1. What does mystery(3) return?

```java
public int mystery (int n)
{
    int m = 0;
    while (n > 1)
    {
        if (n % 2 == 0)
            n = n / 2;
        else n = 3 * n + 1;
        m = m + 1;
    }
    return m;
}
```

(a) 0  
(b) 1  
(c) 6  
(d) (*) 7  
(e) 8

2. What are the values of a and b after this loop?

```java
int a;
int b = 3;
for (a = 0; a < 8 || b < 20; a++)
{
    a = a + b;
    b = b + a;
}
```

(a) a is 9 and b is 15  
(b) a is 11 and b is 16  
(c) a is 24 and b is 24  
(d) a is 24 and b is 39  
(e) (*) a is 28 and b is 43
3. What are the respective values of these expressions?

\[
\begin{align*}
18 / 8 - 3.0 / 2 \\
18 / 8.0 - 3 / 2 \\
18 / (8.0 - 3) / 2
\end{align*}
\]

(a) 0.5, 0.75, and 1.8
(b) (*) 0.5, 1.25, and 1.8
(c) 0.5, 1.25, and 7.2
(d) 1.0, 0.75, and 7.2
(e) 1.0, 1.25, and 1.8

4. Which sentence best describes the collective effect of these statements on the int variables a and b?

\[
\begin{align*}
a &= a + b; \\
b &= a - b; \\
a &= a - b;
\end{align*}
\]

(a) (*) The values of the variables are swapped.
(b) The values of the variables are unchanged.
(c) Both variables hold the initial value of a.
(d) Both variables hold the initial value of b.
(e) One variable holds the sum of the initial values, and the other holds the difference.

5. What is the effect of this declaration?

\[
\text{EtchASketch } e;
\]

(a) It causes a compile-time error, as it is not permitted to declare a variable of reference type without creating the associated object.
(b) It creates a variable e with an unspecified initial value.
(c) It creates a variable e with initial value 0.
(d) (*) It creates a variable e with initial value null.
(e) It creates a variable e that points to an EtchASketch object.
6. What does `mysteryFlag(700)` draw on the screen?

```java
public void mysteryFlag (int n)
{
    SimpleCanvas sc = new SimpleCanvas("What am I?", n, n);
    sc.setForegroundColour(java.awt.Color.red);
    for (int i = 0; i < n; i++)
        sc.drawLine(0, i, i, 0);
    sc.setForegroundColour(java.awt.Color.blue);
    for (int i = 0; i < n; i++)
        sc.drawLine(i, 0, 0, i);
}
```

(a) A square split diagonally into red and blue.
(b) (*) A square split diagonally into blue and white.
(c) A square split diagonally into red and white.
(d) A square uniformly in one colour.
(e) Nothing.

7. Which of these situations causes a `NullPointerException`?

(a) Attempting to illegally access a private instance variable.
(b) Attempting to invoke a method with an argument of the wrong type.
(c) Attempting to use a variable of reference type that hasn’t been declared.
(d) (*) Attempting to use a variable of reference type that doesn’t point at an object.
(e) None of the above.
8. How many constructors is a class allowed to define?

(a) 0
(b) 0 or 1
(c) 1
(d) 1 or more
(e) (*) Any number

9. What is the value of a[99] after these statements?

```java
int[] a = new int[100];
a[0] = 1;
for (int i = 1; i < a.length; i++)
    a[i] = 1 - a[i-1];
```

(a) -2
(b) -1
(c) (*) 0
(d) 1
(e) 2

10. If I want to create and populate an array of n BankAccounts, how many calls to new do I need?

(a) 1
(b) n
(c) (*) n+1
(d) 2n
(e) 2n+1
11. Why can’t 0.2 be represented exactly in Java?
   (a) It is an irrational number.
   (b) It can’t be represented exactly in 32 bits.
   (c) (*) It can’t be represented exactly in binary.
   (d) Floating-point numbers are represented as objects.
   (e) Floating-point numbers are stored on the heap.

12. Which sentence best describes what this method does?

```java
public void mystery (int[] a)
{
    for (int i = 1; i < a.length; i = i+2)
        a[i] = a[i-1];
}
```

   (a) (*) It duplicates the even-indexed elements of a.
   (b) It duplicates the odd-indexed elements of a.
   (c) It copies the first element of a into every other slot.
   (d) It swaps adjacent elements of a.
   (e) It copies the front half of a into the back half.
13. Which of these expressions return \texttt{false} if $x$ and $y$ are both \texttt{true}, and return \texttt{true} in all other cases?

\[
\begin{align*}
!x \lor !y \\
!x \land !y \\
!x \lor x \neq y \\
\end{align*}
\]

(a) None of them  
(b) 1 and 2  
(c) (*) 1 and 3  
(d) 2 and 3  
(e) All of them

14. Which of these literals is \texttt{not} of primitive type?

(a) 7  
(b) '7'  
(c) (*) "7"  
(d) 7.7  
(e) 7e7
The next six questions refer to the following source code, which defines a class that represents circles.

```java
public class Circle
{
    private double centreX, centreY, radius;

    public Circle(double x, double y, double r)
    {
        centreX = x;
        centreY = y;
        radius = r;
    }

    public Circle(double r)
    {
        this(0, 0, r);
    }

    public Circle()
    {
        this(1d);
    }

    // area() returns the area of the circle
    public double area()
    {
        return Math.PI * radius * radius;
    }

    // scale() enlarges/shrinks the circle
    public void scale(double factor)
    {
        radius = radius * factor;
    }

    // bigger() returns the circle with the larger area
    public Circle bigger(Circle other)
    {
        if (this.area() >= other.area()) return this;
        else return other;
    }

    // halve() returns a concentric circle with half the area
    public Circle halve()
    {
        return new Circle(centreX, centreY, radius / Math.sqrt(2));
    }

    // the mystery method does something unclear
    public boolean mystery(Circle c)
    {
        double x = this.centreX - c.centreX;
        double y = this.centreY - c.centreY;
        return this.radius >= c.radius + Math.sqrt(x*x + y*y);
    }
}
```
15. What are the instance variables of Circle?

(a) (*) centreX, centreY, and radius
(b) x, y, and r
(c) factor, other, and c
(d) other and c
(e) bigger and halve

16. How many of these statements correctly construct a Circle?

1. Circle c = new Circle(1e-4);
2. Circle c = Circle();
3. Circle c = new Circle(Math.PI, Math.E, -1);
4. Circle c = Circle(3, 2, 1).new;

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

17. How many Circles does this sequence construct?

Circle c1, c2, c3, c4;
c1 = new Circle(0);
c2 = c1;
c3 = c2.halve();
c4 = c3.bigger(c1).halve().halve();

(a) 1
(b) 2
(c) 3
(d) (*) 4
(e) 5
18. Which sentence best describes the conditions under which `mystery(c)` returns `true`?

(a) When the centre of the circle lies inside \( c \).
(b) When the centre of \( c \) lies inside the circle.
(c) When \( c \) and the circle touch.
(d) (*) When the whole of \( c \) is contained inside the circle.
(e) When the whole of the circle is contained inside \( c \).

19. What value is stored in \( c\text{.area} \) after this code (rounded to the nearest integer)?

```java
Circle c = new Circle(10);
c.scale(1 / Math.sqrt(Math.PI));
double c_area = c.halve().area();
```

(a) 16  
(b) 31  
(c) (*) 50  
(d) 100  
(e) 493

20. If \( c1 \) is a circle with centre \((2, 4)\) and radius 2, and \( c2 \) is a circle with centre \((4, 2)\) and radius 4, what is the value of

\( c1.bigger(c2) \)

(a) An object reference equal to \( c1 \).
(b) (*) An object reference equal to \( c2 \).
(c) A reference to a new \texttt{Circle} object representing a circle with centre \((4, 2)\) and radius 4.
(d) A reference to a new \texttt{Circle} object representing a circle with centre \((4, 4)\) and radius 4.
(e) It causes an error.
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