SAMPLE CONTENT

A collection of

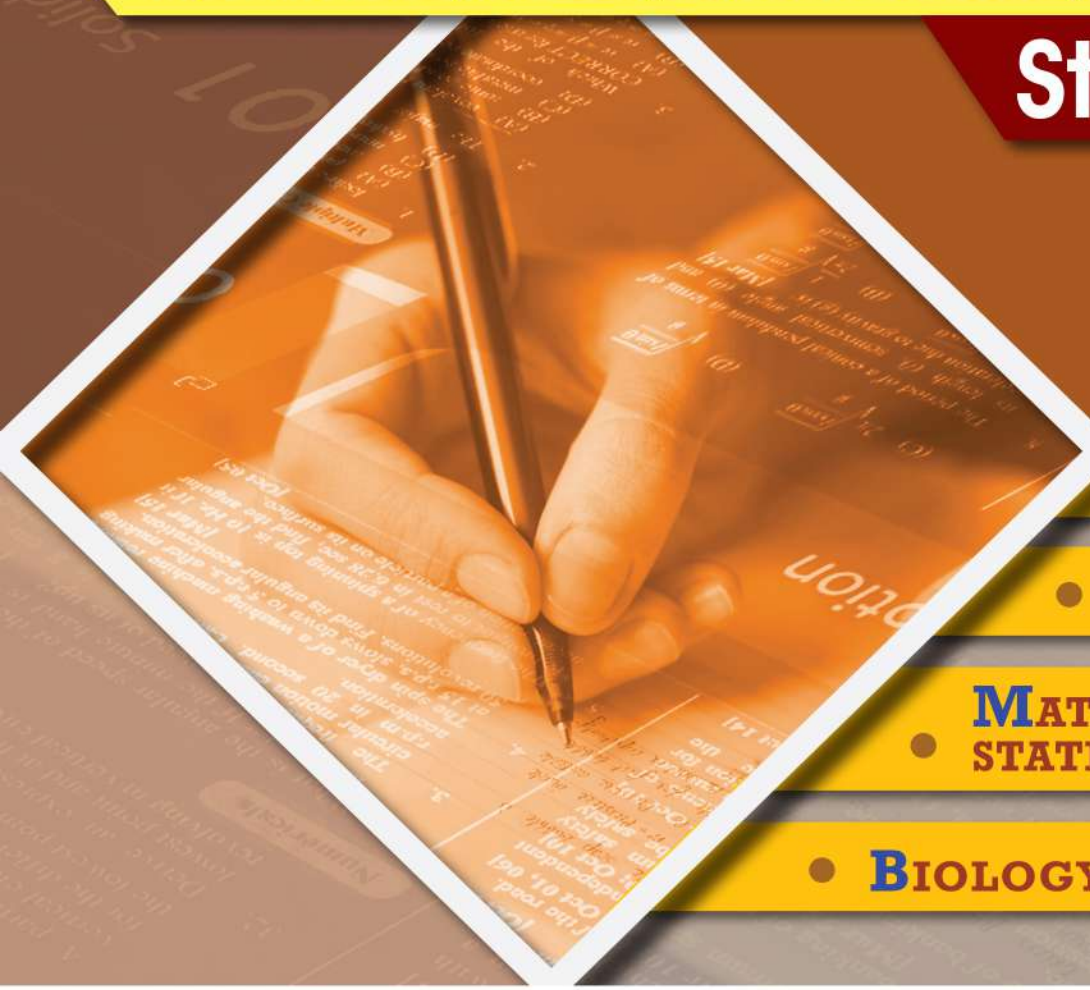
Board Questions

1996 to 2024

With Solutions

Chapterwise & Subtopicwise compilation of relevant board questions from 1996 to 2024

Std. XII Sci.



- PHYSICS
- CHEMISTRY
- MATHEMATICS & STATISTICS (Part I & II)
- BIOLOGY

Target Publications® Pvt. Ltd.

Written as per the latest HSC syllabus prescribed by the Maharashtra State Board of Secondary and Higher Secondary Education, Pune.

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Physics • Chemistry • Mathematics & Statistics (Part I & II) • Biology

STD. XII Sci.

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Salient Features

- **Subjects covered:**
  - Physics • Chemistry • Mathematics & Statistics (Part I & II) • Biology
- **Repository of Board questions:**
  - Includes questions from 1996 to 2024.
  - Includes relevant questions from previous curriculum.
- Chapter wise and Subtopic wise segregation of theory questions and numericals.
- **Expert solutions:** Crafted by subject matter experts, ensuring accuracy and adherence to the boards marking scheme.
- **Important Inclusion:** Log calculations for selective numericals.
- Answers and precise solutions provided to the questions as per *latest edition* of the textbook.
- Latest **July 2024** Question paper and solutions included

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PREFACE

The journey to academic excellence in the Higher Secondary Certificate (HSC) examinations is both challenging and rewarding. **Target's 'Board Questions with Solutions: Std. XII Sci.'** is a compilation of all the relevant questions (MCQs + Theory Questions + Numericals) that have been asked in the previous years' HSC Maharashtra Board Papers of science stream for Physics, Chemistry, Mathematics & Statistics (Part I & II) and Biology. The objective of this book is to offer students quick access to previous years' relevant board questions along with their answers.

The chapter wise and subtopic wise (for Theory Questions & Numericals) segregation of questions enable students gauge the weightage given and type of questions preferred for a chapter. Flow of questions is set year wise with questions from the most recent examination placed last in a subtopic. Only those questions from previous years which fall under the latest syllabus prescribed by Maharashtra State Board of Secondary and Higher Secondary Education are included. The solutions are precise and supplied with suitable diagrams and graphs. To aid students in understanding the different ways questions can be framed, each one is listed with its alternate versions, marked with an 'OR'. Detailed solutions are provided to difficult MCQs. Log calculations are included for selective numericals to aid students. This book is crafted to be an indispensable companion for students aspiring to excel in their HSC exams, providing them with a robust tool to master their subjects comprehensively.

Publisher

Edition: Third

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.

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

Best of luck to all the aspirants!

CONTENT

01 Rotational Dynamics

Multiple Choice Questions

1. A car is moving along a horizontal curve of radius 20 m and coefficient of friction between the road and wheels of the car is 0.25. If acceleration due to gravity is 9.8 m/s^2, then its maximum speed is **[Mar 08]**
(A) 3 m/s (B) 5 m/s (C) 7 m/s (D) 9 m/s

2. A body is acted upon by a constant torque. In 4 seconds its angular momentum changes from L to 4L. The magnitude of the torque is _____. **[Oct 08]**
(A) $\frac{L}{4}$ (B) $\frac{3L}{4}$ (C) 3L (D) 12L

3. Radius of gyration of a ring about a transverse axis passing through its centre is _____. **[Mar 09]**
(A) 0.5 × diameter of ring
(B) diameter of ring
(C) 2 × diameter of ring
(D) (diameter of ring)^2

4. A stone is tied to a string and rotated in a horizontal circle with constant angular velocity. If the string is released, the stone flies _____. **[Oct 09, Mar 10]**
(A) radially inward
(B) radially outward
(C) tangentially forward
(D) tangentially backward

5. The radius of gyration of a solid sphere of mass M and radius R rotating about an axis with its diameter N is **[Mar 10]**
(A) $\sqrt{\frac{1}{5}}\cdot R$ (B) $\sqrt{\frac{2}{5}}\cdot R$
(C) $\sqrt{\frac{3}{5}}\cdot R$ (D) $\sqrt{\frac{7}{5}}\cdot R$

6. The moment of inertia of a thin uniform rod of mass M and length L, about an axis passing through a point, midway between the centre and one end, perpendicular to its length is **[Mar 13]**
(A) $\frac{48}{7}ML^2$ (B) $\frac{7}{48}ML^2$
(C) $\frac{1}{48}ML^2$ (D) $\frac{1}{16}ML^2$

7. If 'L' is the angular momentum and 'I' is the moment of inertia of a rotating body, then $\frac{L^2}{2I}$ represents its **[Oct 13]**
(A) rotational P.E. (B) total energy
(C) rotational K.E. (D) translational K.E.

8. A thin wire of length L and uniform linear mass density ρ is bent into a circular coil. Moment of inertia of the coil about tangential axis in its plane is _____. **[Oct 14]**
(A) $\frac{3\rho L^2}{8\pi^2}$ (B) $\frac{8\pi^2}{3\rho L^3}$ (C) $\frac{3\rho L^3}{8\pi^2}$ (D) $\frac{8\pi}{3\rho L^2}$

9. The period of a conical pendulum in terms of its length (l), semivertical angle (θ) and acceleration due to gravity (g) is: **[Mar 15]**
(A) $\frac{1}{2\pi}\sqrt{\frac{l\cos\theta}{g}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{l\sin\theta}{g}}$
(C) $4\pi\sqrt{\frac{l\cos\theta}{4g}}$ (D) $4\pi\sqrt{\frac{l\tan\theta}{g}}$

10. The kinetic energy of a rotating body depends upon **[Mar 15]**
(A) distribution of mass only.
(B) angular speed only.
(C) distribution of mass and angular speed.
(D) angular acceleration only.

11. A particle rotates in U.C.M. with tangential velocity 'v' along a horizontal circle of diameter 'D'. Total angular displacement of the particle in time 't' is _____. **[Mar 16]**
(A) vt (B) $\left(\frac{v}{D}\right)-t$ (C) $\frac{vt}{2D}$ (D) $\frac{2vt}{D}$

12. A body of moment of inertia 5 kgm^2 rotating with an angular velocity 6 rad/s has the same kinetic energy as a mass of 20 kg moving with a velocity of _____. **[Mar 16]**
(A) 5 m/s (B) 4 m/s
(C) 3 m/s (D) 2 m/s

13. The difference in tensions in the string at lowest and highest points in the path of the particle of mass 'm' performing vertical circular motion is **[July 16]**
(A) 2 mg (B) 4 mg
(C) 6 mg (D) 8 mg

14. The body is rotating with uniform angular velocity (ω) having rotational kinetic energy (E). Its angular momentum (L) is: **[July 16]**
(A) $\frac{2E}{\omega}$ (B) $\frac{E^2}{\omega}$ (C) $\frac{E}{\omega^2}$ (D) $\frac{E}{2\omega}$

15. When the angular acceleration of a rotating body is zero, which physical quantity will be equal to zero? **[Mar 17]**
(A) Angular momentum
(B) Moment of inertia
(C) Torque
(D) Radius of gyration

16. A body of mass 'm' performs uniform circular motion along a circular path of radius 'r' with velocity 'v'. If its angular momentum is L, then the centripetal force acting on it is _____. **[July 17]**
(A) $\frac{mL^2}{r^3}$ (B) $\frac{L^2}{mr}$ (C) $\frac{L^2}{mr^2}$ (D) $\frac{L^2}{mr^3}$

17. If a rigid body of radius 'R' starts from rest and rolls down an inclined plane of inclination 'θ' then linear acceleration of body rolling down the plane is _____. **[July 17]**
(A) $\frac{g\sin\theta}{1+\frac{K}{R}}$ (B) $g\sin\theta\left(1+\frac{K}{R}\right)$
(C) $\frac{g\sin\theta}{1+\frac{K^2}{R^2}}$ (D) $g\sin\theta\left(1+\frac{K^2}{R^2}\right)$

18. A particle of mass m performs vertical motion in a circle of radius r. Its potential energy at the highest point is _____.
(g is acceleration due to gravity) **[Mar 18]**
(A) 2 mgr (B) mgr
(C) 0 (D) 3 mgr

19. A thin ring has mass 0.25 kg and radius 0.5 m. Its moment of inertia about an axis passing through its centre and perpendicular to its plane is _____. **[Mar 18]**
(A) 0.0625 kg m^2 (B) 0.625 kg m^2
(C) 6.25 kg m^2 (D) 62.5 kg m^2

20. The dimensions of angular momentum are _____. **[Mar 08, July 18]**
(A) $[L^{-2} M^1 T^{-1}]$ (B) $[L^2 M^1 T^{-1}]$
(C) $[L^1 M^2 T^1]$ (D) $[L^2 M^2 T^{-2}]$

21. In rotational motion of a rigid body, all particles move with _____. **[Feb 20]**
(A) same linear velocity and same angular velocity
(B) same linear velocity and different angular velocity
(C) different linear velocities and same angular velocities
(D) different linear velocities and different angular velocities

22. When the bob performs a vertical circular motion and the string rotates in a vertical plane, the difference in the tension in the string at horizontal position and uppermost position is _____. **[Mar 22]**
(A) mg (B) 2mg (C) 3mg (D) 6mg

23. A body performing uniform circular motion has constant _____. **[July 23]**
(A) velocity (B) kinetic energy
(C) displacement (D) acceleration

24. The moment of inertia (MI) of a disc of radius R and mass M about its central axis is _____. **[Feb 24]**
(A) $\frac{MR^2}{4}$ (B) $\frac{MR^2}{2}$
(C) MR^2 (D) $\frac{3MR^2}{2}$

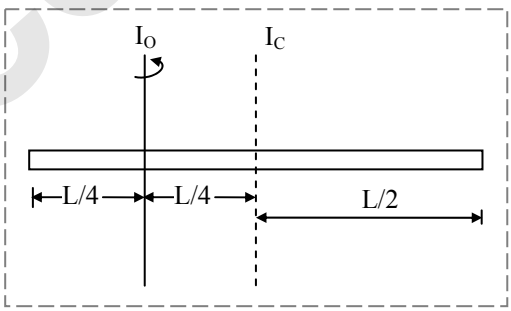
Answers:

1.	(C)	2.	(B)	3.	(A)	4.	(C)
5.	(B)	6.	(B)	7.	(C)	8.	(C)
9.	(C)	10.	(C)	11.	(D)	12.	(C)
13.	(C)	14.	(A)	15.	(C)	16.	(D)
17.	(C)	18.	(A)	19.	(A)	20.	(B)
21.	(C)	22.	(C)	23.	(B)	24.	(B)

Solutions:

1. $v = \sqrt{\mu rg} = \sqrt{0.25\times 20\times 9.8} = 7$ m/s

2. $\left|\vec{\tau}\right| = \left|\frac{d\vec{L}}{dt}\right| = \frac{4L-L}{4} = \frac{3L}{4}$

6. 

From parallel axis theorem,

$$I_O = I_C + Mh^2 = \frac{ML^2}{12} + M\left(\frac{L}{4}\right)^2 = \frac{ML^2}{12} + \frac{ML^2}{16}$$

$$= \frac{7ML^2}{48}$$

8. Linear density $\rho = \frac{M}{L}$

$\therefore$ $M = \rho L$

Wire of length L is bent into a coil of radius R

$\therefore$ $R = \frac{L}{2\pi}$

M.I. of coil through any tangent in the plane of the coil $= \frac{3}{2}MR^2 = \frac{3}{2}(\rho L)\times\left(\frac{L}{2\pi}\right)^2 = \frac{3\rho L^3}{8\pi^2}$

11. $\theta = \frac{s}{r}$, $s = vt$ and $r = \frac{D}{2}$

$\therefore$ $\theta = \frac{2vt}{D}$

01 Solid State

Multiple Choice Questions

1. In body centred cubic structure, the space occupied is about _____. **[Mar 13]**
   (A) 68 % (B) 53 %
   (C) 38 % (D) 32 %

2. To prepare n-type semiconductor, the impurity to be added to silicon should have the following number of valence electrons: **[Mar 14]**
   (A) 2 (B) 3 (C) 4 (D) 5

3. The major binding force in diamond is _____. **[Oct 14]**
   (A) covalent bond
   (B) ionic bond
   (C) metallic bond
   (D) coordinate covalent bond

4. p-type semi-conductors are made by mixing silicon with impurities of _____. **[Mar 15]**
   (A) germanium (B) boron
   (C) arsenic (D) antimony

5. An ionic compound crystallises in FCC type structure with 'A' ions at the centre of each face and 'B' ions occupying corners of the cube. The formula of compound is _____. **[Mar 17]**
   (A) AB_4 (B) A_3B (C) AB (D) AB_3

6. Number of types of orthorhombic unit cell is _____. **[July 18]**
   (A) 7 (B) 3 (C) 4 (D) 2

7. The number of atoms per unit cell of body centred cube is: **[Mar 20]**
   (A) 1 (B) 2 (C) 4 (D) 6

8. The co-ordination number of atoms in body centred cubic structure (bcc) is _____. **[Mar 22]**
   (A) 4 (B) 6 (C) 8 (D) 12

9. The CORRECT relation between edge length and radius of an atom in simple cubic lattice is _____. **[July 22]**
   (A) $2a = r$ (B) $\sqrt{3}a = 4r$
   (C) $a = 2r$ (D) $\sqrt{2}a = 4r$

10. The relation between radius of sphere and edge length in body centered cubic lattice is given by formula: **[Mar 23]**
    (A) $\sqrt{3}r = 4a$ (B) $r = \frac{\sqrt{3}}{a} \times 4$
    (C) $r = \frac{\sqrt{3}}{4} a$ (D) $r = \frac{\sqrt{2}}{4} \times a$

11. The number of particles present in face centred cubic unit cell is/are _____. **[Feb 24]**
    (A) 1 (B) 2
    (C) 3 (D) 4

Answers:

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

Solution:

5. As 'A' ions are present at the face centres of the 6 faces of the cube, the number of ions of 'A' in the unit cell $= \frac{1}{2} \times 6 = 3$

   As 'B' is present at the 8 corners of the cube, number of ions of B in the unit cell

   $= \frac{1}{8} \times 8 = 1$

   $\therefore$ Ratio of atoms A : B = 3 : 1.

   The formula of the compound is A_3B.

Theory Questions

1.2 Types of solids

1. Distinguish between crystalline solids and amorphous solids. [Mar 13, 14, 17, 19]

Ans:

	Crystalline solids	Amorphous solids
i.	The constituent particles are arranged in a regular and periodic manner.	The constituent particles are arranged randomly.
ii.	They have sharp and characteristic melting point.	They do not have sharp melting point. They gradually soften over a range of temperature.
iii.	They are anisotropic, i.e., have different physical properties in different direction.	They are isotropic, i.e., have same physical properties in all directions.
iv.	They have long range order.	They have only short range order.
e.g.	Ice, NaCl, etc.	Glass, rubber, plastics, etc.

2. Define isomorphism. [July 2023]

Ans. **Isomorphism** is the phenomenon by which two or more substances have the same crystal structure.

1.3 Classification of crystalline solids

1. Classify the following molecular solids into different types:

i. HCl **ii. CO_2**

iii. Solid ice **iv. SO_2**

[July 18]

Ans:

i. HCl - Polar molecular solid

ii. CO_2 - Non-polar molecular solid

iii. Solid ice - Hydrogen bonded molecular solid

iv. SO_2 - Polar molecular solid

2. Classify the following solids into different types: [Mar 20]

i. Silver **ii. P_4**

iii. Diamond **iv. NaCl**

Ans:

i. Silver – Metallic solid

ii. P_4 – Molecular solid

iii. Diamond – Covalent network solid

iv. NaCl – Ionic solid

1.5 Cubic system

1. A face centred cube (fcc) consists of how many atoms? Explain. [July 16]

OR

Calculate the number of atoms in a unit cell of a metal crystallising in face centred cubic structure. [July 17]

Ans:

i. A face-centred cubic (fcc) unit cell has particles (atoms) at the eight corners plus particles (atoms) at the centre of its six faces.

ii. Each particle present at the corner of a given unit cell is shared with seven other neighbouring unit cells. As a result, its contribution to the given unit cell is only $\frac{1}{8}$.

Thus, the number of atoms present at corners per unit cell = 8 corner atoms × $\frac{1}{8}$ atom per unit cell = 1

iii. Each particle at the centre of the six faces is shared with one neighbouring cube. Thus, 1/2 of each face particle belongs to the given unit cell.

Thus, the number of atoms present at faces per unit cell = 6 atoms at the faces × $\frac{1}{2}$ atom per unit cell = 3

Therefore, the total number of atoms per unit cell = 1 + 3 = 4

Thus, fcc unit cell has total of 4 atoms per unit cell.

2. Write the number of particles present in fcc per unit cell. [July 23]

Ans: In fcc unit cell, there are 4 particles per unit cell.

3. Derive the relationship between molar mass, density of the substance and unit cell edge length. [Feb 24]

Ans: Relationship between density of a substance and the edge length of unit cell:

i. If edge length of cubic unit cell is 'a', then the volume of unit cell is a^3.

ii. Suppose that mass of one particle is 'm' and that there are 'n' particles per unit cell.

$\therefore$ Mass of unit cell = m × n …(1)

iii. The density of unit cell (ρ), which is same as density of the substance is given by:

$$\rho = \frac{\text{Mass of unit cell}}{\text{Volume of unit cell}} = \frac{m \times n}{a^3}$$

= Density of substance …(2)

iv. Molar mass (M) of the substance is given by:

M = mass of one particle × number of particles per mole

= m × N_A (N_A is Avogadro number)

Therefore, $m = \frac{M}{N_A}$ …(3)

v. Combining equations (1) and (3), gives

$$\rho = \frac{n \times M}{a^3 N_A} \quad \ldots(4)$$

1.6 Packing of particles in crystal lattice

1. What is the ratio of octahedral holes to the number of anions in hexagonal closed packed structure? [Mar 19]

Ans: The ratio of octahedral holes to the number of anions in hexagonal closed packed structure is 1:1.

1.7 Packing efficiency

1. Calculate the percentage efficiency of packing in case of simple cubic cell. [Mar 17]

Ans: Packing efficiency of metal crystal in simple cubic lattice:

Step 1: Radius of sphere:

In simple cubic unit cell, particles (spheres) are at the corners and touch each other along the edge.

Thus, a = 2r or $r = \frac{a}{2}$ ….(1)

where, 'r' is the radius of atom and 'a' is the length of unit cell edge.

Step 2: Volume of sphere:

Volume of a sphere = $(4/3\pi)(r^3)$.

Substitution for r from equation (1) gives:

Volume of one particle = $(4/3\pi)\,(a/2)^3$

$= \frac{\pi a^3}{6}$ …(2)

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To see complete chapter buy **Target Notes**

01 Mathematical Logic

Multiple Choice Questions

1. If A = {2, 3, 4, 5, 6}, then which of the following is not true? **[Oct 13]**
   (A) $\exists\, x \in A$ such that $x + 3 = 8$
   (B) $\exists\, x \in A$ such that $x + 2 < 5$
   (C) $\exists\, x \in A$ such that $x + 2 < 9$
   (D) $\forall\, x \in A$ such that $x + 6 \geq 9$

2. The negation of $p \wedge (q \rightarrow r)$ is **[Mar 16]**
   (A) $p \vee (\sim q \vee r)$ (B) $\sim p \wedge (q \rightarrow r)$
   (C) $\sim p \wedge (\sim q \rightarrow \sim r)$ (D) $\sim p \vee (q \wedge \sim r)$

3. Inverse of the statement pattern $(p \vee q) \rightarrow (p \wedge q)$ is **[July 16]**
   (A) $(p \wedge q) \rightarrow (p \vee q)$
   (B) $\sim(p \vee q) \rightarrow (p \wedge q)$
   (C) $(\sim p \vee \sim q) \rightarrow (\sim p \wedge \sim q)$
   (D) $(\sim p \wedge \sim q) \rightarrow (\sim p \vee \sim q)$

4. The negation of $p \wedge (q \rightarrow r)$ is _____. **[Mar 22]**
   (A) $\sim p \wedge (\sim q \rightarrow \sim r)$ (B) $p \vee (\sim q \vee r)$
   (C) $\sim p \wedge (\sim q \rightarrow r)$ (D) $p \rightarrow (q \wedge \sim r)$

5. The negation of $(p \vee \sim q) \wedge r$ is _____. **[July 22]**
   (A) $(\sim p \wedge q) \wedge r$ (B) $(\sim p \wedge q) \vee r$
   (C) $(\sim p \wedge q) \vee \sim r$ (D) $(\sim p \vee q) \wedge \sim r$

6. If $p \wedge q = F$, $p \rightarrow q = F$, then the truth values of p and q are : **[Oct 15]**
   (A) T, T (B) T, F
   (C) F, T (D) F, F

   OR

   If $p \wedge q$ is F, $p \rightarrow q$ is F then the truth values of p and q are _____ respectively. **[Mar 23]**
   (A) T, T (B) T, F
   (C) F, T (D) F, F

7. The dual of statement $p \wedge \sim q$ is equivalent to _____. **[July 23]**
   (A) $\sim p \wedge q$ (B) $p \leftrightarrow q$
   (C) $\sim p \vee q$ (S) $\sim p \rightarrow \sim q$

8. The dual of statement $t \vee (p \vee q)$ is _____. **[Mar 24]**
   (A) $c \wedge (p \vee q)$ (B) $c \wedge (p \wedge q)$
   (C) $t \wedge (p \wedge q)$ (D) $t \wedge (p \vee q)$

Answers:

1.	(D)	2.	(D)	3.	(D)	4.	(D)
5.	(C)	6.	(B)	7.	(D)	8.	(B)

Hints:

1. Consider option (D)
   For $x = 2 \in A$, we have $x + 6 = 8 < 9$
   i.e., $x = 2$ does not satisfy the condition $x + 6 \geq 9$

2. $\sim[p \wedge (q \rightarrow r)]$
   $\equiv \sim p \vee \sim(q \rightarrow r)$ …[De-Morgan's Law]
   $\equiv \sim p \vee (q \wedge \sim r)$ …[Negation of implication]

3. Inverse of $(p \vee q) \rightarrow (p \wedge q)$ is
   $\sim(p \vee q) \rightarrow \sim(p \wedge q)$
   $\equiv (\sim p \wedge \sim q) \rightarrow (\sim p \vee \sim q)$

4. $\sim[p \wedge (q \rightarrow r)]$
   $\equiv \sim p \vee \sim(q \rightarrow r)$
   $\equiv p \rightarrow [\sim(q \rightarrow r)]$ …[$\because p \rightarrow q \equiv \sim p \vee q$]
   $\equiv p \rightarrow [\sim(\sim q \vee r)]$
   $\equiv p \rightarrow (q \wedge \sim r)$

5. $\sim[(p \vee \sim q) \wedge r]$
   $\equiv \sim(p \vee \sim q) \vee \sim r$ …[De Morgan's law]
   $\equiv (\sim p \wedge q) \vee \sim r$ …[De Morgan's law]

6. $p \rightarrow q = F \Rightarrow p \equiv T$ and $q \equiv F$

7. Dual of $p \wedge \sim q$ is $p \vee \sim q$.
   $p \vee \sim q \equiv \sim p \rightarrow \sim q$ ...[$p \rightarrow q \equiv \sim p \vee q$]

Questions

Based on Exercise 1.1

1. Write down the following statements in symbolic form:

i. A triangle is equilateral if and only if it is equiangular.

ii. Price increases and demand falls. **[Mar 13]**

Solution:

i. Let p : A triangle is equilateral
   q : A triangle is equiangular
∴ Symbolic form of the given statement is $p \leftrightarrow q$.

ii. Let p : Price increases
   q : Demand falls
∴ Symbolic form of the given statement is $p \wedge q$.

2. If p : It is a day time, q : It is warm, write the compound statements in verbal form denoted by–

i. $p \wedge \sim q$ ii. $\sim p \rightarrow q$ iii. $q \leftrightarrow p$ **[Oct 14]**

Solution:

We have

p : It is day time

q : It is warm

$\therefore$ ~p : It is not daytime

~q : It is not warm

$\therefore$ Verbal forms of the given statements are

i. It is daytime but it is not warm.

ii. If it is not daytime, then it is warm.

iii. It is warm if and only if it is daytime.

3. Write truth value of the following statement: $\sqrt{5}$ is an irrational number but $3 + \sqrt{5}$ is a complex number. **[Oct 14]**

Solution:

Let p: $\sqrt{5}$ is irrational.

q: $3 + \sqrt{5}$ is a complex number.

$\therefore$ The symbolic form of the given statement is $p \wedge q$

The truth values of both p and q are T.

$\therefore$ Truth value of $p \wedge q$ is T.

4. If p, q, r are the statements with truth values T, F, T, respectively then find the truth value of $(r \wedge q) \leftrightarrow \sim p$. **[July 16]**

Solution:

$(r \wedge q) \leftrightarrow \sim p \equiv (T \wedge F) \leftrightarrow \sim T$

$\equiv (T \wedge F) \leftrightarrow F$

$\equiv F \leftrightarrow F \equiv T$

Hence, the truth value is 'T'.

5. Write the truth values of the following statements:

i. 2 is a rational number and $\sqrt{2}$ is an irrational number.

ii. $2 + 3 = 5$ or $\sqrt{2} + \sqrt{3} = \sqrt{5}$

[Mar 19]

Solution:

i. Let p : 2 is a rational number

q : $\sqrt{2}$ is an irrational number

$\therefore$ Symbolic form of the given statement is $p \wedge q$

The truth values of both p and q are T.

$\therefore$ Truth value of $p \wedge q$ is T.

ii. Let p : $2 + 3 = 5$

q : $\sqrt{2} + \sqrt{3} = \sqrt{5}$

$\therefore$ Symbolic form of the given statement is $p \vee q$

The truth value of p is T and the truth value of q is F.

$\therefore$ Truth value of $p \vee q$ is T.

6. Write the truth values of the following statements:

i. Two is the only even prime number.

ii. $\cos(2\theta) = \cos^2\theta - \sin^2\theta$, for all $\theta \in R$

[July 19]

Solution:

i. The truth value of this statement is T.

ii. The truth value of this statement is T

7. If the statement p, q are true statements and r, s are false then determine the truth value of $(p \rightarrow q) \vee (r \rightarrow s)$. **[July 22]**

Solution:

$(p \rightarrow q) \vee (r \rightarrow s) \equiv (T \rightarrow T) \vee (F \rightarrow F)$

$\equiv T \vee T$

$\equiv T$

Hence, truth value is T.

8. Write the following compound statements symbolically:

i. Nagpur is in Maharashtra and Chennai is in Tamilnadu.

ii. If ΔABC is right angled at B, then $m\angle A + m\angle C = 90°$

[July 23]

Solution:

i. Let p : Nagpur is in Maharashtra.

q : Chennai is in Tamilnadu.

The symbolic form is $p \wedge q$.

ii. Let p : ΔABC is right angled at B.

q : $m\angle A + m\angle C = 90°$

The symbolic form is $p \rightarrow q$.

9. Write the compound statement 'Nagpur is in Maharashtra and Chennai is in Tamilnadu' symbolically. **[Mar 24]**

Solution:

Let p : Nagpur is in Maharashtra.

q : Chennai is in Tamilnadu.

The symbolic form is $p \wedge q$.

Based on Exercise 1.2

1. Using truth table, prove that:
$p \leftrightarrow q \equiv (p \rightarrow q) \wedge (q \rightarrow p)$
[Mar 98, Oct 00, 01, 04]

Solution:

The truth table is as shown:

1	2	3	4	5	6
p	q	$p \leftrightarrow q$	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \wedge (q \rightarrow p)$
T	T	T	T	T	T
T	F	F	F	T	F
F	T	F	T	F	F
F	F	T	T	T	T

In the above truth table, the entries in the columns 3 and 6 are identical.

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

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01 Differentiation

Multiple Choice Questions

1. If $x^y = e^{x-y}$, then $\frac{dy}{dx}$ = _____ **[Oct 13]**

(A) $\frac{1+x}{1+\log x}$ (B) $\frac{\log x}{(1+\log x)^2}$

(C) $\frac{1-\log x}{1+\log x}$ (D) $\frac{1-x}{1+\log x}$

2. If $y = 1 - \cos\theta$, $x = 1 - \sin\theta$, then $\frac{dy}{dx}$ at $\theta = \frac{\pi}{4}$ is **[Mar 14]**

(A) -1 (B) 1

(C) $\frac{1}{2}$ (D) $\frac{1}{\sqrt{2}}$

3. If $\sec\left(\frac{x+y}{x-y}\right) = a^2$, then $\frac{d^2y}{dx^2}$ = _____. **[Oct 14]**

(A) y (B) x

(C) $\frac{y}{x}$ (D) 0

4. If $y = \sec^{-1}\left(\frac{\sqrt{x}-1}{\sqrt{x}+\sqrt{x}}\right) + \sin^{-1}\left(\frac{x+\sqrt{x}}{\sqrt{x}-1}\right)$, then $\frac{dy}{dx}$ = _____. **[Oct 15]**

(A) x (B) $\frac{1}{x}$

(C) 1 (D) 0

5. Derivative of $\tan^3\theta$ with respect to $\sec^3\theta$ at $\theta = \frac{\pi}{3}$ is _____. **[Mar 17]**

(A) $\frac{3}{2}$ (B) $\frac{\sqrt{3}}{2}$ (C) $\frac{1}{2}$ (D) $-\frac{\sqrt{3}}{2}$

6. If $f(x) = x^5 + 2x - 3$, then $\left(f^{-1}\right)'(-3)$ = _____. **[Mar 22]**

(A) 0 (B) -3

(C) $-\frac{1}{3}$ (D) $\frac{1}{2}$

7. If y is a function of x and $\log(x + y) = 2xy$, then the value of $y'(0)$ = _____. **[Mar 23]**

(A) 2 (B) 0

(C) -1 (D) 1

8. If $x = at^4$, $y = 2at^2$, then $\frac{dy}{dx}$ = _____. **[July 23]**

(A) $\frac{1}{t^2}$ (B) t^2

(C) $2t^2$ (D) $-\frac{1}{t^2}$

Answers:

1. (B) 2. (A) 3. (D) 4. (D)
5. (B) 6. (D) 7. (D) 8. (A)

Hints:

1. $x^y = e^{x-y}$

Taking log on both sides, we get

$y \log x = (x - y) \log e = x - y$

$\therefore$ $y \log x + y = x$

$\therefore$ $y(1 + \log x) = x$

$\therefore$ $y = \frac{x}{(1+\log x)}$

Differentiating w.r.t. x, we get

$\frac{dy}{dx} = \frac{d}{dx}\left(\frac{x}{1+\log x}\right)$

$\therefore$ $\frac{dy}{dx} = \frac{(1+\log x)\frac{d}{dx}(x) - x\frac{d}{dx}(1+\log x)}{(1+\log x)^2}$

$= \frac{(1+\log x).1 - x.\frac{1}{x}}{(1+\log x)^2}$

$= \frac{1+\log x - 1}{(1+\log x)^2}$

$\therefore$ $\frac{dy}{dx} = \frac{\log x}{(1+\log x)^2}$

2. $y = 1 - \cos\theta$

$\therefore$ $\frac{dy}{d\theta} = -(-\sin\theta) = \sin\theta$

$x = 1 - \sin\theta$

$\therefore$ $\frac{dx}{d\theta} = -\cos\theta$

$\therefore$ $\frac{dy}{dx} = \frac{\frac{dy}{d\theta}}{\frac{dx}{d\theta}} = \frac{\sin\theta}{-\cos\theta} = -\tan\theta$

$\therefore$ $\left(\frac{dy}{dx}\right)_{\left(\theta=\frac{\pi}{4}\right)} = -\tan\left(\frac{\pi}{4}\right) = -1$

3. $\sec\left(\frac{x+y}{x-y}\right) = a^2$

$\therefore \quad \frac{x+y}{x-y} = \sec^{-1}(a^2) = b$ (say)

$\therefore \quad x + y = bx - by$

$\therefore \quad (1 + b)\, y = (b - 1)\, x$

$\therefore \quad y = \left(\frac{b-1}{b+1}\right)x$

$\therefore \quad y = cx$, where $c = \frac{b-1}{b+1} = \frac{y}{x}$ …(i)

Differentiating w.r.t. x, we get

$\frac{dy}{dx} = c$

$\therefore \quad \frac{dy}{dx} = \frac{y}{x}$ ...(ii)[From (i)]

$\frac{d^2y}{dx^2} = \frac{x\frac{dy}{dx} - y.1}{x^2}$

$= \frac{x\left(\frac{y}{x}\right) - y}{x^2}$ …[From (ii)]

$= \frac{y - y}{x^2} = 0$

4. $y = \sec^{-1}\left(\frac{\sqrt{x}-1}{x+\sqrt{x}}\right) + \sin^{-1}\left(\frac{x+\sqrt{x}}{\sqrt{x}-1}\right)$

$\therefore \quad y = \cos^{-1}\left(\frac{x+\sqrt{x}}{\sqrt{x}-1}\right) + \sin^{-1}\left(\frac{x+\sqrt{x}}{\sqrt{x}-1}\right)$

$\ldots\left[\because \sec^{-1}x = \cos^{-1}\left(\frac{1}{x}\right)\right]$

$= \frac{\pi}{2}$ $\ldots\left[\because \sin^{-1}x + \cos^{-1}x = \frac{\pi}{2}\right]$

$\therefore \quad \frac{dy}{dx} = \frac{d}{dx}\left(\frac{\pi}{2}\right) = 0$

5. Let $u = \tan^3\theta$ and $v = \sec^3\theta$

$\therefore \quad \frac{du}{d\theta} = 3\tan^2\theta\sec^2\theta$ and

$\frac{dv}{d\theta} = 3\sec^2\theta\sec\theta\tan\theta = 3\sec^3\theta\tan\theta$

$\therefore \quad \frac{du}{dv} = \frac{3\tan^2\theta\sec^2\theta}{3\sec^3\theta\tan\theta} = \frac{\tan\theta}{\sec\theta}$

$\therefore \quad \left(\frac{du}{dv}\right)_{\left(\theta=\frac{\pi}{3}\right)} = \frac{\tan\frac{\pi}{3}}{\sec\frac{\pi}{3}} = \frac{\sqrt{3}}{2}$

6. $f(x) = x^5 + 2x - 3$

$\therefore \quad f'(x) = 5x^4 + 2$

$(f^{-1})'(y) = \frac{1}{f'(x)}$

$f(x) = -3$ corresponds to $x = 0$.

$\therefore \quad (f^{-1})'(-3) = \frac{1}{f'(0)} = \frac{1}{5(0)^4 + 2} = \frac{1}{2}$

7. $\log(x + y) = 2xy$ …(i)

Differentiating w. r. t. x, we get

$\frac{1}{x+y}(1 + y') = 2(xy' + y)$

$\therefore \quad 1 + y' = 2x(x + y)\, y' + 2y(x + y)$ …(ii)

Substituting $x = 0$ in (i), we get

$\log(0 + y) = 0$

$\therefore \quad y(0) = 1$

Substituting $x = 0$, $y = 1$ in (ii), we get

$1 + y'(0) = 0 + 2(1)(0 + 1)$

$\therefore \quad y'(0) = 2 - 1 = 1$

8. $x = at^4$

$\therefore \quad \frac{dx}{dt} = 4at^3$

$y = 2at^2$

$\therefore \quad \frac{dy}{dt} = 4at$

$\therefore \quad \frac{dy}{dx} = \frac{\left(\frac{dy}{dt}\right)}{\left(\frac{dx}{dt}\right)} = \frac{4at}{4at^3} = \frac{1}{t^2}$

Questions

Based on Exercise 1.1

1. If $y = \sec\sqrt{x}$, then find $\frac{dy}{dx}$. [July 16]

Solution:

$y = \sec\sqrt{x}$

Differentiating w.r.t. x, we get

$\frac{dy}{dx} = \frac{d}{dx}\left(\sec\sqrt{x}\right) = (\sec\sqrt{x}\tan\sqrt{x})\,.\,\frac{d}{dx}(\sqrt{x})$

$= (\sec\sqrt{x}\tan\sqrt{x})\,.\,\frac{1}{2\sqrt{x}}$

$\therefore \quad \frac{dy}{dx} = \frac{\sec\sqrt{x}\tan\sqrt{x}}{2\sqrt{x}}$

2. If $y = \tan^2(\log x^3)$, find $\frac{dy}{dx}$. [Mar 18]

Solution:

$y = \tan^2(\log x^3)$

Differentiating w.r.t. x, we get

$\frac{dy}{dx} = \frac{d}{dx}\left[\tan^2\left(\log x^3\right)\right]$

$= 2\tan(\log x^3).\,\frac{d}{dx}[\tan(\log x^3)]$

$= 2\tan(\log x^3).\sec^2(\log x^3).\frac{d}{dx}(\log x^3)$

$= 2\tan(\log x^3).\sec^2(\log x^3).\left(\frac{1}{x^3}\right).\frac{d}{dx}\left(x^3\right)$

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01 Reproduction in Lower and Higher Plants

Multiple Choice Questions

1. The types of pollination exhibited by *Vallisneria* and *Zea mays* respectively are_____ **[Oct 08]**
   (A) Anemophily and Hydrophily
   (B) Entomophily and Hydrophily
   (C) Hydrophily and Anemophily
   (D) Hydrophily and Entomophily

2. The endosperm cells in an angiospermic plant has 18 chromosomes, the number of chromosomes in its roots cells will be _____ **[Mar 09]**
   (A) 12 (B) 6 (C) 18 (D) 24

3. In porogamy, the pollen tube enters into the ovule through _____ **[Mar 09]**
   (A) micropyle (B) integument
   (C) chalaza (D) funicle

4. Egg apparatus consists of _____ **[Oct 09]**
   (A) egg and antipodals
   (B) egg and polar nuclei
   (C) egg and synergids
   (D) egg and secondary nucleus

5. Synergids are _____ **[Mar 10]**
   (A) haploid (B) triploid
   (C) diploid (D) tetraploid

6. How many meiotic divisions are required for the formation of 100 seeds? **[Oct 13]**
   (A) 25 (B) 50 (C) 100 (D) 125

7. During fertilization, male gametes are carried by pollen tube. This is called **[Oct 13]**
   (A) Syngamy (B) Mesogamy
   (C) Polygamy (D) Siphonogamy

8. For formation of 50 seeds, how many minimum meiotic divisions are necessary? **[Mar 14]**
   (A) 25 (B) 50 (C) 75 (D) 63

9. In bisexual flowers, maturation of gynoecium before androecium is known as _____. **[Mar 14]**
   (A) protandry (B) protogyny
   (C) gynandry (D) dicliny

10. If the number of chromosomes in an endosperm cell is 27, what will be the chromosome number in the definitive nucleus? **[Mar 15]**
    (A) 9 (B) 18 (C) 27 (D) 36

11. Lever mechanism of pollination is observed in _____. **[Mar 15]**
    (A) *Salvia* (B) *Jasmine*
    (C) *Bougainvillea* (D) *Butea*

12. Vegetative propagation takes place with the help of leaves in _____ plant. **[Oct 15]**
    (A) *Kalanchoe* (B) *Oxalis*
    (C) *Cynodon* (D) *Dahlia*

13. How many meiotic divisions will be needed to produce 44 female gametophytes in angiosperms? **[Oct 15]**
    (A) 11 (B) 22 (C) 44 (D) 66

14. Endosperm of angiosperm is _____. **[July 16]**
    (A) haploid (B) diploid
    (C) triploid (D) tetraploid

15. A versatile anther is an adaptation for _____ type of pollination. **[July 18]**
    (A) anemophilous (B) entomophilous
    (C) hydrophilous (D) ornithophilous

16. During double fertilization second male gamete fuses with _____. **[Mar 19]**
    (A) antipodal cell (B) egg cell
    (C) secondary nucleus (D) synergids

17. How many meiotic and mitotic divisions are required for the formation of male gametophyte from pollen mother cell? **[Mar 20]**
    (A) 2 meiotic and 1 mitotic
    (B) 1 meiotic and 1 mitotic
    (C) 1 meiotic and 2 mitotic
    (D) 2 meiotic and 2 mitotic

18. How many meiotic and mitotic divisions occur during the development of male gametophyte from the microspore mother cell? **[Mar 22]**
    (A) One meiotic and two mitotic
    (B) Two meiotic only
    (C) Two mitotic only
    (D) One mitotic and one meiotic

19. How many mitotic divisions take place during the formation of a female gametophyte from a functional megaspore? **[Mar 23]**
    (A) One (B) Two
    (C) Three (D) Four

20. Which of the following types require pollinator but result is genetically similar to autogamy? **[Mar 24]**
    (A) Geitonogamy (B) Xenogamy
    (C) Apogamy (D) Cleistogamy

Answers:

1.	(C)	2.	(B)	3.	(A)	4.	(C)
5.	(A)	6.	(D)	7.	(D)	8.	(D)
9.	(B)	10.	(B)	11.	(A)	12.	(A)
13.	(C)	14.	(C)	15.	(A)	16.	(C)
17.	(A)	18.	(A)	19.	(C)	20.	(A)

Solutions:

6. For formation of 100 seeds, 100 male gametes and 100 female gametes are required.
For formation of 100 male gametes, the number of meiotic divisions required will be 25.
(1 Microspore mother cell $\xrightarrow{\text{meiosis}}$ 4 microspores)
For formation of 100 female gametes, the number of meiotic divisions required will be 100.
(1 Megaspore mother cell $\xrightarrow{\text{meiosis}}$ 4 megaspores $\xrightarrow{\text{3 degenerate}}$ 1 functional megaspore)
Therefore, for the formation of 100 seeds 125 meiotic cell divisions are expected.

8. For formation of 50 seeds, 50 male gametes and 50 female gametes are required.
For formation of 50 male gametes, the number of meiotic divisions required will be 12.5 i.e. 13.
(1 Microspore mother cell $\xrightarrow{\text{meiosis}}$ 4 microspores)
For formation of 50 female gametes, the number of meiotic divisions required will be 50.
(1 Megaspore mother cell $\xrightarrow{\text{meiosis}}$ 4 megaspores $\xrightarrow{\text{3 degenerate}}$ 1 functional megaspore)
Therefore, for the formation of 50 seeds 63 meiotic cell divisions are expected.

10. The endosperm is triploid (3n), whereas the definitive nucleus is diploid (2n).

13. For formation of 44 female gametes, the number of meiotic divisions required will be 44.
(1 Megaspore mother cell $\xrightarrow{\text{meiosis}}$ 4 megaspores $\xrightarrow{\text{3 degenerate}}$ 1 functional megaspore)

Theory Questions

1.1 Asexual Reproduction

1. What is vegetative reproduction? Describe any 'three' natural methods of vegetative reproduction with examples. [Oct 14]

Ans:

i. Vegetative reproduction is a method of reproduction in which plants reproduce asexually through their vegetative parts.

ii. Natural methods of vegetative reproduction are as follows:

a. Roots : Sweet potato, *Asparagus*, *Dahlia*

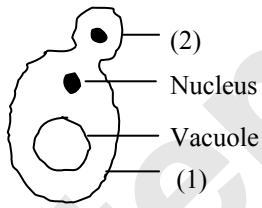
b. Leaf: *Bryophyllum*, *Kalanchoe*, *Begonia*, etc.

c. Stem: Rhizome (Turmeric), Tubers (Potato), Bulbs (Onion), etc.

2. Define vegetative propagation. [Mar 15]

Ans: *Refer Subtopic 1.1: Q. No. 1(i)*

3. Label the parts (1) and (2) in budding of yeast cell. [Oct 15]



Ans: The parts in budding of yeast cell are as follows:
1: Mother cell 2: Bud

4. What is 'vegetative reproduction'? Explain 'any three'natural methods of vegetative reproduction. [July 18]

Ans: *Refer Subtopic 1.1: Q. No. 1*

5. Define stock and scion. [July 18]

Ans:

i. The part of the rooted plant on which grafting is done is called stock (root stock).

ii. The part which is inserted on the stock during grafting is called scion (graft).

6. What is artificial method of vegetative propagation?
Describe:
i. Cutting ii. Budding. [Mar 20]

Ans: The process of growing plants by using artificial methods like cutting, grafting and tissue culture is known as artificial method of vegetative propagation.

i. Cutting:

a. The small piece of any vegetative part of a plant having one or more buds is used for propagation.

b. Some of the common cuttings are:
Stem cutting - e.g. Rose, *Bougainvillea*; leaf cutting - e.g. *Sansevieria*; root cutting e.g. Blackberry.

ii. Budding:

a. Budding is also called bud grafting in which single bud is a scion.

b. A single bud is then inserted in the slit of the stock.

c. Grafting is commonly done in plants like Apple, Rose, Pear, etc.

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