SAMPLE CONTENT

MHT-CET 2021

TRIUMPH

MATHEMATICS

MULTIPLE CHOICE QUESTIONS

3882 MCQS

BASED ON STD. XII SYLLABUS 2020-21

Target Publications® Pvt. Ltd.

Written in accordance with the topics based on new syllabus XII Sci.
(Maharashtra State Board)

MHT-CET TRIUMPH Mathematics MULTIPLE CHOICE QUESTIONS

Based on New Syllabus

Salient Features

- Includes chapters of Std. XII as per the latest textbook of 2020-21.
- Exhaustive subtopic wise coverage of MCQs.
- 3882 MCQs including questions from various competitive exams.
- Chapter at a glance, Shortcuts provided in each chapter.
- Includes MCQs from JEE (Main) (8th April, shift 1), MHT- CET (6th May, Afternoon) 2019 and JEE (Main) (7th January, shift 2) 2020.
- Also, Includes MCQs from JEE (Main) and MHT-CET upto 2019.
- Various competitive examination questions updated till the latest year.
- Evaluation test provided at the end of each chapter.

*Scan the adjacent QR code or visit **www.targetpublications.org/tp1627** to download Hints for relevant questions and Evaluation Test in PDF format.*

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PREFACE

"Don't follow your dreams; chase them!"- a quote by Richard Dumbrill is perhaps the most pertinent for one who is aiming to crack entrance examinations held after std. XII. We are aware of an aggressive competition a student appearing for such career defining examinations experiences and hence wanted to create books that develop the necessary knowledge, tools and skills required to excel in these examinations.

For the syllabus of MHT-CET 2020, 80% of the weightage has given to the syllabus for XIIth standard while only 20% is given to the syllabus for XIth standard (with inclusion of only selected chapters). Since there is no clarity on the syllabus for MHT-CET 2021 till the time when this book was going to be printed and taking the fact into consideration that the entire syllabus for std. XIIth Science has always been an integral part of MHT-CET syllabus, this book includes all the topics of std. XIIth Mathematics.

We believe that although the syllabus for Std. XII and MHT-CET is aligned, the outlook to study the subject should be altered based on the nature of the examination. To score in MHT-CET, a student has to be not just good with the concepts but also quick to complete the test successfully. Such ingenuity can be developed through sincere learning and dedicated practice.

Having thorough knowledge of mathematical concepts, formulae and their applications is a prerequisite for beginning with MCQs on a given chapter in Mathematics. Students must know the required rules, formulae, functions and general equations involved in the chapter. Mathematics requires understanding and application of basic concepts, so students should also be familiar with concepts studied in the earlier standards. They should befriend ideas like Mathematical logic, inverse functions, differential equations, integration and its applications and random variables to tackle the problems.

As a first step to MCQ solving, students should start with elementary questions. Once a momentum is gained, complex MCQs with higher level of difficulty should be practised. Questions from previous years as well as from other similar competitive exams should be solved to obtain an insight about plausible questions.

The competitive exams challenge understanding of students about subject by combining concepts from different chapters in a single question. To figure these questions out, cognitive understanding of subject is required. Therefore, students should put in extra effort to practise such questions.

Promptness being virtue in these exams, students should wear time saving short tricks and alternate methods upon their sleeves and should be able to apply them with accuracy and precision as required.

Such a holistic preparation is the key to success in the examination!
To quote Dr. A.P.J. Abdul Kalam, **"If you want to shine like a sun, first burn like a sun."**

Our **Triumph Mathematics** book has been designed to achieve the above objectives. Commencing from basic MCQs, the book proceeds to develop competence to solve complex MCQs. It offers ample practice of recent questions from various competitive examinations. While offering standard solutions in the form of concise hints, it also provides Shortcuts and Alternate Methods. Each chapter ends with an Evaluation test to allow self-assessment.

Features of the book presented on the next page will explicate more about the same!

We hope the book benefits the learner as we have envisioned.

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.
Please write to us on: mail@targetpublications.org

A book affects eternity; one can never tell where its influence stops.

Best of luck to all the aspirants!

From,
Publisher

Edition: First

FEATURES

Chapter at a glance

1. Elementary Transformations:

Symbol	Meaning
$R_i \leftrightarrow R_j$	Interchange of i^{th} and j^{th} rows
$C_i \leftrightarrow C_j$	Interchange of i^{th} and j^{th} columns
$R_i \rightarrow kR_i$	Multiplying the i^{th} row by non-zero scalar k
$C_i \rightarrow kC_i$	Multiplying the i^{th} column by non-zero scalar k
$R_i \rightarrow R_i + kR_j$	Adding k times the elements of j^{th} row to the corresponding elements of i^{th} row
$C_i \rightarrow C_i + kC_j$	Adding k times the elements of j^{th} column to the corresponding elements of i^{th} column

Chapter at a glance

Chapter at a glance includes short and precise summary along with tables and Key formulae of the chapter.
This is our attempt to make tools of formulae accessible at a glance for the students while solving problems.

Shortcuts

Shortcuts to help students save time while dealing with questions.
This is our attempt to highlight content that would come handy while solving questions.

Shortcuts

1. $\int \frac{f'(x)}{f(x)} dx = \log |f(x)| + c$

2. $\int \frac{f'(x)}{\sqrt{f(x)}} dx = 2\sqrt{f(x)} + c$

3. $\int [f(x)]^n f'(x)\, dx = \frac{[f(x)]^{n+1}}{(n+1)} + c, n \neq -1$

Classical Thinking

1 Area under the curve

1. Area bounded by the curve $y = x^3$, X-axis and ordinates $x = 1$ and $x = 4$ is
   (A) 64 sq. units (B) 27 sq. units
   (C) $\frac{127}{4}$ sq. units (D) $\frac{255}{4}$ sq. units

Classical Thinking

Classical Thinking section encompasses straight forward questions including knowledge based questions.
This is our attempt to revise chapter in its basic form and warm up the students to deal with complex MCQs.

FEATURES

Critical Thinking

Critical Thinking section encompasses challenging questions which test understanding, rational thinking and application skills of the students.

This is our attempt to take the students from beginner to proficient level in smooth steps.

Critical Thinking

3.1 Trigonometric equations and the solutions

1. The values of θ in between 0° and 360° and satisfying the equation $\tan\theta + \frac{1}{\sqrt{3}} = 0$ is equal to

(A) θ = 150° and 300° (B) [illegible]
(C) θ = 60° and 240° (D) [illegible]

Competitive Thinking

2.6 Maxima and Minima

94. If $f(x) = x^3 - 3x$ has minimum value at x [illegible], then a = **[MHT CET 2019]**

(A) –1 (B) –3
(C) 1 (D) [illegible]

Competitive Thinking

Competitive Thinking section encompasses questions from various competitive examinations like MHT CET, JEE, etc.

This is our attempt to give the students practice of competitive questions and advance them to acquire knack essential to solve such questions.

Sub-topic wise segregation

Every section is **segregated sub-topic wise.**

This is our attempt to cater to individualistic pace and preferences of studying a chapter and enabling easy assimilation of questions based on the specific concept.

Subtopics

1.1 Derivative of Composite functions
1.2 Derivative of Inverse functions
1.3 Logarithmic Differentiation
1.4 Derivative of Implicit functions
1.5 Derivative of Parametric functions
1.6 Higher Order derivatives

FEATURES

Miscellaneous

Miscellaneous

39. The distance from the origin to the orthocentre of the triangle formed by the lines $x + y - 1 = 0$ and $6x^2 - 13xy + 5y^2 = 0$ is **[AP EAMCET 2019]**

(A) $\frac{11\sqrt{2}}{2}$ (B) 13

(C) 11 (D) $\frac{11\sqrt{2}}{24}$

Miscellaneous section incorporates MCQs whose solutions require knowledge of concepts covered in different sub-topics of the same chapter or from different chapters.

This is our attempt to develop cognitive thinking in the students which is essemtial to solve questions involving fusion of multiple key concepts.

Evaluation test

Evaluation Test covers questions from chapter for self-evaluation purpose.

This is our attempt to provide the students with a practice test and help them assess their range of preparation of the chapter.

Evaluation Test

1. If f(x) is a polynomial of degree 2, such that f(0) = 3, f ′(0) = –7, f ′′(0) = 8, then $\int_1^2 f(x)dx =$

(A) $\frac{11}{6}$ (B) $\frac{13}{6}$

(C) $\frac{17}{6}$ (D) $\frac{19}{6}$

CONTENTS

01 Mathematical Logic

Subtopics

1.1 Statement, Logical Connectives, Compound Statements and Truth Table
1.2 Statement Pattern, Logical Equivalence, and Algebra of Statements
1.3 Tautology, Contradiction, Contingency
1.4 Quantifiers and Quantified Statements, Duality
1.5 Negation of compound statements
1.6 Switching circuit

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 the joint truth table, then these two statement patterns are **logically equivalent.**

Consider the truth table:

p	q	~p	~q	p → q	q → p	~p → ~q	~q → ~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 '∀' stands for "all values of" or "for every" and is known as **universal quantifier.**

ii. The symbol '∃' 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 "∧" by "∨" and vice versa. The connectives "∧" and "∨" 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. $\sim(\sim p) \equiv p$

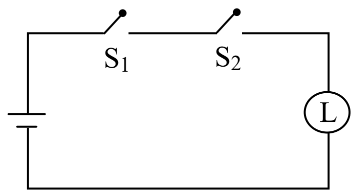
vi. ~ (for all / every x) ≡ for some / there exists x
$\Rightarrow \sim(\forall x) \equiv \exists x$

vii. ~ (for some / there exist x) ≡ for all / every x
$\Rightarrow \sim(\exists x) \equiv \forall x$

viii. $\sim(x < y) \equiv x \geq y$
$\sim(x > y) \equiv x \leq y$

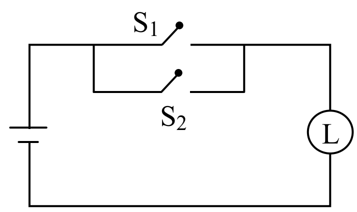
13. Application of Logic to Switching Circuits:

i. AND : [∧] (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 : [∨] (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 $S_2 \equiv \sim S_1$

Classical Thinking

1.1 Statement, Logical Connectives, Compound Statements and Truth Table

1. Which of the following is a statement in logic?
   (A) What a wonderful day!
   (B) Shut up!
   (C) What are you doing?
   (D) Bombay is the capital of India.

2. Which of the following is a statement?
   (A) Open the door.
   (B) Do your homework.
   (C) Switch on the fan.
   (D) Two plus two is four.

3. Which of the following is a statement in logic?
   (A) Go away (B) How beautiful!
   (C) $x > 5$ (D) 2 = 3

4. The connective in the statement "Earth revolves around the Sun and Moon is a satellite of earth", is
   (A) or (B) Earth
   (C) Sun (D) [illegible]nd

5. p: Sunday is a holiday, q: Ram does not [illegible] on holiday.
   The symbolic form of the statement
   'Sunday is a holiday and Ram studies on holiday' is
   (A) $p \wedge \sim q$ (B) [illegible] $\wedge q$
   (C) $\sim p \wedge$ [illegible] (D) p [illegible] ~q

6. p : There are clouds in the sky and q : it is not raining. The symbolic form is
   (A) p [illegible] q (B) $p \rightarrow \sim q$
   (C) [illegible] (D) $\sim p \wedge q$

7. If p: The sun has set, q: The moon has risen, then symbolically the statement 'The sun has not set or the moon has not risen' is written as
   (A) $p \wedge \sim q$ (B) $\sim q \vee p$
   (C) $\sim p \wedge q$ (D) $\sim p \vee \sim q$

8. If p: Rohit is tall, q: Rohit is handsome, then the statement 'Rohit is tall or he is short and handsome' can be written symbolically as
   (A) $p \vee (\sim p \wedge q)$
   (B) $p \wedge (\sim p \vee q)$
   (C) $p \vee (p \wedge \sim q)$
   (D) $\sim p \wedge (\sim p \wedge \sim q)$

9. Assuming the first part of the statement as p, second as q and the third as r, the statement 'Candidates are present, and voters are ready to vote but no ballot papers' in symbolic form is
   (A) $(p \vee q) \wedge \sim r$ (B) [illegible] ~q) [illegible]
   (C) $(\sim p \wedge q) \wedge \sim r$ (D) (p [illegible] q) ∧ ~r

10. Write verbally $\sim p \vee q$ where
    p: She is beautiful; q: She is clever
    (A) She is beautiful but not clever
    (B) She is not beautiful or she is clever
    (C) She is not beautiful or she is not clever
    (D) She is beautiful and clever.

11. If p: Ram is lazy, q: Ram fails in the examination, then the verbal form of $\sim p \vee \sim q$ is
    (A) Ram is not lazy and he fails in the examination.
    (B) Ram is not lazy or he does not fail in the examination.
    (C) Ram is lazy or he does not fail in the examination.
    (D) Ram is not lazy and he does not fail in the examination.

12. A compound statement p or q is false only when
    (A) p is false.
    (B) q is false.
    (C) both p and q are false.
    (D) depends on p and q.

13. A compound statement p and q is true only when
    (A) p is true.
    (B) q is true.
    (C) both p and q are true.
    (D) none of p and q is true.

14. For the statements p and q '$p \rightarrow q$' is read as 'if p then q'. Here, the statement q is called
    (A) antecedent.
    (B) consequent.
    (C) logical connective.
    (D) prime component.

15. If p : Prakash passes the exam,
    q : Papa will give him a bicycle.
    Then the statement 'Prakash passing the exam, implies that his papa will give him a bicycle' can be symbolically written as
    (A) $p \rightarrow q$ (B) $p \leftrightarrow q$
    (C) $p \wedge q$ (D) $p \vee q$

16. 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) $\sim a \to \sim d$ (B) $\sim d \to \sim a$
(C) $\sim d \wedge a$ (D) $a \wedge \sim d$

17. 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) $a \to b$ (D) $b \to a$

18. A compound statement $p \to q$ is false only when
(A) p is true and q is false.
(B) p is false but q is true.
(C) atleast one of p or q is false.
(D) both p and q are false.

19. Assuming the first part of each statement as p, second as q and the third as r, the statement 'If A, B, C are three distinct points, then either they are collinear or they form a triangle' in symbolic form is
(A) $p \leftrightarrow (q \vee r)$ (B) $(p \wedge q) \to r$
(C) $p \to (q \vee r)$ (D) $p \to (q \wedge r)$

20. If m: Rimi likes calculus.
n: Rimi opts for engineering branch.
Then the verbal form of $m \to n$ is
(A) If Rimi opts for engineering branch then she likes calculus.
(B) If Rimi likes calculus then she does not opt for engineering branch.
(C) If Rimi likes calculus then she opts for engineering branch
(D) If Rimi likes engineering branch then she opts for calculus.

21. The inverse of logical statement $p \to q$ is
(A) $\sim p \to$ [illegible] (B) p [illegible] q
(C) $q \to$ [illegible] (D) $q \leftrightarrow p$

22. Contrapositive of $p \to q$ is
(A) q [illegible] p (B) $\sim q \to p$
(C) [illegible] $\to$ [illegible]p (D) $q \to \sim p$

23. The statement "If x^2 is not even then x is not even", [illegible] the converse of the statement
(A) If x^2 is odd, then x is even
(B) If x is not even, then x^2 is not even
(C) If x is even, then x^2 is even
(D) If x is odd, then x^2 is even

24. The converse of the statement "If $x > y$, then $x + a > y + a$", is
(A) If $x < y$, then $x + a < y + a$
(B) If $x + a > y + a$, then $x > y$
(C) If $x < y$, then $x + a > y + a$
(D) If $x > y$, then $x + a < y + a$

25. The inverse of the statement "If you access the internet, then you have to pay the charges", is
(A) If you do not access the internet, then you do not have to pay the charges.
(B) If you pay the charges, then you accessed the internet.
(C) If you do not pay the charges, then you do not access the internet.
(D) You have to pay the charges if and only if you access the internet.

26. The contrapositive of the statement: "If a child concentrates then he learns" is
(A) If a child does not concentrate he does not learn.
(B) If a child does not learn then he does not concentrate.
(C) If a child practises then he learns.
(D) If a child concentrates, he does not forget.

27. If p: Sita gets promotion,
q: Sita is transferred to Pune.
The verbal form of $\sim p \leftrightarrow q$ is written as
(A) Sita gets promotion and Sita gets transferred to Pune.
(B) Sita does not get promotion then Sita will be transferred to Pune.
(C) Sita gets promotion if Sita is transferred to Pune.
(D) Sita does not get promotion if and only if Sita is transferred to Pune.

28. Negation of a statement in logic corresponds to ________ in set theory.
(A) empty set
(B) null set
(C) complement of a set
(D) universal set

29. The logical statement '$p \wedge q$' can be related to the set theory's concept of
(A) union of two sets
(B) intersection of two set
(C) subset of a set
(D) equality of two sets

30. If p and q are two logical statements and A and B are two sets, then $p \to q$ corresponds to
(A) $A \subseteq B$ (B) $A \cap B$
(C) $A \cup B$ (D) $A \not\subseteq B$

1.2 Statement Pattern, Logical Equivalence, and Algebra of Statements

31. Every conditional statement is equivalent to
(A) its contrapositive (B) its inverse
(C) its converse (D) only itself

32. 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.

33. 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) $q \wedge (p \vee r)$

1.3 Tautology, Contradiction, Contingency

34. When the compound statement is true for all its components then the statement is called
(A) negation statement.
(B) tautology statement.
(C) contradiction statement.
(D) contingency statement.

35. The statement $(p \wedge q) \to p$ is
(A) a contradiction (B) a tautology
(C) either (A) or (B) (D) a contingency

36. The proposition $(p \wedge q) \wedge (p \to \sim q)$ is
(A) Contradiction
(B) Tautology
(C) Contingency
(D) Tautology and Contradiction

37. The proposition $(p \to \sim p) \wedge (\sim p \to p)$ is a
(A) Neither tautology nor contradiction
(B) Tautology
(C) Tautology and contradiction
(D) Contradiction

38. The proposition [illegible] $\to \sim(p \wedge q)$ is
(A) contradiction. (B) tautology.
(C) contingency. (D) none of these

39. The proposition [illegible] $\to q) \leftrightarrow (\sim p \to \sim q)$ is a
(A) tautology (B) contradiction
(C) contingency (D) none of these

1.[illegible] Quantifiers and Quantified Statements, Duality

40. Using quantifiers ∀, ∃, convert the following open statement into true statement.
'$x + 5 = 8, x \in N$'
(A) $\forall x \in N, x + 5 = 8$
(B) For every $x \in N, x + 5 > 8$
(C) $\exists x \in N$, such that $x + 5 = 8$
(D) For every $x \in N, x + 5 < 8$

41. Using quantifier the open sentence '$x^2 - 4 = 32$' defined on W is converted into true statement as
(A) $\forall x \in W, x^2 - 4 = 32$
(B) $\exists x \in W$, such that $x^2 - 4 \le 32$
(C) $\forall x \in W, x^2 - 4 > 32$
(D) $\exists x \in W$, such that $x^2 - 4 = 32$

42. Dual of the statement $(p \wedge q) \vee \sim q \equiv p \vee \sim q$ is
(A) $(p \vee q) \vee \sim q \equiv p \vee \sim q$
(B) $(p \wedge q) \wedge \sim q \equiv p \wedge \sim q$
(C) $(p \vee q) \wedge \sim q \equiv p \wedge \sim q$
(D) $(\sim p \vee \sim q) \wedge q \equiv \sim p \wedge q$

43. The dual of the statement "Manoj has the job but he is not happy" is
(A) Manoj has the job or he is not happy.
(B) Manoj has the job and he is not happy.
(C) Manoj has the job and he is happy.
(D) Manoj does not have the job and he is happy.

1.5 Negation of compound statements

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

45. $\sim(p \vee \sim q)$ is equal to
(A) $\sim p \vee q$ (B) $\sim p \wedge q$
(C) $\sim p \vee \sim p$ (D) $\sim p \wedge \sim q$

46. The negation of the statement
" I like Mathematics and English" is
(A) I do not like Mathematics and do not like English
(B) I like Mathematics but do not like English
(C) I do not like Mathematics but like English
(D) Either I do not like Mathematics or do not like English

47. Negation of the statement: '$\sqrt{5}$ is an integer or 5 is irrational' is
(A) $\sqrt{5}$ is not an integer or 5 is not irrational
(B) $\sqrt{5}$ is irrational or 5 is an integer
(C) $\sqrt{5}$ is an integer and 5 is irrational
(D) $\sqrt{5}$ is not an integer and 5 is not irrational

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

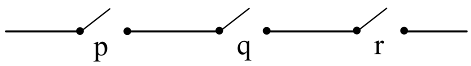
49. The negation of 'If it is Sunday then it is a holiday' is
(A) It is a holiday but not a Sunday.
(B) No Sunday then no holiday.
(C) It is Sunday, but it is not a holiday,
(D) No holiday therefore no Sunday.

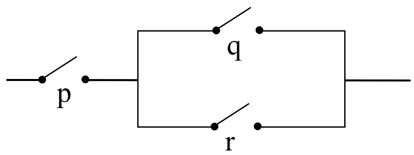
50. The negation of $q \vee \sim(p \wedge r)$ is
(A) $\sim q \wedge \sim(p \vee r)$ (B) $\sim q \wedge (p \wedge r)$
(C) $\sim q \vee (p \wedge r)$ (D) $\sim q \vee (p \wedge r)$

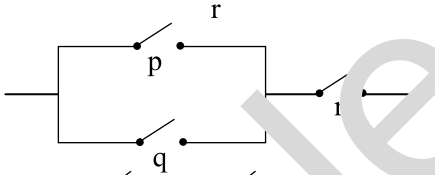
51. Which of the following is always true?
(A) $\sim(p \rightarrow q) \equiv \sim q \rightarrow \sim p$
(B) $\sim(p \vee q) \equiv p \vee \sim q$
(C) $\sim(p \rightarrow q) \equiv p \wedge \sim q$
(D) $\sim(p \vee q) \equiv \sim p \wedge \sim q$

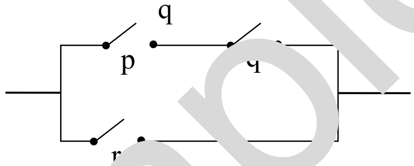
52. The negation of 'For every natural number x, $x + 5 > 4$' is
(A) $\forall\, x \in N, x + 5 < 4$
(B) $\forall\, x \in N, x - 5 < 4$
(C) For every integer x, $x + 5 < 4$
(D) There exists a natural number x, for which $x + 5 \leq 4$

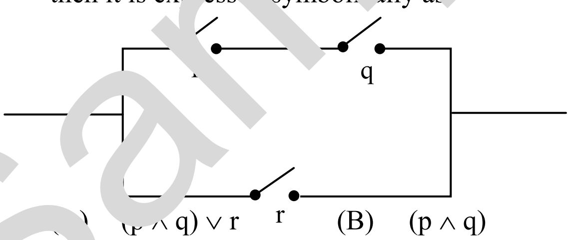
1.6 Switching circuit

53. The switching circuit for the statement $p \wedge q \wedge r$ is
(A)


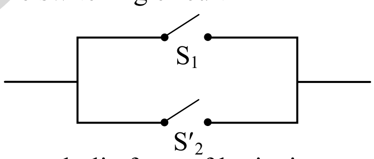
(B)


(C)


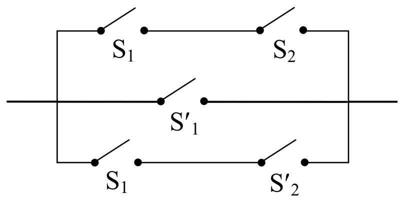
(D)


54. If the current flows through the given circuit, then it is expressed symbolically as


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

55. The switching circuit


in symbolic form of logic, is
(A) $p \wedge \sim q$ (B) $p \vee \sim q$
(C) $p \rightarrow \sim q$ (D) $p \leftrightarrow \sim q$

56. The switching circuit


in symbolic form of logic, is
(A) $(p \wedge q) \vee (\sim p) \vee (p \wedge \sim q)$
(B) $(p \vee q) \vee (\sim p) \vee (p \wedge \sim q)$
(C) $(p \wedge q) \wedge (\sim p) \vee (p \wedge \sim q)$
(D) $(p \vee q) \wedge (\sim p) \vee (p \wedge \sim q)$

Critical Thinking

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 $(p \rightarrow q) \leftrightarrow (\sim q \rightarrow \sim p)$ 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) $q \rightarrow p$ is true (D) $p \rightarrow q$ is true

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

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) $(p \wedge q) \rightarrow r$ is T
(C) $(p \vee q) \wedge (p \vee r)$ is T
(D) $(p \rightarrow q) \leftrightarrow (p \rightarrow r)$ is T

13. If the truth value of statement $p \rightarrow (\sim q \vee r)$ 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 $p \rightarrow (p \wedge \sim q)$ 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 $p \vee q$ is F, then which of the following is correct?
(A) $p \leftrightarrow q$ is T (B) $p \rightarrow q$ is T
(C) $q \rightarrow p$ is T (D) $p \rightarrow q$ is F

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

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. $p \wedge (p \rightarrow q)$ 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) $p \rightarrow q \equiv q \rightarrow p$
(D) $p \rightarrow q \equiv (\sim q) \rightarrow (\sim p)$

22. Which of the following is NOT equivalent to $p \rightarrow q$.
(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 $(p \rightarrow q) \wedge (q \rightarrow \sim p)$ is equivalent to:
(A) p (B) $\sim q$
(C) q (D) $\sim p$

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) $q \to (p \wedge (p \to q))$
    (C) $(p \wedge (p \to q)) \to q$
    (D) $p \wedge (p \vee q))$

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

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

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

32. Which of the following statement is contradiction?
    (A) [illegible] q) $\to q$
    (B) $(p \wedge \sim q) \wedge (p \to q)$
    (C) $p \to \sim (p \wedge \sim q)$
    (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) $(p \wedge q) \leftrightarrow (\sim p \to \sim q)$
    (C) $(\sim q \wedge p) \vee (p \vee \sim p)$
    (D) $(q \to p) \vee (\sim p \leftrightarrow q)$

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) $\forall\, x \in A, x + 1 \le 10$
    (C) $\forall\, x \in A, 2x \le 17$
    (D) $\exists\, x \in A$, such that $x + 1 > 10$

35. Using quantifier the open sentence $x^2 >$ [illegible] 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 $x^2 <$ [illegible]
    (D) $\exists x \notin N$, such that $x^2 <$ [illegible]

36. Which of the following quantified statement is false?
    (A) $\exists x \in N$ such that $x + 5 \le 6$
    (B) $\forall x \in N, x \nless 0$
    (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) $p \vee (p \wedge \sim q)$

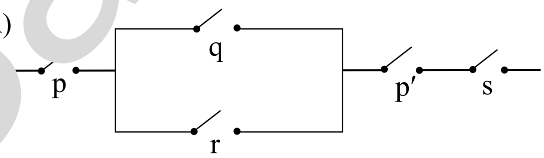
45. The logical statement $[\sim(\sim p \vee q) \vee (p \wedge r)] \wedge (\sim q \wedge r)$ is equivalent to:
(A) $(\sim p \wedge \sim q) \wedge r$ (B) $(p \wedge \sim q) \vee r$
(C) $\sim p \vee r$ (D) $(p \wedge r) \wedge \sim q$

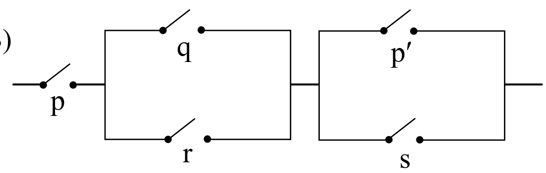
46. $p \leftrightarrow q$ is logically NOT equivalent to
(A) $(\sim p \vee q) \wedge (\sim q \vee p)$
(B) $(p \wedge q) \vee (\sim p \wedge \sim q)$
(C) $(p \wedge \sim q) \vee (q \wedge \sim p)$
(D) $(p \rightarrow q) \wedge (q \rightarrow p)$

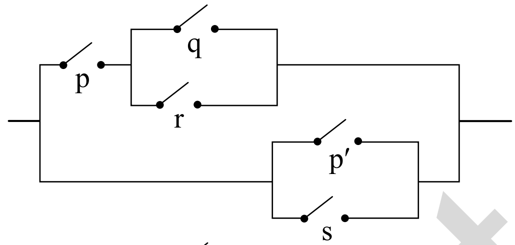
47. The negation of the statement "If Saral Mart does not reduce the prices, I will not shop there any more" is
(A) Saral Mart reduces the prices and still I will shop there.
(B) Saral Mart reduces the prices and I will not shop there.
(C) Saral Mart does not reduce the prices and still I will shop there.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

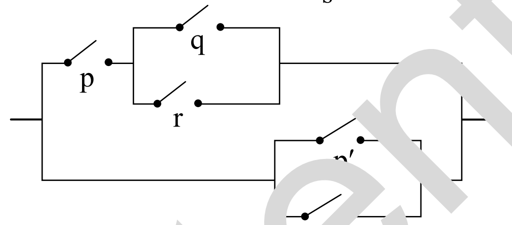
48. The negation of the statement, $\exists\, x \in R$, such that $x^2 + 3 > 0$, is
(A) $\exists\, x \in R$, such that $x^2 + 3 < 0$
(B) $\forall\, x \in R$, $x^2 + 3 > 0$
(C) $\forall\, x \in R$, $x^2 + 3 \leq 0$
(D) $\exists\, x \in R$, such that $x^2 + 3 = 0$

1.6 Switching circuits

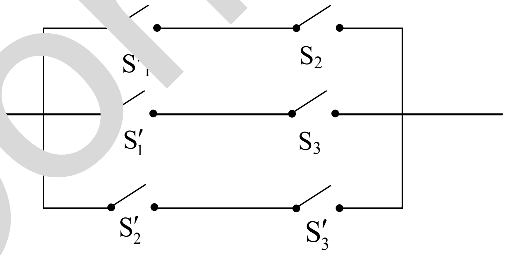
49. The switching circuit for the statement $[p \wedge (q \vee r)] \vee (\sim p \vee s)$ is
(A)


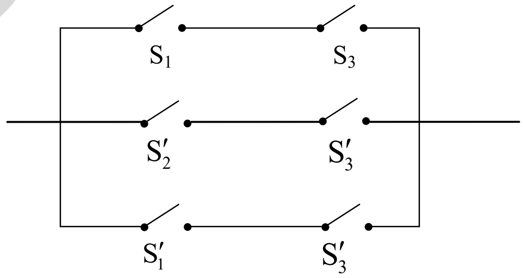
(B)


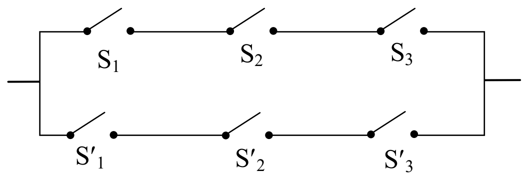
(C)


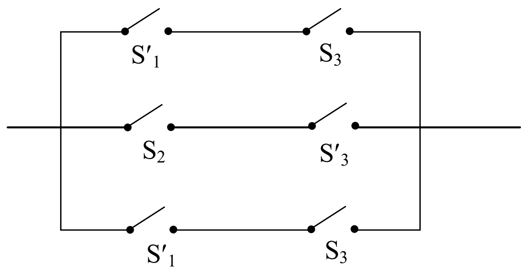
(D)


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

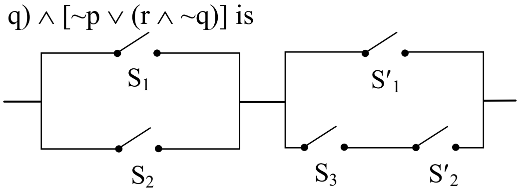
(A)


(B)


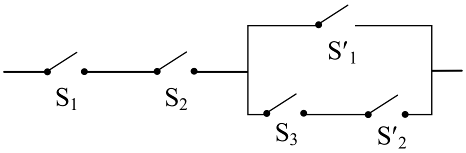
(C)


(D)


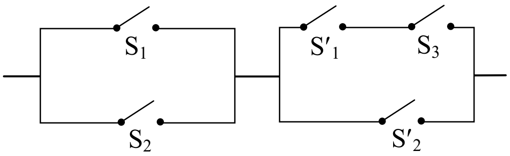
51. The switching circuit for the symbolic form $(p \vee q) \wedge [\sim p \vee (r \wedge \sim q)]$ is

(A)


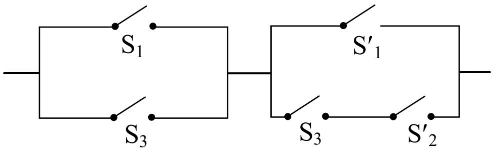
(B)



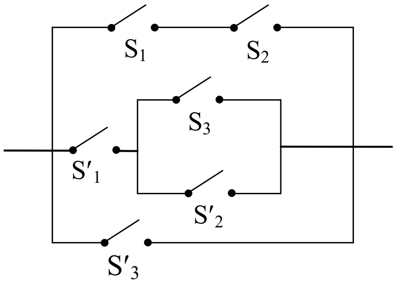
(C)



(D)

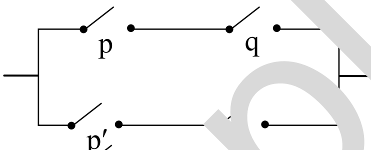


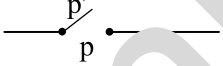
52. The symbolic form of logic for the following circuit is



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

53. The simplified circuit for the following circuit is



(A)


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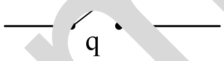

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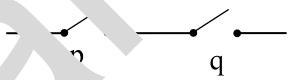

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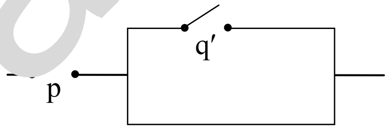
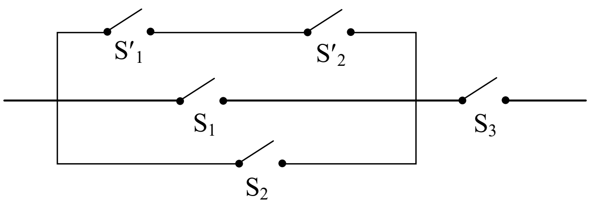
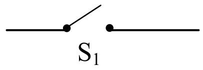
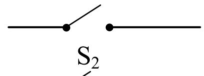
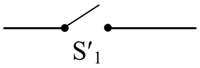


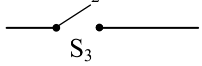
54. The simplified circuit for the following circuit is



(A)


(B)


(C)


(D)


Competitive Thinking

1.1 Statement, Logical Connectives, Compound Statements and Truth Tables

1. Which of the following statement is not a statement in logic? **[MHT CET 2015]**
(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? **[Karnataka CET 2014]**
(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. Let p be the proposition : Mathematics is interesting and let q be the proposition : Mathematics is difficult, then the symbol $p \wedge q$ means **[Karnataka CET 2001]**
(A) Mathematics is interesting implies that Mathematics is difficult.
(B) Mathematics is interesting implies and is implied by Mathematics is difficult.

(C) Mathematics is interesting and Mathematics is difficult.
(D) Mathematics is interesting or Mathematics is difficult.

7. Let p: roses are red and q : the sun is a star. Then the verbal translation of $(\sim p) \vee q$ is **[Kerala (Engg.) 2011]**
(A) Roses are not red and the sun is not a star.
(B) It is not true that roses are red or the sun is not a star.
(C) It is not true that roses are red and the sun is not a star.
(D) Roses are not red or the sun is a star.

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, [illegible]
(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 **[Karnataka CET 2002]**
(A) F, T (B) [illegible], F
(C) T, T (D) T, [illegible]

12. If $(p \wedge \sim q)$ [illegible] $(\sim p \vee$ [illegible]) is a false statement, then respective truth values of p, q and r are **[MH CET 2010]**
OR
If (p [illegible] ~ r) $\rightarrow (\sim p \vee q)$ is false, then the truth values of p, q and r are respectively **[Assam CEE 2018]**
(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 **[Karnataka CET 2005]**
(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 **[Orissa JEE 20[illegible]]**
(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 **[Orissa JEE 2011]**
(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 **[Karnataka CET 2017]**
(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 **[JEE (Main) 2019]**
(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 logically equivalent statement of $p \leftrightarrow q$ is **[Karnataka CET 2000]**
(A) $(p \wedge q) \vee (q \rightarrow p)$
(B) $(p \wedge q) \rightarrow (p \vee q)$
(C) $(p \rightarrow q) \wedge (q \rightarrow p)$
(D) $(p \wedge q) \vee (p \wedge q)$

22. The statement $p \rightarrow (\sim q)$ is equivalent to **[Kerala (Engg.) 2011]**
(A) $q \rightarrow p$ (B) $\sim q \vee \sim p$
(C) $p \wedge \sim q$ (D) $\sim q \rightarrow p$

23. $\sim p \wedge q$ is logically equivalent to **[Karnataka CET 2004]**
(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 **[JEE (Main) 2016]**
(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 **[AIEEE 2008]**
(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? **[Kerala PET 2007]**
(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 **[Karnataka CET 2005]**
(A) Tautology
(B) Contradiction
(C) Tautology and contradiction
(D) Contingency

31. Which of the following statements is a tautology? **[DCE 2009]**
(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 **[AIEEE 2011]**
(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
$(p \rightarrow q) \rightarrow [(\sim p \rightarrow q) \rightarrow q]$ is **[JEE (Main) 2017]**
(A) A fallacy
(B) A tautology
(C) Equivalent to $\sim p \rightarrow q$
(D) Equivalent to $p \rightarrow \sim q$

35. The false statement in the following is **[Karnataka CET 2002]**
(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) $(p \rightarrow q) \leftrightarrow (\sim q \rightarrow \sim p)$ 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 **[Kerala (Engg.) 2011]**
(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 **[JEE (Main) 2015]**
(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 **[JEE (Main) 2018]**
(A) p (B) q
(C) ~ q (D) ~ p

41. The negation of $p \rightarrow (\sim p \vee q)$ is **[Karnataka CET 2011]**
(A) $p \vee (p \vee \sim q)$ (B) $p \rightarrow \sim (p \vee q)$
(C) $p \rightarrow q$ (D) $p \wedge \sim q$

42. Negation of $(\sim p \rightarrow q)$ 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 $(p \wedge q) \rightarrow (\sim p \vee r)$ 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) $(p \vee q) \vee (p$ [illegible]

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

45. The statement $\sim(p \leftrightarrow \sim q)$ is **[JEE (Main) 2014]**
(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 **[Karnataka CET 2018]**
(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 **[Kerala (Engg.) 2010]**
(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 **[Karnataka CET 2007]**
(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.

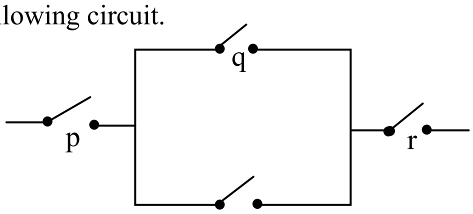
52. The negation of the statement "some equations have real roots" is **[MHT CET 2019]**
(A) All equations do not have real roots
(B) All equations have real roots
(C) Some equations do not have real roots
(D) Some equations have rational roots

53. The negation of the statement "All continuous functions are differentiable" **[Karnataka CET 2019]**
(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? **[AIEEE 2010]**
(A) There is a rational number $x \in$ S such that $x \le 0$
(B) There is no rational number $x \in$ S such that $x \le 0$
(C) Every rational number $x \in$ S satisfies $x \le 0$
(D) $x \in$ S and $x \le 0 \rightarrow x$ is not rational

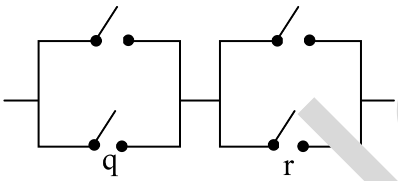
1.6 Switching circuit

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



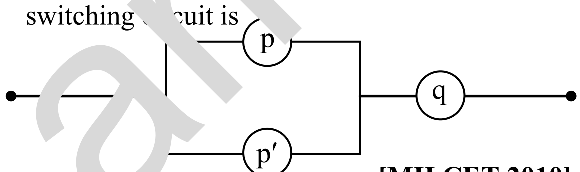
[Karnataka CET 2002]
(A) p, q should be closed and r is open
(B) p, q, r should be open
(C) p, q, r should be closed
(D) none of these

56. If



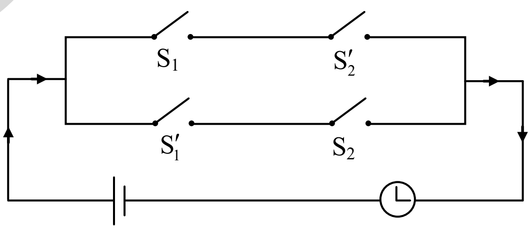
then the symbolic form is **[MH CET 2009]**
(A) $(p \vee q) \wedge (p \vee r)$
(B) $(p \wedge q) \vee (p \vee r)$
(C) $(p \wedge q) \wedge$ (p
(D) $(p \wedge q) \wedge$ r

57. Simplified logical expression for the following switching circuit is



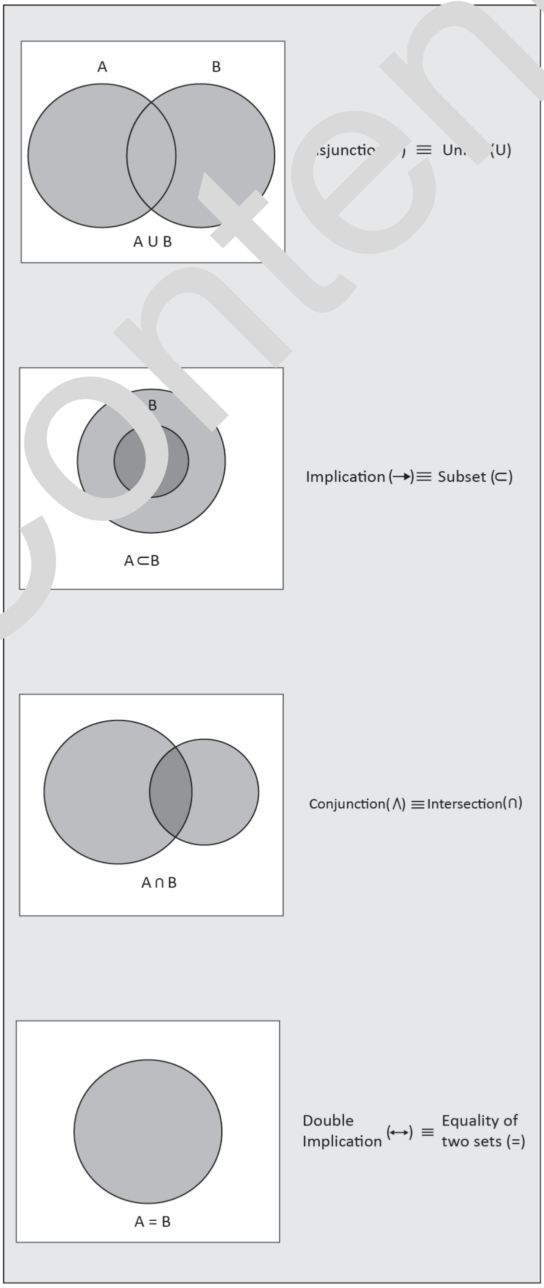
[MH CET 2010]
(A) p (B) q
(C) p′ (D) $p \wedge q$

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) $\sim(p \leftrightarrow q)$

Relations between logical connectives and various operations on sets



The rules of logic and set theory go hand in hand.

Answer Key

Classical Thinking

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

Critical Thinking

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. [illegible]	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. [illegible]	48. (C)	49. (C)	50. (B)
51. (A)	52. (C)	53. (B)	54. (D)						

Competitive Thinking

1. (D)	2. (B)	3. (A)	4. (B)	5. (D)	6. [illegible]	7. (D)	8. (A)	9. (C)	10. (D)
11. (D)	12. (A)	13. (D)	14. (C)	15. [illegible]	16. (B)	17. (A)	18. (D)	19. (B)	20. (C)
21. (C)	22. (B)	23. (D)	24. (B)	25. [illegible]	26. [illegible]	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. [illegible]	55. (C)	56. (A)	57. (B)	58. (D)		

Evaluation Test

1. Which of the following is not a statement in logic?
   (A) Every set is a finite set.
   (B) 2 + 3 < 6
   (C) $x + 3 = 10$
   (D) Zero is a complex number.

2. If p → (q ∨ r) is false, then the truth values of p, q and r are respectively
   (A) T, F, F (B) F, F, F
   (C) T, T, F (D) T, T, F

3. The contrapositive of (~p ∧ q) → ~r is
   (A) (p ∧ q) → r
   (B) (p ∨ q) → r
   (C) r → (p ∨ ~q)
   (D) none of these

4. The converse of the statement, "If $\sqrt{x}$ is a complex number, then x is a negative number" is
   (A) If $\sqrt{x}$ is not a complex number, then x is not a negative number.
   (B) If x is a negative number, then $\sqrt{x}$ is a complex number.
   (C) If x is not a negative number, then $\sqrt{x}$ is not a complex number.
   (D) If $\sqrt{x}$ is a real number, then x is a positive number.

5. The inverse of the proposition (p ∧ ~q) → r is
   (A) ~r → ~p ∨ q (B) ~p ∨ q → ~ r
   (C) r → p ∧ ~q (D) ~p ∧ q → ~ r

6. The negation of the statement $\forall x \in N, x + 1 > 2$ is
   (A) $\forall x \notin N, x + 1 < 2$
   (B) $\exists x \in N$, such that $x + 1 > 2$
   (C) $\forall x \in N, x + 1 \le 2$
   (D) $\exists x \in N$, such that $x + 1 \le 2$

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

8. Which of the following is a contradiction?
   (A) $(p \wedge q) \wedge (\sim(p \vee q))$
   (B) $p \vee (\sim p \wedge q)$
   (C) $(p \rightarrow q) \rightarrow p$
   (D) none of these

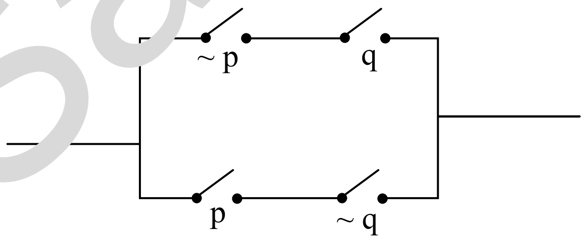
9. If p, q are true and r is a false statement, then which of the following is a true statement?
   (A) $(p \wedge q) \vee r$ is F
   (B) $(p \wedge q) \rightarrow r$ is T
   (C) $(p \vee q) \wedge (p \vee r)$ is T
   (D) $(p \rightarrow q) \leftrightarrow (p \rightarrow r)$ is T

10. The dual of the statement
    $\sim(p \vee q) \wedge [p \vee \sim (q \wedge \sim r)]$ is
    (A) $\sim (p \wedge q) \vee [p \wedge \sim (q \vee \sim r)]$
    (B) $(\sim p \wedge \sim q) \vee [\sim p \wedge (\sim q \vee r)]$
    (C) $(p \vee q) \wedge [\sim p \vee (q \wedge \sim r)]$
    (D) $\sim (p \wedge q) \wedge [\sim p \wedge (q \vee \sim r)]$

11. Consider the following statements:
    P : Suman is brilliant
    Q : Suman is rich
    R: Suman is honest.
    The negation of the statement "Suman is brilliant and dishonest iff suman is rich" can be expressed as
    (A) $\sim P \wedge (Q \leftrightarrow \sim R)$
    (B) $\sim(Q \leftrightarrow (P \wedge \sim R))$
    (C) $\sim Q \leftrightarrow \sim (P \wedge R)$
    (D) $\sim (P \wedge \sim R) \leftrightarrow Q$

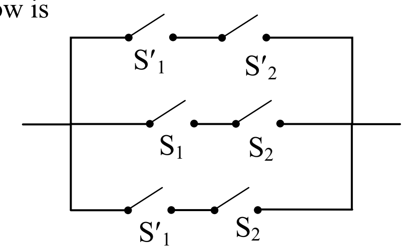
12. Which of the following is true?
    (A) $p \wedge \sim p \equiv T$
    (B) $p \vee \sim p \equiv F$
    (C) $p \rightarrow q \equiv q \rightarrow p$
    (D) $p \rightarrow q \equiv (\sim q) \rightarrow (\sim p)$

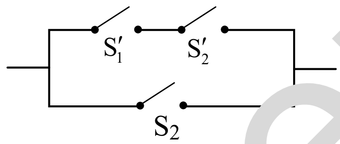
13. The following circuit represent symbolically in logic when the current flow in the circuit.

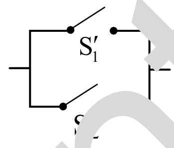


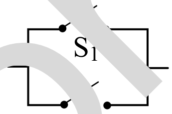
    Which of the symbolic form is correct?
    (A) $(\sim p \vee q) \vee (p \vee \sim q)$
    (B) $(\sim p \wedge p) \wedge (\sim q \wedge q)$
    (C) $(\sim p \wedge \sim q) \wedge (q \wedge p)$
    (D) $(\sim p \wedge q) \vee (p \wedge \sim q)$

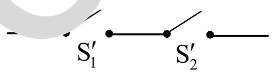
14. Simplified form of the switching circuit given below is



    (A)


    (B)


    (C)


    (D)


15. Statement-1: $\sim(p \leftrightarrow \sim q)$ is equivalent to $p \leftrightarrow q$.
    Statement-2: $\sim(p \leftrightarrow \sim q)$ is a tautology.
    (A) Statement-1 is true, statement-2 is true.
    (B) Statement-1 is true, statement-2 is false.
    (C) Statement-1 is false, statement-2 is true.
    (D) Statement-1 is true, statement-2 is true; statement-2 is a correct explanation for statement-1.

Answers to Evaluation Test

1.	(C)	2.	(A)	3.	(C)	4.	(B)
5.	(B)	6.	(D)	7.	(C)	8.	(A)
9.	(C)	10.	(A)	11.	(B)	12.	(D)
13.	(D)	14.	(B)	15.	(B)		