1. Prove that the following are logically equivalent pairs - use both the truth table method and the formal proof method to get extra practice.

   a.

$p \vee q$	$(p \rightarrow q) \rightarrow q$

   b.

$\sim (p \leftrightarrow q)$	$\sim p \leftrightarrow q$

2. Albert, Bill and Casey are all suspects in a police investigation. Each of them make the following statements.

   - Albert: Bill is guilty and Casey is innocent.
   - Bill: If Albert is guilty, then so is Casey.
   - Casey: I am innocent, but at least one of the others is guilty.

   Let a, b and c be "Alber is innocent", "Bill is innocent" and "Casey is innocent" respectively. And do each of the following exercises.

   a. Rewrite the suspects' statements in terms of a,b, and c with our regular logic operators.
   b. If all are innocent, who committed perjury (lied in their official statement)?
   c. If all the statements are true, who is innocent?
   d. If the innocent were truthful and the guilty lied, who is innocent?

3. For each of the following either give a formal proof to show that the argument is valid or give values for the variables to demonstrate a counter example to show that it is not a valid argument form.

   a.

$a \vee (b \wedge c)$ $a \rightarrow c$
c

   b.

$(d \vee e) \rightarrow (f \rightarrow g)$ $(\sim g \vee h) \rightarrow (d \wedge f)$
g

   c.

$(h \rightarrow i) \wedge (j \rightarrow k)$ $(i \vee k) \rightarrow m$ $\sim m$
$\sim (h \vee j)$

   d.

$(m \vee n) \rightarrow (d \wedge p)$ $(d \vee q) \rightarrow (\sim r \wedge s)$ $(r \vee t) \rightarrow (m \wedge u)$
$\sim r$

   e.

$(k \rightarrow \sim w) \wedge (x \rightarrow y)$ $(\sim w \rightarrow z) \wedge (y \rightarrow \sim a)$ $(z \rightarrow \sim b) \wedge (\sim a \rightarrow g)$ $k \wedge x$
$\sim b \wedge g$