

# Written Test

CSE 1020 3.0

Section M, Winter 2011

Family Name: \_\_\_\_\_

Given Name(s): \_\_\_\_\_

Student Number: |\_\_| |\_\_| |\_\_| |\_\_| |\_\_| |\_\_| |\_\_| |\_\_| |\_\_|

## Guidelines and Instructions:

1. This is a 50-minute test. You can use the textbook, but no electronic aids such as calculators, cellphones etc.
2. Answer questions in the space provided. If you need more space, use the back of the page. Clearly indicate that your answer continues on the back of the page.
3. Write legibly. Unreadable answers will not be marked.
4. Leave your ID on the desk. A sign-up sheet will be distributed during the test. By signing it, you acknowledge that you are registered in the course and you are the owner of the associated ID.
5. Keep your eyes on your own work. At the discretion of the invigilators, students may be asked to move.

Question	Out of	Mark
Q1	20	
Q2	44	
Q3	36	
<b>Total</b>	100	
<b>Letter grade</b>		

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**Q1. [20 marks]**

- (a) [10 marks] Assume that you have written a program that searches through a list of personnel records for the person with the highest salary (the list is not sorted in any way). The program performs linear search, i.e. it has  $O(N)$  complexity.

When the program is executed on a list of 10000 records it takes 2 seconds to finish. How long will it take approximately if we execute it on a list of 30000 records?

For large  $N$ , such as in this question, the time  $T(N)$  to finish this task for a list of  $N$  elements is given by the formula

$$T(N) \approx \alpha N$$

Applying this to  $N = 10000$  and  $N = 30000$  and taking the ratio yields

$$\frac{T(30000)}{T(10000)} \approx \frac{30000}{10000} \approx 3$$

Hence, the program will take approximately  $3 * 2 = 6$  seconds.

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- (b) [10 marks] Assume that you have written a program that searches through a list of personnel records for the pair of persons that have the closest birth dates (the list is not sorted in any way). The program's algorithm has  $O(N^2)$  complexity.

When the program is executed on a list of 10000 records it takes 2 seconds to finish. How long will it take approximately if we execute it on a list of 30000 records?

For large  $N$ , such as in this question, the time  $T(N)$  to finish this task for a list of  $N$  elements is given by the formula

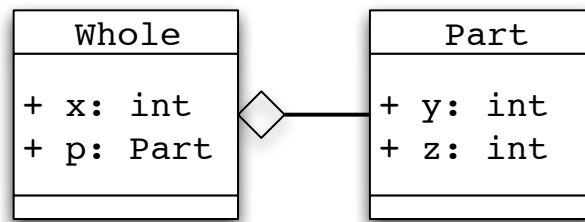
$$T(N) \approx \alpha N^2$$

Applying this to  $N = 10000$  and  $N = 30000$  and taking the ratio yields

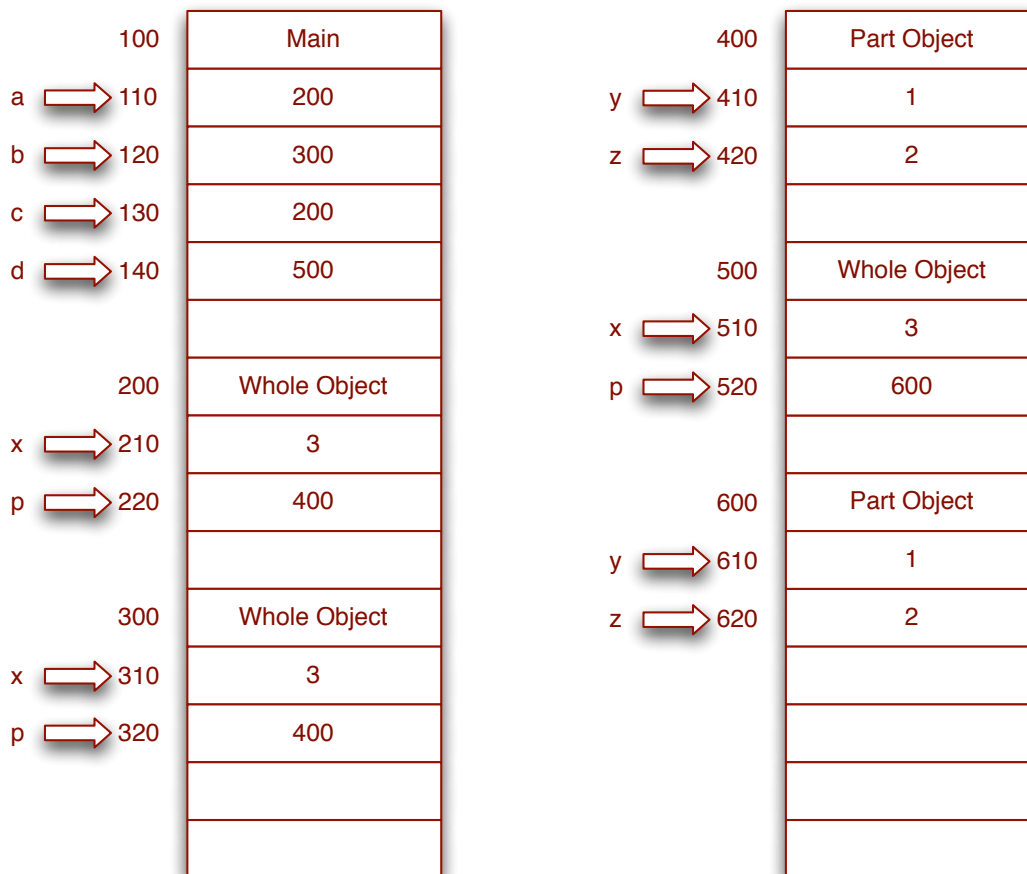
$$\frac{T(30000)}{T(10000)} \approx \frac{(30000)^2}{(10000)^2} \approx 9$$

Hence, the program will take approximately  $9 * 2 = 18$  seconds.

Q2. [44 marks] Consider the classes shown in the following diagram.



Assume that a program you are writing contains 4 references of type Whole called a, b, c, and d. Your program has also instantiated several objects resulting in the following memory diagram (classes loaded in the memory are not shown).



[30 marks] For each of the combinations in the following table, put an X in the appropriate cell in order to designate that the two references are aliases, shallow copies, or deep copies of each other.

Combination	Aliases	Shallow Copies	Deep Copies
a - b		X	
a - c	X		
a - d			X
b - c		X	
b - d			X
c - d			X

In the following space, provide a brief explanation of your choice for each combination.

a and b are shallow copies because they refer to different objects of type Whole but the states of these two objects are identical including any references to Part objects, i.e. they refer to the same Part object.

a and c are aliases because they refer to the same address in the memory (the same object).

a and d are deep copies because they refer to two completely independent object collections. All the primitive values in these two sets of objects though are identical.

Similar explanations can be given for the other combinations.

Marking scheme: 5 marks per combination. No marks are given if there is no explanation.

[14 marks] Describe the simplest set of Java statements that can be executed after the system has reached the state in the earlier memory diagram that would result in none of the combinations in the table being shallow copies.

Several possibilities exist here. The simplest solution (worth all 14 marks) is

`b=d;`

Any other correct solution of reasonable length (2-3 statements) should get 10 marks.

Convolved correct solutions should get 7 marks.

Trivial solutions, such as assigning everything to null, receive 4 marks.

**Q3. [36 marks]** Consider the API for the two classes `Animal` and `Bee` below. For each one of the code segments in the following pages, check the box next to the expected outcome. Follow the instructions given after the selected answer. You can assume all needed classes have been imported. *No marks will be awarded without error explanation or correct output as the case may be.* Each code segment is worth 6 marks.

**public class Animal**

This class encapsulates an animal.

Field Detail**public String name**

The name of this animal

Constructor Detail**public Animal(String s)**

The name field is assigned the value of s

Parameters:

s - the name of this animal

Method Detail**public void eat()**

Always prints out the string "Animal", followed by a space, followed by the value of the name field, followed by a space, followed by the string "eats.", followed by a newline.

**public class Bee extends Animal**

This class encapsulates a bee.

Constructor Detail**public Bee(String s)**

The name field is assigned the value of s

Parameters:

s - the name of this bee

Method Detail**public void eat()**

Always prints out the string "Bee", followed by a space, followed by the value of the name field, followed a space, followed by the string "eats.", followed by a newline.

Overrides:

eat in class Animal

**public void sting()**

Always prints out the string "Ouch!" followed by a newline.

(a) `Bee b1 = new Animal("A1");`  
`b1.sting();`

- Compiles and runs (write output in space below).
- Compile-time error (explain source of error).
- Run-time error (explain source of error).

Compile-time error. Animal is the superclass so an object of type Animal cannot be assigned to a reference of type Bee.

(b) `Bee b2 = new Bee("B2");`  
`b2.eat();`

- Compiles and runs (write output in space below).
- Compile-time error (explain source of error).
- Run-time error (explain source of error).

Compiles and runs. Output is:

Bee B2 eats.

(c) `Animal a3 = new Bee("B3");`  
`a3.eat();`

- Compiles and runs (write output in space below).
- Compile-time error (explain source of error).
- Run-time error (explain source of error).

Compiles and runs. Output is:

Bee B3 eats.



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(d) `Animal a4 = new Animal("A4");`  
`a4.sting();`

- Compiles and runs (write output in space below).
- Compile-time error (explain source of error).
- Run-time error (explain source of error).

**Compile-time error.** The method `sting()` is not available for objects of type `Animal`.

(e) `Animal a5 = new Animal("A5");`  
`((Bee) a5).sting();`

- Compiles and runs (write output in space below).
- Syntax error (explain source of error).
- Run-time error (explain source of error).

**Run-time error.** Class cast exception at line 2.

(f) `Animal a6 = new Bee("B6");`  
`((Bee) a6).sting();`

- Compiles and runs (write output in space below).
- Syntax error (explain source of error).
- Run-time error (explain source of error).

**Compiles and runs.** Output is:

**Ouch!**