CENG 230

Introduction to C Programming

Week 9 – Functions

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Some slides/content are borrowed from Tansel Dokeroglu, Nihan Kesim Cicekli, and the lecture notes of the textbook by Hanly and Koffman.

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Homework

- Write a program to read in numbers until the number -1 is encountered. The sum, max and min of all numbers read until this point should be printed out.

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Modular programming with functions

Modular programming

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"Experience has shown that the best way to develop and maintain a large program is to construct it from **smaller pieces** or **modules, each** of which is more manageable than the original program.

This technique is called **divide and conquer."**

Function **definition**

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```
return_type function_name(parameter declarations)
{
  statement-1;
  statement-2;
…
}
```

- if is *return_type* not void, “return” statement has to be used:

```
return expression;
```

Function declaration

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- *return_type* function_name(list-of-params);
- The parameters have to have the same types as in the function definition although the names of the parameters may differ.
- Example:
  - int factorial(int N);
  - void print_matrix(int matrix[N][M]);
- If a function is used before it is defined, it has to be declared first.

Function call

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function_name(list of arguments)

- Example:
  - Function declaration:

    ```
    int greatest(int A, int B, int C);
    ```

  - Example function call:

    ```
    printf(“%d\n”, greatest(10, 20, -10));
    ```

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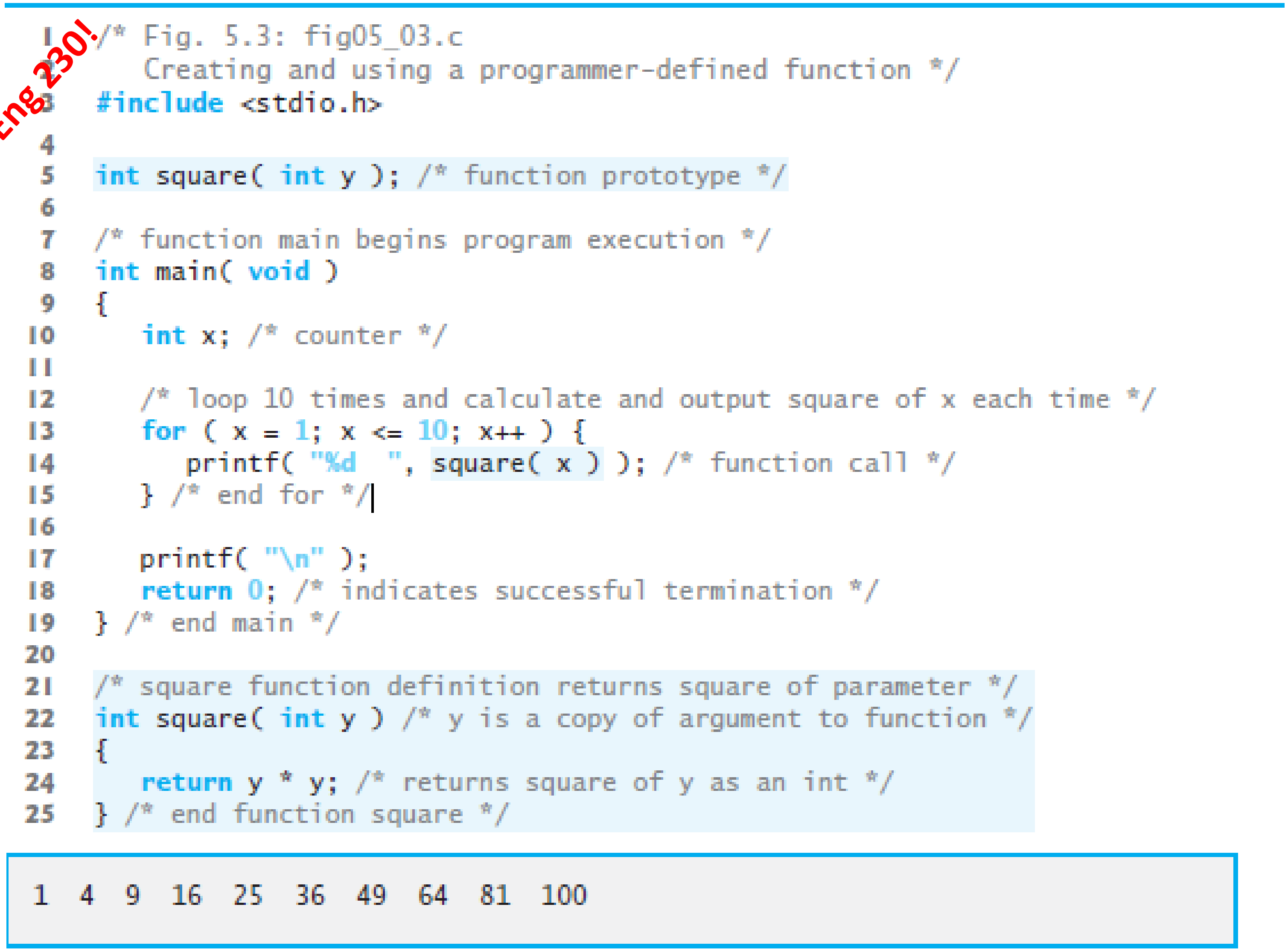

```c
/* Fig. 5.3: fig05_03.c
   Creating and using a programmer-defined function */
#include <stdio.h>

int square( int y ); /* function prototype */

/* function main begins program execution */
int main( void )
{
   int x; /* counter */

   /* loop 10 times and calculate and output square of x each time */
   for ( x = 1; x <= 10; x++ ) {
      printf( "%d  ", square( x ) ); /* function call */
   } /* end for */

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

/* square function definition returns square of parameter */
int square( int y ) /* y is a copy of argument to function */
{
   return y * y; /* returns square of y as an int */
} /* end function square */
```

```
1  4  9  16  25  36  49  64  81  100
```

Fig. 5.3 | Using a programmer-defined function. (Part 2 of 2.)

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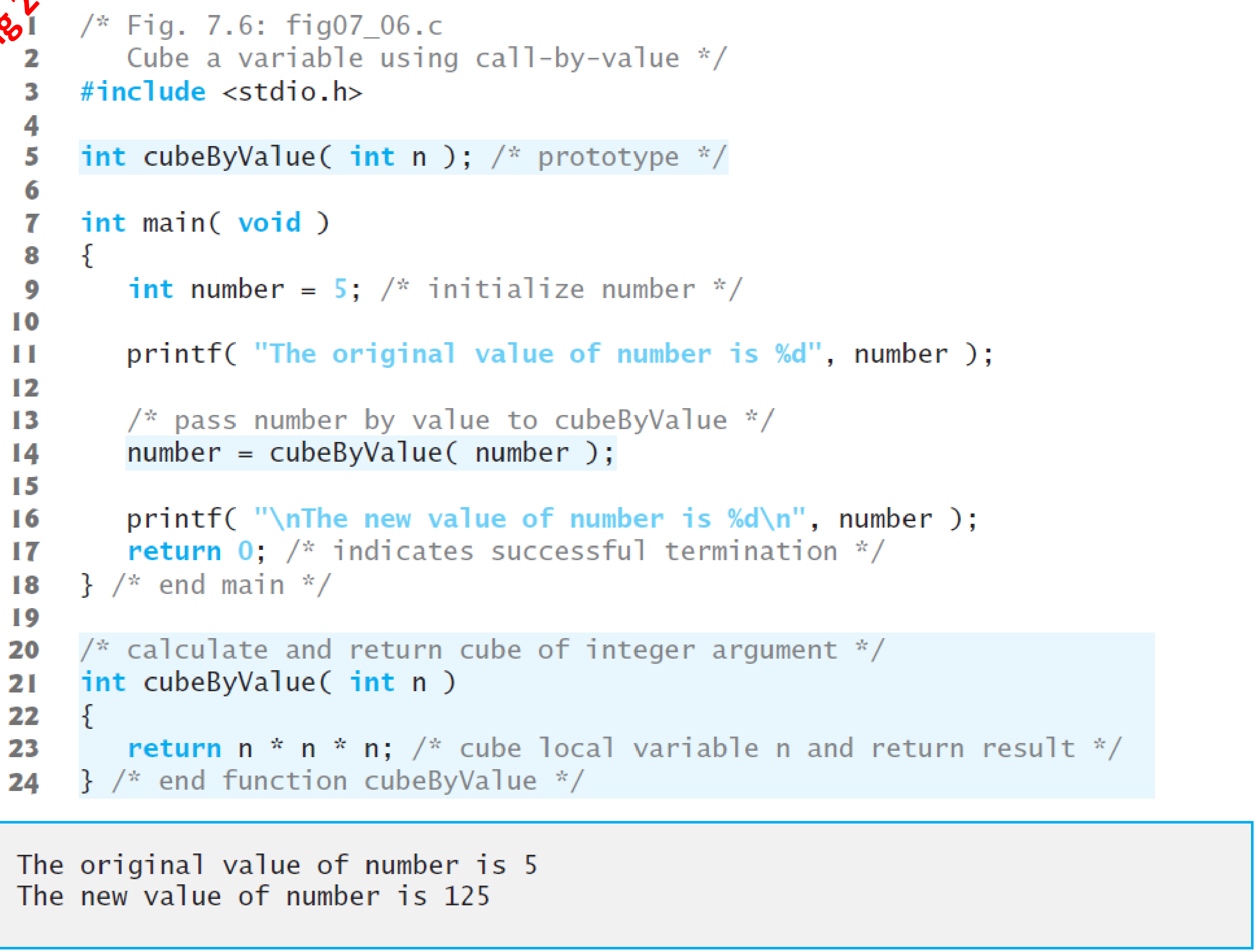

```c
/* Fig. 7.6: fig07_06.c
   Cube a variable using call-by-value */
#include <stdio.h>

int cubeByValue( int n ); /* prototype */

int main( void )
{
   int number = 5; /* initialize number */

   printf( "The original value of number is %d", number );

   /* pass number by value to cubeByValue */
   number = cubeByValue( number );

   printf( "\nThe new value of number is %d\n", number );
   return 0; /* indicates successful termination */
} /* end main */

/* calculate and return cube of integer argument */
int cubeByValue( int n )
{
   return n * n * n; /* cube local variable n and return result */
} /* end function cubeByValue */
```

```
The original value of number is 5
The new value of number is 125
```

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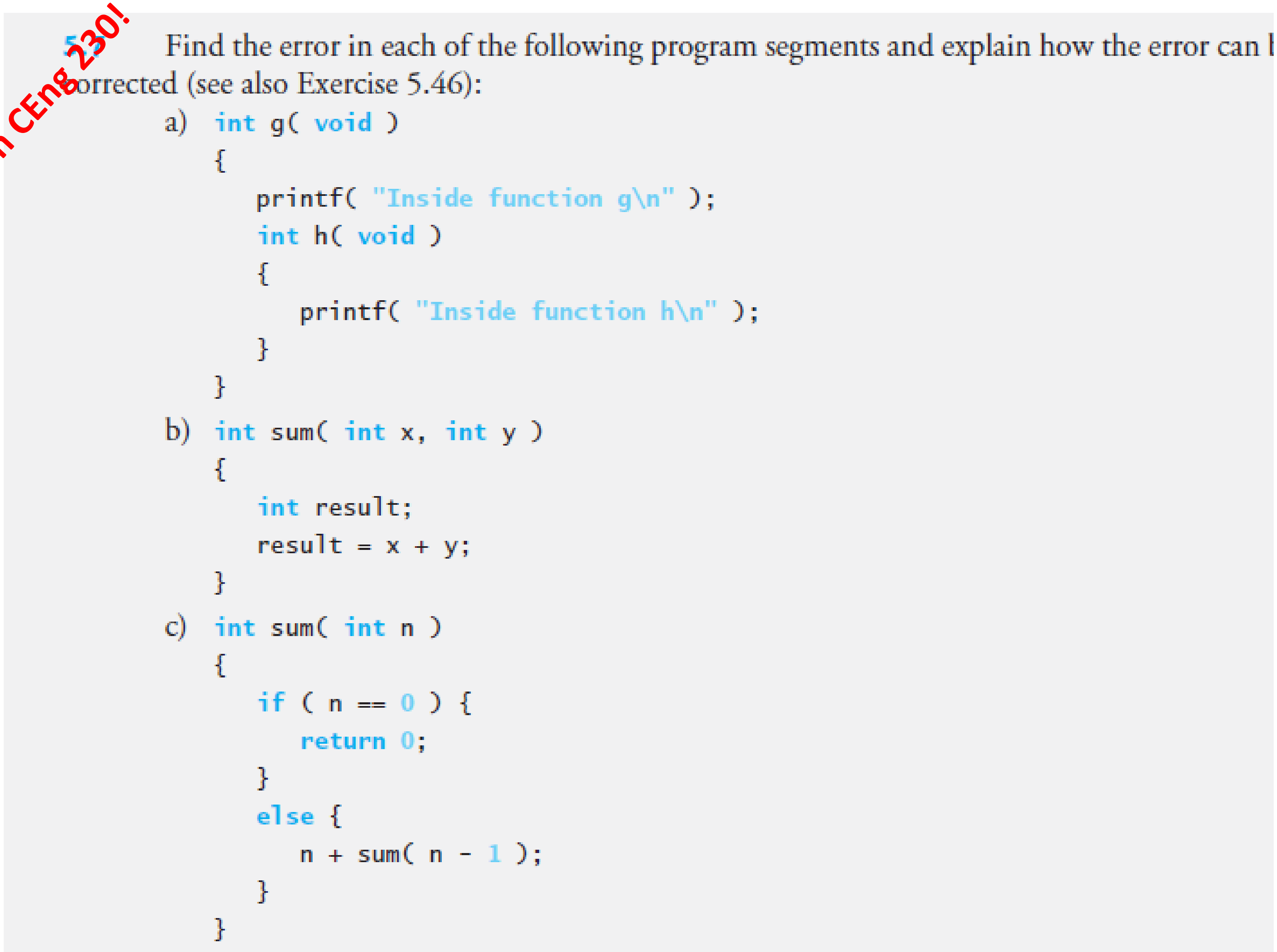

5.7 Find the error in each of the following program segments and explain how the error can corrected (see also Exercise 5.46):

a)
```
int g( void )
{
   printf( "Inside function g\n" );
   int h( void )
   {
      printf( "Inside function h\n" );
   }
}
```

b)
```
int sum( int x, int y )
{
   int result;
   result = x + y;
}
```

c)
```
int sum( int n )
{
   if ( n == 0 ) {
      return 0;
   }
   else {
      n + sum( n - 1 );
   }
}
```

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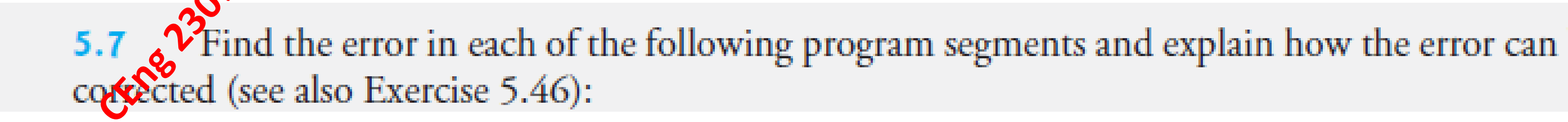
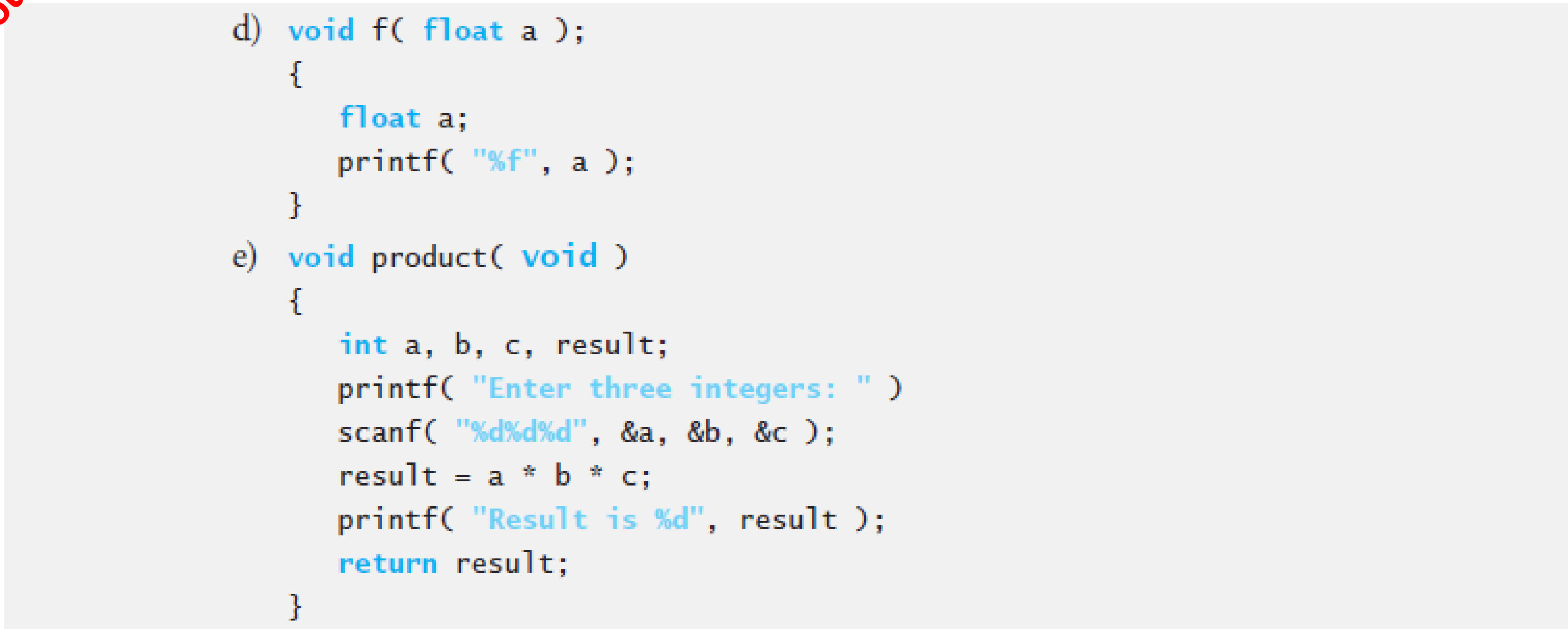


5.7 Find the error in each of the following program segments and explain how the error can corrected (see also Exercise 5.46):



d)
```
void f( float a );
{
   float a;
   printf( "%f", a );
}
```

e)
```
void product( void )
{
   int a, b, c, result;
   printf( "Enter three integers: " )
   scanf( "%d%d%d", &a, &b, &c );
   result = a * b * c;
   printf( "Result is %d", result );
   return result;
}
```

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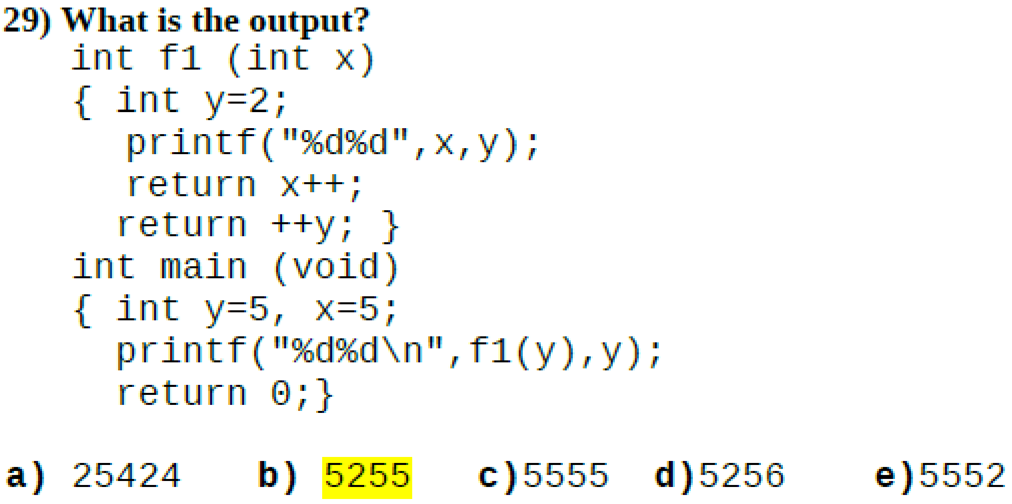
Sample 1



29) What is the output?

```
int f1 (int x)
{ int y=2;
   printf("%d%d",x,y);
   return x++;
  return ++y; }
int main (void)
{ int y=5, x=5;
  printf("%d%d\n",f1(y),y);
  return 0;}
```

a) 25424 **b)** 5255 **c)**5555 **d)**5256 **e)**5552

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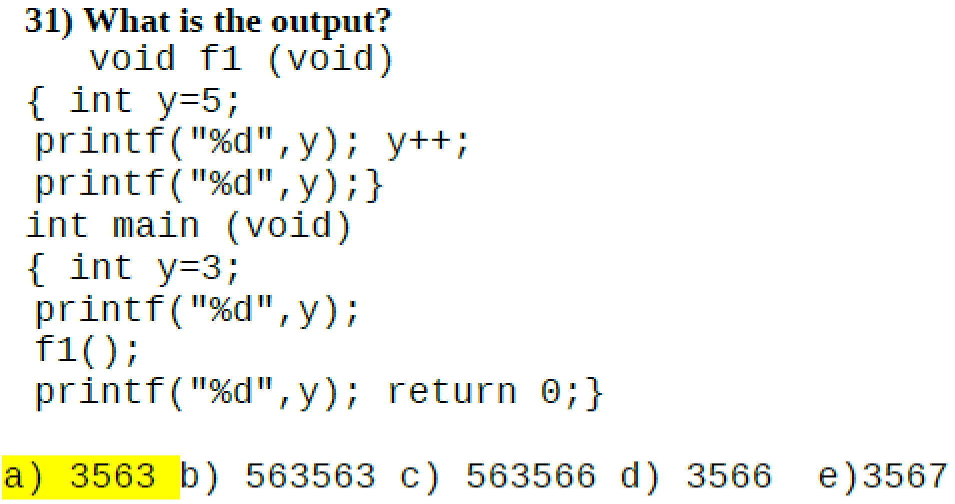
Sample 2

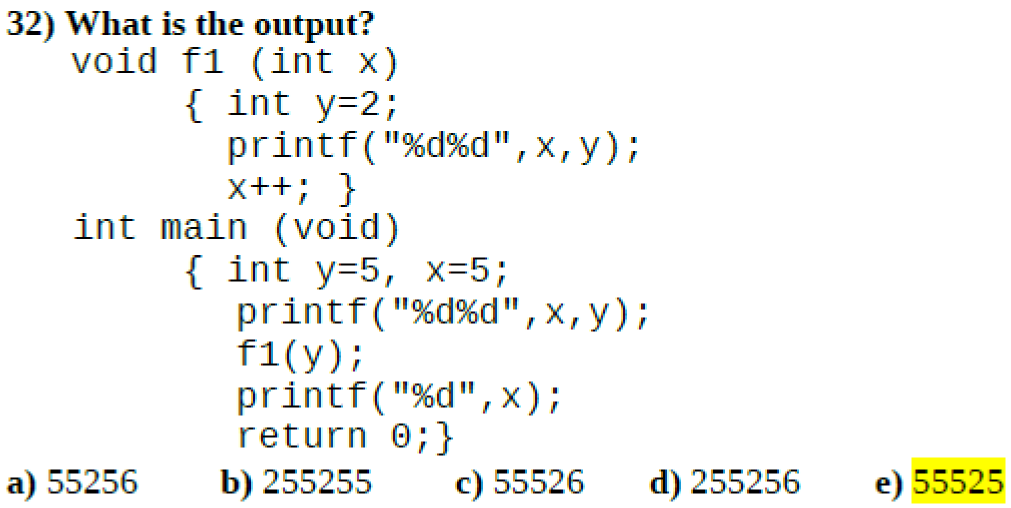


31) What is the output?

```
   void f1 (void)
{ int y=5;
 printf("%d",y); y++;
 printf("%d",y);}
int main (void)
{ int y=3;
 printf("%d",y);
 f1();
 printf("%d",y); return 0;}
```

a) 3563 b) 563563 c) 563566 d) 3566 e)3567

Sample 3



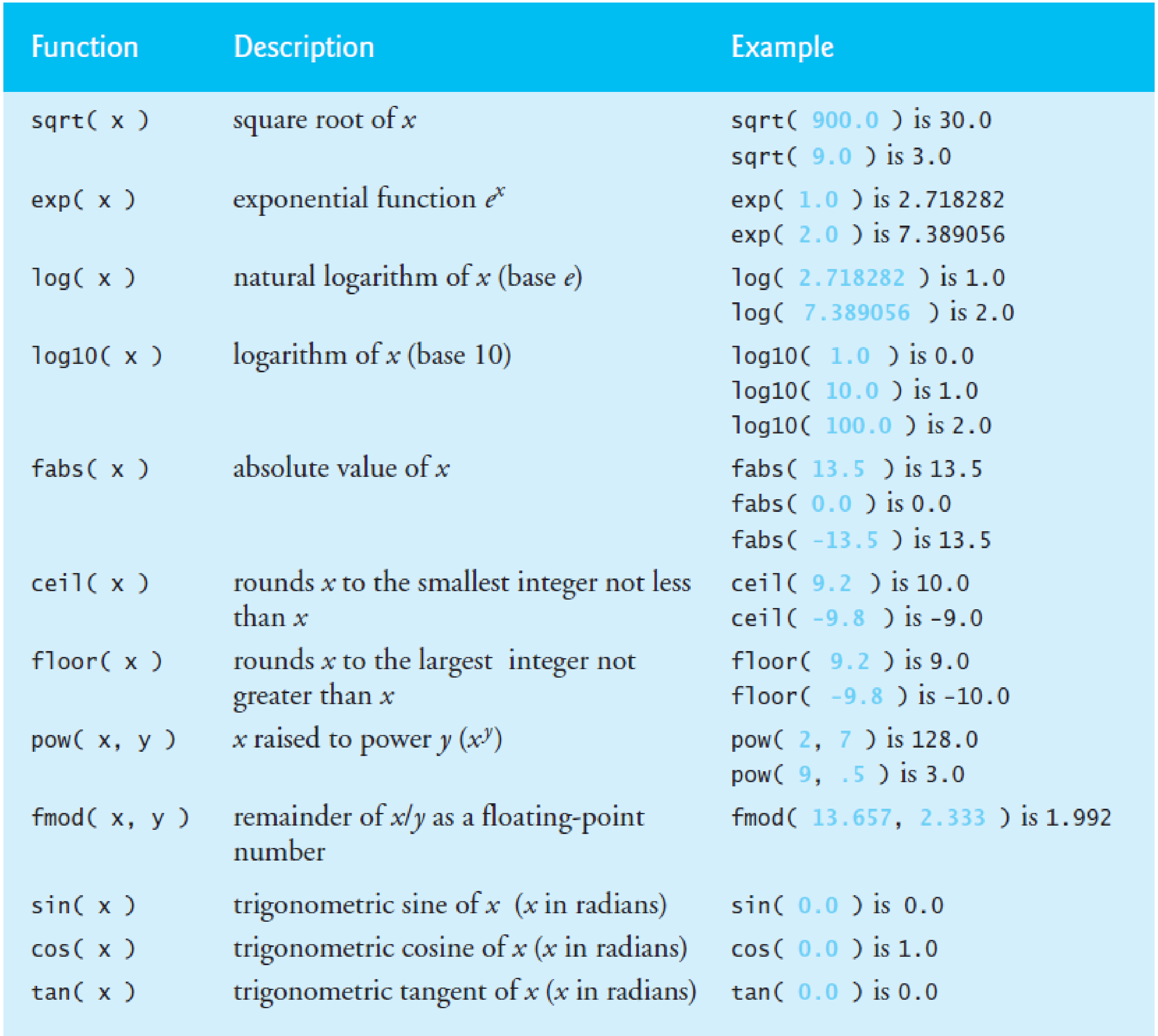
32) What is the output?

```
void f1 (int x)
     { int y=2;
       printf("%d%d",x,y);
       x++; }
int main (void)
     { int y=5, x=5;
       printf("%d%d",x,y);
       f1(y);
       printf("%d",x);
       return 0;}
```

a) 55256 **b)** 255255 **c)** 55526 **d)** 255256 **e)** 55525

Today

- Built-in functions
  - Math library (#include<math.h>)
  - Stdlib library (#include<stdlib.h>)



Function	Description	Example

`sqrt( x )`	square root of *x*	`sqrt( 900.0 )` is `30.0`
		`sqrt( 9.0 )` is `3.0`

`exp( x )`	exponential function e^x	`exp( 1.0 )` is `2.718282`
		`exp( 2.0 )` is `7.389056`

`log( x )`	natural logarithm of *x* (base *e*)	`log( 2.718282 )` is `1.0`
		`log( 7.389056 )` is `2.0`

`log10( x )`	logarithm of *x* (base 10)	`log10( 1.0 )` is `0.0`
		`log10( 10.0 )` is `1.0`
		`log10( 100.0 )` is `2.0`

`fabs( x )`	absolute value of *x*	`fabs( 13.5 )` is `13.5`
		`fabs( 0.0 )` is `0.0`
		`fabs( -13.5 )` is `13.5`

`ceil( x )`	rounds *x* to the smallest integer not less than *x*	`ceil( 9.2 )` is `10.0`
		`ceil( -9.8 )` is `-9.0`

`floor( x )`	rounds *x* to the largest integer not greater than *x*	`floor( 9.2 )` is `9.0`
		`floor( -9.8 )` is `-10.0`

`pow( x, y )`	*x* raised to power *y* (x^y)	`pow( 2, 7 )` is `128.0`
		`pow( 9, .5 )` is `3.0`

`fmod( x, y )`	remainder of *x*/*y* as a floating-point number	`fmod( 13.657, 2.333 )` is `1.992`
`sin( x )`	trigonometric sine of *x* (*x* in radians)	`sin( 0.0 )` is `0.0`
`cos( x )`	trigonometric cosine of *x* (*x* in radians)	`cos( 0.0 )` is `1.0`
`tan( x )`	trigonometric tangent of *x* (*x* in radians)	`tan( 0.0 )` is `0.0`

Fig. 5.2 | Commonly used math library functions.

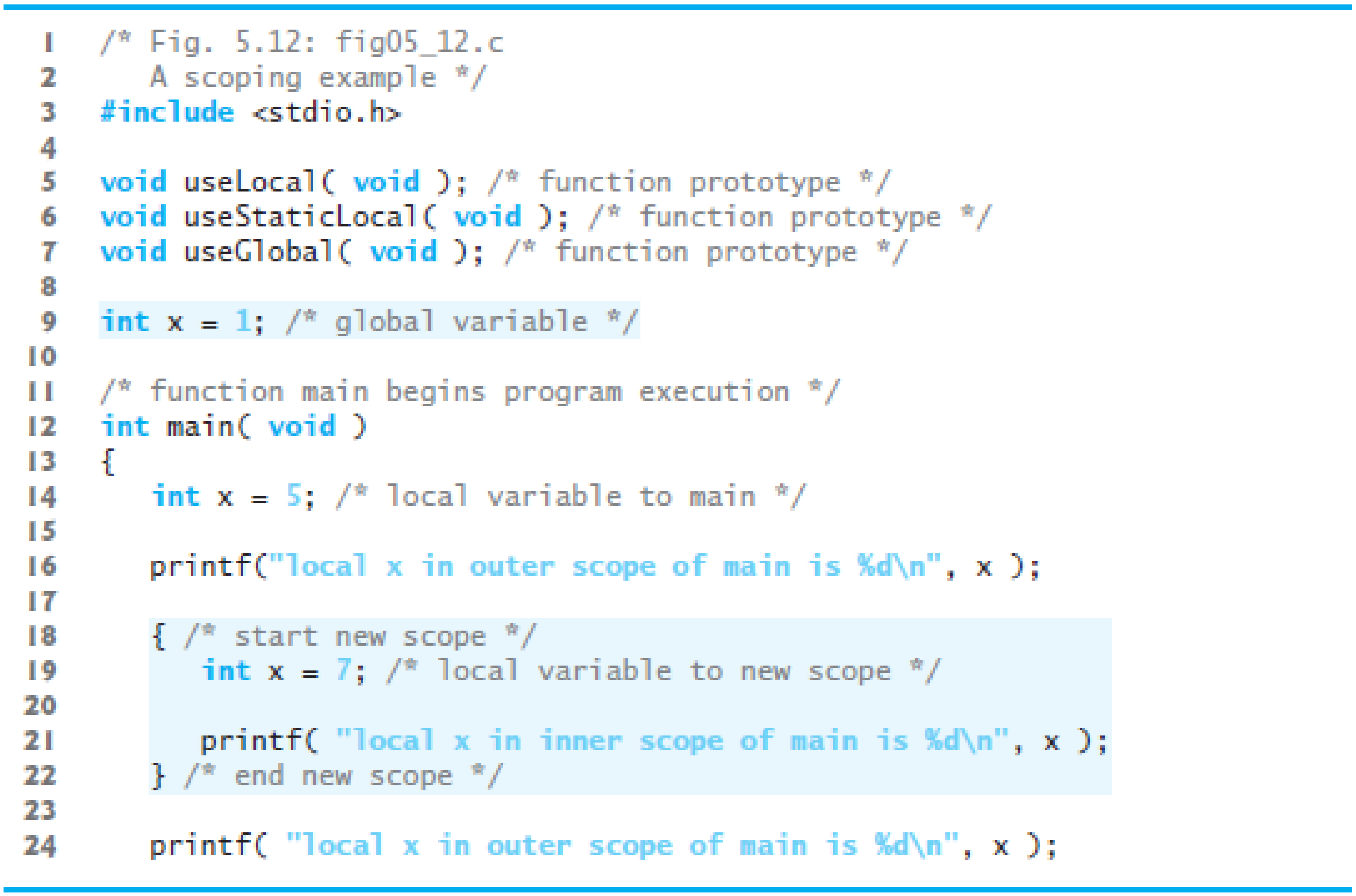
#include<math.h>

```c
/* Fig. 5.7: fig05_07.c
   Shifted, scaled integers produced by 1 + rand() % 6 */
#include <stdio.h>
#include <stdlib.h>

/* function main begins program execution */
int main( void )
{
   int i; /* counter */

   /* loop 20 times */
   for ( i = 1; i <= 20; i++ ) {

      /* pick random number from 1 to 6 and output it */
      printf( "%10d", 1 + ( rand() % 6 ) );

      /* if counter is divisible by 5, begin new line of output */
      if ( i % 5 == 0 ) {
         printf( "\n" );
      } /* end if */
   } /* end for */

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

```
         6         6         5         5         6
         5         1         1         5         3
         6         6         2         4         2
         6         2         3         4         1
```

Fig. 5.7 | Shifted, scaled random integers produced by 1 + rand() % 6. (Part 2 of 2.)

Scope



```c
/* Fig. 5.12: fig05_12.c
   A scoping example */
#include <stdio.h>

void useLocal( void ); /* function prototype */
void useStaticLocal( void ); /* function prototype */
void useGlobal( void ); /* function prototype */

int x = 1; /* global variable */

/* function main begins program execution */
int main( void )
{
   int x = 5; /* local variable to main */

   printf("local x in outer scope of main is %d\n", x );

   { /* start new scope */
      int x = 7; /* local variable to new scope */

      printf( "local x in inner scope of main is %d\n", x );
   } /* end new scope */

   printf( "local x in outer scope of main is %d\n", x );
```

Fig. 5.12 | Scoping example. (Part 1 of 3.)

Scope Rules

- File scope
  - Identifier defined outside function, known in all functions
  - Used for global variables, function definitions, function prototypes
- Function scope
  - Can only be referenced inside a function body

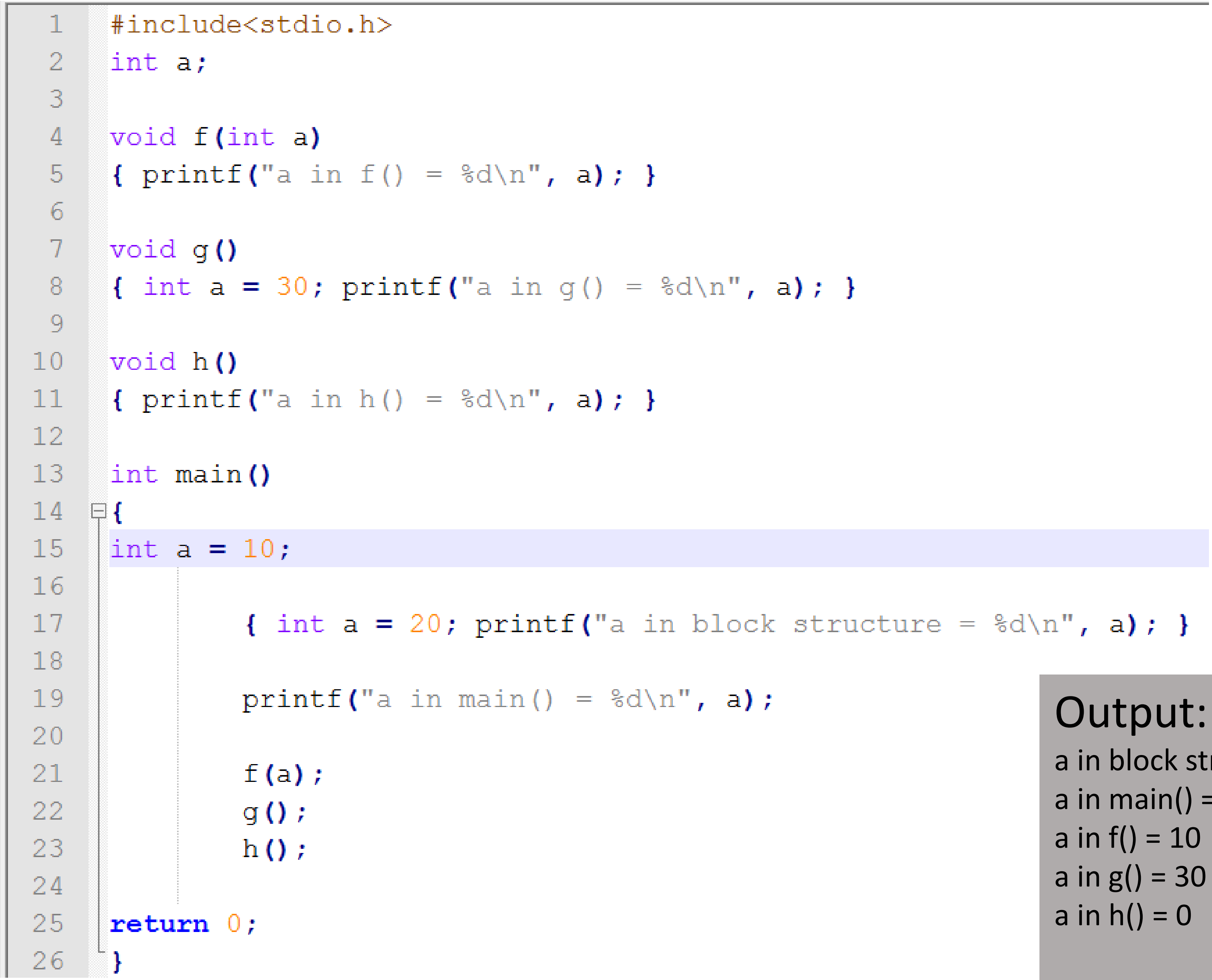
Scope Rules

- Block scope
    - Identifier declared inside a block
        - Block scope begins at definition, ends at right brace
    - Used for variables, function parameters (local variables of function)
    - Outer blocks "hidden" from inner blocks if there is a variable with the same name in the inner block
- Function prototype scope
    - Used for identifiers in parameter list

Namespaces

- Determines where the definition of variables are valid!
- Global space.
- main() function space.
- Block structures.

Namespace Example



```c
#include<stdio.h>
int a;

void f(int a)
{ printf("a in f() = %d\n", a); }

void g()
{ int a = 30; printf("a in g() = %d\n", a); }

void h()
{ printf("a in h() = %d\n", a); }

int main()
{
int a = 10;

        { int a = 20; printf("a in block structure = %d\n", a); }

        printf("a in main() = %d\n", a);

        f(a);
        g();
        h();

return 0;
}
```

Output:

```
a in block structure = 20
a in main() = 10
a in f() = 10
a in g() = 30
a in h() = 0
```

Storage-based Types of Variables

Auto vs. register vs. static variables

Storage Classes

- Storage class specifiers
  - Storage duration – how long an object exists in memory
  - Scope – where object can be referenced in program
  - Linkage – specifies the files in which an identifier is known (more in Chapter 14)
- Automatic storage
  - Object created and destroyed within its block
  - `auto`: default for local variables

    ```
    auto double x, y;
    ```
  - `register`: tries to put variable into high-speed registers
    - Can only be used for automatic variables

      ```
      register int counter = 1;
      ```

Storage Classes

- Static storage
  - Variables exist for entire program execution
  - Default value of zero
  - `static`: local variables defined in functions.
    - Keep value after function ends
    - Only known in their own function
  - `extern`: default for global variables and functions
    - Known in any function

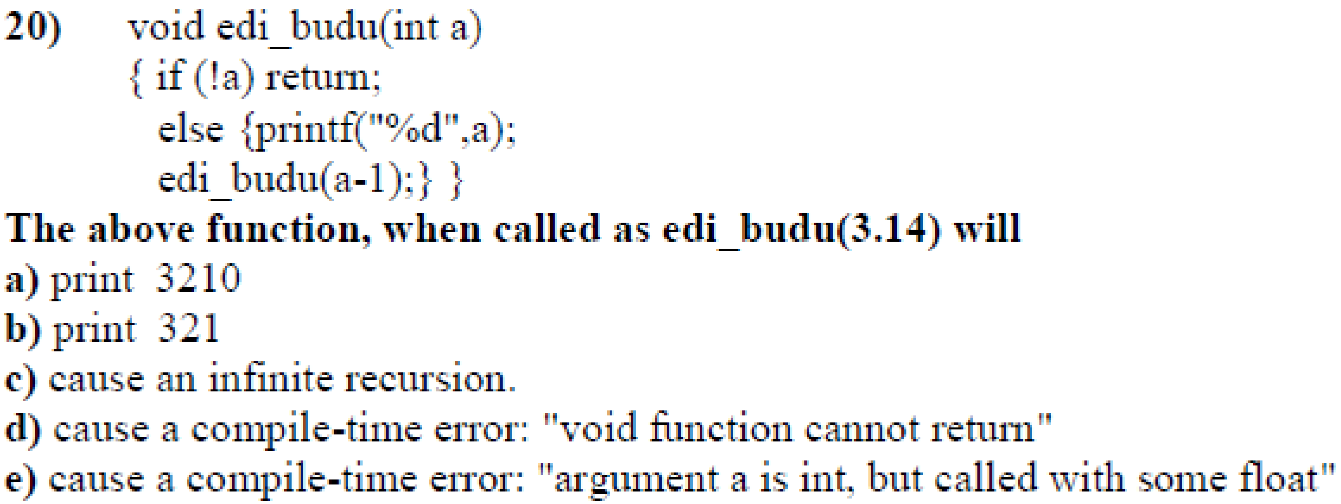
Parameter passing in functions

Call by Value

- The arguments of the function are just copies of the passed data!

```
void f(int a)
{
   a = 10 * a;
}
void g(int b)
{
   b = 10;
   f(b);
   printf(“%d”,  b);
}
```

Sample 4



20)
```
void edi_budu(int a)
{ if (!a) return;
  else {printf("%d",a);
  edi_budu(a-1);} }
```

The above function, when called as edi_budu(3.14) will

a) print 3210

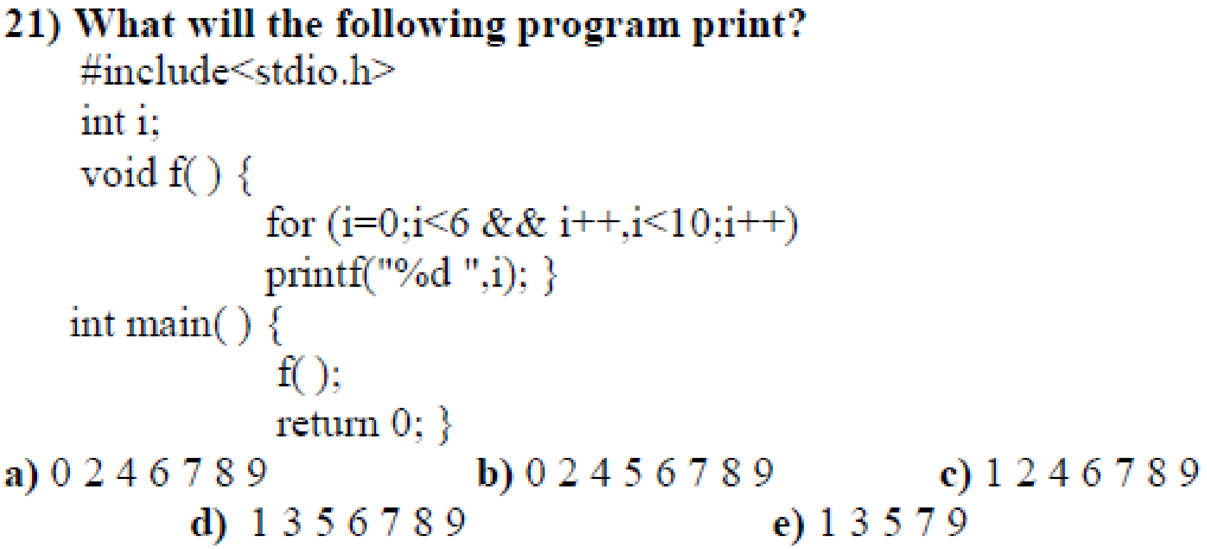
b) print 321

c) cause an infinite recursion.

d) cause a compile-time error: "void function cannot return"

e) cause a compile-time error: "argument a is int, but called with some float"

Sample 5

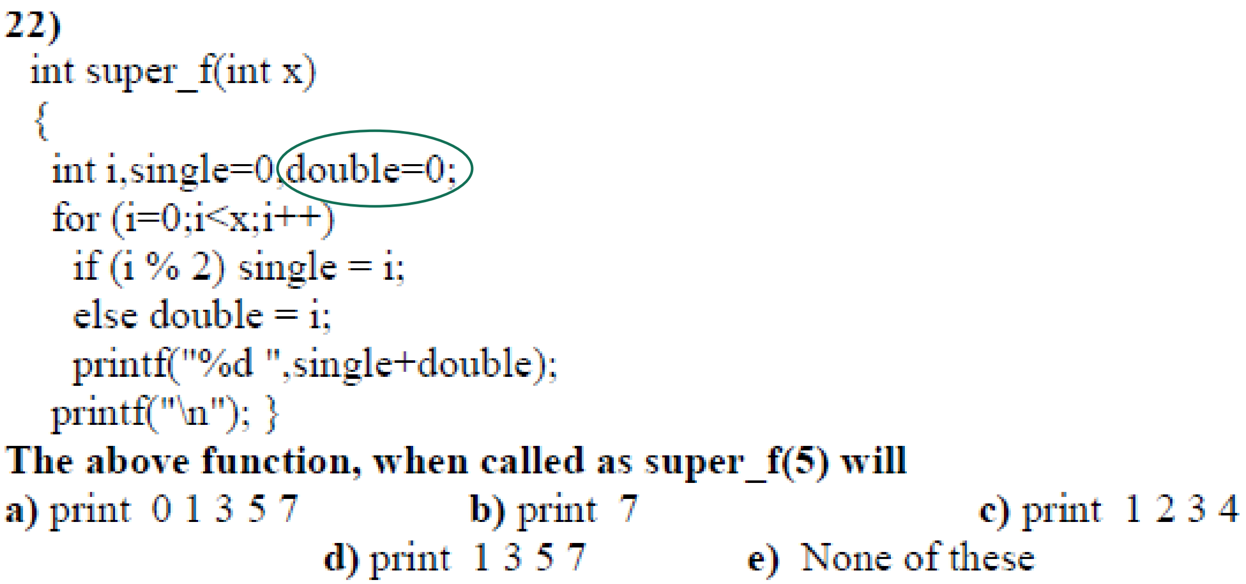


21) What will the following program print?
```
 #include<stdio.h>
 int i;
 void f( ) {
           for (i=0;i<6 && i++,i<10;i++)
           printf("%d ",i); }
int main( ) {
            f( );
            return 0; }
```

a) 0 2 4 6 7 8 9 **b)** 0 2 4 5 6 7 8 9 **c)** 1 2 4 6 7 8 9

d) 1 3 5 6 7 8 9 **e)** 1 3 5 7 9

Sample 6



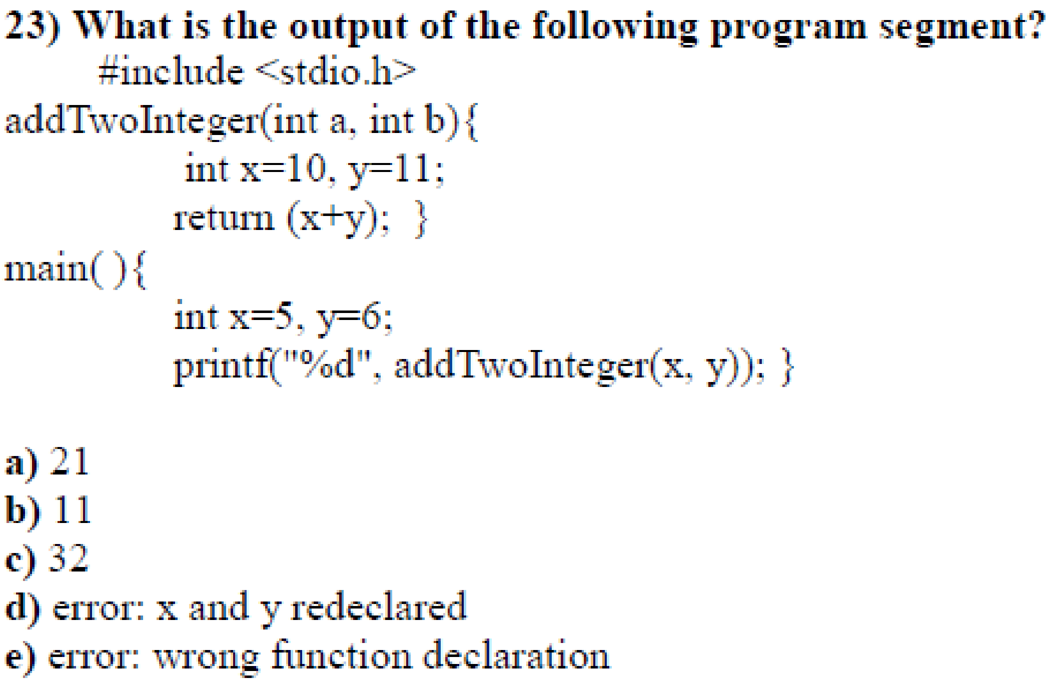
22)

```
 int super_f(int x)
 {
   int i,single=0,double=0;
   for (i=0;i<x;i++)
     if (i % 2) single = i;
     else double = i;
     printf("%d ",single+double);
   printf("\n"); }
```

The above function, when called as super_f(5) will

a) print 0 1 3 5 7 **b)** print 7 **c)** print 1 2 3 4 **d)** print 1 3 5 7 **e)** None of these

Sample 7



23) What is the output of the following program segment?

```
    #include <stdio.h>
addTwoInteger(int a, int b){
          int x=10, y=11;
          return (x+y);  }
main( ){
          int x=5, y=6;
          printf("%d", addTwoInteger(x, y)); }
```

a) 21

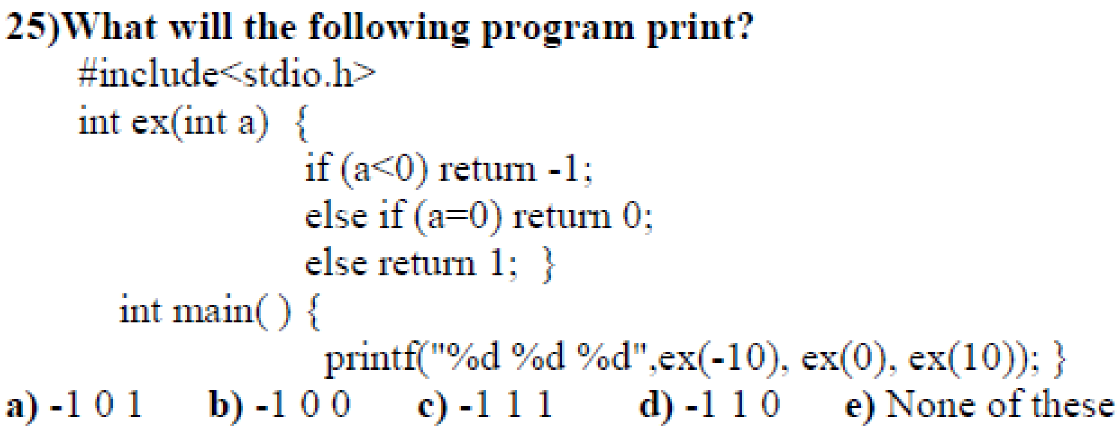
b) 11

c) 32

d) error: x and y redeclared

e) error: wrong function declaration

Sample 8

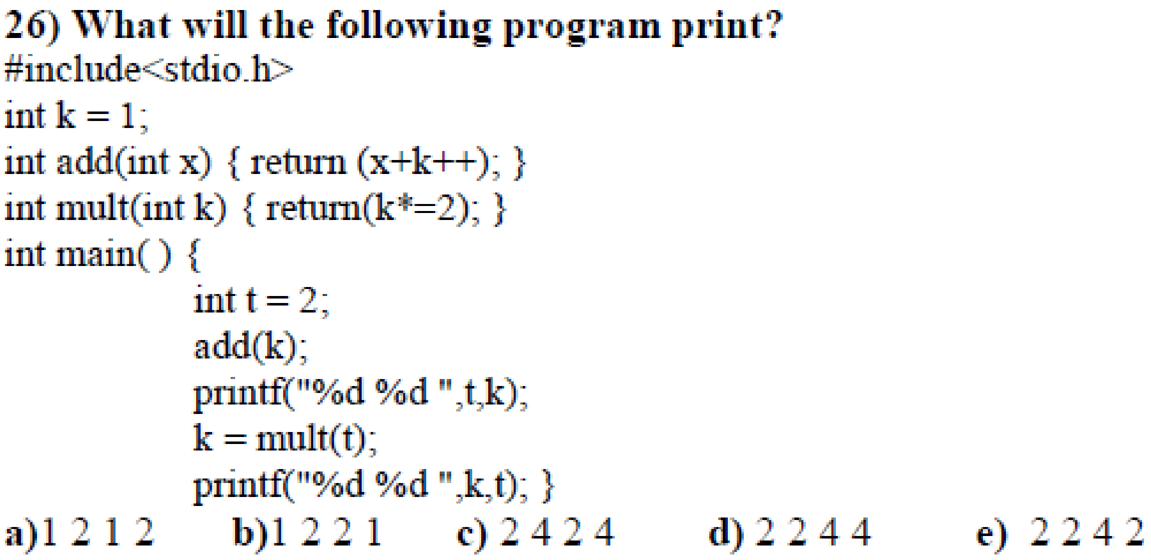


25)What will the following program print?

```
#include<stdio.h>
int ex(int a)  {
                    if (a<0) return -1;
                    else if (a=0) return 0;
                    else return 1;  }
    int main( ) {
                    printf("%d %d %d",ex(-10), ex(0), ex(10)); }
```

a) -1 0 1   **b)** -1 0 0   **c)** -1 1 1   **d)** -1 1 0   **e)** None of these

Sample 9

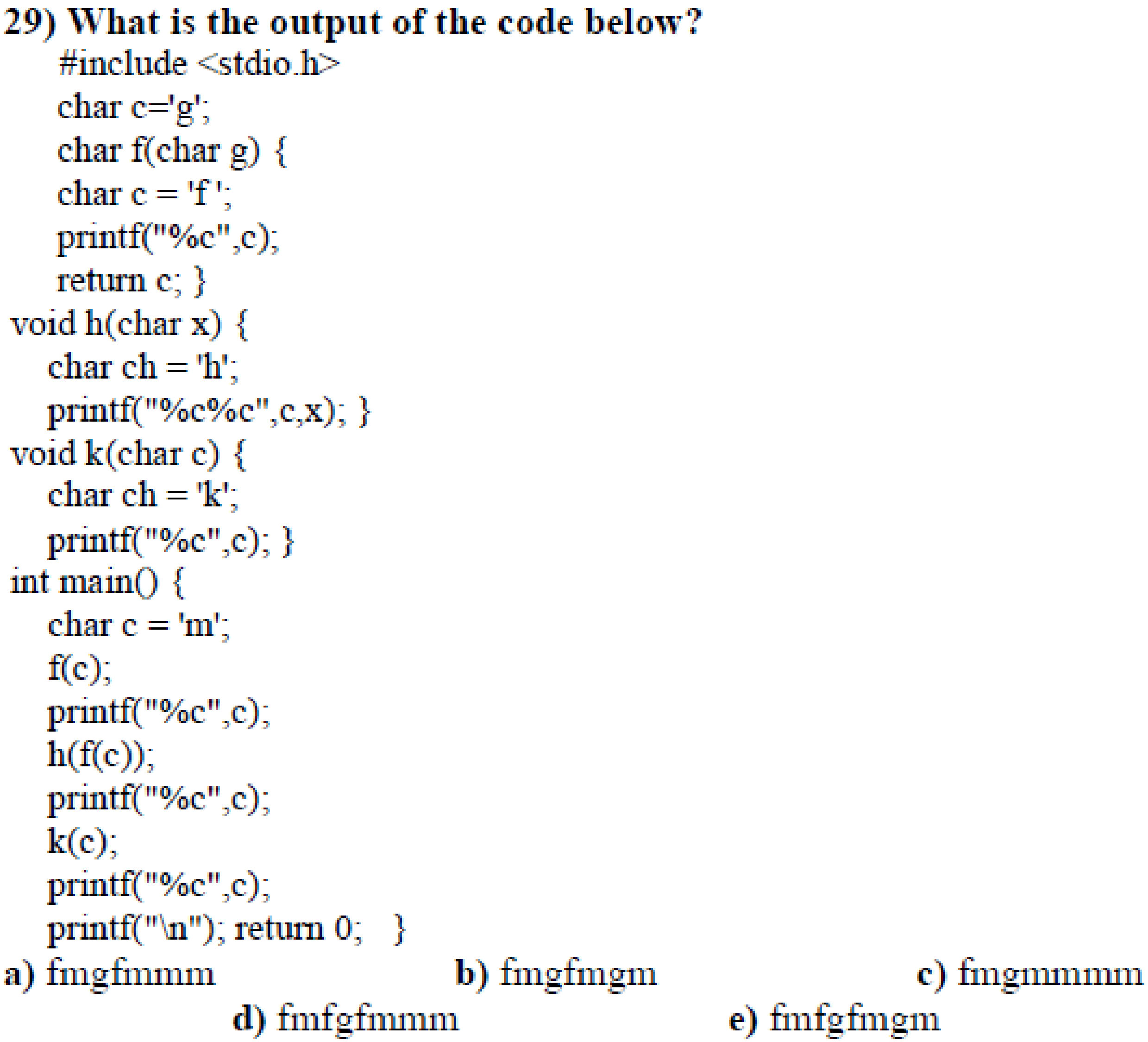


26) What will the following program print?

```
#include<stdio.h>
int k = 1;
int add(int x) { return (x+k++); }
int mult(int k) { return(k*=2); }
int main( ) {
                int t = 2;
                add(k);
                printf("%d %d ",t,k);
                k = mult(t);
                printf("%d %d ",k,t); }
```

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

Sample 11



29) What is the output of the code below?

```
     #include <stdio.h>
     char c='g';
     char f(char g) {
     char c = 'f ';
     printf("%c",c);
     return c; }
void h(char x) {
    char ch = 'h';
    printf("%c%c",c,x); }
void k(char c) {
    char ch = 'k';
    printf("%c",c); }
int main() {
    char c = 'm';
    f(c);
    printf("%c",c);
    h(f(c));
    printf("%c",c);
    k(c);
    printf("%c",c);
    printf("\n"); return 0;   }
```

a) fmgfmmm　**b)** fmgfmgm　**c)** fmgmmmm

d) fmfgfmmm　**e)** fmfgfmgm