Boolean Algebra Worksheet

Instructions

Use Java boolean notation: `&&` (AND), `||` (OR), `!` (NOT) Variables: A, B, C, D represent boolean values (true or false)

Part 1: Apply DeMorgan's Laws

Simplify the following expressions using DeMorgan's laws:

1. `!(A && B)`
2. `!(A || B || C)`
3. `!(!A && B)`
4. `!(A && !B)`
5. `!((A || B) && C)`
6. `!(A && B && !C)`

Part 2: Truth Tables

Create complete truth tables for each of the following expressions:

1. `A && (B || C)`
2. `!A || (B && C)`
3. `(A || B) && (!A || C)`
4. `A && B || !A && C`

Part 3: Which Identities Are True?

For each statement, write **TRUE** or **FALSE**:

1. `A && true = A`
2. `A || false = false`
3. `A && !A = false`
4. `A || (A && B) = A`
5. `A && A = A`
6. `!(A && B) = !A || !B`

Part 4: Java Code Analysis

Given the following Java code:

```java
boolean x = true;
boolean y = false;
boolean z = true;

if (x && y) {
   System.out.println("Line A");
} else if (!x || z) {
   System.out.println("Line B");
} else {
   System.out.println("Line C");
}

if (x || (!y && z)) {
   System.out.println("Line D");
}

if (!(x && !z)) {
   System.out.println("Line E");
} else if (y || z) {
   System.out.println("Line F");
} else {
   System.out.println("Line G");
}
```

Questions:

1. What does the first if-else block print?
2. Does "Line D" get printed?
3. What does the second if-else block print?
4. If we changed `z = false`, what would be the complete output?

Answer Key

Part 1: DeMorgan's Laws

1. `!A || !B`
2. `!A && !B && !C`
3. `A || !B`
4. `!A || B`
5. `(!A && !B) || !C`
6. `!A || !B || C`

Part 2: Truth Tables

1. **`A && (B || C)`**

A	B	C	B||C	A&&(B||C)
T	T	T	T	T
T	T	F	T	T
T	F	T	T	T
T	F	F	F	F
F	T	T	T	F
F	T	F	T	F
F	F	T	T	F
F	F	F	F	F

2. `!A || (B && C)`

A	B	C	!A	B&&C	!A||(B&&C)
T	T	T	F	T	T
T	T	F	F	F	F
T	F	T	F	F	F
T	F	F	F	F	F
F	T	T	T	T	T
F	T	F	T	F	T
F	F	T	T	F	T
F	F	F	T	F	T

3. `(A || B) && (!A || C)`

A	B	C	A||B	!A	!A||C	(A||B)&&(!A||C)
T	T	T	T	F	T	T
T	T	F	T	F	F	F
T	F	T	T	F	T	T
T	F	F	T	F	F	F
F	T	T	T	T	T	T
F	T	F	T	T	T	T
F	F	T	F	T	T	F
F	F	F	F	T	T	F

4. `A && B || !A && C`

A	B	C	A&&B	!A	!A&&C	(A&&B)||(!A&&C)
T	T	T	T	F	F	T
T	T	F	T	F	F	T
T	F	T	F	F	F	F
T	F	F	F	F	F	F
F	T	T	F	T	T	T
F	T	F	F	T	F	F
F	F	T	F	T	T	T
F	F	F	F	T	F	F

Part 3: Which Identities Are True?

1. **TRUE** - Identity Law
2. **FALSE** - Should be `A || false = A`
3. **TRUE** - Complement Law
4. **TRUE** - Absorption Law
5. **TRUE** - Idempotent Law
6. **TRUE** - DeMorgan's Law

Part 4: Java Code Analysis

1. **Line B** - First condition `x && y` is false, so checks `!x || z` which is `false || true = true`
2. **Yes** - `x || (!y && z)` = `true || (true && true)` = `true`
3. **Line E** - `!(x && !z)` = `!(true && false)` = `!false` = `true`
4. **Complete output if z = false**: Line B, Line D, Line F
   - First block: `!x || z` = `false || false = false`, so Line C
   - Middle: `x || (!y && z)` = `true || false = true`, so Line D
   - Last block: `!(x && !z)` = `!(true && true)` = `false`, so check `y || z` = `false || false = false`, so Line G
   - **Correction: Line C, Line D, Line G**