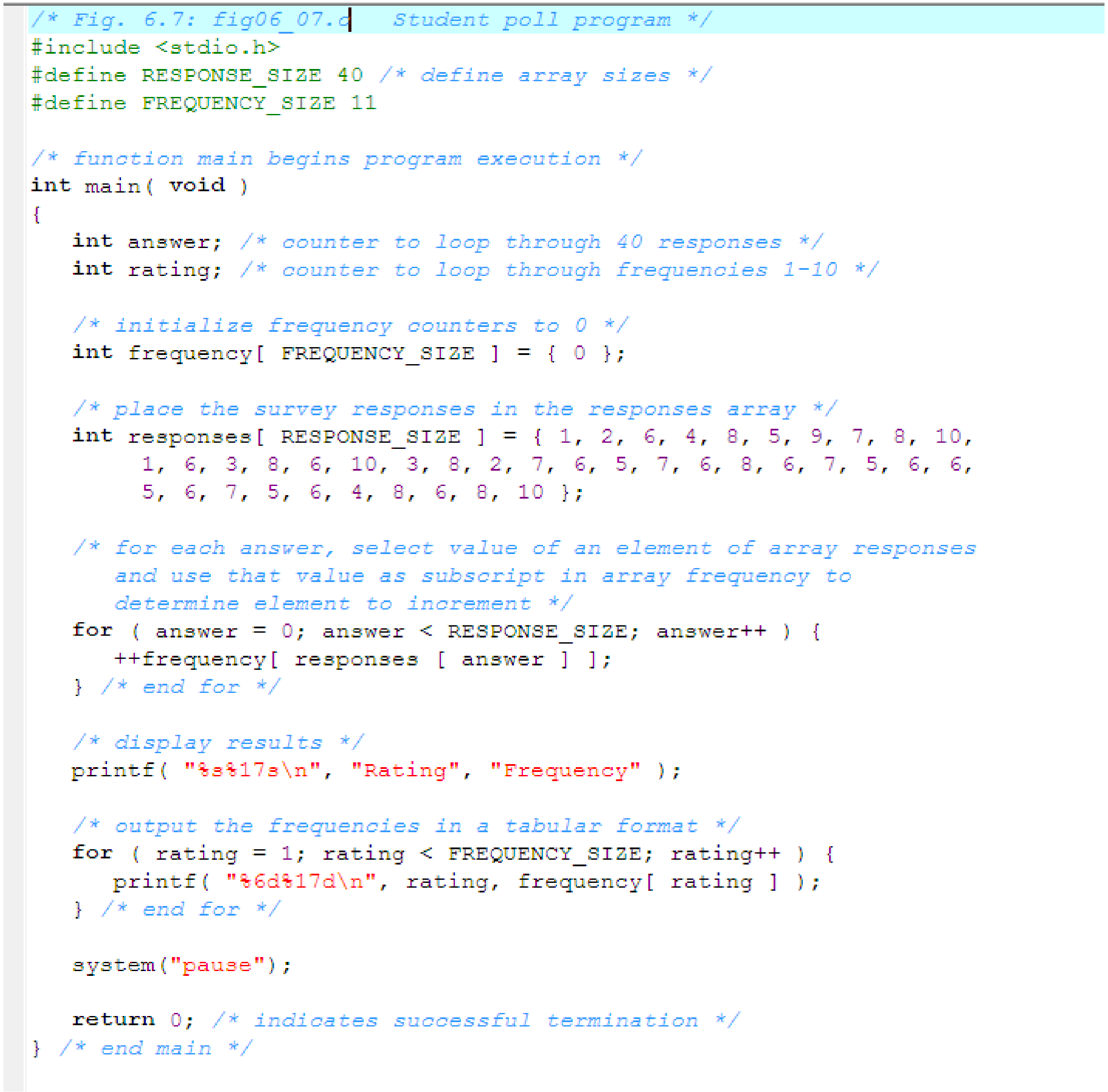
```c
/* Fig. 6.5: fig06_05.c
   Initialize the elements of array s to the even integers from 2 to 20 */
#include <stdio.h>
#define SIZE 10 /* maximum size of array */

/* function main begins program execution */
int main( void )
{
   /* symbolic constant SIZE can be used to specify array size */
   int s[ SIZE ]; /* array s has SIZE elements */
   int j; /* counter */

   for ( j = 0; j < SIZE; j++ ) { /* set the values */
      s[ j ] = 2 + 2 * j;
   } /* end for */

   printf( "%s%13s\n", "Element", "Value" );

   /* output contents of array s in tabular format */
   for ( j = 0; j < SIZE; j++ ) {
      printf( "%7d%13d\n", j, s[ j ] );
   } /* end for */

   return 0; /* indicates successful termination */
} /* end main */
```

Summing the Elements of an Array



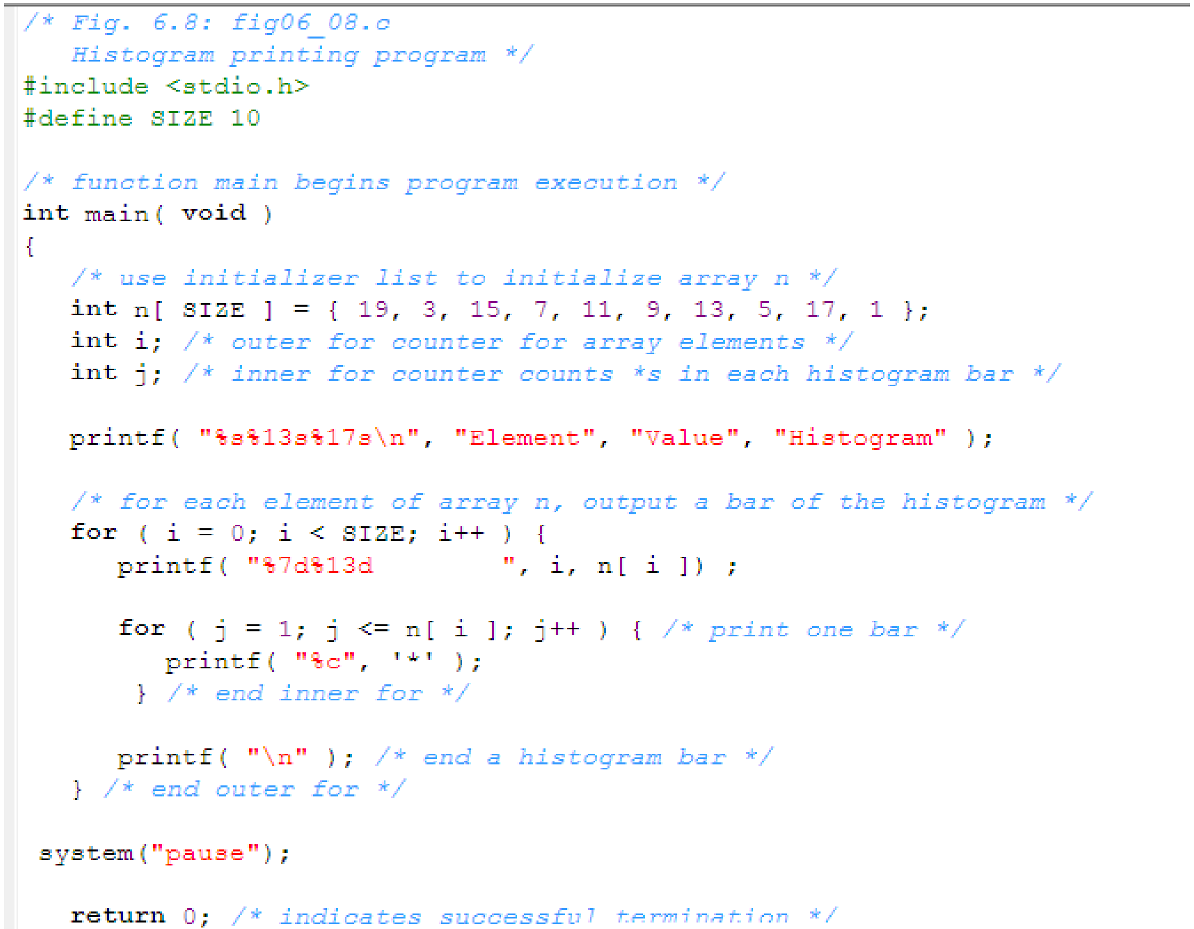
```
/* Fig. 6.6: fig06_06.c   Compute the sum of the elements of the array
#include <stdio.h>
#define SIZE 12

/* function main begins program execution */
int main( void )
{
   /* use initializer list to initialize array */
   int a[ SIZE ] = { 1, 3, 5, 4, 7, 2, 99, 16, 45, 67, 89, 45 };
   int i; /* counter */
   int total = 0; /* sum of array */

   /* sum contents of array a */
   for ( i = 0; i < SIZE; i++ ) {
      total += a[ i ];
   } /* end for */

   printf( "Total of array element values is %d\n", total );

    system("pause");
   return 0; /* indicates successful termination */
} /* end main */
```

Using Arrays to Summarize Survey Results

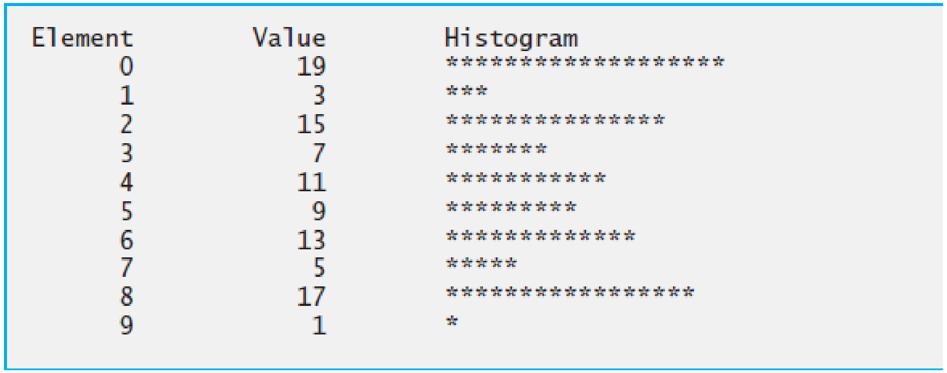


```c
/* Fig. 6.7: fig06_07.c   Student poll program */
#include <stdio.h>
#define RESPONSE_SIZE 40 /* define array sizes */
#define FREQUENCY_SIZE 11

/* function main begins program execution */
int main( void )
{
   int answer; /* counter to loop through 40 responses */
   int rating; /* counter to loop through frequencies 1-10 */

   /* initialize frequency counters to 0 */
   int frequency[ FREQUENCY_SIZE ] = { 0 };

   /* place the survey responses in the responses array */
   int responses[ RESPONSE_SIZE ] = { 1, 2, 6, 4, 8, 5, 9, 7, 8, 10,
        1, 6, 3, 8, 6, 10, 3, 8, 2, 7, 6, 5, 7, 6, 8, 6, 7, 5, 6, 6,
        5, 6, 7, 5, 6, 4, 8, 6, 8, 10 };

   /* for each answer, select value of an element of array responses
      and use that value as subscript in array frequency to
      determine element to increment */
   for ( answer = 0; answer < RESPONSE_SIZE; answer++ ) {
      ++frequency[ responses [ answer ] ];
   } /* end for */

   /* display results */
   printf( "%s%17s\n", "Rating", "Frequency" );

   /* output the frequencies in a tabular format */
   for ( rating = 1; rating < FREQUENCY_SIZE; rating++ ) {
      printf( "%6d%17d\n", rating, frequency[ rating ] );
   } /* end for */

   system("pause");

   return 0; /* indicates successful termination */
} /* end main */
```

Graphing Array Element Values with Histograms

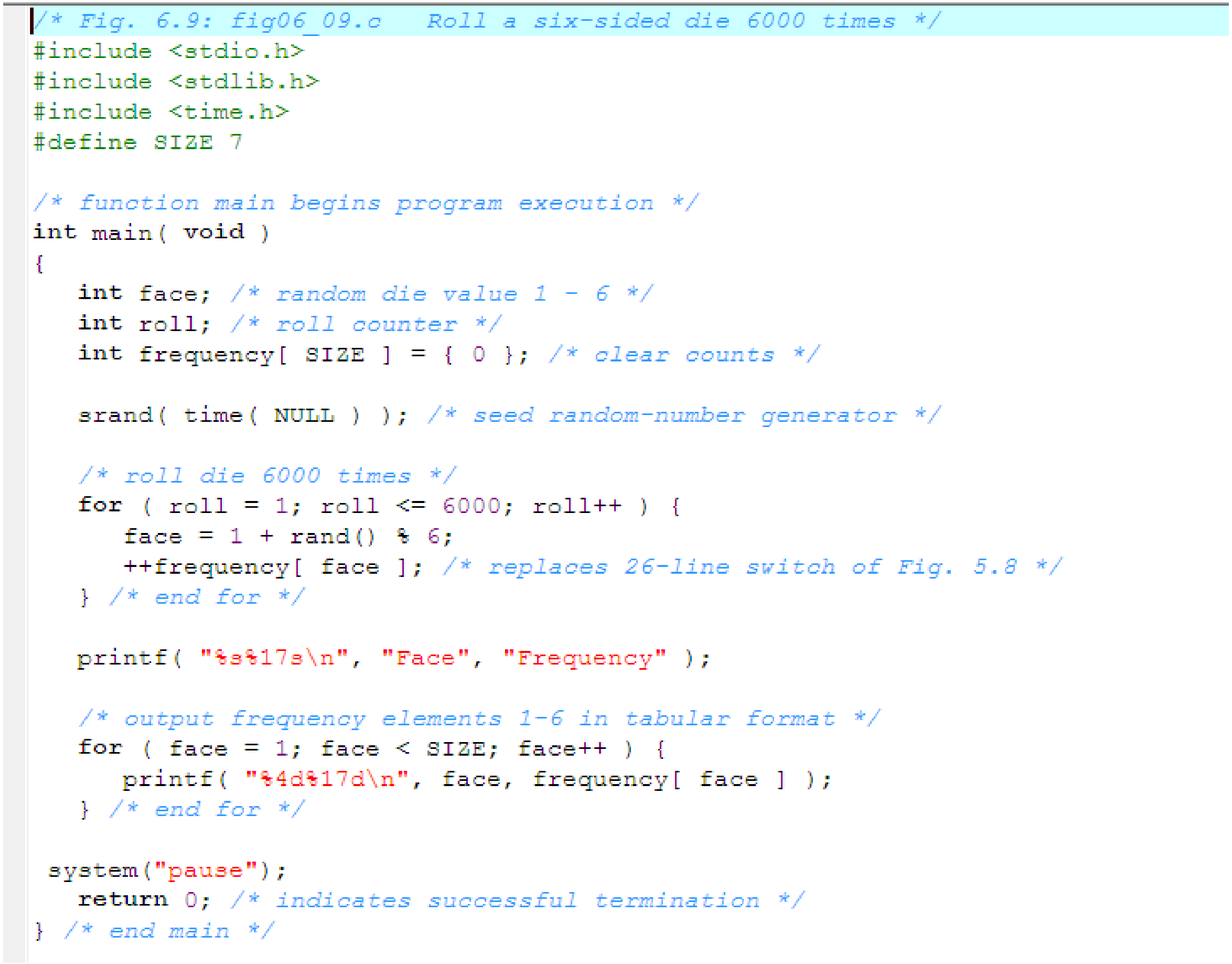


```c
/* Fig. 6.8: fig06_08.c
   Histogram printing program */
#include <stdio.h>
#define SIZE 10

/* function main begins program execution */
int main( void )
{
   /* use initializer list to initialize array n */
   int n[ SIZE ] = { 19, 3, 15, 7, 11, 9, 13, 5, 17, 1 };
   int i; /* outer for counter for array elements */
   int j; /* inner for counter counts *s in each histogram bar */

   printf( "%s%13s%17s\n", "Element", "Value", "Histogram" );

   /* for each element of array n, output a bar of the histogram */
   for ( i = 0; i < SIZE; i++ ) {
      printf( "%7d%13d        ", i, n[ i ]) ;

      for ( j = 1; j <= n[ i ]; j++ ) { /* print one bar */
         printf( "%c", '*' );
       } /* end inner for */

      printf( "\n" ); /* end a histogram bar */
   } /* end outer for */

 system("pause");

   return 0; /* indicates successful termination */
} /* end main */
```



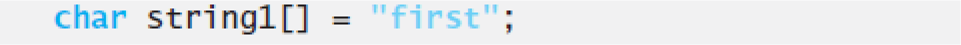
```
Element        Value          Histogram
      0           19          *******************
      1            3          ***
      2           15          ***************
      3            7          *******
      4           11          ***********
      5            9          *********
      6           13          *************
      7            5          *****
      8           17          *****************
      9            1          *
```

Rolling a Die 6000 Times and Summarizing the Results in an Array

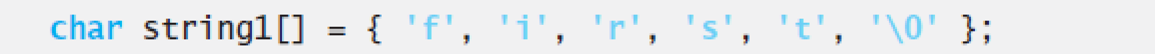


```c
/* Fig. 6.9: fig06_09.c   Roll a six-sided die 6000 times */
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#define SIZE 7

/* function main begins program execution */
int main( void )
{
   int face; /* random die value 1 - 6 */
   int roll; /* roll counter */
   int frequency[ SIZE ] = { 0 }; /* clear counts */

   srand( time( NULL ) ); /* seed random-number generator */

   /* roll die 6000 times */
   for ( roll = 1; roll <= 6000; roll++ ) {
      face = 1 + rand() % 6;
      ++frequency[ face ]; /* replaces 26-line switch of Fig. 5.8 */
   } /* end for */

   printf( "%s%17s\n", "Face", "Frequency" );

   /* output frequency elements 1-6 in tabular format */
   for ( face = 1; face < SIZE; face++ ) {
      printf( "%4d%17d\n", face, frequency[ face ] );
   } /* end for */

 system("pause");
   return 0; /* indicates successful termination */
} /* end main */
```

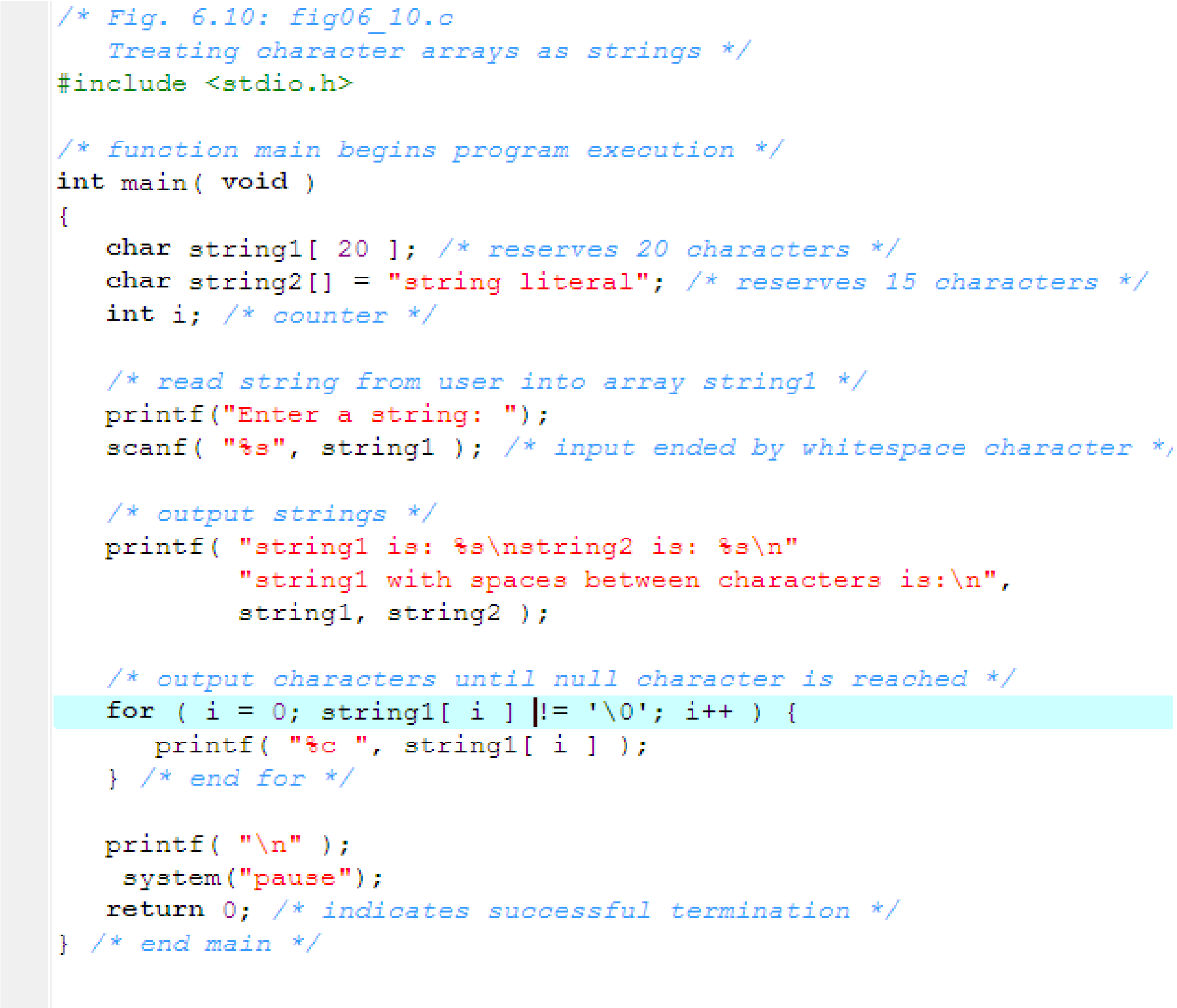
Using Character Arrays to Store and Manipulate Strings



```
char string1[] = "first";
```



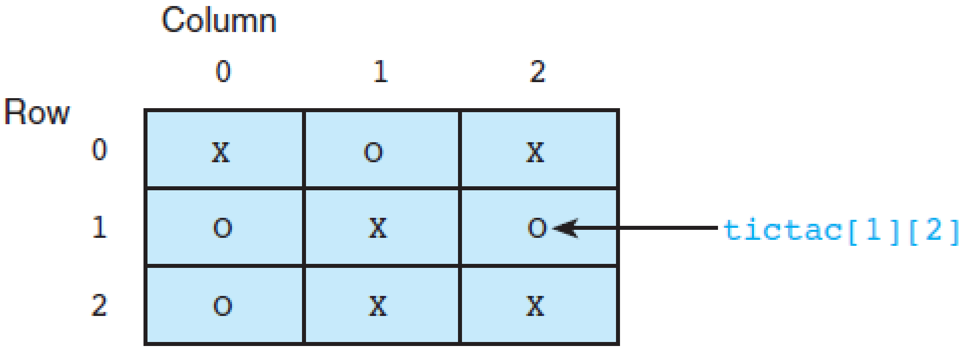
```
char string1[] = { 'f', 'i', 'r', 's', 't', '\0' };
```



```
/* Fig. 6.10: fig06_10.c
   Treating character arrays as strings */
#include <stdio.h>

/* function main begins program execution */
int main( void )
{
   char string1[ 20 ]; /* reserves 20 characters */
   char string2[] = "string literal"; /* reserves 15 characters */
   int i; /* counter */

   /* read string from user into array string1 */
   printf("Enter a string: ");
   scanf( "%s", string1 ); /* input ended by whitespace character *,

   /* output strings */
   printf( "string1 is: %s\nstring2 is: %s\n"
           "string1 with spaces between characters is:\n",
           string1, string2 );

   /* output characters until null character is reached */
   for ( i = 0; string1[ i ] != '\0'; i++ ) {
      printf( "%c ", string1[ i ] );
   } /* end for */

   printf( "\n" );
    system("pause");
   return 0; /* indicates successful termination */
} /* end main */
```

Multidimensional Arrays

```
char tictac[3][3];
```



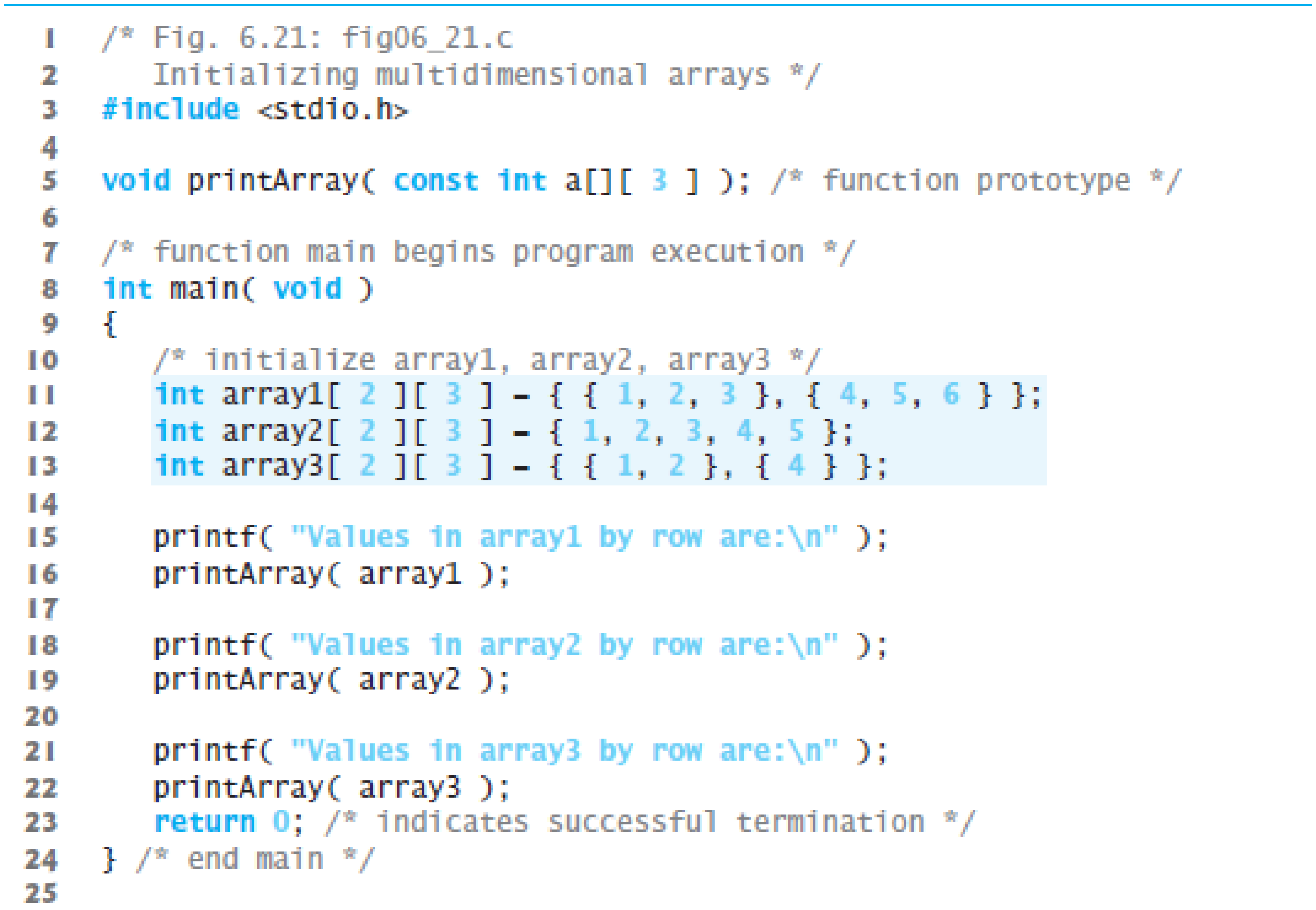
Column

Row	0	1	2
0	X	O	X
1	O	X	O
2	O	X	X

tictac[1][2]

FIGURE 7.21 Function to Check Whether Tic-tac-toe Board Is Filled

```
/* Checks whether a tic-tac-toe board is completely filled.                  */
int
filled(char ttt_brd[3][3])  /* input - tic-tac-toe board                     */
{
      int r, c, /* row and column subscripts   */
          ans;  /* whether or not board filled */

      /* Assumes board is filled until blank is found                        */
      ans = 1;

      /* Resets ans to zero if a blank is found                              */
      for (r = 0; r < 3; ++r)
         for  (c = 0; c < 3; ++c)
            if (ttt_brd[r][c] == ' ')
                 ans = 0;

      return (ans);
}
```



```c
/* Fig. 6.21: fig06_21.c
   Initializing multidimensional arrays */
#include <stdio.h>

void printArray( const int a[][ 3 ] ); /* function prototype */

/* function main begins program execution */
int main( void )
{
   /* initialize array1, array2, array3 */
   int array1[ 2 ][ 3 ] = { { 1, 2, 3 }, { 4, 5, 6 } };
   int array2[ 2 ][ 3 ] = { 1, 2, 3, 4, 5 };
   int array3[ 2 ][ 3 ] = { { 1, 2 }, { 4 } };

   printf( "Values in array1 by row are:\n" );
   printArray( array1 );

   printf( "Values in array2 by row are:\n" );
   printArray( array2 );

   printf( "Values in array3 by row are:\n" );
   printArray( array3 );
   return 0; /* indicates successful termination */
} /* end main */

```

6.5 Passing Arrays to Functions

To pass an array argument to a function, specify the name of the array without any brackets. For example, if array hourlyTemperatures has been defined as

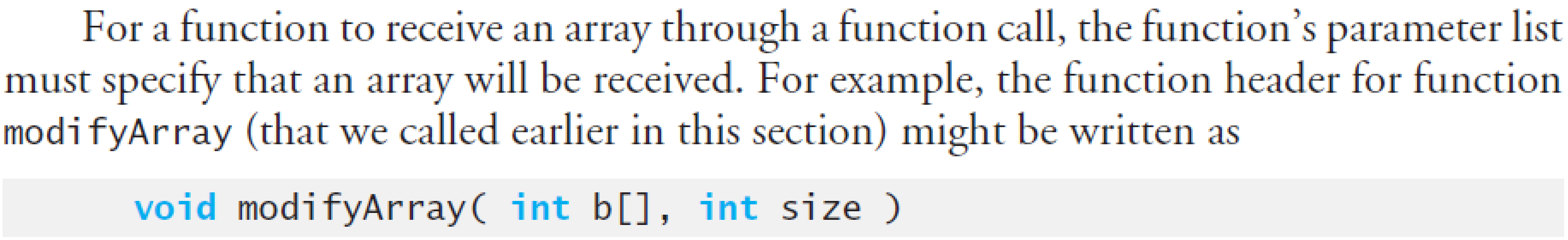
```
      int hourlyTemperatures[ 24 ];
```

the function call

```
      modifyArray( hourlyTemperatures, 24 )
```

passes array hourlyTemperatures and its size to function modifyArray. Unlike char arrays that contain strings, other array types do not have a special terminator. For this reason, the size of an array is passed to the function, so that the function can process the proper number of elements.

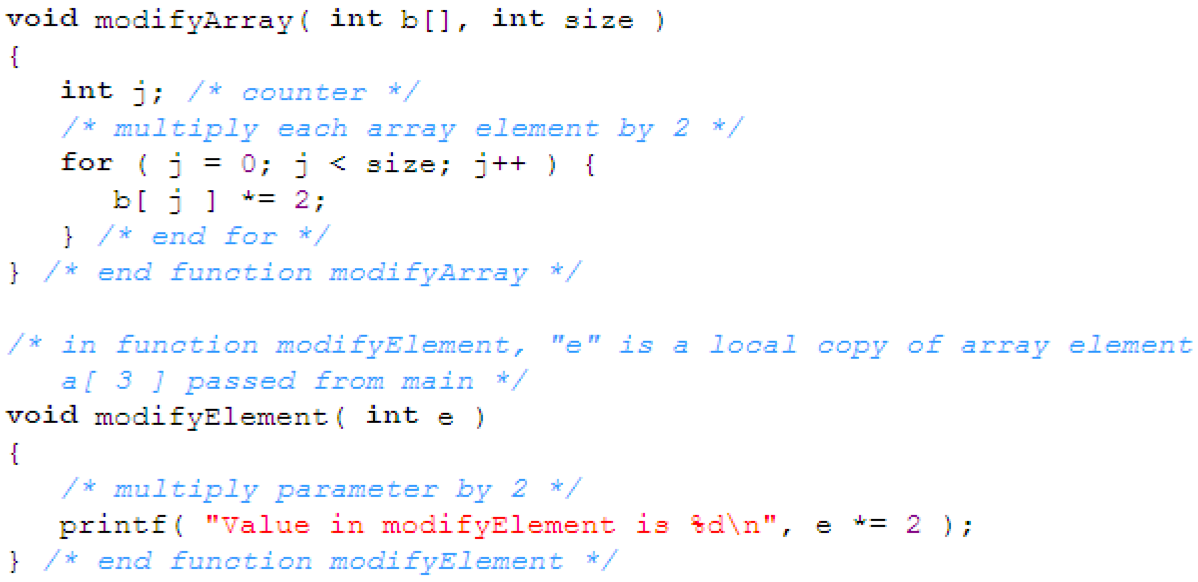
C automatically passes arrays to functions by reference—the called functions can modify the element values in the callers' original arrays. The name of the array evaluates to the address of the first element of the array. Because the starting address of the array is passed, the called function knows precisely where the array is stored. Therefore, when the called function modifies array elements in its function body, it's modifying the actual elements of the array in their original memory locations.



For a function to receive an array through a function call, the function's parameter list must specify that an array will be received. For example, the function header for function `modifyArray` (that we called earlier in this section) might be written as

```
void modifyArray( int b[], int size )
```

Fig. 6.13:



```
void modifyArray( int b[], int size )
{
   int j; /* counter */
   /* multiply each array element by 2 */
   for ( j = 0; j < size; j++ ) {
      b[ j ] *= 2;
   } /* end for */
} /* end function modifyArray */

/* in function modifyElement, "e" is a local copy of array element
   a[ 3 ] passed from main */
void modifyElement( int e )
{
   /* multiply parameter by 2 */
   printf( "Value in modifyElement is %d\n", e *= 2 );
} /* end function modifyElement */
```

modifyArray(a, SIZE);

modifyElement(a[3]); /* pass array element a[3] by value */

Performance Tip 6.3

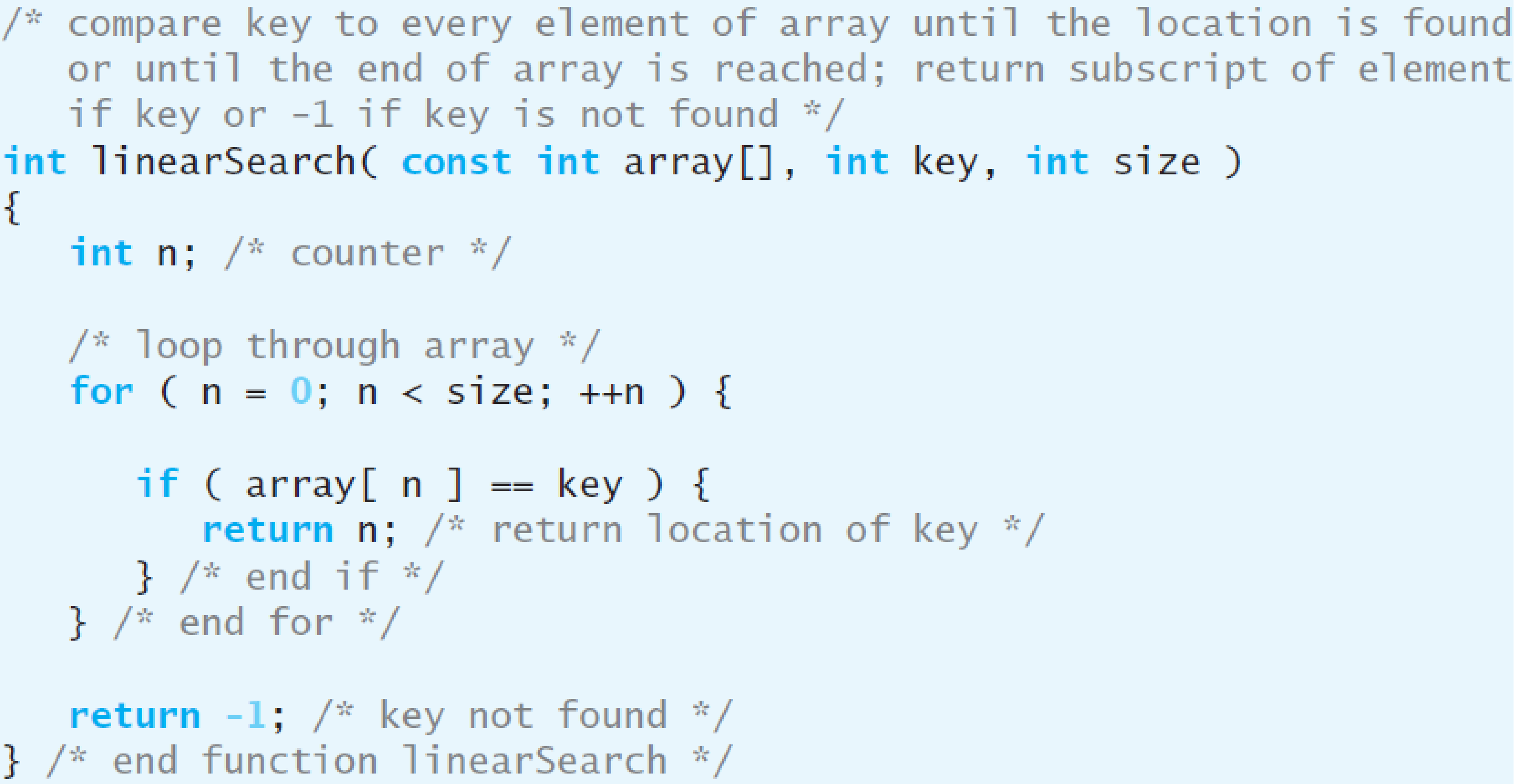
Passing arrays by reference makes sense for performance reasons. If arrays were passed by value, a copy of each element would be passed. For large, frequently passed arrays, this would be time consuming and would consume storage for the copies of the arrays.

```c
/* Fig. 6.12: fig06_12.c
   The name of an array is the same as &array[ 0 ] */
#include <stdio.h>

/* function main begins program execution */
int main( void )
{
   char array[ 5 ]; /* define an array of size 5 */

   printf( "    array = %p\n&array[0] = %p\n   &array = %p\n",
      array, &array[ 0 ], &array );
   return 0; /* indicates successful termination */
} /* end main */
```

```
    array = 0012FF78
&array[0] = 0012FF78
   &array = 0012FF78
```

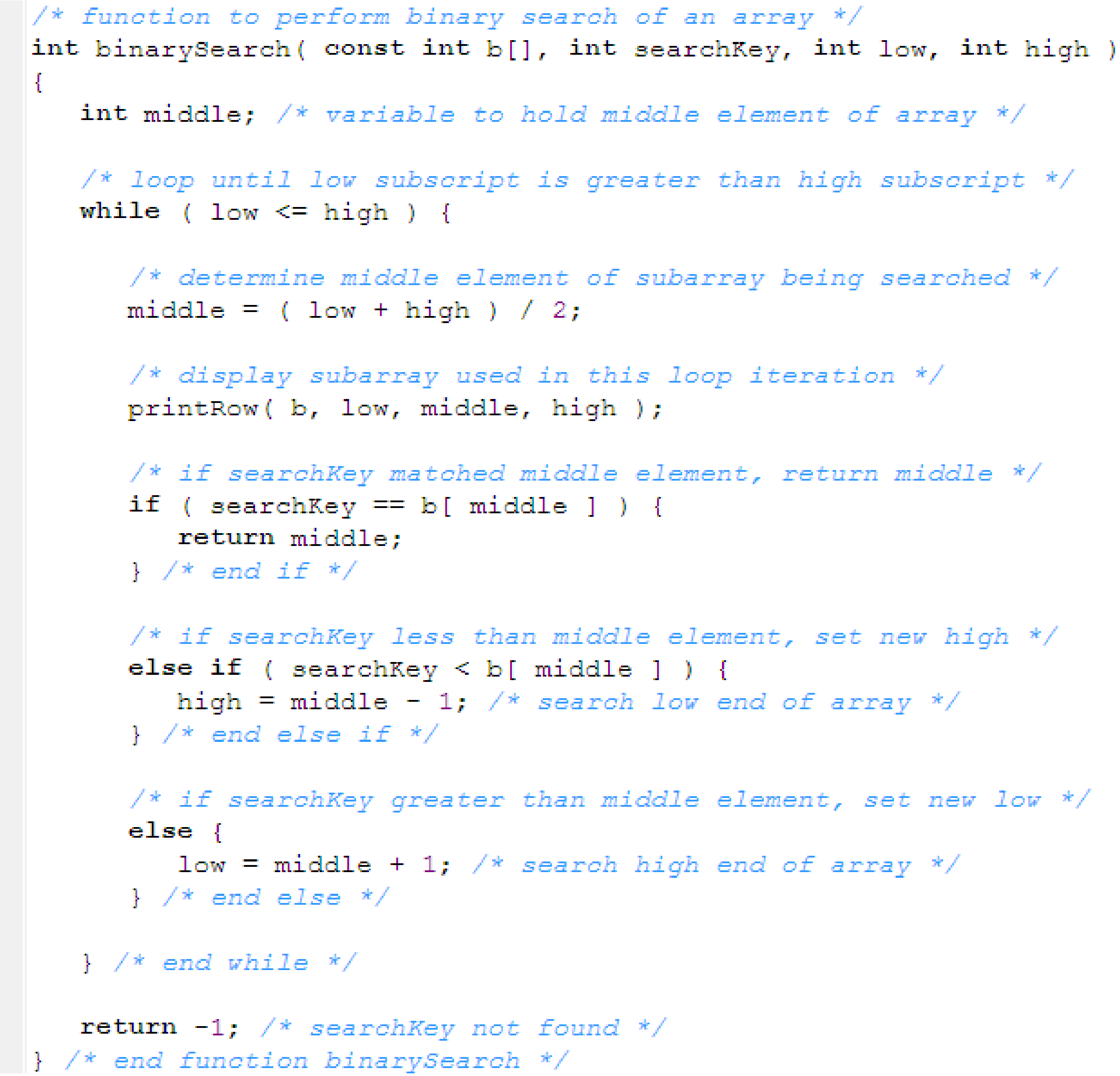
Fig. 6.12 | Array name is the same as the address of the array's first element.

Searching Arrays (linear)



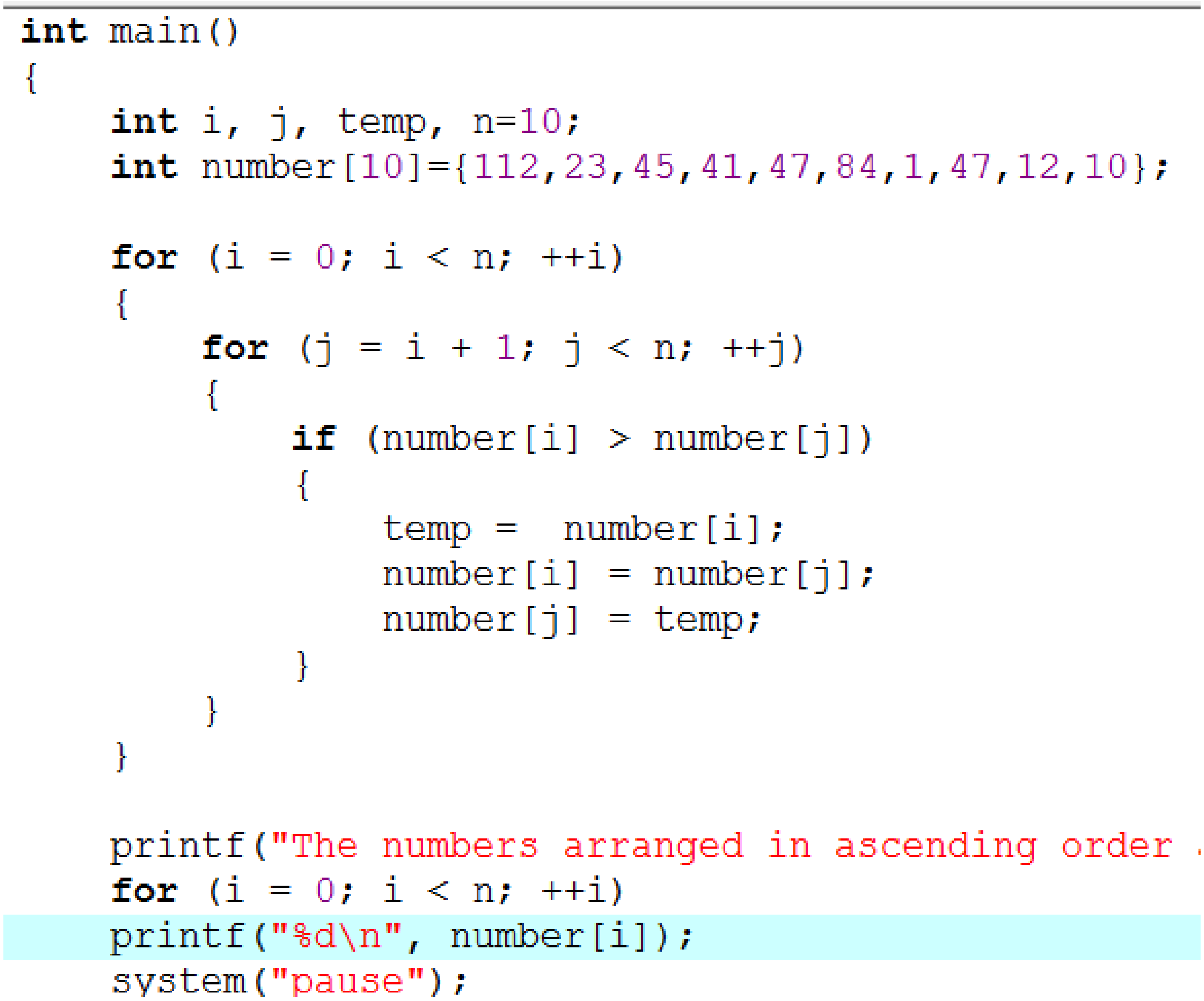
```
/* compare key to every element of array until the location is found
   or until the end of array is reached; return subscript of element
   if key or -1 if key is not found */
int linearSearch( const int array[], int key, int size )
{
   int n; /* counter */

   /* loop through array */
   for ( n = 0; n < size; ++n ) {

      if ( array[ n ] == key ) {
         return n; /* return location of key */
      } /* end if */
   } /* end for */

   return -1; /* key not found */
} /* end function linearSearch */
```

Searching Arrays (binary)



```
/* function to perform binary search of an array */
int binarySearch( const int b[], int searchKey, int low, int high )
{
   int middle; /* variable to hold middle element of array */

   /* loop until low subscript is greater than high subscript */
   while ( low <= high ) {

      /* determine middle element of subarray being searched */
      middle = ( low + high ) / 2;

      /* display subarray used in this loop iteration */
      printRow( b, low, middle, high );

      /* if searchKey matched middle element, return middle */
      if ( searchKey == b[ middle ] ) {
         return middle;
      } /* end if */

      /* if searchKey less than middle element, set new high */
      else if ( searchKey < b[ middle ] ) {
         high = middle - 1; /* search low end of array */
      } /* end else if */

      /* if searchKey greater than middle element, set new low */
      else {
         low = middle + 1; /* search high end of array */
      } /* end else */

   } /* end while */

   return -1; /* searchKey not found */
} /* end function binarySearch */
```

Sorting Arrays



```
int main()
{
    int i, j, temp, n=10;
    int number[10]={112,23,45,41,47,84,1,47,12,10};

    for (i = 0; i < n; ++i)
    {
        for (j = i + 1; j < n; ++j)
        {
            if (number[i] > number[j])
            {
                temp =  number[i];
                number[i] = number[j];
                number[j] = temp;
            }
        }
    }

    printf("The numbers arranged in ascending order
    for (i = 0; i < n; ++i)
    printf("%d\n", number[i]);
    system("pause");
```

Static Local Arrays and Automatic Local Arrays

Chapter 5 discussed the storage-class specifier `static`. A `static` local variable exists for the duration of the program, but is visible only in the function body. We can apply `static` to a local array definition so the array is not created and initialized each time the function is called and the array is not destroyed each time the function is exited in the program. This reduces program execution time, particularly for programs with frequently called functions that contain large arrays.

Arrays that are `static` are initialized once at compile time. If you do not explicitly initialize a `static` array, that array's elements are initialized to zero by the compiler.

```c
/* Fig. 6.11: fig06_11.c
   Static arrays are initialized to zero */
#include <stdio.h>

void staticArrayInit( void ); /* function prototype */
void automaticArrayInit( void ); /* function prototype */

/* function main begins program execution */
int main( void )
{
   printf( "First call to each function:\n" );
   staticArrayInit();
   automaticArrayInit();
```

35) What is the output?

```
 int i,a[]={1,2,3,4,5},b[]={10,20,30,40,50};
for(i=1; i<5; i++)
   b[i]=a[i]+b[i-1];
for(i=0; i<5; i++)
   printf("%d ",b[i]);
```

[✓ **a)** 10 12 15 19 24] **b)** 1 12 23 34 45 **c)** 11 22 33 44 55
d) 10 32 53 74 95 **e)** 21 32 43 54 50

36) What is the output?

```
int i,a3[4];
  for(i=0; i<4; i++)
     a3[i]=i*2+1;
  for(i=0; i<3; i++)
     a3[i]=a3[i+1];
  a3[3]=a3[0];
  for(i=0; i<4; i++)
     printf("%d",a3[i]);
```

a) 1111 **b)** 3571 [✓ **c)** 3573] **d)** 5793 **e)** 7777

37) What is the output?

```
 int ar1[]={1,2,3,4,5};
  int ar2[3]={9};
  printf("%d,%d",ar1[1],ar2[1]);
```

a) 0,9 **b)** 1,9 **c)** 1,0 **d)** 2,0 **e)** 2,9

38) What is the output?

```
      int a[5]={11,1,16,-1,13};
      printf("%d",a[a[2]-a[4]]);
```

a) -1 **b)** 1 **c)** 2 **d)** 11 **e)** 16

39) What is the output?

```
      int j,c,x[]={5,-3,-1,7,8,-2,0,9,-6,8};
      for(c=0,j=0;j<10;j++)
      if (x[j]<0) c=c+j;
      printf("%d",c);
```

a) 0 **b)** 16 **c)** 20 **d)** 8 **e)** 4

40) Which one of the following declarations is wrong and causes a compile error?

a) `char a[]={'a',61,'9'};`

b) `int b[5]={0,1};`

c) `float c[]={5.5,3};`

d) `int d[]={};`

e) `double e[3]={7.8,1.0,3.5};`

43) What is the output?

```
void main() {
  int A[10][10]={{1,2,3},{3,4,5}};
  int B[10][10]={{2,2,2},{5,4,3}},C[10][10];
  int i,j, N=2, M=3;
  for (i=0;i<N;i++)
    for (j=0;j<M;j++)
      if (A[i][j]>B[i][j])
       C[i][j]=A[i][j];
      else
      C[i][j]=B[i][j];
  for (i=0;i<N;i++)
  {
    for (j=0;j<M;j++)
    printf("%d ",C[i][j]);
    printf("\n");
  }
}
```

a) 1 2 3 3 4 5	**b)** 2 5 2 4 2 3	**c)** 1 2 3 5 4 3	**d)** 2 5 2 4 3 5	**e)** 2 2 3 5 4 5

44) What is the output?

```
 void main() {
  int A[10][10]={{1,2,3},{3,4,5}};
  int B[10][10]={{2,2,2},{5,4,3}},C[10][10];
  int i,j, N=2, M=3;
  for (i=0;i<N;i++)
    for (j=0;j<M;j++)
      if (A[i][j]>B[i][j])
       C[j][i]=A[i][j];
      else
      C[j][i]=B[i][j];
  for (i=0;i<M;i++)
  {
    for (j=0;j<N;j++)
    printf("%d ",C[i][j]);
    printf("\n");
  }
}
```

a)
```
1 2 3
3 4 5
```

b)
```
2 5
2 4
2 3
```

c)
```
1 2 3
5 4 3
```

d)
```
2 5
2 4
3 5
```

e)
```
2 2 3
5 4 5
```

45) What is the output?

```
#include <stdio.h>
 void f3(int n, int a[]) {
  int i;
   for (i=0;i<n;i++)
     a[i]++;
   for (i=0;i<n;i++)
     printf("%d ",a[i]);
   printf("\n"); }
void main() {
  int A[]={1,2,3,3,4,5},B[10];
  int i, N=6;
  for (i=0;i<N;i++)
    B[i]=A[i];
  f3(N,A);
  for (i=0;i<N;i++)
     printf("%d ",A[i]);
  printf("\n");
  for (i=0;i<N;i++)
     printf("%d ",B[i]);
  printf("\n");  }
```

a) 1 2 3 3 4 5
1 2 3 3 4 5
1 2 3 3 4 5

[✓ **b)** 2 3 4 4 5 6
2 3 4 4 5 6
1 2 3 3 4 5]

c) 1 2 3 3 4 5
2 3 4 4 5 6
1 2 3 3 4 5

d) 2 3 4 4 5 6
1 2 3 3 4 5
1 2 3 3 4 5

e) 2 3 4 4 5 6
2 3 4 4 5 6
2 3 4 4 5 6

46) What is the output?

```
#include <stdio.h>
void f4(int n, int a[])
{
   int i; int b[10];
   for (i=0;i<n;i++)
      b[i]=a[i];
   for (i=0;i<n;i++)
    b[i]++;
   for (i=0;i<n;i++)
     printf("%d ",a[i]);
   printf("\n");
   for (i=0;i<n;i++)
     printf("%d ",b[i]);
  printf("\n");
}
void main() {
  int A[]={1,2,3,3,4,5};
  int i, N=6;
  f4(N,A);
  for (i=0;i<N;i++)
     printf("%d ",A[i]);
  printf("\n");
}
```

```
a) 1 2 3 3 4 5  b) 2 3 4 4 5 6  c) 1 2 3 3 4 5   d)  2 3 4 4 5 6  e) 2 3 4 4 5 6
   1 2 3 3 4 5     2 3 4 4 5 6     2 3 4 4 5 6        1 2 3 3 4 5     2 3 4 4 5 6
   1 2 3 3 4 5    1 2 3 3 4 5      1 2 3 3 4 5        1 2 3 3 4 5     2 3 4 4 5 6
```

47) What is the output?

```
#include <stdio.h>
void main () {
 int A[10][10]={{1,2,3},{3,4,5},{5,6,7}};
 int i,j,N=3,t;
 for (i=0;i<N;i++)
 {
  t=A[i][i];
  A[i][i]=A[i][N-i-1];
  A[i][N-i-1]=t;
 }
 for (i=0;i<N;i++)
 {
  for (j=0;j<N;j++)
  printf("%d ",A[i][j]);
  printf("\n");
 }  }
```

a) 1 2 3
3 4 5
5 6 7

b) 5 2 7
3 4 5
1 6 3

c) 1 2 3
5 4 3
5 6 7

d) 1 6 3
3 4 5
5 2 7

[✓ **e)** 3 2 1
3 4 5
7 6 5]

30) What is the output of the code below?

```
#include <stdio.h>
int main (void) {
                int b[3] [2]={1,2,3,4,5,6},i,j;
                for(i=0;i<2;++i) {
                                printf("\n");
                                for(j=0;j<3;j+=2)
                                     printf ("%d", b[j][i]);
                                }
                return 0; }
```

```
a) 12          b) 12          c) 135          d) 15          e)  246
   56             34              246              26              135
                  56
```

31) What is the output of the code below?

```
#include <stdio.h>
int main (void) {
                int b[2][2]={{1},{2}},i,j;
                for(i=0;i<2;++i) {
                                printf("\n");
                                for(j=0;j<2;j++)
                                  printf ("%d", b[i][j]);  }
                 return 0; }
```

Note: (Assume, uninitialized elements are supposed to be zero)

```
a) 10          b) 00          c) 12          d) 11          e) 01
   20             12              00             22              02
```

33) int x[10];

is given. Which of the array referencing is illegal?

a) x[(10%6)*4]=7; **b)** x[(10/3)-1]=7; **c)** x[(10/3)+1]=7;

d) x[(10%3)-1]=7; **e)** x[(100%30)-1]=7.5;

38) What will be output if you will compile and execute the following c code?

```
#include <stdio.h>
        main (){
          int array[3][2][2]={0,1,2,3,4,5,6,7,8,9,10,11};
          printf("%d",array[1][1][1]);    }
```

a) 7 **b)** 8 **c)** 9 **d)** 10 **e)** 11

39) What is the output of the following program?

```
#include <stdio.h>
int compute(int [], int);
void main( ){
int a[]={6,7,8,9},i;
printf("%d", compute(a, 4));    }
int compute(int array[], int arraySize){
   int i, sum =0;
   for(i=0; i<arraySize; i++)
          if (array[i]%2==0) sum += array[i];
   return sum;  }
```

a) 6 **b)** 8 **c)** 14 **d)** 13 **e)** 16

41) Determine the output of the below program?

```
#include <stdio.h>
main ( ){
  int i, j, k, array[3][2][2]={1, 3, 5, 2, 4, 6, 7};
  for (i=0;i<2;++i)
    for (j=0;j<2;++j)
      for (k=0;k<2;++k)
   printf("%d  ", array[i][j][k]);
  return 0; }
```

```
a) 1 3 5    b) 1 3 5    c) 1 3    d) 1 3 5 2 4 6 7 0     e) 1 3 5 2 4 6
   2 4 6       2 4 6       2 4
   6 7         6 7 0
```

42) Determine the output of the below program?

```
#include <stdio.h>
int a=0, b=5, index=0, array[5] = {8,3,7,2,9};
calculate_a_b(){
  for( index=0; index<4; ++index )
    a = array[index];
  return 0;  }
main(){
  if (!a)
   if (a=++b)
     calculate_a_b();
   else b=8;
  else a++;
  printf("a=%d b=%d", a, b);
  return 0; }
```

a) a=2 b=6 **b)** a=6 b=2 **c)** a=0 b=5 **d)** a=0 b=8 **e)** a=0 b=0

44) Determine the output of the below program?

```
  #include <stdio.h>
      main ( ){
        int i, j;
        int array[3][5]={0, 1, 2, 3, 4,
                          1, 2, 3, 4, 5,
                          2, 3, 4, 5, 6};
        for (i=0;i<=2;++i){
          for (j=0;j<5;++j)
            if (i==0||i==2)
                      printf("%d", array[i][j]);
            else if (j==0) printf("%d", array[i][j]);
            else if (j==4) printf("%d", array[i][j]);
            else printf("  ");
        printf("\n");    }
       return 0; }
```

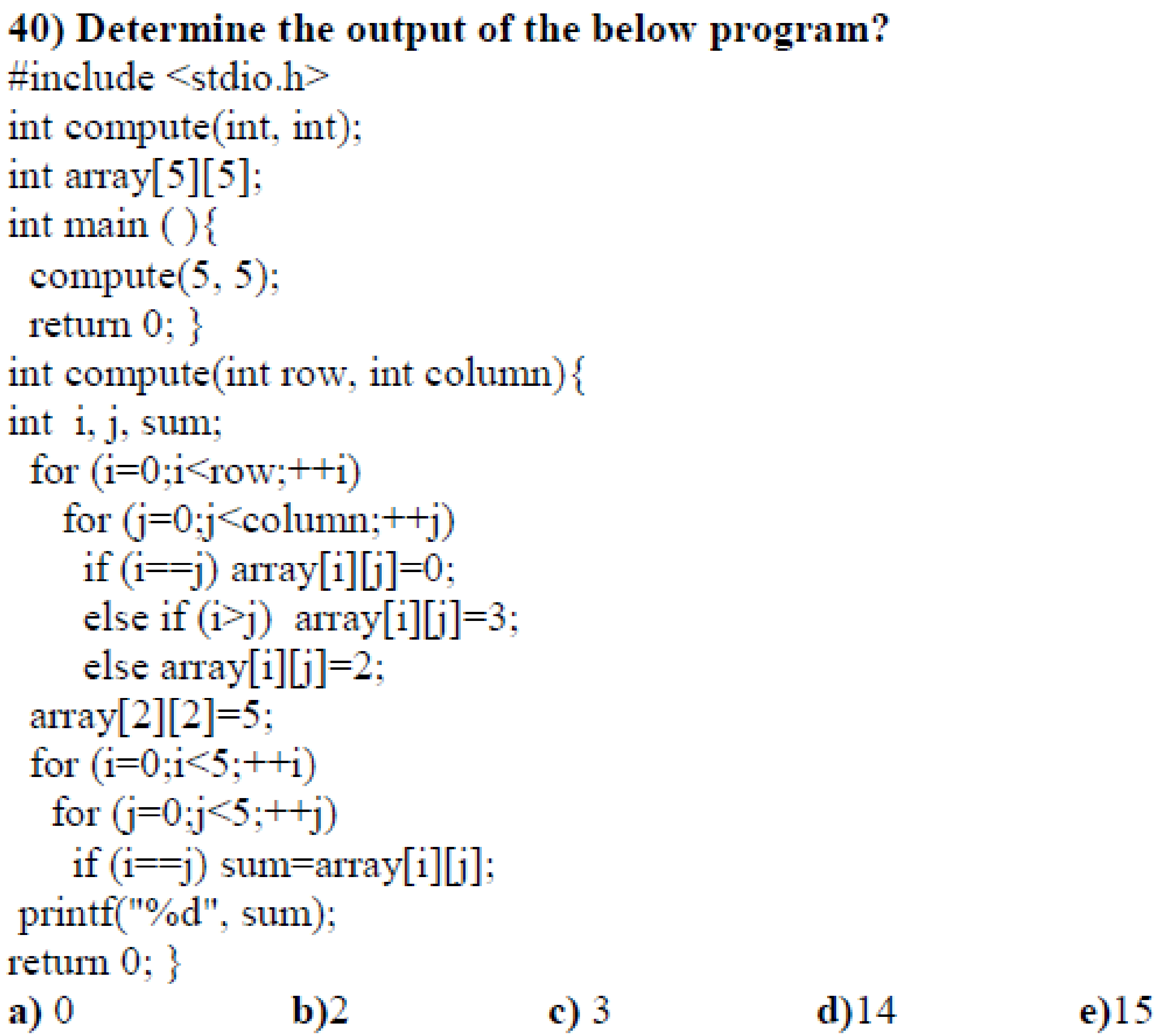
a)
```
01234
12345
23456
```

b)
```
01234
1     5
23456
```

c)
```
0, 1, 2, 3, 4
1, 2, 3, 4, 5
2, 3, 4, 5, 6
```

d)
```
0, 1, 2, 3, 4
1,          5
2, 3, 4, 5, 6
```

e)
```
012341    523456
```



40) Determine the output of the below program?

```
#include <stdio.h>
int compute(int, int);
int array[5][5];
int main (){
 compute(5, 5);
 return 0; }
int compute(int row, int column){
int  i, j, sum;
 for (i=0;i<row;++i)
    for (j=0;j<column;++j)
      if (i==j) array[i][j]=0;
      else if (i>j)  array[i][j]=3;
      else array[i][j]=2;
 array[2][2]=5;
 for (i=0;i<5;++i)
   for (j=0;j<5;++j)
     if (i==j) sum=array[i][j];
 printf("%d", sum);
return 0; }
```

a) 0 **b)**2 **c)** 3 **d)**14 **e)**15