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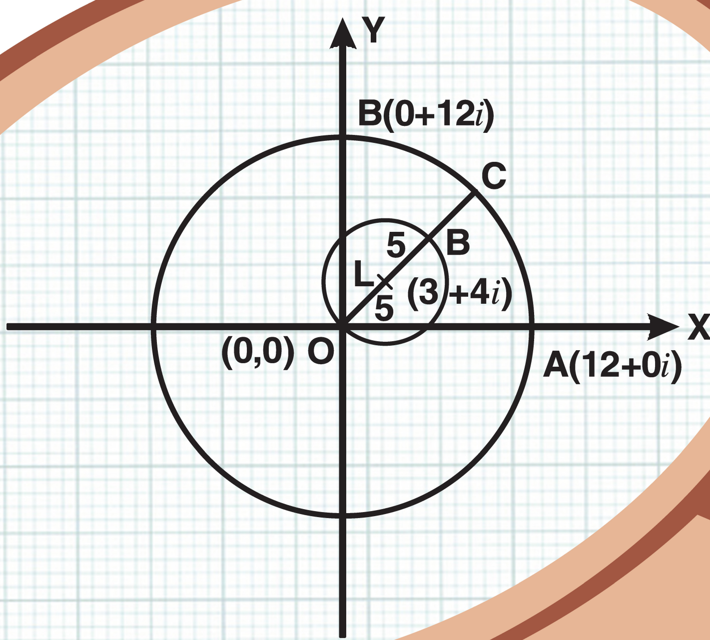
Objective MATHEMATICS For MH-CET

Maharashtra State Engineering Entrance Examination



J. P. Mohindru
Bharat Mohindru

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- Review Section emphasizes important definitions, terms, key point, formulae, mathematical relations, etc.
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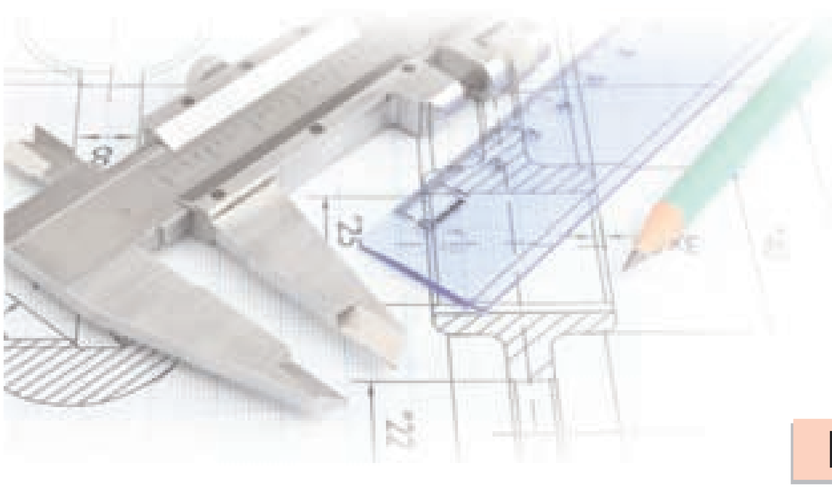

By

J.P. Mohindru

(Author of Modern's abc + of Mathematics Series)

&

Bharat Mohindru

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PREFACE

We feel pleasure in presenting the book 'Modern's abc of Objective Mathematics' for students appearing in MH-CET examinations . The book has been thoroughly written in accordance with the latest syllabus and changing trends of examinations.

CHAPTER OVERVIEW

This provides complete but brief synopsis alongwith IN FOCUS of each chapter emphasising the principles, definitions, terms, mathematical relations ; etc. This part can serve as QUICK REVISION OF THE CHAPTER BEFORE THE EXAMINATION.

QUESTIONS

These include a variety of objective questions in the form of Multiple Choice Questions (M.C.Q.) have been classified into two levels as : Level-I Concept Based Questions, Level-II Applications & Brain Teasing Questions. These have been added in accordance with the latest style and thrust of the examinations. Questions from all types of competitive examinations have been included.

HINTS AND SOLUTIONS

The book gives answers to all questions. Hints and Solutions of all questions are given, which is an important feature of the book.

UNIT TEST PAPERS AND MOCK TESTS

This is an important feature of the book. Revision Test Papers have been added at the end of each Chapter . These will help the student to check his/her performance after covering the Chapter. Mock Test Paper covering the complete syllabus is given at the end of each part of the book.

–J.P. Mohindru

ACKNOWLEDGEMENTS

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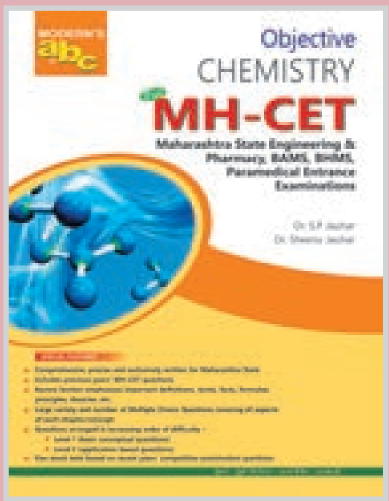
I express my sincere indebtedness to my friends, colleagues and dear students who have been helping me in different ways during the preparation of this book. I wish to acknowledge my special thanks and deep appreciation for their valuable suggestions.

I acknowledge with thanks to Shri Balwant Sharma (National Sales Head), Sh. Manik Juneja National Head (Content Operation) and their efficient staff to bring out the book. I am also indebted to Mr. S.K. Sikka (General Manager, Publication) and Mr. Ravinder Pathania (Publication Manager) for their valuable help.

I hope that the book will be warmly received by the young scholars. It will give an excellent guidance and will induce confidence in them to face the challenges of the examinations. Suggestions for the improvement of the book will be gratefully acknowledged.

J. P. Mohindru



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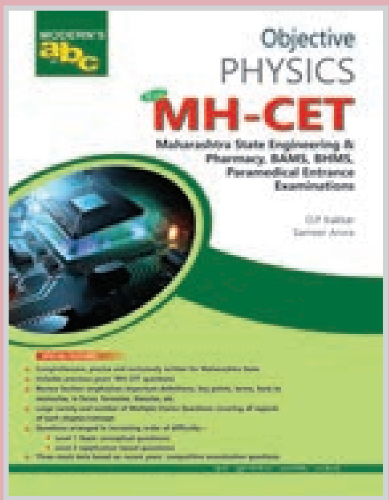

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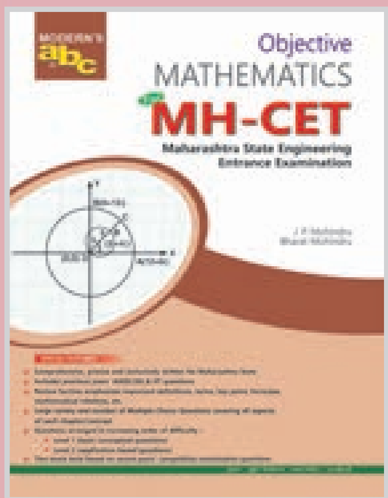

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CONTENTS

1 MATHEMATICAL LOGIC

Revision Notes

Important Formulae, Facts and Terms

1. STATEMENTS

A mathematically acceptable statement is a sentence, which is either true or false but not both simultaneously.

For Examples :

(*i*) Mumbai is in India, which is a **true statement.**

(*ii*) Earth is a star, which is a **false statement.**

(*iii*) Shut the door, which is not a statement but a **command.**

(*iv*) Where are you going ? This is not a statement but a **question.**

(*v*) Alas ! you have failed, which is not a statement but an **exclamatory.**

(*vi*) Good morning, Sir, which is not a statement but a **wish.**

(*vii*) Please give me a glass of water, which is not a statement but a **request.**

2. TRUTH VALUE OF A STATEMENT

The truth or falsity of a statement is called its truth value.

If the statement is true, then its truth value is 'True' or 'T'.

If the statement is false, then its truth value is 'False' or 'F'.

For Examples :

(I) Jaipur is the capital of Rajasthan.

The statement is 'True' or 'T'.

(II) Two plus two is five.

The statement is 'False' or 'F'.

3. OPEN STATEMENTS

A declarative sentence involving variable(s) is said to be an open statement if the variable(s) is (are) replaced by a definite value(s).

For Example :

$x^2 - 3x + 2 = 0.$

This is true when $x = 1, 2$ and false when x is other than 1 and 2.

4. SIMPLE AND COMPOUND STATEMENTS

(*a*) Simple Statement : A statement, which cannot be broken into two or more statements, is called a simple statement.

For Example :

(I) 5 is a natural number.

(II) New Delhi is the capital of India.

(*b*) Compound Statement. A statement, which consists of two or more statements, is called a compound statement.

For Example : If it is hot, then we use fan.

Key Point

Truth value of a compound statement is determined by the truth values of the sub-statements.

5. QUANTIFIERS

Quite often the terms : '*for all*', '*there exists*', '*for some*', '*there is at least*' appear in Mathematical statements. These are called quantifiers.

There are two types of quantifiers :

(*a*) Universal Quantifiers (*b*) Existential Quantifiers.

(*a*)Universal Quantifier.

This is used in statements, which refer to each and every object.

These statements use phrases : '*for all*', '*every*', '*for any*', '*there does not exist*'; etc.

For Example :

Each human being is mortal.

(*b*) Existential Quantifier.

This is used in statements, which refer to at least one object.

These statements use phrases '*there exists some*', : '*for some*', '*there is at least one*' ; etc.

For Example : There is at least one prime, which is even.

6. LOGICAL CONNECTIVES

(*a*) Conjunction (AND)

When two statements (p and q) are connected by logical connective '*and*', then the compound statement is called as conjunctive statement (denoted by $p \wedge q$).

RULE : $p \wedge q$ is true only when both p and q are true.

Table

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

(*b*) Disjunction (OR)

When two statements (p and q) are connected by logical connective '*or*', then the compound statement is called as disjunctive statement (denoted by $p \vee q$).

RULE : $p \vee q$ is false only when both p and q are both false, otherwise $p \vee q$ is true.

Table

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

(*c*) Negation

(*i*) The denial of a statement is called the negation of the statement.

Negation of a statement 'p' is denoted by '$\sim p$' and read as 'not p'.

(*ii*) (I) The negation of the conjunction statement means the negation of at least one of the two component statements.

Symbolically : $\sim (p \wedge q) = (\sim p) \vee (\sim q)$.

(II) The negation of the disjunction statement means the negation of both the compound statements simultaneously.

Symbolically : $\sim (p \vee q) = (\sim p) \wedge (\sim q)$.

7. IMPLICATIONS

Here we shall discuss implications of '*if.....then*' and '*if and only if*'.

(*a*) Conditional Statement : When two statements (p and q) are connected by the connective '*if then*', then the compound statement is called the conditional statement and is denoted by $p \Rightarrow q$.

RULE : $p \Rightarrow q$ is false only when p is true and q is false. In all other cases, $p \Rightarrow q$ is true.

Table

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

(*b*) **Biconditional Statement :** When two statements (p and q) are connected by the connective *'if and only if'*, then the compound statement is called the Biconditional statement and is denoted by $p \Leftrightarrow q$.

RULE : $p \Leftrightarrow q$ is true only when p and q are both true or both false. In all other cases, $p \Leftrightarrow q$ is false.

TABLE

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

8. TAUTOGICAL AND FALLACIAL STATEMENTS

When the compound statement is true for all its components, then the statement is called tautogical statement. When the compound statement is false for all its components, then the statement is called fallacial statement.

9. DUALITY PRINCIPLE

When we exchange the symbols $\wedge$, $\vee$, T and F for $\vee$, $\wedge$, F and T respectively in any law, it is called a duality principle.

For Example :

We can show that $\sim (p \wedge q) = (\sim p) \vee (\sim q)$ is a tautology.

By the *Principle of Duality,* we have :

$\sim (p \vee q) = (\sim p) \wedge (\sim q)$ is also a tautology.

These are **duals** of each other.

10. CONVERSE AND CONTRAPOSITIVE

(I) 'If p, then q' ($p \Rightarrow q$), then its **converse** is :

If q, then p' ($q \Rightarrow p$).

(II) 'If p, then q' ($p \Rightarrow q$), then its **contrapositive** is :

'If not q, then not p' ($\sim q \Rightarrow \sim p$).

For Example : If a number is divisible by 9, then it is divisible by 3.

Its converse is : If a number is divisible by 3, then it is divisible by 9.

Its contrapositive is : If a number is not divisible by 3, then it is not divisible by 9.

TABLE

p	q	$\sim p$	$\sim q$	**CONVERSE** $q \Rightarrow p$	**CONTRA-POSITIVE** $\sim q \Rightarrow \sim p$
T	T	F	F	T	T
T	F	F	T	T	F
F	T	T	F	F	T
F	F	T	T	T	T

11. TAUTOLOGY AND CONTRADICTION

A proposition, which is true for any truth values of its variables, is called a **tautology.**

A principle, which is false for any truth values of its variables, is called a **fallacy** or **contradiction.**

Note : A statement, which is neither tautology nor a contradiction is called a **contingency.**

12. LAWS OF PROPOSITIONS

If a statement t is a tautology and f is a fallacy (contradiction), then for any statement (p), we have :

(I) $p \vee t = t$ (II) $p \wedge t = p$

(III) $p \vee f = p$ (IV) $p \wedge f = f$

(V) $p \vee \sim p = t$ (VI) $p \wedge \sim p = f$

(VII) $\sim t = f$ (VIII) $\sim f = t$.

13. LAWS OF LOGIC

We list below the most basic equivalence and implications of logic. It may be remembered that '1' and '0' stand for tautology and contradiction respectively.

(*i*) Identity Laws

(*a*) $(p \wedge 1) \Leftrightarrow p,$ (*b*) $(p \vee 0) \Leftrightarrow p.$

(*ii*) Negation Laws

(*a*) $p \vee \sim p \Leftrightarrow 1$ (*b*) $(p \wedge \sim p) \wedge 0.$

(*iii*) Idempotent Laws

(*a*) $p \vee p \Leftrightarrow p$ (*b*) $p \wedge p \Leftrightarrow p.$

(*iv*) Null Laws

(*a*) $p \wedge 1 \Leftrightarrow p$ (*b*) $p \wedge 0 \Leftrightarrow 0.$

(*v*) Absorption Laws

(*a*) $p \vee (p \wedge q) \Leftrightarrow p$ (*b*) $p \wedge (p \vee q) \Leftrightarrow p$

(*vi*) Commutative Laws

(*a*) $(p \vee q) \Leftrightarrow (q \vee p)$ (*b*) $(p \wedge q) \Leftrightarrow (q \wedge p).$

(*vii*) Associative Laws.

(*a*) $(p \vee q) \vee r \Leftrightarrow p \vee (q \vee r)$ (*b*) $(p \wedge q) \wedge r \Leftrightarrow p \wedge (q \wedge r).$

(*viii*) Distributive Laws.

(*a*) $p \vee (q \wedge r) \Leftrightarrow (p \vee q) \wedge (p \vee r)$ (*b*) $p \wedge (q \wedge r) \Leftrightarrow (p \vee r) \vee (p \vee r).$

(*ix*) De Morgan's Laws.

(*a*) $\sim (p \vee q) \Leftrightarrow (\sim p) \wedge (\sim q)$ (*b*) $\sim (p \wedge q) \Leftrightarrow (\sim p) \vee (\sim q).$

(*x*) Involution laws. $\sim (\sim p) = p.$

14. APPLICATIONS OF LOGIC TO SWITCHING CIRCUITS

Switching system *viz.* an electrical network consisting of switches is a major application of Boolean algebra. An example of such a device is ordinary ON-OFF switch. By a switch, we shall mean a device in electric circuit, which lets and does not let the current to flow through the circuit.

It can have two states—**'Closed'** or **'Open'** (**ON** or **OFF**). In the first case, the current flows and in the later case it does not flow.

Symbolically : *a, b, c; p, q, r; x, y, z;* .... denote the switches in a circle.

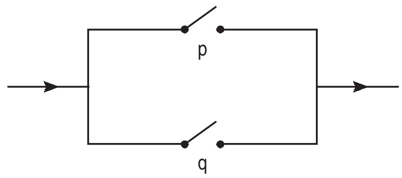
(*a*) TYPES OF SWITCHES

There are two ways when switches are interconnected.

(*i*) Series. Two switches p and q are said to be connected in series when the current can flow only when both are in closed state and the current does not flow when any one or both are open.

The above figure shows the circuit.

(*ii*) **Parallel.** Two switches p and q are said to be connected in parallel if the current flows when either or both are closed and the current does not flow when both are open.

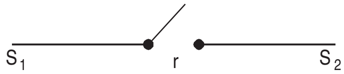


The above figure represents the circuit given by $p \vee q$.

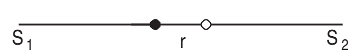
Notes. 1. When two switches in a circuit are both open (closed), then they are represented by the same letter.

2. When two switches in a circuit are such that one is open and the other is closed, then they are represented by p and p'.

Notation. The value of a closed switch or when it is **on** equals 1 and that of an open switch or when it is **off** equals 0.



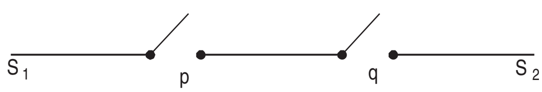
Open Switch



Closed Switch

(*b*) **Operations on Switching Circuits.**

(*i*) **Multiplication.** We have two switches p and q, which will perform multiplication operation of Boolean Multiplication.



Here the current does not flow from S_1 to S_2 when either or both p and q are open and it flows when both are closed.

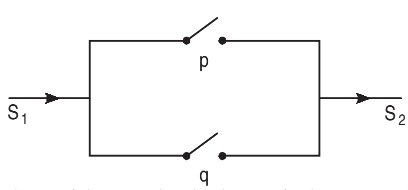
TABLE

p	q	p ∧ q
1	1	1
1	0	0
0	1	0
0	0	0

The above operation is true in only one of the four cases *i.e.* when both the switches are closed.

(*ii*) **Addition.**

Here the operation of addition, the two switches are in parallel series as shown below:



The current passes when either or both the switches are closed and the current does not pass only when both switches are open.

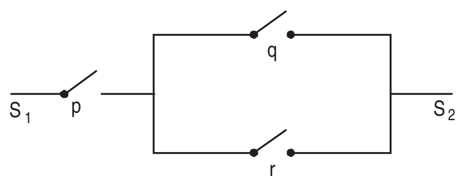
TABLE

p	q	p ∨ q
1	1	1
1	0	1
0	1	1
0	0	0

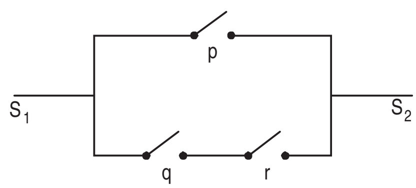
The above operation is not true only in one of the four cases *i.e.* when both p and q are open.

(*iii*) Circuits with Composite Operations.

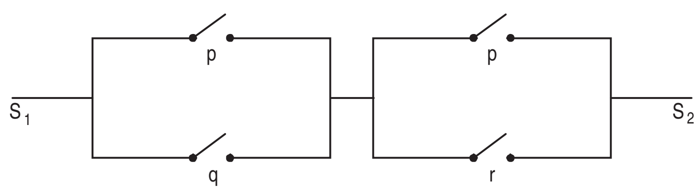
(I) $\mathbf{p \wedge (q \vee r)}$



(II) $\mathbf{p \vee (q \wedge r)}$

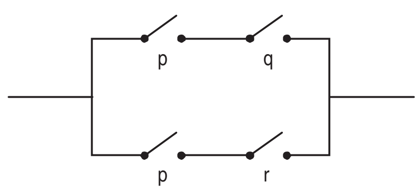


(III) $\mathbf{(p \vee q) \wedge (p \vee r)}$



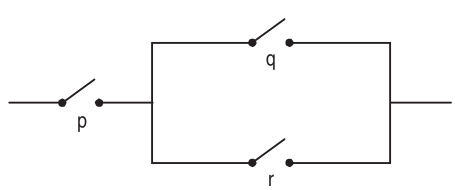
(IV) Simpification of Circuits

Consider the circuit given by $(p \wedge q) \vee (p \wedge r)$.



Since $(p \wedge q) \vee (p \wedge r) = p \wedge (q \vee r)$,

$\therefore$ the circuit can be simplified as :



In Focus

IMPORTANT RESULTS AND DEFINITIONS

1. $p \wedge q$ is true only when both p and q are true.

2. $p \vee q$ is false only when both p and q are false.

3. $p \Rightarrow q$ is false when p is true and q is false, in all other cases $p \Rightarrow q$ is always true.

4. $p \Leftrightarrow q$ is true only when p and q are both true or both false. In all other cases, $p \Leftrightarrow q$ is false.

5. Demorgan's Laws

(*a*) $\sim (p \vee q) \equiv (\sim p) \wedge (\sim q)$

(*b*) $\sim (p \wedge q) \equiv (\sim p) \vee (\sim q)$

6. Distributive Laws.

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

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

7. Absorption Laws.

$p \vee (p \wedge q) \equiv p, \ (p + p.q = p)$

$p \wedge (p \vee q) \equiv p, \ (p \cdot (p + q) = p)$.

MCQs Multiple Choice Questions

Select the correct answer :

LEVEL – I

1. A sentence is a logical statement, when it is
(A) either true or false (B) neither true nor false
(C) true and false (D) None of these.

2. When two or more logical statements are combined by logical connective 'and', 'or', 'not' 'if then', 'if and only if', then that statement is called :
(A) simple logical statement
(B) compound statement
(C) simple and compound statement
(D) None of these.

3. When two statements are connected by logical connective 'and', then the compound statement is called :
(A) conjunctive statement
(B) disjunctive statement
(C) negation statement
(D) conditional statement.

4. When two statements are connected by logical connective 'or', then the compound statement is called :
(A) conjunctive statement
(B) disjunctive statement
(C) negation statement
(D) conditional statement.

5. When two statements are connected by the connective 'if then', then compound statement is called :
(A) conjunctive statement
(B) disjunctive statement
(C) biconditional statement
(D) conditional statement.

6. When the two statements are connected by the connective 'if and only if', then the compound statement is called :
(A) conjunctive statement
(B) disjunctive statement
(C) biconditional statement
(D) conditional statement.

7. When the compound statement is true for all its components, then the statement is called :
(A) negation statement (B) tautogical statement
(C) fallacial statement (D) None of these.

8. When the compound statement is false for all its components, then the statement is called :
(A) negation statement (B) tautogical statement
(C) fallacial statement (D) None of these.

9. When a statement is presented by its contradictions, then the statement is known as :
(A) negation statement (B) tautogical statement
(C) fallacial statement (D) None of these.

10. If p and q be two statements, then the conjunctive
(A) both p and q are true
(B) either p or q is true
(C) either p or q is false
(D) None of these.

11. If p and q be two statements, then the disjunctive statement $p \vee q$ is false, when :
(A) both p and q are true
(B) either p or q is true
(C) both p and q is false
(D) None of these.

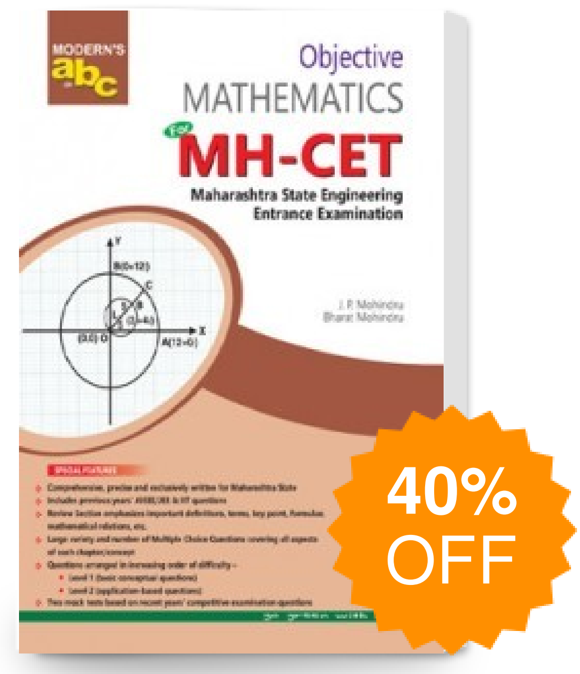
12. If p and q be two statements, then the conditional statement $p \Rightarrow q$ is false, when :
(A) p is true and q is true
(B) p is false and q is true
(C) p is true and q is false
(D) None of these.

13. If p and q be two statements, then the Biconditional statement $p \Leftrightarrow q$ is true only when :
(A) p is true and q is flase
(B) p is false and q is true
(C) p and q are both true or both false
(D) None of these.

14. If p : Sham is honest, q : Sham will pass, then the statement 'either Sham is honest or he will pass', is written in symbols as :
(A) $p \wedge q$ (B) $p \wedge \sim q$
(C) $p \vee q$ (D) None of these.

15. If p : Sham is honest, q : work hard, then the statement 'Sham is honest and hard working', is written in symbols as :
(A) $p \wedge q$ (B) $p \wedge \sim q$
(C) $p \vee q$ (D) None of these.

MOD ABC Of Objective Mathematics MH-CET



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