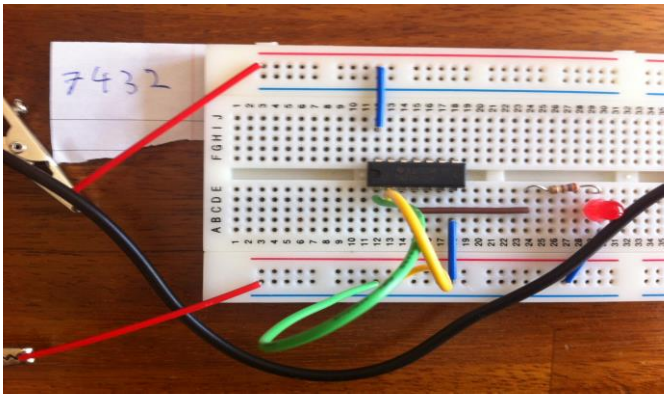
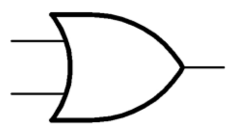
Task 1: Practical - Build a logic circuit/circuits to show the operation six digital IC's

Circuit 1:



Logic Gate Name: OR

Logic Gate Symbol:

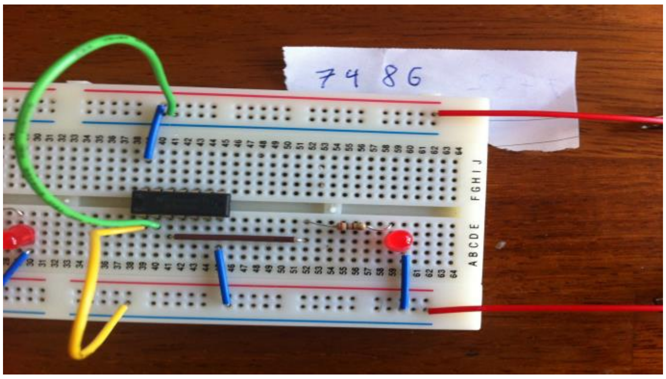


Chip Number: 7432

Create a truth table for this logic circuit.

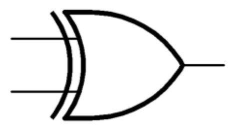
p	q	
1	1	1
1	0	1
0	1	1
0	0	0

Circuit 2:



Logic Gate Name: XOR

Logic Gate Symbol:

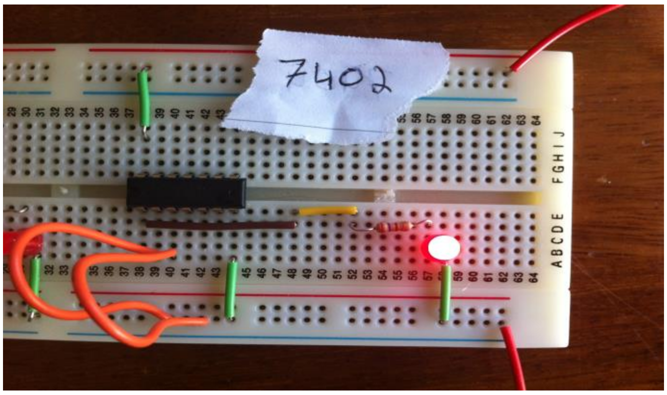


Chip Number: 7486

Create a truth table for this logic circuit.

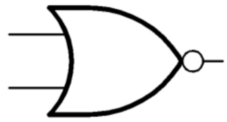
p	q	
1	1	0
1	0	1
0	1	1
0	0	0

Circuit 3:



Logic Gate Name: NOR

Logic Gate Symbol:

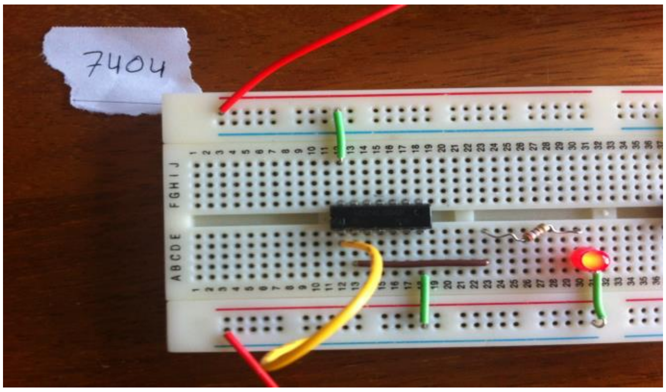


Chip Number: 7402

Create a truth table for this logic circuit.

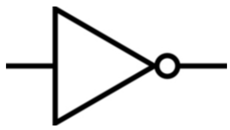
p	q	
1	1	0
1	0	0
0	1	0
0	0	1

Circuit 4:



Logic Gate Name: NOT

Logic Gate Symbol:

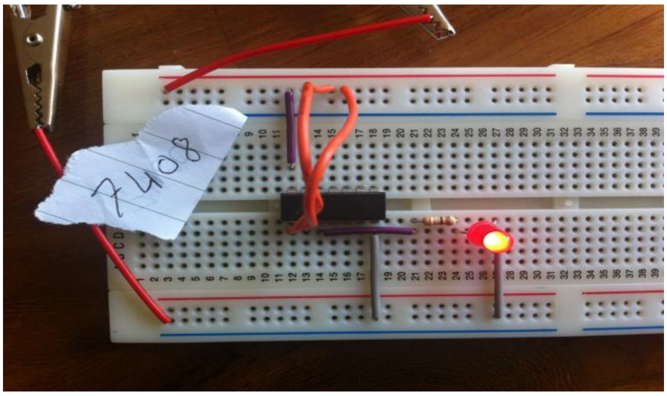


Chip Number: 7404

Create a truth table for this logic circuit.

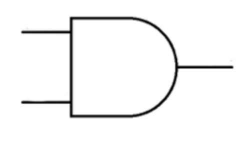
p	
1	0
0	1

Circuit 5:



Logic Gate Name: AND

Logic Gate Symbol:

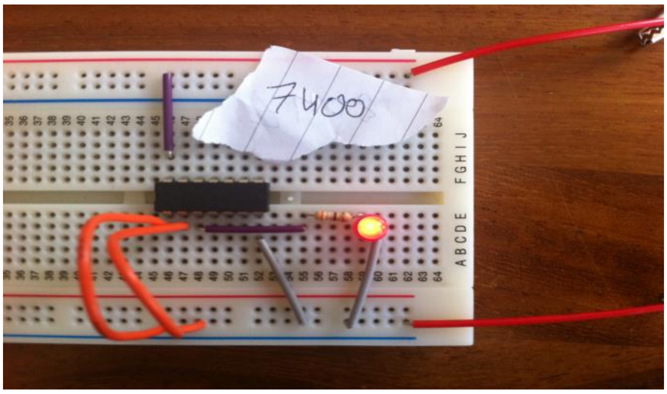


Chip Number: 7408

Create a truth table for this logic circuit.

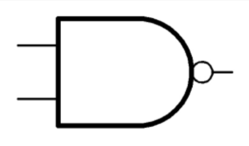
p	q	
1	1	1
1	0	0
0	1	0
0	0	0

Circuit 6:



Logic Gate Name: NAND

Logic Gate Symbol:



Chip Number: 7400

Create a truth table for this logic circuit.

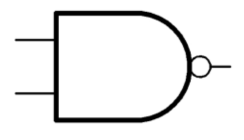
p	q	
1	1	0
1	0	1
0	1	1
0	0	1

Circuit 7:Assemble a logic gate circuit to represent the following statement ~ (p ^ q)

See end of report

Logic Gate Names: NAND

Logic Gate Symbols:



Chip Numbers: 7408 and 7404

Create a truth table for this logic circuit.

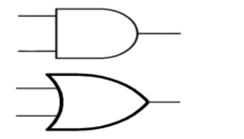
p	q	p^q	~(p^q)
1	1	1	0
1	0	0	1
0	1	0	1
0	0	0	1

Circuit 8: Assemble a logic gate circuit to represent the following statement r v (p ^ q)

See end of report

Logic Gate Names: AND OR

Logic Gate Symbols:



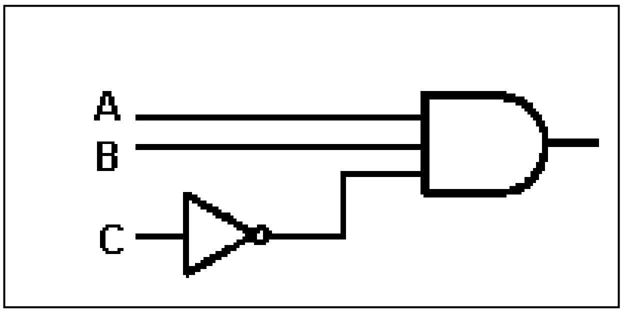
Chip Numbers: 7408 7432

Create a truth table for this logic circuit.

p	q	r	p ^ q	r v (p^q)
1	1	1	1	1
1	1	0	1	1
0	1	1	0	1
1	0	1	0	1
1	0	0	0	0
0	1	0	0	0
0	0	1	0	1
0	0	0	0	0

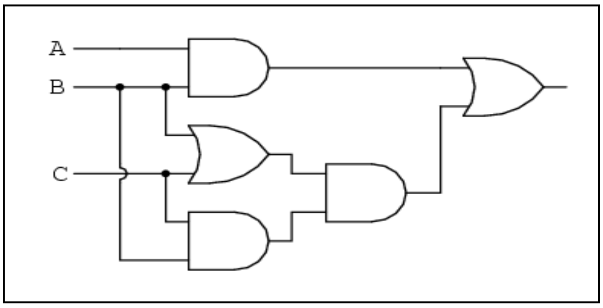
Task 2: Problems Solving:

1.Write a Boolean expression to represent the following logic gate circuit



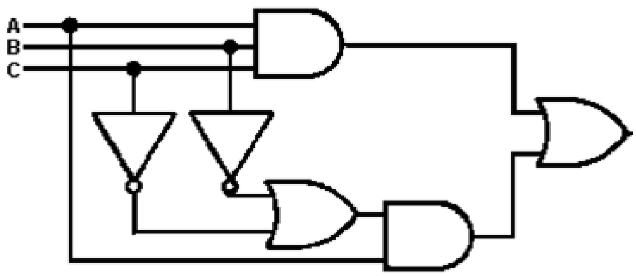
Boolean Expression: a ^ b ^ ~c

2.Write a Boolean expression to represent the following logic gate circuit



Boolean Expression: (a ^ b) v ((b v c) ^ (b ^ c))

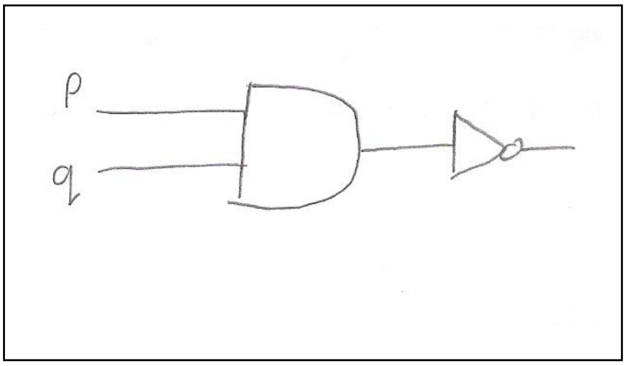
3.Write a Boolean expression to represent the following logic gate circuit



Boolean Expression: (a ^ b ^ c) v (~b v ~c) ^ a

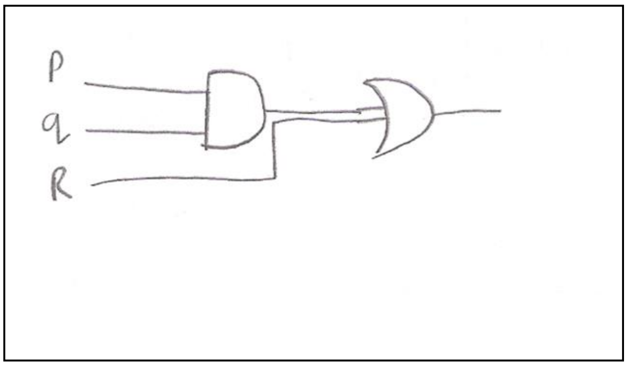
4.Draw the logic gates to represent this Boolean expression.

~ (p ^ q)



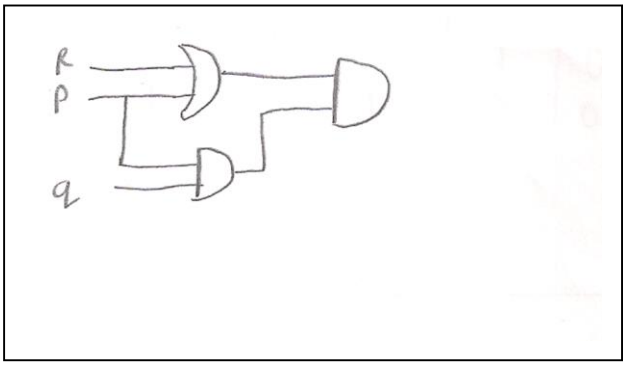
5.Draw the logic gates to represent this Boolean expression.

r v (p ^ q)



6.Draw the logic gates to represent this Boolean expression.

(r v p) ^ (p ^ q)



7.Use a truth table to determine if the following statement is true or false.

p ^ (q v r) Ξ (p ^ q) v (p ^ r)

p	q	r	q v r	p ^ (q v r)		p ^ q	p ^ r	(p ^ q) v (p ^ r)
1	1	1	1	1		1	1	1
1	1	0	1	1		1	0	1
0	1	1	1	0		0	0	0
1	0	1	1	1	≡	0	1	1
1	0	0	0	0		0	0	0
0	1	0	1	0		0	0	0
0	0	1	1	0		0	0	0
0	0	0	0	0		0	0	0

8.Using truth tables prove de Morgan's law that

~ (p ^ q) Ξ ~ p v ~ q

p	q	p ^ q	~(p ^ q)		p	q	~p	~q	~p v ~q
1	1	1	0		1	1	0	0	0
1	0	0	1	≡	1	0	0	1	1
0	1	0	1		0	1	1	0	1
0	0	0	1		0	0	1	1	1

9. Design an interactive worksheet to convert from base 2, 8 and 16 to the base 10 equivalent.

a .Explain the operation of converting a base 2, base 8 and base 16 number to it's decimal equivalent. Include a minimum of 3 worked examples.

To convert from any base to base 10, we use the place values of the binary number as powers. We then multiply each digit of the binary number by the base to the place value power. We then add the results to get the decimal equivalent.

From Base 2 to Base 10:

1(4) 0(3) 0(2) 1(1) 1(0) (base 2)

$1x2^4 + 0x2^3 + 0x2^2 + 1x2^1 + 1x2^0$

= 16 + 0 + 0 + 2 + 1

= 19

From Base 8 to Base 10:

5(2) 4(1) 5(0) (base 8)

$5x8^2 + 4x8^1 + 5x8^0$

= (5x64) + (4x8) + (5x1)

= 320 + 32 + 5

= 357

From Base 16 to Base 10:

1(2) 6(1) 5(0) (base 16)

$1x16^2 + 6x16^1 + 5x16^0$

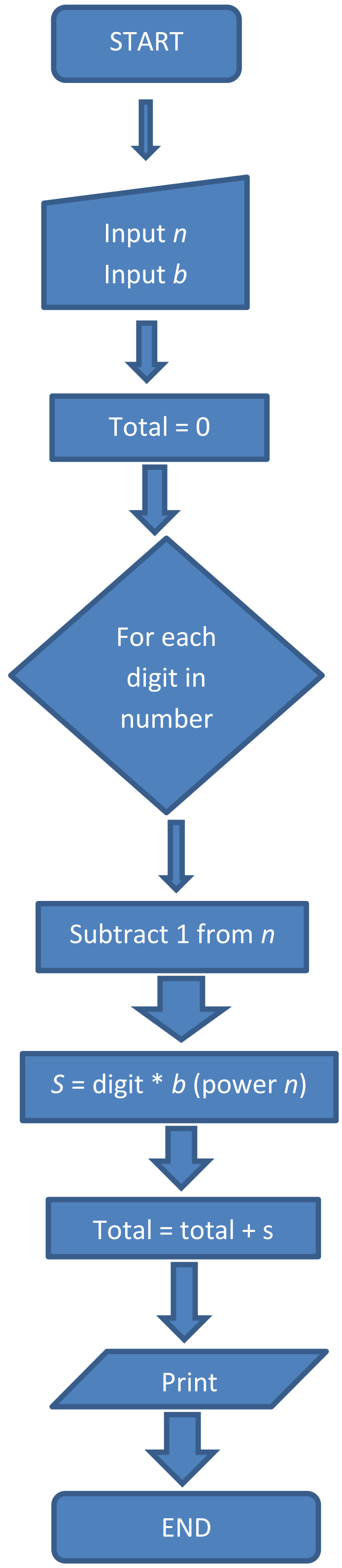
= 256 + 96 + 5

= 357

b . Produce an algorithm of the above task.

1. Start
2. Let *n* be the number of digits in the number
3. Let *b* be the base of the number
4. Set total (*s*) to zero
5. For each digit in the number
    a. Subtract 1 from *n*
    b. Multiply the digit times *b* to the power of *n* and add it to *s*
6. Print total
7. End procedure

c. Produce a flowchart of the above algorithm.



d. Include screenshots of worksheet showing solutions to problems specified in part a.

Base 2 to Base 10:

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	Place Value	128	64	32	16	8	4	2	1			
3	Power	7	6	5	4	3	2	1	0		BASE:	2
4					1	0	0	1	1			
5												
6												
7				BASE 10:	19							
8												
9												

Base 8 to Base 10:

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	Place Value	2097152	262144	32768	4096	512	64	8	1			
3	Power	7	6	5	4	3	2	1	0		BASE:	8
4							5	4	5			
5												
6												
7				BASE 10:	357							
8												
9												

Base 16 to Base 10:

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	Place Value	2.68E+08	16777216	1048576	65536	4096	256	16	1			
3	Power	7	6	5	4	3	2	1	0		BASE:	16
4							1	6	5			
5												
6												
7				BASE 10:	357							
8												
9												

e. Include printouts of worksheet showing cell references, gridlines and formulas.

	A	B	C
1			
2	Place Value	=C2*L3	=D2*L3
3	Power	7	6
4			

	D	E
1		
2	=E2*L3	=F2*L3
3	5	4
4		
5		
6		
7	BASE 10:	=SUMPRODUCT(B2:I2,B4:I4)

	F	G
1		
2	=G2*L3	=H2*L3
3	3	2
4		

	H	I
1		
2	=I2*L3	1
3	1	0
4	2	2

K	L
BASE:	2

N	O	P
	Hexidecimal Table	
Base 10		Base 16
0		0
1		1
2		2
3		3
4		4
5		5
6		6
7		7
8		8
9		9
10		A
11		B
12		C
13		D
14		E
15		F

10. Design an interactive worksheet that can add and subtract two 6 digit binary numbers.

a .Explain the operation of adding and subtracting two . Include a minimum of 3 worked examples.

When adding two binary numbers, we must follow a set of rules (1+0=1, 0+0=1) unless both numbers are a 1, in which case we put down a 0 and carry a 1 (as 1+1 in binary is 10(one zero)). If there are three 1's, we then put down a 1 and carry a 1 (as 1+1+1 in binary is 11(one one)).

Examples:

		1	1	1	0	1	1
+		(1)1	(1)0	1	(1)0	1	0
=	1	1	0	0	1	0	1

When subtracting two binary numbers, we must first get the 1's complement of the number. This is achieved by changing 1's to 0's, and 0's to 1's (e.g. 100110 becomes 011001). We then find the 2's complement of our inverted binary number, this is done by adding 1 to the least significant digit. Once we've done that, we then add our original number to the 2's complement.

Example:

	1	0	1	1	1	0	(Original Number)
	0	1	0	0	0	1	(1's Complement)
+	0	0	0	0	(1)0	1	
=	0	1	0	0	1	0	(2's Complement)

		1	0	1	1	1	0	(Original Number)
+		(1)0	(1)1	(1)0	(1)0	1	0	(2's Complement)
=	1	0	0	0	0	0	0	

b . Produce an algorithm of the above task.

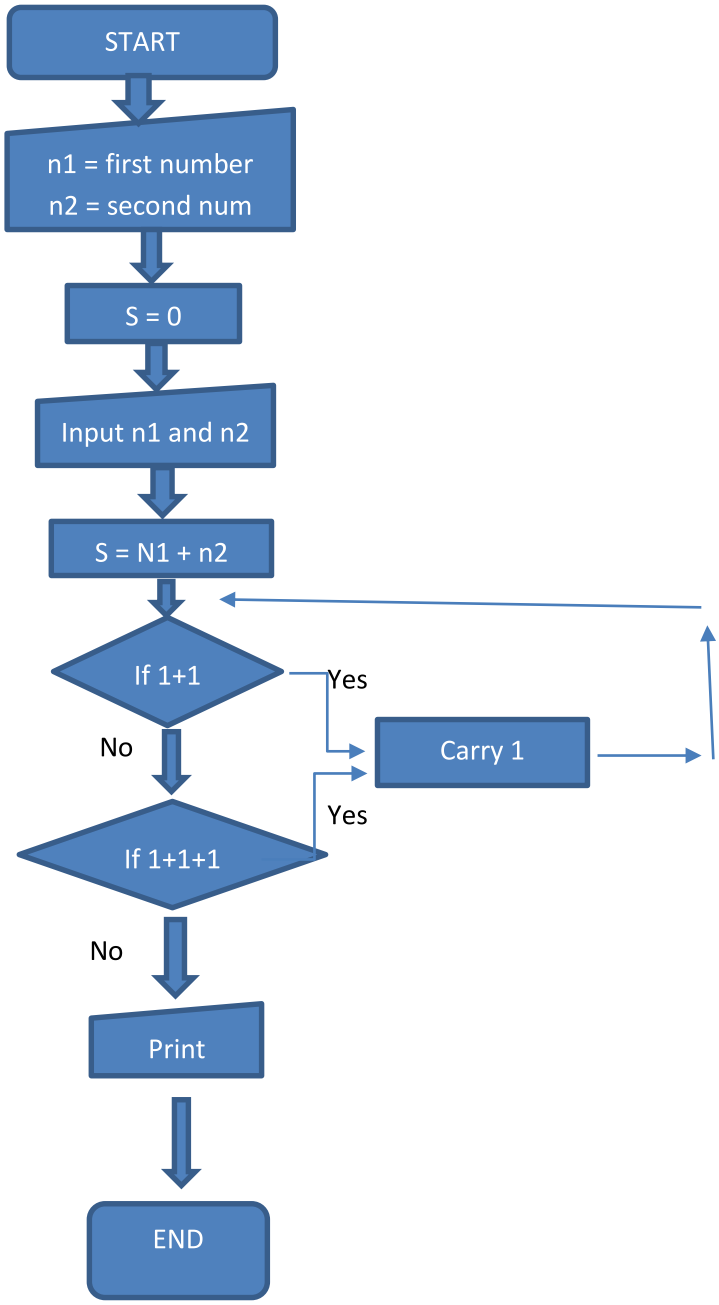
Addition:

1. Start
2. Let *n1* be the first number
3. Let *n2* be the second number
4. Let *s* be the total
5. Add the two numbers
    a. Put down 0 and Carry 1 if the sum is 1 + 1
    b. Put down 1 and Carry 1 if sum is 1 + 1 + 1
6. Print result
7. End

Subtraction:

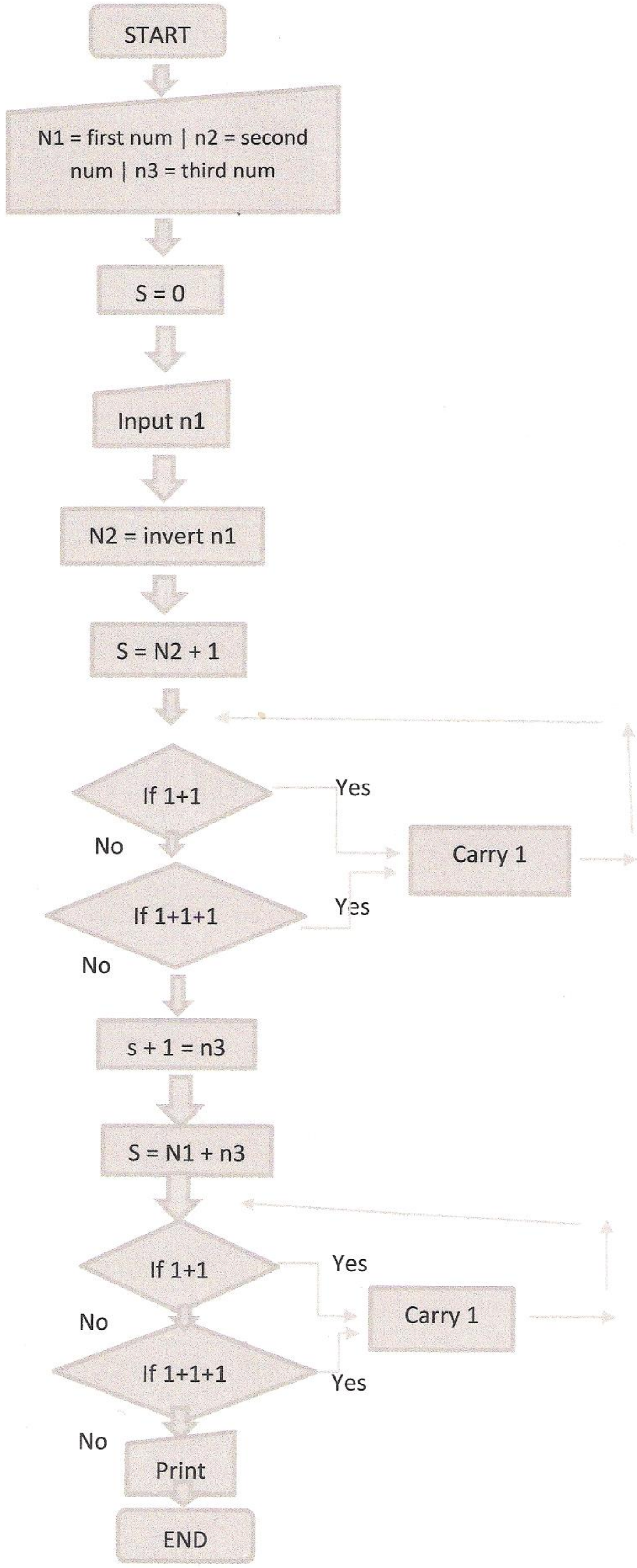
1. Start
2. Let *n1* be the original number
3. Let *n2* be the 1's complement
4. Let s = total
5. Invert *n1* to find *n2*
6. Add 1 to *n2* to get *n3*
    a. Put down 0 and carry 1 if the sum is 1+1
    b. Put down 1 and carry 1 if the sum is 1+1+1
7. Let *n3* be the 2's complement
8. Add *n1* and *n3*
    a. Put down 0 and carry 1 if the sum is 1+1
    b. Put down 1 and carry 1 if the sum is 1+1+1
9. Print result
10. End

c. Produce a flowchart of the above algorithm.



(Addition Flow Chart)

(Subtraction Flowchart)



Had to use a scanned printed copy of this flowchart, as the middle part wouldn't save properly in PDF

d. Include screenshots of your worksheet showing solutions to problems specified in part a above

Addition:

	A	B	C	D	E	F	G	H
1								
2								
3								
4								
5	Carry		1	1	0	1	0	
6			1	1	1	0	1	1
7			1	0	1	0	1	0
8		1	1	0	0	1	0	1
9								

Subtraction:

	A	B	C	D	E	F	G	H	I
1									
2									
3									
4									
5		Carry	0	0	0	0	1		
6		Original Number	1	0	1	1	1	0	
7		1's Complement	0	1	0	0	0	1	
8	+	[redacted]	0	0	0	0	0	1	
9	=	2's Complement	0	1	0	0	1	0	
10									
11		Carry	1	1	1	1	0		
12		Original Number	1	0	0	1	1	0	
13	+	2's Complement	0	1	1	0	1	0	
14	=	1	0	0	0	0	0	0	
15									
16									

C20 fx

	A	B	C	D	E	F	G	H
1								
2								
3								
4								
5		Carry	0	0	0	0	0	
6		Original Number	1	1	0	1	0	1
7		1's Complement	0	0	1	0	1	0
8	+	[redacted]	0	0	0	0	0	1
9	=	2's Complement	0	0	1	0	1	1
10								
11		Carry	1	0	0	0	0	
12		Original Number	1	1	0	1	0	1
13	+	2's Complement	0	1	1	0	1	0
14	=	1	0	0	1	1	1	1

e. Include printouts of worksheet showing cell references, gridlines and formulas.

Addition:

B
[redacted]
=IF(OR(AND(C5=1,C6=1,C7=1),AND(C5=0,C6=1,C7=1),AND(C5=1,C6=1,C7=0),AND(C5=1,C6=0,C7=1)),1,0)

C
=IF(OR(AND(D5=1,D6=1,D7=1),AND(D5=0,D6=1,D7=1),AND(D5=1,D6=1,D7=0),AND(D5=1,D6=0,D7=1)),1,0)
1
1
=IF(OR(AND(C5=0,C6=0,C7=0),AND(C5=0,C6=1,C7=1),AND(C5=1,C6=1,C7=0),AND(C5=1,C6=0,C7=1)),0,1)

D
=IF(OR(AND(E5=1,E6=1,E7=1),AND(E5=0,E6=1,E7=1),AND(E5=1,E6=1,E7=0),AND(E5=1,E6=0,E7=1)),1,0)
1
0
=IF(OR(AND(D5=0,D6=0,D7=0),AND(D5=0,D6=1,D7=1),AND(D5=1,D6=1,D7=0),AND(D5=1,D6=0,D7=1)),0,1)

E
=IF(OR(AND(F5=1,F6=1,F7=1),AND(F5=0,F6=1,F7=1),AND(F5=1,F6=1,F7=0),AND(F5=1,F6=0,F7=1)),1,0)
1
1
=IF(OR(AND(E5=0,E6=0,E7=0),AND(E5=0,E6=1,E7=1),AND(E5=1,E6=1,E7=0),AND(E5=1,E6=0,E7=1)),0,1)

e. Include printouts of worksheet showing cell references, gridlines and formulas.

F
=IF(OR(AND(G5=1,G6=1,G7=1),AND(G5=0,G6=1,G7=1),AND(G5=1,G6=1,G7=0),AND(G5=1,G6=0,G7=1)),1,0)
0
0
=IF(OR(AND(F5=0,F6=0,F7=0),AND(F5=0,F6=1,F7=1),AND(F5=1,F6=1,F7=0),AND(F5=1,F6=0,F7=1)),0,1)

G
=IF(AND(H6=1,H7=1),1,0)
1
1
=IF(OR(AND(G5=0,G6=0,G7=0),AND(G5=0,G6=1,G7=1),AND(G5=1,G6=1,G7=0),AND(G5=1,G6=0,G7=1)),0,1)

H
1
0
=IF(OR(AND(H6=0,H7=0),AND(H6=1,H7=1)),0,1)

e. Include printouts of worksheet showing cell references, gridlines and formulas.

Subtraction:

	B
	Carry
	Original Number
	1's Complement
+	
=	2's Complement
	Carry
	Original Number
+	2's Complement
=	=IF(OR(AND(B11=0,B12=0,B7=0),AND(B11=0,B12=1,B13=1),AND(B11=1,B12=1,B13=0),AND(B11=1,B12=0,B13=1)),0,1)

C
=IF(OR(AND(D5=1,D7=1,D8=1),AND(D5=0,D7=1,D8=1),AND(D5=1,D7=1,D8=0),AND(D5=1,D7=0,D8=1)),1,0)
1
=IF(C6=0,1,IF(C6=1,0))
0
=IF(OR(AND(C5=0,C7=0,C8=0),AND(C5=0,C7=1,C8=1),AND(C5=1,C7=1,C8=0),AND(C5=1,C7=0,C8=1)),0,1)
=IF(OR(AND(D11=1,D12=1,D13=1),AND(D11=0,D12=1,D13=1),AND(D11=1,D12=1,D13=0),AND(D11=1,D12=0,D13=1)),1,0)
1
0
=IF(OR(AND(C11=0,C12=0,C7=0),AND(C11=0,C12=1,C13=1),AND(C11=1,C12=1,C13=0),AND(C11=1,C12=0,C13=1)),0,1)

D
=IF(OR(AND(E5=1,E7=1,E8=1),AND(E5=0,E7=1,E8=1),AND(E5=1,E7=1,E8=0),AND(E5=1,E7=0,E8=1)),1,0)
0
=IF(D6=0,1,IF(D6=1,0))
0
=IF(OR(AND(D5=0,D7=0,D8=0),AND(D5=0,D7=1,D8=1),AND(D5=1,D7=1,D8=0),AND(D5=1,D7=0,D8=1)),0,1)
=IF(OR(AND(E11=1,E12=1,E13=1),AND(E11=0,E12=1,E13=1),AND(E11=1,E12=1,E13=0),AND(E11=1,E12=0,E13=1)),1,0)
0
1
=IF(OR(AND(D11=0,D12=0,D7=0),AND(D11=0,D12=1,D13=1),AND(D11=1,D12=1,D13=0),AND(D11=1,D12=0,D13=1)),0,1)

E
=IF(OR(AND(F5=1,F7=1,F8=1),AND(F5=0,F7=1,F8=1),AND(F5=1,F7=1,F8=0),AND(F5=1,F7=0,F8=1)),1,0)
1
=IF(E6=0,1,IF(E6=1,0))
0
=IF(OR(AND(E5=0,E7=0,E8=0),AND(E5=0,E7=1,E8=1),AND(E5=1,E7=1,E8=0),AND(E5=1,E7=0,E8=1)),0,1)
=IF(OR(AND(F11=1,F12=1,F13=1),AND(F11=0,F12=1,F13=1),AND(F11=1,F12=1,F13=0),AND(F11=1,F12=0,F13=1)),1,0)
0
1
=IF(OR(AND(E11=0,E12=0,E7=0),AND(E11=0,E12=1,E13=1),AND(E11=1,E12=1,E13=0),AND(E11=1,E12=0,E13=1)),0,1)

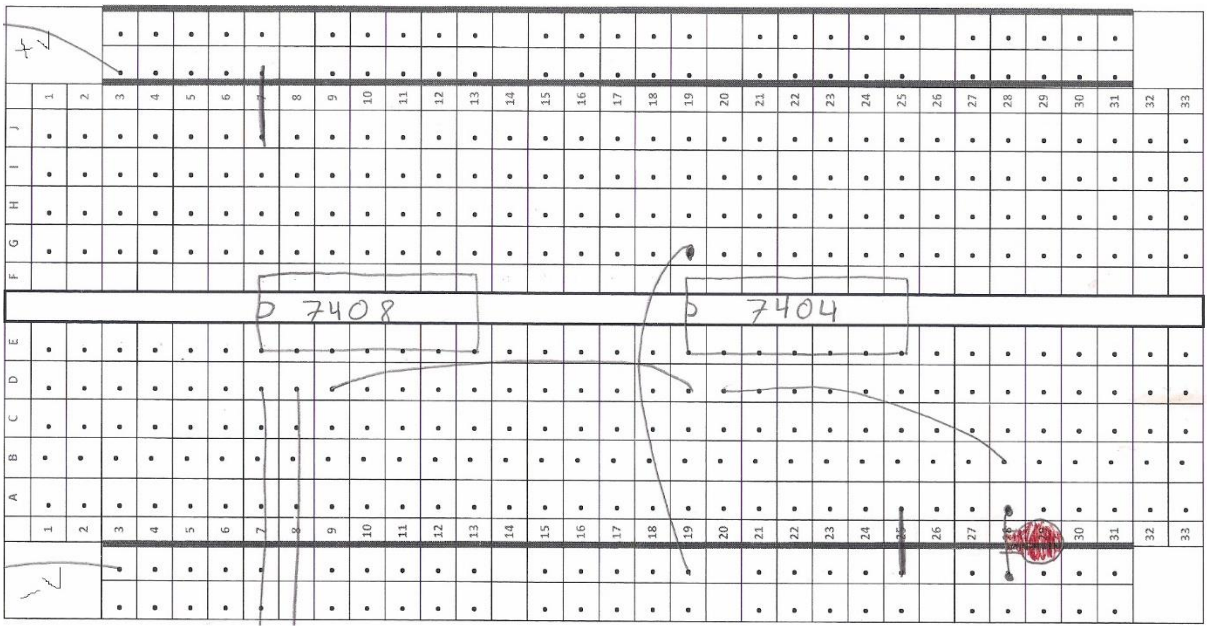
e. Include printouts of worksheet showing cell references, gridlines and formulas.

F
=IF(OR(AND(G5=1,G7=1,G8=1),AND(G5=0,G7=1,G8=1),AND(G5=1,G7=1,G8=0),AND(G5=1,G7=0,G8=1)),1,0)
1
=IF(F6=0,1,IF(F6=1,0))
0
=IF(OR(AND(F5=0,F7=0,F8=0),AND(F5=0,F7=1,F8=1),AND(F5=1,F7=1,F8=0),AND(F5=1,F7=0,F8=1)),0,1)
=IF(OR(AND(G11=1,G12=1,G13=1),AND(G11=0,G12=1,G13=1),AND(G11=1,G12=1,G13=0),AND(G11=1,G12=0,G13=1)),1,0)
1
0
=IF(OR(AND(F11=0,F12=0,F7=0),AND(F11=0,F12=1,F13=1),AND(F11=1,F12=1,F13=0),AND(F11=1,F12=0,F13=1)),0,1)

G
=IF(AND(H7=1,H8=1),1,0)
1
=IF(G6=0,1,IF(G6=1,0))
0
=IF(OR(AND(G5=0,G7=0,G8=0),AND(G5=0,G7=1,G8=1),AND(G5=1,G7=1,G8=0),AND(G5=1,G7=0,G8=1)),0,1)
=IF(AND(H12=1,H13=1),1,0)
1
1
=IF(OR(AND(G11=0,G12=0,G7=0),AND(G11=0,G12=1,G13=1),AND(G11=1,G12=1,G13=0),AND(G11=1,G12=0,G13=1)),0,1)

H
0
=IF(H6=0,1,IF(H6=1,0))
1
=IF(OR(AND(H7=0,H8=0),AND(H7=1,H8=1)),0,1)
0
0
=IF(OR(AND(H12=0,H13=0),AND(H12=1,H13=1)),0,1)

Circuit 7



Circuit 8