Discrete Mathematics and Proof Unit 1 worksheet: Building a truth table for a compound statement

Name _____ Date _____ Period _____

1. Build a truth table for each statement, with a column for every piece. A piece that appears twice gets its column only once.

(a) $\neg P \wedge \neg(Q \wedge \neg P)$

(b) $(P \vee \neg Q) \wedge (\neg P \vee R)$

2. Do not fill in these tables. For each statement, say how many rows its truth table needs, list every column after the letters in an order in which they can be filled, building a repeated piece only once, and say how many columns the table has in all, letters included (do not count the row-number column).

(a) $(P \wedge \neg Q) \vee (\neg Q \wedge R)$

(b) $\neg\big(Q \vee \neg(P \wedge R)\big) \vee (P \wedge R)$

(c) $(P \vee \neg S) \wedge \neg(Q \vee R)$

3. Kofi built this table for $(\neg P \vee Q) \wedge \neg(Q \wedge R)$. He made exactly two mistakes, each in a single entry, and filled every later column correctly from what he had already written.

Row	P	Q	R	$\neg P$	$\neg P \vee Q$	$Q \wedge R$	$\neg(Q \wedge R)$	$(\neg P \vee Q) \wedge \neg(Q \wedge R)$
1	T	T	T	F	T	T	F	F
2	T	T	F	F	T	F	T	T
3	T	F	T	F	T	F	T	T
4	T	F	F	F	F	F	T	F
5	F	T	T	T	T	T	F	F
6	F	T	F	T	T	T	F	F
7	F	F	T	T	T	F	T	T
8	F	F	F	T	T	F	T	T

Find each mistake: give its row, the column it is in and the correct entry. Then write the correct last column.

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4. A shop's instructions say: "The alarm sounds when the back door is opened and the system is armed or the panic button is pressed." Let D be "the back door is opened", A be "the system is armed" and B be "the panic button is pressed".

(a) The sentence can be grouped in two ways. Write both as statements with parentheses.

(b) Build one truth table, in the order D, A, B, with a last column for each reading.

(c) In which rows do the two readings differ? Describe those situations in words, and say which reading the shop most likely means.

5. A statement is built from the letters P and Q using only $\wedge$ and $\vee$, as many times as you like and with any parentheses, but never $\neg$.

(a) Explain why its last column must be T in row 1, where both letters are true, and F in row 4, where both are false.

(b) Use (a) to explain why no statement built this way has the same column as $\neg P$, and none has the same column as $P \wedge \neg Q$.

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