Your answers may be slightly different! That's OK!

Question 1.

(a)
```
/** An instance is for an out-of-space exception */
public class OutOfSpaceException
                              extends RuntimeException {

  /** Constructor: An instance with no detail message */
  public OutOfSpaceException() {
    super();
  }

  /** Constructor: An instance with detail message m */
  public OutOfSpaceException(String m) {
    super(m);
  }
}
```

(b)
```
import java.util.*;

/** An instance maintains info about a hard drive. ... */
public class HardDrive extends Storage {

  private int used; // Amount of spaced used on drive

  // Objects on the drive. The location of an object
  // is its index in this vector.
  private Vector contents;

  /** Constructor: empty hard drive with capacity c */
  public HardDrive(int c) {
    super(c);
    used= 0;
    contents= new Vector();
  }

  /** = amount of unused space */
  public int remainingSpace() {
     return getCapacity() - used;
  }

  /** Add ob, of size s, to drive, and return its location.
    Throw OutOfSpaceException if not enough room */
  public int add(Object ob, int s) {
    if (remainingSpace() < s)
      throw new OutOfSpaceException(
             "not enough space on hard drive");
    used= used + s;
    contents.add(ob);
    return contents.size()-1;
  }

  /** Erase contents of this hard drive. */
  public void format() {
    contents= new Vector();
    used= 0;
  }

  /** = contents of location i of the hardDrive.
    Precondition: i is OK. */
  public Object get(int i) {
    return contents.get(i);
  }
}
```

Question 2 (a)
```
public MP3Song(Object f, String n) {
    if (!(n.endsWith(".mp3")))
      throw new IllegalArgumentException(
          "title does not end in .mp3");
    mp3= f;
    title= n;
}
```

(b)
```
/** Instance is a hard drive with only mp3 songs,
      Each object on this drive is of class MP3Song. */

public class MP3 extends HardDrive {
  /** Constructor: A new MP3 player with capacity c */
  public MP3(int c) {
    super(c);
  }

  /** Add song mp3, with title n and size s, to this MP3
     drive and  return its location.
     Throw an IllegalArgumentException if ... */
  public int add(Object mp3, String n, int s) {
    return add(new MP3Song(mp3, n), s);
  }

  /** = the title of song at location i */
  public String getTitle(int i) {
    MP3Song song= (MP3Song)(get(i));
    return song.title;
  }

  /** = the song at location i */
  public Object getSong(int i) {
    MP3Song song= (MP3Song)(get(i));
    return song.mp3;
  }
}
```

Question 3.
```
public static Point partition(int[] b, int h, int k) {
    int i= h;
    int j= i;
    int t= k;

    // inv:b[h..i-1 < x, b[i..j] = x,
           b[j+1..t] is unknown, and b[t+1..k] > x
    while (j < t) {
      if (b[j+1] < b[i]) {
        j= j+1;
        int temp= b[j]; b[j]= b[i]; b[i]= temp;
        i= i+1;
      }
      else if (b[j+1] == b[i]) {
        j= j+1;
      }
      else {
        int temp= b[j+1]; b[j+1]= b[t]; b[t]= temp;
        t= t-1;
      }
    }
    return new Point(i, j);
}
```

Question 4.

```
/** Place the m x n Bricks, as requested on the exam
      and return the array. */
public Brick[][] placeSquares(int m) {
      Brick[][] b= new Brick[m][m];

      for (int c= 0; c < m; c= c+1) {
         // Place col c of bricks
         for (int r= 0; r < m; r= r+1) {
            b[c][r]= new Brick(r*BrickSide, c*BrickSide,
                                                BrickSide);
            if (r == 0 || r == m-1 || c == 0 || c == m-1)
               b[c][r].setColor(Color.pink);
            else if ((r+c) % 2 == 0)
               b[c][r].setColor(Color.red);
            else b[c][r].setColor(Color.green);

            add(b[c][r]);
         }
      }

      return b;
}
```

Question 5.

```
/** = the length of the sequence of equal
         characters beginning at s[i].
     Precondition: 0 <= i < s.length().. */
public static int eqChars(String s, int i) {
      int k= 1;
      /** inv: Characters in s[i..i+k-1] are the same */
      while (i+k < s.length() &&
               s.charAt(i) == s.charAt(i+k)) {
         k= k+1;
      }

      return k;
}

/** = a string that compresses successive sequence of
equal elements as specified on the exam.
E.g. for s = "bbbbaa$$$$$$$$$$$$$xxx",
      the result is "b4a2$13x3" */
public static String compress(String s) {
      if (s.length() == 0)
         return s;

      // s has at least one character
      int len= eqChars(s, 0);
      return s.charAt(0) +
               (len + compress(s.substring(len)));
}
```

Question 6. (a)

```
public interface P {
   int m(int x);
   void p();
}
```

(b)

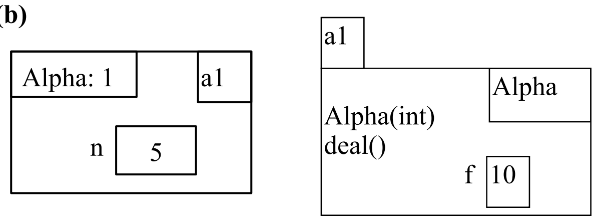
```
public class Answer extends JFrame implements P {
   public int m(int x) {
      return x;
   }
   public void p() {}
}
```

(c)

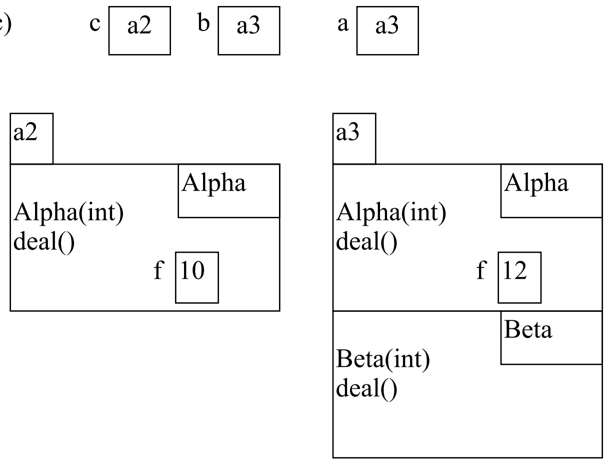
```
/** = length of string s */
public static int length(String s) {
   int k= 0;
   while (true) {
      try {
         char c= s.charAt(k);
      } catch (StringIndexOutOfBoundsException e) {
         return k;
      }
      k= k+1;
   }
}
```

Question 7 (a). Evaluation the expression. If it is true, execute statement S1; otherwise, execute statement S2.

(b)



(c)



c
a2
b
a3
a
a3
a2
Alpha
Alpha(int)
deal()
f
10
a3
Alpha
Alpha(int)
deal()
f
12
Beta
Beta(int)
deal()