

DEPARTMENT OF PHYSICS & ASTRONOMY

3459 EXAM-1

10:00 - 13:00 : November 16th 2011

Please read the exam guidelines, rules, instructions and marking criteria at <http://moodle.ucl.ac.uk/mod/wiki/view.php?id=13963&page=Mid-term+exam> (linked from the *Exams and coursework* page).

This exam is worth 25% of your final mark for the course and is made up of two parts:

- 15 multiple-choice questions, worth 7.5% of your final mark;
- a programming exercise, worth 17.5% of your final mark.

You should endeavour to spend no more than 30 minutes on the multiple-choice section.

Both the answers to the multiple-choice questions (in a file called `mc.txt`) and Java source code of your solution to the programming exercise should be uploaded using Moodle under the section headed “Exam 1”.

DEPARTMENT OF PHYSICS & ASTRONOMY

3459 EXAM-1

PROGRAMMING EXERCISE

You will write Java classes and methods to read data from a URL, analyse the data and present the results.

A beam of particles travels down a beam pipe in the z direction, and is monitored at a number of locations using beam position monitors (BPMs). At a certain point, the beam pipe narrows, causing some of the particles to be lost on the wall of the beam pipe. The beam position monitors can measure the x and y position of the particles as they pass the z position of the monitor. The data from BPMs is in a text file at the following URL:

<http://www.hep.ucl.ac.uk/undergrad/3459/exam-data/bpm.txt>

Each line of the file corresponds to a measurement of the position of a single particle by one of the beam position monitors. Unfortunately, the data from the monitors has been scrambled so the data is not grouped in any order. Each line contains three columns of x , y and z data in millimetres, giving the measured x and y positions for a single particle at a given BPM z position. An example line is:

3.27289 5.6767 200

You should write a program using appropriate classes and methods to read the data from the URL and store the measurements in suitable collection objects. You should:

- Determine the number and separation distance of the BPMs. (NB: Each beam position monitor has a single fixed value of z , corresponding to the location of the monitor relative to the start of the beam pipe.)
- Print out the number of particles measured by each of the BPMs. (NB. Due to losses in the system each BPM does not necessarily measure the same number of particles.)
- Determine and print to screen the mean x and y positions, \bar{x} and \bar{y} , of the beam at each BPM.
- Calculate the radial distance of each particle from the beam axis, r , where $r_i^2 = (x_i - \bar{x})^2 + (y_i - \bar{y})^2$ for particle i .
- Determine and print to screen, the *rms* radius, r_{rms} , of the beam as measured by each BPM, where for N particles measured at a given BPM location: $r_{rms} = \sqrt{\frac{\sum r_i^2}{N}}$.
- Determine and print to screen the maximum radius measured at each BPM.
- Use this information to work out the z -location at which the beam pipe narrows and the minimum radius of the beam pipe after this point.

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3459 EXAM-1
MULTIPLE CHOICE

You should endeavour to spend no more than 30 minutes on the multiple-choice section.

DO NOT WASTE TIME CODING THE QUESTIONS TO GET THE ANSWERS

You should enter your answers to the multiple-choice questions into a text file called `mc.txt` created using a text editor such as WordPad. The file should have the following format:

YOUR NAME

01 a

02 b

03 c

...

14 b

15 a

There is exactly one correct answer to each question.

Q1. What does the following line do?

```
double times[] = new double[20];
```

- (a) It creates an array that can hold 20 doubles, referred to as `times[0] ... times[19]`.
- (b) It creates an array that can hold 20 doubles, referred to as `times[1] ... times[20]`.
- (c) It creates an array that can hold 21 doubles, referred to as `times[0] ... times[20]`.
- (d) It creates an array that can contain one double, and assigns to this double the value 20.

Q2 What would happen if you tried to compile this code?

```
public class ExamClass {  
    public void changeSomething() { }  
    public static void main(String[] args) {  
        changeSomething();  
    }  
}
```

- (a) It is valid code and will compile successfully.
- (b) The `changeSomething` method does not contain a `return` statement, so the code will not compile.
- (c) The code won't compile as the `main` method is static and so cannot call the non-static method `changeSomething` without first creating an instance of `ExamClass`.
- (d) The code won't compile as the `main` method does not take the correct argument type.

Q3 How many lines of output will the following code print to the screen?

```
int loopCount=0;
System.out.println("Starting loop");
do {
    System.out.println("Loop"+loopCount);
    loopCount++;
}
while (loopCount<10);
```

- (a) 9
- (b) 10
- (c) 11
- (d) 12

Q4 What does private mean in the following code extract?

```
public class AnotherExample {
    private double secret;
    public void setV(double d) {v = d;}
}
```

- (a) The variable `secret` is stored in an encrypted form.
- (b) The variable `secret` can only be accessed from the `AnotherExample` class.
- (c) The variable `secret` can only be accessed from the main program.
- (d) The value of the variable `secret` cannot be changed once it has been set.

Q5 Which of the following methods will NOT compile when incorporated into a class?

- (a) `private static void funcA() {}`
- (b) `private int funcB() {return 1;}`
- (c) `public void funcC(int j) {}`
- (d) `private double funcD() {System.out.println(1.2);}`

Q6 What number will be printed to the screen by the following program?

```
public class YetAnotherExample {  
    private int nonStaticVar = 0;  
    private static int staticVar = 2;  
    public static void main(String[] args) {  
        YetAnotherExample a = new YetAnotherExample();  
        YetAnotherExample b = new YetAnotherExample();  
        a.nonStaticVar = 6;  
        b.staticVar = 3;  
        System.out.println(a.nonStaticVar + a.staticVar);  
    }  
}
```

- (a) 2
- (b) 8
- (c) 9
- (d) 62

Q7. What will happen if you attempt to compile and run the following code fragment?

```
int anInt = Integer.parseInt("12.5");  
System.out.println(anInt);
```

- (a) 12.5 being printed to the screen
- (b) 12 being printed to the screen
- (c) A compilation error
- (d) The program crashing and a `NumberFormatException` being thrown

- Q8.** Which of the following would not be a valid line of code (i.e. would result in a compilation error) if inserted after the "//here" line?

```
public class AClassForTheExam {
    public static void first() {System.out.println("first");}
    public void second() {System.out.println("second");}
    public static void main(String[] args) {
        AClassForTheExam theClass = new AClassForTheExam();
        // here
    }
}
```

- (a) first();
- (b) second();
- (c) theClass.second();
- (d) AClassForTheExam anotherClass = theClass;

- Q9** Which of the following lines will successfully create a Vector object and add an Integer element?

- (a) Vector<int> v = new Vector(); v.add(2);
- (b) Vector<Integer> v = new Vector<Integer>(); v.add(2);
- (c) Vector<Integer> v = new Vector<Integer>(); v[0] = 2;
- (d) Vector<Integer> v = {2};

- Q10** What type of object is created by this line of Java code?

```
HashMap<Integer,String> h = new HashMap<Integer,String>();
```

- (a) A map that can use strings as keys to access integer numbers.
- (b) An array that can hold a mixture of strings and integer numbers.
- (c) A map that can use integer numbers as keys to access strings.
- (d) A string of digits representing an integer number.

Q11 What will the following line print to the screen?

```
System.out.println("18"+2);
```

- (a) 2
- (b) 20
- (c) 18
- (d) 182

Q12 Under what circumstance will the word “Finally!” be printed by the following program?

```
public class AlmostPenultimateExamClass {  
    public static void main(String[] args) {  
        try {  
            test();  
        } catch (Exception e) {  
            System.out.println("Exception!");  
        } finally {  
            System.out.println("Finally");  
        }  
    }  
    public static void test() throws Exception {  
        // ...  
    }  
}
```

- (a) Always.
- (b) Never.
- (c) Only if the method `test` throws an exception.
- (d) Only if the method `test` does not throw an exception.

Q13 What will be printed to the screen by the following code fragment?

```
int i=1;
Scanner s = new Scanner("exp(0) = 1");
while (s.hasNext()) {s.next(); i++;}
System.out.println(i);
```

- (a) 1
- (b) 2
- (c) 3
- (d) 4

Q14 What will be printed to the screen by the following program?

```
public class PenultimateExamClass {
    private int c = 3;
    public static void main(String[] args) {
        PenultimateExamClass apec = new PenultimateExamClass();
        apec.c = 1;
        System.out.println(apec.c);
    }
}
```

- (a) 3
- (b) 1
- (c) c
- (d) An exception will be thrown because the code attempts to change the value of a private member variable.

Q15 How could you test the `LastExamQuestion` objects `fred` and `jane` in this program to verify that they contain the same value of `mark`?

```
public class LastExamQuestion {
    private int mark;
    public LastExamQuestion(int val) {mark=val;}
    public static void main(String[] args) {
        Counter fred = new LastExamQuestion(85);
        Counter jane = new LastExamQuestion(85);
        // Test here!
    }
}
```

- (a) Use `if (fred=jane) ...`
- (b) Use `if (fred==jane) ...`
- (c) Use the Java built-in `equals` method.
- (d) Define your own `equals` method for the class.

END OF PAPER