Question 2

Five people attempted this question. Two knew what they were doing, the other three did not. In other words only two people wrote non-trivial Java code on the exam.

This question is about **practical Java programming** using loops and arrays.

You are writing a class which contains information about events and the dates on which they occurred. Events are just Strings. Dates are objects of a class called Date, for which the following items are relevant:

The **Date** class has a method

```
public boolean moreRecentThan(Date other)
```

which returns true if the **Date** object the method is called on is more recent than the other **Date** object.

It also has a method

```
public boolean equals(Date other)
```

which is true if the dates are the same.

It has a constant `BEGINNING_OF_TIME` which is guaranteed to be older than any other **Date** objects.

It has a `toString()` method which returns a sensible String representation of a **Date**.

In your class you have an array of **Date** objects called `_dates` and an array of Strings called `_events`. Each element of `_dates` is the date of the corresponding element of `_events`, e.g. `_dates[3]` is the date of `_events[3]`.

2.1 [ Marks: 2 ]

How would you check whether the fifth date is more recent than the seventh, assuming that there are at least 7 dates? (2 marks)

```
_dates[4].moreRecentThan(_dates[6])
```

2.2 [ Marks: 4 ]

Write a method `public Date mostRecent()` which returns the most recent date in the `_dates` array.
Hint: the BEGINNING_OF_TIME constant and the moreRecentThan() method are useful here

public Date mostRecent() {
    Date result = BEGINNING_OF_TIME;
    for (Date date: _dates) {
        if (date.moreRecentThan(result)) {
            result = date;
        } else {
            // Do nothing
        }
    }
    return result;
}

2.3 [ Marks: 4 ]

Write a method public String eventAt(Date date) which returns the event at the given date, if any (you can assume there is not more than one). If there is no event at that date, it should return the String “No event at that date”.
Hint: the equals() method is useful here.

public String eventAt(Date date) {
    String result = "No event at that date";
    int i = 0;
    // We need to use a while loop because we need to access both arrays
    while (i < _dates.length) {
        if (_dates[i].equals(date)) {
            result = _events[i];
        } else {
            // Do nothing
        }
        i++;
    }
    return result;
}

2.4 [ Marks: 5 ]

Write a method which prints the most recent event and its date on one line.

public void printMostRecent() {
    Date mostRecentDate = BEGINNING_OF_TIME;
    int i = 0;
    // The easiest way of doing this is to remember the index of the most recent date.
    int indexOfMostRecent = 0;
    while (i < _dates.length) {
        if (_dates[i].moreRecentThan(mostRecentDate)) {
            indexOfMostRecent = i;
        }
    }
Question 3

This question is about Inheritance

Everybody did this question; most people did ok.

3.1 [ Marks: 3 ]

Briefly explain, with an example, how inheritance in Java relates to the way we think about the world.

The answer should be along the following lines (the important thing is to use a good example).

We deal with complexity in the real world by thinking in terms of classes, and organising these classes into concept hierarchies. For example Plant -> Tree -> Oak Tree. Similarly (in a forestry management system for example) we might have an abstract Tree class with subclasses such as OakTree.

This was mostly answered well.

3.2 [ Marks: 1 ]

What is the basic rule to apply when deciding whether inheritance is appropriate?

There must be a clear is-a-kind-of relationship between superclass and subclasses

Most people got this correct.

3.3 [ Marks: 2 ]

Give one example of inheritance which obeys the basic rule and one which does not. Use different examples from that in your answer to question 3.1.
Good example: a Television class inheriting from a CustomerElectronics class
Bad example: a Screen class inheriting from a Television class (a screen is part of a
television, not a kind of one)

Most people got this right too, but part of the reason for that was that the question is
carelessly phrased as it does not disallow examples on the lecture slides.

3.4

3.4a [ Marks: 3 ]

Draw a UML diagram which shows an abstract Bird class with subclasses Penguin,
Sparrow and EddieTheEagle.
Almost nobody got full marks here, as almost nobody used the correct notation for inheritance (the triangle). I showed several examples on the whiteboard during the lectures…

3.4b [ Marks: 3 ]

Show the Java class declarations corresponding to the diagram

```java
public abstract class Bird

public class Penguin extends Bird
```
public class Sparrow extends Bird
public class EddieTheEagle extends Bird

(Adding braces after Bird is also ok). Around 50% of people got this right.

3.4c [ Marks: 3 ]

Is the above example a good use of inheritance, a bad use, or a bit of both? Briefly explain why

Having an abstract Bird class with subclasses Penguin and Sparrow is ok at least in principle, as there is a clear is-a-kind-of relationship. (In practice it would depend on the application, since there could potentially be an extremely large number of subclasses). The name EddieTheEagle (if a bird at all) indicates an instance of an Eagle class, not a class.

A lot of people missed the last point, in particular several people suggested that EddieTheEagle should inherit from an Eagle class rather than directly from Bird, but the name clearly suggests that Eddie is an instance not a class (either that or a very bad class name, which would also be a bad use of inheritance.

Question 4

Nobody attempted this question. Probably just as well.

This question is about Collections

Note. The following description of the Date class is the same as in question 2.

You are writing a class which contains information about events and the dates on which they occurred. Events are just Strings. Dates are objects of a class called Date, for which the following items are relevant:

• The Date class has a method
  public boolean moreRecentThan(Date other)
  which returns true if the Date object the method is called on is more recent than the other Date object
• It also has a method public boolean equals(Date other) which is true if the dates are the same.
• It has a constant BEGINNING_OF_TIME which is guaranteed to be older than any
other Data objects.
• It has a toString() method which returns a sensible String representation of a Date.

In your class you have two Lists, _dates and _events, where each element of _dates is the
date of the corresponding element of _events, e.g. the third element of _dates is the date
of the third element of _events.

4.1 [ Marks: 2 ]

How would you declare and initialise the list of dates, assuming that you are using
ArrayLists

private List<Date> _dates;

then in the constructor:

_dates = new ArrayList<Date>();

4.2 [ Marks: 2 ]

How would you check whether the fifth date is more recent than the seventh, assuming
that there are at least 7 dates?

_dates.get(4).moreRecentThan(_dates.get(6))

4.3 [ Marks: 4 ]

Write a method public String eventAt(Date date) which returns the event at the given
date, if any (you can assume there is not more than one). If there is no event at that date,
it should return the String “No event at that date”. Hint: the equals() method is useful
here.

public String eventAt(Date date) {
    String result = "No event at that date";
    int i = 0;
    // We need to use a while loop because we need to access both
    // lists
    while (i < _dates.size()) {
        if (_dates.get(i).equals(date)) {
            result = _events.get(i);
        } else {
            // Do nothing
        }
        i++;
    }
    return result;
}
4.4
Suppose instead of ArrayLists you use a Map, _eventMap from dates to events.

4.4a [ Marks: 2 ]
Show how this Map would be declared and initialised

private Map<Date,String> _eventMap;

Then in the constructor:

_eventMap = new HashMap<Date, String>();

4.4b [ Marks: 2 ]
Show how the eventAt() method would be implemented using the Map

public String eventAt(Date date) {
    String result = "No event at that date";
    if (_eventMap.containsKey(date)) {
        result = _eventMap.get(date);
    } else {
        // Do nothing
    }
    return result
}

Note how using a Map gives a much better solution, we no longer need a loop.
It's also ok to write it like this:

    public String eventAt(Date date) {
        if (_eventMap.containsKey(date)) {
            return _eventMap.get(date);
        } else {
            return "No event at that date";
        }
    }

4.5 [ Marks: 3 ]
Briefly discuss the advantages of using a Map rather than a pair of ArrayLists or a pair of arrays. Are there any disadvantages?

Generally using a Map is much better as it avoids using loops. It also is easier to manage as the association is made automatically, you don't have two arrays/Lists to keep in step. On the other hand, there is no easy way to get the date of an event, but
this could easily be fixed by having a second map, Map<String, Date> Since the contents of a Map are not ordered, doing things like getting the events in date order is more difficult.

Question 5

13/18 attempted this, which is fewer than I expected, and the answers were significantly worse than for similar questions in previous years. I suspect a number of people didn’t revise this material (certainly there were only a handful at the lecture), which was unwise as this was the easy, get-out-of-jail question which doesn’t require writing any Java code at all. Around half the class here either fried here or burnt in question 2.

This question is about data storage

5.1 [ Marks: 3 ]

For three of the four forms of data storage introduced in the course, explain in one sentence how data is written out in that form from a Java program

3 of:
Relational databases: the JDBC package is used to make SQL queries, which can be used to create and update tables
Serialization: an object, or a large collection of objects, can be written out in one go using an ObjectOutputStream
XML is just text, so we write it out step by step, starting with the first opening tag and finishing with the last closing tag.
Likewise for CSV we write a text file where each line represents an object and the parts of that object are separated by commas.

Many answers were not specific enough - the question is about how data is written out from Java, not just what the formats are.

5.2 [ Marks: 3 ]

For the same three forms, explain in one sentence how stored data is read back into a Java program
Databases: again we use JDBC we send SQL queries and get back data in the form of a collection called a ResultSet
Serialization: we read the objects back in using an ObjectInputStream
XML: we need to parse it, using Java libraries designed for the purpose, checking that it is well-formed and valid.
CSV: we read it in line by line from a text file and convert each line to an object.

Some people didn’t even attempt this, and of those that did, the problem was often as in 5.1.

5.3 [ Marks: 1 ]

Which of the forms is not normally used for long-term data storage, and why?

Serialization because if the classes change in even very minor ways, the stored objects become incompatible (schema evolution)

A lot of people even got this wrong.

5.4

The ABC exam software uses all four forms. While you are taking the exam, backups of your work are sent to the server using Java serialization. These backups and exam and answer data generally are stored as XML files on the server. Information about which students are taking which courses etc. (hundreds of thousands of records) are stored in a relational database. Finally, marks are produced as CSV files.

5.4a [ Marks: 4 ]

For each of the formats, suggest one reason why we use it in the particular role (i.e. real time data backup, long term exam data storage, student data storage, result production) stated above

Backups: serialization is simple and fast, and we know that the classes will be compatible Exam data: this is inherently tree structured so it's natural to use XML, we can also deal with changes in structure fairly easily Student data: this is large, and table structured, and we get it from a database (Campus Solutions) anyway Marks: simple table structure, we want to view them in Excel, hence CSV

Most people were along the right lines here.

5.4b [ Marks: 4 ]
For each role, suggest an alternative form of data storage we could have used, briefly explaining why.

Backup: could use XML to avoid conversion on the server. Exam data: could use a database for this (other systems do) although we would need to map the tree structure to tables. Student data: could use XML or CSV (the original system stored everything as XML and used CSV for data input). Marks: could use a database (the marks end up in one) or XML.

There were a number of wacky suggestions here, in a number of cases not even one of the four formats discussed in the course. Serialization is no good for anything involving long term storage, so will always be the wrong answer here. HTML doesn’t allow you to specify a data format (tags) and so also is no good.