Prove the following equivalences by showing that the given sentences are tautologies.

A) $(p \rightarrow q) \Leftrightarrow (\neg p \vee q)$

p	q	$p \rightarrow q$	$\Leftrightarrow$	$\neg p \vee q$	$\neg p$
0	0	1	1	1	1
1	0	0	1	0	0
0	1	1	1	1	1
1	1	1	1	1	0

B) $\neg(p \rightarrow q) \Leftrightarrow (p \wedge \neg q)$

p	q	$\neg(p \rightarrow q)$	$\Leftrightarrow$	$p \wedge \neg q$	$\neg q$
0	0	0	1	0	1
1	0	1	1	1	1
0	1	0	1	0	0
1	1	0	1	0	0

C) $\neg(p \wedge q) \Leftrightarrow (\neg p \vee \neg q)$

p	q	$p \wedge q$	$\neg(p \wedge q)$	$\Leftrightarrow$	$(\neg p \vee \neg q)$	$\neg p$	$\neg q$
0	0	0	1	1	1	1	1
1	0	0	1	1	1	0	1
0	1	0	1	1	1	1	0
1	1	1	0	1	0	0	0

D) $\neg(p \vee q) \Leftrightarrow (\neg p \wedge \neg q)$ **is not tautology**

p	q	$p \vee q$	$\neg(p \vee q)$	$\Leftrightarrow$	$(\neg p \vee \neg q)$	$\neg p$	$\neg q$
0	0	0	1	0	1	1	1
1	0	1	0	0	1	0	1
0	1	1	0	0	1	1	0
1	1	1	0	1	0	0	0