only if both are true ↓ | false ↓ | or

1

| p | q | r | p∧q | r∨p | (r∨p)∧q | (p∧q)∨((r∨p)∧q) |
|---|---|---|---|---|---|---|
| F | F | F | T | T | F | T |
| F | F | T | T | F | F | T |
| F | T | F | T | T | T | T |
| F | T | T | T | F | F | T |
| T | F | F | T | F | F | T |
| T | F | T | T | F | F | T |
| T | T | F | F | F | F | F |
| T | T | T | F | F | F | F |

2 a) 47 ∧ 98 (xor)

$2\overline{)47} = 23 = 1$
$2\overline{)23} = 11 = 1$
$2\overline{)11} = 5 = 1$
$2\overline{)5} = 2 = 1$
$2\overline{)2} = 1 = 0$
$2\overline{)1} = 0 = 1$

$2\overline{)98} = 49 = 0$
$2\overline{)49} = 24 = 1$
$2\overline{)24} = 12 = 0$
$2\overline{)12} = 6 = 0$
$2\overline{)6} = 3 = 0$
$2\overline{)3} = 1 = 1$
$2\overline{)1} = 0 = 1$

Start 0's to left
keep value the same

0101111
⊕ 1100010
1001101

B) 13 & 211 (and)

$2\overline{)13} = 6 = 1$
$2\overline{)6} = 3 = 0$
$2\overline{)3} = 1 = 1$
$2\overline{)1} = 0 = 1$

$2\overline{)211} = 105 = 1$
$2\overline{)105} = 52 = 1$
$2\overline{)52} = 26 = 0$
$2\overline{)26} = 13 = 0$
$2\overline{)13} = 6 = 1$
$2\overline{)6} = 3 = 0$
$2\overline{)3} = 1 = 1$
$2\overline{)1} = 0 = 1$

00001101
∧ 11010011
00000001

C 99 | 131 (or)

$2\overline{)99} = 49 = 1$
$2\overline{)49} = 24 = 1$
$2\overline{)24} = 12 = 0$
$2\overline{)12} = 6 = 0$
$2\overline{)6} = 3 = 0$
$2\overline{)3} = 1 = 1$
$2\overline{)1} = 0 = 1$

$2\overline{)131} = 65 = 1$
$2\overline{)65} = 32 = 1$
$2\overline{)32} = 16 = 0$
$2\overline{)16} = 8 = 0$
$2\overline{)8} = 4 = 0$
$2\overline{)4} = 2 = 0$
$2\overline{)2} = 1\ 0$

1100011
V 0000011
1100011

D 13 << 3 (left shift)

$k = 3$ $13 \times 2^k = 13 \times 2^3 = 104$
$13 = 1101$ left shift by 3 = [1101000]
64 + 32 + 8 = 104

e 198 >> 4 (Right shift)

$2\overline{)198} = 99 = 0$
$2\overline{)99} = 49 = 1$
$2\overline{)49} = 24 = 1$
$2\overline{)24} = 12 = 0$
$2\overline{)12} = 6 = 0$
$2\overline{)6} = 3 = 0$
$2\overline{)3} = 1 = 1$
$2\overline{)1} = 0 = 1$

00001100011~~0~~
00001100

3 $p \vee ((p \wedge (r \vee (\bar{r} \vee p))) \wedge q) \equiv p$

(1) $p \vee (p \wedge ((r \vee \bar{r}) \vee p)) \wedge q$
Associative Law on premise

(2) $p \vee (p \wedge (T \vee p)) \wedge q$
Inverse Law on (1)

(3) $p \vee (p \wedge T) \wedge q$
Domination Law on (2)

(4) $p \vee (p \wedge q)$
Identity Law on (3)

(5) $p$ absorbtion Law on (4)

4 $(p \wedge (p \vee q)) \wedge (p \vee \bar{p}) \rightarrow q \equiv (\bar{p} \vee q)$

(1) $((p \wedge (p \vee q)) \wedge T) \rightarrow q$
Identity Law on premise

(2) $(p \wedge T) \rightarrow q$
Absorption Law on (1)

(3) $p \rightarrow q$
Identity Law on (2)

(4) $(\bar{p} \vee q)$
Implication Identity of (3)

5 Ada Lovelace is considered the first computer programmer. She was mentored by Charles Babbage who is known as the father of the computer. He invented the difference engine which performed mathematical calculations. Ada was captivated by the machine.

In 1843 Ada translated an article on Babbage's invention the analytical engine. Not only did she translate them, She added her own personal work such as, How codes could be created to add letters and symbols along with the numbers, She also theorized a method for looping.

1 = True
0 = False

$1 \le i \le 3$
$1 \le n \le 3$
$0 \le j \le 1$

6 Tic-tac-toe

| | | |
|---|---|---|
| 1 | 0 | 1 |
| 1 | 0 | 0 |
| 0 | 1 | 1 |

Each Row contains a 1 or 0

$\bigwedge_{i=1}^{3} \bigvee_{j=1}^{0} P(i, j)$

each column contains a 1 or 0

$\bigwedge_{n=1}^{3} \bigvee_{j=0}^{1} P(n, j)$

each diagnol contains either a 0 or 1.

$\bigwedge_{i=1}^{3} \bigwedge_{n=1}^{3} \bigvee_{j=0}^{1} P(i, n, j)$