Problem 1: Multiple Choice- Circle the correct choice(s) [4 marks]

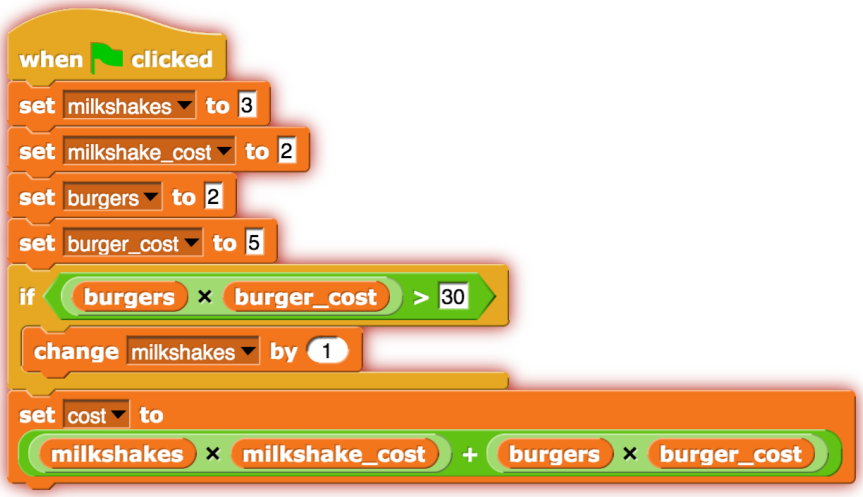
1. [1 mark] Which of the following answers has the terms from the "Memory Hierarchy" in order from Lowest to Highest Capacity.
    a. Disc Storage, Physical Ram, Level 2 & Level 1 Cache, CPU Registers
    b. CPU Registers, Physical Ram, Disc Storage, Level 2 & Level 1 Cache
    c. Physical Ram, Disc Storage, CPU Registers, Level 1 & Level 2 Cache
    d. Physical Ram, CPU Registers, Level 2 & Level 1 Cache, Disc Storage
    e. CPU Registers, Level 1 & Level 2 Cache, Physical Ram, Disc Storage

2. [1 mark] Which sort(s) require the most space?
    a. Selection Sort
    b. Insertion Sort
    c. Simple Sort
    d. They all required the same amount of space
    e. You can't tell—it depends on what kind of cards you are given to work with

3. [1 mark] What is an algorithm? Pick the best answer (i.e., pick **one** answer).
    a. A series of steps written to solve a specific problem with specific inputs
    b. A series of steps written to solve a specific problem with non-specific inputs
    c. A way to sort things
    d. A class exercise we keep doing

4. [1 mark] Operating system is a type of:
    a. Software
    b. Hardware

Problem 2: Snap! Snap! Snap! [9 marks]



1. [1 mark] How many variables are in this code snippet? 5

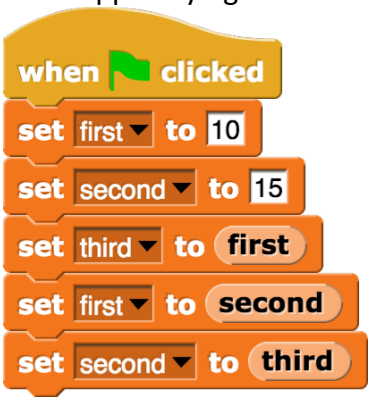
2. [2 marks] What are the final values for each of the variables in the code snippet above?

   milkshakes = 3
   milkshake_cost = 2
   burgers = 2
   burger_cost = 5
   cost = 16

   - 1 mark for the variable names
   - 1 mark for the variable values

   Base this answer on the answer from question 1. For example, if someone put 4 as the answer for question 1 and have listed four variables in this question, that is fine (i.e., try not to penalize them twice for the same thing.

3. [2 marks] Use one to three sentences to describe the purpose of the code snippet. We are NOT looking for a line by line description of what this code is doing. What is this code snippet trying to achieve as a whole?



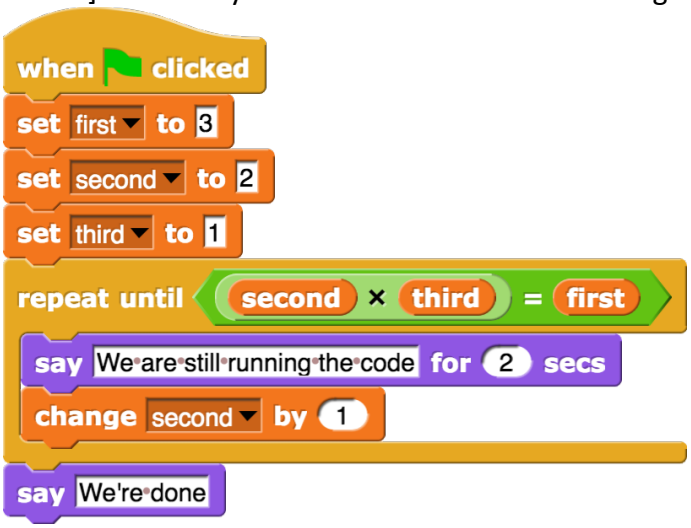
   This code is trying to swap the values of the variables first and second by using the variable third as a temporary storage.

   - 1 mark for using swap in the answer
   - 1 mark for correctly identifying which values are being swapped

   Answers that describe what the code is trying to do line by line will be given a 0.

4. [1 mark] How many times does “We are still running the code” appear on screen?

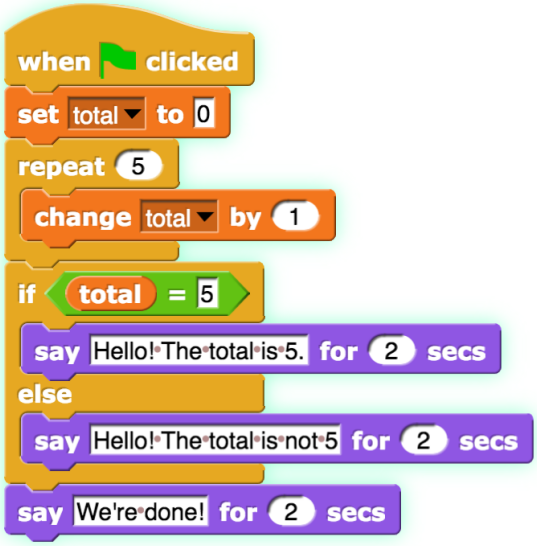
Once.



5. [2 marks] Which words will appear on the stage when this code snippet is run?

Hello! The total is 5.
We’re done!

- 1 mark for “Hello! The total is 5.”
- 1 mark for “We’re done!”



6. [1 mark] What will the arrow sprite look like on the stage after the following code snippet is run?

The rectangle below represents the stage you see when you run Snap!. Draw what the stage would look like after the code snippet is run. The sprite will start in the middle of the stage (think back to how the sprite looked when you first started Snap! in the lab).

Problem 3: Algorithms [17 marks]

1. [4 marks] Albert has invented a new language called Gatadebasldf. He has given some translations below that demonstrate how this language works.

English	Gatadebasldf
Almond	Dnomlay
Apple	Elppay
Beet	Teebay
Carrot	Torracay

Write an algorithm that will translate English to Gatadebasldf.

a. Starting from the last letter of the English word, write down each letter until there are no more letters left
b. If the last letter in your Gatadebasldf word is an "a", add a "y" to the Gatadebasldf word
c. If the last letter in your Gatadebasldf word is not an "a", add an "ay" to the end of your Gatadebasldf word

- 1 mark for generalization (e.g., does the algorithm work for any English word or does it only work for the sample words we gave above)
- 1 mark for handling the case where a word starts with an "A" or a vowel depending on how the question was interpreted by the student
- 1 mark for handling the case where a word starts with a letter other than an "A" or a vowel
- 1 mark for having the algorithm broken down into steps in a way that makes sense

2. [3 marks] Mona and Anna are secret agents and are trying to pass messages to each other through leaving notes in a box. Note that this box is magical and cannot be stolen by enemy agents (the box will run away and go back to Mona and Anna).

   To avoid having their message tampered with, Mona and Anna have come up with a great message passing algorithm by using one box and two locks (Mona and Anna only know the combination to their own lock).

   Write down an algorithm that Mona and Anna can use to exchange messages.

   In our algorithm, we are assuming that Anna is sending a message to Mona. This algorithm could also work for the situation where Mona is sending a message to Anna.

   a. Anna puts her message in the box and locks the box with her lock.
   b. Anna puts the box in the message drop spot and leaves.
   c. Mona arrives at the message drop spot. If she sees a locked box, she will put her lock onto the box
   d. Anna arrives at the message drop spot.
      i. If she sees the box with two locks on it, she will take her lock off the box.
      ii. If the box only has one lock on it, she will leave.
   e. Mona arrives at the message drop spot.
      i. If she sees that the box only has her lock, she will take the box and unlock it to get the message.
      ii. If she sees that the box still has two locks on it, she will leave.

   - 1 mark for generalization (e.g., does the algorithm work for any English word or does it only work for the sample words we gave above)
   - 2 mark for correctness
     - 1 mark if the algorithm is generally correct but does not handle cases that should be handled
     - 2 marks if the algorithm is completely correct

   [Note] There were variations on this answer depending on how you interpreted the question.

3. Clarissa is sorting 200 midterms by numerical order. The exams have numbers ranging from 100 to 299. Unfortunately, as she was carrying the exams, she dropped them down the stairs. After gathering the exams back up in the box, she needs to figure out how to resort them quickly.

   Here are two algorithms that she can potentially use to resort the exams. It does not matter if the exams are sorted from largest exam ID to smallest or vice versa.

   Assumptions for this question:
   - You have access to a genie that gives you as many boxes as you need
   - Each box can hold as much or as little as you need it to
   - You have a magical table that stretches to become as long as you need it to be

   Algorithm 1:
   1. Take each exam and put it in a box based on the leftmost number of the exam ID.
   2. Take each box from step 1 and sort the exams into another box based on the number to the right of what you used in step 1.
   3. Repeat step 2 until there is only one exam in a box.
   4. Put the exams back in order by going through each box.

   Algorithm 2:
   1. Put each exam in a box and lay them all beside each other.
   2. Starting from the first box on your table (let's call it box A), compare the exam ID with the exam in the box next to it (let's call it box B).
      a. If the exam ID in box A belongs after the exam ID in box B, swap the exams.

         For example, if the exam ID in box A is 510 and the exam ID in box B is 500 and we wanted to sort from the smallest ID to the largest, we would want to put exam 500 in box A and exam 510 in box B.
   3. Shift your focus over to the next box and compare that with the box next to it. Box B now becomes box A and the box next to box B (what was box C in step 2) becomes box B.
   4. When there are no more boxes left to compare, go back to the first box you haven't looked at yet and repeat steps 2-3.
   5. Repeat steps 2-4 until you no longer need to swap exams when going through the line of boxes.
   6. Put the exams back in order by going through each box.

a. [2 marks] Which algorithm requires the use of more boxes? Justify your answer with 2-3 sentences. Anything longer than that will not be graded.

Algorithm 1 will require more boxes. The max number of boxes Algorithm 2 will need is however many exams you have. However, Algorithm 1 will require the much more than that since you need to have intermediate boxes that hold piles of exams. For example, you would need a box to hold all the exams that start with a 1, then you would need more boxes to hold exams that start with a 11, 12, 13, etc.

- 1 mark for the answer
- 1 mark for justifying the answer

b. [2 marks] Which algorithm will take more comparisons to sort? Justify your answer with 2-3 sentences. Anything longer than that will not be graded.

Algorithm 2 would take more comparisons to sort. Regardless of the order of the exams, Algorithm 1 takes the same amount of comparisons to sort (think of comparisons like the number of times you have to touch each exam). With Algorithm 2, the number of times you have touch (or compare) exam IDs will vary depending on the order of the exams.

- 1 mark for the answer
- 1 mark for justifying the answer

c. [2 marks] Which is the worst possible order for the exams to be in when it comes to the number of comparisons needed for algorithm 1? Why?

There is no possible worst order for algorithm 1. Regardless of what order the exams are in, you will still touch the exams the same amount of times when sorting them into boxes (and then more boxes).

- 1 mark for the answer
- 1 mark for justifying the answer

d. [2 marks] Which is the worst possible order for the exams to be in when it comes to the number of comparisons needed for algorithm 2? Why?

Completely backwards from the order which you wanted the exams in. You would have to swap each and every exam that you handle each time.

- 1 mark for the answer
- 1 mark for justifying the answer

e. [2 marks] Which algorithm would you recommend to Clarissa? Why?
Answers here can vary.

We will accept answers from "I want to be save the environment so I want Clarissa to use Algorithm 2" to "Algorithm 1 is faster so I prefer that algorithm".

- 1 mark for the answer
- 1 mark for justifying the answer

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Note that any work that you do below this paragraph will NOT be graded. If you want to do work here you MUST transfer it to the appropriate spot in the rest of the exam.

Problem 4: Algorithms and Bias [6 marks]

1. Algorithms are increasingly used to recommend jobs to people. For example, websites like LinkedIn will collect data about you and based on that data, it will present jobs that it thinks would be suitable.

    a. [2 marks] List a decision that could be made that would be the result of conscious bias and say why.

    The people who create the algorithm would be deciding what jobs are appropriate for certain people irrespective of the job seeker's interests and desires. If you search up jobs for yourself, you are more likely to look at a wider variety of jobs. If you have an algorithm, the people creating it have effectively created thresholds or prioritized certain jobs for certain people. The biases of those people can prioritize or disadvantage people depending on their education or job experience (not to mention what kinds of key words they know to use/not use).

    - 1 mark for stating a decision that could come about because of conscious bias
    - 1 mark for justifying the answer
    - 0 marks if the decision is not because of conscious bias

    b. [2 marks] List a decision that could be made that would be the result of unconscious bias and say why.

    Someone living in a rural area could be recommended jobs that don't necessarily fit their education/skill level. They are judged based on the area's socioeconomic status as opposed to their individual qualifications.

    - 1 mark for stating a decision that could come about because of conscious bias
    - 1 mark for justifying the answer
    - 0 marks if the decision is not because of conscious bias

2. [2 marks] Consider an algorithm that decides what ads to show someone as they are browsing the web. Using terms discussed in class and in the readings, state why the programmers may want to consider sensitive information in their algorithm.
We need to consider sensitive information to ensure that the ads being shown to individuals are fair and at a rate equal across different demographics/populations.

[Note] This example was drawn from the real life case where Google was found showing ads for high paying job positions to males more frequently than females even if the two had equivalent qualifications (https://techcrunch.com/2015/07/09/researchers-probe-online-ad-targeting-bias/) and from Google showing more ads related to arrest records when searching for a more black sounding name (https://www.nytimes.com/2015/07/10/upshot/when-algorithms-discriminate.html).

- 1 mark for stating why you should consider using sensitive information (answer needed to include words like sensitive information and unconscious bias)
- 1 mark for justifying answer with a relevant and correct example or further elaboration on why it is important. Simply stating something like sensitive information is needed to avoid bias was not considered sufficient to earn this mark.

There are many answers about targeted advertising and why sensitive information was needed for companies to make more profit. This was not what we were looking for nor was it the focus of the Cynthia Dwork article or the class discussions. No marks were given for these types of answers.

Some other answers used examples that were not relevant to the situation. For example, the bank loan example we did in class is an example of why we might need to consider sensitive information but it is not relevant in this situation. We did not give any marks for irrelevant examples made.

Problem 5: Internet [11 marks]

1. [4 marks] Neatly label the parts that make up the following URL.

http://phdcomics.com/comics/archive.php

Protocol **Domain** **Directory** **File**

- 1 mark for each of protocol, domain, directory, and file

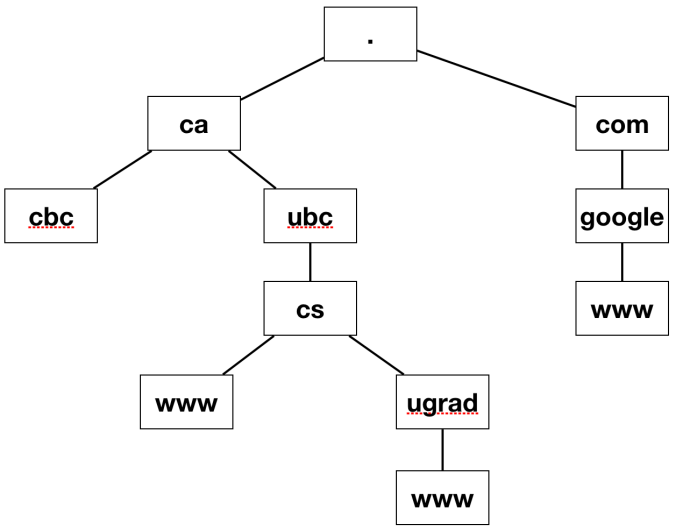
2. [1 mark] What information does the "/comics/archive.php" portion of the URL tell us?
   It tells us how the information is stored on the computer.

3. [1 mark] When we simulated the Internet in class (the activity where we all wore party hats), how did we ensure that a message can be reconstructed by the person receiving the message (partner B)?

   Each tablet needed to have a number on it to ensure that partner B could reconstruct the message even if the tablets arrived out of order.

4. [4 marks] Draw the hierarchy for the following URLs.

   http://www.google.com
   http://cbc.ca
   http://cs.ubc.ca
   http://www.cs.ubc.ca
   http://www.ugrad.cs.ubc.ca



- 1 mark for www.google.com
- 1 mark for http://cbc.ca
- 1 mark for http://cs.ubc.ca
- 0.5 marks for http://www.cs.ubc.ca
- 0.5 marks for http://www.ugrad.cs.ubc.ca