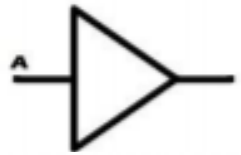
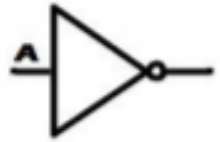
UIL Official List of Boolean Algebra Identities (Laws)

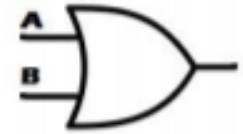
1	$A + A = A$	Indempotent Law for OR
2	$A * A = A$	Indempotent Law for AND
3	$A + B = B + A$	Commutative Law for OR
4	$A * B = B * A$	Commutative Law for AND
5	$A + (B + C) = (A + B) + C$	Associative Law for OR
6	$A * (B * C) = (A * B) * C$	Associative Law for AND
7	$A * (B + C) = A * B + A * C$	Distributive Law for AND over OR
8	$A + B * C = (A + B) * (A + C)$	Distributive Law for OR over AND
9	$A + 1 = 1$	Law of Union
10	$A * 0 = 0$	Law of Intersection
11	$A * (A + B) = A$	Law of Absorption
12	$A + A * B = A$	Law of Absorption
13	$A * 1 = A$	Identity Law for AND
14	$A + 0 = A$	Identity Law for OR
15	$\overline{\overline{A}} = A$	Double Negative Law

16	$A + \overline{A} = 1$	Law of Complement for OR
17	$A * \overline{A} = 0$	Law of Complement for AND
18	$\overline{A + B} = \overline{A} * \overline{B}$	DeMorgan's Law
19	$\overline{A * B} = \overline{A} + \overline{B}$	DeMorgan's Law
20	$A \oplus B = A * \overline{B} + \overline{A} * B = \overline{A} * B + A * \overline{B}$	Exclusive OR (XOR)
21	$\overline{A \oplus B} = A * B + \overline{A} * \overline{B}$	Exclusive NOR (XNOR)
22	$A + \overline{A} * B = A + B$	Law of the "disappearing opposite"
23	$(A + B) * (A + C) = A + B * C$	Reverse of Law #8
24	$(A + B) * (C + D) = A * C + A * D + B * C + B * D$	FOIL (**F**irst,**O**uter,**I**nner,**L**ast) Distribut

Note: ***AND*** will always be expressed explicitly with the * operator

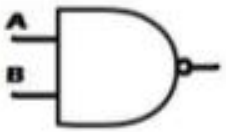
A A 

$\overline{A}$ NOT A 

$A+B$ A OR B 

$A*B$ A AND B 

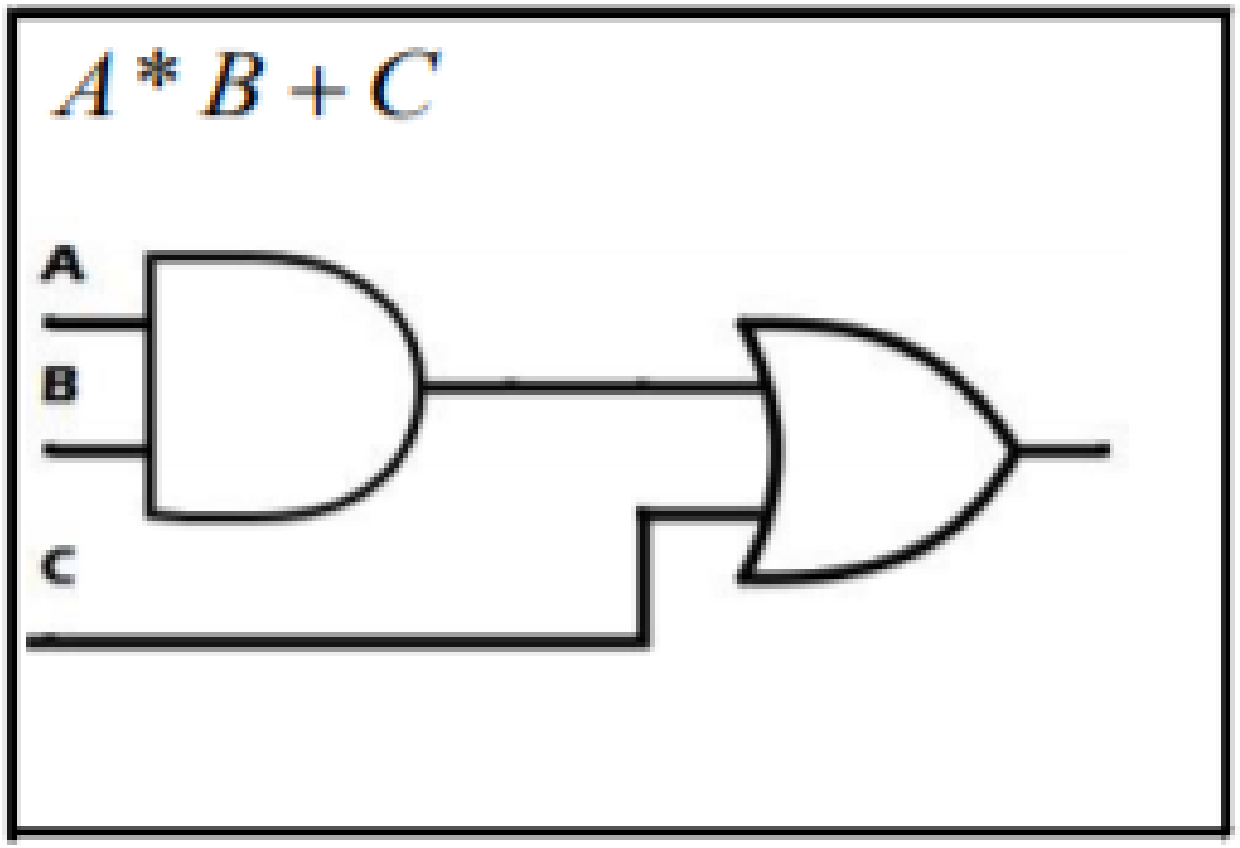
$\overline{A+B}$ A NOR B 

$\overline{A*B}$ A NAND B 

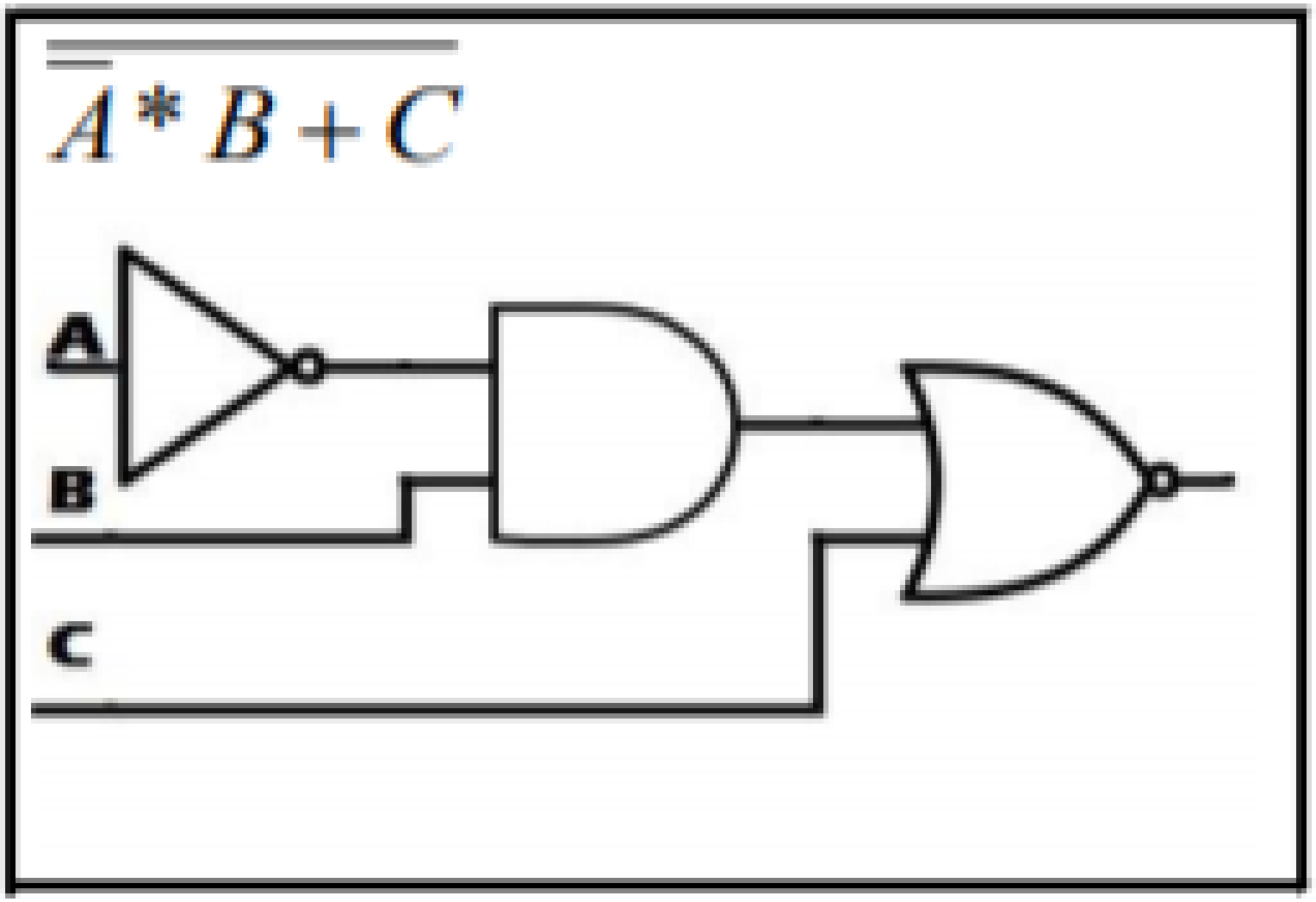
$\overline{A \oplus B}$ A XNOR B 

$A \oplus B$ A XOR B 

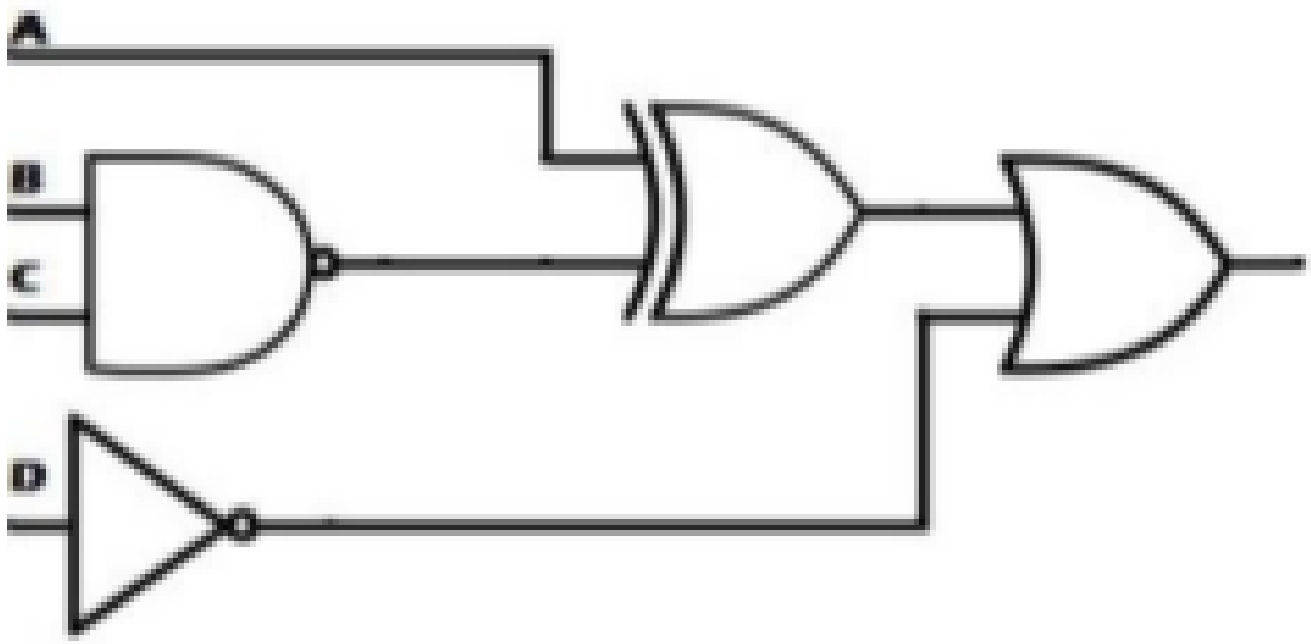
$A * B + C$



$$\overline{A * B + C}$$



$$A \oplus \overline{\overline{B} * C} + \overline{D}$$



Question 34.

Which of the following Boolean expressions corresponds to the logic diagram to the right?

A) $X = (P + \overline{Q}) * R$

B) $X = (\overline{P} * Q) + \overline{R}$

C) $X = (P * \overline{Q}) + R$

D) $X = \overline{(P + Q)} * \overline{R}$

E) $X = (\overline{P} + Q) * \overline{R}$

Question 35.

Which of the following set of inputs for the logic diagram to the right will result in a `true` output for `X`?

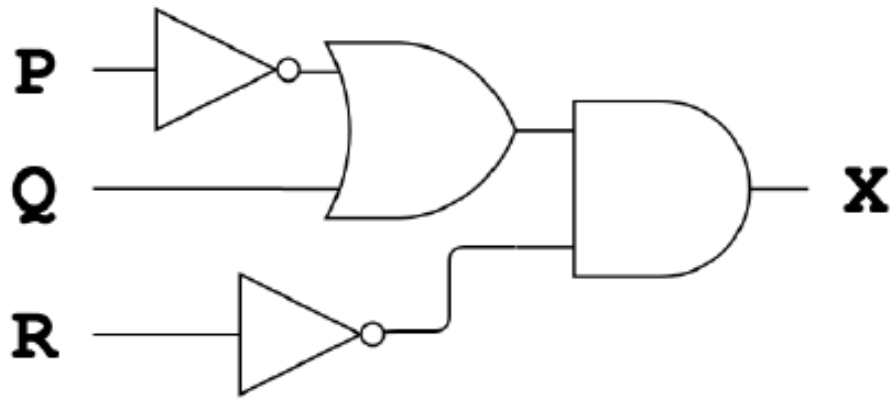
A) `P = true; Q = true; R = false;`

B) `P = false; Q = false; R = true;`

C) `P = false; Q = true; R = true;`

D) `P = true; Q = false; R = false;`

E) `P = true; Q = false; R = true;`



Question 40.

Write a simplified, Boolean expression to describe output `X`, given inputs `A`, `B`, and `C`, as shown in the truth table to the right, where `0` denotes `false` and `1` denotes `true`. Your answer should use as few logical operators as possible.

Write your answer on the answer sheet.

A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Question 27.

Which of the following is equivalent to the Boolean expression to the right?

```
!(P && Q) || Q
```

A) `P || Q`

B) `!P && !Q`

C) `!P || Q`

D) `true`

E) `false`

Question 5.

Which of the following values for `p`, `q`, and `r` will cause the Boolean expression to the right to evaluate to `true`?

A) `p = false; q = false; r = false;`

B) `p = false; q = true; r = false;`

C) `p = true; q = false; r = true;`

D) `p = true; q = true; r = false;`

E) `p = true; q = true; r = true;`

```
!(p || !(q && !r))
```

Question 35.

Which of the following is equivalent to the Boolean expression shown to the right?

$$(X + \overline{Y})(X + Z)$$

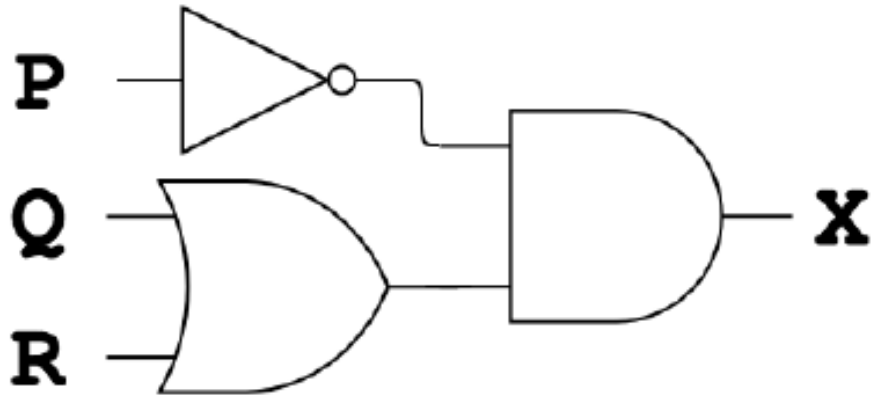
A) $X\overline{Y} + XZ$ **B)** $\overline{X}Y + \overline{X}\,\overline{Z}$ **C)** $X + \overline{Y}Z$

D) $X(\overline{Y} + Z)$ **E)** $X + (\overline{Y} + Z)$

Question 39.

What is the Boolean expression for output X described by the logic diagram to the right? Your answer should use the fewest logical operators as is necessary for this component.

Write your answer on the answer sheet.



3. Diamonds are a Girl's Best Friend

Program Name: Diamonds.java Input File: diamonds.dat

Everyone knows that diamonds are a girl's best friend. You are to write a program that prints diamonds of different dimensions.

Input

The first line of input will contain a single integer n that indicates the number of diamonds that you are to print. Each the following n lines will contain an upper case letter of the alphabet, followed by a space and positive, odd integer d, $3 \leq d \leq 19$.

Output

For each line input, you will print a diamond of the letter input. The width and height of the diamond will be equal to d. Print a blank line after each diamond printed. The distance from the left edge of the screen is not important.

Example Input File

```
3
U 11
I 3
L 7
```

Example Output to Screen