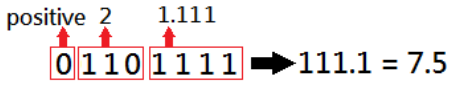
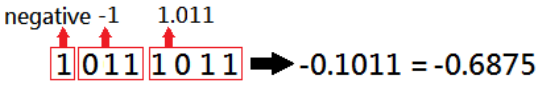
1. a. 1568 = 11000100000_b → 011000100000
   b. -1569 = -11000100001_b → 100111011111

2. a. base ten: 1179 hexadecimal: 49B
   b. base ten: 1501 hexadecimal: 5DD

3. a. 0000000 b. 1010000 c. 0101110 overflow

4. a. 10100000 b. 11111010 c. 01011010

5. a. 

   b. 

6. a. -8.25 = -1000.01_b = $-1.00001_b \times 2^3$ → 1 111 1000 has a truncation error
   b. 0.1 = $0.000110011001100\ldots\ldots_b$ = $1.100110011001100\ldots\ldots_b \times 2^{-4}$
   → 0 000 1100 has a truncation error

7. the bit pattern of the largest number : 0 111 1111
   → $1.111_b \times 2^3 = 1111_b = 15$
   the bit pattern of the smallest positive number : 0 000 1000
   → $1.000_b \times 2^{-4} = 0.0001_b = 0.0625$

8. a. 3 possible answers

1	a: NOT b: AND c: OR
2	a: NOT b: OR c: AND
3	a: NOT b: XOR c: OR

   b. 1
   c. If the inputs are x and y from top to bottom, then x = 0, y = 1 or x = 1, y = 1

9. R0 = $3F_H$, R3 = FF_H, R5 = $C0_H$, memory cell 00_H = FF_H
   (Should include program counter (PC) and instruction register (IR). They are also registers.)

10.

Address	00	01	02	03	04	05	06	07	08	09
Contents	1X	30	2Y	7F	8Z	XY	3Z	31	C0	00

   X, Y, Z are Registers

11. Solution 1:

Address	00	01	02	03	04	05	06	07	08	09
Contents	1X	30	2Y	80	8Z	XY	20	00	BZ	12
Address	0A	0B	0C	0D	0E	0F	10	11	12	13
Contents	2Y	FF	2Z	01	9X	XY	5X	XZ	3X	31
Address	14	15								
Contents	C0	00								

X, Y, Z are Registers

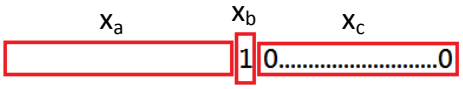
Solution 2:

Address	00	01	02	03	04	05	06	07	08	09
Contents	1X	30	20	7F	7Y	0X	BY	10	2Z	FF
Address	0A	0B	0C	0D	0E	0F	10	11	12	13
Contents	9Y	ZX	2Z	01	5X	YZ	3X	31	C0	00

X, Y, Z are Registers

想法:由 30_h 讀出值寫入 Reg X，和 0111 1111($7F_h$)做 or。如為正數(和 $7F_h$ 同)，寫回 31_h。若否，則和 1111 1111(FF_h)做 XOR 取 1 補數，再加一，寫回 31_h。 XYZ 皆為非 0 的任意 Register

12. a. Suppose input x has n bits, and output y has n bits, then x can be separated into 3 parts:



x_b is the first 1 when copying x from right to left.

x_a is on the left side of x_b and x_c is on the right side of x_b.

Suppose x_b is the k-th bit from right to left.

Then we can know that x_a has n – k bits and x_c has k – 1 bits.

By the algorithm, y could also be separated into 3 parts.

y_a is the complement of x_a.

$y_b = x_b = 1$

$y_c = x_c = \underbrace{000\ldots\ldots0}_{k-1}$

$x + y = (x_a + y_a)\times 2^k + (x_b + y_b)\times 2^{k-1} + (x_c + y_c)$

Assume $x + y = z$, $x_a + y_a = z_a$, $x_b + y_b = z_b$, $x_c + y_c = z_c$

Because $x_c = y_c = \underbrace{000\ldots\ldots0}_{k-1}$, $x_c + y_c = z_c = \underbrace{000\ldots\ldots0}_{k-1}$.

$x_b + y_b = 10 = z_b$

Because y_a is the complement of x_a, $x_a + y_a = \underbrace{111.....1}_{n-k} = z_a$.

So z =

$$\begin{array}{r} \overset{k-1}{\boxed{000.....0}} \\ \overset{n-k}{\boxed{111.....1}}\ 10 \\ + \\ \hline 000.....000.....0 \end{array}$$

Because x + y = z = 0, y is the 2's complement of x.

- 你只需要證明他產生出來的 binary pattern 和原來相加等於 0 即可
  (You only need to prove the addition of the binary pattern produced by this algorithm and the original bit pattern equals to 0.)

b. Truth Table of the circuit:

input	**Output**	Output is the 2's complement of input
0000	0000	Yes
0001	1111	Yes
0010	1110	Yes
0011	1101	Yes
0100	1100	Yes
0101	1011	Yes
0110	1010	Yes
0111	1001	Yes
1000	1000	Yes
1001	0111	Yes
1010	0110	Yes
1011	0101	Yes
1100	0100	Yes
1101	0011	Yes
1110	0010	Yes
1111	0001	Yes

By the above truth table, the circuit correctly implements the algorithm.

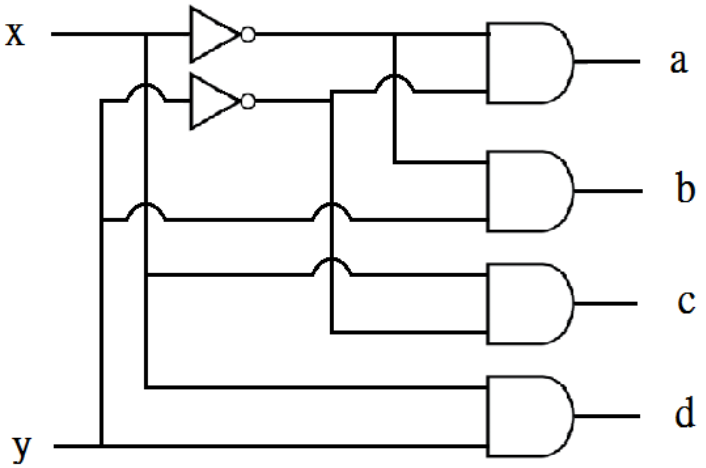
- 你只需要證明在遇到第一個 1 之前，(包含第一個 1) output bit=input bit，而之後 output bit= input bit's complement 即可
  (You only need to prove before and including the first 1, the output equals input, and after the first 1, all bits are complemented.)

13. a. input: x, y; output: a, b, c, d

Truth Table

x	y	a	b	c	D
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

b.



14. 這一題沒有標準答案，看你如何解釋。Program(當動詞)最早的意思是「規劃」，包含如何一步一步的進行。課本(page20)上定義是 (The process of developing a program, encoding it in machine- compatible form, and inserting it into a machine is called programming.) 如果你認為這個 rice cooker 可以設定連續或是複合的指令，比方說先預熱 80 度 10 分鐘再調高溫度到 100 度 20 分鐘，那這個 rice cooker 是 programmable. 如果你認為這個 rice cooker 只可設定溫度和時間，每做完一樣事都還要在設定下一步驟，那它最多是 configurable. 另外，如果這個 rice cooker 可以將每次的 program(食譜)記下來，你下次要煮同樣東西時可以把這個食譜叫出來，不需要再重新 program 它，那這個 rice cooker 就具有 stored-program 的能力了。

The answer depends on how you interpret the function of the rice cooker. If you think the rice cooker can be set by a sequence of instructions, then it is programmable. If it can only accept a single setting at a time, it is called "configurable".

15. 65536 = 2^{16}, so it needs 16bits = 2Bytes to save a sample.

40000Hz = 40000 samples per second

5munites×60×2Bytes×40000Hz = 24000000Bytes

24000000/2^{20} ＝ 22.888 = 23Mbytes (24M bytes is also acceptable)