THE UNIVERSITY OF WESTERN AUSTRALIA
Achieving International Excellence

School of Computer Science & Software Engineering

SEMESTER 1, 2010 SUPPLEMENTARY & DEFERRED EXAMINATIONS

CITS1200
Java Programming

FAMILY NAME: ______________________  GIVEN NAMES: ______________________

STUDENT ID: □ □ □ □ □ □ □ □ □ □  SIGNATURE: ______________________

This Paper Contains:  27 pages (including title page)
Time allowed: 2 hours 10 minutes

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.

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<td>4</td>
<td>5</td>
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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 rectangle with a width:height ratio of 2:1 and showing the following pattern.

```
red
white
red
white
red
white
red
white
```

blue

Write a method

```java
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.

[PUT YOUR ANSWER ON THE NEXT PAGE]
Answer the Flag Question Here

(10 marks)
(a) The speed limit on the freeway to Noland is 100km/h. The following table summarises the penalties which apply for exceeding this limit under various circumstances.

<table>
<thead>
<tr>
<th>Speed (s)</th>
<th>First offence?</th>
<th>Penalty</th>
</tr>
</thead>
<tbody>
<tr>
<td>$s \leq 100$</td>
<td>not applicable</td>
<td>$0$</td>
</tr>
<tr>
<td>$100 &lt; s &lt; 120$</td>
<td>yes</td>
<td>$105$</td>
</tr>
<tr>
<td>$120 \leq s$</td>
<td>yes</td>
<td>$160$</td>
</tr>
<tr>
<td>$100 &lt; s$</td>
<td>no</td>
<td>$200$</td>
</tr>
</tbody>
</table>

Write a method

public String speedResponse(int s, boolean f)

that returns the message and penalty that apply in a given situation.
(b) Write a method

```java
public boolean alternating(boolean[] a)
```

that returns `true` if and only if `a` contains no adjacent elements which have the same value.

For example `alternating({false, true, false})` returns `true`, but `alternating({true, false, false})` returns `false`. 

(5 marks)
3.

Given a function \( f(x) = y \) such that \( 0 \leq y \leq c \) whenever \( a \leq x \leq b \), we wish to estimate the area under \( f \) using a sampling procedure.

Imagine the curve for \( f \) is enclosed in a rectangle with width \( b - a \) and height \( c \).

\[
\begin{array}{c}
y \uparrow \\
c \\
\downarrow \\
\hspace{1cm} y = f(x) \\
\hspace{1cm} a \\
\hspace{1cm} b \\
x
\end{array}
\]

Generate \( n \) points randomly in this rectangle, and count how many points lie under the curve. The proportion of points that lie under the curve approximates \( A/B \), where \( A \) is the area under the curve, and \( B \) is the area of the rectangle. From this we can estimate \( A \). Clearly the precision of the estimate increases with the number of samples.

Given a method with the signature

\[
\text{public double } f(\text{double } x)
\]

write a method

\[
\text{public double area(} \text{double a, double b, double c, int n)}
\]

that implements the above procedure for \( f \).

You should use an object from the library class java.util.Random to generate a sequence of random points inside the rectangle, and you will need the following method from that class.

\[
\text{public double } \text{nextDouble()}
\]

Returns the next pseudorandom, uniformly-distributed double between 0.0 and 1.0 from this random number generator's sequence.
Answer the Sampling Question Here

(10 marks)
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 accNumber;
    private int balance;

    public String getName() {
        return accName;
    }

    public int getBalance() {
        return balance;
    }

    // constructor and other details omitted
}
```

Write an efficient method

```java
public int range(BankAccount[] accList)
```

that returns the difference between the largest and smallest balances in accList. range should throw an exception if accList is empty or null.

You may assume that the records are sorted by their account numbers.
ANSWER THE BANK ACCOUNT QUESTION HERE

(10 marks)
A word search puzzle gives the player a rectangular grid of letters \( g \) and a word \( w \) to find in the grid.

\[
\begin{array}{cccccc}
q & s & w & w & o & w \\
h & e & w & a & w & a \\
e & r & l & y & l & a \\
g & e & w & a & l & e \\
s & w & a & k & v & b \\
a & a & l & r & h & b \\
l & l & e & e & h & k \\
e & e & i & l & o & v \\
s & s & l & y & n & d \\
\end{array}
\]

The goal is to find out whether \( w \) occurs anywhere in \( g \). For our purposes we will recognise \( w \) if it occurs in \( g \) either

- left-to-right, or
- downwards, or
- left-to-right and downwards, i.e. diagonally down and across \( g \).

Thus the word \textit{wales} occurs exactly three times in the above grid. Write a method

\[
\text{public boolean wordsearch(String w, char[][] g)}
\]

that returns \text{true} if and only if the word \( w \) is found in the grid \( g \) according to the above rules.

You may assume that \( g \) is rectangular. You will benefit from writing one or more private helper methods to decompose the problem.
Answer the Word Search Question Here

(10 marks)
6.

(a) Write a method

```
public boolean subset(int[] a, int[] b)
```

that returns true if and only if every element of `a` also occurs in `b`. For example, `subset({1,2,1},{4,2,3,1})` returns true, but `subset({1,5,1},{4,2,3,1})` returns false.
(b) Write a method

    public int[][] pairs(int[] a)

    that returns a 2D array containing all pairs of adjacent elements from a.
    For example pairs([1,2,3,4]) returns [[1,2],[2,3],[3,4]].
7. Multiple Choice Questions [2 marks each]

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

```java
double d = 10;
int i = 20;

do {d = d + i;
    i = i / 3;}
while (i > 2);
```

A. 26.00  
B. 28.89  
C. 36.00  
D. 38.00  
E. 38.89

(2) What does this expression evaluate to, and why?

```java
(3 == 3.0) == (4.00 == 4.0)
```

A. It contains a syntax error, because you can't combine applications of == in this way.
B. It causes a type error, because you can't compare an int to a double.
C. false, because 3 and 3.0 are represented differently.
D. false, because 4.00 creates a different precision error to 4.0.
E. true, because there is no precision error in representing an int as a double.

(3) In code that uses the term Math E, what does E 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 \( a == b \) after these statements, and why?

```java
double[] a = new double[5];
double[] b = new double[5];
for (int i=0; i<5; i++)
    {a[i] = i;
     b[i] = a[i] % 5;}
```

A. The statements cause a type error, because you can't assign a value of type int to a variable of type double.
B. false, because a and b contain different values.
C. false, because applying == to doubles incurs a precision error.
D. false, because a and b are different arrays, even though they contain the same values.
E. true, because a and b have the same length and they contain the same values.

(5) What does `mystery(a, b)` calculate, assuming \( a, b > 0 \)?

```java
public int mystery(int a, int b)
{if (a < b) return 0;
    else return 1 + 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) Which two of these statements describe a program written in good object-oriented style?

1. Classes hide as much as possible about their implementation details.
2. Each class provides a narrow range of well-defined services.
3. Objects can act as clients or servers, but never both, at runtime.
4. A problem is decomposed into several classes whose objects communicate as little as possible at runtime.

A. 1 and 2
B. 1 and 4
C. 2 and 3
D. 2 and 4
E. 3 and 4
(7) The class `java.lang.Arrays` contains a method that checks if two arrays contain identical elements. The Java API describes this method as follows:

```java
public static boolean equals(int[] a, int[] a2)
```

Returns true if the two specified arrays of ints are equal to one another. Two arrays are considered equal if both arrays contain the same number of elements, and all corresponding pairs of elements in the two arrays are equal. In other words, two arrays are equal if they contain the same elements in the same order. Also, two array references are considered equal if both are null.

Parameters:
- `a`: one array to be tested for equality.
- `a2`: the other array to be tested for equality.

Returns:
- true if the two arrays are equal.

Which of these expressions uses this method to obtain the equality of arrays `a` and `b`?

A. `a.equals(b)`  
B. `b.equals(a)`  
C. `equals(a,b)`  
D. `Arrays.equals(a,b)`  
E. `Arrays.equals(a.length, b.length)`

(8) How many of these statements about constructors are true?

1. All constructors in a class must have different return types.  
2. All constructors in a class must have different argument types.  
3. A constructor can call an instance method.  
4. A constructor can call a class method.

A. 0  
B. 1  
C. 2  
D. 3  
E. 4
(9) Consider these two expressions, where \( x \) is an int.

\[
(5 \div x > 10) \land (x \neq 5)
\]

\[
(x \neq 5) \land (5 \div x > 10)
\]

Which statement is most correct about evaluating these expressions for different values of \( x \)?

A. Neither expression can ever be evaluated without causing a runtime error.

B. The second expression can always be evaluated, but for some values of \( x \), the first expression cannot be evaluated without causing a runtime error.

C. The first expression can always be evaluated, but for some values of \( x \), the second expression cannot be evaluated without causing a runtime error.

D. Both expressions can always be evaluated successfully.

E. For a given value of \( x \), either both expressions can successfully be evaluated, or both will cause a runtime error.

(10) If we apply BubbleSort to the array \{10, 2, 17, 3, 7\}, how many passes are required until the array is sorted?

A. 1

B. 2

C. 3

D. 4

E. 5

(11) When searching for an item in a sorted array containing 1,000 items, approximately how many comparisons must we make in the worst case if we use binary search?

A. About 5

B. About 11

C. About 16

D. About 50

E. About 100
(12) 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.

B.

C.

D.

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

```java
public void mystery(int[] a)
{int x;
  for(int i = 0; i < a.length - 1; i++)
    {x = a[i]; a[i] = a[i+1]; a[i+1] = x;}
}
```

A. `a` is unchanged.
B. `a` has been sorted.
C. Adjacent elements of `a` have been exchanged.
D. Even-indexed elements of `a` have been exchanged with the following element.
E. The first element of `a` has been moved to the end.

(14) How many iterations does this loop perform?

```java
for (int i = 1; i < 21; i=i+4)
  i++;
```

A. 3
B. 4
C. 5
D. 6
E. 20

(15) What are the respective values of these three expressions?

1. `19 / 4 * 4 / 15`
2. `19 / 4 / 15 * 4`
3. `19 * 4 / 4 / 15`

A. 0, 0, 1
B. 0, 0, 1.0
C. 0.0, 0.0, 1.0
D. 1, 0, 1
E. 1.0, 0.0, 1.0
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.max(rx, ry);
     return new Ellipse(cx, cy, r, r);}
}
```
(16) What are the instance variables of Ellipse?

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

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

Ellipse a;
a = new Ellipse(1, Math.PI);
Ellipse b = a;
Ellipse c = a.bigger(b).scale(10);

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

(18) What value is stored in area after these statements (rounded to one decimal place)?

Ellipse e = new Ellipse(3, -4, 1, 2);
double area = e.scale(Math.sqrt(3)).fitsQuadrant().area();

A. -37.7
B. -18.8
C. 6.3
D. 18.8
E. 37.7
(19) How many of these statements correctly construct an Ellipse?

1. Ellipse e = Ellipse(5);
2. Ellipse e = new Ellipse(1, 2, 1);
3. Ellipse e = new Ellipse(Math.PI);
4. Ellipse e = Ellipse(2, 1).new();

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

(20) What does the mystery method do?

A. It rotates the ellipse through 90°.  
B. It rotates the ellipse through 180°.  
C. It returns a circle with the same area as the original ellipse.  
D. It returns the smallest circle that contains the original ellipse.  
E. It returns the largest circle contained by the original ellipse.
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BLANK PAGE FOR ROUGH WORK