Answer Key:

Row:	Seat:

Final Exam F22 V3

CSci 127: Introduction to Computer Science

Hunter College, City University of New York

December 19, 2022

Exam Rules

- Show all your work. Your grade will be based on the work shown.
- The exam is closed book and closed notes with the exception of an 8 1/2" x 11" piece of paper filled with notes, programs, etc.
- When taking the exam, you may have with you pens and pencils, and your note sheet.
- You may not use a computer, calculator, tablet, phone, earbuds, or other electronic device.
- **Do not open this exam until instructed to do so.**

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I understand that all cases of academic dishonesty will be reported to the Dean of Students and will result in sanctions.	
Name:	
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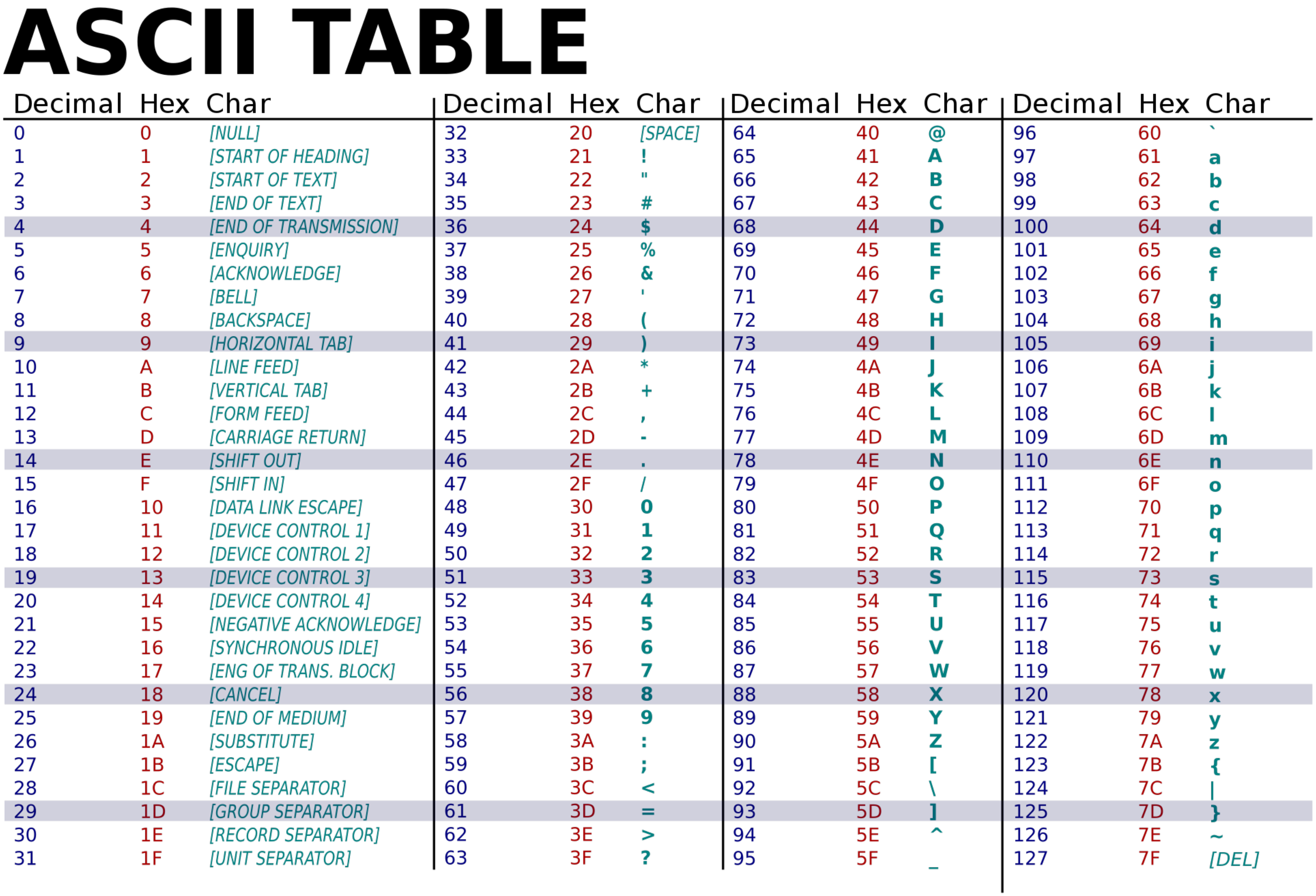
Email:	
Signature:	



ASCII TABLE

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[ENG OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]

(Image from wikipedia commons)

1. (a) Fill in the code below to produce the output on the right:

```
colors='Red-Green-Blue-Yellow-Cyan'
```

i.

```
green = colors[ □ ]
print(green)
```

Output:

```
Green
```

Answer Key:

```
print(colors[4:9]) #Green
or
print(colors[-22:-17]) #Green
```

ii.

```
yellow_green = □
for s in yellow_green:
    print( □ )
```

Output:

```
yellow
green
```

Answer Key:

```
yellow_green = colors.split('-')[3::-2]
for s in yellow_green:
     print(s.lower())
#yellow
#green
```

(b) Consider the following shell commands:

```
$ pwd
/usr/staff
$ ls
a.out hello.py  p50_growth.cpp p60_binary.cpp
```

i. What is the output for:

```
$ rm a.out
$ mv hello.py p1_hello.py
$ mkdir progs
$ mv *.cpp progs
$ ls
```

Output:

□

Answer Key:

```
p1_hello.py  progs
```

ii. What is the output for:

```
$ cd progs
$ pwd
```

Output:

Answer Key:

```
/usr/staff/progs
```

iii. What is the output for:

```
$ cd ..
$ ls | grep p | wc -l
```

Output:

Answer Key:

```
2
```

2. (a) Select the color corresponding to the rgb values below:

i. `rgb = (100, 0, 0)`
□ black □ red □ cyan □ gray □ purple

ii. `rgb = "#FFFFFF"`
□ red □ green □ blue □ black □ white

iii. `What is rgb values for cyan?`
□ 0, 0, 1 □ 0, 1, 1 □ 1, 0, 0 □ 1, 0, 1 □ 1, 1, 0

iv. What is the binary number equivalent of decimal number 69?

`Decimal 69 = Binary`

v. What is the Decimal number equivalent to Hexadecimal A6?

`Hexadecimal A6 = Decimal`

Answer Key:

i. `rgb = (100, 0, 0)`
□ black **X** red □ cyan □ gray □ purple

ii. `rgb = "#FFFFFF"`
□ red □ green □ blue □ black **X** white

iii. `What is rgb values for cyan?`
□ 0, 0, 1 **X** 0, 1, 1 □ 1, 0, 0 □ 1, 0, 1 □ 1, 1, 0

iv. What is the binary number equivalent of decimal number 69?

```
   2   | 69
       +---
     2 | 34     1
       +---
     2 | 17     0
       +---
     2 |  8     1
       +---
     2 |  4     0
       +---
     2 |  2     0
       +---
     2 |  1     0
       +---
          0     1
```

`Decimal 50 = Binary`

1	**0**	**0**	**0**	**1**	**0**	**1**

v. What is the Decimal number equivalent to Hexadecimal A6?
Hexadecimal A6 = A * 16 + 6 = 10 * 16 + 6 = 166

1	**6**	**6**

(b) Given the list `fruits` below, fill in the code to produce the Output on the right:

```
fruits = ['apple', 'banana', 'coconut', 'dragon fruit', 'elderberry']
```

i.
```
for j in range( □ ):
    print(fruits[□])
```

Output:

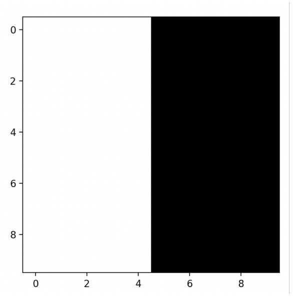
```
coconut
banana
apple
```

Answer Key:

```
fruits = ['apple', 'banana', 'coconut', 'dragon␣fruit', 'elderberry

for j in range(2, -1, -1):
    print(fruits[j])
```

ii.
```
import numpy as np
import matplotlib.pyplot as plt
img = np.ones( (10,10,3) )
img[ □ , □ ] = 0
plt.imshow(img)
plt.show()
```

Output:



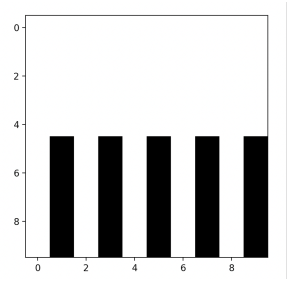
Answer Key:

```
import numpy as np
import matplotlib.pyplot as plt

img = np.ones( (10, 10, 3) )
img[:, 5:] = 0
plt.imshow(img)
plt.show()
```

iii.

```
import numpy as np
import matplotlib.pyplot as plt
img = np.ones( (10,10,3) )
img[□ , □ ] = 0
plt.imshow(img)
plt.show()
```

Output:



Answer Key:

```
import numpy as np
import matplotlib.pyplot as plt

img = np.ones( (10, 10, 3) )
img[5:, 1::2] = 0
plt.imshow(img)
plt.show()
```

3. (a) What is the value (True/False):

i.
```
in1 = True
in2 = False
out = not (not in1 or in2)
```
□ True □ False

Answer Key:
```
out = True
```

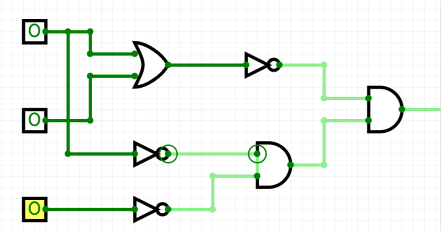
ii.
```
in1 = True
in2 = False
in3 = True
out = not (in1 and not in2) or not in3
```
□ True □ False

Answer Key:
```
out = False
```

iii.
```
in1 = True
in2 = False
in3 = in1 and not in2
out = not in1 and (in2 or not in3)
```
□ True □ False

Answer Key:
```
out = False
```

iv.

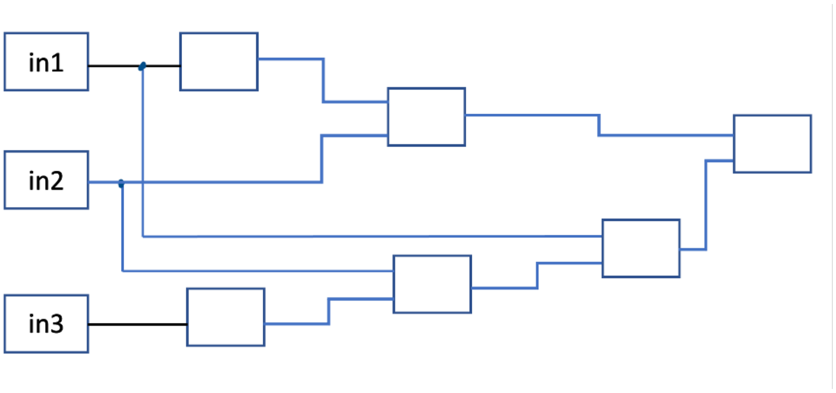


```
in1 = False
in2 = True
in3 = False
```
□ True □ False

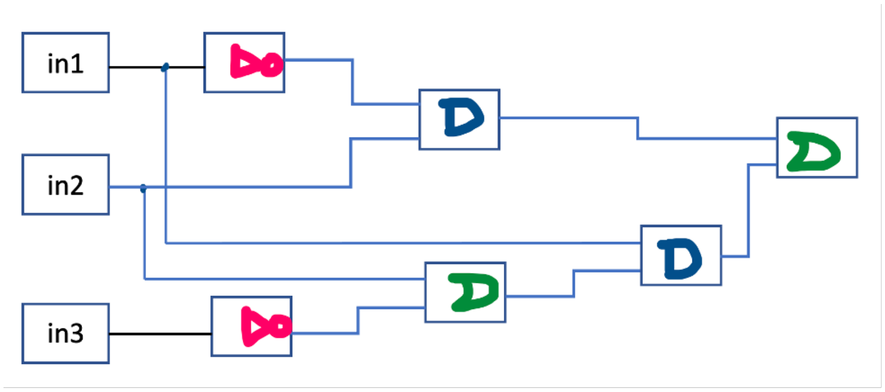
Answer Key:
```
out = False
```

(b) Draw a circuit that implements the logical expression:

```
(not in1 and in2) or (in1 and (in2 or not in3))
```



Answer Key:



4. Consider the following functions:

```
def count(mylist, target):          def leq(s, t):
    num_occur = 0                       return s <= t
    for num in mylist:
        if leq(num, target):        def main():
           num_occur += 1               crr = [21, 32, -55, 91, -26, 72, 1]
                                        print(count(crr, 32))
    return num_occur
```

(a) What are the formal parameters for `leq()`?

Answer Key: s, t

(b) What are the actual parameters for `count()`?

Answer Key: crr, 32

(c) How many calls are made to `leq()` after calling `main()`?

Answer Key: 7

(d) What is the output after calling `main()`?

Output:

Answer Key:

```
5
```

5. Design an algorithm that asks the user for the name of a text file containing a grid of numbers and loads it into a 2D array of integers(think like an image without the color channel) and a threshold. The program outputs the **sum** of all elements in the grid that are larger than or equal to the threshold. For example, suppose the grid has values

```
[[1 2]
 [3 4]]
```

and the given threshold is 3. Then the sum is 3 + 4 = 7.

Libraries:

Answer Key: numpy

Input:

Answer Key: the name of the text file, a number as a threshold

Output:

Answer Key: The sum of all elements in the grid that are larger than or equal to the given threshold.

Design Pattern:

□ Find Min □ Find Max □ Find All

Answer Key:

□ Find Min □ Find Max **X** Find All

Principal Mechanisms (select all that apply):

□ Single Loop □ Nested Loop □ Conditional (if/else) statement
□ Indexing / Slicing □ `split()` □ `groupby()`

Answer Key:

□ Single Loop **X** Nested Loop **X** Conditional (if/else) statement
XIndexing / Slicing □ `split()` □ `groupby()`

Process (as a concise and precise LIST OF STEPS / pseudocode):
(Assume libraries have already been imported.)

Answer Key:

(a) Ask the user for text file name

(b) Ask the user for a number as a threshold.

(c) Load data into grid.

(d) Set total to be zero.

(e) Use a nested loop to consider every element in grid, looping for rows in outer loop and columns in inner loop if the element is larger than or equal to the threshold, add the element to total.

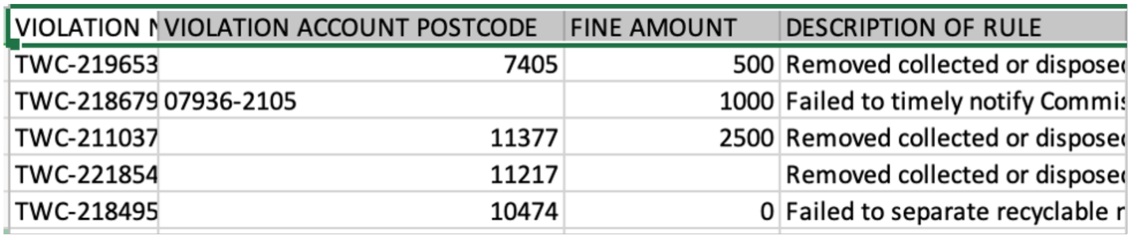
(f) Report total.

An implementation of the above code is as follows (This part is **optional** and will **not** be counted towards grading).

```
#suppose airtravel.csv has the following contents.
#”Month”, ”1958”, ”1959”, ”1960”
#”JAN”,   340,   360,   417
#”FEB”,   318,   342,   391
#”MAR”,   362,   406,   419
#”APR”,   348,   396,   461
#”MAY”,   363,   420,   472
#”JUN”,   435,   472,   535
#”JUL”,   491,   548,   622
#”AUG”,   505,   559,   606
#”SEP”,   404,   463,   508
#”OCT”,   359,   407,   461
```

```
#"NOV",   310,   362,   390
#"DEC",   337,   405,   432

import numpy as np

in_file = input("Enter input file name: ")
threshold = int(input("Enter a threshold: "))
grid = np.loadtxt(in_file, skiprows=1, delimiter=',', usecols=range(1,4))
#skip the first row, which is column head
#skip the first column, since it is row head
#print(grid)

numRows = grid.shape[0]
numCols = grid.shape[1]

total = 0
for i in range(numRows):
    for j in range(numCols):
        if grid[i,j] >= threshold:
           total += grid[i,j]

print(total)
```

6. Consider the `violations.csv` dataset that reports violations issued by Business Integrity Commission for companies operating in the trade waste industry. A snapshot given in the image below:



VIOLATION N	VIOLATION ACCOUNT POSTCODE	FINE AMOUNT	DESCRIPTION OF RULE
TWC-219653	7405	500	Removed collected or dispose
TWC-218679	07936-2105	1000	Failed to timely notify Commis
TWC-211037	11377	2500	Removed collected or dispose
TWC-221854	11217		Removed collected or dispose
TWC-218495	10474	0	Failed to separate recyclable r

Assume we write `import pandas as pd` already. Fill in the Python program below:

```
#Read input data into data frame:

df =

#Print the min value in column 'NUMBER OF COUNTS'.

#Groups the data by 'VIOLATION ACCOUNT POSTCODE' to extract data in 10474.

zip10474 =

#Print the average of FINE AMOUNT in zip10474.

#Print the most common (aka top) TEN rules violated.
#Hint: look at 'DESCRIPTION OF RULE' and value_counts method.
```

Answer Key:

```
#To test, download https://data.cityofnewyork.us/Business/BIC-Issued-Violatio
#shorten the file name as violations.csv.
import pandas as pd

df = pd.read_csv("violations.csv")
print(df["NUMBER_OF_COUNTS"].min())
zip10474 = df.groupby("VIOLATION_ACCOUNT_POSTCODE").get_group("10474")
print(zip10474['FINE_AMOUNT'].mean())
print(df["DESCRIPTION_OF_RULE"].value_counts()[:10])
```

7. Complete the following code in Python.

   Define `diffFreq` function, for strings s1 and s2, char ch, see whether s1 and s2 have different number of occurrences of ch. For example, the return of `diffFreq('abc', 'acd', 'a')` is false since 'a' appears in same frequency in 'abc' and 'acd', but the return of `diffFreq('abc', 'acd', 'b')` is true since 'b' has different number of occurrences in 'abc' and 'acd'.

   Define `existDiffFreq` function, for strings s1, s2, and s3, check whether s1 and s2 have different number of occurrences for some letter in s3. For example, existDiffFreq('abcd', 'bcae', 'abc') returns false, since each letter in s3 has the same frequency in s1 and s2, but existDiffFreq('abcd', 'bcae', 'abd') returns true since letter 'd' in s3 has different frequency in s1 and s2.

   Hints: once you encounter a letter in s3 that has different number of occurrences in s1 and s2, can you stop and know what `existDiffFreq` function should return immediately? What if after testing every letter in s3, and each one has the same number of occurrences in s1 and s2?

Answer Key:

```
def diffFreq(s1, s2, ch):
    return s1.count(ch) != s2.count(ch)

def existDiffFreq(s1, s2, s3):
    for ch in s3:
        if diffFreq(s1, s2, ch):
            return True

    return False

def main():
    print(existDiffFreq('abcd', 'bcae', 'abc')) #False
    print(existDiffFreq('abcd', 'bcae', 'abd')) #True

if __name__ == '__main__':
    main()
```

8. (a) What does the MIPS program below print:

Output:

Answer Key:

```
ghij
```

(b) Modify the program to print out string ”86420”. Shade in the box for each line that needs to be changed and rewrite the instruction below. Warning: you need to modify from the above code. Need to use j and beq commands.

```
□ ADDI $sp, $sp, -5 # Set up stack

□ ADDI $t0, $zero, 103 # Set $t0 at 103 (’g’)

□ ADDI $s2, $zero, 4 # Use to test when you reach 4

□ SETUP: SB $t0, 0($sp) # Next letter in $t0

□ ADDI $sp, $sp, 1 # Increment the stack

□ ADDI $s2, $s2, -1 # Decrement the counter by 1

□ ADDI $t0, $t0, 1 # Increase the letter by 1

□ BEQ $s2, $zero, DONE # Jump to DONE if s2 == 0

□ J SETUP # Else, jump back to SETUP

□ DONE: ADDI $t0, $zero, 0 # Null (0) to terminate string

□ SB $t0, 0($sp) # Add null to stack

□ ADDI $sp, $sp, -4 # Set up stack to print

□ ADDI $v0, $zero, 4       # 4 is for print string
```

□ `ADDI $a0, $sp, 0          # Set $a0 to stack pointer`

□ `syscall                   # Print to the log`

Answer Key:

```
ADDI $sp, $sp, -6                  # Set up stack
ADDI $t0, $zero, 56                     # Set $t0 at 56 ('8')
ADDI $s2, $zero, 5                          # Use to test when you reach 5
SETUP: SB $t0, 0($sp)           # Next letter in $t0
ADDI $sp, $sp, 1                          # Increment the stack
ADDI $s2, $s2, -1                         # Decrement the counter by 1
ADDI $t0, $t0, -2                  # Decrease the letter by 2
BEQ $s2, $zero, DONE            # Jump to DONE if s2 == 0
J SETUP                                   # Else, jump back to SETUP
DONE: ADDI $t0, $zero, 0        # Null (0) to terminate string
SB $t0, 0($sp)                            # Add null to stack
ADDI $sp, $sp, -5                  # Set up stack to print
ADDI $v0, $zero, 4         # 4 is for print string
ADDI $a0, $sp, 0           # Set $a0 to stack pointer
syscall                    # Print to the log
```

9. Fill in the C++ programs below to produce the Output on the right.

```
#include <iostream>
using namespace std;
int main()
{

    for(int i = 3; i <= □  ; □ ){

       cout << i-2  << endl;
    }
    return 0;
}
```

Answer Key:

(a)

```
#include <iostream>
using namespace std;

int main()
{
    for (int i = 3; i <= 9; i+=2)
    //Warning: do not add ; right after for-head,
    //or the loop body is empty.
    //That is,
    //the following writing is WRONG
    //for (int i = 2; i <= 9; i+=2) ;
    //We say, each statement in C++ ends with ;
    //we do not say, each line in C++ ends with ;
    {   //this pair of curly braces can be omitted,
        //since the loop body has only statement
        cout << i - 2 << endl;
    }

    return 0;
}
```

Output:

```
1
3
5
7
```

(b)

```
#include <iostream>
using namespace std;

int main()
{
    int size = 4;
    for (int i = 1; i <= size; i++)
    {
        for (int j = 0; j < size - i; j++)
            cout << " ";
        for (int j = 0; j < i; j++)
            cout << "*";
        cout << endl;
    }

    return 0;
}
```

Output:

□

Answer Key:

```
   *
  **
 ***
****
```

(c)

```
#include <iostream>
using namespace std;
int main(){
    int m = 3;
    int n = 4;

    while ( m + n <= □ ) {

        cout << m << " " << n << endl;

        □ //update m

        n += 3
    }
    return 0;
}
```

Output:

```
3 4
1 7
-1 10
-3 13
```

Answer Key:

```
m + n <= 10

m = m -2
```

```
or
m -= 2
```

A complete C++ code is as follows.

```
#include <iostream>
using namespace std;

int main()
{
    int m = 3;
    int n = 4;
    while (m + n <= 10)
    {
        cout << m << " " << n << endl;
        m -= 2;
        n += 3;
    }

    return 0;
}
```

10. (a) Translate the following python program into a **complete C++ program**:

```
num = -1
while num < 25 or num > 75:
    num = int(input("Enter␣an␣integer␣in␣[25,␣75]:␣"))

print("num␣=", num)
```

```
//include library and namespace



//main function signature


{
  //initialization



  //loop line



  //loop body
  {



  }
  //print num


  //return
}
```

Answer Key:

```
#include <iostream>
using namespace std;

int main()
{
    int num = -1;
    while (num < 25 || num > 75)
    {
        cout << "Enter␣an␣integer␣in␣[25,␣75]:␣";
        cin >> num;
    }

    cout << "num␣=␣" << num << endl;

    return 0;
}
```

(b) Write a C++ code. Declare variables for cm and inch. Declare variable for choice. If choice is 1, then enter number of inch, and convert it to cm and print the result out. Otherwise, enter number of cm, and convert it to inch and print the result out.

1 inch = 2.54 cm

1 cm = 1 / 2.54 inch

Some sample input/output is as follows.

```
Enter a choice: 1
Enter number of inch: 5
5 inch = 12.7 cm

Enter a choice: 2
Enter number of cm: 2
2 cm = 0.787402 inch
```

Just finish the code in main function. No need to write include library and main function signature and return statement.

```
//declare variables inch and cm.
```

```
//declare and obtain input for variable choice
```

```
//Write if-statement when choice is 1,
//input inch, convert to cm, and output result.
```

```
//Write else-statement, input cm, convert to inch, and output result.
```

Answer Key:

```cpp
#include <iostream>
using namespace std;

int main()
{
    //declare variables for inch and cm.
    double inch;
    double cm;

    //declare and input for variable choice
    int choice;
    cout << "Enter a choice: ";
    cin >> choice;

    //when choice is 1
    if (choice == 1)
    {
        cout << "Enter number of inch: ";
        cin >> inch;
        cm = inch * 2.54;
        cout << inch << " inch = " << cm << " cm" << endl;
    }
    else //when choice is not 1
    {
        cout << "Enter number of cm: ";
        cin >> cm;
        inch = cm / 2.54;
        cout << cm << " cm = " << inch << " inch" << endl;

    }
    return 0;
}
```

SCRATCH PAPER

SCRATCH PAPER