◇ MOTION IN A LINE ◇

LEARNING OBJECTIVES :

♦ Rest and motion,kinds of motion.

♦ We will investigate the words used to describe the motion of objects.The hope is to gain a comfortable foundation with the language that is used throughout the study of mechanics. We will study the terms such as scalars, vectors, distance, displacement, speed, velocity and acceleration.

♦ How to describe straight-line motion in terms of average velocity,instantaneous velocity, average acceleration and instantaneous acceleration etc.

♦ How to solve problems involving straight-line motion with uniform acceleration.

♦ Usage of equations of motion,vertical projection.

Real time application:

Φ What distance must an airliner travel down a runway before reaching takeoff speed? When you throw a baseball straight up in the air, how high does it go? When a glass slips from your hand, how much time do you have to catch it before it hits the floor? This kind of all questions are answered.

Φ Usefull to sketch the time tables for buses,trains,etc.

Φ Usefull in Engineering works.

Φ Usefull in finding height of a building,height of a bridge from water level etc.

Φ Without motion there will be no vehicle,no river,no wind can flow etc i.e.we can not expect our life without these.

♠ **Important Formulae:**

1. $\text{Speed} = \dfrac{\text{Distance travelled}}{\text{Time taken}}$.

2. $\text{Average speed} = \dfrac{\text{total distance}}{\text{total time}}$.

3. If a body travels first half of the distance with a speed V_1 and second half of the distance with a speed V_2 then average speed is given by $V_{avg} = \dfrac{2V_1V_2}{v_1 + v_2}$

4. If v_1 and v_2 are the speeds of a body during the first half and second half times then average speed $= \dfrac{v_1 + v_2}{2}$.

5. If a body travels first 1/3 rd of the distance with a speed V_1 and next 1/3 rd of the distance with a speed V_2 and remaining 1/3 rd of the distance with a speed V_3 then the average speed is given by $V = \dfrac{3v_1v_2v_3}{v_1v_2 + v_2v_3 + v_3v_1}$

6.   Velocity$(\vec{V})$ = $\dfrac{\text{Displacement}}{\text{time}}$ = $\dfrac{\vec{s}}{t}$

7. $Average\ Velocity(V)$ = $\dfrac{Total\ displacement}{Total\ time}$.

8.   If a body covers the first half of the distance with velocity V_1 and the remaining half distance with velocity V_2 then, $Average\,Velocity = \dfrac{2V_1V_2}{V_1 + V_2}$

9. $Acceleration\ \overrightarrow{(a)}$ = $\dfrac{\vec{v} - \vec{u}}{t}$ = $\dfrac{change\ in\ velocity}{time}$.

10. Equations of motion:

   i) $V = u + at$ where $u \rightarrow$ Initial Velocity

   ii) $s = ut + \dfrac{1}{2}at^2$ $v \rightarrow$ Final Velocity

   iii) $v^2 - u^2 = 2as$ $t \rightarrow$ time

   iv) $S_n = u + a\left(n - \dfrac{1}{2}\right)$ $a \rightarrow$ uniform acceleration

                                                                 $S \rightarrow$ Distance travelled

11. Equations of motion for a freely falling body:

   a) $v = gt$ b) $s = \dfrac{1}{2}gt^2$ c) $v^2 = 2gs$ d) $Sn = g\left(n - \frac{1}{2}\right)$

12. Equations of motion for a body projected vertically upwards:

   i) $u = gt$ ii) $s = ut - \dfrac{1}{2}gt^2$ iii) $u^2 = 2gs$ iv) $S_n = u - g\left(n - \frac{1}{2}\right)$

13. $H_{\mathbf{max}} = \dfrac{u^2}{2g}$ 14. $t_a = \dfrac{u}{g}$ 15. $t_d = \dfrac{u}{g}$ 16. $t = ta + td = \dfrac{2u}{g}$

   Note: In the presence of air resistance, $t_d > t_a$.

14. When a body projected vertically up form top of tower

   a) Height of the tower is $h = -ut + \dfrac{1}{2}gt^2$

   b) Time taken by the body to reach the ground t = $\dfrac{u + \sqrt{u^2 + 2gh}}{g}$

   c) The velocity of the body at the foot of the tower v = $\sqrt{u^2 + 2gh}$

   d) Velocity of the body after 't' sec. is $v = u - gt$

   e) The height of the balloon by the time the body reaches the ground is $\dfrac{1}{2}gt^2$.

§§ **Introduction**

      Kinematics is the science of describing the motion of objects using words, diagrams, numbers, graphs, and equations. Kinematics is a branch of mechanics. The goal of any study of kinematics is to develop sophisticated mental models that serve to describe (and ultimately, explain) the motion of real-world objects.

In this lesson, we will investigate the words used to describe the motion of objects.That is, we will focus on the language of kinematics. The hope is to gain a comfortable foundation with the language that is used throughout the study of mechanics. We will study such terms as scalars, vectors, distance, displacement, speed, velocity and acceleration. These words are used with regularity to describe the motion of objects. Your goal should be to become very familiar with their meaning.

§§ **Mechanics :** The branch of physics which deals with the study of force and motion their relatationship is called mechanics.The study of mechanics is divided into three parts.

   i) Statics: the branch of mechanics which deals with objects at rest is called statics.

   ii) Kinematics : Kinematics which is derived from a Greek word kinema meaning motion, is a branch of physics,the branch of mechanics which deals with the motion of objects only without considering the cause of motion is called kinematics.

   iii) dynamics: the branch of mechanics which deals with the cause of motion is called dynamics.

§§ *Rest:* A body is said to be at rest if it does not change its position with respect to the reference point. The objects which remain stationary at a place and do not change their position are said to be at rest.

   The position of a body with respect to surroundings does not change with time, the body is said to be in the state of rest.

   Ex: A chair lying in a room is in the state of rest, because it doesn't change its position with respect to the surroundings of the room.A tree, An electric pole, our house, our school .... etc.

Motion: A body is said to be in motion if it changes its position with respect to the surroundings with the passage of time. All moving things are said to be in motion.All moving things are said to be in motion.

   Ex: A moving car, a moving train, a flying bird ...etc.

§§ **Rest and motion are relative terms :** Rest and motion are relative terms. A body can be at rest as well as in motion at the same time.

   For example, when a bus moves on a road, then the bus as well as the passengers sitting in it change their position with respect to a person standing on the road side. So, the bus and the passengers sitting in it are in motion with respect to the person standing on the road side. However, the passengers sitting in the bus do not change their positions with respect to each other. It means, the passengers sitting in a moving bus are not in motion with respect to each other.

   Ex : A person sitting in the compartment of a moving train is in the state of rest, with respect to the surroundings of compartment. Yet he is in the state of motion, if he compares

himself with surroundings outside the compartment.

§§ *Scalars:* The physical quantities which have only magnitude but not direction are called scalars.

Ex: Mass, length, distance, time, area, volume, density, work etc.

§§ *Vectors:* The physical quantities which have both magnitude and direction are calle vectors.

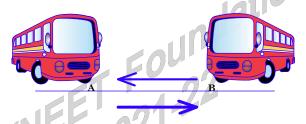**Ex:** Displacement, velocity, acceleration, force etc.

§§ *Distance:* The length of the curve along which the body moves is called a distance. It is scalar quantity.

Units: cm (In C.G.S. System); m(In S.I. System)

§§ *Displacement:* The shortest pathlength between the initial and final positions of a body is called displacement. It is a vector quantity.
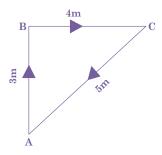
Examples:

1) Suppose a bus starting from station A travels 15000 m to reach stationB then the distance covered by the bus is 15000 m. Now if the bus returns to the station A then distance covered is 15000 m and the total distance covered by the bus during the trip from A to B and then back to A from B is 15000 m + 15000 m = 30000 m.

A bus moving from A to B and again from B to A

But the displacement when the bus moves from A to B and then from B to A is zero

2) Suppose a person moves 3 meters from A to B and 4 meters from B to C as shown in the figure. The total distance traveled by him is 7 meters and he is displaced only by 5 m which is the shortest distance between his initial position and final position.
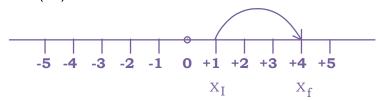
3) Now let us consider an object changing its position, with respect to a fixed point called the origin 0. x_i and x_f are the initial position and final position of the object. Then the displacement of the object = $x_f - x_i$.

Case 1

Suppose the object is moving from +1 to +4, then displacement
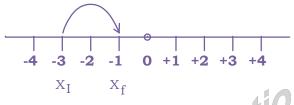
= $x_f - x_i$ = +4 − (+1) = +3

DISPLACEMENT CASE-1

Case 2

If the object is moving from -3 to -1 then displacement = $x_f - x_i$ = −1 − (−3)= 2

DISPLACEMENT CASE - 2

Case 3
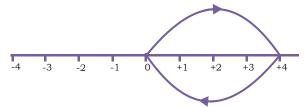
If the object is moving from +5 to +2 then displacement = $x_f - x_i$ = +2 − (+5) = −3.

DISPLACEMENT CASE-3
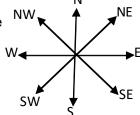
Case 4

If the object follows the path as shown in the figure then the final position and the initial position is the same i.e., the displacement is zero.

Getting Direction

On the Earth the directions parallel to the ground which are

assumed to be flat are called as horizontal directions.

North, East,West & south directions are horizontal and

they are represented on paper as in side figure.

The direction exactlly midway between N and E is called NE.
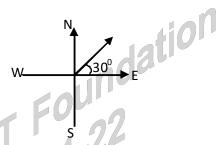
Similarly NW, SW & SE.

If the directions don't fall exactly midway then they won't be

represented as NE, NW, SE, SW & SE. They are represented as in the

following example.

EXAMPLE
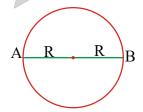
√   **Example-1:**The direction represented in the given figure is

Sol: 30^0 due N of E or 60^0 due E of N

√   **Example-2:**An athlete completes one round of a circular track of radius R in 40 s. What will be his displacement at the end of 2 min 20 s?

Sol.   The time = 2 min 20s = 140s
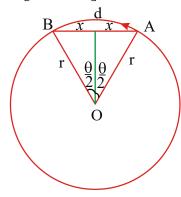
In 40 seconds athlete completes = 1 round

In 140 seconds athlete will completes
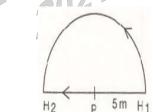
$$=\frac{140}{40}\text{ round} = 3.5 \text{ rounds}$$

The displacement in 3 rounds = 0

So net displacement =2R

√ **Example-3:** If an object turns through an angle θ along a circular path of radius r from point A to point B then

i) distance $d = r\theta$

ii) displacement $2x = 2r\sin(\theta/2)\left[\because \sin\dfrac{\theta}{2} = \dfrac{x}{r}\right]$
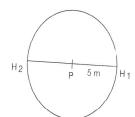
√ **Example-4:** A horse is tied to a rope of length 5 m and the other end of the rope is tied to a pole. find the diplacement and the distance travelled by the horse in the following cases.

i) When the horse makes half revolution along a circular path.

ii) When it makes one full revolution

iii) when it makes 3/4 th of the revolution

sol: i) Half revolution along the circular path.

Distance travelled by the horse $= \dfrac{2\pi r}{2} = \pi r = \pi \times 5 = 5\pi \; m.$

Displacement of the horse = diameter of the circular path,

$\overrightarrow{H_1 H_2}$ 10 m from H_1 to H_2

ii) When the horse makes full revolution

Distance travelled by the horse = circumference of the circular path

$= 2\pi r = 2\pi \times 5 = 10\pi \ m$

Displacement of the horse = zero

iii) When the horse makes 3/4 th of the rrevolution
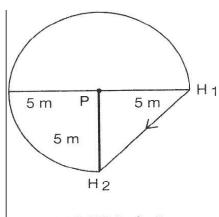
FIGURE 2.5

Distance travelled by the horse = 3/4 th of the circumference of the circle

$$= \frac{3}{4}(2\pi)$$

$$= \frac{3}{2} \times \pi \times 5 = \frac{15}{2}\pi = 7.5\pi \ m.$$

Displacement of the horse = $\overrightarrow{H_1 H_2}$

$|\overrightarrow{H_1 H_2}|$ = shortest distance between H_1 and H_2

$$= \sqrt{5^2 + 5^2} = \sqrt{25 + 25} = \sqrt{50}$$

$$= 5\sqrt{2} \ m \text{ along } H_1 \text{ to } H_2$$

TEACHING TASK

I) *Single correct answer questions:*

1. A student walks 1kilometer due east and 1kilometer due south. Then she runs 2 kilometers due west.The magnitude of the student's resultant displacement is
   A) 3.4 km   B) 1.4 km   C) 4km   D) 0 km

2. If a person could fly nonstop around the equator of the earth and reaches back at initial point then displacement of person is ...
   A) 2π radius of the earth   B) 2π square of radius of the earth
   C)   diameter of earth   D) 0

3. A person walks 3m towards east and then 4m towards north. Find the displacement of the person.

     A) 5m   B) 10m   C) 15m   D) 7m

4. A boy walks 12m towards west and then 5m towards south. Find the displacement of the boy.

     A) 17m   B) 13 m   C) 8m   D) 12m

5. A car travels 10km towards south and then 24km towards east. Find the displacement of the car.

     A)15m   B) 9m   C) 34m   D) 26m

6. A train travels 60km towards north and then 80km towards west. Find the displacement of the car.

     A) 180km   B) 100km   C) 240km   D) 208km

7. Statement of a scalar just consists of its magnitude along with a proper algebraic sign. Among the following the quantity which is not a scalar?

     A) 20 kg   B) 15 m   C) 40 s   D) 13 m due north

8. Among the following the quantity which one is a scalar?

     A) 18m due west   B) 20 m due south   C) 30 m   D) 23 m due north

9. Mohini walks 100m towards west then turns and walks back the way she came 20m. What distance she travelled? What is her displacement?

     A) 80m, 120m   B) 120m, 80m   C) 120m,100m   D) 100m, 120m

10. An Olympic runner is running totally 1600m circle track during a race. What are the distance and displacement he covered?

     A) 1600m, 0m.   B)40m,1600m   C) 6400m,0m   D) 1600m,64m

11. A shopper walks forward 20 m turns right and walks 5 m then turns left and walks in the original direction 10m there after turns left again for 5m. What is the distance she covered? What is her displacement?

     A) 20m, 10m   B) 30m, 20m   C) 30m,40m   D) 40m, 30m

12. Some hikers travel 2 km north turns toward the west and travel 4km turns towards the south and travel 6 km then finally travel east for 4 km. What is their distance? What is their displacement

     A) 5m,20m   B) 10m, 8m   C) 16m, 4km   D) 4m, 16m

II) **Multi correct answer questions :**

♦ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

13. Rakesh drives his bike 7 kilometer north.He stops for lunch and then drives 5 kilometer east. Then choose the correct

    a) Totally he covered a distance of 12 km

    b) his displacement is 8.6 km

    c) finally he travelling towards west

     A) Only a, b   B) Only b, c   C) Onlny a, c   D) all a, b, c

14. Abdul walks to the pizza place for lunch. He walks 1 km east then 1 km south and then 1 km east again. Then choose the correct

    a) Toally he covered a distance of 3 km

    b) His displacement is $\sqrt{5}$ km

    c) his displacement after travelling 1 km south is $\sqrt{2}$ km

A) Only a, b   B) Only b, c   C) Onlny a, c   D) all a, b, c

III) <u>Fill in the blanks</u>

15. A person starts from his house to office and is back again to his house.Then the displacement is...........

16. A person moves 3 m due north then turns towards east and moves again 4 m.The displacement of person is............

17. An object is moving round in a circular path. It completes one revolution and goes back to its starting point. The _____ is zero but the _____ travelled is the circumference of the circular path.

IV) <u>*Match the following.*</u>

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

18. A person is running in the circular path of radius 'r' then

a] after one complete revolution   1] distance = $2\pi r$, displacement = 0

b] after half revolution   2] distance = π r, displacement = 2r

c) after one fourth revolution   3] distance = π r/2, displacement = $\sqrt{2}$ r

d)after three by fourth of revolution   4] distance = 3π r/2, displacement = $\sqrt{2}$ r

A) a-1, b-2, c-3, d-4   B) a-1, b-2, c-4, d-2

C) a-2, b-1, c-3, d-4   D) a-1, b-3, c-2, d-4

V) <u>Comprehension type questions:</u>

♦ *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE** is correct. Choose the correct option.*

19. An athlete running in a circular track of radius 70 m.Calculate his distance and displacement for

a) one revolution   b) two revolutions   c) half revolution

d) one fourth revolution   e) three by fourth revolution.

VI) <u>Solve the following:</u>

20. On his fishing trip Justin takes the boat 12km south.The fish aren't biting so he goes 4km west.He follows a school of fish 1km north.What distance did he cover?What was his displacement?

21. Preston goes on a camel safari in Africa.He travels 5km north then 3 km east and then 1km north again.What distance did he cover?What was his displacement?

22. Naresh travels 8 m east then 4 m north.What distance did he cover?What was his displacement?

VII) <u>*Higher order thinking skills (HOTS)*</u>

23. Stephen buys a new moped.He travels 3 km south and then 4 km east.How far does he need to go to get back to where he started in a shortest way?

24. A man is facing south.He turns 135⁰ in the anti clock wise direcion and then 180⁰ in clock-wise direction.Which direction is he facing now?

25. An athlete completes one round of a circular track of radius R in 40 sec.What will be his displacement at the end of 2 min.20 sec?

26. A body moves from one corner of an equilateral triangle of side 10 cm to the same corner along the sides.Then the distance and displacement are respectively?

27. A body is moving along the circumference of a circle of radius 'R' and completes half of the revolution.The ratio of its displacement to distance is?

KEY

ΦΦ **TEACHING TASK :**

1)A,   2)D,   3)A,   4)B,   5)D,   6)B,   7)D,   8)C,   9)B,   10)A,   11)D
12)C,   13)A,   14)D,   15)zero,   16)5 m, 17)displacement,distance, 18)A,
19) a)440 m,0 m b)880 m,0 m c)220 m,140 m d) 110 m,140 m e) 330 m,140 m
20)11.6 m,   21)9 km,6.7 km,   22)8.94 m,   23)5 km,   24)SE,
25)2R,   26)30 cm,0 cm,   27) $2 : \pi$

LEARNER'S TASK

BEGINNERS (Level - I)

Single correct option questions:

1. The position of a body changes w.r.t surroundings with time then the body is said to be in the state of................with the same surroundings

A) rest   B) motion   C) neither in motion nor in rest D) none

2. A wooden bench lying in the corner of a garden is an example of

A) A body in motion   B) A body in rest

C) body neither in state of rest nor motion   D) none of these.

3. A person sitting in a speeding bus is at rest w.r.t

A) trees   B) fields   C) buildings   D) other passengers

4. Distance is

A) always positive   B) always -ve

C) may be +ve as well as -ve   D) is neither +ve nor -ve.

5. A displacement

A) always +ve   B) always -ve

C) either +ve or -ve or zero   D) neither +ve nor -ve.

6. Choose the correct one

A) displacement > distance   B) displacement < distance

C) displacement $\geq$ distance   D) displacement $\leq$ distance

7. The ratio of distance travelled to displacement is

A) 1   B) ≤ 1 C) ≥ 1 D) <1

8. The S.I unit of displacement

A) m   B) cm   C) ft   D) km

9. The ratio of C.G.S to S.I units of distance is

A) 1:100   B) 100:1   C) 1:1   D) 50:1

10. A physical quantity which has both magnitude and direction is called

A) scale   B) vector   C) both A and B   D) none of these

11. If the distance covered by a particle is zero, what can you say about its displacement

A) It may (or) may not be zero   B) It cannot be zero

C) It is negative   D) It must be zero

12. If the displacement of a particle is zero distance covered by it

A) May (or) may not be zero   B) Must be zero

C) it is negative   D) All are true

13. In the following a physical quantity consisting of only magnitude is

A) Displacement   B) force   C) velocity   D) Density

14. A scalar consists of

A) direction   B) magnitude   C) direction & magnitude   D) None

15. Choose the wrong statement.

A) temperature is a vector   B) current is a scalar

C) electric charge is a scalar   D) both B and C

16. Anitha runs 2 m south then turns back and runs 3 m north. Distance and displacement are.

A) 2m,3m   B) 5m, 1m   C) 4m, 1m   D) 1m,5m

17. Jayanth runs exactly 2 laps around 400 m track, then distance and displacement are.

A) 200m, 0   B) 500m, 0m   C) 800 m, zero   D) 700m,0m

18. A snail crawls 4 ft south then turns east and crawls 6 ft, then distance and displacement are.

A) 11ft,2.7ft   B) 10 ft, 7.2 ft C)12 ft, 1ft   D) 9ft,2ft

19. Rashmi runs 30 feet north, 30 feet west and then 30 feet south, then distance and displacement are.

A) 90ft,30ft   B)80ft,20ft   C) 90ft,22ft   D) 90 ft, 40 ft

20. David walks 3 km north turns east and walks 4 km distance and displacement are.

A) 7km,5km   B) 10km,5km   C) 9km, 11km   D) 5km,7km

21. John flies directly east for 20 km then turns to the north and flies for another 10 km, then distance and displacement are.

A) 30 km,22km   B) 30 km,22.4 km   C) 40 km,22.4 km   D) 3.0 km,22.4 km

22. Cameron flies directly west for 13 km then turns to south and flies for another 30 km. He then flies east 13 km before landing at he airport.

A) 56 km, 3 km   B) 66 km, 30 km   C) 56 km, 30 km   D)56 km, 3.0 k

23. Meghana runs north for 37 meters then turns east and runs for another 10 meters and then stops then distance and displacement are.

A) 47 m, $\sqrt{1496}$ m   B) 48 m, $\sqrt{1496}$ m   C) 487 m, $\sqrt{1496}$ m   D)47m, $\sqrt{1496}$ m

◆ ▐▌ ◆   **ACHIEVERS (Level - II)**   ◆ ▐▌ ◆

Solve the following:

1. A particle moves along a straight line. At some time it is at x = 20 m. After some time it is at x = 35 m. Find the displacement during the interval.

2. A body is moving along a circular path of Radius 'R' what will be the distance travelled and displacement of the body when it completes one revolution ?

3. A body is moving along a circular path of Radius 'r' what will be the distance travelled and displacement when it completes half a revolution ?

4. If on a round trip you travel 6 km and then arive back home.

   a) what distance you have travelled ? b) what is your final displacement ?

5. A body thrown vertically upwards reaches a maximum height h. If then returns to the ground. Calculate the distance and the displacement ?

6. A body travels a distance of 15 m. from P to Q and then moves a distance of 20 m. At right angles to P Q. Calculate the total distance travelled and displacement.

7. An ant travels a distance of 4 m from A to B and moves a distance of 3m at right angles to AB. Find its resultant displacement ?

8. A particle moves 3m north then 4 m east and finally 6 m south. Calculate its distance travelled and displacement.

◀ ▐▌ ▌   **EXPLORERS (Level - III)**   ◀ ▐▌ ▌

I)   Multiple option type:

♦   *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

1. The examples for random motion

   a) marching of soldiers   b) the tip of hands of a clock

   c) movement of people in bazaar   d) motion of flies and mosquitoes

   A) a,b and c   B) c and d   C) a,c and d   D) b and d

2. The distance between Sahithi's home and Anuhya's home is 1425 m.This distance is
    equal to

   a) 142.5 km   b) 1.425 km   c) 1425×10^2 cm   d) 14.25 km

   A) a and b   B) a and d   C) b and c   D) a,b and c

3. If a body completes half revolution in a circular path of radius R then

   a) distance is π R b) displacement is 2R c) distance is 2R   d) displacement is π R

   A) a and b   B) a and c   C) a,c and d   D) b and c

Fill in the blanks

4. distance is a.......... quantity

5. displacement is a.......quantity

6. The SI unit for measuring distance ....

Match the following:

♦   *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

7.   a) Distance   1) force
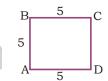
b) Displacement   2) work

c) vector   3) shortest path

d) scalar   4) path covered

A) a - 1, b - , c - 3, d - 4   B) a - 4, b -3, c -1, d - 2

C) a - 1, b - 4, c - 3, d - 2   D) a - 2, b - 1, c - 4, d - 3
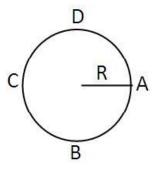
Comprehension Type:

♦   *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

28.. A boy walks along the square path ABCD each of side 5m. Then

i) Along the path ABC distance travelled by a boy is

A) 5 m   B)10 m   C) 15   D) 20 m

ii) Along the path CDA displacement covered by a boy

A) 5 m   B)$10\sqrt{2}$ m   C) $5\sqrt{2}$ m   D) 10 m

iii) Total distance covered by a boy along the path ABCDA

A) 0 m   B)5 m   C) 10 m   D) 20 m

29. Consider an ant moving along the circumference of circle or radius R m.

i) find distance and displacement from A to B

A) $\dfrac{\pi R}{4}, 2R$ B) $\dfrac{\pi R}{2}, \sqrt{2}R$ C)   D) 0,0

ii) find distance and displacement from A to c

A) π R,2R   B) 2R, π R   C) π R,0 D) 0,2R

iii) find distance and displacement from A to D

A) $\dfrac{\pi R}{4}, 2R$ B) $\dfrac{3\pi R}{2}, \sqrt{2}R$ C) $\sqrt{2}R, \dfrac{\pi R}{2}$ D) 0,0

KEY

ΦΦ **LEARNER'STASK :**

☐ **BEGINNERS :**

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

☐ **ACHIEVERS:** 1)15 m,   2) $2\Pi R, 0$,   3) $\Pi r, 2r$,   4) 6km,0 km,   5)2 h, 0,
6)35m, 25 m,   7)5m,   8)13 m, 5m ,

☐ **EXPLORERS:** 1)B   2)C,   3)A,   4)Scalar,   5)Vector,   6)meter,   7)B,
8) i)B ,ii)C, iii) D,   9) i) B, ii)A, iii)B

§§ _Speed:_ The distance travelled by the body in unit time is called its speed.

$$\text{Speed (V)} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

* speed is a scalar quantity.

* it is represented by v or u

units: CGS Unit : cm/s,   SI unit: m/s,

§§ _Uniform speed:_ If a body travels equal distances in equal intervals of time then it is said to be moving with uniform speed.

Eg: motion of ball on a frictionless plane surface.

§§ _Non - uniform speed:_ If a body travels unequal distances in equal intervals of time (or)equal distance in unequal intervals of time the body is said to be travelling with non uniform (or) variable speed.

§§ **Instantaneous speed :** The speed of a body at any instant known as the instantaneous speed.speedometer of vehicle measures the instantaneous speed.

§§ _Velocity:_ The rate of displacement (or) displacement per unit time is called velocity.

$$\therefore \text{Velocity} \left(\vec{v} \right) = \frac{Displacement}{time} = \frac{\vec{S}}{t}$$

* velocity is a vector quantity.

units: CGS Unit : cm/s, SI unit: m/s,

Note: * The velocity of a body can be zero, negative or positive.

* The numerical value of velocity of a body can be equal to speed only if the body is moving along a straight line in the same direction.

* The velocity of a body can never be greater than the speed of that body.

§§ _Uniform velocity:_ If a body travels equal displacements in equal intervals of time then the body is said to be travelling with uniform velocity.

§§ _Non - uniform (or) variable velocity:_ If a body covers cover unequal displacements in equal intervals of time then it is said to be travelling with variable velocity.

TEACHING TASK

Single correct answer questions:

1. A body moves with a speed of 36 km/h. What is its speed in m/s.

A) 10 m/s   B) 20 m/s   C) 30 m/s   D) 40 m/s

2. A man moves with a speed of 15 m/s. Express his speed in km/hr.

A) 34 km/h   B) 54 km/h   C) 36 km/h   D) 18 km/h

3. An athlete runs in a circular path of radius 14 m, 10 times in 10 minutes. Calculate the speed.

A) 1.6 m/s   B) 1.26 m/s   C) 1.36 m/s   D) 1.46 m/s

4. The train 'A' travelled a distance of 120 km in 3 hours where as another train 'B' travelled a distance of 180 km in 4 hours. Which train travelled faster ?

A) train A   B) both trains   C) train B   D) none

5. Calculate the distance travelled by a car moving with a speed 35 km/h in 12 minutes.

A) 15 km   B) 7 km   C) 14 km   D) 9km

6. Imagine two boys Ramu and Somu running a 300 m race. Let as imagine that Ramu finishes the race in 15 sec and somu finishes 30sec. Who run faster ?

A) Ramu   B) somu   C) equal speed   D) none

II) ***Multiple option type:***

♦ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

7. A scooterist covers a distance of 3 kilometers in 5 minutes. This speed equal to

a) 1000 cm/s   b) 10 m/s   c) 36 km/h

A) a, b only correct   B) a, c only correct   C) b, c only correct   D) all a, b, c correct

8. Ahmed is moving in his car with a velocity of 45 km/h. Then he will cover a distance of

a) 45 km in one hour   b) 750 m in one minute   c) 12.5 m in one sec

A) a, b only correct   B) a, c only correct   C) b, c only correct   D) all a, b, c correct

Fill in the blanks:

9. 1 km/h = ... m/s.

10. The speedometer of a vehicle measures ....

11. 15 m/s = ... km/h

12. 1 m/s = ... cm/s.

13. 1 km/min = ... m/s.

Match the following:

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

14. A body moving in circular path of radius 7 m completes half rotation in 2 sec, then its

a) distance traveled   1) 11 m/s
b) displacement   2) 22m
c) speed   3) 7 m/s
d) velcoity   4) 14 m

A) a - 1, b - 2, c - 3, d - 4   B) a - 4, b -3, c -1, d - 2

C) a - 1, b - 4, c - 3, d - 2   D) a - 2, b - 4, c - 1, d - 3

Comprehension type:

♦   *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

15. In a wall clock length of seconds arm is 7 cm, minutes arm is 5 cm, hours arm is 3.5 cm

   i) speed of seconds arm is

   A) $\frac{11}{15}$ cm/s   B) $\frac{7}{5}$ cm/s   C) $\frac{10}{7}$ cm/s   D) none

   ii) Speed of minutes arm is

   A) $\frac{11}{15}$ cm/s   B) $\frac{11}{378}$ cm/s   C) $\frac{11}{180}$ cm/s   D) none

   ii) Speed of hours arm is

   A) $\frac{11}{15}$ cm/s   B) $\frac{11}{378}$ cm/s   C) $\frac{11}{21600}$ cm/s   D) none

Level - III

Solve the following:

16. A Randy Johnson fastball is thrown with a velocity of 41.5 m/s, How long does it take the ball to reach the plate that is 18.44 meters from the pitcher's mound?

17. A bicyclist has an average velocity of 35 km/hr. How far will she travel in 6 hrs?

18. How long will it take you to complete a 135 mile trip if your velocity is 45 mph?

Level - IV

Higher order thinking skills (HOTS)

19. A car covers a distance of 600 m in 2 minutes whereas a train covers a distance of 75 km in 50 minutes. Find the ratio of their speed

   A) 1 : 5   B) 5 : 1   C) 1 : 2   D) 2 : 1

20. A bus covers a certain distance in 60 minutes if it runs at a speed of 60 km/hr. What must be the speed of the bus in order to reduce the time of journey by 40 minutes?

   A) 90 kmph   B) 80 km/h   C) 70 km/h   D) 60 km/h

21. A person crosses a 600cm long bridge in 5cmin. What is his speed in kmph?

   A) 7.2   B) 6   C) 5   D) 4.5

22. How far would you travel moving at 12m/s for 3min?

   A) 160 m   B) 2160m   C) 612 m   D) 123 m

KEY

ΦΦ **TEACHING TASK :**

1) A,   2) B,   3) D,   4) C,   5) B,   6) A,   7) D,   8) D,   9) 5/18,

10) instantaneous speed,   11) 54,   12) 100,   13) 50/3,   14) D,

15) i) A, ii) B, iii) C,   16) 0.444sec   17) 210km   18) 3hr   19) A,   20) A,

21) A,   22) B

LEARNER'S TASK

BEGINNERS (Level - I)

Single correct answer questions:

1. A speed is
   A) always +ve   B) always -ve   C) may be +ve or -ve   D) neither +ve nor -ve

2. When the distance travelled by a body is directly proportional to time the body is said to have
   A) zero velocity   B) zero speed   C) uniform sped   D) none of these

3. If the distances covered by an object are very large then speed can be expressed in
   A) m/s   B) cm/s   C) km/h   D) none

4. In 12 minutes a car whose speed is 35 km/h travels a distance of
   A) 7 km   B) 3.5 km   C) 14 km   D) 28 km

5. 1km/h = ... m/s
   A) 5/18   B) 18/5   C) 9/5   D) 5/9

6. Velocity is
   A) always +Ve   B) always -ve VC) may be +ve as well as -ve D) neither +ve nor -ve

7. Which of the following is a scalar quantity
   A) displacement   B) distance   C) velocity   D) all the above

8. A body starts from rest then its
   A) initial velocity is zero B) final velocity is zero C) distance is zero D) none

9. The S.I unit of velocity
   A) cm/s   B) m/s   C) no units   D) cm/s^2

10. Select the in correct relation

    A) speed = $\dfrac{\text{distance}}{\text{time}}$ B) velocity = $\dfrac{\text{displacement}}{\text{distance}}$

    C) displacement = velocity x time   D) $\dfrac{velocity}{displacement}$ = time

11. Given the distance between earth and sun is 1.6×10^8 km and velocity of light is 4×10^5 km/sec. Find time taken for sunlight to reach the earth is
    A) 400 s   B) 700 s   C) 500 s   D) 600 s

12. A bullet is shot from a gun with a velocity of 120 m/s. How long will it take the bullet to strike the target that is 200 meters away?
    A) 2 sec   B) 6.7 sec   C) 5 sec   D)A:1.67sec

13. A car covered a distance of 30km in 2.5 hours. What is the speed of the car?
    A) 12 kmph   b) 30 km/h   C) 2.5 km/h   D) 25 km/h

14. An aeroplane travels with a speed of 195m/s for 5 hours. What is the total distance traveled?
    A) 3510 km   B) 1530 km   C) 5103 km   D) 150 km

15. Ron walks 22.5 km in 5 hours.Find his speed
    A) 5 km/h   B) 22.5 km/h   C) 20 km/h   D) 4.5 km/hr

16. A train covers 168 km in 4 hours. Find its speed

A) 4 km/h   B) 164 km/h   C) 42 km/h   D) 24 km/h

17. Mom pushes a stroller up and down the mall with an average speed of 6m/s. How far will she go in 30 min?

A) 1080m   B) 2160m   C) 612 m   D) 123 m

18. If the mom in problem 33 stops to sit on a bench located 20m to the east of her starting place what was her average velocity during her 30min walk?

A) 0.90 m/s   B) 0.80 m/s   C) 0.70 m/s   D) 0.011m/s

19. George walks to a friend's house. He walks 750 meters North then realizes he walked too far. He turns around and walks 250 meter towards South. The entire walk takes him 20 seconds. What is his speed?

A) 50 m/s   B) 80 m/s   C) 70 m/s   D) 60 m/s

◀ ▐▐ ▶ ACHIEVERS (Level - II) ◀ ▐▐ ▶

Solve the following:

1. Convert 54km/h into m/s

2. A car moves with a velocity of 6m/s. Express the same in km/h.

3. A car urns in a race a distance of 22km along a circular path and reaches a diametrically opposite end in 3 minutes 20 seconds. Calculate the velocity of car ?

◀ ▐▐▐ ▶ EXPLORERS (Level - III) ◀ ▐▐▐ ▶

Multiple option type:

♦ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which ONE or MORE is correct. Choose the correct options*

1. Two friends Nithin and Jethin want to have a running race. Nithin can run 300 m in 15 sec where as Jethin can run 600 m in one minute.

a) Nithin will win the race   b) Jethin will win the race

c) Nithin will loose the race   d) Jethin will loose the race

A) only a, d are correct   B) only b, c are correct

C) only a, b are correct   D) only c, d are correct

2. Arrange the following speeds in decreasing order.

a) An athlete running with a speed of 10m/s

b) A bicycle moving with a speed of 20 m/min

c) A scooter moving with a speed of 30 km/h

A) a > b >c   B) a > b = c   C) a =b > c   D) a = b= c

3. The information about fastest trains in India is given below. Then choose the correct

i) Gatimaan Express (travels between New Delhi-Agra) takes a travel time of 75 minutes to cover 200 km journey.

ii) Shatabdi Express (travels between New Delhi- Bhopal) takes a travel time of 60 min to cover 150 km journey.

iii) Rajdhani Express (travels between Mumbai- New Delhi) takes a travel time of 120 min to cover 280 km journey.

a) Gatimaan Express is the fastest compared to remaining trains

b) Shatabdi express travels faster than Rajadhani express

c) Rajdhani express has least speed in the given trains

A) only a, b   B) only b, c   C) only a, c   D) all a, b, c

Fill in the blanks:

4. The rate at which the distance covered by the body is called ....

5. The rate of change of displacement of body is called.......

6. The SI unit of velocity is.....

7. The C.G.S unit of speed is .....

8. 1m/s=................kmph

9. 20cm/s=...........m/s

10. 3m/s =........ ....kmph

11. 18kmph =...........m/s

Match the following:

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

12.

Column A	Column B
a) distance	1) m^2/s
b) velocity	2) m
c) $\dfrac{speed}{distance}$	3) s^{-1}
d) velocity x displacement	4) m/s

A) a - 1, b - 2, c - 3, d - 4   B) a - 4, b -3, c -1, d - 2

C) a - 1, b - 4, c - 3, d - 2   D) a - 2, b - 4, c - 1, d - 3

Comprehension type:

♦ *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

13. Apara and Pranathi start from home at the same time and travel by different routes to school. Aparna's house is at a distance of 150m from the school while Pranathi's house is at 200 m from the school. Both reach the school at the same time.

i) Who travelled faster?

A) Pranathi   B) aparna   C) both equal   D) none

ii) The difference of distance between Aparna's house to school and Pranathi's house to

school?

A) 10 m   B) 50 m   C) 150 m   D) 200 m

iii) Whose house is near to school?

A) Pranathi   B) aparna   C) both equal   D) none

KEY

ΦΦ **LEARNER'STASK :**

☐ **BEGINNERS :**

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

☐ **ACHIEVERS :** 1) 15 m/s ,   2) 21.6km/h,   3) 110m/s,

☐ **EXPLORERS :** ,1) A,   2) A,   3) D,   4) Speed,   5) velocity,   6) m/s,   7) cm/s,
8) 18/5,   9) 0.2,   10) 10.8,   11) 5,   12) D,   13) i) A ii) B iii) B ,

§§ *Average speed:* The ratio of the total distance travelled to the total time of travel is called average speed.

Average speed = $\dfrac{Total\,dis\tan ce}{total\,time}$

Note:

a) It a particle travels a distance s_1 with a speed v_1 in a time t_1, a distance s_2 with a speed v_2 in a time t_2 and a distance s_3 with a speed v_3 in time t_3 then,

Total distance travelled = $s_1+s_2+s_3$,

Total time = $t_1+t_2+t_3$.

i) $V_{avg} = \dfrac{s_1+s_2+s_3}{t_1+t_2+t_3}$ ii) $V_{avg} = \dfrac{v_1 t_1 + v_2 t_2 + v_3 t_3}{t_1 + t_2 + t_3}$ iii) $V_{avg} = \dfrac{s_1+s_2+s_3}{\dfrac{s_1}{v_1}+\dfrac{s_2}{v_2}+\dfrac{s_3}{v_3}}$

b) If a body travels first half of the distance with a speed v_1 and second half of the distance with a speed v_2, then $V_{avg} = \dfrac{2v_1 v_2}{v_1 + v_2}$

c) If a body travels with a speed v_1 for first half of time and with a speed v_2 for second half of time, then $V_{avg} = \dfrac{v_1 + v_2}{2}$

§§ *Average velocity:* The ratio of total displacement to the total interval of time of a body is called average velocity.

∴ Average Velocity $(V) = \dfrac{Total\ displacement}{Total\ time}$

$V_{avg} = \dfrac{x_f - x_i}{t_f - t_i}$ Where x_i = Initial Distance, x_f = Final distance,

t_i = Initial time, t_f = Final time, V = Final Velocity.

EXAMPLE

√ **Example-5:** A motor vehicle travelled the first third of a distance 's' at a speed of $V_1 = 10$ kmph, the second one third at a speed of $V_2 = 20$ kmph and the last one third at a speed of $V_3 = 60$ kmph. Determine the mean speed of the vehicle over the entire distances.

Sol: $V_{mean} = \dfrac{s_1 + s_2 + s_3}{t_1 + t_2 + t_3}$, $V_{mean} = \dfrac{\dfrac{s}{3} + \dfrac{s}{3} + \dfrac{s}{3}}{\dfrac{s}{3v_1} + \dfrac{s}{3v_2} + \dfrac{s}{3v_3}}$ $\therefore t = \dfrac{s}{v}$

$$= \dfrac{s}{\dfrac{s}{3}\left[\dfrac{1}{10} + \dfrac{1}{20} + \dfrac{1}{60}\right]} \quad = \dfrac{3}{\dfrac{6+3+1}{60}} \quad = \dfrac{180}{10} = 18 \quad \therefore V_{mean} = 18 Kmph$$

√ **Example-6:** A motorist drives north for 35.0 minutes at 85.0 Km/h and then stops for 15.0 minutes. He next continues north travelling 130 km in 2hours a) What is his total displacement? b) What is his average velocity?

Sol: *a)* Distance travelled in 35min $(S_1) = 85 \times \dfrac{35}{60} = 49.6 \, km$

Distance travelled in 2 hrs (S_2) = 130km

Total displacement = $S_1 + S_2 = 130 + 49.6 = 179.6 \, km$

b) $V_{avg} = \dfrac{S_1 + S_2}{t_1 + t_2} = \dfrac{49.6 + 130}{\dfrac{35}{60} + 2} = 63.4 \, kmph$

√ **Example-7:** A particle is at x = +5m at t = 0s, x = -7m at t = 6 s and x = +2m at t = 10s. Find the average velocity of the particle during the intervals
(a) t = 0s to t = 6s   (b) t = 6s to t = 10s   (c) t = 0s to t = 10s.

Sol: From the definition of average velocity

$$\overline{v} = \dfrac{\Delta x}{\Delta t} = \dfrac{x_2 - x_1}{t_2 - t_1}$$

a) the average velocity between the times t = 0 to t = 6s

$x_1 = +5m, t_1 = 0, x_2 = -7m, t_2 = 6s$

Hence $\overline{v_1} = \dfrac{x_2 - x_1}{t_2 - t_1} = \dfrac{-7-5}{6-0} = -2ms^{-1}$

b) The average velocity between the times $t_2 = 6s$ to $t_3 = 10s$ is

$\overline{v_2} = \dfrac{x_3 - x_2}{t_3 - t_2} = \dfrac{2 - (-7)}{10-6} = \dfrac{9}{4} = 2.25 ms^{-1}$

c) The average velocity between times $t_1 = 0$ to $t_3 = 10s$ is

$\overline{v_3} = \dfrac{x_3 - x_1}{t_3 - t_1} = \dfrac{2-5}{10-0} = -0.3 ms^{-1}$

TEACHING TASK

Single correct answer questions:

1. A car travels first 30 km at a uniform speed of 40 km/h and the next 30 km at a uniform speed of 20 km/hr. Find its average speed.

   A) 25.6 km/h   B) 26.2 km/h   C) 26.6 km/h   D) 22.6 km/h

2. A train travels 60 km/h for 0.52 h 30 km/h for the next 0.24 h and finally 70 km/h for the next 0.71 h What is the average speed of the train?

   A)52.9 km/h   B) 59.9 km/h   C) 55.9 km/h   D) 51.9 km/h

3. A body covers 15 m in first second, 25 m in 2nd second and 35 m in 3rd second .What is the average speed of the body ?

   A) 15 m/s   B) 35 m/s   C) 20 m/s   D) 25 m/s

4. A train travels the first 100 km at a speed of 50 km/h between Delhi and Agra (the distance between Delhi and Agra is 200 km). How much fast must the train travel in the next 100 km so as to maintain an average speed of 70 km/h for the whole journey ?

   A) 115.6 km/h   B) 116.6 km/h   C) 106.6 km/h   D) 16.6 km/h

5. A car is moving along a circular track covering its one complete round of 225 m in 5 sec. Its average velocity is

   A) 15m/s   B) 0 m/s   C) 10 m/s   D) 15 km/s

6. If a car covers first $\frac{2}{5}^{th}$ of the total distance with a speed v_1 and the remaining $\frac{3}{5}^{th}$ of the total distance with a speed v_2 then its average speed is

   A) $\frac{5v_1}{3v_1 + 2v_2}$ B) $\frac{5v_1v_2}{2v_1 + 3v_2}$ C) $\frac{5v_2}{3v_1 + 2v_2}$ D) $\frac{5v_1v_2}{3v_1 + 2v_2}$

7. A particle is moving along its straight line with different velocities 20 kmph in 5 sec, 40 kmph in 10 sec, 60 kmph in 15 sec. Find its average velocity will be

   A) 46.6 kmph   B) 36.6 kmph   C)48.6 kmph   D) 52.5 kmph

II) *Multiple option type:*

♦   *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

8. A car travels a distance of 200km from Delhi to Ambla towards North in 5 hours, returns to Delhi in same time.Then choose the correct

   a) average speed of car is 40 km/h

   b) total time taken to return back to Delhi is 10 hours

   c) average velocity of the car is zero

   A) only a, b   B) only a, c   C) only a, c   D) all a, b, c

III) *Fill in the blanks:*

9. If a body travels first half of the distance with a speed v_1 and second half of the distance with

a speed v_2 then average speed = ...

10. If a body travels first half of the total time with a speed v_1 and second half of the time with a speed v_2 then average speed = ...

11. Average velocity of earth in completing one rotation around sun is ....

IV) *Match the following:*

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

*If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

12. If a body covers the first x % of the total distance with velocity v_1 and the remaining

(100 - x) % of the distance with velocity v_2, then

a] If x = 20   1] $V_{avg} = \dfrac{2v_1v_2}{v_1 + v_2}$

b] If x = 30   2] $V_{avg} = \dfrac{10v_1v_2}{6v_1 + 4v_2}$

c] If x = 40   3] $V_{avg} = \dfrac{10v_1v_2}{7v_1 + 3v_2}$

d] If x = 50   4] $V_{avg} = \dfrac{10v_1v_2}{8v_1 + 2v_2}$

A) a-1, b-2, c-3, d-4   B) a-2, b-1, c-4, d-3

C) a-4, b-3, c-2, d-1   D) a-4, b-3, c-1, d-2

V) *Comprehension type:*

♦ *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

13. A person is moving along a circular path of radius r with uniform speed as shown in the figure. He completes one revolution in four seconds.

i) Average speed along AB is

A) πr B) $\dfrac{\pi r}{2}$ C) $\dfrac{\pi r}{3}$ D) $\dfrac{\pi r}{4}$

ii) Average speed along AC is

A) πr B) $\dfrac{\pi r}{2}$ C) $\dfrac{\pi r}{3}$ D) $\dfrac{\pi r}{4}$
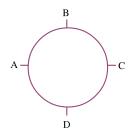
iii) Average speed for one complete revolution is

A) πr B) $\dfrac{\pi r}{2}$ C) $\dfrac{\pi r}{3}$ D) $\dfrac{\pi r}{4}$

III) Solve the following:

14. A car is moving with initial velocity of 20 m/s and it reaches its destiny at 50 m/s. Calculate its average velocity.

15. In 1988 Summer Olympic Games, Florence Griffith-Joyner set the women's world record in the 100 meter dash. She completed the race in 10.48 seconds. What was her average velocity?

16. How far will you travel if you walk for 6 hrs at an average velocity of 4 km/hr?

IV) Higher order thinking skills (HOTS)

17. A person runs 4.0 km in 32 minutes then 2.0 km in 22 minutes and finally 1.0 km in 16 minutes. Find average speed of him in km per minute?

   A) 36   B) 18   C) 0.1   D) 10

18. A train travels 120 km in 2 hours and 30 minutes. What is its average speed?

   A) 36 km/h   B) 48 km/h   C) 56 km/h   D) 84 km/h

19. A plane's average speed between two cities is 600 km/hr. If the trip takes 2.5 hrs. how far does the plane fly?

   A) 1500km   B) 600km   C) 2500km   D) 3000km

KEY

ΦΦ **TEACHING TASK :**

1) C,   2) B,   3) D,   4) B,   5) B,   6) A,   7) A,   8) D,   9) $(2v_1v_2)/(v_1+v_2)$,
10) $(v_1+v_2)/2$,   11) zero,   12) C,   13) i) D, ii) B, iii) B,   14) 35 m/s,
15) 9.54m/s,   16) 24km,   17) C,   18) B,   19) A

LEARNER'S TASK

◆ ▐ ▌ ◆   BEGINNERS (Level - I)   ◆ ▐ ▌ ◆

Choose the correct option:

1. The numerical ratio of average velocity and average speed.

   A) always less than one   B) always equal to one

   C) always more than one   D) equal or less than one

2. An ant covers 2cm, 1.5cm , 2.5cm, 3cm in one second each.Find average speed of it.....

   A) 3m/s   B) 2.5 m/s   C) 1.5m/s   D) none

3. A car covers 40km in 1 hr and then 10 km in 15min then car moving with

   A) variable speed   B) uniform speed   C) average speed   D) none

4. 36kmph =...... m/min

A) 10   B) 129.6   C) 600   D) 100

5. A cyclist moving in circular path of radius 200m covers half revolution in 5min. its average

speed is......m/s

A) 44/21   B) 4/3   C) 88/7   D) 2/3

6. The magnitude of average velocity is equal to average speed when a particle moves

A) in a curved path   B) in the same direction

C) with constant speed   D) with constant speed

7. A car completes one lap around a circular track of radius 50 meters. The time it takes to

complete the lap is 1.2 minutes. What is the total distance covered?

A) 4.66m/s   B) 4.26m/s   C) 4.36m/s   D)3.36m/s

8. In the above question what is the average speed of the car in meters per second?

A) 0.694   B) 0.56   C) 0.51   D)0.88

9. A family leaves from New York City and is flying to Los Angles which is 2800miles away. It

takes 3.25 hours to fly from New York to O'Hare International Airport in Chicago IL. There

they have a one hour layover and fly to Los Angles in 2.75 hours. What is the average

speed of the whole travel?

A) 30 mph   B) 40 mph   C) 50 mph   D) 60 mph

10. A car travels 300.0 m East then 400.0 m West. If it takes 18.0 seconds to do this.what is

the car's average speed and average velocity?

A) 38.18 m/s, 5.55m/s   B) 38.88 m/s, 5.55m/s

C) 38.88 m/s, 5.05m/s   D) 30.88 m/s, 5.55m/s

11. A runner runs for 1.00 hour at an average speed of 2.00 m/s. How far does she run during

this time?

A) 120m   B) 12m   C) 1.20m   D) Both a&c

12. A car travels a distance of 30 miles for 2 hrs and 45 miles for next 3 hrs.Calculate its

average speed.

A) 15mph   B) 1.5mph   C) 5mph   D) 10mph

13. A body moves 30 m at a uniform speed of 20 m/s and next 30 m at a uniform speed of 12

m/s. Calculate its average speed.

A) 15 m/s   B) 12 m/s   C) 10 m/s   D) 20m/s

14. A car covers 30 km at a uniform speed of 60 km/h and the next 30 km at a uniform speed of

40 km/h.Find the total time taken and the average speed ?

A) 70 minutes, 48 km/h   B) 75 minutes, 48 km/h

C) 75 minutes, 40 km/h   D) 25 minutes, 48 km/h

15. A train travels some distance with a speed of 30 km/h and returns with a speed of 45 km/h.Calculate the average speed of the train.

    A) 36 km/h   B) 18 km/h   C) 56 km/h   D) 24 km/h

16. Sam is driving along the highway towards Saint John. He travels 150km in 3.00hrs. What is his average speed for his trip?

    A) 50 km/h   B) 18 km/h   C) 56 km/h   D) 24 km/h

17. A vehicle travels 2345 m [W] in 315 s towards the evening sun. What is its average velocity?

    A) 8m/s   B) 7.4 m/s   C) 8m/s   D) 6m/s

◆▐◀ ACHIEVERS (Level - II) ◀▐◀

II) *Solve the following:*

1. Hari is practicing for a running race. For 1st 1/2 hour he runs 0.25 miles and for the next 1/2 hour he runs for 0.2 miles. Calculate the average speed?

2. A car moves from A to B at a speed of 50 km/hr and comes back from B to A at a speed of 30 km/hr. Find its average speed during the journey.

3. A car covers a distance of 60 km in 3 hours. However, for the first 40 km it travels 16 km/hr. At what speed must it travel for the rest of the distance in order to complete the journey on time?

4. Calculate the average velocity at a particular time interval of a particle if it is moves 5 m at 2 s and 15 m at 4s along x-axis?

◀▐▌ EXPLORERS (Level - III) ◀▐▌

I) *Multiple option type:*

♦ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options.*

1. Consider the motion of the tip of the minute hand of a clock. In one hour

    a) The displacement is zero   b) The distance covered is zero

    c) average speed is zero   d) average velocity is zero.

    A) only a,b correct   B) only a,c correct

    C) only a, d correct   D) all a, b, c, d are correct

2. When a body completes certain journey, then choose the correct

    a) its distance can be zero   b) its displacement can be zero

    c) its average speed can be zero   d) its average velocity can be zero

    A) only a, b   B) only a, c   C) only b, c   D) only b, d

3. When a body moves form one place to another place, choose the correct

a) its distance can be equal to or greater than displacement

b) its average speed can be equal to or greater than average velocity

A) only a   B) only b   C) both a, b   D) both are wrong

II) *Fill in the blanks:*

4. Car moving on circular track its average velocity after one round......

5. The ratio of total displacement to the total interval of time of a body is ......called

6. The ratio of the total distance travelled to the total time of travel is called   ......

7. SI unit of average speed or average velocity is ....

8. If average speed is zero then average velocity is ....

Match the following:

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

9. A car is running in a circular track of radius R, and takes a time T to complete each 1/4 th of the distance.

a) after one rotation average speed is   1) zero

b) after one rotation average velocity is   2) π R / 2T

c) after half rotation average velocity is   3) $\sqrt{2}$ R / T

d) after 1/4 th rotation average velocity is   4) R / T

A) a-2, b-1, c-4, d-3   B) a-1, b-2, c-3, d-4

C) a-4, b-3, c-2, d-1   D) a-2, b-3, c-4, d-1

10. If a body covers the first x % of the total time with velocity v_1 and the remaining (100 - x) % of the time with velocity v_2, then

a] If x = 20   1] $V_{avg} = \dfrac{v_1 + v_2}{2}$

b] If x = 30   2] $V_{avg} = \dfrac{4v_1 + 6v_2}{10}$

c] If x = 40   3] $V_{avg} = \dfrac{3v_1 + 7v_2}{10}$

d] If x = 50   4] $V_{avg} = \dfrac{2v_1 + 8v_2}{10}$

A) a-1, b-2, c-3, d-4   B) a-2, b-1, c-4, d-3

C) a-4, b-3, c-2, d-1   D) a-4, b-3, c-1, d-2

Comprehension type:

♦   *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

11. If a particle moves along a straight line distance of 29 m in time of 5 sec and a distance 55m in time of 14 sec.Then

i) Total distance traveled by the particle

A) 29 m   B) 55 m   C) 84 m   D) 14 m

ii) Total time taken by the particle is

A) 5 sec   B) 14 sec   C) 19 sec   D) 29 sec.

iii) The average velocity of a particle is

A) 2.89 m/sec   B) 4.42 m/s   C) 9.82 m/s   D) zero

12. Mr.Bean travelled 240 km in 4 hours by train and then travelled 120 km in 3 hours by car and 3 km in 1/2 hour by cycle. Then

i) Speed of train is

A) 20 kmph   B) 40 kmph   C) 60 kmph   D) 80 kmph

ii) Speed of car is

A) 20 kmph   B) 40 kmph   C) 60 kmph   D) 80 kmph

iii) Speed of bicycle is

A) 6 kmph   B) 8 kmph   C) 10 kmph   D) 12 kmph

iv) Total distance travelled by Mr. Bean is

A) 240 km   B) 120 km   C) 3 km   D) 363 km

v) Mr.Bean travelled for a total time of

A) 3.5 hr   B) 5.5 hr   C) 7.5 hr   D) 9.5 hr

vi) Average speed of Mr.Been for the total trip is

A) 48.4 km/hr   B) 52.3 km/h   C) 56.7 km/h   D) zero

KEY

ΦΦ **LEARNER'STASK :**

□ **BEGINNERS :**

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

□ **ACHIEVERS :**1) 0.45mph,   2) 37.5 km/hr   3) 40 km/hr   4) 5 m/s

□ **EXPLORERS :**1) C,   2) D,   3) C,   4) zero,   5) average velocity,
   6) average speed,   7) m/s,   8) zero,   9) A,   10) C,   11) i) C, ii) C, iii) B,
   12) C, ii) B, iii) A, iv) D, v) C, vi) A,

§§ *Acceleration:* The change in velocity per unit time (OR) The rate of change of velocity of a body is called Acceleration.

$$\text{Acceleration} = \frac{change\ velocity}{time}$$

Units: m/s² (S.I system), cm/s² (C.G.S system)

The velocity of the car increases continuously with respect to time says that the car accelerates.The increase in velocity per unit time is called acceleration. The velocity of the car decreases continuously with respect to time says that the car decelerates or retards.The decrease in velocity per unit time is called deceleration or retardation.Negative acceleration is called Retardation or Deceleration.

§§ *Accelerations are of two types:*

i) Positive acceleration: If body's velocity increases gradually then it said to possesses positive acceleration.

Example: A freely falling body.

ii) Negative acceleration (or) Deceleration (or) Retardation:

If body's velocity decreases gradually then it said to possesses retardation.

Ex: A vertically projected body.

§§ *Equations of motion:*

The relation between v, u,a and s for a body moving with uniform acceleration in a straight path are well known to us. Equations which relate these quantities are known as equations of motion.

The equations of motion are

i)   V = u+at   where u → Initial Velocity

ii) s = ut+ $\frac{1}{2}$ at²   v → Final Velocity

iii) v²- u² = 2as   t → time

a → uniform acceleration

S → Distance travelled

EXAMPLE

√ **Example-8:** If a sports car at rest accelerates uniformly to a speed of 144 km h⁻¹ in 5 s then find distance travelled by it ?

Sol : $u = 0, v = 144km\ h^{-1} = 144 \times \frac{5}{18} m\ s^{-1} = 40m\ s^{-1}, t = 5\ s$

$a = \frac{v-u}{t} = \frac{40}{5} = 8m\ s^{-2}, \quad s = \frac{1}{2} \times 8 \times (5)^2 = 100\,m$

√ **Example-9:** The driver of a car moving with a velocity of 54 km h⁻¹ applies brakes to decrease its velocity to 36 km h⁻¹. If the retardation produced by the brakes is 2m s⁻², arange the following steps in a sequential order to calculate the distance travelled by the car.

Sol: $u = 54\,km\,h^{-1} = 54 \times \dfrac{5}{18} = 15m\,s^{-1}, v = 36km\,h^{-1} = 36 \times \dfrac{5}{18} = 10\,m\,s^{-1}, a = -2.0\,m\,s^{-1}$

$U\sin g\,v^2 - u^2 = 2as\,(a) \Rightarrow s = \dfrac{v^2 - u^2}{-2a}\,(c) \Rightarrow s = \dfrac{100 - 225}{-2a}\,(c)$

$\Rightarrow s = 125/4 = 31.25m\,(d)$

√ **Example-10:** A bike starting from rest picks up a velocity of 72 km h⁻¹ over a distance of 40m. Calculate its acceleration.

Sol : Given, u = 0, v = 72 km h⁻¹ $= 72 \times \dfrac{5}{18} = 20ms^{-1}$, s = 40m

using v² - u² = 2as $\Rightarrow$ (20)² - 0 = 2a x 40 $\Rightarrow a = \dfrac{400}{2 \times 40} = 5\,m\,s^{-2}$

√ **Example-11:** A car moving along a straight road with a speed of 72 km h⁻¹ is brought to rest within 3 s after the application of brakes. Calculate the deceleration produced by the brakes.

Sol: Initial velocity 'u' = 72 km h⁻¹ = $72 \times \dfrac{5}{18} = 20\,ms^{-1}$

Final velocity , v=0 m s⁻¹,

$\dfrac{v - u}{t} = a \Rightarrow \dfrac{0 - 20}{3} = a \Rightarrow deceleration = 6.67ms^{-2}$

TEACHING TASK

I) ***Choose the correct answer:***

1. A train starting initially with a speed of 36 km/h picks up a velocity of 108 km/h in half minute. Calculate its acceleration in m/s².

    A) 0.66 m/s²   B) 0.76 m/s²   C) 0.86 m/s²   D) 0.96 m/s²

2. A motor cyclist has 8sec to stop his motor cycle which is travelling at 50 km/h. What is his retardation ?

    A) 1.4 m/s²   B) 1.74 m/s²   C) 1.04 m/s²   D) 2.74 m/s²

3. A scooter acquires a velocity of 36 km/h in 10seconds just after the start. Calculate the acceleration of the scooter.

    A) 7m/s²   B) 4m/s²   C) 3m/s²   D) 1m/s²

4. A bus increases its speed from 36km/h to 72km/h in 10seconds. Calculate its acceleration.

    A) 7m/s²   B) 4m/s²   C) 3m/s²   D) 1m/s²

5. If a Ferrari with an initial velocity of 10 m/s accelerates at a rate of 50 ms^{-2} for 3 s, what will be its final velocity?

A) 150m/s   B) 100 m/s   C) 120 m/s   D) 160 m/s

6. Josh rolled a bowling ball down a lane in 2.5 s. The ball traveled at a constant acceleration of 1.8 m/s^2 down the lane and was traveling at a speed of 7.6 m/s by the time it reached the pins at the end of the lane. How fast was the ball going when it left Tim's hand?

A) 1.2 m/s   B) 3 m/s   C) 3.1 m/s   D) 4.1 m/s

7. An aeroplane accelerates down on a runway at 3.20 m/s^2 for 32.8 s until is finally lifts off the ground. Determine the distance traveled before takeoff.

A) 1720m   B) 1270m   C) 1050m   D) 1500m

8. A car starts from rest and accelerates uniformly over a time of 5.21 seconds for a distance of 110 m. Determine the acceleration of the car.

A) 6.4m/s^2 B) 7.1m/s^2 C) 8.1 m/s^2 D) 7.4m/s^2

9. A race car accelerates uniformly from 18.5 m/s to 46.1 m/s in 2.47 seconds. Determine the acceleration of the car and the distance traveled.

A) 73.8m   B) 79.8m   C) 98.7m   D) 89.7m

10. Rocket-powered sleds are used to test the human response to acceleration. If a rocket-powered sled is accelerated to a speed of 444 m/s in 1.83 seconds then what is the acceleration and distance that the sled travel?

A) 406m   B) 306m   C) 206m   D) 604m

II) *Multiple option type:*

♦ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which* **ONE or MORE** *is correct. Choose the correct options*

11. A body starting from rest and moving with uniform acceleration of 5 m/s^2. Then choose the correct

a) its initial velocity is zero

b) its velocity will increase with time

c) its velocity at the end of 5 sec is 25 m/s

d) its velocity at the end of 10 sec is 250 m/s

A) only a, b, c   B) only b, c, d   C) only a, c, d   D) all a, b, c, d

12. A person running at 20 m/s speeds up to 60 m/s in 4 seconds. Then choose the correct

a) his initial velocity is 20 m/s   b) his final velocity is 60 m/s

c) his acceleration is 10 m/s^2 d) his velocity will be 120 km/h in next 6 sec

A) only a, b, c   B) only b, c, d   C) only a, c, d   D) all a, b, c, d

Fill in the blanks:

13. The velocity of the body decreasing gradually is said to be in...................

14. The S.I unit of deceleration is ....

15. Another name for deceleration is.....................

Match the following:

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in* **Column–I** *have to be*

*matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

16.   **Column A**   **Column B**

   a.   u = 10m/s, v = 0m/s, t =1s   1. $a = 2m/s^2$.

   b.   u = 5m/s, v = 5m/s, t =5s   2. $a = -10m/s^2$

   c.   u = 0m/s, v = 10m/s, t=5s   3. $a = -0.5m/s^2$

   d.   u = 2m/s, v = 1m/s, t=2s   4. $a = 0m/s^2$

  A. a-2, b-4, c-1, d-3   B. a-2, b-3, c-4, d-1

  C. a-3, b-2, c-1, d-4   D. a-3, b-4, c-1, d-2

Comprehension type:

♦ *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

17. Acceleration is ratio between change in velocity and time

  i) The velocity of car changes from 18 km/h to 72 km/h in 30 s the acceleration in km/h^2 is

    A) 648   B) 6480   C) 64800   D) 648000

  ii) The change in velocity of motor bike is 54 km/h in one minute the acceleration in km/h^2 is

    A) 324   B) 3240   C) 32400   D) 324000

  iii) A speeding car changes its velocity from 108 km/h to 36 km/h in 4s the deceleration in m/s^2.

    A) 6   B) 5   C) 4   D) 3

Solve the following:

18. A bullet is moving at a speed of 367 m/s when it embeds into a lump of moist clay. The bullet penetrates for a distance of 0.0621 m. Determine the acceleration of the bullet while moving into the clay. (Assume a uniform acceleration.)

19. A stone is dropped into a deep well and is heard to hit the water 3.41 s after being dropped. Determine the depth of the well.

20. A plane has a takeoff speed of 88.3 m/s and requires 1365 m to reach that speed. Determine the acceleration of the plane and the time required to reach this speed.

IV) Higher order thinking skills (HOTS)

21. A bike accelerates uniformly from rest to a speed of 7.10 m/s over a distance of 35.4 m. Determine the acceleration of the bike.

  A) $0.8m/s^2$ B) $7.1m/s^2$ C) $0.712 m/s^2$ D) $7.4m/s^2$

22. An engineer is designing the runway for an airport. Of the planes that will use the airport, the lowest acceleration rate is likely to be 3 m/s^2. The takeoff speed for this plane will be 65 m/s. Assuming this minimum acceleration and what is the minimum allowed length for the runway?

A) 738m	B) 798m	C) 987m	D) 704m

KEY

ΦΦ **TEACHING TASK :**

1) A,   2) B,   3) D,   4) D,   5)D,   6)C,   7) A,   8)C,   9)B,   10) A , 11)C
12) D, 13)Acceleration,   14)ms^{-2},   15) retardation,   16)A,   17) i)B
ii) B iii) B,   18) -1.08x10^6 m /s^2 ,   19) 57 m ,   20) 30.8 s,   21)C,   22)D

LEARNER'S TASK

◆❚❚◆   BEGINNERS (Level - I)   ◆❚❚◆

Single correct answer questions:

1. Relation between change in velocity, acceleration and time is

A) v = u - at   B) v - u = at   C) v = at - u   D) v - at = 0

2. The S.I unit of deceleration

A) m/min^2 B) m/s^2 C) cm/s^2 D) ft/s^2

3. The rate of change of velocity is known as

A) speed   B) displacement   C) acceleration D) none of these

4. The value of g is

A) 980 m/s^2 B) 9.8 m/s^2 C) 980 cm/s^2 D) 0.98 m/s^2

5. A body moves with a uniform velocity. Among the following the correct statement is

A) Its velocity is zero   B) Its speed is zero

C) Its acceleration is zero   D) Both 1 & 2 are correct

6. If a particle is in uniform motion along its straight line then its acceleration is

A) zero   B) increases   C) decreases   D) constant

7. Unit of acceleration is
A) N/s^2 B) cm/s^2 C) m/s   D) cm/s

8. Choose the correct statements:

A) a body having constant speed can have varying velocity

B) a body can posses zero acceleration with non-zero velocity

C) If velocity is constant,acceleration is uniform and motion is non-uniform.

D) If velocity is not constant,acceleration and motion are non-uniform.

9. Acceleration of a body can be due to

A) change in magnitude of velocity of the body

B) change in direction of velocity of the body

C) change in magnitude of velocity but not in direction

D) change in direction of velocity but not in magnitude

10. What is the relation between S.I and C.G.S units of acceleration?

A) 1:100   B) 100:1   C) 200:1   D)1:200

11. Find the ratio between C.G.S and S.I units of speed ?

A) 1:100   B) 100:1   C) 200:1   D)1:200

12. A car traveling at 22.4 m/s skids to a stop in 2.55 s. Determine the skidding distance of the car (assume uniform acceleration).

A) 40.6m   B) 30.6m   C) 20.6m   D) 28.6m

13. A kangaroo is capable of jumping to a height of 2.62 m. Determine the takeoff speed of the kangaroo.

A) 1.2 m/s   B) 7.17 m/s   C) 3.1 m/s   D) 4.1 m/s

◄▐▌► ACHIEVERS (Level - II) ◄▐▌►

Solve the following:

1. How far does a plane fly in 15 s while its velocity is changing from 145 m/s to 75 m/s at a uniform rate of acceleration?

2. A skater is moving at 1.6m/s and then accelerates at $4m/s^2$ for 4 sec. How far did he travel during that motion?

3. A car is moving 12 m/s and coasts up a hill with a uniform acceleration of -1.0 m/s^2. How far has it traveled after 6.0 s?

4. A plane travels 500 m while being accelerated uniformly from rest at the rate of 5.0 m/s^2. What final velocity does it attain?

5. A race car can be slowed with a constant acceleration of –11 m/s2. If the car is going 55 m/s, how many meters will it take to stop?

6. The observation deck of tall skyscraper 370 m above the street. Determine the time required for a penny to free fall from the deck to the street below.

◄▐▌▌► EXPLORERS (Level - III) ◄▐▌▌►

Multiple option type:

♦ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

1. Acceleration of a body can be

a) positive   b) negative   c) zero

A) only a, b correct   B) only a, c correct

C) only b, c correct   D) all a, b, c are correct

2. A train strating from rest, attains a velocity of 75 km/h in 5 minutes. Assuming that the acceleration is uniform, Choose the correct option

a) The acceleration of the train is 5/72 ms^{-2}

b) The distance travelled by the train while it attained the velocity is 25/4km

c) The acceleration of the train is 1/20 ms^{-2}

d) The distance travelled by the train while it attained the velocity is 2 km

A)a,b   B)a,d   C)b,c   D)none

Fill in the blanks:

3. Velocity is a .... quantity

4. Speed in a given direction is called ....

5. .... and .... are relative terms

6. Acceleration of a body moving with increasing velocity is ....

7. Acceleration of a body moving with decreasing velocity is ....

8. Initial velocity of a body starting from rest is ....

9. Final velocity of a body coming to rest is ....

Match the following:

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in* **Column–I** *have to be matched with statements (p, q, r, s) in* **Column–II**. *The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

10.   a) distance   1) m

b) speed   2) s

c) acceleration   3) m/s

d) time   4) m/s^2

A) a - 1, b - 2, c - 3, d - 4   B) a - 1, b - 3, c - 4, d - 2

C) a - 1, b - 4, c - 3, d - 2   D) a - 2, b - 1, c - 4, d - 3

11.   a) velocity   1) $\dfrac{\vec{S}_{Total}}{t_{Total}}$

b) speed   2) $\dfrac{\vec{v}-\vec{u}}{t}$

c) acceleration   3) $\dfrac{\vec{S}}{t}$

d) average velocity   4) $\dfrac{S}{t}$

A) a - 1, b - 2, c - 3, d - 4   B) a - 2, b - 3, c - 1, d - 4

C) a - 3, b - 4, c - 2, d - 1   D) a - 4, b - 3, c - 1, d - 2

Comprehension type:

♦ *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which* **ONLY ONE i**s *correct. Choose the correct option.*

12. A train starts from rest and moves with a constant acceleration of 2.0 m/s² for half a minute.The breakes are then applied and the train comes to rest in one minute.

   i) Find the total distance moved by the train.

   A) 2.7 km   B) 2.2 km   C) 4.1 km   D) 1.7 km

   ii) Find the maximum speed attained by the train.

   A) 60 m/s   B) 80 m/s   C) 50 m/s   D) 30 m/s

   iii) Find the position(s) of the train at half the maximum speed.

   A) 225m   B) 200 m   C) 250 m   D) 180 m

13. A cyclist who starts from the top of a hill accelerates uniformly with 0.5 m/s^2 to reach the foot with a velocity of 54 kmph.

   i) He reaches the foot of the hill in ....s.

   A) 30s   B) 20s   C) 10s   D) 15s

   ii) Find the velocities of the cyclist at the end of 5 s

   A) 1.5m/s   B) 2.5m/s   C) 3m/s   D) 5m/s

   iii) Find the ratio of velocities of cyclist at the end of the 21sts and 7ths.

   A) 3:2   B) 1:3   C) 3:1   D) 2:3

   iv) Find the ratio of velocities of cyclist 6 s after the start to that of 6 s before reaching the foot of the hill.

   A) 1:1   B) 1:2   C) 1:3   D) 1:4

◄ ▮ ▮ ▮ ►   **RESEARCHERS (Level - IV)**   ◄ ▮ ▮ ▮ ►

Single correct answer questions:

1. What statement best describes the given figure ?   **[NSO-2017]**

   A) The earth is rotating around the sun   B) The sun is rotating around the Earth

   C) The Earth is revolving around the sun   D) The sun is revolving around the Earth

2. In circular motion the,..........   **[NSO-2016]**

   A) direction of motion is fixed   B) direction of motion changes continuously

   C) velocity constant   D) none

3. Consider the motion of the tip of the minute hand of clock. In on hour. **[NSO - 2014]**

   A) The distance covered zero   B) the displacement is zero

   C) the average speed is zero   C) none

4. Which of the following is example of vibratory motion ?   [**NSO - 2009**]

   A) a car moving along a circular track   B) a freely falling stone

   B) motion of the string of violin   D) motion of the planet around the sun

5. Which of the following is example of periodic motion?   [**NSO - 2008**]

   A) A car taking a turn on a curved road   B) A crane fling over a water pond

   C) A lift moving down   D) march past of soldiers

6. A passenger in a moving train is at ....w.r.t ground and is at....... with other passenger in same train.   [**NISO - 2009**]

   A) Motion,motion   B)rest,rest   C) motion, rest   D) rest, motion

7. If a body travels half the distance with velocity v_1 and the next half with velocity v_2.ts average velocity will be given by.   [**NSO - 2008**]

8. An artificial satellite is moving in circular orbit of 4225.km.find its speed if it takes 24hr to revolve around the earth.   [**NSO - 2012**]

   A) 30.7km/s   B) 5.67km/s   C) 6.14km/s   D)1.57km/s

9. The length of a square field is 6 *m*. Parul ran 6 rounds around the field. The total distance that she covered, is ....   [**NSO - 2008**]

   A) 216 *m*   B) 144 *m*   C) 176 *m*   D) 186 *m*

10. Two simple pendulums P and Q are given. P completes 20 oscillations in 32 sec and Q completes 30 oscillations in 45 sec. Which pendulum is faster ?   [**NSO - 2008**]

   A) P   B) Q   C) both have same time period   D) data insufficiently

11. Two boys P and Q are running along the same path. P is 10 m ahead of Q initialy.However, Q catches up with P. after running 50 m. Assuming that both boys are running at a constant speed. What is the ratio of the speeds of P and Q ?   [**NSO - 2014**]

   A) 6 : 5   B) 5 : 6   C) 4 : 1   D) 4 : 5

12. Sonic vibrations were sent down from a return after 2 seconds. What is the depth of the sea. If the speed of sound in water is 1.5 kms^{-1} ?   [**NSO - 2012**]

   A) 150 m   B) 3 m   C) 1.5 m   D) 750 m

13. A car driver took a total of two hours to make a journey of 75 km. He had a coffee break of half an hour and spend a quarter of an hour stationary in a traffic jam. What was his average speed during the journey ?   [**NSO - 2012**]

   A) 38 kms^{-1} B) 50 kms^{-1} C) 60 kms^{-1} D) 75 kms^{-1}

14. Talking one light year equal to 9.4×10^{15} m and one day equal to 86400 s, what will be the speed of light in light year per day if the speed of light in ms^{-1} is 3×10^8 ?

   A) 2.75×10^{-3} ly day^{-1} B) 3.75×10^{-3} ly day^{-1} [**NSO - 2012**]

   C) 2.75×10^{3} ly day^{-1} D) 3.75×10^{-3} ly day^{-1}

15. The ultrasonic waves take 4 second to travel from the ship to the bottom of the sea and back to the ship (in the form of an echo). What is the depth of the sea)?[**NSO - 2009**]

A) 3000 m   B) 2000 m   C) 1000 m   D) 500 m

16. A taxi driver noted reading on the odometer fitted in vehicle as 1050 km, when he started the journey. After 30 minutes drive, he noted that the odometer reading was1086 km. What is the average speed of the taxi ?   [NSO - 2009]

A) 20 m/s   B) 25 m/s   C) 30 m/s   D) 40

17. How long does it take for the earth to rotate on its axis seven times ?**[NSO - 2010]**

A) One day   B) One week   C) One month D) One year

KEY

ΦΦ **LEARNER'STASK :**

☐ **BEGINNERS :** 1) B,   2) B,   3) C,   4) B,   5) C,   6)A,   7) B,   8)A,   9)A,
              10) A,   11)A   12)D,   13)B

☐ **ACHIEVERS :**1) 1650m,   2) 9.6m,   3)54m,   4) 71m/s,   5) 138m,   6) 8.69 s

☐ **EXPLORERS :**1) D,   2)A,   3) vector,   4) velocity,   5) rest & motion,
              6) positive acceleration,   7) negative acceleration,   8) zero,   9) zero
              10) B,   11) C,   12) i) A, ii) A, iii)A,   13) i) A, ii) B, iii) C, iv) D,

☐ **RESEARCHERS :**
              1) C,   2) B,   3) B,   4) C,   5) D,   6) C,   7) V_{avg} =(2v_1v_2)/(v_1+v_2),
              8)A,   9) B,   10) B,   11) D   12) C,   13) C,   14)A,   15)A,   16)A,   17) B

§§ *Vertical motion :*

§§ *Acceleration due to gravity(g):* The acceleration caused by the gravitational attraction of the Earth is called as acceleration due to gravity. Its value g=9.8 m/s² (or) 10 m/s²

§§ *Equations of motion for a freely falling body:*
    In case of a freely falling body the initial velocity u=0 and acceleration(a) = g (+ve)

    i) v = gt   ii) s = $\frac{1}{2}$gt²   iii) v ² = 2gs   iv) Sn = g $\left(n - \frac{1}{2}\right)$

§§ *Equations of motion for a body projected vertically upwards:*
    In case of a body projected vertically upwards a = -g
    final velocity (v) = 0 at its highest point.

    i) u = gt   ii) s = ut $-\frac{1}{2}gt^2$ iii) u² = 2gs   iv) S_n = u - g $\left(n - \frac{1}{2}\right)$

§§ *Maximum Height (H) :* It is defined as the height of the point where the final velocity of a vertically projected body becomes zero.

    Maximum height reached by the body (H) = $\frac{u^2}{2g}$

§§ *Time of ascent (t_a) :* Time taken by the body to reach the maximum height.

i.e. $t_a = \dfrac{u}{g}$

§§ **_Time of descent t_d):_** Time taken by the body to reach the ground

i.e. $t_d = \dfrac{u}{g}$

§§ **_Time of flight (T) :_** It is defined as the time for which a body remains in the air.

$$\therefore \ t \ = \ ta + td \ = \ \dfrac{2u}{g}$$

Note: In medium having resistance $t_d > t_a$

§§ **_Velocity on reaching the point of projection:_**

When a body is dropped from a height h, then u = 0, a = g

Final Velocity (V) = $\sqrt{2gh}$

If the above is projected vertically upward with velocity 'u' then h = H = $\dfrac{u^2}{2g}$,

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EXAMPLE

√ **Ex 1:** A stone is dropped from top of a tower 300m high and at the same time another is projected vertically upward with a velocity of 100 ms^{-1} . Find when and where the two stones meet.

Sol: Let the two stones meet at height 'X' from the ground

1st stone : u=0, a=g, s=(300-x)

$$s{=}ut+\dfrac{1}{2}at^2 \Rightarrow 300 - X = 0 + \dfrac{1}{2}gt^2 \Rightarrow 300 - X = \dfrac{1}{2}gt^2 ....(1)$$

2nd stone: $u = 100 m/\sec, a = -g, s = X$

$$s = ut + \dfrac{1}{2}at^2 \Rightarrow X = 100t - \dfrac{1}{2}gt^2 ....(2)$$

$eq(1) + eq(2) \Rightarrow 300 = 100t \qquad\qquad \therefore t = 3\sec$

't' value in eq (2) $\quad X = 300 - \dfrac{1}{2} \times 9.8 \times 9 \Rightarrow \therefore X = 255.9m$

√   **Ex 2:** A stone is dropped from the top of a cliff. It is seen to hit the ground below after 4.2 s. How high is the cliff?

Sol: Initial velocity u = 0

Time taken to reach the foot of the cliff t = 4.2sec

Heigt of the cliff H= -ut + $\dfrac{1}{2}gt^2 \Rightarrow$ H = $\dfrac{1}{2}gt^2$

$$\Rightarrow H = \frac{1}{2} \times 9.8 \times (4.2)^2 \Rightarrow \qquad H = 86.44m$$

√   **Ex 3:** How long does it take a brick to reach the ground if dropped from a height of 65 m? What will be its velocity just before it reaches the ground?

Sol: Height = 65m, Initial velocity u = 0

Time = $\sqrt{\dfrac{2H}{g}} = \sqrt{\dfrac{2 \times 65}{9.8}}$ =3.64 sec

velocity v = $\sqrt{2gH} \qquad \Rightarrow \qquad$ v = $\sqrt{2 \times 9.8 \times 65} \Rightarrow \quad$ v = 35.6 m/sec.

√   **Ex 4:** A ball is thrown vertically up with a velocity of 39.2 ms^{-1} Calculate its maximum height.

Sol: Initial velocity of the body (u) = 39.2 ms^{-1}

Maximum height (H) = $\dfrac{u^2}{2g} \qquad = \dfrac{39.2 \times 39.2}{2 \times 9.8}$ =78.4 m

√   **Ex 5:** If the times of fall of two bodies are in the ratio 1:2. What is the ratio of the heights from whcih they fall?

Sol: The ratio of the times $t_1 : t_2$ = 1:2, $h \propto t^2 \Rightarrow \dfrac{h_1}{h_2} = \left(\dfrac{t_1}{t_2}\right)^2 \Rightarrow \qquad \left(\dfrac{1}{2}\right)^2 = 1/4$

√   **Ex 6:** A ball is dropped freely from a height. Find the distance travelled in the sixth second.(g = 9.8 ms^{-2})

Sol: Given that initial velocity (u) = 0
Distance travelled by the body in the nth second

$$(s_n) = u + a\left(n - \frac{1}{2}\right) \Rightarrow \quad \Rightarrow s_6 = 0 + 9.8\left(6 - \frac{1}{2}\right) = 53.9 \text{ m}$$

TEACHING TASK

Single correct answer questions

1. A ball dropped freely takes 0.2s to cross the last 6m distance before hitting the ground. Total time of fall is (g = 10 m/s^2)

    A) 2.9 s   B) 3.1 s   C) 2.7 s   D) 0.2 s

2. A body thrown up with a velocity reaches a maximum height of 100 m. Another body withe double the mass is thrown up with double the velocity of the first one, maximum height reached by the second body is

    A) 400 m   B) 200 m   C) 100 m   D) 25 m

3. A body is dropped from a height of 300 m. Exactly at the same instant another body is

projected from the ground vertically up with a velocity of 150 m/s. They will meet, from top at a height of

A) 19.6 m   B) 16.9 m   C) 69.1 m   D) 96.1 m

4. One body is dropped while a second body is thrown down ward with an initial velocity of 1 m/s simultaneously. The separation between these is 18 m after a time.

A) 18 sec   B) 9 sec   C) 4.5 sec   D) 36 sec

II) *More than one correct answers*

♦ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

5. Average value of acceleration due to gravity of earth is

a) 32 ft/s^2 b) 98 m/s^2 c) 9.8 m/s^2 d) 980 cm/s^2

A) a,b,c correct   B) b,c,d correct   C) a,c,d correct   D) all correct

Fill in the blanks :

6. At a point where the final velocity of a vertically projected body becomes zero is called as ....

7. Equation for time of flight ....

8. Units for accleration due to gravity in SI and CGS system are ....

9. value of 'g' in SI system ....

Assertion - A and Reason - R:

♦ *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

A) Both A and R are true and   R is correct explanation of A

B) Both A and R are true and R is not correct explanation of A

C) A is true but R is false.

D) A is false but R is true.

10. A : The direction is reversed at maximum height in the case of a vertically projected body

   R : Acceleration due to gravity acts as constant in the case of a vertically projected body

11. A : At maximum final height velocity of a vertically projected body is zero.

   R : At maximum height acceleration due to gravity is never zero.

12. A : The displacement of a freely falling body in successive seconds is in the ratio 1:3:5:...

   R : Because it is moving with uniform velocity

Match the following:

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

13. a) Maximum height (H)   1) 2u/g

b) Time of ascent (t_a)   2) u/g

c) Time of descent (t_d)   3) u²/2g

d) Time of flight (T)   4) $\sqrt{2h/g}$

A) a-3, b-2, c-4, d-1   B) a-3, b-2, c-1, d-4

C) a-2, b-3, c-4, d-1   D) a-3, b-4, c-2, d-1

KEY

ΦΦ **TEACHING TASK :**

1) B,   2) A,   3) A,   4) A,   5) C,   6) Maximum height ,   7) 2u/g,

8) m/s² , cm/ s²   9) 9.8m/s²   10) A,   11) A,   12) C,   13) A.

LEARNER'S TASK

◆ ⊦⊦ ◆ **BEGINNERS (Level - I)**   ◆ ⊦⊦ ◆

I)   **Single correct option questions:**

1.   A body falls freely from rest. If the velocity acquired is numerically equal to the displacement, then the velocity acquired is

A) 9.8 m/s   B) 19.6 m/s   C) 29.4 m/s   D) 39.2 m/s

2.   A body dropped from the top of a tower reaches the ground in 4s. Height of the tower is

A) 39.2 m   B) 44.1 m   C) 58.8 m   D) 78.4 m

3.   A boy throws a ball in air and in such a way that when the ball is at its maximum height he throws another ball. If the balls are thrown with a time difference of 1 sec. What will be the height attained by them

A) 19.6 m   B) 9.8 m   C) 4.9 m   D) 2.45 m

4.   A body is released from the top of a tower a height 'h' metres. It takes 't' seconds to reach the ground. Where is the ball at the time t/2 sec.

A) at h/2 meters from the ground   B) at h/4 meters from the ground

C) depends upon the mass of the body   D) at 3h/4 meters from the ground.

5.   At a place the acceleration due to gravity is

A) zero   B) constant   C) varies   D) we can't define

6.   Average value of acceleration due to gravity of earth is

A) 32 m/s²   B) 98 m/s²   C) 9.8 m/s²   D) 980 m/s²

7.   If two stones of different sizes are dropped simultaneously from the top of a building in vacuum, then

A) smaller stone reaches the ground first   B) larger stone reaches the ground first

C) both reach the ground simultaneously   D) it depends upon material of stone

8. A motor car moving with a uniform velocity of 20 m/s, comes to a stop, on the application of the brakes, after travelling a distance of 10 m. Its acceleration is

A) 20 m/s^2 B) - 20 m/s^2 C) - 40 m/s^2 D) 2 m/s^2

9. A stone released freely from the top of a tower reaches the ground in 4 s. The height of the tower is about (g = 10 m/s^2)

A) 20 m   B) 40 m   C) 80 m   D) 160 m

10. If a body travels 30 m in an interval of 2 s, and 50 m in next interval of 2 s, the acceleration of the body is

A) 10 m/s^2 B) 5 m/s^2 C) 20 m/s^2 D) 2.5 m/s^2

11. A particle is travelling with uniform acceleration. Its velocities after 1 s, 5 s are respectively 2 cm/s and 10 cm/s. The distance travelled in the 3 rd second is

A) 7 cm   B) 5 cm   C) 4 cm   D) 14 cm

12. The ratio of the distance travelled by a freely falling body in the 1st, 2nd, 3rd seconds of its fall is

A) 1 : 2 : 3   B) 1 : 3 : 5   C) 1 : 4 : 9   D) none of the above

13. A body is projected vertically upwards. Maximum height reached by it is equal to acceleration due to gravity in magnitude. Initial velocity of the body is (g = 10 m/s^2)

A) 19.6 m/s   B) 14.14 m/s   C) 10 m/s   D) 10.02 m/s

14. A stone is thrown upwards from the surface of earth with a initial velocity of 5 m/s. The stone comes to rest at a height of (assume g = 10 m/s^2)

A) 1.25 m   B) 12.5 m   C) 0.125 m   D) 1250 m

15. An object is projected vertically upwards with a velocity of 100 m/s. It strikes the ground in approximately (assume g = 10 m/s^2)

A) 10 sec   B) 15 sec   C) 20 sec   D) 5 sec

16. A stone is dropped freely from the top of a tower reaches the ground in 4 sec. The height of the tower is about (assume g = 10 m/s^2)

A) 20 m   B) 40 m   C) 80 m   D) 160 m

17. A body is projected vertically upwards from bottom of a tower. The body crosses an observer on the top of the tower with a velocity of 2 m/s in 2 sec.Height of the tower is

A) 23.6 m   B) 20 m   C) 4 m   D) 15.6 m

18. If a body travels 30 m in an interval of 2 sec, and 50 m in the next interval of 2 sec, the acceleration of the body is

A) 10 m/s^2 B) 5 m/s^2 C) 20 m/s^2 D) 2.5 m/s^2

19. How far will a freely falling body travels in first 5 seconds. (assume g = 10 m/s^2)

A) 125 m   B) 250 m   C) 50 m   D) 225 m

20. The distance travelled by a freely falling stone in its 3rd second of its travel is

A) 9.8 m   B) 19.6 m   C) 24.5 m   D) 39.2 m

21. A ball is thrown vertically upwards returns to its starting point in 4 s. The initial velocity with which ball was thrown is

A) 12 m   B) 9.8 m   C) 19.6 m   D) 392 m

22. The acceleration due to gravity on moon is $g/6$ m/s². If a boy can thrown a stone 12 m up straight on the earth, how high should the boy with same initial velocity able to throw the stone on the moon.

A) 50 m   B) 60 m   C) 140 m   D) 72 m

23. Three blocks of identical dimensions are dropped simultaneously from the same height. Ones block is made of lead one of brass and the other of aluminium. The block that reach the ground first is

A) The lead block   B) the brass block   C) the aluminium block   D) all simultaneously

24. Two bodies from the top of a mountain cliff with one held directly above 1 m the other are released simultaneously to fall under gravity. After 2 sec their relative separation will be

A) 1 m   B) 2 m   C) 3 m   D) 4 m

25. A body of mass 3 kg is thrown vertically up with a speed of 100 m/s. On the return journey, its speed in m/s at the starting point will be

A) 10000   B) 1000   C) 100   D) 9.8

26. A ball released from a height falls 5 m in first second. In 4 s it falls through a height of

A) 20 m   B) 1.25 m   C) 40 m   D) 80 m

27. Two bodies of masses m_1 and m_2 are projected vertically upwards with velocities u_1 and u_2. The ratio of their times of flights is

A) $\dfrac{m_1}{u_1} : \dfrac{m_2}{u_2}$ B) $\dfrac{u_1}{m_1} : \dfrac{u_2}{m_2}$ C) $u_1 : u_2$ D) $\dfrac{1}{u_1} : \dfrac{1}{u_2}$

28. A freely falling body travels a distance of 2450 cm in the last second of its journey. Find the height from which its is falling

A) 980 cm   B) 1960 cm   C) 2940 cm   D) 4410 cm

29. A ball is dropped from the top of a tower 400 m high at the same time another ball is projected vertically upwards from the ground with a velocity of 100 m/s. After how much time they will meet

A) 2 s   B) 8 s   C) 6 s   D) 4 s

30. A stone falls freely from rest and the total distance covered by it in the last second of its motion equals the distance covered by it in the first five seconds of its motion. The stone remains in air for

A) 17 s   B) 11 s   C) 7   D) 13 s

◆❚❚◆ ACHIEVERS (Level - II) ◆❚❚◆

Solve the following:

1. A ball is thrown vertically down from a building top with a velocity equal in magnitude to that of acceleration due to gravity. If it reaches the ground with double the velocity, height of building in meters is

2. A ball is thrown vertically down with a velocity of 20.6 m/s from a height of 105.9 m. The velocity with which the ball hits the ground is

3. A stone is dropped from the top of a tower 200 metres in height and at the same instant another is projected vertically upwards from the ground with a velocity of 50m/s. Find when and where the stones will meet.

4. Find the ratio of distances travelled by freely falling body. In the first second to next second and next second.

5. A body moving from rest with uniform acceleration travels a distance S_1 in the first 2 seconds and travels a distance S_2 with uniform velocity in the next 4 seconds. Then show that $S_2 = 4S_1$.

6. A stone is dropped down vertically from a height of 490m displaces, how much in its last second of its travel ?

7. A body released from the top of a tower of height h takes time 't' to reach the ground. What is its height from the ground after time t/2 ?

8. Show that for a freely falling body if displacement in 1st, 2nd, 3rd...... Seconds are $S_1, S_2, S_3,$........ then $S_2 - S_1 = S_3 - S_2 = S_4 - S_3 = $...............$= g$.

9. Show that the distances travelled by a freely falling body in succesive seconds in the ratio 1 : 3 : 5 :...............

10. Show that for a freely falling body, travels a distance x in n^{th} second, distance travelled by in the next $(n+1)^{th}$ second is x+g.

11. Show that for a freely falling body, travels a distance x in n th second, distance travelled by it before one second [(n-1) th second] is x - g

◄❚❚► EXPLORERS (Level - III) ◄❚❚►

More than one correct option questions:

◆ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

1. In the case of a vertically projected body which of the following are wrong

   a) at maximum height v = 0, g = 0   b) at maximum height v = 0, g = constant

   c) at maximum height v $\neq$ 0, g = 0   d) at maximum height v $\neq$ 0, g = constant

   A) a,b,c   B)b,c,d   C) a,c,d   D)none

Fill in the blanks :

2. At maximum height the final velocity of a vertically projected body becomes ------------

3. Time taken by the body to rach the ground is called ----------------

4. Average value of the earth is --------------------

5. For a freely falling body initial velocity is ---------------

Assertion - A and Reason - R:

♦ *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

    A) Both A and R are true and R is correct explanation of A

    B) Both A and R are true and R is not correct explanation of A

    C) A is true but R is false.   D) A is false but R is true.

6. **A :** A metal ball and a wooden ball of some radius are dropped from the same height in vacuum reach the ground same time.

    R : In vacuum all the bodies dropped from same height take same time to reach the ground.

7. **A :** If a bird starts from its nest in the morning for food, and returns to his nest in the evening, its average velocity is zero

    R : The ratio between total displacement to total time taken is called as average velocity

8. **A :** In the case of a vertically projected body its acceleration remains constant through out the journey.

    R : Earth attracts all the bodies towards its centre.

9. **A :** Any freely falling body moves an extra distance 'g' in every second compared to that in the previous second.

    R : Any freely falling body moves with an acceleration 'g'.

Match the following.

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

    If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

10. a) starting from rest   1) $u = 0$

    b) freely falling   2) $v = 0$

    c) vertically projected up   3) $a = g$

    d) comes to rest   4) $a = -g$

    A) a-1, b-3, c-4, d-2 B) a-2, b-1, c-4, d-3 C) a-1, b-3, c-2, d-4 D) a-1, b-3, c-4, d-2

Comprehension Type questions:

♦ *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

11. When a body is projected vertically upwards, its velocity decreases since its motion is against gravity,hence g is taken as -ve:

    i) A ball is projected upward with velocity of $100 ms^{-1}$. It will strike the ground in nearly

A) 5s   B) 10s   C) 15s   D) 20s

ii) Two bodies are thrown vertically upwards with their initial velocity in the ratio 2:3.Then the ratio of the maximum heights attained by them is

A) 1:1   B) 4:9   C) 2:3   D) $\sqrt{2}:\sqrt{3}$

iii) A stone thrown vertically upwards attains a maximum height of 45m. In what time the velocity of stone become equal to one half the velocity of throw?(Given g = 10ms⁻²)

A) 2s   B) 1.5s   C) 1s   D) 0.5s

KEY

ΦΦ **LEARNER'STASK :**

☐ **BEGINNERS :** 1) B,   2) D,   3) C,   4) D,   5) B,   6) C,   7) C,   8) B,   9) C,   10) B

11) B,   12) B, 13) B, 14) A, 15) C, 16) C, 17) A, 18) B, 19) A,

20) C,   21) C, 22) D, 23) D, 24) A, 25) C, 26) D, 27) C, 28) D,

29) D,   30) D

☐ **ACHIEVERS :** 1) 14.7m ,   2) 50m/s⁻²,   3) 4 sec after start, 78.4m from the ground,

4) 1 : 3 : 5,   5) 93.1m,   7) h/2g.

☐ **EXPLORERS :** 1) C,   2) Zero,   3) Time of desent   (t_d),   4) 9.8 m/s²,

5) Zero,   6) A,   7) A,   8) A,   9) A,   10) A,   11) i) D, ii) B, iii) B.

§§   **Body Projected Vertically up from a Tower :**

A body projected vertically up from a tower of height 'h' with a velocity 'u' (or a body dropped from a rising balloon (or) a body dropped from an helicopter rising up vertically with constant velocity 'u' reaches the ground exactly below the point of projection after a time 't'. Then

a) Height of the tower is $h = -ut + \dfrac{1}{2}gt^2$

b) Time taken by the body to reach the ground t = $\dfrac{u + \sqrt{u^2 + 2gh}}{g}$

c) The velocity of the body at the foot of the tower v = $\sqrt{u^2 + 2gh}$

d) Velocity of the body after 't' sec. is $v = u - gt$

e) The height of the balloon by the time the body reaches the ground is $\dfrac{1}{2}gt^2$.

A body projected vertically down from a tower with a velocity 'u' reaches the foot of the tower after a time 't_1' with a velocity 'v_1'. Another body projected vertically up from the tower with same velocity reaches the foot of the tower after a time 't_2' with a velocity 'v_2'. A freely dropped body reaches the foot of the tower after a time 't' with a velocity 'v', then

(a) $t = \sqrt{t_1 t_2}$ (b) $h = \frac{1}{2} gt_1 t_2$ (c) $u = \frac{1}{2} g(t_1 - t_2)$

(d) $v_1 = v_2 = \sqrt{u^2 + 2gh}$ (e) $v = \sqrt{2gh}$

EXAMPLE

√ **Ex 1:** A helicopter is ascending vertically with a speed of 8.0 ms^{-1}. At a height of 120 m above the earth, a package is dropped from a window. How much time does it take for the package to reach the ground?

Sol: Initial velocity u = 8 m/sec, Height H= 65m, H=-ut + $\frac{1}{2} gt^2$, Time (t) = ?

65 = -8t + $\frac{1}{2} \times 9.8 \times t^2$, By solving t = 5.83 sec.

√ **Ex 2:** A stone is thrown vertically upward with a speed of 10.0 ms^{-1} from the edge of a cliff 65m high. How much later will it reach the bottom of the cliff? What will be its speed just before hitting the bottom.

Sol: Initial velocity of stone u = 10m/sec, Height of the cliff H = 65m

i) Time taken to reach the bottom of the cliff t = ?

$H = \frac{1}{2} gt^2 - ut$

$\Rightarrow$ $65 = \frac{1}{2} \times 9.8 \times t^2 - 10t$

$\Rightarrow 4.9t^2 - 10t - 65 = 0$

By solving it we get t= 4.79 sec.

ii) Speed of the stone just before hitting the bottom v = ?

$v = \sqrt{2gh}$ $\Rightarrow$ $v = \sqrt{2 \times 9.8 \times 65}$ $\Rightarrow$ $v = 37.14$ m/sec

√ **Ex 3:** From the top of the tower of height 39.2m, a stone is thrown vertically up with a velocity of 9.8 ms^{-1}. Find out the time taken by it to reach the ground (g=9.8 m/s^2)

Sol: Given that Height of the tower (h)= 39.2 m, Velocity of the body (u) = 9.8 ms^{-1}
Time taken by the body to reach the ground

(t) = $= \dfrac{u + \sqrt{u^2 + 2gh}}{2}$ $= \dfrac{9.8 + \sqrt{9.8 \times 9.8 + 2 \times 9.8 \times 39.2}}{2}$ = 19.6 sec.

TEACHING TASK

Choose the correct option:

1. A food packet is released from a helicopter which is rising at 2 m/s. The velocity of the food packet after 2 seconds is

A) 17.6 m/s up words   B) 21.6 m/s down words

C) 17.6 m/s down words   D) 21.6 m/s down words

2. A stone is dropped from a rising balloon at a height of 300m above the ground and it reaches the ground in 10s. The velocity of the balloon when it was dropped is

A) 19 m/s   B) 19.6 m/s   C) 29 m/s   D) 0 m/s

3. A body thrown vertically up with a velocity 'u' reaches the maximum height 'h' after 'T' second. Correct statement among the following is

A) at a height h/2 from the ground its velocity is u/2

B) at a time 'T' its velocity is 'u'

C) at a time '2T' its velocity is '-u'   D) at a time '2T' its velocity is '-6u'

4. A stone is thrown vertically up with a speed of 4.9 m/s from a bridge. It fell down in water after 2 sec. The height of the bridge is

A) 9.8 m   B) 19.8 m   C) 14.7 m   D) 19.5 m

5 A balloon starts rising from the ground with an acceleration of 1.25 ms^{-2}, After 8 seconds, a stone is released from the balloon, The stone will ($g = 10 \text{ ms}^{-2}$)

A) cover a distance of 40 m   B) having a displacement of 50 m

C) reach the ground in 4 s   D) begin to move down after being released

6. A ball is thrown straight upward with a speed v from a point h meters above the ground. The time taken for the ball to strike the grounds is

A) $\dfrac{v}{g}\left[1 + \sqrt{1 + \dfrac{2hg}{v^2}}\right]$ B) $\dfrac{v}{g}\left[1 - \sqrt{1 - \dfrac{2hg}{v^2}}\right]$ C) $\dfrac{v}{g}\left[1 - \sqrt{1 + \dfrac{2hg}{v^2}}\right]$ D) $\dfrac{v}{g}\left[2 + \dfrac{2hg}{v^2}\right]$

7. A body thrown up with a velocity of 98 m/s reaches a point 'P' in its path 7 second after projection. Since its projection it comes back to the same position after

A) 13s   B) 14s   C) 6s   D) 22s

8. A stone projected vertically up from the top of a cliff reaches the foot of the cliff in 8s. If it is projected vertically downwards with the same speed, it reaches the foot of the cliff in 2s. Then its time of free fall from the cliff is

A) 16s   B) 8s   C) 2s   D) 4s

9. A stone projected vertically up from the ground reaches a height y in its path at t_1 seconds and after further t_2 seconds reaches the ground. The height y is equal to

A) $\dfrac{1}{2}g(t_1 + t_2)$ B) $\dfrac{1}{2}g(t_1 + t_2)^2$ C) $\dfrac{1}{2}g\,t_1t_2$ D) $g\,t_1t_2$

Assertion A and Reason R:

♦ *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

A) Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'

B) Both 'A' and 'R' are true and 'R' is not correct explanation of 'A'

C)'A' is true and 'R' is false   D) 'A' is false and 'R' is true

10. **A:** Time taken by the bomb to reach the ground from amoving aeroplane depends on height of aeroplane only.

   R: horizontal component of velocity of the bomb remains constant and vertical component of bomb changes due to gravity.

11. **A :** A body thrown up from the top of a tower and another body thrown down from the same point strike the ground with the same velocity.

   R : Initial velocity and acceleration are common for both.

Multiple option type:

♦ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

12. A stone is vertically projected with velocity U from the top of a tower then

   a) Total displacement is zero but distance is not zero

   b) Total displacement is +Ve

   c) The average velocity of the stone from its maximum height to the top of the tower is U/2

   d) The total displacement is - Ve

   A) only c, d are correct   B) only a, d are correct

   C) only a, c, d are correct   D) all are correct

Fill in the blanks :

13. A stone is vertically projected with velocity 'u' from the top of tower and it reaches the maximum height then final velocity is --------------

14. Equation for height of the tower is ------------------

15. Equation for the velocity of the body at the foot of the tower v = ----------

16. Equation for time taken by the body to reach the ground t = -----------------

Match the following:

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

   If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

17. (a) Height of the tower is   1) $h = -ut + \dfrac{1}{2}gt^2$

(b) Time taken by the body to reach the ground   2) $t = \dfrac{u + \sqrt{u^2 + 2gh}}{g}$

(c) The velocity of the body at the foot of the tower   3) $v = u - gt$

(d) Velocity of the body after 't' sec.   4) $v = \sqrt{u^2 + 2gh}$

A) a-3, b-2, c-4, d-1   B) a-3, b-2, c-1, d-4

C) a-1, b-2, c-4, d-3   D) a-3, b-4, c-2, d-1

Comprehension type:

♦ *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

18. A body dropped from an helicopter rising up vertically with constant velocity 'u' reaches the ground exactly below the point of projection after a time 't'. Then The velocity of the body after 't' sec. is $v = u - gt$

i) A bag is dropped from a helicopter rising vertically at a constant speed of 2m/s. The distance between the two after 2s is

A) 4.9m   B) 15.6m   C) 29.4m   D) 39.2m

ii) The velocity of bag after 2s is

A) 17.6 m/s   B) -17.6 m/s   C) 19.6 m/s   D) -19.6 m/s

> ### KEY

ΦΦ **TEACHING TASK :**

1) C,   2) A,   3) C,   4) A,   5) C,   6) A,   7) A,   8) D,   9) C,   10) A,

11) C,   12) A,   13) Zero   14) $h = -ut + \dfrac{1}{2}gt^2$ 15) $v = \sqrt{u^2 + 2gh}$

16) $t = \dfrac{u + \sqrt{u^2 + 2gh}}{g}$ 17) C ,   18) i) B, ii) B

LEARNER'S TASK

◆▐▐◆ **BEGINNERS (Level - I)** ◆▐▐◆

Choose the correct option:

1. A balloon rises up with uniform velocity 'u'. A body is dropped from ballon. The time of descent for the body is given by is

A) $\sqrt{\dfrac{2h}{g}}$ B) $h = ut + \dfrac{1}{2}gt^2$ C) $h = -ut + \dfrac{1}{2}gt^2$ D) $-h = ut + \dfrac{1}{2}gt^2$ s

2. In the above problem if body is thrown down with velocity 'u' the equation for the descent time is ___

A) $h = \dfrac{1}{2}gt^2$ B) $h = ut + \dfrac{1}{2}gt^2$ C) $h = -ut + \dfrac{1}{2}gt^2$ D) $-h = -ut + \dfrac{1}{2}gt^2$
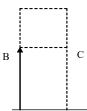
3. A stone is dropped from a rising balloon at a height of 75m in 6 sec. What was the velocity of the balloon just at the moment when the stone was dropped

A) 16.9 m/s   B) 7.12 m/s   C) 19.6 m/s   D) None

4. A stone is dropped from a balloon moving vertically up wards with a velocity of 15 m/s and is observed to strike of ground 4 sec. Calculate the height of the balloon when the stone was dropped and velocity of stone when it strikes the ground

A) 24.2 m, 12.4 m/s   B) 18.4 m, 24.2 m/s   C) 30 m, 30 m/s   D) None

5. A balloon descending at 10 m/s drops a food packet when it is at an altitude of 400 m. The packet strike the ground with a velocity (g=10 m/s²)

A) $40\sqrt{5}$ m/s   B) 81 m/s   C) 45 m/s   D) 90 m/s

6. A stone is thrown vertically up wards from the top of a tower with a velocity of 9.8 m/s and it reaches the ground after 4sec. Find the height of tower.

A) 19.6 m   B) 9.8 m   C) 39.2 m   D) None

7. A stone is projected vertically up with velocity of 14.7 m/s from a height of 49 m. Calculate the time taken by the stone to reach the ground.

A) 1 sec   B) 2 sec   C) 3 sec   D) 5 sec

8. A stone is throws vertically upwards with an initial velocity 'u' from the top of a tower, reaches the ground with a velocity 3u. The height of the tower is

A) 3u²/g   B) 4u²/g   C) 6u²/g   D) 9u²/g

9. A body is projected vertically as in the figure from the top of a tower AB = 10 m from B with initial velocity $\sqrt{29}$ m/s. What are the velocity of the body at C and D

A) $\sqrt{29}$ m/s, 15 m/s   B) 15 m/s, $\sqrt{29}$ m/s

C) 30 m/s, 40 m/s   D) None

10. Two bodies are projected simultaneously with the same velocity of 19.6 m/s from the top of a tower, one vertically upwards and the other vertically downwards. As they

reach the ground, the time gap is

A) 0 s   B) 2 s   C) 4 s   D) 6 s

11. A stone is dropped from a balloon at an altitude of 280m. If the balloon ascends with a velocity of 5m/s and descends with a velocity of 5 m/s, times taken by the stone to reach the ground in the two cases respectively are (g=10m/s^2)

A) 8 s and 9 s   B) 9 s and 8 s   C) 3 s and 4 s   D) 8 s and 7 s

12. A ball is thrown vertically upwards with a speed of 10 m/s from the top of a tower 200m height and another is thrown vertically downwards with the same speed simultaneously. The time difference between them on reaching the ground is

A) 12s   B) 6s   C) 2s   D) 1s   (g=10m/s^2)

13. A balloon is rising vertically with a velocity of 9.8 m/s. A packet is dropped from it when it is a height of 39.2 m. Time taken by the packet to reach the ground is

A) 1s   B) 2s   C) 3s   D) 4s

14. A body projected vertically up travels a height 'h' in the nth second. The distance travelled by it in the next two seconds is

A) h + 2g   B) 2h + g   C) 2h + 2g   D) 2h + 3g

15. A ball is thrown vertically upwards with a speed of $10\ \mathrm{ms}^{-1}$ from the ground at the bottom of a tower 200 m high. Another is dropped vertically downward simultaneously, from the top of a tower. If $g = 10\mathrm{ms}^{-2}$ the time interval after which the projected body will be at the same level as the dropped body is

A) 20 s   B) 25 s   C) $2\sqrt{10}$ s   D) 5 s

16. A body is thrown vertically up to reach its maximum height in seconds. The total time from the time of projection to reach a point at half of its maximum height while returning(in seconds) is

A) $\sqrt{2}\ t$ B) $\left(1+\dfrac{1}{\sqrt{2}}\right)t$ C) $\dfrac{3t}{2}$ D) $\dfrac{t}{\sqrt{2}}$

17. A body is projected vertically upwards with a velocity 'u' . It crosses a point in its journey at a height 'h' twice , just after 1 and 7 seconds .

The value of u in $ms^{-1} is \left(g = 10ms^{-2}\right)$

A) 50   B) 40   C) 30   D) 20

18. A body projected vertically upwards crosses a point twice its journey at a height 'h' just after t_1 and t_2 seconds. Maximum height reached by the body is

A) $\dfrac{g}{4}\left(t_1+t_2\right)^2$ B) $g\left(\dfrac{t_1+t_2}{4}\right)^2$ C) $2g\left(\dfrac{t_1+t_2}{4}\right)^2$ D) $\dfrac{g}{4}\left(t_1 t_2\right)$

◆ **▐▌** ◆   **ACHIEVERS (Level - II)**   ◆ **▐▌** ◆

Solve the following :

1.   Two stones are located at the same height above the ground at a horizontal distance of 20 m. One of them is projected vertically upward at 20 m/s and the other dropped from rest at the same moment. Find the distance between them one second later. (Assume acceleration due to gravity is 10 ms^{-2})

2.   A body is thrown up from a certain height and another thrown down from the same point with the same speed at the same time. If they hit the ground with a time gap of 4 s, the speed of projection is ....

3.   A body is dropped from a height of 20 m above the ground. If gravity disappears 1 second after it starts falling , the time it takes to hit the ground is (Assume acceleration due to gravity = 10 ms^{-2}) ....

◄ **▐▌** ►   **EXPLORERS (Level - III)**   ◄ **▐▌** ►

More than one option is correct:

♦   *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

1.   Height of the body from the ground can be calculated by using the formula h = – ut + (1/2)gt^2 in

a) A body projected vertically with velocity 'u' from the top of tower, reaches the ground in 't' sec.

b) A body dropped from a balloon moving up with uniform velocity, reaches the ground in 't' sec

c) A body dropped from a helicaptor moving up with uniform velocity, reaches the ground in 't' sec

d) A body projected vertically from the ground reaches the ground in 't' sec.

A) a, b and c are correct   B) a, b, c and d are correct

C) a is only correct   D) b and d are correct

2.   A balloon from rest accelerates uniformly upward with 'a' ms^{-2}, for t seconds of time. A stone is released from the balloon. Now, read the following statements to pick the right ones.

a) The stone's initial velocity is zero, relative to balloon

b) The stone's initial velocity is non-zero, relative to earth

c) The time taken to reach the ground from the balloon's frame of reference is inversely proportional to $\sqrt{(a+g)}$.

d) The time take to reach the ground from earth's frame of reference is directly proportionalto $\sqrt{(a+g)}$.

A) a, b, c   B) a, c, d   C) a, b, d   D) a, c

Fill in the blanks :

3.   The direction is --------------- at maximum height in the case of a vertically projected body.

4.   Any body projected vertically moves with ---------------

5.   A body can have ------------- even if its velocity zero at a given instant of time.

6.   Velocity and acceleration can be ----------- each other for a vertically projected body.

Assertion - A and Reason - R :

♦   *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

Options:A) Both A & R are true and R is correct explanation of A

        B) Both A & R are true and R is not correct explanation of A

        C) A is true but R is false.

        D) Both A & R are false.

7.   **A :** The direction is reversed at maximum height in the case of a vertically projected body

      R : Acceleration due to gravity acts as constant in the case of a vertically projected body

8.   **A :** A body can have acceleration even if its velocity is zero at a given instant of time.

      R : A body is momentarily at rest when it reverses its direction of motion

9.   **A :** Velocity and acceleration can be opposite to each other

      R : Any body projected vertically moves with deceleration.

Match the following

♦   *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

      If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

10.   a. When body projected up   1) a = +g

      b. When body falling down   2) a = -g

      c. Time of ascent   3) u/g

      d. Velocity at maximum height   4) v = 02

      A) a-2, b-1, c-3, d-4   B) a-1, b-2, c-3, d-4

      C) a-2, b-1, c-4, d-3   D) a-4, b-1, c-3, d-2

11.   Study the following.

          List - I   **List - II**

          a) Constant speed and varying velocity   I) At height point of body projected vertically up

          b) Zero displacement and finite distance   II) Uniform circular motion

          c) Zero velocity and finite acceleration   III) At any intermediate point of freely falling body.

          d) Non-zero velocity and non-zero   IV) Body on reaching point of projection

          acceleration.

A) a-IV,b-II, c-III, d-I   B) a-II, b-IV, c-I, d-III

C) a-III, b-I, c-IV, d-II   D) a-I, b-III, c-II, d-IV

Comprehension type questions:

♦   *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

12.   A body is allowed to fall freely from certain height

i) Ratio of distances covered in the successive seconds is

A) 1 : 2 : 3 : ....   B) 1 : 3 : 5 : ...   C) 2 : 4 : 6 : ...   D) none

ii) If it travels a distance x in n th second, the distance it can travel in the next sec is

A) x   B) x+g   C) x - g   D) g

iii) if it travels a distance x in n th second, the distance it covered in the previous sec is

A) x   B) x+g   C) x - g   D) g

◄ ▌▐ ► **RESEARCHERS (Level - IV)** ◄ ▌▐ ►

Choose the correct option:

1.   What statement best describes the given figure ?   [**NISO-2018**]

A) The earth is rotating around the sun   B) The sun is rotating around the Earth

C) The Earth is revolving around the sun D) The sun is revolving around the Earth

2.   In circular motion the,..........   [**NSO-2017**]

A) direction of motion is fixed   B) direction of motion changes continuously

C) velocity constant   D) none

3.   Consider the motion of the tip of the minute hand of clock. In on hour.[**NISO - 2018**]

A) The distance covered zero   B) the displacement is zero

C) the average speed is zero   C) none

4.   Which of the following is example of vibratory motion ?   [**NISO - 2016**]

A) a car moving along a circular track   B) a freely falling stone

B) motion of the string of violin   D) motion of the planet around the sun

5.   Which of the following is example of periodic motion?   [**NISO - 2015**]

A) A car taking a turn on a curved road   B) A crane fling over a water pond

C) A lift moving down   D) march past of soldiers

6.   A passenger in a moving train is at ....w.r.t ground and is at....... with other passenger in same train.   [**NISO - 2014**]

a) Motion,motion   B)rest,rest   C) motion, rest   D) rest, motion

7.   If a body travels half the distance with velocity v_1 and the next half   with velocity v_2.ts average velocity will be given by.   [**NSO - 2012**]

8. An artificial satellite is moving in circular orbit of 4225.km.find its speed if it takes 24hr to revolve around the earth. **[NISO - 2012]**

A) 30.7km/s   B) 5.67km/s   C) 6.14km/s   D)1.57km/s

9. The length of a square field is 6 *m*. Parul ran 6 rounds around the field. The total distance that she covered, is .... **[NISO - 2008]**

A) 216 *m*   B) 144 *m*   C) 176 *m*   D) 186 *m*

10. Two simple pendulums P and Q are given. P completes 20 oscillations in 32 sec and Q completes 30 oscillations in 45 sec. Which pendulum is faster ? **[ISO - 2008]**

A) P   B) Q   C) both have same time period   D) data insufficient

11. Two boys P and Q are running along the same path. P is 10 m ahead of Q initialy.However, Q catches up with P. after running 50 m. Assuming that both boys are running at a constant speed. What is the ratio of the speeds of P and Q ?

A) 6 : 5   B) 5 : 6   C) 4 : 1   D) 4 : 5   **[NSO - 2014]**

12. Sonic vibrations were sent down from a return after 2 seconds. What is the depth of the sea. If the speed of sound in water is 1.5 kms^{-1} ? **[NSO - 2012]**

A) 150 m   B) 3 m   C) 1.5 m   D) 750 m

13. A car driver took a total of two hours to make a journey of 75 km. He had a coffee break of half an hour and spend a quarter of an hour stationary in a traffic jam. What was his average speed during the journey ? **[NSO - 2012]**

A) 38 kms^{-1} B) 50 kms^{-1} C) 60 kms^{-1} D) 75 kms^{-1}

14. Talking one light year equal to 9.4×10^{15} m and one day equal to 86400 s, what will be the speed of light in light year per day if the speed of light in ms^{-1} is 3×10^8 ?

A) 2.75×10^{-3} ly day^{-1} B) 3.75×10^{-3} ly day^{-1} **[NSO - 2012]**

C) 2.75×10^3 ly day^{-1} D) 3.75×10^{-3} ly day^{-1}

15. The ultrasonic waves take 4 second to travel from the ship to the bottom of the sea and back to the ship (in the form of an echo). What is the depth of the sea ?

A) 3000 m   B) 2000 m   C) 1000 m   D) 500 m**[NSO - 2009]**

16. A taxi driver noted reading on the odometer fitted in vehicle as 1050 km, when he started the journey. After 30 minutes drive, he noted that the odometer reading was1086 km. What is the average speed of the taxi ? **[NSO - 2009]**

A) 20 m/s   B) 25 m/s   C) 30 m/s   D) 40

17. How long does it take for the earth to rotate on its axis seven times ? **[NSO - 2010]**

A) One day   B) One week   C) One month   D) One year

II) Additional work-sheet for practice-I

1. Chetana spins around 5 times without moving any direction, then distance and displacement are

A) 5,5   B) 10,10   C) 1,1   D)zero, zero

2. Kanchana walks 1 m north then turns west and walks 2 m, then distance and

displacement are.

A) 3m,25m   B) 3m,2.24m   C) 3 m, 224 m D) 2.24m,3m

3. Teja walks 2 m north from his home to park, then returns to home, then distance and displacement are.

A) 4 m, zero   B) 10 m, 7.m   C) ft   D) 0m,0m

4. Sandhya runs 8 blocks north, and then 2 blocks south back towards her starting point, then distance and displacement are.

A) 20 blocks, 9 blocks   B) 10 blocks, 6 blocks

C)11 blocks, 6 blocks   D) 10 blocks, 5 blocks

5. Naveen swim 3 complete laps in a 50 m pool. (One lap is one length of the poll in straight line), then distance and displacement are.

A) 150 m, 50 m   B) 15 m, 50 m C) 150 m, 70 m   D) 10 m, 50 m

6. A runner does a 10K (10 kilometers) in one hour. What is his speed in k/h? m/s?

A) 10 , 2.8   B) 2.8 , 10   C) 15 , 7   D) 10 , 5

7. A ball rolls 8m in 2 sec. What is the ball's speed?

A) 10 m/s   B) 2.8m/s   C) 4m/s   D) 5m/s

8. A cyclist travels 4km in 15min. What is her speed in m/s?

A) 4.4m/s   B) 2.8m/s   C) 4m/s   D) 5m/s

9. A runner circles the track *exactly* 2 times for distance of 800m. It takes 4.0min. What is her average speed in m/s? What is her average velocity?

A) 3m/s ,25m/s   B) 3.3 m/s ,0 m/s   C) 0m/s ,3.3m/s   D) 3m/s ,0 m/s

10. A car averaged 20m/s on a road trip to a city 400km away. How long did the trip take?

A) 20,000sec   B) 5.5 hr   C) both A and B   D) none

11. A tortoise can crawl 1.0m in 6 sec. What is his speed?

A) 4.4m/s   B) 2.8m/s   C) 0.4m/s   D) 0.167m/s

12. A hare (rabbit) can run 2.5 m/s. If he runs for 36 sec, how far did he run?

A) 150 m   B) 90m   C) 150 m   D) 10 m

13. The tortoise and the hare were racing a distance of 100m. The hare stopped to take a nap 10m from the finish line and ended up losing the race. How long was his nap?

A) 20,000sec   B) 5.5 hr   C) 9min 20sec   D) 10 min

14. A car's velocity changes from 32 m/s to 96 m/s in an 8.0-s period. What is its acceleration?

A) 8 m/s^2 B) 2.8 m/s^2 C) 4 m/s^2 D) 5 m/s^2

15. Rocket-powered sleds are used to test the responses of humans to acceleration. Starting from *rest*, one sled can reach a speed of 244 m/s in 1.80 s. What is its acceleration?

A) 84 m/s^2 B) 136 m/s^2 C) 48 m/s^2 D) 56 m/s^2

16. A car with a velocity of 22 m/s is accelerated uniformly at the rate of 1.5 m/s^2 for 6.0 s. What is its final velocity?

A) 10 m/s   B) 31 m/s   C) 4m/s   D) 5m/s

17. A supersonic jet flying at 150 m/s is accelerated uniformly at the rate of 22 m/s^2 for 20.0 s. What is its final velocity?

A) 180 m/s   B) 355 m/s   C) 590m/s   D) 225m/s

18. Determine the displacement of a plane that is uniformly accelerated from 66 m/s to 88 m/s in 12 s.

A) 924 m/s   B) 355 m/s   C) 590m/s   D) 225m/s

III) *Additional problems for practice-II*

1. The time of ascent of a body thrown vertically up is

A) t = u/g   B) t = g/u   C) t = ug   D) t = u + g

2. In the case of bodies moving up under gravity, the acceleration is

A) g   B) 0   C) - g   D) not constant

3. While the body is falling freely, the acceleration is

A) + Ve   B) - ve   C) $\pm g$ D) none of these

4. The body left freely from the height 'h' will strike the ground with a velocity of

A) gh   B) 1/2gh   C) gh^2 D) $\sqrt{2gh}$

5. The height from which the body is falling freely when it strikes the ground in 't' secs is

A) gt   B) vg   C) - gt^2 D) (1/2) gt^2

6. Maximum height attained by a body projected up vertically with a velocity 'u' is given by

A) u^2/2g   B) u^2 C) 2u^{2}g   D) $\frac{1}{2}gu$

7. Maximum height attained by a body projected vertically up is directly proportional to

A) u   B) u^2 C) u^3 D) $\sqrt{u}$

8. Time taken by a body to reach maximum is called

A) time of decent   B) time of ascent   C) time period   D) time of flight

9. Time taken by a body to fall on to ground from maximum height is called

A) time of decent   B) time of ascent   C) time period   D) time of flight

10. At maximum height, the

A) velocity is zero   B) acceleration act vertically down wards

C) direction is reversed   D) all the above

11. Time of ascent depends upon

A) initial velocity of projection   B) nature of the body

C) place of projection   D) atmosphere

12. The time for which the projected body remains in the air is equal to

A) time of descent   B) time of ascent   C) time of flight   D) time period

13. A paper weight is dropped from the roof of a block of multistorey flats each storey being 3 meters high. It passes the ceiling of the 20th storey at 30m/s. If (g = 10 m/s^2), how many storey does the flat have?

A) 25   B) 30   C) 35   D) 40

14. A ball of mass 100 gm is projected vertically upwards from the ground with a velocity of 49 m/s. At the same time another identical ball is dropped from a height of 98 m. After some time the two bodies collide. When they collide, their velocities are

1) 29.4 m/s upwards; 29.4 m/s downwards

2) 29.4 m/s upwards; 19.6 m/s downwards.

3) 19.6 m/s upwards; 19.6 m/s downwards   4) None

15. A stone is dropped from a height h. Simultaneously another stone is thrown up from the ground which reaches the height 4h. The two stones cross each other after a time.

1) $\sqrt{\dfrac{h}{2g}}$ 2) $\sqrt{\dfrac{h}{8g}}$ 3) $\sqrt{8hg}$ 4) $\sqrt{2hg}$

16. An objective falls from a bridge that is 45 m above the water. It falls directly into a small row-boat moving with constant velocity that was 12m from the point of impact when the object was released. The speed of the boat is

1) $3\,ms^{-1}$ 2) $4\,ms^{-1}$ 3) $5\,ms^{-1}$ 4) $6\,ms^{-1}$

17. A body is thrown vertically upwards with an initial velocity 'u' reaches a maximum height in 6s. The ratio of the distance travelled by the body in the first second to the seventh second is

1) 1:1 2) 11:1 3) 1:2 4) 1:11

18. A stone is dropped from the top of a tower of height 49m. Another stone is thrown up vertically with velocity of 24.5 m/s from the foot of the tower at the same instant. They will meet in a time of

1) 1s 2) 2s 3) 0.5s 4) 0.25s

19. A ball is dropped from the top of a tower. Another ball thrown up vertically with a velocity of 20 m/s from the ground level at the same instant meets the first after 1.5s. Height of the tower is

1) 20m 2) 30m 3) 40m 4) 50m

20. A ball is dropped from the top of a building. The ball takes 0.2s to fall past the 3m length of a window some distance from the top of the building. Speed of the ball as it crosses the top edge of the window is (g = 10ms⁻²)

1) 3.5 m/s 2) 8.5 m/s 3) 5 m/s 4) 14 m/s

21. A ball is projected vertically upwards with a velocity of 100 m/s. After 2 second, a second ball is projected vertically upwards from the same point with a velocity 110 m/s. When they meet, time taken by the first ball to meet the second one is (g =10ms⁻²)

1) 6s 2) 8s 3) 10s 4) 12s

22. Two bodies are projected vertically upwards with a velocity of 49 m/s. They are projected with a time gap of 2s. After the projection of the first body, they will meet in a time of

A) 5s B) 3s C) 6s D) 7s

23. A loose nut from a bolt on the bottom of an elevator which is moving up the shaft at 3m/s falls freely. The nut strikes the bottom of the shaft in 2s. Distance of the elevator from the bottom of the shaft when the nut fell off is

A) 19.6m B) 13.6m C) 9.8m D) 3.8m

24. A ball is thrown vertically up with a velocity of 14.7 m/s from the top of a tower of height 49m. On its return, it misses the tower and finally strikes the ground. The time that elapsed from the instant the ball was thrown until it passes the edge of the tower is

A) 1.5s B) 3s C) 6s D) 0.5s

	KEY	

ΦΦ **LEARNER'STASK :**

☐ **BEGINNERS :**

         1) C,   2) B,   3) A,   4) B,   5) D,   6) C,   7) D,   8) B ,   9) A,   10) C ,

         11) D, 12) C, 13) D 14) D, 15) A, 16) B, 17) B, 18) C

☐ **ACHIEVERS :** 1) $20\sqrt{2}$ M   2) 20 m/s or 19.6 m/s   3) 1.5 sec

☐ **EXPLORERS :** 1) A,   2) A   ,3) Reversed 4) Deceleration 5) Acceleration

         6) opposite.   7) A,   8) A,   9) A,   10) A, 11) B, 12) i) A, ii) B, iii) C,

☐ **RESEARCHERS :**

  I)   1) C,   2) B,   3) B,   4) C,   5) D,   6) C,   7) $V_{avg} = (2v_1v_2)/(v_1+v_2)$,   8) A,

     9) B, 10) B, 11) D 12) C, 13) C, 14) A,   15) A, 16) A, 17) B

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

     12) B, 13) C, 14) A, 15) B, 16) B, 17) C, 18) A

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

     12) C, 13) C, 14) B, 15) B,   16) B, 17) B, 18) B, 19) B, 20) D, 21) B, 22) B,

     23) D, 24) B