

Derive each of the following using basic and derived rules.

1.  $(Q \rightarrow R), (R \rightarrow P) \vdash \sim P \rightarrow \sim Q$

2.  $(S \vee R), (R \rightarrow T), \sim T \vdash S$

3.  $P \vee \sim(Q \vee S), Q \vdash P$

4.  $P \leftrightarrow (M \& R), \sim M \vee \sim R \vdash P \rightarrow S$

5.  $P \rightarrow (\sim R \rightarrow S), Q \rightarrow (\sim T \rightarrow S), (Q \vee P) \vdash \sim(\sim R \rightarrow S) \rightarrow (\sim T \rightarrow S)$

6.  $(P \rightarrow S) \vdash ((T \& M) \& R) \rightarrow (P \rightarrow S)$

7.  $S \rightarrow T \vdash T \vee \sim S$

8.  $(T \vee \sim S) \vdash S \rightarrow T$

9.  $\vdash (P \leftrightarrow \sim P) \rightarrow S$

10.  $\vdash R \rightarrow (P \rightarrow (P \& R))$

The following problems are the two versions of DeMorgan's Rules equivalences. They will be covered on the next screencast, but it is excellent practice to try to derive them on your own.

11.  $\vdash \sim(P \& Q) \leftrightarrow (\sim P \vee \sim Q)$

12.  $\vdash \sim(P \vee Q) \leftrightarrow (\sim P \& \sim Q)$