

1. Let p be the statement "DATAENDFLAG is off,"
 q the statement "ERROR equals 0," and r the statement "SUM is less than 1,000." Express the following sentences in symbolic notation.
 - a. DATAENDFLAG is off, ERROR equals 0, and SUM is less than 1,000.
 - b. DATAENDFLAG is off but ERROR is not equal to 0.
 - c. DATAENDFLAG is off; however, ERROR is not 0 or SUM is greater than or equal to 1,000.
 - d. DATAENDFLAG is on and ERROR equals 0 but SUM is greater than or equal to 1,000.

2. Write the converse and inverse of each of the following statements:
 - a. If Howard can swim across the lake, then Howard can swim to the island.
 - b. If today is Easter, then tomorrow is Monday.

3. verify the logical equivalences :
 - a. $\sim((\sim p \wedge q) \vee (\sim p \wedge \sim q)) \vee (p \wedge q) \equiv p$
 - b. $(p \wedge \sim q) \vee (p \wedge q) \equiv p \wedge (\sim q \vee q)$
 - c. $p \vee q \rightarrow r$ and $(p \rightarrow r) \wedge (q \rightarrow r)$

4. Write negations for each of the following statements. (Assume that all variables represent fixed quantities or entities, as appropriate.)
 - If P is a square, then P is a rectangle.
 - If today is New Year's Eve, then tomorrow is January.
 - If the decimal expansion of r is terminating, then r is rational.
 - If n is prime, then n is odd or n is 2.
 - If x is nonnegative, then x is positive or x is 0.
 - If Tom is Ann's father, then Jim is her uncle and Sue is her aunt.
 - If n is divisible by 6, then n is divisible by 2 and n is divisible by 3.

5. Verify whether given proposition is tautology or not : $p \rightarrow (q \rightarrow r)$ and $(p \rightarrow q) \rightarrow r$

6. You are about to leave for school in the morning and discover that you don't have your glasses. You know the following statements are true:
- If I was reading the newspaper in the kitchen, then my glasses are on the kitchen table.
 - If my glasses are on the kitchen table, then I saw them at breakfast.
 - I did not see my glasses at breakfast.
 - I was reading the newspaper in the living room or I was reading the newspaper in the kitchen.
 - If I was reading the newspaper in the living room then my glasses are on the coffee table. Where are the glasses?
7. In the back of an old cupboard you discover a note signed by a pirate famous for his bizarre sense of humor and love of logical puzzles. In the note he wrote that he had hidden treasure somewhere on the property. He listed five true statements (a–e below) and challenged the reader to use them to figure out the location of the treasure.
- If this house is next to a lake, then the treasure is not in the kitchen.
 - If the tree in the front yard is an elm, then the treasure is in the kitchen.
 - This house is next to a lake.
 - The tree in the front yard is an elm or the treasure is buried under the flagpole.
 - If the tree in the back yard is an oak, then the treasure is in the garage.

Where is the treasure hidden?

8. Sharky, a leader of the underworld, was killed by one of his own band of four henchmen. Detective Sharp interviewed the men and determined that all were lying except for one. He deduced who killed Sharky on the basis of the following statements:

Socko: Lefty killed Sharky

Fats: Muscles didn't kill Sharky

Lefty: Muscles was shooting craps with Socko when Sharky was knocked off

Muscles: Lefty didn't kill Sharky

Who killed Sharky and why?

9. The logician Raymond Smullyan describes an island containing two types of people: knights who always tell the truth and knaves who always lie.* You visit the island and are approached by two natives who speak to you as follows: A says: B is a knight. B says: A and I are of opposite type. What are A and B?
10. The famous detective Hercule Poirot was called in to solve a baffling murder mystery. He determined the following facts:
- a. Lord Hazelton, the murdered man, was killed by a blow on the head with a brass candlestick.
 - b. Either Lady Hazelton or a maid, Sara, was in the dining room at the time of the murder.
 - c. If the cook was in the kitchen at the time of the murder, then the butler killed Lord Hazelton with a fatal dose of strychnine.
 - d. If Lady Hazelton was in the dining room at the time of the murder, then the chauffeur killed Lord Hazelton.
 - e. If the cook was not in the kitchen at the time of the murder, then Sara was not in the dining room when the murder was committed.
 - f. If Sara was in the dining room at the time the murder was committed, then the wine steward killed Lord Hazelton.

Is it possible for the detective to deduce the identity of the murderer from these facts? If so, who did murder Lord Hazelton? (Assume there was only one cause of death.)