1. Use the following list of values with length of list being 11. Show the state of the list when the first recursive call is made in Quicksort using list[0] as the split value.　**(10%)**

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
24	42	66	20	3	90	10	35	18	40	99

2. What is the difference between 1K of memory and 1K transfer rate. **(10%)**

Let the A register be the accumulator used to hold data and the results of operations. There are two bytes in the A register. The information shown in Table 1, Table 2, Figure 1, and Figure 2 are used in solving the following machine-language problems 3-5.

3. What are the content of the A register after the execution of the following two machine-language instructions?　**(10%)**
   00001001 00000000 00000001
   00011000 00000000 00000001

4. What are the content of the A register after the execution of the following two machine-language instructions?　**(10%)**
   00001000 00000000 00000001
   00011001 00000000 00000010

5. What are the content of the A register after the execution of the following two machine-language instructions?　**(10%)**
   00001001 00000000 00000011
   00100001 00000000 00000010

Table 1.　State of Memory.　Each cell of memory has one byte.

Address	state of memory (in hexadecimal)
0001	A2
0002	11
0003	FF
0004	00

Table 2.   The subset of operation codes.

Operation code	Meaning of Instruction
00001	Load operand into the A register
00010	Store the contents of the A register into operand
00011	Add the operand to A register
00100	Subtract the operand from A register
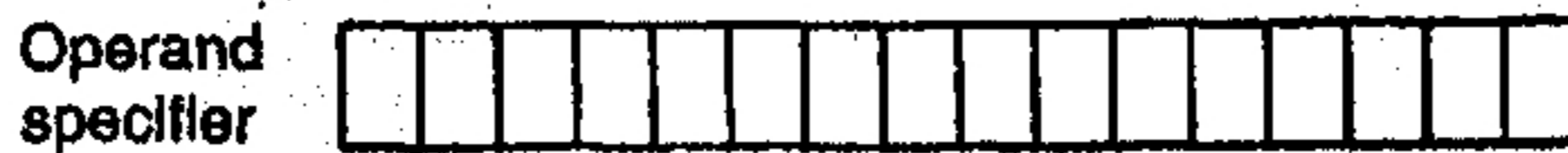
(a) The two parts of an instruction

Addressing mode specifier
Register specifier
Operation code
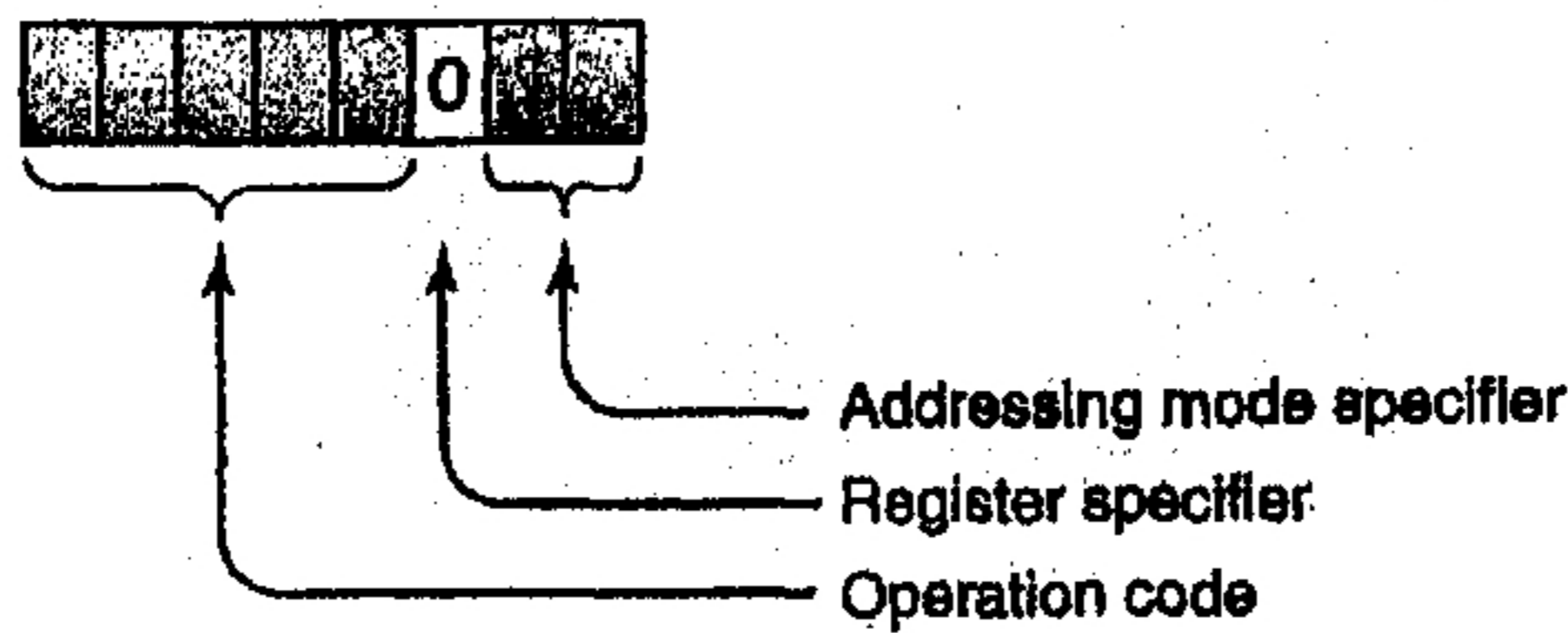
(b) The instruction specifier part of an instruction

Figure 1.   The format of a machine-language instruction.   (a) There are two parts in the machine-language instruction.   The first part is the 8-bit instruction specifier and the second part is the 16-bit operand specifier. (b) There are three sub-parts in the operand specifier. The first sub-part is the 5-bit operation code, the second sub-part is the 1-bit register specifier, which is always 0 here, and the third sub-part is the 2-bit addressing mode specifier.
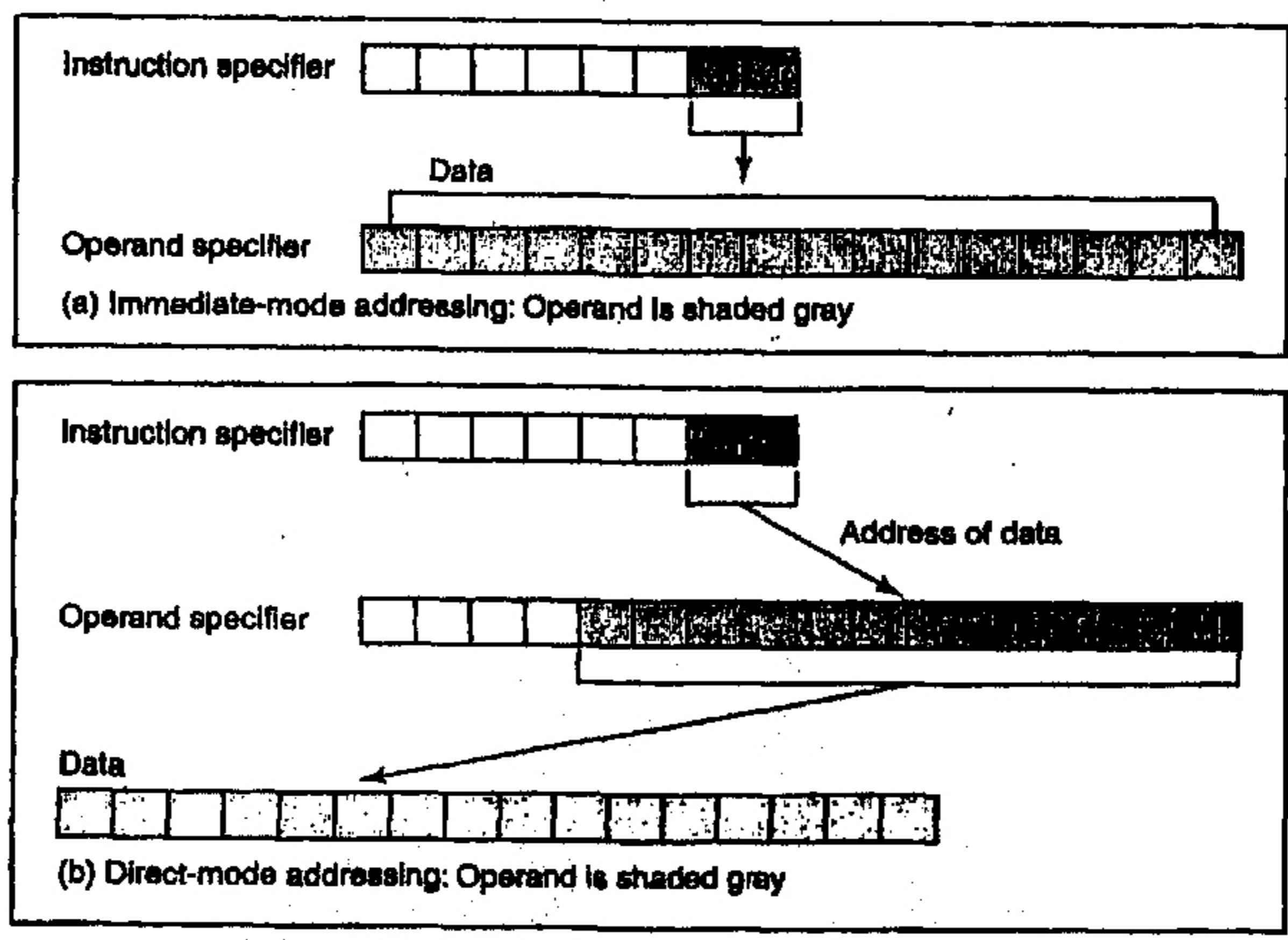
Figure 2. Two different addressing modes. If the addressing mode specifier is 00, the operand is in the operand specifier of the instruction. If the addressing mode specifier is 01, the operand is in the memory address named in the operand specifier of the instruction.

6. (30 points)

Consider the following recursive function

```
void f(int n)
{
    if (n == 0 || n == 1) { cout << n << '\n'; return; }
    f(n/2);
    f(n-n/2);
}
```

(a) What is the output after the invocation of f(2)?

(b) What is the output after the invocation of f(5)?

(c) What is the output after the invocation of f(2*k) with k a positive integer?

(d) What is the output after the invocation of f(2*k-1) with k a positive integer?

(e) What is the output after the invocation of f(-1)?

(f) Please modify the function so that function f won't cause (function) stack overflow problem.

7. (20 points)

(a) Describe the quick sort algorithm.

(b) Implement quick sort in C++.