Name: ____**Sample Solution**_____

Email address (UW NetID): _____

CSE 160 Spring 2018: Final Exam

(closed book, closed notes, no calculators)

Instructions: This exam is closed book, closed notes. You have 50 minutes to complete it. It contains 7 questions and 9 pages (including this one), totaling 70 points. Before you start, please check your copy to make sure it is complete. A syntax sheet will be provided separately. When time has been called you must put down your pencil and stop writing. **Points will be deducted from your score if you are writing after time has been called.** You should only use parts of Python that have been covered in the class so far.

Total: 70 points. Time: 50 minutes.

Problem	Max Points	Score
1	**4**	
2	**4**	
3	**4**	
4	**12**	
5	**10**	
6	**12**	
7	**24**	
Total	**70**	

0) [0 points] Question: What do you call a snake that is 3.14 meters long?

Answer: A “Pi-thon”

(get it? This is not a real question, just a joke. Smile and move on to question 1! ☺)

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1) [4 pts] Grab Bag:

a) When should you write tests: before, during, or after writing the code? Why?

Probably the strongest arguments are for writing test cases BEFORE you write the code. You have not looked at the code yet and will not be biased (e.g. only generating test cases that you know your code can handle). You also may write better code because you thought about edge cases first.

There are some arguments for writing test cases afterwards. You can only write test cases that cover parts of the code (e.g. making sure each part of the code is exercised), once you have the actual code.

b) What is Data Abstraction and why is it useful? Be specific.

Data Abstraction is hiding the implementation details of the representation of and operations on data. In Python, classes support Data Abstraction by allowing us to collect the data representation and the associated functions together as one unit, effectively creating our own datatype. This is useful because the client of a class does not need to know what underlying data structure is being used to represent the data; ideally, the implementer of the class could change the data structure used, and the client would not need to change their program. Having abstract data representations is also convenient for making code and documentation more readable; we can simply refer to the datatype name rather than needing to describe complex internal formats (e.g. "this function takes a PollsterPredictions" instead of "this function takes a dictionary of pollster names to state abbreviations to democratic edges").

2) [4 pts] Write the output of the code below in the box here:

```
def mystery():
    result = 0
    for i in range(20 , 0, -2):
        result += i
        if i % 8 == 0:
            result -= 8
        elif i % 4 == 0:
            result -= 4
        if i % 9 == 0:
            return result
    return result

print mystery()
```

MY ANSWER:

34

In the first iteration, `result` first becomes 20, then has 4 subtracted (20 % 4 == 0). In the second iteration, `result` += 18 and becomes 34. Notice that 18 % 9 == 0, so `result` is *returned* as 34

3) [4 pts] Indicate (circle) if there is an Error or No Error. **For any credit, **if there is an error,** you MUST **very briefly** say what the problem is.**

a)
```
d = {}
d[{0, 1, 2}] = {0, 1, 2}
```
Error / No Error

If an Error, describe briefly:

`TypeError: unhashable type: 'set'`

We cannot index into d with a set

b)
```
d = {}
d[[0, 1, 2]] = {0, 1, 2}
```
Error / No Error

If an Error, describe briefly:

`TypeError: unhashable type: 'list'`

We cannot index into d with a list

c)
```
d = {}
d["0, 1, 2"] = (0, 1, 2)
d["0, 1, 2"][1] = 0
```
Error / No Error

If an Error, describe briefly:

`TypeError: 'tuple' object does not support item assignment`

`d["0, 1, 2"]` returns a tuple. We cannot modify the [1]th element of a tuple

d)
```
d = {}
d["0, 1, 2"] = {0, 1, 2}
print d.keys()["0, 1, 2"][0]
```
Error / No Error

If an Error, describe briefly:

`TypeError: list indices must be integers, not str`

(`.keys()` returns a list, we cannot index into a list with a string)

4) [12 pts] Write a function called `remove_words` that takes two arguments: the name of a file and a list of undesirable words that should be removed from the contents of that file. **The function should not modify the original file or create a new file**, but instead it should read in the file and return a single list containing the words from the original file, with all occurrences of the undesirable words removed. For example, if the input file named "`cool_essay.txt`" contained these 4 lines:

```
like happy like birthday

yep summer is totally here
lol happy summer
```

and you had this list of words:

```
words_to_remove = ['like', 'whatever', 'lol', 'yep', 'totally']
```

The function call:

```
remove_words("cool_essay.txt", words_to_remove)
```

would return this single list:

```
["happy", "birthday", "summer", "is", "here", "happy", "summer"]
```

You may assume that the input file contains no punctuation and all words in the input file and in the list `words_to_remove` are in lowercase.

```
def remove_words(filename, words_to_remove):
    # Your code here:

    clean_list = []
    infile = open(filename)
    for line in infile:
        line_list = line.split()
        for word in line_list:
        if word not in words_to_remove:
            clean_list.append(word)
    infile.close()
    return clean_list
```

5) [10 pts] a) **Draw** the entire environment, including all active environment frames and all user-defined variables, **at the moment that the MINUS OPERATION IS performed**. Feel free to draw out the entire environment, but be sure to CLEARLY indicate what will exist at the moment the **MINUS** operation is performed (e.g. cross out frames that no longer exist).

b) When finished executing, **what is printed out by this code**? **MY ANSWER:** -2

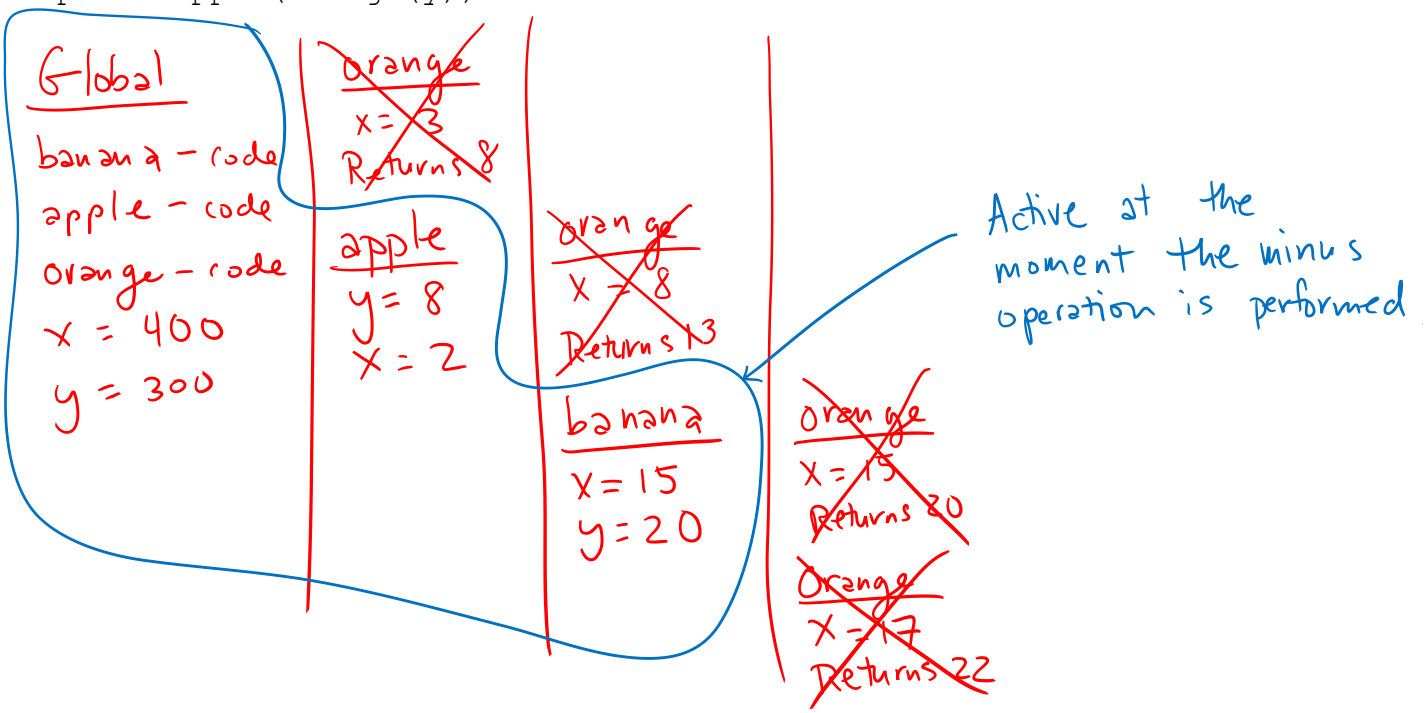
c) **How many different stack frames** (environment frames) are active when the call stack is DEEPEST/LARGEST? (Hint: The global frame counts as one frame.) **MY ANSWER:** 4

```
def banana(x):
    y = orange(x)
    return y - orange(x + 2)

def apple(y):
    x = 2
    return banana(orange(y) + x)

def orange(x):
    return x + 5

x = 400
y = 3
print apple(orange(y))
```



6) [12 pts] You are given the following class definition:

```
class City:
    def __init__(self, name, population, area):
        '''name: a string representing the name of a city
           population: an integer representing the number of
                       people in the city
           area: a number representing area in square miles '''
        self.name = name
        self.pop = population
        self.area = area

    def add_people(self, num_new_people):
        '''num_new_people: an integer representing the number of
           people to be added to the current population of the city '''
        self.pop = self.pop + num_new_people

    def get_pop_density(self):
        '''Returns a float representing the population density
           in the city.  Population density is defined as the
           number of people per square mile. '''
        # Code not visible
```

a) Write code in the `main` function, using methods from the `City` class, to:

- Add 177 new people to the population of `sea`.
- Print the population density of `lax`

This code is outside of the class **`City.`**

```
def main():
    sea = City("Seattle", 704352, 83.78)
    lax = City("Los Angeles", 3976000, 503)
    # Your code here:

    sea.add_people(177)

    print lax.get_pop_density()
```

6) (continued)

b) Describe your overall approach to testing `get_pop_density`. Be as specific as you can (as close to actual code as possible).

Create multiple `City` objects with different values for area and population and write `assert` statements that call `get_pop_density()` on those objects. Since `get_pop_density` returns a float, you should use something like the `eq()` function we used in hw5 which checks to see if you are within some epsilon of the desired value. You want tests that determine not just that a float is returned, but that floating point division is being done (as opposed to converting the result of integer division to a float). Although the specification is not clear about whether or not population or area should be allowed to be zero, it was a good idea to think about checking those edge cases. Just checking large or small values for population and area is not specific enough. Here are a few example tests:

```
# Should be eq() .1 (checks that fp division is being done)
ts1 = City("Test City 1", 1, 10)
assert eq(ts1.get_pop_density(), 0.1)
# Varying types on area (population must be an integer)
ts2 = City("Test City 2", 10, 2.5)
assert eq(ts2.get_pop_density(), 4.0)
```

c) Finally, write the code for the `get_pop_density` method below. As shown above, this method is a part of the class **`City`**:

```
def get_pop_density(self):
    '''Returns a float representing the population density
       in the city.  Population density is defined as the
       number of people per square mile. '''
    # Your code here

    return self.pop/float(self.area)
```

Something (`self.pop` or `self.area`) needs to be converted into a float before the division happens to ensure it is floating point division instead of integer division.

7) [24 pts total] You want to learn cake-baking from your friend by following along with them over video chat, but you're not sure which cake recipes you can both make. Given the following:

```
alice_pantry = {'egg': 12, 'cup of sugar': 4, 'cup of flour': 4}
bob_pantry = {'egg': 12, 'cup of sugar': 4, 'chocolate': 5}
recipes = {
    'dusty cake' : {'cup of sugar': 4, 'cup of flour': 4},
    'eggy cake'  : {'egg': 1 },
    'eggier cake'  : {'egg': 10 },
    'mega egg'  : {'egg': 100 },
    'chocolate cake' : {'egg': 2, 'cup of sugar': 2, 'chocolate': 1}
}
```

- A `pantry` is a dictionary mapping ingredients to counts of those ingredients available in that kitchen pantry.
- `recipes` is a nested dictionary mapping cake names to the ingredients and amounts they require.
- A cake recipe is considered ***bakeable*** if you have at least enough of every ingredient required by the recipe.

a) Write a function `find_bakeable(my_pantry, friend_ pantry, recipes)` that returns an **alphabetically-sorted** list of all cake names that you and your friend can both make using the ingredients you both have available in your own kitchen pantries. For example, the function call:

```
find_bakeable(alice_pantry, bob_pantry, recipes)
```

should return the following list:

```
['eggier cake', 'eggy cake']
```

****For full credit you should be sure to call the function `single_bakeable` inside of `find_bakeable`. Read its description (shown on the next page in part b) NOW. ****

```
def find_bakeable(my_pantry, friend_pantry, recipes):
    # Your code here
    my_set = single_bakeable(my_pantry, recipes)
    friend_set = single_bakeable(friend_pantry, recipes)
    can_bake_set = my_set & friend_set
    cake_list = []
    for cake in can_bake_set:
        cake_list.append(cake)
    return sorted(cake_list)
    # OR you can call sorted directly on a set:
    # return sorted(can_bake_set)
```

7) (continued)

b) Now, write the helper function `single_bakeable(pantry, recipes)` that returns a set of cake names that can be made from that pantry. For example, the function call:

```
single_bakeable(alice_pantry, recipes)
```

should return the set containing these three cake names:

```
{'eggier cake', 'eggy cake', 'dusty cake'}
```

```
def single_bakeable(pantry, recipes):
    # Your code here
```

```
    bakeable_set = set()
    for cake_name in recipes.keys():
        cake_dict = recipes[cake_name]
        bakeable = True
        for ingredient in cake_dict.keys():
            if ingredient not in pantry.keys() or \
                pantry[ingredient] < cake_dict[ingredient]:
                    bakeable = False
        if bakeable:
            bakeable_set.add(cake_name)
    return bakeable_set
```