Please write your solutions on this page, by \textit{circling} your answer. If you change your mind several times, and make it illegible, then use the box at the right to just enter the correct letter.

\begin{tabular}{|l|c|c|c|c|c|}
\hline
1 & a & b & c & d & e \\
\hline
2 & a & b & c & d & e \\
\hline
3 & a & b & c & d & e \\
\hline
4 & a & b & c & d & e \\
\hline
5 & a & b & c & d & e \\
\hline
6 & a & b & c & d & e \\
\hline
7 & a & b & c & d & e \\
\hline
8 & a & b & c & d & e \\
\hline
9 & a & b & c & d & e \\
\hline
10 & a & b & c & d & e \\
\hline
11 & a & b & c & d & e \\
\hline
12 & a & b & c & d & e \\
\hline
13 & a & b & c & d & e \\
\hline
14 & a & b & c & d & e \\
\hline
15 & a & b & c & d & e \\
\hline
16 & a & b & c & d & e \\
\hline
17 & a & b & c & d & e \\
\hline
18 & a & b & c & d & e \\
\hline
19 & a & b & c & d & e \\
\hline
20 & a & b & c & d & e \\
\hline
\end{tabular}
1. Consider the following variable declaration

```java
Player pl;
```

This declaration

(a) has created a variable called `pl` referring to a newly created `Player` object
(b) (***) has created a variable called `pl` with the initial value `null`
(c) has created a variable called `pl` with the initial value `0`
(d) has created a variable called `pl` with the initial value `false`
(e) will cause a syntax error, as it is not permitted to declare a variable of reference type without creating the associated object.

2. Which of the following is a true statement about constructors?

(a) A class can have only one constructor.
(b) A constructor cannot have any parameters.
(c) A constructor can return a primitive type.
(d) A constructor cannot call an instance method.
(e) (***) None of the above are true statements about constructors.

3. What are the values of `c` and `d` after the following sequence of statements?

```java
boolean a = true;
boolean b = false;
boolean c = (a || b) && !(a && b);
boolean d = c && (a && b || !(a && b || (a && !b)));
```

(a) true, true
(b) (***) true, false
(c) false, true
(d) false, false
(e) true, 0
The next five questions refer to the following source code, which deals with rectangles with integer co-ordinates.

```java
public class Rectangle {

    // x and y store the location of the
    // top-left corner of the Rectangle
    // width and height store the width
    // and height of the Rectangle

    private int x;
    private int y;
    private int width;
    private int height;

    public Rectangle(int xpos, int ypos, int w, int h) {
        x = xpos;
        y = ypos;
        width = w;
        height = h;
    }

    public int area() {
        return width*height;
    }

    public Rectangle translate(int distance) {
        Rectangle r;
        r = new Rectangle(x+distance,y,width,height);
        return r;
    }

    public boolean mystery(Rectangle r) {
        boolean b;
        b = (x <= r.x) && (r.x+r.width <= x+width);
        b = b && (y <= r.y) && (r.y+r.height <= y+height);
        return b;
    }
}
```
4. What are the instance variables of the objects of this class?

(a) (***), x, y, width and height
(b) xpos, ypos, w and h
(c) xpos, ypos, width, height, x, y, w and h
(d) area, translate and mystery
(e) area, translate, mystery and Rectangle

5. Which of the following are legal ways to construct a Rectangle object?

1. Rectangle r = new Rectangle()
2. Rectangle r = new Rectangle(50,50,100,200);
3. Rectangle r = Rectangle().new(50,50,100,200);
4. Rectangle r = new(50,50,100,200);

(a) 1 and 2 only
(b) (***), 2 only
(c) 2 and 4 only
(d) 4 only
(e) 3 and 4 only

6. How many Rectangle objects have been created, in total, after the following sequence of commands?

Rectangle r1;
Rectangle r2;
Rectangle r3;

r1 = new Rectangle(0,0,100,100);
r2 = r1.translate(50);
r3 = r1;

(a) 0
(b) 1
(c) (***), 2
(d) 3
(e) 4

7. If r4 and r5 are objects of the class Rectangle, then what does the method call r4.mystery(r5) return?

(a) (***), It returns true if r4 contains r5
(b) It returns true if r4 and r5 overlap
(c) It returns true if r4 is to the left of r5
(d) It returns true if r4 is to the right of r5
(e) It returns true if r5 contains r4
8. What is the value of \( x \) after the following lines of code?

```java
Rectangle r1 = new Rectangle(100, 30, 100, 80);
Rectangle r2 = new Rectangle(50, 100, 20, 50);
int x = r1.area();
if (r2.area() > r1.area())
    x = r2.area();
```

(a) 1000  
(b) 2000  
(c) 3000  
(d) 5000  
(e) (***) 8000

9. What are the values of the following three expressions respectively?

\[
\begin{align*}
16 / 20 & \times 15 \\
16 / 20.0 & \times 15 \\
16 / 20 & \times 15.0
\end{align*}
\]

(a) (***), 12.0 and 0.0  
(b) 12.0, 12.0 and 12.0  
(c) 0, 12.0 and 12.0  
(d) 0, 0.0 and 0.0  
(e) 12, 12.0 and 12.0
10. Suppose the following method is incorporated into a class that draws on a Canvas (you may assume that the variable c refers to a blank, visible, $400 \times 400$ Canvas).

```java
public void mystery() {
    for (int i=0; i<400; i=i+80)
        c.drawLine(0,i,i,399);
}
```

Which of the following diagrams most closely resembles the picture that this method will draw?

(a) [Diagram]

(b) [Diagram]

(c) [Diagram]

(d) [Diagram]

(e) [Diagram]
11. Suppose you have the class `Die` defined as follows:

```java
class Die {
    private int topFace; // the top face value of the die

    public Die(int value) {
        topFace = value;
    }
}
```

Suppose also that you have created two `Die` objects `d1` and `d2` in your program. What is the value of the expression `d1 == d2` immediately after they have been created?

(a) `true` because they are objects from the same class  
(b) `true` if the two dice have the same value of `topFace`, and `false` otherwise  
(c) this is not a valid expression because `==` can only be used with primitive types  
(d) (***)`false` because the two dice are different objects  
(e) most probably `false` because round-off error means that you cannot compare the `topFace` precisely

12. What are the values of `a` and `b` after the following loop?

```java
int a = 0;
int b = 1;

for (a = 0; a < 12; a = b + 1) {
    a = a + b;
    b = b + a + 1;
}
```

(a) `a` is 36, and `b` is 35  
(b) `a` is 33, and `b` is 55  
(c) `a` is 12, and `b` is 21  
(d) `a` is 35, and `b` is 53  
(e) (***)`a` is 12, and `b` is 11
13. What will the value of \texttt{sum} be after the following statements?

\begin{verbatim}
int sum = 0;
for (int i=5; i<8; i=i+1) {
    sum = sum + i*i;
}
\end{verbatim}

(a) 25  
(b) 85  
(c) (*** 110  
(d) 149  
(e) 174 

14. What will the value of \texttt{x} be after the following statements:

\begin{verbatim}
int x = 0;
for (int i=1; i<4; i++) {
    for (int j=i; j<4; j++) {
        x = x + (i*j);
    }
}
\end{verbatim}

(a) 6  
(b) (*** 25  
(c) 36  
(d) 65  
(e) 100
15. Your firm is developing a class `Customer` to store information about your customers for marketing purposes. Among other things, you wish to store their name, sex and whether or not they are married. Which **types** would be **most appropriate** for these three variables respectively. (Notice that more than one choice may be **feasible**.)

(a) `Customer`, `boolean` and `boolean`
(b) `String`, `boolean` and `char`
(c) (***) `String`, `char` and `boolean`
(d) `String`, `byte` and `byte`
(e) `int`, `short` and `short`

16. What type of variable should be used to store data that is important throughout an object’s lifespan?

(a) A method variable
(b) (***) An instance variable
(c) A primitive variable
(d) A parameter variable
(e) A reference variable

17. What are the values of the following three expressions respectively?

\[
\begin{align*}
3.0 + 17 / 5 \\
3 + 17.0 / 5 \\
3 + 17 / 5.0
\end{align*}
\]

(a) 6.4, 6.4 and 6.4
(b) 6, 6.4 and 6.4
(c) 6, 6 and 6
(d) 6.0, 6.0 and 6.0
(e) (***) 6.0, 6.4 and 6.4

18. Which of the following literals is not of primitive type?

(a) ‘a’
(b) (***) "a"
(c) `true`
(d) `1`
(e) `2e3`
19. What is the value of \texttt{method(8)}, where \texttt{method} is defined as follows?

\begin{verbatim}
public int method(int n) {
    if (n == 1 || n == 2)
        return 1;

    int last = 1;
    int current = 1;
    int next;

    for (int i=3; i<=n; i++) {
        next = current + last;
        last = current;
        current = next;
    }

    return current;
}
\end{verbatim}

(a) 12  
(b) 13  
(c) (***) 21  
(d) 34  
(e) 55

20. Which of the following statements describes a program written in a good object-oriented style?

1. Objects are capable of many complex tasks and communicate as little as possible during runtime.
2. Complex problems are solved by the co-operation of objects from several different classes.
3. Each class of objects provides a narrow range of well-defined services.
4. In carrying out their tasks, objects act as clients or servers but never both, during runtime.

(a) 1 and 2 only  
(b) 3 and 4 only  
(c) 1 and 4 only  
(d) 2, 3 and 4 only  
(e) (***) 2 and 3 only