On my honor, I/we have not given, nor received,
nor witnessed any unauthorized assistance on this work.

Name/Signature: _____

Name/Signature: _____

Name/Signature: _____

Name/Signature: _____

Name/Signature: _____

Question:	1	2	3	4	5	6	7	Total
Points:	8	11	12	15	30	8	15	99
Score:								

1. Draw the truth table and logic gate for each of the following logical operations:
   (a) (2 points) AND

   (b) (2 points) OR

   (c) (2 points) NOT

   (d) (2 points) NAND

2. Translate the following Boolean algebra equations to logic gate diagrams. Then draw the truth table for the circuit.

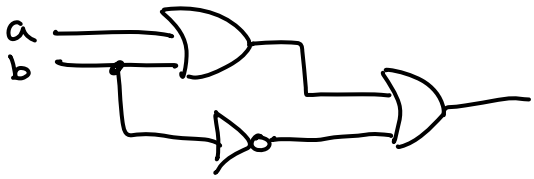
   (a) (3 points) $z = a \vee (b \wedge \neg c)$

   (b) (4 points) $z = (a \wedge b) \vee (\neg c \wedge a)$

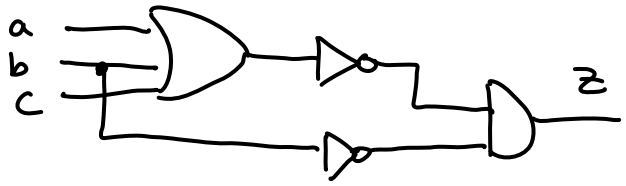
(c) (4 points) $z = \neg(a \wedge b) \vee \neg(b \wedge c)$

3. Write the compound proposition computed by each of the following circuits.

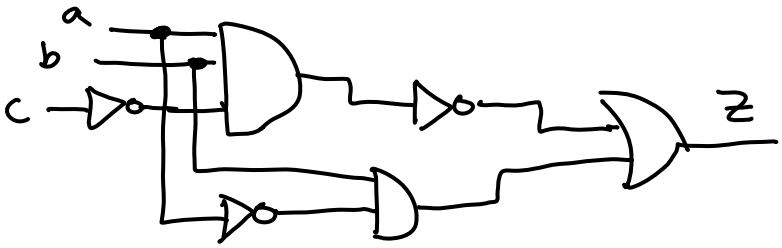
(a) (4 points)



(b) (4 points)



(c) (4 points)



4. For each of the following truth tables, draw a circuit which implements it.

   (a) (5 points)

a	b	z
0	0	1
0	1	1
0	1	1
1	1	0

   (b) (5 points)

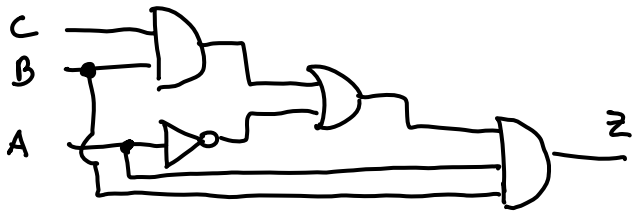
a	b	c	z
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

(c) (5 points)

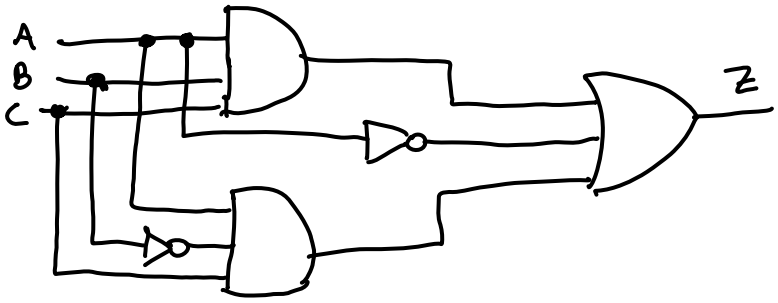
a	b	c	z
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

5. Simply the following circuits. You can do this by writing the output of the circuit as a boolean expression and then using the laws of Boolean algebra to simplify it. Then re-draw the simplified circuit.

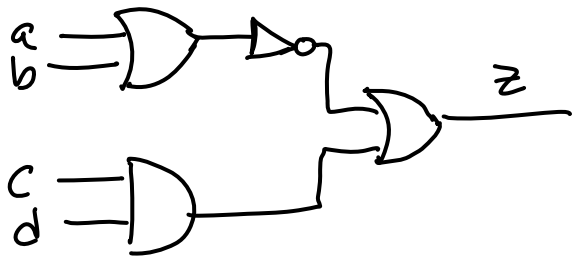
   (a) (15 points)



(b) (15 points)

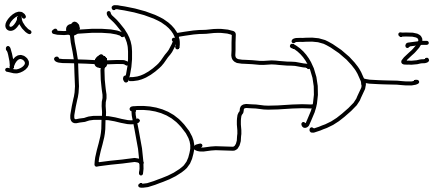


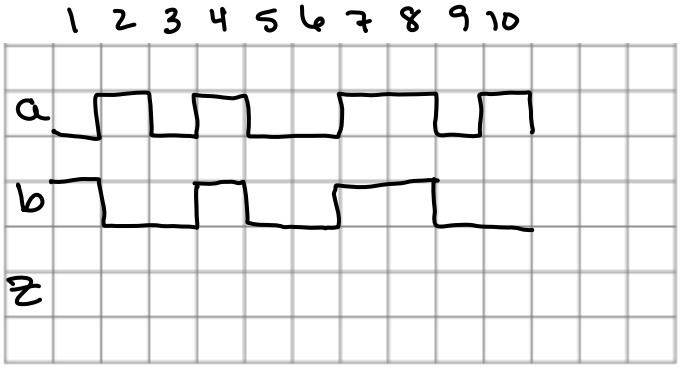
6. (8 points) Convert and simplify the following circuit to only use NAND gates.



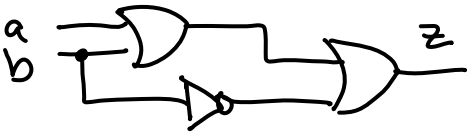
7. Engineers often use **timing diagrams** to represent how the inputs and outputs to logic circuits change over time (for example, as a computer's system clock cycles on and off.) For each of the logic circuits below, draw the timing diagram of the output given the timing diagrams of the inputs.

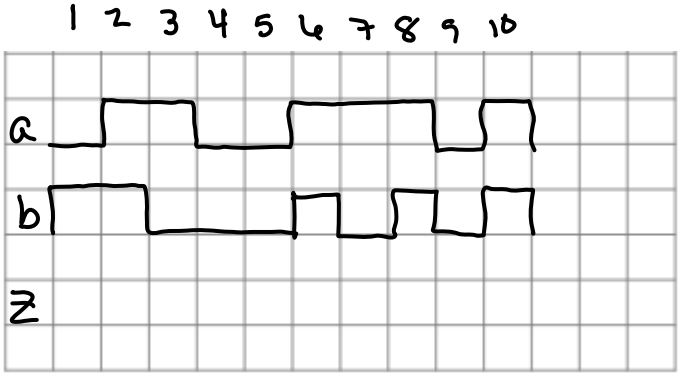
(a) (5 points)





(b) (5 points)





(c) (5 points)