HOLISTIC

MHT-CET

ROADMAP TO SUCCESS

- Based on latest paper pattern
- Chapter at a glance
- Important Formulae & Shortcuts
- Subtopic wise segregation
- Classwork/Homework segregation
- Previous Years' Questions

MATHEMATICS (STD. XII)

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HOLISTIC

MHT-CET Mathematics

MULTIPLE CHOICE QUESTIONS

Based on Std. XII Syllabus of MHT-CET

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Textbook
Chapter No.

01 Mathematical Logic

Subtopics

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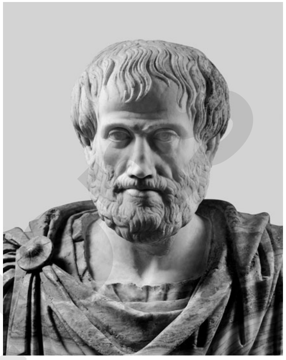
Aristotle (384 - 322 B.C.)

Aristotle the great philosopher and thinker laid the foundations of study of logic in systematic form. The study of logic helps in increasing one's ability of systematic and logical reasoning and develops the skill of understanding validity of statements.



Chapter at a glance

1. Statement

A statement is declarative sentence which is either true or false, but not both simultaneously.

- Statements are denoted by lower case letters p, q, r, etc.
- The truth value of a statement is denoted by '1' or 'T' for True and '0' or 'F' for False.

Open sentences, imperative sentences, exclamatory sentences and interrogative sentences **are not considered as Statements** in Logic.

2. Logical connectives

Type of compound statement	Connective	Symbol	Example
Conjuction	and	$\wedge$	p and q : $p \wedge q$
Disjunction	or	$\vee$	p or q : $p \vee q$
Negation	not	$\sim$	negation p : $\sim p$ not p : $\sim p$
Conditional or Implication	if….then	$\rightarrow$ or $\Rightarrow$	If p, then q : $p \rightarrow q$
Biconditional or Double implication	if and only if, i.e., iff	$\leftrightarrow$ or $\Leftrightarrow$	p iff q : $p \leftrightarrow q$

i. When two or more simple statements are combined using logical connectives, then the statement so formed is called **Compound Statement**.
ii. Sub-statements are those simple statements which are used in a compound statement.
iii. In the conditional statement $p \rightarrow q$, p is called the antecedent or hypothesis, while q is called the consequent or conclusion.

3. Truth Tables for compound statements:

i. Conjuction, Disjunction, Conditional and Biconditional:

p	q	$p \wedge q$	$p \vee q$	$p \rightarrow q$	$p \leftrightarrow q$
T	T	T	T	T	T
T	F	F	T	F	F
F	T	F	T	T	F
F	F	F	F	T	T

ii. Negation:

p	$\sim p$
T	F
F	T

4. Relation between compound statements and sets in set theory:

i. Negation corresponds to 'complement of a set'.
ii. Disjunction is related to the concept of 'union of two sets'.
iii. Conjunction corresponds to 'intersection of two sets'.
iv. Conditional implies 'subset of a set'.
v. Biconditional corresponds to 'equality of two sets'.

5. Statement Pattern:

When two or more simple statements p, q, r …. are combined using connectives $\wedge$, $\vee$, ~, $\rightarrow$, $\leftrightarrow$ the new statement formed is called a **statement pattern.**

e.g.: $\sim p \wedge q$, $p \wedge (p \wedge q)$, $(q \rightarrow p) \vee r$

6. Converse, Inverse, Contrapositive of a Statement:

If $p \rightarrow q$ is a conditional statement, then its

i. Converse: $q \rightarrow p$ ii. Inverse: $\sim p \rightarrow \sim q$ iii. Contrapositive: $\sim q \rightarrow \sim p$

7. Logical equivalence:

If two statement patterns have the same truth values in their respective columns of their joint truth table, then these two statement patterns are **logically equivalent.**

Consider the truth table:

p	q	~p	~q	$p \rightarrow q$	$q \rightarrow p$	$\sim p \rightarrow \sim q$	$\sim q \rightarrow \sim p$
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

From the given truth table, we can summarize the following:

i. The given statement and its contrapositive are logically equivalent.
i.e., $p \rightarrow q \equiv \sim q \rightarrow \sim p$

ii. The converse and inverse of the given statement are logically equivalent.
i.e., $q \rightarrow p \equiv \sim p \rightarrow \sim q$

8. Algebra of statements:

i. $p \vee q \equiv q \vee p$
$p \wedge q \equiv q \wedge p$
} Commutative property

ii. $(p \vee q) \vee r \equiv p \vee (q \vee r) \equiv p \vee q \vee r$
$(p \wedge q) \wedge r \equiv p \wedge (q \wedge r) \equiv p \wedge q \wedge r$
} Associative property

iii. $p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$
$p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$
} Distributive property

iv. $\sim (p \vee q) \equiv \sim p \wedge \sim q$
$\sim (p \wedge q) \equiv \sim p \vee \sim q$
} De Morgan's laws

v. $p \rightarrow q \equiv \sim p \vee q$

vi. $p \leftrightarrow q \equiv (p \rightarrow q) \wedge (q \rightarrow p)$
$\equiv (\sim p \vee q) \wedge (\sim q \vee p)$
} Conditional laws

vii. $p \vee (p \wedge q) \equiv p$
$p \wedge (p \vee q) \equiv p$
} Absorption law

viii. If T denotes the tautology and F denotes the contradiction, then for any statement 'p':
a. $p \vee T \equiv T$; $p \vee F \equiv p$
b. $p \wedge T \equiv p$; $p \wedge F \equiv F$
} Identity law

ix. a. $p \vee \sim p \equiv T$
b. $p \wedge \sim p \equiv F$ } Complement law

x. a. $\sim(\sim p) \equiv p$
b. $\sim T \equiv F$
c. $\sim F \equiv T$ } Involution laws

xi. $p \vee p \equiv p$
$p \wedge p \equiv p$ } Idempotent law

9. Types of Statements:

i. If a statement is **always true**, then the statement is called a "**tautology**".
ii. If a statement is **always false**, then the statement is called a "**contradiction**" or a "**fallacy**".
iii. If a statement is **neither a tautology nor a contradiction,** then it is called "**contingency**".

10. Quantifiers and Quantified Statements:

i. The symbol '$\forall$' stands for "all values of " or "for every" and is known as **universal quantifier.**
ii. The symbol '$\exists$' stands for "there exists atleast one" and is known as **existential quantifier.**
iii. When a quantifier is used in an open sentence, it becomes a statement and is called a **quantified statement.**

11. Principles of Duality:

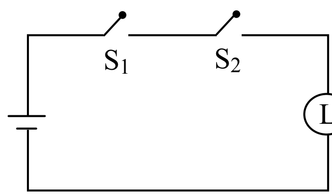
Two compound statements are said to be dual of each other, if one can be obtained from the other by replacing "$\wedge$" by "$\vee$" and vice versa. The connectives "$\wedge$" and "$\vee$" are duals of each other. If 't' is tautology and 'c' is contradiction, then the special statements 't' & 'c' are duals of each other.

12. Negation of a Statement:

i. $\sim(p \vee q) \equiv \sim p \wedge \sim q$
ii. $\sim(p \wedge q) \equiv \sim p \vee \sim q$
iii. $\sim(p \rightarrow q) \equiv p \wedge \sim q$
iv. $\sim(p \leftrightarrow q) \equiv (p \wedge \sim q) \vee (q \wedge \sim p)$
v. $\sim(\sim p) \equiv p$
vi. ~ (for all / every x) ≡ for some / there exists x
$\Rightarrow \sim(\forall x) \equiv \exists x$
vii. ~ (for some / there exist x) ≡ for all / every x
$\Rightarrow \sim(\exists x) \equiv \forall x$
viii. $\sim(x < y) \equiv x \geq y$
$\sim(x > y) \equiv x \leq y$

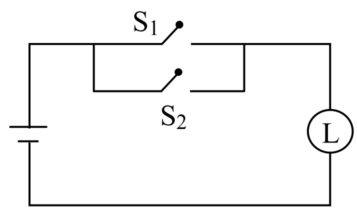
13. Application of Logic to Switching Circuits:

i. AND : [$\wedge$] (Switches in series)



Let p : S_1 switch is ON
q : S_2 switch is ON
For the lamp L to be 'ON' both S_1 and S_2 must be ON
Using theory of logic, the adjacent circuit can be expressed as, $\mathbf{p \wedge q}$.

ii. OR : [$\vee$] (Switches in parallel)



Let p : S_1 switch is ON
q : S_2 switch is ON
For lamp L to be put ON either one of the two switches S_1 and S_2 must be ON.
Using theory of logic, the adjacent circuit can be expressed as $\mathbf{p \vee q}$.

iii. If two or more switches open or close simultaneously then the switches are denoted by the same letter.
If p : switch S is closed.
~ p : switch S is open.
If S_1 and S_2 are two switches such that if S_1 is open S_2 is closed and vice versa.
then $S_1 \equiv \sim S_2$
or $S_2 \equiv \sim S_1$

Classwork

1.1 Statement, Logical Connectives, Compound Statements and Truth Table

1. Which of the following statement is not a statement in logic? **[MH CET 2005]**
(A) Earth is a planet.
(B) Plants are living object.
(C) $\sqrt{-9}$ is a rational number.
(D) I am lying.

2. Which of the following is not a correct statement?
(A) Mathematics is interesting.
(B) $\sqrt{3}$ is a prime.
(C) $\sqrt{2}$ is irrational.
(D) The sun is a star.

3. If p: Rahul is physically disable. q: Rahul stood first in the class, then the statement "In spite of physical disability Rahul stood first in the class in symbolic form is **[MHT CET 2019]**
(A) $p \wedge q$ (B) $p \vee q$
(C) $\sim p \vee q$ (D) $p \rightarrow q$

4. p : A man is happy
q : The man is rich.
The symbolic representation of "If a man is not rich then he is not happy" is **[MH CET 2004]**
(A) $\sim p \rightarrow \sim q$ (B) $\sim q \rightarrow \sim p$
(C) $p \rightarrow q$ (D) $p \rightarrow \sim q$

5. p: Ram is rich
q: Ram is successful
r: Ram is talented
Write the symbolic form of the given statement.
Ram is neither rich nor successful and he is not talented **[MH CET 2008]**
(A) $\sim p \wedge \sim q \vee \sim r$ (B) $\sim p \vee \sim q \wedge \sim r$
(C) $\sim p \vee \sim q \vee \sim r$ (D) $\sim p \wedge \sim q \wedge \sim r$

6. If d: driver is drunk, a: driver meets with an accident, translate the statement 'If the Driver is not drunk, then he cannot meet with an accident' into symbols
(A) $\sim a \rightarrow \sim d$ (B) $\sim d \rightarrow \sim a$
(C) $\sim d \wedge a$ (D) $a \wedge \sim d$

7. If a: Vijay becomes a doctor,
b: Ajay is an engineer.
Then the statement 'Vijay becomes a doctor if and only if Ajay is an engineer' can be written in symbolic form as
(A) $b \leftrightarrow \sim a$ (B) $a \leftrightarrow b$
(C) $a \rightarrow b$ (D) $b \rightarrow a$

8. Let p : Boys are playing
q : Boys are happy
the equivalent form of compound statement $\sim p \vee q$ is **[MH CET 2013]**
(A) Boys are not playing or they are happy.
(B) Boys are not happy or they are playing.
(C) Boys are playing or they are not happy.
(D) Boys are not playing or they are not happy.

9. If p and q are true statements in logic, which of the following statement pattern is true? **[MH CET 2007]**
(A) $(p \vee q) \wedge \sim q$ (B) $(p \vee q) \rightarrow \sim q$
(C) $(p \wedge \sim q) \rightarrow q$ (D) $(\sim p \wedge q) \wedge q$

10. If truth values of p, $p \leftrightarrow r$, $p \leftrightarrow q$ are F, T, F respectively, then respective truth values of q and r are **[MHT CET 2019]**
(A) F, T (B) T, T (C) F, F (D) T, F

11. If $p \rightarrow (\sim p \vee q)$ is false, the truth values of p and q are respectively
(A) F, T (B) F, F
(C) T, T (D) T, F

12. If $(p \wedge \sim q) \rightarrow (\sim p \vee r)$ is a false statement, then respective truth values of p, q and r are **[MH CET 2010]**
OR
If $(p \wedge \sim r) \rightarrow (\sim p \vee q)$ is false, then the truth values of p, q and r are respectively
(A) T, F, F (B) F, T, T
(C) T, T, T (D) F, F, F

13. If p : Every square is a rectangle
q : Every rhombus is a kite then truth values of $p \rightarrow q$ and $p \leftrightarrow q$ are ________ and ________ respectively. **[MH CET 2016]**
(A) F, F (B) T, F
(C) F, T (D) T, T

14. The converse of the contrapositive of $p \rightarrow q$ is
(A) $\sim p \rightarrow q$ (B) $p \rightarrow \sim q$
(C) $\sim p \rightarrow \sim q$ (D) $\sim q \rightarrow p$

15. If Ram secures 100 marks in maths, then he will get a mobile. The converse is
(A) If Ram gets a mobile, then he will not secure 100 marks in maths.
(B) If Ram does not get a mobile, then he will secure 100 marks in maths.
(C) If Ram will get a mobile, then he secures 100 marks in maths.
(D) None of these

16. Let p : A triangle is equilateral, q : A triangle is equiangular, then inverse of $q \rightarrow p$ is **[MH CET 2013]**
(A) If a triangle is not equilateral then it is not equiangular.
(B) If a triangle is not equiangular then it is not equilateral.
(C) If a triangle is equiangular then it is not equilateral.
(D) If a triangle is equiangular then it is equilateral.

17. If it is raining, then I will not come. The contrapositive of this statement will be
(A) If I will come, then it is not raining
(B) If I will not come, then it is raining
(C) If I will not come, then it is not raining
(D) If I will come, then it is raining

18. The contrapositive statement of the statement "If x is prime number, then x is odd" is
(A) If x is not a prime number, then x is not odd.
(B) If x is a prime number, then x is not odd.
(C) If x is not a prime number, then x is odd.
(D) If x is not odd, then x is not a prime number.

19. The contrapositive of the statement: "If the weather is fine then my friends will come and we go for a picnic." is **[MHT CET 2018]**
(A) The weather is fine but my friends will not come or we do not go for a picnic.
(B) If my friends do not come or we do not go for a picnic then weather will not be fine.
(C) If the weather is not fine then my friends will not come or we do not go for a picnic.
(D) The weather is not fine but my friends will come and we go for a picnic.

20. The contrapositive of the statement "If you are born in India, then you are a citizen of India", is
(A) If you are a citizen of India, then you are born in India.
(B) If you are born in India, then you are not a citizen of India.
(C) If you are not a citizen of India, then you are not born in India.
(D) If you are not born in India, then you are not a citizen of India.

1.2 Statement Pattern, Logical Equivalence, and Algebra of Statements

21. The statement, 'If it is raining then I will go to college' is equivalent to
(A) If it is not raining then I will not go to college.
(B) If I do not go to college, then it is not raining.
(C) If I go to college then it is raining.
(D) Going to college depends on my mood.

22. The logically equivalent statement of $(p \wedge q) \vee (p \wedge r)$ is
(A) $p \vee (q \wedge r)$ (B) $q \vee (p \wedge r)$
(C) $p \wedge (q \vee r)$ (D) $q \wedge (p \vee r)$

23. $\sim p \wedge q$ is logically equivalent to
(A) $p \rightarrow q$ (B) $q \rightarrow p$
(C) $\sim(p \rightarrow q)$ (D) $\sim(q \rightarrow p)$

24. The statement pattern $(\sim p \wedge q)$ is logically equivalent to **[MHT CET 2017]**
(A) $(p \vee q) \vee \sim p$ (B) $(p \vee q) \wedge \sim p$
(C) $(p \wedge q) \rightarrow p$ (D) $(p \vee q) \rightarrow p$

25. $(p \wedge q) \vee (\sim q \wedge p) \equiv$ **[MH CET 2009]**
(A) $q \vee p$ (B) p
(C) $\sim q$ (D) $p \wedge q$

26. The Boolean Expression $(p \wedge \sim q) \vee q \vee (\sim p \wedge q)$ is equivalent to:
(A) $p \wedge q$ (B) $p \vee q$
(C) $p \vee \sim q$ (D) $\sim p \wedge q$

27. The statement $p \rightarrow (q \rightarrow p)$ is equivalent to
(A) $p \rightarrow (p \wedge q)$ (B) $p \rightarrow (p \leftrightarrow q)$
(C) $p \rightarrow (p \rightarrow q)$ (D) $p \rightarrow (p \vee q)$

1.3 Tautology, Contradiction, Contingency

28. Which of the following is not true for any two statements p and q?
(A) $\sim[p \vee (\sim q)] \equiv \sim p \wedge q$
(B) $(p \vee q) \vee (\sim q)$ is a tautology
(C) $\sim(p \wedge \sim p)$ is a tautology
(D) $\sim(p \vee q) \equiv \sim p \vee \sim q$

29. The statement pattern $p \wedge (\sim p \wedge q)$ is **[MHT CET 2018]**
(A) a tautology
(B) a contradiction
(C) equivalent to $p \wedge q$
(D) equivalent to $p \vee q$

30. $(p \wedge \sim q) \wedge (\sim p \wedge q)$ is a
(A) Tautology
(B) Contradiction
(C) Tautology and contradiction
(D) Contingency

31. Which of the following statements is a tautology?
(A) $(\sim q \wedge p) \wedge q$
(B) $(\sim q \wedge p) \wedge (p \wedge \sim p)$
(C) $(\sim q \wedge p) \vee (p \vee \sim p)$
(D) $(p \wedge q) \wedge (\sim(p \wedge q))$

32. The only statement among the following i.e., a tautology is
(A) $A \wedge (A \vee B)$
(B) $A \vee (A \wedge B)$
(C) $[A \wedge (A \rightarrow B)] \rightarrow B$
(D) $B \rightarrow [A \wedge (A \rightarrow B)]$

33. Which of the following statement pattern is a tautology? **[MHT CET 2017]**
(A) $p \vee (q \rightarrow p)$
(B) $\sim q \rightarrow \sim p$
(C) $(q \rightarrow p) \vee (\sim p \leftrightarrow q)$
(D) $p \wedge \sim p$

34. The following statement $(p \to q) \to [(\sim p \to q) \to q]$ is
    (A) A fallacy
    (B) A tautology
    (C) Equivalent to $\sim p \to q$
    (D) Equivalent to $p \to \sim q$

35. The false statement in the following is
    (A) $p \wedge (\sim p)$ is a contradiction
    (B) $p \vee (\sim p)$ is a tautology
    (C) $\sim (\sim p) \leftrightarrow p$ is tautology
    (D) $(p \to q) \leftrightarrow (\sim q \to \sim p)$ is a contradiction

1.4 Quantifiers and Quantified Statements Duality

36. Which of the following quantified statement is true ? **[MH CET 2016]**
    (A) The square of every real number is positive
    (B) There exists a real number whose square is negative
    (C) There exists a real number whose square is not positive
    (D) Every real number is rational

37. If c denotes the contradiction then dual of the compound statement $\sim p \wedge (q \vee c)$ is **[MHT CET 2017]**
    (A) $\sim p \vee (q \wedge t)$ (B) $\sim p \wedge (q \vee t)$
    (C) $p \vee (\sim q \vee t)$ (D) $\sim p \vee (q \wedge c)$

1.5 Negation of compound statements

38. The negation of $(p \vee \sim q) \wedge q$ is
    (A) $(\sim p \vee q) \wedge \sim q$ (B) $(p \wedge \sim q) \vee q$
    (C) $(\sim p \wedge q) \vee \sim q$ (D) $(p \wedge \sim q) \vee \sim q$

39. The negation of $\sim s \vee (\sim r \wedge s)$ is equivalent to
    (A) $s \wedge \sim r$ (B) $s \wedge (r \wedge \sim s)$
    (C) $s \vee (r \vee \sim s)$ (D) $s \wedge r$

40. The Boolean expression $\sim (p \vee q) \vee (\sim p \wedge q)$ is equivalent to
    (A) p (B) q (C) $\sim q$ (D) $\sim p$

41. The negation of $p \to (\sim p \vee q)$ is
    (A) $p \vee (p \vee \sim q)$ (B) $p \to \sim(p \vee q)$
    (C) $p \to q$ (D) $p \wedge \sim q$

42. Negation of $(\sim p \to q)$ is **[MH CET 2009]**
    (A) $\sim p \vee \sim q$ (B) $\sim p \wedge \sim q$
    (C) $p \wedge \sim q$ (D) $\sim p \vee q$

43. Negation of $(p \wedge q) \to (\sim p \vee r)$ is **[MH CET 2005]**
    (A) $(p \vee q) \wedge (p \wedge \sim r)$ (B) $(p \wedge q) \vee (p \wedge \sim r)$
    (C) $(p \wedge q) \wedge (p \wedge \sim r)$ (D) $(p \vee q) \vee (p \wedge \sim r)$

44. Negation of $p \leftrightarrow q$ is **[MH CET 2005]**
    (A) $(p \wedge q) \vee (p \wedge q)$
    (B) $(p \wedge \sim q) \vee (q \wedge \sim p)$
    (C) $(\sim p \wedge q) \vee (q \wedge p)$
    (D) $(p \wedge q) \vee (\sim q \wedge p)$

45. The statement $\sim(p \leftrightarrow \sim q)$ is
    (A) a tautology
    (B) a fallacy
    (C) equivalent to $p \leftrightarrow q$
    (D) equivalent to $\sim p \leftrightarrow q$

46. Negation of the statement 'A is rich but silly' is **[MH CET 2006]**
    (A) Either A is not rich or not silly.
    (B) A is poor or clever.
    (C) A is rich or not silly.
    (D) A is either rich or silly.

47. The negation of the statement given by "He is rich and happy" is **[MH CET 2006]**
    (A) He is not rich and not happy
    (B) He is rich but not happy
    (C) He is not rich but happy
    (D) Either he is not rich or he is not happy

48. The negation of the statement "72 is divisible by 2 and 3" is
    (A) 72 is not divisible by 2 or 72 is not divisible by 3.
    (B) 72 is divisible by 2 or 72 is divisible by 3.
    (C) 72 is divisible by 2 and 72 is divisible by 3.
    (D) 72 is not divisible by 2 and 3.

49. Let p : 7 is not greater than 4 and q : Paris is in France be two statements. Then $\sim(p \vee q)$ is the statement
    (A) 7 is greater than 4 or Paris is not in France.
    (B) 7 is not greater than 4 and Paris is not in France.
    (C) 7 is not greater than 4 and Paris is in France.
    (D) 7 is greater than 4 and Paris is not in France.

50. The negation of the proposition "If 2 is prime, then 3 is odd" is
    (A) If 2 is not prime, then 3 is not odd.
    (B) 2 is prime and 3 is not odd.
    (C) 2 is not prime and 3 is odd.
    (D) If 2 is not prime then 3 is odd.

51. The negation of the statement: "Getting above 95% marks is necessary condition for Hema to get admission in good college" is **[MHT CET 2018]**
    (A) Hema gets above 95% marks but she does not get admission in good college.
    (B) Hema does not get above 95% marks and she gets admission in good college.
    (C) If Hema does not get above 95% marks then she will not get admission in good college.
    (D) Hema does not get above 95% marks or she gets admission in good college.

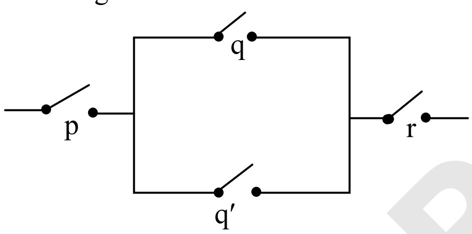
52. The negation of the statement "some equations have real roots" is **[MHT CET 2019]**
    (A) All equations do not have real roots
    (B) All equations have real roots
    (C) Some equations do not have real roots
    (D) Some equations have rational roots

53. The negation of the statement "All continuous functions are differentiable"
    (A) Some continuous functions are differentiable
    (B) All differentiable functions are continuous
    (C) All continuous functions are not differentiable
    (D) Some continuous functions are not differentiable

54. Let S be a non-empty subset of R. Consider the following statement:
    p : There is a rational number $x \in S$ such that $x > 0$.
    Which of the following statements is the negation of the statement p?
    (A) There is a rational number $x \in S$ such that $x \leq 0$
    (B) There is no rational number $x \in S$ such that $x \leq 0$
    (C) Every rational number $x \in S$ satisfies $x \leq 0$
    (D) $x \in S$ and $x \leq 0 \rightarrow x$ is not rational

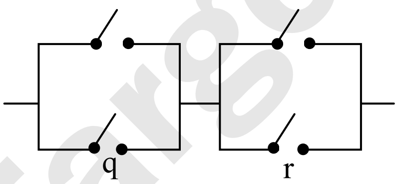
1.6 Switching circuit

55. When does the current flow through the following circuit.



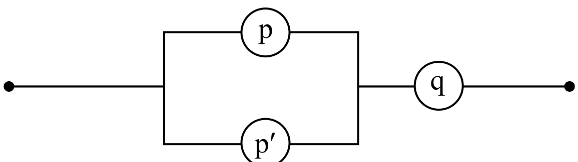
    (A) p, q should be closed and r is open
    (B) p, q, r should be open
    (C) p, q, r should be closed
    (D) none of these

56. If



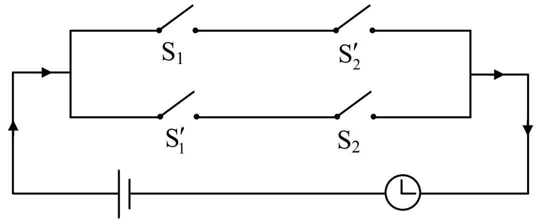
    then the symbolic form is **[MH CET 2009]**
    (A) $(p \vee q) \wedge (p \vee r)$ (B) $(p \wedge q) \vee (p \vee r)$
    (C) $(p \wedge q) \wedge (p \wedge r)$ (D) $(p \wedge q) \wedge r$

57. Simplified logical expression for the following switching circuit is



    [MH CET 2010]
    (A) p (B) q
    (C) p′ (D) $p \wedge q$

58.



    Symbolic form of the given switching circuit is equivalent to ________ **[MH CET 2016]**
    (A) $p \vee \sim q$ (B) $p \wedge \sim q$
    (C) $p \leftrightarrow q$ (D) $\sim(p \leftrightarrow q)$

Homework

1.1 Statement, Logical Connectives, Compound Statements and Truth Table

1. Which of the following is an incorrect statement in logic ?
   (A) Multiply the numbers 3 and 10.
   (B) 3 times 10 is equal to 40.
   (C) What is the product of 3 and 10?
   (D) 10 times 3 is equal to 30.

2. Let p : I is cloudly, q : It is still raining. The symbolic form of "Even though it is not cloudy, it is still raining" is
   (A) $\sim p \wedge q$ (B) $p \wedge \sim q$
   (C) $\sim p \wedge \sim q$ (D) $\sim p \vee q$

3. Assuming the first part of the sentence as p and the second as q, write the following statement symbolically:
   'Irrespective of one being lucky or not, one should not stop working'
   (A) $(p \wedge \sim p) \vee q$ (B) $(p \vee \sim p) \wedge q$
   (C) $(p \vee \sim p) \wedge \sim q$ (D) $(p \wedge \sim p) \vee \sim q$

4. If first part of the sentence is p and the second is q, then the symbolic form of the statement 'It is not true that Physics is not interesting or difficult' is
   (A) $\sim(\sim p \wedge q)$ (B) $(\sim p \vee q)$
   (C) $(\sim p \vee \sim q)$ (D) $\sim(\sim p \vee q)$

5. The symbolic form of the statement 'It is not true that intelligent persons are neither polite nor helpful' is
   (A) $\sim(p \vee q)$ (B) $\sim(\sim p \wedge \sim q)$
   (C) $\sim(\sim p \vee \sim q)$ (D) $\sim(p \wedge q)$

6. Given 'p' and 'q' as true and 'r' as false, the truth values of $\sim p \wedge (q \vee \sim r)$ and $(p \rightarrow q) \wedge r$ are respectively
   (A) T, F (B) F, F (C) T, T (D) F, T

7. If p and q have truth value 'F', then the truth values of $(\sim p \vee q) \leftrightarrow \sim(p \wedge q)$ and $\sim p \leftrightarrow (p \rightarrow \sim q)$ are respectively
   (A) T, T (B) F, F (C) T, F (D) F, T

8. If p is true and q is false then the truth values of $(p \to q) \leftrightarrow (\sim q \to \sim p)$ and $(\sim p \vee q) \wedge (\sim q \vee p)$ are respectively
(A) F, F (B) F, T (C) T, F (D) T, T

9. Let a : $\sim(p \wedge \sim r) \vee (\sim q \vee s)$ and
b : $(p \vee s) \leftrightarrow (q \wedge r)$.
If the truth values of p and q are true and that of r and s are false, then the truth values of a and b are respectively.
(A) F, F (B) T, T
(C) T, F (D) F, T

10. If p is false and q is true, then
(A) $p \wedge q$ is true (B) $p \vee \sim q$ is true
(C) $q \to p$ is true (D) $p \to q$ is true

11. Given that p is 'false' and q is 'true' then the statement which is 'false' is
(A) $\sim p \to \sim q$ (B) $p \to (q \wedge p)$
(C) $p \to \sim q$ (D) $q \to \sim p$

12. If p, q are true and r is false statement then which of the following is true statement?
(A) $(p \wedge q) \vee r$ is F
(B) $(p \wedge q) \to r$ is T
(C) $(p \vee q) \wedge (p \vee r)$ is T
(D) $(p \to q) \leftrightarrow (p \to r)$ is T

13. If the truth value of statement $p \to (\sim q \vee r)$ is false (F), then the truth values of the statements p, q, r are respectively.
(A) T, F, T (B) F, T, T
(C) T, T, F (D) T, F, F

14. If $p \to (p \wedge \sim q)$ is false, then the truth values of p and q are respectively.
(A) F, F (B) T, F
(C) T, T (D) F, T

15. If $\sim q \vee p$ is F, then which of the following is correct?
(A) $p \leftrightarrow q$ is T (B) $p \to q$ is T
(C) $q \to p$ is T (D) $p \to q$ is F

16. The contrapositive of $(p \vee q) \to r$ is
(A) $\sim r \to \sim p \wedge \sim q$ (B) $\sim r \to (p \vee q)$
(C) $r \to (p \vee q)$ (D) $p \to (q \vee r)$

17. The converse of 'If *x* is zero then we cannot divide by *x*' is
(A) If we cannot divide by *x* then *x* is zero.
(B) If we divide by *x* then *x* is non-zero.
(C) If *x* is non-zero then we can divide by *x*.
(D) If we cannot divide by *x* then *x* is non-zero.

1.2 Statement Pattern, Logical Equivalence, and Algebra of Statements

18. Find out which of the following statements have the same meaning:
i. If Seema solves a problem then she is happy.
ii. If Seema does not solve a problem then she is not happy.
iii. If Seema is not happy then she hasn't solved the problem.
iv. If Seema is happy then she has solved the problem
(A) (i, ii) and (iii, iv) (B) i, ii, iii
(C) (i, iii) and (ii, iv) (D) ii, iii, iv

19. Find which of the following statements convey the same meanings?
i. If it is the bride's dress then it has to be red.
ii. If it is not bride's dress then it cannot be red.
iii. If it is a red dress then it must be the bride's dress.
iv. If it is not a red dress then it can't be the bride's dress.
(A) (i, iv) and (ii, iii) (B) (i, ii) and (iii, iv)
(C) (i), (ii), (iii) (D) (i, iii) and (ii, iv)

20. $p \wedge (p \to q)$ is logically equivalent to
(A) $p \vee q$ (B) $\sim p \vee q$
(C) $p \wedge q$ (D) $p \vee \sim q$

21. Which of the following is true?
(A) $p \wedge \sim p \equiv T$
(B) $p \vee \sim p \equiv F$
(C) $p \to q \equiv q \to p$
(D) $p \to q \equiv (\sim q) \to (\sim p)$

22. Which of the following is NOT equivalent to $p \to q$.
(A) p is sufficient for q
(B) p only if q
(C) q is necessary for p
(D) q only if p

23. The statement pattern $(p \wedge q) \wedge [\sim r \vee (p \wedge q)] \vee (\sim p \wedge q)$ is equivalent to
(A) $p \wedge q$ (B) r
(C) p (D) q

24. The logical statement $(p \to q) \wedge (q \to \sim p)$ is equivalent to:
(A) p (B) ~q (C) q (D) ~p

1.3 Tautology, Contradiction, Contingency

25. $\sim(\sim p) \leftrightarrow p$ is
(A) a tautology
(B) a contradiction
(C) neither a contradiction nor a tautology
(D) none of these

26. Which of the following statement pattern is a tautology?
(A) $(p \to q) \vee q$ (B) $p \vee (q \to p)$
(B) $p \to (q \vee p)$ (D) $(p \vee q) \to p$

27. Which one of the following statements is not a tautology?
(A) $p \to (p \vee q)$
(B) $(p \wedge q) \to (\sim p \vee q)$
(C) $(p \wedge q) \to p$
(D) $(p \vee q) \to (p \vee \sim q)$

28. Which one of the following is a tautology?
 (A) $p \vee (p \wedge q)$
 (B) $q \rightarrow (p \wedge (p \rightarrow q))$
 (C) $(p \wedge (p \rightarrow q)) \rightarrow q$
 (D) $p \wedge (p \vee q))$

29. Which of the following statements is a tautology?
 (A) $\sim(p \wedge \sim q) \rightarrow (p \vee q)$
 (B) $(\sim p \vee \sim q) \rightarrow (p \wedge q)$
 (C) $p \vee (\sim q) \rightarrow (p \wedge q)$
 (D) $\sim(p \vee \sim q) \rightarrow (p \vee q)$

30. Which of the following is a tautology?
 (A) $p \rightarrow (p \wedge q)$
 (B) $q \wedge (p \rightarrow q)$
 (C) $\sim(p \rightarrow q) \leftrightarrow p \wedge \sim q$
 (D) $(p \wedge q) \leftrightarrow \sim q$

31. $(\sim p \wedge \sim q) \wedge (q \wedge r)$ is a
 (A) tautology
 (B) contingency
 (C) contradiction
 (D) neither tautology nor contradiction

32. Which of the following statement is contradiction?
 (A) $(p \wedge q) \rightarrow q$
 (B) $(p \wedge \sim q) \wedge (p \rightarrow q)$
 (C) $p \rightarrow \sim (p \wedge \sim q)$
 (D) $(p \wedge q) \vee \sim q$

33. Which of the following statement is a contingency?
 (A) $(p \wedge \sim q) \vee \sim(p \wedge \sim q)$
 (B) $(p \wedge q) \leftrightarrow (\sim p \rightarrow \sim q)$
 (C) $(\sim q \wedge p) \vee (p \vee \sim p)$
 (D) $(q \rightarrow p) \vee (\sim p \leftrightarrow q)$

1.4 Quantifiers and Quantified Statements Duality

34. If A ≡ {4, 5, 7, 9}, determine which of the following quantified statement is true.
 (A) $\exists\, x \in A$, such that $x + 4 = 7$
 (B) $\forall\, x \in A, x + 1 \leq 10$
 (C) $\forall\, x \in A, 2x \leq 17$
 (D) $\exists\, x \in A$, such that $x + 1 > 10$

35. Using quantifier the open sentence '$x^2 > 0$' defined on N is converted into true statement as
 (A) $\forall x \in N, x^2 > 0$
 (B) $\forall x \in N, x^2 = 0$
 (C) $\exists x \in N$, such that $x^2 < 0$
 (D) $\exists x \notin N$, such that $x^2 < 0$

36. Which of the following quantified statement is false?
 (A) $\exists x \in N$, such that $x + 5 \leq 6$
 (B) $\forall x \in N, x^2 \not\leq 0$
 (C) $\exists x \in N$, such that $x - 1 < 0$
 (D) $\exists x \in N$, such that $x^2 - 3x + 2 = 0$

37. Given below are four statements along with their respective duals. Which dual statement is not correct?
 (A) $(p \vee q) \wedge (r \vee s), (p \wedge q) \vee (r \wedge s)$
 (B) $(p \vee \sim q) \wedge (\sim p), (p \wedge \sim q) \vee (\sim p)$
 (C) $(p \wedge q) \vee r, (p \vee q) \wedge r$
 (D) $(p \vee q) \vee s, (p \wedge q) \vee s$

38. The dual of '$(p \wedge t) \vee (c \wedge \sim q)$' where t is a tautology and c is a contradiction, is
 (A) $(p \vee c) \wedge (t \vee \sim q)$
 (B) $(\sim p \wedge c) \wedge (t \vee q)$
 (C) $(\sim p \vee c) \wedge (t \vee q)$
 (D) $(\sim p \vee t) \wedge (c \vee \sim q)$

1.5 Negation of compound statements

39. Negation of the proposition $(p \vee q) \wedge (\sim q \wedge r)$ is
 (A) $(p \wedge q) \vee (q \vee \sim r)$
 (B) $(\sim p \vee \sim q) \wedge (\sim q \wedge r)$
 (C) $(\sim p \wedge \sim q) \vee (q \vee \sim r)$
 (D) $(p \wedge q) \wedge (q \wedge \sim r)$

40. The negation of $p \vee (\sim q \wedge \sim p)$ is
 (A) $\sim p \wedge q$ (B) $p \vee \sim q$
 (C) $\sim p \wedge \sim q$ (D) $\sim p \vee \sim q$

41. The negation of the Boolean expression $\sim s \vee (\sim r \wedge s)$ is equivalent to:
 (A) $\sim s \wedge \sim r$ (B) r
 (C) $s \wedge r$ (D) $s \vee r$

42. The Boolean expression $\sim(p \Rightarrow \sim q)$ is equivalent to:
 (A) $p \wedge q$ (B) $(\sim p) \Rightarrow q$
 (C) $q \Rightarrow \sim p$ (D) $p \vee q$

43. For any two statements p and q, the negation of the expression $p \vee (\sim p \wedge q)$ is:
 (A) $\sim p \vee \sim q$ (B) $p \leftrightarrow q$
 (C) $p \wedge q$ (D) $\sim p \wedge \sim q$

44. Which of the following is logically equivalent to $\sim[p \rightarrow (p \vee \sim q)]$?
 (A) $p \vee (\sim p \wedge q)$ (B) $p \wedge (\sim p \wedge q)$
 (C) $p \wedge (p \vee \sim q)$ (D) $p \vee (p \wedge \sim q)$

45. The logical statement $[\sim (\sim p \vee q) \vee (p \wedge r)] \wedge (\sim q \wedge r)$ is equivalent to:
 (A) $(\sim p \wedge \sim q) \wedge r$
 (B) $(p \wedge \sim q) \vee r$
 (C) $\sim p \vee r$
 (D) $(p \wedge r) \wedge \sim q$

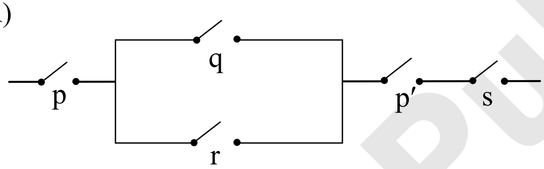
46. $p \leftrightarrow q$ is logically NOT equivalent to
 (A) $(\sim p \vee q) \wedge (\sim q \vee p)$
 (B) $(p \wedge q) \vee (\sim p \wedge \sim q)$
 (C) $(p \wedge \sim q) \vee (q \wedge \sim p)$
 (D) $(p \rightarrow q) \wedge (q \rightarrow p)$

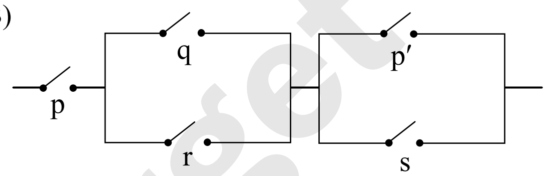
47. The negation of the statement "If Saral Mart does not reduce the prices, I will not shop there any more" is
    (A) Saral Mart reduces the prices and still I will shop there.
    (B) Saral Mart reduces the prices and I will not shop there.
    (C) Saral Mart does not reduce the prices and still I will shop there.
    (D) Saral Mart does not reduce the prices or I will shop there.

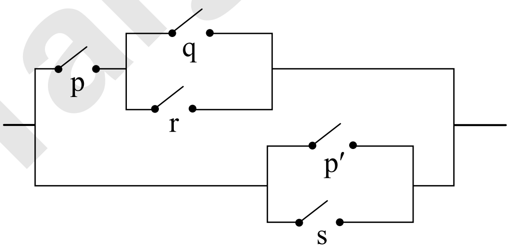
48. The negation of the statement, $\exists\ x \in \mathrm{R}$, such that $x^2 + 3 > 0$, is
    (A) $\exists\ x \in \mathrm{R}$, such that $x^2 + 3 < 0$
    (B) $\forall\ x \in \mathrm{R}, x^2 + 3 > 0$
    (C) $\forall\ x \in \mathrm{R}, x^2 + 3 \leq 0$
    (D) $\exists\ x \in \mathrm{R}$, such that $x^2 + 3 = 0$

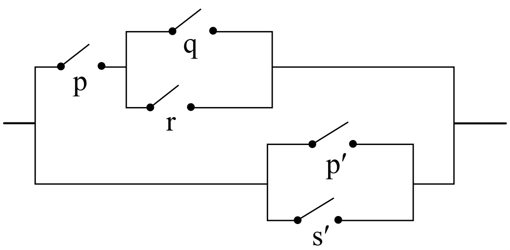
1.6 Switching circuit

49. The switching circuit for the statement $[p \wedge (q \vee r)] \vee (\sim p \vee s)$ is

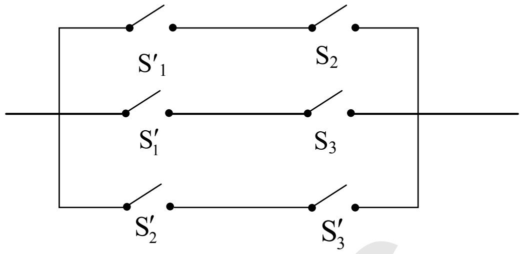
(A)


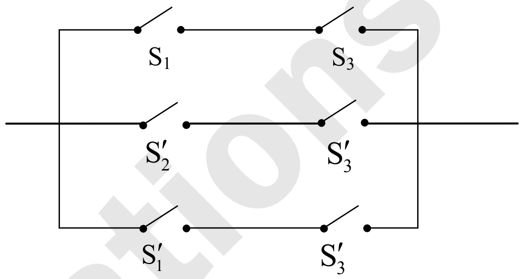
(B)


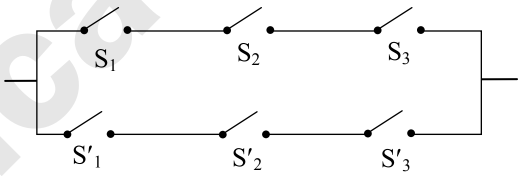
(C)


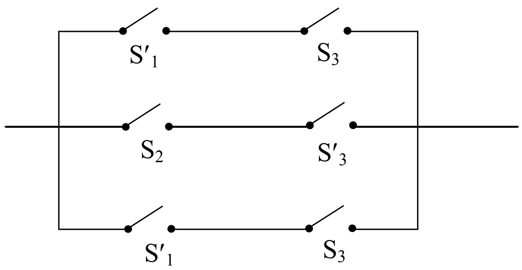
(D)


50. If the symbolic form is $(p \wedge r) \vee (\sim q \wedge \sim r) \vee (\sim p \wedge \sim r)$, then switching circuit is

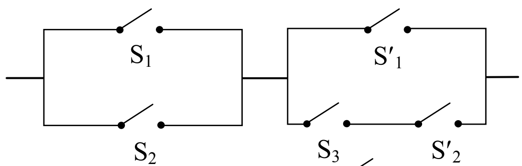
(A)


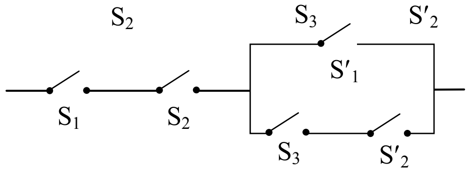
(B)


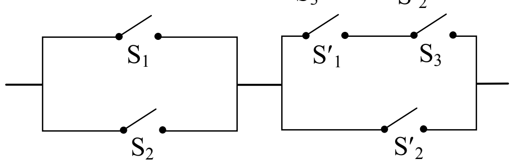
(C)


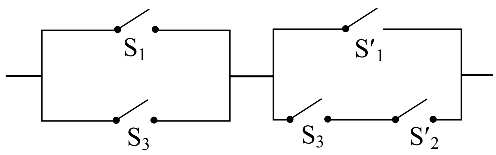
(D)


51. The switching circuit for the symbolic form $(p \vee q) \wedge [\sim p \vee (r \wedge \sim q)]$ is

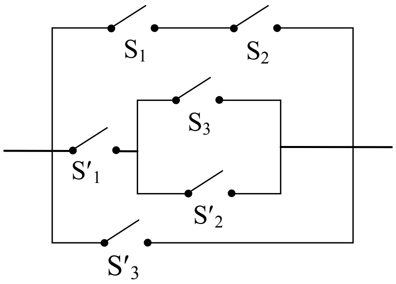
(A)


(B)


(C)


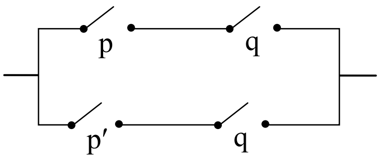
(D)


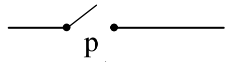
52. The symbolic form of logic for the following circuit is

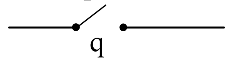


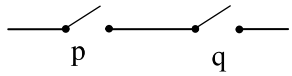
(A) (p ∨ q) ∧ (~p ∧ r ∨ ~q) ∨ ~r
(B) (p ∧ q) ∧ (~p ∨ r ∧ ~q) ∨ ~r
(C) (p ∧ q) ∨ [~p ∧ (r ∨ ~q)] ∨ ~r
(D) (p ∨ q) ∧ [~p ∨ (r ∧ ~q)] ∨ ~r

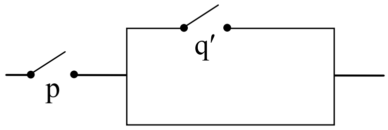
53. The simplified circuit for the following circuit is



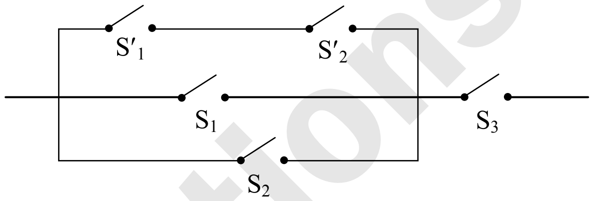
(A) 

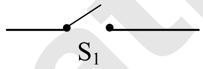
(B) 

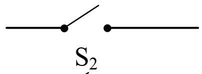
(C) 

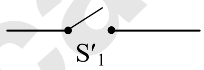
(D) 

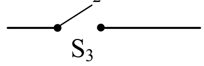
54. The simplified circuit for the following circuit is



(A) 

(B) 

(C) 

(D) 

Previous Years' Questions

1. The contrapositive of the statement 'If Raju is courageous, then he will join Indian Army', is **[MHT CET 2020]**
(A) If Raju does not join Indian Army, then he is not courageous.
(B) If Raju join Indian Army, then he is not courageous
(C) If Raju join Indian Army, then he is courageous.
(D) If Raju does not join Indian Army, then he is courageous.

2. The logical expression [p ∧ (q ∨ r)] ∨ [~r ∧ ~q ∧ p] is equivalent to **[MHT CET 2020]**
(A) p (B) ~ p (C) ~ q (D) q

3. The logical expression p ∧ (~ p ∨ ~ q) ∧ q ≡ **[MHT CET 2021]**
(A) p ∨ q (B) T
(C) F (D) p ∧ q

4. The negation of a statement '$x \in A \cap B \rightarrow (x \in A \text{ and } x \in B)$' is **[MHT CET 2021]**
(A) $x \in A \cap B \rightarrow (x \in A \text{ or } x \in B)$
(B) $x \in A \cap B \text{ or} (x \in A \text{ and } x \in B)$
(C) $x \in A \cap B \text{ and } (x \notin A \text{ or } x \notin B)$
(D) $x \notin A \cap B \text{ and } (x \in A \text{ and } x \in B)$

5. For three simple statements p, q, and r, p → (q ∨ r) is logically equivalent to **[MHT CET 2022]**
(A) (p ∨ q) → r
(B) (p → ~q) ∧ (p → r)
(C) (p → q) ∨ (p → r)
(D) (p → q) ∧ (p → ~r)

6. Which of the following statement pattern is a contradiction? **[MHT CET 2022]**
(A) S_4 ≡ (~p ∧ q) ∨ (~q)
(B) S_2 ≡ (p → q) ∨ (p ∧ ~q)
(C) S_1 ≡ (~p ∨ ~q) ∨ (p ∨ ~q)
(D) S_3 ≡ (~p ∧ q) ∧ (~q)

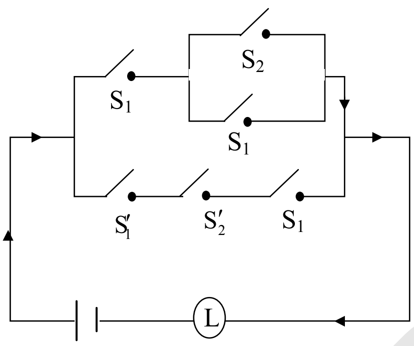
7. If truth values of statements p, q are true, and r, s are false, then the truth values of the following statement patterns are respectively **[MHT CET 2023]**
a : ~(p ∧ ~r) ∨ (~q ∨ s)
b : (~q ∧ ~r) ↔ (p ∨ s)
c : (~p ∨ q) → (r ∧ ~s)
(A) T, F, F (B) F, F, F
(C) F, T, T (D) T, F, T

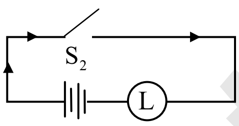
8. The negation of the statement (p ∧ q) → (~p ∨ r) is **[MHT CET 2023]**
(A) p ∨ q ∨ ~r (B) p ∧ q ∧ ~r
(C) ~p ∨ q ∧ r (D) ~p ∨ ~q ∨ ~r

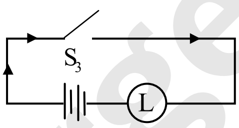
9. The logical statement
$(\sim(\sim p \vee q) \vee (p \wedge r)) \wedge (\sim q \wedge r)$ is equivalent to **[MHT CET 2023]**
(A) $\sim p \vee r$
(B) $(p \wedge \sim q) \vee r$
(C) $(p \wedge r) \wedge \sim q$
(D) $(\sim p \wedge \sim q) \wedge r$

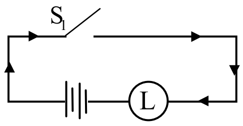
10. If truth value of logical statement $(p \leftrightarrow \sim q) \rightarrow (\sim p \wedge q)$ is false, then the truth values of p and q are respectively **[MHT CET 2023]**
(A) F, T (B) T, T
(C) T, F (D) F, F

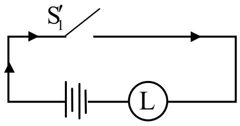
11. The new switching circuit for the following circuit by simplifying the given circuit is **[MHT CET 2024]**



(A)


(B)


(C)


(D)


12. If $\wedge \sim q \ \wedge \ p \wedge r \ \rightarrow \sim p \vee q$ is false, then the truth values of p, q and r are respectively **[MHT CET 2024]**
(A) T, T, T (B) F, F, F
(C) T, F, T (D) F, T, F

13. Negation of the statement "The payment will be made if and only if the work is finished in time." is **[MHT CET 2024]**
(A) The work is finished in time and the payment is not made.
(B) The payment is made and the work is not finished in time.
(C) The work is finished in time and the payment is not made, or the payment is made and the work is finished in time.
(D) Either the work is finished in time and the payment is not made, or the payment is made and the work is not finished in time.

14. The inverse of $p \rightarrow (q \rightarrow r)$ is logically equivalent to **[MHT CET 2024]**
(A) $p \rightarrow (q \rightarrow r)$
(B) $(q \rightarrow r) \rightarrow \sim p$
(C) $(p \vee q) \rightarrow r$
(D) $(q \rightarrow r) \rightarrow p$

Answer Key

Classwork

1.	(D)	2.	(B)	3.	(A)	4.	(B)	5.	(D)	6.	(B)	7.	(B)	8.	(A)	9.	(C)	10.	(D)
11.	(D)	12.	(A)	13.	(D)	14.	(C)	15.	(C)	16.	(B)	17.	(A)	18.	(D)	19.	(B)	20.	(C)
21.	(B)	22.	(C)	23.	(D)	24.	(B)	25.	(B)	26.	(B)	27.	(D)	28.	(D)	29.	(B)	30.	(B)
31.	(C)	32.	(C)	33.	(C)	34.	(B)	35.	(D)	36.	(C)	37.	(A)	38.	(C)	39.	(D)	40.	(D)
41.	(D)	42.	(B)	43.	(C)	44.	(B)	45.	(C)	46.	(B)	47.	(D)	48.	(A)	49.	(D)	50.	(B)
51.	(B)	52.	(A)	53.	(D)	54.	(C)	55.	(C)	56.	(A)	57.	(B)	58.	(D)				

Homework

1.	(B)	2.	(A)	3.	(C)	4.	(D)	5.	(B)	6.	(B)	7.	(A)	8.	(C)	9.	(A)	10.	(D)
11.	(A)	12.	(C)	13.	(C)	14.	(C)	15.	(B)	16.	(A)	17.	(A)	18.	(C)	19.	(A)	20.	(C)
21.	(D)	22.	(D)	23.	(D)	24.	(D)	25.	(A)	26.	(C)	27.	(D)	28.	(C)	29.	(D)	30.	(C)
31.	(C)	32.	(B)	33.	(B)	34.	(B)	35.	(A)	36.	(C)	37.	(D)	38.	(A)	39.	(C)	40.	(A)
41.	(C)	42.	(A)	43.	(D)	44.	(B)	45.	(D)	46.	(C)	47.	(C)	48.	(C)	49.	(C)	50.	(B)
51.	(A)	52.	(C)	53.	(B)	54.	(D)												

Previous Years' Questions

1.	(A)	2.	(A)	3.	(C)	4.	(C)	5.	(C)	6.	(D)	7.	(B)	8.	(B)	9.	(C)	10.	(C)
11.	(C)	12.	(C)	13.	(D)	14.	(D)												

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