Question 1 ................................................................. (20 points)
What is printed by the following program fragments?

```java
int i = 2 * 4 - 4 / 4;
int j = i/3;
int k = i%3;
System.out.println("i=\"i\" j=\"j\" k=\"k\"\t\n";
for (i=0,j=1; j<10; ++i,j=j*2)
    System.out.println(i","j);
```

```java
i=0; j=1; k=2;
while (i<3) {
    ++i;
    j = j - 1;
    k = k * 2;
}
System.out.println("i=\"i\" j=\"j\" k=\"k\"\t\n";
```

```java
for (i=0,j=9; i<j; ++i,--j)
    k = (i+j)/2;
System.out.println("i=\"i\" j=\"j\" k=\"k\"\t\n";
```

Question 2 ................................................................. (15 points)
Identify and fix eight errors in the following program fragments.

```java
float fsqrt2 = Math.sqrt(2.0);
double dsqrt3 = Math.sqrt(3.0);
float fratio = fsqrt2/dsqrt3;
double dratio = dsqrt3/fsqrt2;
```

```java
public class Util {
    public static final double 2PI = 2.0*Math.PI;
    public static void equals(float x, float y) {
        return x==y;
    }
}
```
Question 3 ................................................................. (35 points)

Complete the following methods.

// Returns the smallest of the values a, b, and c.
public static float min(float a, float b, float c) {

}

// Returns the largest of the values in the array a.
public static float max(float[] a) {

}

// Returns a clipped copy of the array a. In the returned array,
// any values in the array a less than 0 are replaced by 0, and
// any values greater than 255 are replaced by 255.
public static float[] clip(float[] a) {

}
(Question 3 continued.)

// Returns a 1D array containing all values in a specified 2D image.
public static float[] packImage(float[][] image) {
  // ... (code snippet)
}

// Reads an image from a binary file containing exactly w*h floats,
// where w and h are the image width and height, respectively.
// Returns a new 2D array float[h][w] that represents the image.
// Throws a new RuntimeException if any IOException is thrown.
public static float[][] readImage(String fileName, int w, int h) {
  // ... (code snippet)
}

Question 4 ................................................................. (5 points)
  How many bits in a Java byte?
  How many bytes in a Java int?
  How many bytes in a Java short?
  How many bytes in a Java float?
  How many bytes in a Java double?
Complete the classes and methods described below. Before completing the class `Minimizer`, please see the interface `Function` defined on the following page.

```java
/**
 * Finds the value x that minimizes an arbitrary function y = f(x).
 */
public class Minimizer {

    /**
     * Constructs a function minimizer.
     * @param neval the number of different x values at which to evaluate the function when searching for the minimizing x.
     */
    public Minimizer(int neval) {
    }

    /**
     * Finds a value x that minimizes the specified function y = f(x).
     * This method searches for the minimizing x by simply evaluating the function for different x values in the interval [a,b].
     * @param a the lower bound on x; must be less than b.
     * @param b the upper bound on x; must be greater than a.
     * @param func the function y = f(x) to be minimized.
     * @return the x (not y) for which y = f(x) is minimized.
     */
    public double findMin(double a, double b, Function func) {
        private // number of function evaluations
    }
```
What fundamental principle (one word) of object-oriented programming enables the class Minimizer to be written without having to know what type of Function will be minimized?