CHAPTER 14

Statements

SYNOPSIS

- **Statement:** A sentence which can be judged either true or false but not both is called a **statement**. Statements are denoted by lower case letters like p, q, r etc.
- **Truth value:** The truthness or falsity of a statement is called its truth value. Truthness of a statement is denoted by T, while its falsity is denoted by F.
- **Negation of a statement:** The denial of a statement is called its negation. Negation of a statement p is denoted by ~p and read as not p or negation p.

  Truth table:

p	~ p
T	F
F	T

- **Compound statement:** A statement obtained by combining two or more simple statements using connectives is called a compound statement.
- **Conjunction:**

  Truth table:

p	q	$p \wedge q$
T	T	T
T	F	F
F	T	F
F	F	F

We observe that $p \wedge q$ is true only when both p and q are true.

- **Disjunction:**

  Truth table:

p	q	$p \vee q$
T	T	T
T	F	T
F	T	T
F	F	F

We observe that, $p \vee q$ is false only when both p and q are false.

- **Implication or Conditional:**

  Truth table:

p	q	$p \Rightarrow q$
T	T	T
T	F	F
F	T	T
F	F	T

We observe that, a true statement cannot imply a false statement.

- **Bi-conditional or Bi-implication:**

Truth table:

p	q	$p \Leftrightarrow q$
T	T	T
T	F	F
F	T	F
F	F	T

We observe that, $p \Leftrightarrow q$ is true if both p and q have the same truth values.

- **Converse, inverse and contrapositive of a conditional:**

Let $p \Rightarrow q$ or if p then q be a conditional,

(i) If q then p i.e., $q \Rightarrow p$, is called the converse of $p \Rightarrow q$.

(ii) If not p then not q i.e., $\sim p \Rightarrow \sim q$, is called the inverse of $p \Rightarrow q$

(iii) If not q then not p i.e., $\sim q \Rightarrow \sim p$ is called the contrapositive of $p \Rightarrow q$.

- **Truth table:**

p	q	~p	~q	Conditional $p \Rightarrow q$	Converse $q \Rightarrow p$	Inverse $\sim p \Rightarrow \sim q$	Contrapositive $\sim q \Rightarrow \sim p$
T	T	F	F	T	T	T	T
T	F	F	T	F	T	T	F
F	T	T	F	T	F	F	T
F	F	T	T	T	T	T	T

- **Tautology:** A compound statement which always takes **True** as its truth value is called a tautology.

Examples:

p	~ p	$p \vee \sim p$
T	F	T
F	T	T

We observe that $p \vee \sim p$ takes T as its truth value always. So, $p \vee \sim p$ is a tautology.

- **Contradiction:** A compound statement which always takes **False** as its truth value is called a contradiction.

Examples:

p	~ p	$p \wedge \sim p$
T	F	F
F	T	F

We observe that $p \wedge \sim p$ takes F as its truth value always. So $p \wedge \sim p$ is a contradiction.

- **Contingency:** A compound statement which is neither a tautology nor a contradiction is called a contingency.

Truth table:

p	q	~p	$p \vee q$	$p \vee q \Rightarrow \sim p$
T	T	F	T	F
T	F	F	T	F
F	T	T	T	T
F	F	T	F	T

- **Logically equivalent statements:** Two statements *r* and *s* are said to be logically equivalent, if the last columns of their truth tables are identical.

Laws of Algebra of Statements

1. Commutative Laws:

(a) $p \vee q \equiv q \vee p$

(b) $p \wedge q \equiv q \wedge p$

2. Associative laws:

(a) $(p \vee q) \vee r \equiv p \vee (q \vee r)$

(b) $(p \wedge q) \wedge r \equiv p \wedge (q \wedge r)$

3. Distributive Laws:

(a) $p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$

(b) $p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$

4. Idempotent Laws:

(a) $p \vee p \equiv p$

(b) $p \wedge p \equiv p$

5. De Morgan's laws:
   (a) $\sim(p \vee q) \equiv (\sim p) \wedge (\sim q)$
   (b) $\sim(p \wedge q) \equiv (\sim p) \vee (\sim q)$
6. Identity Laws:
   (a) $p \vee f \equiv p$, $p \vee t \equiv t$.
   (b) $p \wedge f \equiv f$, $p \wedge t \equiv p$.
7. Complement Laws:
   (a) $p \vee (\sim p) \equiv t$
   (b) $p \wedge (\sim p) \equiv f$
   (c) $\sim(\sim p) \equiv p$
   (d) $\sim t \equiv f$
   (e) $\sim f \equiv t$

List of Equivalences based on Implications

(i) $p \Rightarrow q \equiv \sim p \vee q$
(ii) $\sim(p \Rightarrow q) \equiv p \wedge \sim q$
(iii) $p \Rightarrow q \equiv \sim q \Rightarrow \sim p$
(i.e., a conditional and its contrapositive are logically equivalent)
(iv) $q \Rightarrow p \equiv \sim q \Rightarrow \sim p$
(i.e., converse and inverse of a conditional are logically equivalent)
(v) $p \Leftrightarrow q \equiv (p \Rightarrow q) \wedge (q \Rightarrow p)$
(vi) $\sim(p \Leftrightarrow q) \equiv (\sim p) \Leftrightarrow q$ or $p \Leftrightarrow (\sim q)$

- **Open sentence:** A sentence involving one or more variables is called an open sentence, if it becomes TRUE or FALSE when the variables are replaced by some specific values from the given set. The set from which the values of a variable can be considered is called the replacement set or domain of the variable.
- **Quantifiers:** A quantifier is a word or phrase which quantifies a variable in the given open sentence. There are two types of quantifiers.

Universal quantifier

The quantifiers like for all, for every, for each are called universal quantifiers. A universal quantifier is denoted by '∀'.

Existential quantifier

The quantifiers like for some, not all, there is/exists at least one are called existential quantifiers. An existential quantifier is denoted by '∃'.

Negation of Statements Involving Quantifiers

1. p: All odd numbers are prime.
   ~p: Not all odd numbers are prime
   (or)
   Some odd numbers are not prime.
   (or)
   There is an odd number which is not prime.

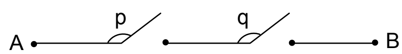
Application to Switching Networks

Now we consider the statements p and p^1 as switches with the property that if one is on, then the other is off and vice-versa.

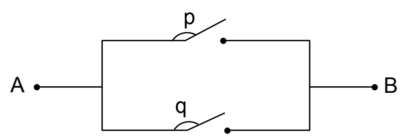
Further, a switch allows only two possibilities. They are

(i) it is either open (F) in which case there is no flow of current.
(or)
(ii) it is closed (T) in which case there is a flow of current.

Hence, every switch has two truth values T or F only. Let p and q denote two switches. We can connect p and q by using a wire in a series or parallel combination as shown below.



series combination



parallel combination

Note:
$p \wedge q$ denote the series combination and $p \vee q$ denote the parallel combination.

Switching Network

A switching network is a repeated arrangement of wires and switches in series and parallel combinations.

So, such a network can be described by using the connectives $\wedge$ and $\vee$.

Solved Examples

1. Write the conjunction and implication of the following statements:

(a) $x + 3 = 0$; $x = -3$

(b) He is smart; He is intelligent.

Solution:

(a) Conjunction: $x + 3 = 0$ and $x = -3$

Implication: If $x + 3 = 0$, then $x = -3$

(b) Conjunction: He is smart and he is intelligent.

Implication: If he is smart, then he is intelligent.

2. Write the truth table of $p \Rightarrow (p \wedge q)$.

Solution: Truth table of $p \Rightarrow p \wedge q$:

p	q	$p \wedge q$	$p \Rightarrow p \wedge q$
T	T	T	T
T	F	F	F
F	T	F	T
F	F	F	T

3. Write the converse, inverse and contrapositive of the conditional, "If she is rich, then she is happy".

Solution: Conditional: If she is rich, then she is happy.

Converse: If she is happy, then she is rich.

Inverse: If she is not rich, then she is not happy.

Contrapositive: If she is not happy, then she is not rich.

4. Show that $p \Rightarrow p \vee q$ is a tautology.

Solution: Truth table of $p \Rightarrow p \vee q$:

p	q	$p \vee q$	$p \Rightarrow p \wedge q$
T	T	T	T
T	F	T	T
F	T	T	T
F	F	F	T

Since $p \Rightarrow p \vee q$ is always true, $p \Rightarrow p \vee q$ is a tautology.

5. Show that $(p \wedge \sim p) \wedge (p \vee q)$ is a contradiction.

Solution: Truth table of $(p \wedge \sim p) \wedge (p \vee q)$:

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

we observe that $(p \wedge \sim p) \wedge (p \vee q)$ is always false.

Hence, $(p \wedge \sim p) \wedge (p \vee q)$ is a contradiction.

6. Prove that $(\sim p \wedge q) \wedge q$ is neither a tautology nor a contradiction.

Solution: Truth table of $(\sim p \wedge q) \wedge q$:

p	q	$\sim p$	$\sim p \wedge q$	$(\sim p \wedge q) \wedge q$
T	T	F	F	F
T	F	F	F	F
F	T	T	T	T
F	F	T	F	F

$\therefore$ $(\sim p \wedge q) \wedge q$ is neither true always nor false always.

Hence, $(\sim p \wedge q) \wedge q$ is neither a tautology nor a contradiction.

7. Write the suitable quantifier for the following sentences

(a) $x + 1 > x$ for all real values of x.

(b) there exists a real number x such that $x + 2 = 3$.

(c) there is no real number x such that $x^2 + 2x + 2 = 0$.

Solution:

(a) Universal quantifier ($\forall$)

(b) Existential quantifier ($\exists$)

(c) Universal quantifier ($\forall$)

8. Show that $\sim(p \wedge q) \equiv \sim p \vee \sim q$.

Solution: Truth table:

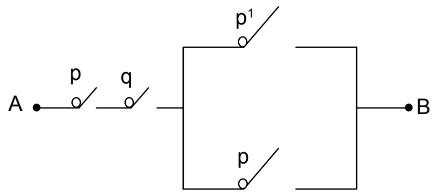
p	q	$\sim p$	$\sim q$	$p \wedge q$	$\sim(p \wedge q)$	$\sim p \vee \sim q$
T	T	F	F	T	F	F
T	F	F	T	F	T	T

p	q	~p	~q	p ∧ q	~(p ∧ q)	~p ∨ ~q
F	T	T	F	F	T	T
F	F	T	T	F	T	T

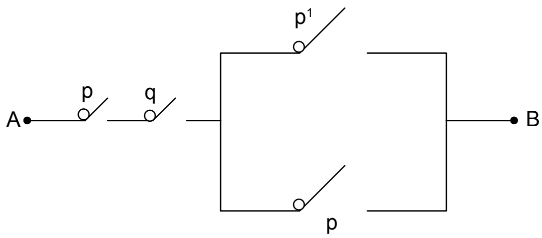
The truth values of ~(p ∧ q) and ~p ∧~q are same

Hence, ~ (p ∧ q) ≡ ~p ∨ ~q

9. Discuss when does the current flow from A to B in the network given.



☝ ***Solution:*** Given network is



The network can be described by the compound statement (p ∧ q) ∧ (p' ∨ p).

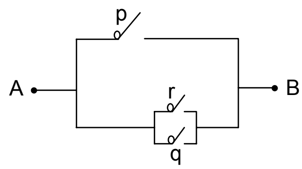
Truth table of (p ∧ q) ∧ (p' ∨ p) is:

p	q	p'	p ∧ q	p' ∨ p	(p ∧ q) ∧ (p' ∨ p)
T	T	F	T	T	T
T	F	F	F	T	F
F	T	T	F	T	F
F	F	T	F	T	F

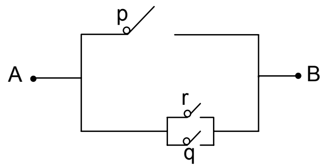
So, the current flows from A to B if.

(i) p is closed, q is closed.

10. Discuss when does the current flow from A to B in the given network.



☝ ***Solution:*** Given network is:



The network can be described by the statement of p ∨ (q ∨ r)

p	q	r	q ∨ r	p ∨ (q ∨ r)
T	T	T	T	T
T	T	F	T	T
T	F	T	T	T
F	T	T	T	T
T	F	F	F	T
F	T	F	T	T
F	F	T	T	T
F	F	F	F	F

So, the current flows from A to B in the following cases.

(i) p is closed, q is closed, r is closed

(ii) p is closed, q is closed, r is open

(iii) p is closed, q is open, r is closed

(iv) p is open, q is closed, r is closed

(v) p is closed, q is open, r is open

(vi) p is open, q is closed, r is open

(vii) p is open, q is open, r is closed.

PRACTICE EXERCISE 14 (A)

Directions for questions 1 to 35: Select the correct alternative from the given choices.

1. Which of the following sentences is a statement?

(1) Ramu is a clever boy.
(2) What are you doing?
(3) Oh! It is amazing.
(4) Two is an odd number.

2. Find the truth value of "Are you attending the meeting tomorrow?".

(1) T (2) F
(3) Neither T nor F (4) Both (1) and (2)

3. The statement $p \Rightarrow p \vee q$ is

(1) a tautology.
(2) a contradiction.
(3) both tautology and contradiction.
(4) neither a tautology nor a contradiction.

4. For which of the following cases does the statement $p \wedge \sim q$ take the truth value as true?

(1) p is true, q is true. (2) p is false, q is true.
(3) p is false, q is false. (4) p is true, q is false.

5. The symbolic form of the statement, "If p, then neither q nor r" is

(1) $p \Rightarrow q \wedge r$. (2) $p \Rightarrow \sim q \wedge \sim r$.
(3) $p \Rightarrow \sim q \vee \sim r$. (4) $p \Rightarrow \sim q \wedge r$.

6. Find the quantifier which best describes the variable of the open sentence $x^2 + 2 \geq 0$.

(1) Universal. (2) Existential.
(3) Neither (1) nor (2). (4) Does not exist.

7. The contrapositive of the statement $p \Rightarrow \sim q$ is

(1) $\sim p \Rightarrow q$. (2) $p \Rightarrow q$.
(3) $\sim q \Rightarrow \sim p$. (4) $q \Rightarrow \sim p$.

8. Which of the following laws does the connective $\wedge$ satisfy?

(1) Commutative law (2) Idempotent law
(3) Associative law (4) All the above

9. Which of the following is a tautology?

(1) $p \wedge q$ (2) $p \vee q$
(3) $p \vee \sim p$ (4) $p \wedge \sim p$

10. Find the inverse of the conditional, "If I am tired, then I will take rest".

(1) If I am tired, then I will not take rest.
(2) If I am not tired, then I will take rest.
(3) If I am not tired, then I will not take rest.
(4) None of these

11. Which of the following compound statement represents a series network?

(1) $p \vee q$ (2) $p \Rightarrow q$
(3) $p \wedge q$ (4) $p \Leftrightarrow q$

12. Find the truth value of the compound statement, 4 is the first composite number and 2 + 5 = 7.

(1) T (2) F
(3) Neither T nor F (4) Cannot be determined

13. Find the truth value of the compound statement, 'If 2 is a prime number, then hockey is the national game of India'.

(1) T (2) F
(3) Neither T nor F (4) Cannot be determined

14. What is the truth value of the statement 'Two is an odd number iff 2 is a root of $x^2 + 2 = 0$'?

(1) T
(2) F
(3) Neither T nor F
(4) Cannot be determined

15. The negation of the statement, "I go to school everyday", is

(1) I never go to school.
(2) Some days, I do not go to school.
(3) Not all the days I do not go to school.
(4) All days I go to school.

16. Which of the following pairs are logically equivalent?

(1) Conditional, Contrapositive
(2) Conditional, Inverse
(3) Contrapositive, Converse
(4) Inverse, Contrapositive

17. Find the converse of the statement, "If ABCD is square, then it is a rectangle".

(1) If ABCD is a square, then it is not a rectangle.
(2) If ABCD is not a square, then it is a rectangle.
(3) If ABCD is a rectangle, then it is square.
(4) If ABCD is not a square, then it is not a rectangle.

18. The property $p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$ is called

(1) associative law (2) commutative law

(3) distributive law (4) idempotent law

19. The counter example of the statement, "All odd numbers are primes", is

(1) 7 (2) 5

(3) 9 (4) All the above

20. Which of the following is equivalent to $p \Leftrightarrow q$?

(1) $p \Rightarrow q$ (2) $q \Rightarrow p$

(3) $(p \Rightarrow q) \wedge (q \Rightarrow p)$ (4) None of these

21. If p: The number of factors of 20 is 5 and q: 2 is an even prime number, then the truth values of inverse and contrapositive of $p \Rightarrow q$ respectively are

(1) T, T (2) F, F

(3) T, F (4) F, T

22. If p: 3 is an odd number and q: 15 is a prime number, then $[\sim(p \Leftrightarrow q)]$ is equivalent to ______.

(a) $p \Leftrightarrow (\sim q)$ (b) $(\sim p) \Leftrightarrow q$

(c) $\sim(p \wedge q)$

(1) only (a) (2) only (c)

(3) Both (a) and (b) (4) (a), (b) and (c)

23. Which of the following is a tautology?

(1) $p \Rightarrow p \wedge q$ (2) $p \Rightarrow p \vee q$

(3) $(p \vee q) \Rightarrow (p \wedge q)$ (4) None of these

24. $p \Rightarrow [p \vee (\sim q)]$ is a

(1) contradiction (2) tautology

(3) contingency (4) None of these

25. Which of the following is contingency?

(1) $p \vee \sim p$ (2) $p \wedge q \Rightarrow p \vee q$

(3) $p \wedge (\sim q)$ (4) None of these

26. The compound statement, "If you want to top the school, then you do not study hard" is equivalent to

(1) "If you want to top the school, then you need to study hard".

(2) "If you will not top in the school, then you study hard".

(3) "If you study hard, then you will not top the school".

(4) "If you do not study hard, then you will top in the school".

27. Write the negation of the statement "If the switch is on, then the fan rotates".

(1) "If the switch is not on, then the fan does not rotate".

(2) "If the fan does not rotate, then the switch is not on".

(3) "The switch is not on or the fan rotates".

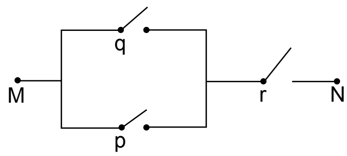
(4) "The switch is on and the fan does not rotate".

28. If "All odd numbers are primes and the sum of three angles in a triangle is 190°", then "All odd numbers are primes or the sum of the angles in a triangle is 190°" is a

(1) tautology (2) contradiction

(3) contingency (4) not a statement

29.



In the above network, current flows from M to N, when

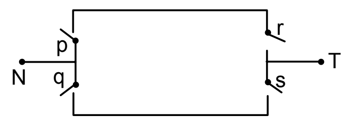
(1) q closed, r opened and p closed.

(2) q opened, p opened and r closed.

(3) q opened, p closed and r closed.

(4) q closed, p closed and r opened.

30.



In the above network, current flows from N to T when

(1) p closed, q closed, r opened and s opened.

(2) p closed, q opened, s closed and r opened.

(3) q closed, p opened, r opened and s closed.

(4) p opened, q opened, r closed and s closed.

31. "No square of a real number is less than zero" is equivalent to

(1) for every real number a, a^2 is non negative.

(2) $\forall\ a \in R, a^2 \geq 0$.

(3) either (1) or (2).

(4) None of these

32. Which of the following is/are counter example(s) of the statement $x^2 - 7x + 10 > 0$, for all real x?

(a) 2 (b) 3

(c) 4 (d) 5

(1) Only (a) and (d).

(2) Only (b) and (c).

(3) All (a), (b), (c) and (d).
(4) None of these

33. "If a polygon is a triangle, then a polyhedron is a pyramid" is a _______

(1) tautology
(2) contradiction
(3) contingency
(4) None of these

34. If a compound statement r is contradiction, then find the truth value of $(p \Rightarrow q) \wedge (r) \wedge [p \Rightarrow (\sim r)]$.

(1) T (2) F
(3) T or F (4) None of these

35. When does the truth value of the statement $(p \vee r) \Leftrightarrow (q \vee r)$ become true?

(1) p is true, q is true. (2) p is false, q is false.
(3) p is true, r is true. (4) Both (1) and (3)

PRACTICE EXERCISE 14 (B)

Directions for questions 1 to 35: Select the correct alternative from the given choices.

1. Which of the following sentences is a statement?

(1) What a cracking shot?
(2) Please open the door.
(3) Four is first prime number.
(4) Thank you.

2. The truth value of the statement, "We celebrate our Independence day on 15 August", is

(1) T
(2) F
(3) neither T nor F
(4) Cannot be determined

3. The statement $p \vee q$ is

(1) a tautology.
(2) a contradiction.
(3) neither a tautology nor a contradiction.
(4) Cannot say.

4. When does the inverse of the statement $\sim p \Rightarrow q$ results in T?

(1) p = T, q = T (2) p = T, q = F
(3) p = F, q = F (4) Both (2) and (3)

5. Write the compound statement, "If p, then q and if q, then p" in symbolic form.

(1) $(p \wedge q) \wedge (q \wedge p)$ (2) $(p \Rightarrow q) \vee (q \Rightarrow p)$
(3) $(q \Rightarrow p) \wedge (p \Rightarrow q)$ (4) $(p \wedge q) \vee (q \wedge p)$

6. Find the quantifier which best describes the variable of the open sentence $x + 3 = 5$.

(1) Universal (2) Exsitential
(3) Neither (1) nor (2) (4) Cannot be determined

7. The converse of converse of the statement $p \Rightarrow \sim q$ is _______.

(1) $\sim q \Rightarrow p$ (2) $\sim p \Rightarrow q$
(3) $p \Rightarrow \sim q$ (4) $\sim q \Rightarrow \sim p$

8. Which of the following connectives satisfy commutative law?

(1) $\wedge$ (2) $\vee$
(3) $\Leftrightarrow$ (4) All the above

9. Which of the following is a contradiction?

(1) $p \vee q$ (2) $p \wedge q$
(3) $p \vee \sim p$ (4) $p \wedge \sim p$

10. What is the converse of the statement $p \Rightarrow p \vee q$?

(1) $p \vee q \Rightarrow p$ (2) $\sim p \Rightarrow p \wedge \sim q$
(3) $\sim p \wedge \sim q \Rightarrow \sim p$ (4) $\sim p \Rightarrow p \vee q$

11. Which of the following connectives can be used for describing a switching network?

(1) $\vee$ (2) $\wedge$
(3) Both (1) and (2) (4) None of these

12. What is the truth value of the statement, $2 \times 3 = 6$ or $5 + 8 = 10$?

(1) T (2) F
(3) Neither T nor F (4) Cannot be determined

13. Find the truth value of the statement, "The sum of any two odd numbers is an odd number".

(1) T (2) F
(3) Neither T nor F (4) Cannot be determined

14. In which of the following cases, $p \Leftrightarrow q$ is true?

(1) p is true, q is true. (2) p is false, q is true.
(3) p is true, q is false. (4) None of these

15. Find the negation of the statement, "Some odd numbers are not prime".

(1) Some odd numbers are primes.
(2) There is an odd number which is not a prime.
(3) All odd numbers are primes.
(4) Not all odd numbers are primes.

16. Which of the following pairs are logically equivalent?

(1) Converse, Contrapositive
(2) Conditional, Converse
(3) Converse, Inverse
(4) Conditional, Inverse

17. Find the inverse of the statement, "If ΔABC is equilateral, then it is isosceles".

(1) If ΔABC is isosceles, then it is equilateral.
(2) If ΔABC is not equilateral, then it is isosceles.
(3) If ΔABC is not equilateral, then it is not isosceles.
(4) If ΔABC is not isosceles, then it is not equilateral.

18. The property $\sim(p \wedge q) \equiv \sim p \vee \sim q$ is called ________.

(1) associative law (2) De morgan's law
(3) commutative law (4) idempotent law

19. Find the counter example of the statement "Every natural number is either prime or composite".

(1) 5 (2) 1
(3) 6 (4) None of these

20. $p \Rightarrow q$ is logically equivalent to _____.

(1) $p \vee \sim q$ (2) $\sim p \wedge q$
(3) $p \wedge q$ (4) $\sim p \vee q$

21. If p: In a triangle, the centroid divides each median in the ratio 1: 2 from the vertex and q: In an equilateral triangle, each median is perpendicular bisector |of one of its sides. The truth values of inverse and converse of $p \Rightarrow q$ are respectively

(1) T, T (2) F, F
(3) T, F (4) F, T

22. If p: 25 is a factor of 625 and q: 169 is a perfect square then $\sim(p \Rightarrow q)$ is equivalent to

(1) $p \wedge q$ (2) $(\sim p) \wedge q$
(3) $p \wedge (\sim q)$ (4) Both (2) and (3)

23. $(p \wedge q) \wedge (\sim q)$ is a

(1) contradiction (2) tautology
(3) contingency (4) None of these

24. Which of the following statements is a contradiction?

(1) $p \vee q \Rightarrow p$ (2) $\sim(p \wedge q) \Rightarrow p$
(3) $\sim(p \wedge q \Rightarrow p)$ (4) $p \wedge q \Rightarrow p$

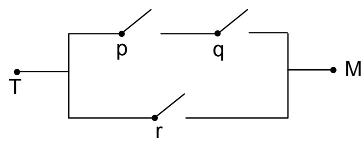
25. The compound statement, "If you won the race, then you did not run faster than others" is equivalent to

(1) "If you won the race, then you ran faster than others".
(2) "If you ran faster than others, then you won the race".
(3) "If you did not win the race, then you did not run faster than others".
(4) "If you ran faster than others, then you did not win the race".

26. "If natural numbers are whole numbers, then rational numbers are integers" or "If rational numbers are integers, then natural numbers are whole numbers" is

(1) a tautology (2) a contradiction
(3) a contingency (4) not a statement

27.



In the above network, current flows from T to M, when

(1) p closed, q closed and r opened.
(2) p closed, q opened and r closed.
(3) p opened, q closed and r closed.
(4) All the above

28. Which of the following is negation of the statement "All birds can fly".

(1) "Some birds cannot fly".
(2) "All the birds cannot fly".
(3) "There is at least one bird which can fly".
(4) All the above

29. The counter example of the statement, "The roots of $x^2 - 6x - 112 = 0$ are natural numbers"?

(1) −8 (2) 14
(3) −16 (4) −7

30. "If x is a good actor, then y is bad actress" is

(1) a tautology (2) a contradiction
(3) a contingency (4) None of these

31. If p: 5x + 6 = 8 is an open sentence and q: 3, 4 are the roots of the equation $x^2 - 7x + 12 = 0$, then which of following is equivalent to $\sim[\sim p \vee q]$?

(1) "The negation of "If 5x + 6 = 8 is an open sentence, then 3, 4 are the roots of the equation $x^2 - 7x + 12 = 0$".

(2) 5x + 6 = 8 is an open sentence or 3, 4 are not roots of the equation $x^2 - 7x + 12 = 0$

(3) 5x + 6 = 8 is not an open sentence and 3, 4 are the roots of the equation $x^2 - 7x + 12 = 0$

(4) None of these

32. If p: Every equilateral triangle is isosceles and q: Every square is a rectangle, then which of the following is equivalent to $\sim(p \Rightarrow q)$?

(1) The negation of "Every equilateral triangle is not isosceles or every square is rectangle".

(2) "Every equilateral triangle is not isosceles, then every square is not a rectangle".

(3) "Every equilateral triangle is isosceles, then every square is a rectangle".

(4) None of these

33. Find the truth value of negation of compound statement $\sim[(\sim p \vee q) \wedge (\sim p \vee q)]$, when q is false.

(1) only T (2) only F

(3) Either T or F (4) None of these

34. $\sim[p \vee (p \Rightarrow q)] \equiv$

(1) p (2) q

(3) T (4) F

35. $\sim(\sim p \Leftrightarrow \sim q) \vee \sim(p \Leftrightarrow q) \equiv$

(a) $\sim(p \Leftrightarrow q)$

(b) $\sim[\sim p \Leftrightarrow \sim q]$

(c) $p \Rightarrow \sim q$

(1) only (a) (2) only (b)

(3) Both (a) and (b) (4) only (c)

ANSWER KEYS

PRACTICE EXERCISE 14 (A)

1. 4	**2.** 3	**3.** 1	**4.** 4	**5.** 2	**6.** 1	**7.** 4	**8.** 4	**9.** 3	**10.** 3
11. 3	**12.** 1	**13.** 1	**14.** 1	**15.** 2	**16.** 1	**17.** 3	**18.** 3	**19.** 3	**20.** 3
21. 4	**22.** 4	**23.** 2	**24.** 2	**25.** 3	**26.** 3	**27.** 4	**28.** 1	**29.** 3	**30.** 3
31. 3	**32.** 3	**33.** 4	**34.** 2	**35.** **4**					

PRACTICE EXERCISE 14 (B)

1. 3	**2.** 1	**3.** 3	**4.** 4	**5.** 3	**6.** 3	**7.** 3	**8.** 4	**9.** 4	**10.** 1
11. 3	**12.** 1	**13.** 2	**14.** 1	**15.** 3	**16.** 3	**17.** 3	**18.** 2	**19.** 2	**20.** 4
21. 2	**22.** 4	**23.** 1	**24.** 3	**25.** 4	**26.** 1	**27.** 4	**28.** 1	**29.** 1	**30.** 4
31. 1	**32.** 1	**33.** 3	**34.** 4	**35.** 3					