Logic and Sets: Entry Test MCQs

Multiple-Choice Questions

1. What is a proposition?

(A) A question that requires an answer
(B) A statement that is either true or false, but not both
(C) A command or instruction
(D) A statement that is always true

2. Which symbol represents the logical operation "and"?

(A) $\vee$
(B) $\rightarrow$
(C) $\wedge$
(D) $\sim$

3. What is the union of sets $A = \{1, 2\}$ and $B = \{2, 3\}$?

(A) $\{1, 2, 3\}$
(B) $\{2\}$
(C) $\{1, 3\}$
(D) $\{1, 2, 2, 3\}$

4. Which of the following is an example of deductive logic?

(A) Observing that the sun rises daily and concluding it always rises
(B) All birds have wings; a sparrow is a bird, so a sparrow has wings
(C) Testing a few cases and generalizing a rule
(D) Assuming a statement is true without evidence

5. What is the truth value of $p \wedge q$ when p is true and q is false?

(A) True
(B) False
(C) Depends on the context
(D) Neither true nor false

6. What is the converse of the conditional $p \rightarrow q$?

(A) $\sim p \rightarrow \sim q$
(B) $q \rightarrow p$
(C) $\sim q \rightarrow \sim p$
(D) $p \leftrightarrow q$

7. Which of the following is always false for all truth values of p?

(A) $p \vee \sim p$
(B) $p \wedge \sim p$
(C) $p \rightarrow p$

(D) $p \leftrightarrow p$

8. What is the complement of set $A = \{1, 3\}$ in the universal set $U = \{1, 2, 3, 4\}$?

(A) $\{1, 3\}$
(B) $\{2, 4\}$
(C) $\{1, 2, 3, 4\}$
(D) $\{2, 3, 4\}$

9. Which statement best describes non-Aristotelian logic?

(A) Every statement is either true or false
(B) Allows for possibilities beyond true or false, like "maybe"
(C) Only applies to mathematical statements
(D) Based on specific observations

10. What is the truth value of $p \rightarrow q$ when p is false and q is true?

(A) True
(B) False
(C) Depends on p
(D) Neither true nor false

11. What is the contrapositive of $\sim p \rightarrow q$?

(A) $q \rightarrow \sim p$
(B) $\sim q \rightarrow p$
(C) $p \rightarrow \sim q$
(D) $\sim p \rightarrow \sim q$

12. Which of the following is a tautology?

(A) $p \wedge \sim p$
(B) $p \rightarrow (p \vee q)$
(C) $p \wedge q$
(D) $\sim p \wedge q$

13. What is the logical form of the set theorem $(A \cap B)' = A' \cup B'$?

(A) $\sim (p \vee q) = \sim p \wedge \sim q$
(B) $\sim (p \wedge q) = \sim p \vee \sim q$
(C) $p \wedge q = \sim p \vee \sim q$
(D) $\sim p \rightarrow q$

14. For the statement $p \leftrightarrow q$, when is it false?

(A) When both p and q are true
(B) When p is true and q is false
(C) When both p and q are false
(D) When p is false and q is false

15. Which statement is logically equivalent to $\sim (p \rightarrow q)$?

(A) $p \wedge \sim q$
(B) $\sim p \vee q$
(C) $p \vee \sim q$
(D) $\sim p \wedge q$

16. Construct the truth table for $(p \rightarrow \sim p) \vee (p \rightarrow q)$. What is its truth value when p is true and q is false?

(A) True

(B) False

(C) Depends on other values

(D) Neither true nor false

17. Which of the following is a contingency?

(A) $p \vee \sim p$

(B) $p \wedge \sim p$

(C) $p \wedge q$

(D) $p \rightarrow p$

18. Given the set identity $A \cup B = A \cup (A' \cap B)$, what is the logical equivalent?

(A) $p \vee q = p \vee (\sim p \wedge q)$

(B) $p \wedge q = p \wedge (\sim p \vee q)$

(C) $\sim (p \vee q) = \sim p \wedge \sim q$

(D) $p \rightarrow q = \sim p \vee q$

19. What is the truth value of $\sim q \wedge (p \rightarrow q) \rightarrow \sim p$ when p is true and q is true?

(A) True

(B) False

(C) Depends on other values

(D) Neither true nor false

20. Which of the following proves that $p \vee (\sim p \wedge \sim q) \vee (p \wedge q) = p \vee (\sim p \wedge \sim q)$?

(A) The truth tables have identical columns for both expressions

(B) The expressions are both tautologies

(C) The expressions are both contingencies

(D) The converse of one implies the other

Answers and Explanations

1. B
Explanation: A proposition is a declarative statement that is either true or false, but not both (e.g., "2 + 2 = 4" is true). Questions (A), commands (C), or statements that are always true (D, tautologies) are not propositions.

2. C
Explanation: The symbol $\wedge$ represents conjunction ("and") in symbolic logic. $\vee$ is disjunction ("or"), $\rightarrow$ is conditional ("if...then"), and $\sim$ is negation ("not").

3. A
Explanation: The union $A \cup B$ includes all elements in $A = \{1, 2\}$ or $B = \{2, 3\}$, which is $\{1, 2, 3\}$. Option B is the intersection, and D includes duplicates, which sets do not allow.

4. B
Explanation: Deductive logic draws specific conclusions from general facts (e.g., "All birds have wings; a sparrow is a bird, so it has wings"). A and C describe inductive logic, and D is not a valid reasoning method.

5. B
Explanation: For $p \wedge q$, both p and q must be true for the conjunction to be true. If p is true and q is false, then $p \wedge q$ is false.

6. B
Explanation: The converse of $p \rightarrow q$ is $q \rightarrow p$. The inverse is $\sim p \rightarrow \sim q$, contrapositive is $\sim q \rightarrow \sim p$, and biconditional is $p \leftrightarrow q$.

7. **B**
Explanation: $p \wedge \sim p$ is an absurdity, always false, as p and $\sim p$ cannot both be true. $p \vee \sim p$, $p \to p$, and $p \leftrightarrow p$ are tautologies (always true).

8. **B**
Explanation: The complement A' includes all elements in $U = \{1, 2, 3, 4\}$ not in $A = \{1, 3\}$, which is $\{2, 4\}$. Option C is the universal set, and D is incorrect.

9. **B**
Explanation: Non-Aristotelian logic allows for truth values beyond true/false, like "maybe" in fuzzy logic. Aristotelian logic (A) is binary, C is too specific, and D describes induction.

10. **A**
Explanation: For $p \to q$, if p is false, the conditional is true regardless of q. Here, p is false, q is true, so $p \to q$ is true.

11. **B**
Explanation: For $\sim p \to q$, the contrapositive is $\sim q \to p$. The converse is $q \to \sim p$, inverse is $p \to \sim q$, and D is unrelated.

12. **B**
Explanation: From Exercise 2.4, Q.3, $p \to (p \vee q)$ is a tautology (always true). $p \wedge \sim p$ is an absurdity, and C, D are contingencies (true or false depending on values).

13. **B**
Explanation: From Exercise 2.5, Q.1, the set theorem $(A \cap B)' = A' \cup B'$ translates to $\sim (p \wedge q) = \sim p \vee \sim q$, which is De Morgan's law.

14. **B**
Explanation: The biconditional $p \leftrightarrow q$ is false when p and q have different truth values (e.g., p true, q false). It is true when both are true (A) or both false (C, D).

15. **A**
Explanation: From Exercise 2.4, Q.2 iii, $\sim (p \to q)$ is equivalent to $p \wedge \sim q$. Truth table: when $p \to q$ is false (p true, q false), $\sim (p \to q)$ is true, and so is $p \wedge \sim q$.

16. **B**
Explanation: From Exercise 2.4, Q.2 i, truth table for $(p \to \sim p) \vee (p \to q)$:

p	q	$\sim p$	$p \to \sim p$	$p \to q$	$(p \to \sim p) \vee (p \to q)$
T	F	F	F	F	F

When p is true, q is false, the result is false.

17. **C**
Explanation: A contingency is true or false depending on values. $p \wedge q$ is true (T, T) and false otherwise. $p \vee \sim p$ and $p \to p$ are tautologies, $p \wedge \sim p$ is an absurdity.

18. **A**
Explanation: The set identity $A \cup B = A \cup (A' \cap B)$ translates to $p \vee q = p \vee (\sim p \wedge q)$, as shown in the document. Other options are unrelated.

19. **A**
Explanation: From Exercise 2.4, Q.3 iv, for $\sim q \wedge (p \to q) \to \sim p$, when p is true, q is true:

- $\sim q = \sim T = F$, $p \to q = T \to T = T$
- $\sim q \wedge (p \to q) = F \wedge T = F$
- $F \to \sim p = F \to F = T$

The result is true.

20. **A**
Explanation: From Exercise 2.4, Q.5, the truth tables for $p \vee (\sim p \wedge \sim q) \vee (p \wedge q)$ and $p \vee (\sim p \wedge \sim q)$ have identical columns, proving equivalence.