LESSON MAKER PRO

Logic Check

Test statements with truth tables.

HIGH SCHOOL · FM.LR.A.3

FM.LR.A.3 "Use truth tables to solve application-based logic problems and determine the truth value of simple and compound statements including negations and implications. a..."

NAME _____ DATE _____

THE BIG IDEA

A truth table checks every T and F choice for p and q. The statement $p \rightarrow q$ is false only when p is T and q is F. Statements are equivalent when their final columns match in every row.

WORKED EXAMPLE

Let p mean the bus arrives and q mean the gate is open. Are $\neg(p \rightarrow q)$ and $p \wedge \neg q$ equivalent?

p	q	$p \rightarrow q$	$\neg(p \rightarrow q)$	$p \wedge \neg q$
T	T	T	F	F
T	F	F	T	T
F	T	T	F	F
F	F	T	F	F

1. List all four choices for p and q.
2. Find $p \rightarrow q$, then flip its values.
3. Find $p \wedge \neg q$ and compare the last two columns.

Answer: Yes. Both final columns are F, T, F, F.

PRACTICE 4 problems

1 If p is T and q is F, what is the truth value of $p \rightarrow q$?

ANSWER _____

2 If p is F and q is T, what is the truth value of $\neg p \wedge q$?

ANSWER _____

3 List the truth values of $\neg(p \vee q)$ and $\neg p \wedge \neg q$ in the order TT, TF, FT, FF. Are they equivalent?

ANSWER _____

4 Are $p \vee q$ and $p \wedge q$ equivalent? Give one row that shows why.

ANSWER _____

APPLY IT Show your work

1 A video can be uploaded only if its file is under 100 MB. Let p mean the video is uploaded and q mean the file is under 100 MB. Today p and q are both F. Is $p \rightarrow q$ true? Write an equivalent statement using $\neg p$ and $\neg q$.

WORK SPACE

ANSWER _____

2 A club says, "If you register, you get a ticket." Let p mean you register and q mean you get a ticket. Complete the table. Are $p \rightarrow q$ and $q \rightarrow p$ equivalent?

p	q	$p \rightarrow q$	$q \rightarrow p$
T	T		
T	F		
F	T		
F	F		

ANSWER _____

CHALLENGE One step up

A livestream rule says, "If the stream is public (p), chat is open (q)." Which are equivalent to $p \rightarrow q$: $\neg p \vee q$, $\neg q \rightarrow \neg p$, or $q \rightarrow p$? Use a truth table and name a row that rejects any nonmatch.

WORK SPACE AND ANSWER

Logic Check

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	If p is T and q is F, what is the truth value of $p \rightarrow q$?	**F**
2	If p is F and q is T, what is the truth value of $\neg p \wedge q$?	**T**
3	List the truth values of $\neg(p \vee q)$ and $\neg p \wedge \neg q$ in the order TT, TF, FT, FF. Are they equivalent?	**Both have F, F, F, T. Yes, they are equivalent.**
4	Are $p \vee q$ and $p \wedge q$ equivalent? Give one row that shows why.	**No. When p is T and q is F, $p \vee q$ is T but $p \wedge q$ is F.**

PART 2 · APPLY IT

1. **Yes, $p \rightarrow q$ is T. Equivalent statement: If the file is not under 100 MB, the video is not uploaded.** A conditional is true when p and q are both F. Its contrapositive, $\neg q \rightarrow \neg p$, is equivalent.
2. **For TT, TF, FT, FF: $p \rightarrow q$ is T, F, T, T; $q \rightarrow p$ is T, T, F, T. They are not equivalent.** The columns differ in the TF and FT rows, so the two rules are not equivalent.

CHALLENGE

$\neg p \vee q$ and $\neg q \rightarrow \neg p$ are equivalent to $p \rightarrow q$. In TT, TF, FT, FF order, all three columns are T, F, T, T. The column for $q \rightarrow p$ is T, T, F, T, so it is not equivalent. For example, at TF, $p \rightarrow q$ is F but $q \rightarrow p$ is T.

Accept any row with different truth values as a counterexample in Practice 4. For the challenge, either TF or FT rejects $q \rightarrow p$.