Foundations of Programming

(a) Briefly explain the relationship between the Java classes `Exception` and `RuntimeException` and say how they differ. [4 marks]

(b) The following program employs the `ArrayIndexOutOfBoundsException` (in the Java library) and also two user-supplied exceptions `TwoException` and `FiveException` (not shown) which are declared as extensions of class `Exception`. Explain how the program works and what output is produced. [6 marks]

```java
public class ExceptionTest {
    private static int n = 0;
    private static int[] a = {2,3,5,7,11,13,17};

    public static int next() throws FiveException {
        try {
            if (n == 2) throw new TwoException();
            if (n == 5) throw new FiveException();
        } catch (TwoException e) {}
        return n++;
    }

    public class TwoException extends Exception {}
    public class FiveException extends Exception {}

    public static void main(String[] args) {
        while (true) {
            try {
                System.out.println(a[next()]);
            } catch (ArrayIndexOutOfBoundsException e) { break; }
            catch (FiveException e) { n++; continue; }
        }
    }
}
```

(c) For each of the three `catch`-clauses explain whether or not it could be removed without provoking a compile-time error. If so, explain what difference, if any, would occur at run time. [4 marks]

(d) Explain whether or not the `throws`-clause in the heading of method `next()` could be removed without provoking a compile-time error. [2 marks]

(e) Explain whether or not your answer to (d) would differ if the `FiveException` were declared as extending `RuntimeException` rather than `Exception`. [4 marks]