

14.

Consider the following piece of code:

```
public class A
{
    private int a;

    public int getA() {
        return a;
    }

    public void increaseA(int m) {
        a += m;
    }
}
```

Imagine that this code has been written quickly, as part of a preliminary proof of concept system. The successful proof of concept system was single-threaded. The code must now be reviewed and re-written for a multi-threaded system.

- 1) Why is the code above not thread safe? **[1 Mark]**  
 Give an example of how the lack of thread safety would be observed. **[1 Mark]**
  
- 2) While reviewing this code, a friend suggests that making the integer `volatile` would be the simplest, easiest and most efficient way to make this class thread-safe.  
 State the purpose of the `volatile` keyword. **[1 Mark]**  
 Explain why it will not make this class thread safe. **[1 Mark]**
  
- 3) You are responsible for re-writing this code to make it thread safe.  
 Write your complete implementation of this class (it must have the same public methods, but the internal implementation is your responsibility). **[2 Marks]**  
 A colleague asks you to justify your choice.  
 State why your solution is thread-safe. **[1 Mark]**  
 Provide another possible and reasonable solution. **[1 Mark]**  
 Explain why your solution is the best of these choices. **[1 Mark]**
  
- 4) During the refactoring of the system, it is decided that this class will need at least one more method: `int getInvocationCount()`. This method returns the number of times `increaseA` has been called.  
 Write a new version (do not just amend your previous answer) of this class that supports this functionality. **[1 Mark]**  
 Explain why you did, or did not, need to make substantial changes to your answer given in (3) **[1 Mark]**

18.

You are working for a company that produces software for the medical profession. The company is currently working on a wall mounted touch-screen device for radiologists which allows them to view high resolution X-Ray images. The images are loaded from the hospital's image file server. Typically, a group of radiologists view a group of related images in a batch, and move to a different batch of images later.

Two of the requirements of this system are that it must be available 24x7, and that it should be responsive.

Initial trials of the system showed that the strategy of loading the images and retaining them in memory was fast but after two days of simulated use, the system would run out of memory and crash. A quick fix to the problem was to load the images from the file store each time they were used. However, this proved to be frustratingly slow.

Your manager has explained that just adding more memory to the system is not a solution that is available to you.

Propose and justify a solution to this problem using standard Java Technology. **[4 Marks]**

Describe how you would write your solution so that it required the minimum number of changes to the current code, and was suitable for future development. **[1 Mark]**