



# MATHS

## BOOKS - FULL MARKS MATHS (TAMIL ENGLISH)

### DISCRETE MATHEMATICS

#### Example

1. Examine the binary operation (closure property) of the following operation on the

respective sets (if is not , make it binary),

$$(i) a * b = a^2 + 3ab - 5b^2, \forall a, b \in \mathbb{Z}$$

$$(ii) a * b = \left( \frac{a - 1}{b - 1} \right), \forall a, b \in \mathbb{Q}$$



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2. Draw truth table for  $\neg p \wedge q$



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3. For a group to be abelian what is the property that is to be satisfied?



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4. Draw truth table for  $p \wedge \neg q$



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5. In the set of real number  $R$ , an operation  $*$  is defined by  $a * b = (a^2 + b^2)$ . Then the value of  $(3 * 4) * 5$  is .....



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6. In the set of real number  $R$ , an operation  $*$  is defined by  $a * b = (a^2 + b)$ . Then the value of  $(3 * 4) * 5$  is .....



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7. Identify the valid statement from the following: Go to your room!.



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8. Let  $A = \begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix}$ ,  $B = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$  be any two boolean matrices of the same type find  $A \vee B$  and  $A \wedge B$



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9. In the set of real number  $R$ , an operation  $*$  is defined by  $a * b = (a + b^2)$ . Then the value of  $(3 * 4) * 5$  is .....



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10. What the statement in words corresponding to  $\neg p, p \vee q, p \wedge q, q \vee \neg p$  where p is "it is cold" and q is "It is raining".



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11. How many rows are needed for following statement formulae?

(i)  $p \vee \neg t \wedge (p \vee \neg s)$

(ii)

$((p \wedge q) \vee (\neg r \vee \neg s)) \wedge (\neg t \wedge v)$



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12. Consider  $p \rightarrow q$ : If today is Monday , then  $4+4=8$ .

Here the component statement  $p$  and  $q$  are given by,  $p$ : Today is Monday ,  $q$ : $4+4=8$ .

The truth value of  $p \rightarrow q$  is T because the conclusion  $q$  is T.

An important point is that  $p \rightarrow q$  should not be treated by actually considering the meaning of  $p$  and  $q$  in English. Also it is not necessary that  $p$  should be related to  $q$  at all.



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**13.** Writes down the (i) conditional statement (ii) converse statement (iii) inverse statement and (iv) contrapositive statement for the two statement p and q given below. P: The number of printers is infinity .q : Ooty is in Kerala.



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**14.** Construct the truth table for

$$\left( p \bar{U} q \right) \wedge \left( p \bar{U} - q \right).$$



$p$	$q$	$\neg q$	$r: (p \bar{\vee} q)$	$s: (p \bar{\vee} \neg q)$	$r \wedge s$
T	T	F	F	T	F
T	F	T	T	F	F
F	T	F	T	F	F
F	F	T	F	T	F



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15. Establish the equivalence property:

$$p \rightarrow q \equiv \neg p \vee q$$



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16. Establish the equivalence property connecting the bi-conditional with

conditional:

$$p \leftrightarrow q \equiv (p \rightarrow q) \wedge (q \rightarrow p)$$



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## Exercise 12 1

1. Determine whether  $*$  is a binary operation on the sets given below.

(i)  $a * b = a \cdot |b|$  on  $\mathbb{R}$ .

(ii)  $a * b = \min(a, b)$  on  $A = \{1, 2, 3, 4, 5\}$

(iii)  $(a * b) = a\sqrt{b}$  is binary on  $\mathbb{R}$ .



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2. On  $\mathbb{Z}$ , define  $\otimes$  by

$$(m \otimes n) = m^n + n^m: \forall m, n \in \mathbb{Z}. \text{ Is } \otimes$$

binary on  $\mathbb{Z}$ ?



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3. Let  $*$  be defined on  $\mathbb{R}$  by

$$(a * b) = a + b + ab - 7. \text{ Is } * \text{ binary on } \mathbb{R}? \text{ If}$$

$$\text{so, find } 3 * \left( -\frac{7}{15} \right).$$





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4. Let  $A = \{a + \sqrt{5}b : a, b \in \mathbb{Z}\}$ . Check whether the usual multiplication is a binary operation on  $A$ .



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5. Define an operation  $*$  on  $\mathbb{Q}$  as follows:

$$a \cdot b = \left( \frac{a + b}{2} \right), a, b \in \mathbb{Q}. \quad \text{Examine the}$$

closure, commutative, and associative

properties satisfied by  $\cdot$  on  $\mathbb{Q}$ .



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6. Fill in the following table so that the binary operation  $*$  on  $A=\{a,b,c\}$  is commutative.

$*$	$a$	$b$	$c$
$a$	$b$		
$b$	$c$	$b$	$a$
$c$	$a$		$c$



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7. Let  $A = \begin{pmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 \end{pmatrix},$

$$B = \begin{pmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 \end{pmatrix}$$

$$C = \begin{pmatrix} 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 \end{pmatrix}$$
 by any three boolean

matrices of the same type. Find (i)  $A \vee B$ , (ii)

$A \wedge B$ , (iii)  $(A \vee A) \wedge C$ , (iv)  $(A \wedge B) \vee C$ .



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8. (i) Let  $M = \left\{ \begin{pmatrix} x & x \\ x & x \end{pmatrix} : x \in R - \{0\} \right\}$  and

let  $*$  be the matrix multiplication. Determine whether  $M$  is closed under  $*$ . If so, examine the existence of identity, existence of inverse properties for the operation  $*$  on  $M$ .



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9. Let  $A$  be  $\mathbb{Q}/\{1\}$ . Define  $*$  on  $A$  by  $x * y = x + y - xy$ . Is  $*$  binary on  $A$ ? If so, examine the commutative and association properties satisfied by  $*$  on  $A$ .



## Exercise 12 2

1. Let  $p$ : Jupiter is a planet and  $q$ : India is an island be any two simple statements. Give verbal sentence describing each of the following statements:

(i)  $\sim p$

(ii)  $p \wedge \sim q$

(iii)  $\sim p \vee q$



$$(iv) p \rightarrow \sim q$$

$$(v) p < \Rightarrow q$$



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2. In the set of real number  $R$ , an operation  $*$  is defined by  $a * b = a + b$ . Then the value of  $(3 * 4) * 5$  is .....



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**3.** Determine the truth value of each of the following statements.

(i) If  $6+2=5$ , then the milk is white.

(ii) China is an Europe or  $\sqrt{3}$  is an integer.

(iii) It is not true that  $5+5=9$  or Earth is a planet.

(iv) 11 is a prime number and all the sides of a rectangle are equal.



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4. Which one of the following sentences is a proposition?

(i)  $4+7=12$

(ii) What are you doing?

(iii)  $3^n \leq 81, n \in \mathbb{N}$

(iv) Peacock is our national bird

(v) How tall this mountain is?



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5. Write the converse, inverse, and contrapositive of each of the following implication.

(i) If  $x$  and  $y$  are numbers such that  $x=y$ , then  $x^2 = y^2$ .

(ii) If a quadrilateral is a square then it is a rectangle.



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6. Construct the truth table for the following statements.

$$\neg (p \wedge \neg q)$$



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7. Verify whether the following compound propositions are tautologies or contradictions or contingency

(i)  $(p \wedge q) \wedge (p \vee q)$



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

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



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9. Prove that  $q \rightarrow p \equiv \sim p \rightarrow \sim q$



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10. Show that  $p \rightarrow q$  and  $q \rightarrow p$  are not equivalent.



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11. Show that  $\neg(p \leftrightarrow q) \equiv p \leftrightarrow \neg q$ .



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12. Check whether the statement  $p \rightarrow (q \rightarrow p)$  is a tautology or a contradiction without using

the truth table.



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**13.** Using truth table check whether the statements  $\sim(p \vee q) \vee (\sim p \wedge q)$  and  $\sim p$  are logically equivalent.



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**14.** Prove  $p \rightarrow (q \rightarrow r) \equiv (p \wedge q) \rightarrow r$  without using truth table.





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15. Prove that  $p \rightarrow (\sim q \vee r) \equiv \sim p \vee (\sim q \vee r)$  using truth table.



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## Exercise 12 3

1. A binary operation on a set  $S$  is a function from

A.  $S \rightarrow S$

B.  $(s \times S) \rightarrow S$

C.  $S \rightarrow (S \times S)$

D.  $(S \times S) \rightarrow (S \times S)$

**Answer: b**



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**2. Subtraction is not binary operation in**

A.  $\mathbb{R}$

B.  $\mathbb{Z}$

C.  $\mathbb{N}$

D.  $\mathbb{Q}$

**Answer: c**



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**3. Subtraction is not binary operation in**

A. Substraction

B. Multiplication

C. Division

D. All the above

**Answer: b**



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4. In the set  $\mathbb{R}$  of real number  $*$  is defined as follows. Which one of the following is not a binary operation on  $\mathbb{R}$ ?

A.  $a * b = \min (a, b)$

B.  $a * b = \max(a, b)$

C.  $a * b = a$

D.  $a * b = a^b$

**Answer: d**



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5. The operation  $*$  defined by  $a * b = \frac{ab}{7}$  is

not a binary operation on

A.  $\mathbb{Q}^+$

B.  $\mathbb{Z}$

C.  $\mathbb{R}$

D.  $\mathbb{C}$

**Answer: b**



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**6.** In the set  $\mathbb{Q}$  define  $a \odot b = a + b + ab$ . For

what value of  $y$ ,  $3 \odot (y \odot 5) = 7$ ?

A.  $y = \frac{2}{3}$

B.  $y = \frac{-2}{3}$

C.  $y = \frac{-3}{2}$

D.  $y=4$

**Answer: b**



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7. If  $a * b = \sqrt{a^2 + b^2}$  on the real numbers

then  $*$  is

A. commutative but not associative

B. associative but not commutative

C. both commutative and associative

D. neither commutative nor associative

**Answer: c**



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**8.** Which one of the following statements has the truth value T?

A.  $\sin x$  is an even function.



B. Every square matrix is non-singular

C. The product of complex number and its conjugate is purely imaginary

D.  $\sqrt{5}$  is an irrational number

**Answer: d**



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**9. Which one of the following statements has truth value F?**

A. Chennai is in India or  $\sqrt{2}$  is an integer

B. Chennai is in India or  $\sqrt{2}$  is an irrational number

C. Chennai is in China or  $\sqrt{2}$  is an integer

D. Chennai is in China or  $\sqrt{2}$  is an irrational number

**Answer: c**



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**10.** If a compound statement involves 3 simple statements, then the number of rows in the truth table is

A. 9

B. 8

C. 6

D. 3

**Answer: b**



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11. Which one is the inverse of the statement

$$(p \vee q) \rightarrow (p \wedge q)?$$

A.  $(p \wedge q) \rightarrow (p \vee q)$

B.  $\neg(p \vee q) \rightarrow (p \wedge q)$

C.  $(\neg p \vee \neg q) \rightarrow (\neg p \wedge \neg q)$

D.  $(\neg p \wedge \neg q) \rightarrow (\neg p \vee \neg q)$

**Answer: d**



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12. Which one is the contrapositive of the statement  $(p \vee q) \rightarrow r$ ?

A.  $\neg r \rightarrow (\neg p \wedge \neg q)$

B.  $\neg r \rightarrow (\neg p \vee q)$

C.  $r \rightarrow (p \wedge q)$

D.  $p \rightarrow (q \vee r)$

**Answer: a**



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13. The truth table for  $(P \wedge q) \vee \neg q$  is given below

$P$	$q$	$(P \wedge q) \vee (\neg q)$
T	T	(a)
T	F	(b)
F	T	(c)
F	F	(d)

Which of the following is true?

- A. (A) (B) (C) (D)  
T T T T
- B. (A) (B) (C) (D)  
T F T T
- C. (A) (B) (C) (D)  
T T F T

D.  $(A)$   $(B)$   $(C)$   $(D)$   
 $T$   $F$   $F$   $F$

**Answer: c**



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**14.** In the last column of the truth table for  $\sim(p \vee \sim q)$  the number of final outcomes of the truth value 'F' are

A. 1

B. 2

C. 3

D. 4

**Answer: c**



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**15.** Which one of the following is incorrect? For any two propositions  $p$  and  $q$ , we have

A.  $\neg(p \vee q) \equiv \neg p \wedge \neg q$

B.  $\neg(p \wedge q) \equiv \neg p \vee \neg q$



C.  $\neg(p \vee q) \equiv \neg p \vee \neg q$

D.  $\neg(\neg p) \equiv p$

**Answer: c**



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$p$	$q$	$(p \wedge q) \rightarrow \neg p$
T	T	(a)
T	F	(b)
F	T	(c)
F	F	(d)

**16.**

Which one of the following is correct for the

truth value of  $(p \vee q) \rightarrow \neg p$ ?

A. (A) (B) (C) (D)  
*T T T T*

B. (A) (B) (C) (D)  
*F T T T*

C. (A) (B) (C) (D)  
*F F T T*

D. (A) (B) (C) (D)  
*T T T F*

**Answer: b**



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**17.** The dual of  $\sim(p \vee q) \vee [p \vee (p \wedge \sim r)]$  is

A.  $\neg(p \wedge q) \wedge [p \vee (p \wedge \neg r)]$

B.  $(p \wedge q) \wedge [p \wedge (p \vee \neg r)]$

C.  $\neg(p \wedge q) \wedge [p \wedge (p \wedge r)]$

D.  $\neg(p \wedge q) \wedge [p \wedge (p \vee \neg r)]$

**Answer: d**



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**18.** The proposition  $p \wedge (\sim p \vee q)$  is

A. a tautology

B. a contraction

C. logically equivalent to  $p \wedge q$

D. logically equivalent to  $p \vee q$

**Answer: c**



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**19.** Determine the truth value of each of the following statements:

(a)  $4+2=5$  and  $6+3=9$

(b)  $3+2=5$  and  $6+1=7$

(c )  $4+5 =9$  and  $1+2=4$

(d)  $3+2=5$  and  $4+7=11$

A.  $4+2=5$  and  $6+3=9$

B.  $3+2=5$  and  $6+1=7$

C.  $4+5=9$  and  $1+2=4$

D.  $3+2=5$  and  $4+7=11$

**Answer: a**



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20. Which one of the following is not true?

A. Negation of a negation of a statement is the statement itself.

B. If the last column of the truth table contains only T then it is a tautology.

C. If the last column of its truth table contains only F then it is a contradiction

D. If  $p$  and  $q$  are any two statements then  $p \leftrightarrow q$  is a tautology.

**Answer: d**



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## Additional Question Solved

1. In the multiplicative group of cube root of unity the order of  $\omega$  is.....



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2. Show that  $(\mathbb{Z}_7 - \{[0]\}, \cdot_7)$  write to the binary operation multiplication module 7 satisfies closure, associative, identify and inverse properties.



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3. In the multiplicative group of cube root of unity the order of 1 is.....



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4. In the multiplicative group of cube root of unity the order of group is.....



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5. Show that the set  $\{[1],[3],[4],[5],[9]\}$  under multiplication modulo 11 satisfies closure, associative, identity and inverse properties.



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6. Show that  $[\neg p \vee \neg q] \vee p$  is a tautology.



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7. Show that  $[\neg q \wedge p] \wedge q$  is a contradiction.



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



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9. Show that  $\neg(p \wedge q) \equiv ((\neg p) \vee (\neg q))$



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10. Which of the following are statement ?

(i) May God bless you

(ii) Rose is a flower

(iii) milk is white

(iv) 1 is a prime number

A. (i),(ii),(iii)

B. (i),(ii),(iv)

C. (i),(iii),(iv)

D. (ii),(iii),(iv)

**Answer: d**



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**11.** If a compound statement involves 3 simple statements, then the number of rows in the truth table is

A. 8

B. 6

C. 4

D. 2

**Answer: a**



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**12.** If truth value of  $p$  is T and  $q$  is F then which of the following are having the truth value T.(i)

$p \vee q$  (ii)  $\sim p \vee q$  (iii)  $p \vee (\sim q)$  (iv)  $p \wedge (\sim q)$

A. (i),(ii),(iii)

B. (i),(ii),(iv)

C. (i),(iii),(iv)

D. (ii),(iii),(iv)

**Answer: c**



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**13.** The number of row in the truth of

$\sim[p \wedge (\sim q)]$  is.....

A. 2

B. 4

C. 6

D. 8

**Answer: b**



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**14.** Which conditional statement  $p \rightarrow q$  is equivalent to :

A.  $p \vee q$

B.  $p \vee \sim q$

C.  $\sim p \vee q$

D.  $p \wedge q$

**Answer: c**



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**15. Which of the following is a tautology ?**

A.  $p \vee q$



B.  $p \wedge q$

C.  $p \vee \sim p$

D.  $p \wedge \sim p$

**Answer: c**



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**16.** In the set of integers with operation  $*$  defined by  $a * b = a + b - ab$ , the value of  $3 * (4 * 5)$  is.....

A. 25

B. 15

C. 10

D. 5

**Answer: a**



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**17.** In the multiplicative group of cube root of unity the order of  $\omega^2$  is.....

A. 4

B. 3

C. 2

D. 1

**Answer: b**



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**18.** The value of  $_{-11}[5] +_{11}[6]$  is.....

A. [0]

B. [1]

C. [2]

D. [3]

**Answer: a**



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**19.** In the set of real number  $R$ , an operation  $*$  is defined by  $a * b = \sqrt{a^2 + b^2}$ . Then the value of  $(3 * 4) * 5$  is .....



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20. The order of  $-i$  in the multiplicative group of 4th roots of unity is .....

A. 4

B. 3

C. 2

D. 1

**Answer: a**



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