Names (pair) _____ Date _____

# Equivalent Expressions and De Morgan's Laws

**Remember**

Two expressions are **equivalent** (≡) if they have the same truth table. **De Morgan's laws:** $\neg(A \wedge B) \equiv \neg A \vee \neg B$ and $\neg(A \vee B) \equiv \neg A \wedge \neg B$. Negation "turns" ∧ into ∨ and the other way round.

**1** IN PAIRS Check the first of De Morgan's laws with a table.

| $A$ | $B$ | $A \wedge B$ | $\neg(A \wedge B)$ | $\neg A$ | $\neg B$ | $\neg A \vee \neg B$ |
|---|---|---|---|---|---|---|
| 0 | 0 | | | | | |
| 0 | 1 | | | | | |
| 1 | 0 | | | | | |
| 1 | 1 | | | | | |

**2** ON YOUR OWN Check the second law.

| $A$ | $B$ | $A \vee B$ | $\neg(A \vee B)$ | $\neg A \wedge \neg B$ |
|---|---|---|---|---|
| 0 | 0 | | | |
| 0 | 1 | | | |
| 1 | 0 | | | |
| 1 | 1 | | | |

**3** IN PAIRS **Everyday language.** Say the negation without "it is not true that".

It is not true that Mark is tired and hungry. → _____

It is not true that it is raining or snowing. → _____

Names (group) _____ Date _____

**4** IN A GROUP Are the expressions equivalent? If not, write values of $A$ and $B$ for which they differ.

| Expression | Expression | ≡? | They differ for |
|---|---|---|---|
| $A \lor (A \land B)$ | $A$ | yes / no | |
| $\neg(A \land B)$ | $\neg A \land \neg B$ | yes / no | |
| $A \oplus B$ | $(A \land \neg B) \lor (\neg A \land B)$ | yes / no | |
| $\neg\neg A$ | $A$ | yes / no | |

**5** IN A GROUP **The distributive law.** Check with a table: $A \land (B \lor C) \equiv (A \land B) \lor (A \land C)$.

| $A$ | $B$ | $C$ | $B \lor C$ | $A \land (B \lor C)$ | $A \land B$ | $A \land C$ | $(A \land B) \lor (A \land C)$ |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | | | | | |
| 0 | 0 | 1 | | | | | |
| 0 | 1 | 0 | | | | | |
| 0 | 1 | 1 | | | | | |
| 1 | 0 | 0 | | | | | |
| 1 | 0 | 1 | | | | | |
| 1 | 1 | 0 | | | | | |
| 1 | 1 | 1 | | | | | |

**The Logic Gates app · otooly.com/logic-gates**

**Expression** mode: type two expressions and the app checks whether they are equivalent. Find De Morgan's laws under **Examples...**

★ ON YOUR OWN **Exit card.** Negate: "It is raining or it is windy."