INSTRUCTIONS:
Questions 1--6 are code-writing questions worth 10 marks each.
They must be answered in the spaces provided on this paper.
Question 7 contains 20 multiple choice questions worth 2 marks each.
They must be answered in pencil on the computer-readable answer sheet at
the end of this paper.

The exam is CLOSED BOOK - books and notes are not permitted.
Students must return the question paper at the end of the exam.

PLEASE NOTE

Examination candidates may only bring authorised materials into the examination room. If a
supervisor finds, during the examination, that you have unauthorised material, in whatever form, in
the vicinity of your desk or on your person, whether in the examination room or the toilets or en
route to/from the toilets, the matter will be reported to the head of school and disciplinary action
will normally be taken against you. This action may result in your being deprived of any credit for
this examination or even, in some cases, for the whole unit. This will apply regardless of whether
the material has been used at the time it is found.

Therefore, any candidate who has brought any unauthorised material whatsoever into the
examination room should declare it to the supervisor immediately. Candidates who are uncertain
whether any material is authorised should ask the supervisor for clarification.

Supervisors Only - Student left at:
Instructions

Read the entire paper first and plan your time. In general, you can get full marks on a code-writing question more easily than getting five multiple-choice questions correct, so you may wish to consider attempting the code-writing questions first.

Minor syntactic errors will not be punished in the code-writing questions.

The questions, including the multiple-choice questions, are not in any particular order of difficulty, so answer the ones that you find straightforward first.

Don’t forget to include your name and student number on the multiple-choice answer sheet, and double-check your student number as it will be read by computer.

**Do not spend too much time on the multiple choice questions.**

**They should average only 2.6 minutes each.**
1.

The Noland national flag is a square showing the following pattern.

Write a method

public void drawNoland(int n)

that draws the Noland flag on the screen with a height of n pixels. Your method should create and use a SimpleCanvas (as used in lectures and laboratories) to draw on. All of the colours needed are pre-constructed Color objects.
Answer the Flag Question Here

(10 marks)
The price of a ticket to use TransPerth services depends on your status (standard, concession, or school student) and the number of zones you travel in.

Standard (status=1) and Concession (status=2) passengers may pay by cash or use a SmartRider. If a SmartRider is used, then a discount of 15% applies on the cash fare. The following table shows the cash fares for Zones 1 and 2.

<table>
<thead>
<tr>
<th>Number of Zones</th>
<th>Status</th>
<th>Cash Fare (cents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>standard</td>
<td>250</td>
</tr>
<tr>
<td>2</td>
<td>standard</td>
<td>370</td>
</tr>
<tr>
<td>1</td>
<td>concession</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>concession</td>
<td>150</td>
</tr>
</tbody>
</table>

Students travelling to or from school (status=3) pay 50 cents when travelling with a SmartRider, regardless of how many zones they travel in. Students must use a SmartRider to get the special fare.

Write a method `calculateFare` that returns the fare payable for any situation, or -1 if the arguments are in error.

```java
public int calculateFare(int status, int numZones, boolean smartRiderUsed)
```

**Put your answer on the next page**
Answer the Fares Question Here

(10 marks)
3.

Consider the class `BankAccount`, for use in a bank’s account record system.

```java
public class BankAccount {
    private String accName; // the account holder’s name, e.g. Bill Gates
    private int balance;

    public String getAccName() {
        return accName;
    }

    public int getBalance() {
        return balance;
    }

    // constructor and other details omitted
}
```

Write an efficient method

```java
public String findHighest(BankAccount[] accList)
```

that returns the name of the account holder of the account with the highest balance in `accList`. `findHighest` should throw an exception if `accList` is empty or null.

You may assume that the records are sorted by their account names.

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PUT YOUR ANSWER ON THE NEXT PAGE
Answer the BankAccount Question Here
4.

Write a method

```java
public boolean substring(String str1, String str2)
```

that returns `true` if `str1` is a substring of `str2`, and `false` otherwise.

For example, `substring("abc", "abcd")` returns `true`, but `substring("de", "abcd")` and `substring("ac", "abcd")` both return `false`.

Implement the method from first principles. That is, you may use only the Java String library methods `charAt` and `length`. No other String methods (such as `indexOf`) may be used.

Write 3 (three) JUnit4 `assertEquals` statements to test your `substring` method. Your tests should cover different cases for the method.
Answer the substring question here
5. Write a method

```java
public char checkWinner(char[][] grid)
```

to identify the winner from a given game state in a TicTacToe game. The game is played on a square grid of size at least 3 x 3. Every position in the grid contains one of the characters 'X', 'O' or ' '. The method `checkWinner` should return the winner's character ('X' or 'O') if any row, column, or corner-to-corner diagonal in its argument array `grid` contains all the same non-blank character; it should return ' ' otherwise.

Write helper methods to make your code readable.
Answer the checkWinner Question Here

(10 marks)
6.

(a) Write a method

```java
public boolean moreUpsThanDowns(int[] a)
```

that returns true if and only if the elements of `a` increase more often than they decrease. For example, `moreUpsThanDowns({1,4,4,2,3,3})` returns true, because the elements increase twice (1–4 and 2–3) but they decrease only once (4–2); but `moreUpsThanDowns({4,2,2,2,3})` returns false, because the elements increase once and decrease once.

(5 marks)
(b) Write a method

```java
public int[][] separate(int[] a)
```

that returns a 2D array where the first row contains the even-indexed elements from `a`, and the second row contains the odd-indexed elements.

For example `separate({8,10,4,9,3,56})` returns `{8,4,3},{10,9,56}`.
7. Multiple Choice Questions [2 marks each]

(1) Which of these types does + not work on?

A. int
B. double
C. boolean
D. char
E. String

(2) What is the value of the expression $3 < 5 == 5 > 3$?

A. It contains a syntax error.
B. It causes a type error.
C. It causes a run-time error.
D. false.
E. true.

(3) In code that uses the term Math.sqrt(x), what does sqrt refer to?

A. It is a class variable belonging to the class java.lang.Math.
B. It is a class method belonging to the class java.lang.Math.
C. It is an instance variable belonging to an object of type java.lang.Math.
D. It is a method belonging to an object of type java.lang.Math.
E. It is an exception belonging to the class java.lang.Exception.

(4) What is the value of the expression $-2 / -5$?

A. It contains a syntax error.
B. -1
C. 0
D. 0.4
E. 1
(5) What does `mystery(a, b)` calculate, assuming `a, b > 0`?

```java
public int mystery(int a, int b)
{
    if (a < b) return a;
    else return mystery(a - b, b);
}
```

A. It calculates `a + b`.
B. It calculates `a - b`.
C. It calculates `a * b`.
D. It calculates `a / b`.
E. It calculates `a % b`.

(6) How many of these statements apply to a large program written in good object-oriented style?

- The problem is decomposed into several classes.
- Each class provides a narrow range of well-defined services.
- Each class hides its implementation details as far as possible.
- Objects communicate as little as possible at runtime.

A. 0
B. 1
C. 2
D. 3
E. 4

(7) QuickSort is much faster than InsertionSort because

A. it doesn’t shuffle the data in the array as much.
B. it splits the data into two halves at each step.
C. it has fewer loops.
D. it uses less space for temporary variables.
E. recursion is executed faster than iteration in Java.
(8) How many of these statements about constructors are true?

- All constructors in a class must have different return types.
- All constructors in a class must have different argument types.
- Every class must have at least one constructor.
- Constructors cannot initialise class variables.

A. 0  
B. 1  
C. 2  
D. 3  
E. 4

(9) What is the value of \( d \) after these statements?

\[
\begin{align*}
\text{int } i &= 11; \\
\text{double } d &= i; \\
\text{do } &\{i = i / 2; \\
&\quad d = d / 2;\} \\
\text{while } &\{i > 2\};
\end{align*}
\]

A. 1.000  
B. 1.375  
C. 2.000  
D. 2.750  
E. 5.500

(10) If we apply SelectionSort to sort the array \( \{10, 2, 17, 3, 7\} \) into ascending order, what does the array look like after two passes?

A. \( \{10, 2, 17, 3, 7\} \)  
B. \( \{2, 10, 17, 3, 7\} \)  
C. \( \{2, 3, 10, 17, 7\} \)  
D. \( \{2, 3, 17, 10, 7\} \)  
E. \( \{2, 3, 7, 10, 17\} \)
(11) What sort of variables are used to store the state of an individual object?

A. Local variables.
B. Instance variables.
C. Class variables.
D. Argument variables.
E. Method variables.

(12) If a method uses checked exceptions to deal with unexpected (but recoverable) run-time events, how is that fact communicated to potential users of that method?

A. In its name.
B. In its arguments.
C. In its return type.
D. In its signature.
E. In its body.

(13) Which sentence best describes the overall effect of applying mystery to a?

public void mystery(boolean[] a)
{for(int i = 1; i < a.length; i++)
   a[i] = a[i] || a[i-1];
}

A. a is unchanged.
B. a is unchanged unless it contains a true, in which case it becomes all true.
C. a becomes all true.
D. a becomes all true up to its first true.
E. a becomes all true after its first true.

(14) How many iterations does this loop perform?

for (int i = 1; i < 10; i=i*2) i++;  

A. 2  
B. 3  
C. 4  
D. 5  
E. 10
(15) Which of these diagrams most closely resembles the picture drawn by `drawPicture`?

```java
public void drawPicture()
    {
        SimpleCanvas c = new SimpleCanvas();
        for (int i=0; i<=400; i=i+80)
            c.drawLine(i, 399, 399+i, 0);
    }
```

A. ![Diagram A]

B. ![Diagram B]

C. ![Diagram C]

D. ![Diagram D]

E. ![Diagram E]
The next five questions refer to this class that represents ellipses.

```java
public class Ellipse {
    // an ellipse with centre (cx, cy) and horizontal and vertical axes
    private double cx, cy, rx, ry;

    public Ellipse(double x, double y, double r1, double r2)
    {cx = x; cy = y; rx = r1; ry = r2;}

    public Ellipse(double r1, double r2)
    {this(0, 0, r1, r2);}

    public Ellipse(double r)
    {this(r, r);}

    public Ellipse()
    {this(1);}

    // returns the area of the ellipse
    public double area()
    {return Math.PI * rx * ry;}

    // enlarges/shrinks the ellipse
    public void scale(double factor)
    {rx = rx * factor; ry = ry * factor;}

    // returns the ellipse with the larger area
    public Ellipse bigger(Ellipse other)
    {if (this.area() >= other.area()) return this; else return other;}

    // returns an ellipse that fits the quadrant it’s in
    public Ellipse fitsQuadrant()
    {return new Ellipse(cx, cy, Math.abs(cx), Math.abs(cy));}

    // the mystery method does something unclear
    public Ellipse mystery()
    {double r = Math.sqrt(rx * ry);
     return new Ellipse(cx, cy, r, r);}
}
```
(16) What are the instance variables of **Ellipse**?

A. cx, cy, rx, and ry  
B. x, y, r1, and r2  
C. factor and other  
D. other  
E. bigger, fitsQuadrant, and mystery

(17) How many Ellipse objects, in total, are created during the execution of these statements?

```java
Ellipse a = new Ellipse(1, -1);
Ellipse b = a;
Ellipse c = a.bigger(b.fitsQuadrant());
```

A. 1  
B. 2  
C. 3  
D. 4  
E. 5

(18) To the nearest integer, what value is stored in area after these statements?

```java
Ellipse e = new Ellipse(Math.PI, -Math.PI, 3, 1);
double area = e.fitsQuadrant().scale(1 / Math.PI).area();
```

A. -1  
B. 0  
C. 1  
D. 3  
E. 10
(19) How many of these statements correctly construct an Ellipse?

1. Ellipse e = Ellipse(5);
2. Ellipse e = new Ellipse(0.0, 0.0, 0.0, 0.0);
3. Ellipse e = new Ellipse(423);
4. Ellipse e = Ellipse(0, 0).new();

A. 0  
B. 1  
C. 2  
D. 3  
E. 4

(20) What does the mystery method do?

A. It returns a circle with the same area as the original ellipse. 
B. It returns the smallest circle that contains the original ellipse.  
C. It returns the largest circle contained by the original ellipse. 
D. It rotates the ellipse through 90°.
E. It rotates the ellipse through 180°.
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Family (Last) Name

First Name                                             Initial

Exam Date (dd mm yyyy)

- Use pencil only for all parts of this answer sheet.
- Ensure the answer circle is completely filled.
- Erase any errors fully.
- Enter your name in the text boxes at the top right
- Enter the unit/exam code in the text boxes to the left and fill in the corresponding circles
- Enter your student number in the text boxes to the left and fill in the corresponding circles

1  A  B  C  D  E  21  A  B  C  D  E  41  A  B  C  D  E
2  A  B  C  D  E  22  A  B  C  D  E  42  A  B  C  D  E
3  A  B  C  D  E  23  A  B  C  D  E  43  A  B  C  D  E
4  A  B  C  D  E  24  A  B  C  D  E  44  A  B  C  D  E
5  A  B  C  D  E  25  A  B  C  D  E  45  A  B  C  D  E
6  A  B  C  D  E  26  A  B  C  D  E  46  A  B  C  D  E
7  A  B  C  D  E  27  A  B  C  D  E  47  A  B  C  D  E
8  A  B  C  D  E  28  A  B  C  D  E  48  A  B  C  D  E
9  A  B  C  D  E  29  A  B  C  D  E  49  A  B  C  D  E
10 A  B  C  D  E  30  A  B  C  D  E  50  A  B  C  D  E
11 A  B  C  D  E  31  A  B  C  D  E  51  A  B  C  D  E
12 A  B  C  D  E  32  A  B  C  D  E  52  A  B  C  D  E
13 A  B  C  D  E  33  A  B  C  D  E  53  A  B  C  D  E
14 A  B  C  D  E  34  A  B  C  D  E  54  A  B  C  D  E
15 A  B  C  D  E  35  A  B  C  D  E  55  A  B  C  D  E
16 A  B  C  D  E  36  A  B  C  D  E  56  A  B  C  D  E
17 A  B  C  D  E  37  A  B  C  D  E  57  A  B  C  D  E
18 A  B  C  D  E  38  A  B  C  D  E  58  A  B  C  D  E
19 A  B  C  D  E  39  A  B  C  D  E  59  A  B  C  D  E
20 A  B  C  D  E  40  A  B  C  D  E  60  A  B  C  D  E