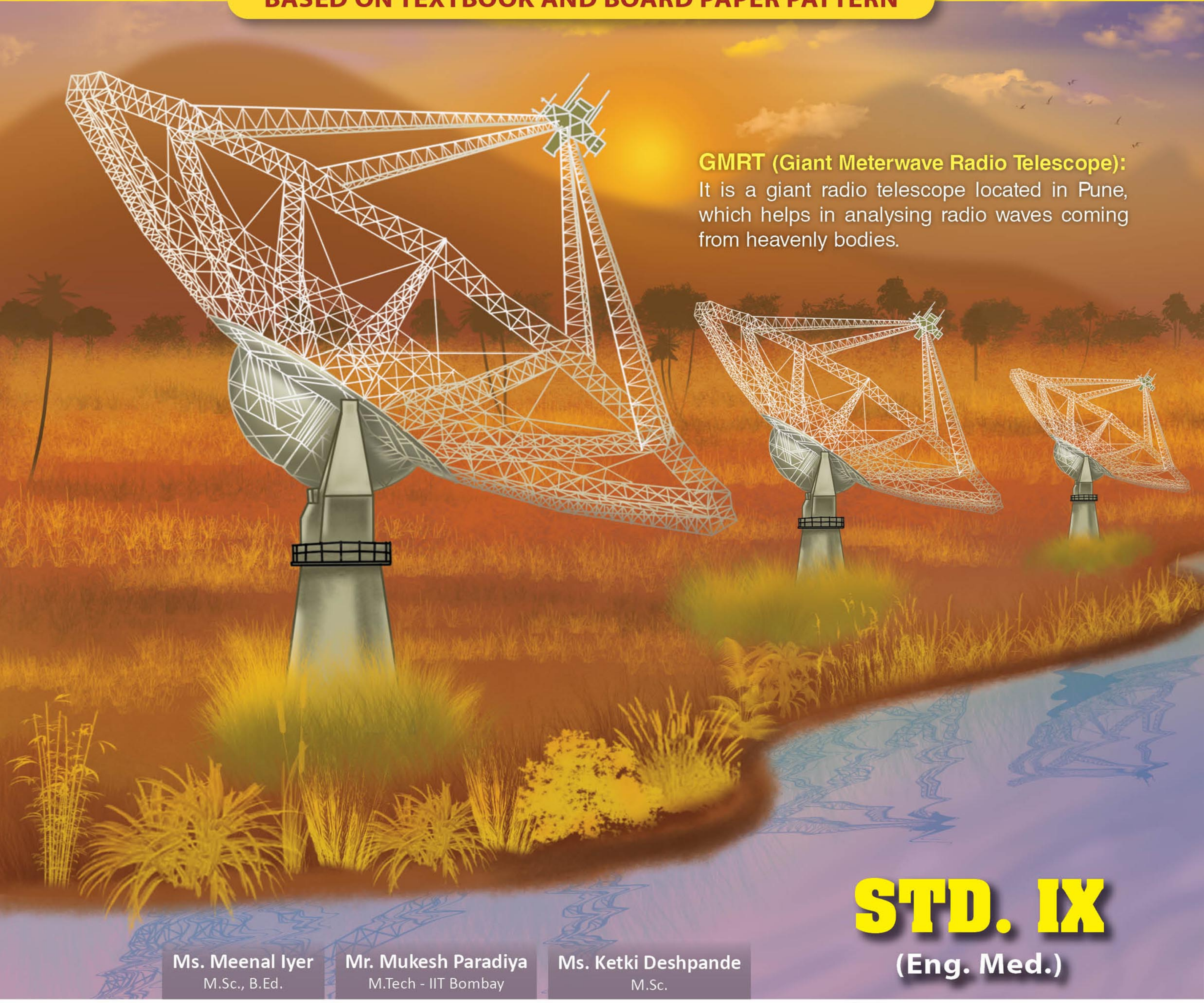
SAMPLE CONTENT

PERFECT

SCIENCE AND TECHNOLOGY

BASED ON TEXTBOOK AND BOARD PAPER PATTERN



GMRT (Giant Meterwave Radio Telescope): It is a giant radio telescope located in Pune, which helps in analysing radio waves coming from heavenly bodies.

STD. IX

(Eng. Med.)

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With your Buddy GG

Target Publications® Pvt. Ltd.

Based on the **Latest Board Paper Pattern** prescribed by the Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04

PERFECT
Science and Technology
STD. IX

Salient Features

- Written as per Latest Board Paper Pattern
- Exhaustive coverage of entire syllabus
- Ample numericals for thorough revision
- Memory maps provided for revision at a glance
- 'Illustrative Examples' provided for numerical elaboration
- 'Reading between the lines' provided for concept elaboration
- Chapter-wise assessment with every chapter for knowledge testing
- Activity demonstration/concept explanation videos included wherever required

This book comprises of **Q.R. Codes** at strategic touch points. You can simply scan this Code through your Smartphone camera and get a plethora of subject knowledge at your disposal. The Q.R. Codes included herein would take you to videos that shall provide you a better understanding of 'Activities', 'Experiments', 'Projects' and 'Try This' section of the book. We hope students would maximize the use of this book with the aid of these videos.

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PREFACE

While designing the book, our main intention was to create a book that would act as a single point of reference for students. We wanted this book to provide students, the much needed answers for their textual questions as well as build up their knowledge quotient in the process.

Perfect Science and Technology: Std. IX has been prepared as per the Latest Board Paper Pattern.

We have infused the book with a liberal sprinkling of real life examples, pictorial explanations and additional questions. Questions titled under 'Use your brain power', 'Can you tell' and a series of 'In-text Questions', pave the way for a robust concept building.

Every chapter begins with covering all the textual content in the format of Objectives, Question - Answers, Give Reasons, Numericals, Diagram-based questions, Paragraph-based questions and a host of other Objective and Subjective type of questions. A detailed thinking process involved in solving numerical problems is explained in step wise manner in 'Illustrative Examples.' The solution to these examples is elaboration of the answer of the numerical and not the exact solution expected in examination. 'Practice Problems' are provided for further revision of numericals; solutions to which are provided through Q.R. code. The chapter also includes Activity Based Questions that explain certain concepts to students in a point wise manner through the medium of an activity. For the students to grasp a better understanding of the concept lying behind the answer, 'Reading between the lines' (not a part of the answer) has been provided wherever necessary. Questions that entail students to apply higher order thinking skills are marked *[HOTS]*. To enhance audio-visual learning, videos showing demonstration of activities/concept explanation are included wherever required.

Wherever possible, questions are allotted with marks in accordance with new marking scheme. The question can be modified as per the new marking scheme and asked in examination. Memory maps have been included wherever needed which provides a quick revision of the important topics of a chapter. The chapter eventually ends with a Chapter-wise Assessment that stands as a testimony to the fact that the child has understood the chapter thoroughly. Answers to each chapter Assessment can be viewed by scanning the given Q.R. Code.

With absolute trust in our work, we hope our holistic efforts towards making this book an ideal knowledge hub for students pays off.

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

Please write to us at: mail@targetpublications.org

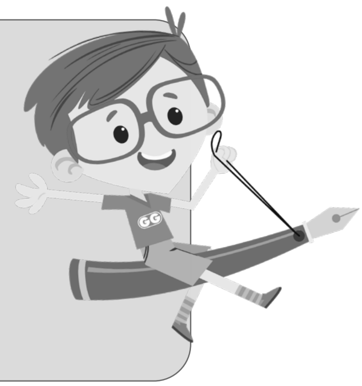
A book affects eternity; one can never tell where its influence stops.

Best of luck to all the aspirants!

Publisher
Edition : Third

Gyan Guru (GG)

We present to you our very own mascot-'GG'. GG is a student-buddy who pops up throughout the book and draws your attention to important bits of knowledge. This 'GG – Gyan Guru' section helps you understand a concept distinctly with a corresponding example, which you can relate to easily. This is our initiative that helps to link learning with life, thereby educating the students much more practically. We're hopeful that you will love this initiative.



KEY FEATURES

Reading between the lines

'Reading between the lines' (not a part of the answer) helps students to grasp a better understanding of the concept lying behind the answer.

GG – Gyan Guru

Gyan Guru illustrates real life applications or examples related to the concept discussed.

Illustrative Example

A detailed thinking process involved while solving numerical problems is explained in step wise manner in **'Illustrative Examples'**.

Weightage of Marks

Wherever possible, questions are allotted with marks in accordance with new marking scheme.

Numerical Section

Solved numerical questions (segregated type wise) are provided wherever applicable. For revision, list of all important formulae is provided at the beginning of the section.

Practice Problems

Practice Problems include additional problems related to the chapter.

Memory Maps

Memory Maps summarize the key points in the chapter and provide chapter overview succinctly.

Chapter Assessment

Chapter Assessment helps students to evaluate understanding of the chapter.

QR code

QR code provides:

i. Access to a video/PDF in order to boost understanding of a concept or activity
ii. Answers to Chapter Assessment and Solutions to Practice Problems

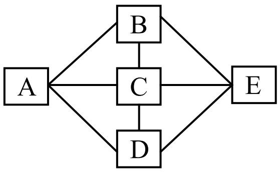
CONTENTS

Note: *Textual exercise questions are represented by * mark.*
Textual solved examples are represented by + mark.
Modified textual questions are represented by ♣ mark.

1 Laws of Motion

Choose the correct alternative *[1 Mark each]*

1. Five cities A, B, C, D and E are connected to each other as shown in diagram. A person wants to reach from A to E using the shortest path. He should travel via



   (A) city B. (B) city C.
   (C) city D. (D) any of the above.

2. A ball at rest released vertically from a height h from ground exhibits maximum velocity
   (A) at height h/2.
   (B) at height h/4.
   (C) at height h/7.
   (D) just before hitting the ground.

3. If velocity of an object changes by unequal amounts in equal time intervals, the object is said to be in _______ acceleration.
   (A) negative (B) positive
   (C) uniform (D) non-uniform

4. The coin placed on the cardsheet does not move along with the sheet, when cardsheet is flicked with a finger. This is due to
   (A) inertia of rest.
   (B) inertia of motion.
   (C) Newton's third law of motion.
   (D) Newton's law of gravitation.

5. To verify Newton's first law of motion, balloon with the wooden disc is placed on smooth glass sheet. A smooth glass sheet surface is used because
   (A) smooth glass sheet is insulator.
   (B) smooth glass sheet offers very less friction.
   (C) smooth glass sheet is reflector of light.
   (D) smooth glass sheet offers very less inertia.

6. _______ force acting on an object brings it in motion.
   (A) Balanced (B) Unbalanced
   (C) Tangential (D) all of these

7. The force necessary to cause an acceleration of 1 cm/s^2 in an object of mass 1 gram is called _______.
   (A) 1 newton (B) 1 dyne
   (C) 1 kilonewton (D) 1 kilodyne

8. Momentum = _______.
   (A) $\dfrac{\text{Velocity}}{\text{Mass}}$ (B) $\dfrac{\text{Acceleration}}{\text{Time}}$
   (C) mass × velocity (D) mass × speed

9. The momentum of a body of mass 5 kg is 10 kg m/s, then its velocity will be _______.
   (A) 1 m/s (B) 2 m/s
   (C) 4 m/s (D) 10 m/s

10. The forces of action and reaction have the same _______ and opposite _______.
    (A) unit, direction
    (B) direction, unit
    (C) momentum, inertia
    (D) inertia, momentum

11. Newton's _______ law of motion is used in rocket launching.
    (A) first (B) third
    (C) second (D) gravitational

12. When a bullet is fired from a gun, it causes the gun to move backward after firing. This backward motion of the gun is called its _______.
    (A) impact
    (B) imbalanced force
    (C) inertia
    (D) recoil

13. When two objects collide, the total momentum before the collision is _______ the total momentum after collision.
    (A) equal to (B) greater than
    (C) double (D) less than

14. In a collision, _______ is always conserved.
    (A) velocity (B) acceleration
    (C) total momentum (D) all of these

Answers:

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

Complete the paragraph *[3 Marks]*

1. Select the appropriate options and complete the following paragraph.

(moving, increases, decreases, uniform, accelerated, direction, magnitude, opposite)

The velocity of _______ object changes with time. This change in velocity can be in terms of _______or _______of velocity or both.

When the velocity of a body _______with time, its acceleration is positive. Here acceleration is in the direction of velocity.

When the velocity of a body _______with time, its acceleration is negative. Here acceleration is _______ to direction of velocity.

Answer:

The velocity of **accelerated** object changes with time. This change in velocity can be in terms of **direction** or **magnitude** of velocity or both.

When the velocity of a body **increases** with time, its acceleration is positive. Here, acceleration is in the direction of velocity.

When the velocity of a body **decreases** with time, its acceleration is negative. Here, direction of acceleration is **opposite** to direction of velocity.

Name the following *[1 Mark each]*

1. The first scientist to measure speed as distance/time
2. Ratio of total distance covered to total time taken
3. Type of motion exhibited by vehicle while moving through heavy traffic
4. Motion showed by the tip of the second hand of a clock
5. Term used for negative acceleration
6. Direction along which coin kept on rotating disc would be thrown off if the disc is rotated fast enough
7. Phenomenon explained by Newton's first law of motion
8. A quantitative measure of inertia of a body
9. Product of mass and acceleration
10. The force equal to and opposite to action force

Answers:

1. Galileo
2. Average speed
3. Non-uniform
4. Uniform circular motion
5. Deceleration
6. Tangential
7. Inertia
8. Mass
9. Force
10. Reaction

True or False. If false, write the correct sentence *[1 Mark each]*

1. Whenever the displacement of an object is zero, distance traversed by it is also zero.
2. The magnitude of velocity and speed will be equal if motion is along a straight path.
3. Earth moves around the Sun with uniform velocity.
4. Acceleration is always positive.
5. If the velocity of an object does not change with time, then the object has negative acceleration.
6. An accelerated motion is an example of non-uniform motion.
7. Slope of distance-time graph gives acceleration in case of uniform motion.
8. For non-uniformly accelerated motions, velocity-time graph is a straight line.
9. The direction of velocity of an object performing uniform circular motion is along the tangential direction to its position.
10. When a body is performing uniform circular motion, its velocity changes at every point.
11. All instances of inertia are examples of Newton's third law of motion.
12. An electric fan stops immediately after switching it off.
13. When a body is at rest, there is no force acting on it.
14. Force is a reciprocal action between two objects.
15. Momentum is necessary to cause a change in force applied on an object.
16. When a force 'F' acts for time 't' on an object, change in momentum in object is equal to 'Ft'.
17. When no external force is acting on two interacting objects, momentum gets redistributed between the colliding objects.

18. Law of conservation of momentum is a corollary to Newton's third law of motion.

Answers:

1. False
Even if the displacement of an object is zero, the actual distance traversed by it may not be zero.
2. True
3. False
Earth moves around the Sun with uniform speed.
4. False
Acceleration can be positive, negative or zero.
5. False
If the velocity of an object does not change with time, then the object has zero acceleration.
6. True
7. False
Slope of distance – time graph gives velocity in case of uniform motion.
8. False
For uniformly accelerated motions, velocity-time graph is a straight line.
9. True
10. True
11. False
All instances of inertia are examples of Newton's first law of motion.
12. False
An electric fan keeps on rotating for some time even after it is switched off due to its inertia of motion.
13. False
When a body is at rest, there is balanced force acting on it.
14. True
15. False
Force (unbalanced) is necessary to cause change in momentum in object.
16. True
17. True
18. True

Odd one out *[1 Mark each]*

1. Force, momentum, acceleration, mass
2. newton, joule, kg m/s^2, dyne
3. Motion of vehicles on a crowded street, a man going for a stroll on a beach, soldiers marching, motion of fishes in water

Answers:

1. Mass
It is a scalar quantity whereas remaining are vector quantities.
2. joule
It is a unit of energy whereas remaining are units of force.
3. Soldiers marching
This is an example of uniform motion whereas the rest are examples of non uniform motion.

Complete the analogy *[1 Mark each]*

1. Velocity and time relation: v = u + at :: displacement and time relation : ________.
2. Tendency of a body to resist change in a state of rest or state of motion : Inertia :: Product of mass and velocity of an object : ________
3. 1 kg × 1 m/s^2 : 1 N :: 1 g × 1 cm/s^2 : ________
4. 1 m/s^2 : 10^2 cm/s^2 :: 1 N : ________.
5. Force: newton :: Momentum: ________.

Answers:

1. $s = ut + \frac{1}{2}at^2$
v = u + at gives the velocity and time relation and $s = ut + \frac{1}{2}at^2$ gives the displacement and time relation.
2. Momentum
Tendency of a body to resist change in a state of rest or state of motion is termed as inertia, similarly, product of mass and velocity of an object is termed as momentum.
3. 1 dyne
The product of 1 kg and 1 m/s^2 is equivalent to 1 N, similarly, the product of 1 g and 1 cm/s^2 is equivalent to 1 dyne.
4. 10^5 dynes
$1\text{ N} = 1\text{ kg} \times 1\text{ m/s}^2$
$= 10^3\text{ g} \times 10^2\text{ cm/s}^2$
$= 10^5\text{ g cm/s}^2$
$= 10^5$ dynes
5. kg m/s
SI unit of force is newton and SI unit of momentum is kg m/s.

Match the following

*1. **Match the first column with appropriate entries in the second and third columns and remake the table.**

	Column 1		Column 2		Column 3
i.	Negative acceleration	a.	The velocity of the object remains constant	p.	A car, initially at rest reaches a velocity of 50 km/hr in 10 seconds
ii.	Positive acceleration	b.	The velocity of the object decreases	q.	A vehicle is moving with a velocity of 25 m/s
iii.	Zero acceleration	c.	The velocity of the object increases	r.	A vehicle moving with the velocity of 10 m/s, stops after 5 seconds.

Answer:

	Column 1		Column 2		Column 3
i.	Negative acceleration	b.	The velocity of the object decreases	r.	A vehicle moving with the velocity of 10 m/s, stops after 5 seconds.
ii.	Positive acceleration	c.	The velocity of the object increases	p.	A car, initially at rest reaches a velocity of 50 km/hr in 10 seconds
iii.	Zero acceleration	a.	The velocity of the object remains constant	q.	A vehicle is moving with a velocity of 25 m/s

Define *[1 Mark each]*

1. **Motion**

Ans: The change in the position of an object with respect to its surroundings is called motion.

2. **Distance**

Ans: The length of the actual path travelled by an object in motion is called distance.

3. **Displacement**

Ans: The minimum distance between the starting and finishing points of an object in motion is called displacement.

4. **Speed**

Ans: The distance covered by a body in unit time is called speed.

5. **Velocity**

Ans: The distance travelled by a body in a given direction in unit time is called velocity.

6. **Uniform motion**

Ans: The motion in which the object covers equal distances in equal intervals of time is called uniform motion.

7. **Non uniform motion**

Ans: The motion in which an object covers unequal distances in equal intervals of time is called non uniform motion.

8. **Acceleration**

Ans: The rate of change of velocity is called acceleration.

9. **Uniform circular motion**

Ans: When an object moves with constant speed along a circular path, the motion is called uniform circular motion.

10. **1 newton**

Ans: The force necessary to cause an acceleration of 1 m/s^2 in an object of mass 1 kg is called 1 newton.

11. **1 dyne**

Ans: The force necessary to cause an acceleration of 1 cm/s^2 in an object of mass 1 g is called 1 dyne.

State the following laws with examples *[2 Mark each]*

1. **Newton's first law of motion**

Ans: **Statement:** An object continues to remain at rest or in a state of uniform motion along a straight line unless an external unbalanced force acts on it.

Examples:

i. When we are travelling by a bus, we experience backward jerk as the bus starts moving from rest.

ii. A toy car in motion travels along straight line unless stopped by an obstacle.

2. **Newton's second law of motion**

Ans: **Statement:** The rate of change of momentum is proportional to the applied force and the change of momentum occurs in the direction of the force.

Examples:

i. While catching a ball, cricketer moves his hands backwards.

ii. In a high jump athletic event, the athletes are made to fall on a sand bed to prevent injury.

3. Newton's third law of motion

Ans: **Statement:** Every action force has an equal and opposite reaction force which acts simultaneously.

Examples:

i. A book kept on a table remains stationary.

ii. An air filled balloon held in hand when released, moves forward.

4. Law of conservation of momentum

Ans: **Statement:** When no external force acts on two interacting objects, their total momentum remains constant. It does not change.

OR

When two objects collide, the total momentum before collision is equal to the total momentum after collision.

Examples:

i. When a person jumps from a boat, the boat is pushed away.

ii. A hammer rebounds after hitting a nail into a wall.

Answer the following

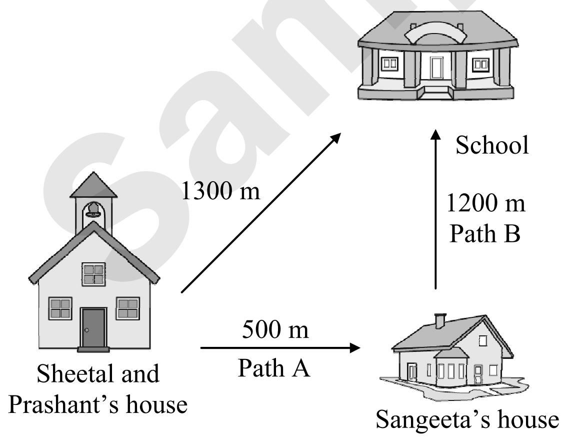
1. Think about it. ***(Textbook page no. 1)***

i. Sheetal first went to her friend Sangeeta's house on her way to school (see figure below).

ii. Prashant went straight from home to school. Both are walking with the same speed.

a. Who will take less time to reach the school and why?

b. In the above example, is there a difference between the actual distance and the distance travelled? What is it?



Ans:

a. Prashant will take less time than Sheetal.

As Prashant and Sheetal both are walking with same speed. Since Sheetal covers more distance than Prashant, she will require more time to reach the school.

b. Yes, there is a difference between the actual distance and distance travelled.

The actual distance between school and house along the straight line is 1300 m, while distance travelled by Sheetal is 500 + 1200 = 1700 m.

Thus, distance travelled in this case (by Sheetal) is greater than the actual distance.

2. Intext Question. ***(Textbook page no. 3)***

Sachin is travelling on a motorbike. Explain what will happen in the following events during Sachin's ride.

i. What will be the effect on the velocity of the motorcycle if its speed increases or decreases, but its direction remains unchanged?

ii. a. In case of a turning on the road, will the velocity and speed be same?

b. If Sachin changes the direction of the motorcycle, keeping its speed constant, what will be the effect on the velocity?

iii. If, on a turning, Sachin changes the direction as well as the speed of the motorcycle, what will be the effect on its velocity? ***[3 Marks]***

Ans: Velocity of an object depends on its speed and direction of motion. Hence, in Sachin's motorcycle ride, its velocity will change

i. when Sachin changes its speed keeping its direction same,

ii. when Sachin changes direction of motorcycle keeping its speed same,

iii. during turning of motorcycle, when both speed and direction of motorcycle changes.

[Note: Students are expected to refer the accompanying Q. R. Code in *Quill - The Padhai App* for demonstration of the activity.**]**

3. Give one example of each of the following:

i. change in speed without a change in direction of motion of a body.

ii. change in direction of motion without a change in speed of a body.

iii. change in speed as well as direction of motion of a body. ***[3 Marks]***

Ans:

i. When a body falls under gravity (free fall), its speed increases, but its direction of motion remains the same.

ii. When a body moves along a circular path, covering equal distances in equal intervals of time, its direction of motion changes continuously but there is no change in its speed.

iii. When a body moves along a curved path such that its speed as well as direction of motion changes continuously.

4. Use your brain power!

(Textbook page no. 4)

Amar, Akbar and Anthony are travelling in different cars with different velocities. The distances covered by them during different time intervals are given in the following table.

Time in the clock	Distance covered by Amar in km	Distance covered by Akbar in km	Distance covered by Anthony in km
5.00	0	0	0
5.30	20	18	14
6.00	40	36	28
6.30	60	42	42
7.00	80	70	56
7.30	100	95	70
8.00	120	120	84

i. What is the time interval between the noting of distances made by Amar, Akbar and Anthony?

ii. Who has covered equal distances in equal time intervals?

iii. Are all the distances covered by Akbar in the fixed time intervals the same?

iv. Considering the distances covered by Amar, Akbar and Anthony in fixed time intervals, what can you say about their speeds? ***[2 Marks]***

Ans:

i. 30 minutes.

ii. Amar and Anthony have covered equal distances in equal time intervals.

iii. No. Akbar has covered unequal distances in equal time intervals.

iv. Amar and Anthony are travelling with uniform speed (40 km/hr and 28 km/hr respectively) while Akbar is travelling with non-uniform speed.

5. In the table given below, the distances covered by Rahul for different time intervals are mentioned. Study the table and determine the type of motion. ***[1 Mark]***

Time in the clock(pm)	Distance covered by Rahul in km
5:00	0
5:30	15
6:00	30
6:30	45
7:00	60

Ans: The type of motion followed by Rahul is uniform linear motion.

6. Use your brain power!

(Textbook page no. 5)

i. When an object is at rest in the beginning of its motion, what is its initial velocity?

ii. When an object comes to rest at the end of its motion, what is its final velocity? ***[2 Marks]***

Ans:

i. When an object is at rest in the beginning of its motion, its initial velocity is zero.

ii. When an object comes to rest at the end of its motion, its final velocity is zero.

7. Use your brain power!

(Textbook page no. 6)

What difference do you see in the distance-time graphs for uniform and non-uniform motion? ***[2 Marks]***

Ans:

i. In uniform motion, the graph of distance-time is a straight line.

ii. In non-uniform motion, an object covers unequal distances in equal time intervals. Hence, the graph of distance-time can have any shape depending on how distance varies with time.

8. How is positive and negative acceleration different in terms of velocity? ***[1 Mark]***

Ans: In positive acceleration, the acceleration is in the direction of the velocity while in negative acceleration, the direction of acceleration is opposite to the direction of the velocity.

9. Explain the term zero acceleration with two examples. ***[2 Marks]***

Ans: Zero acceleration:

When there is no change in the velocity of a body with time (i.e., the velocity is uniform), its acceleration is zero.

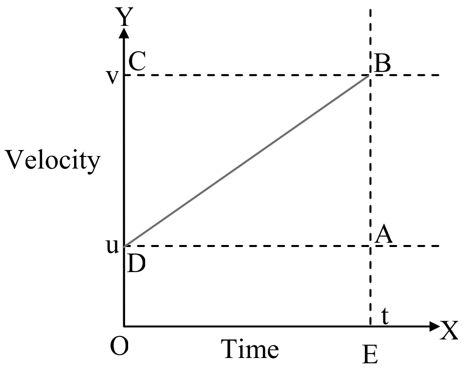
Examples:

i. When body is at rest, its acceleration is zero.

ii. When body is moving with constant velocity, its acceleration is zero.

10. In the case of a body moving along a straight line with uniform acceleration, obtain the equations of motion by graphical method. ***[5 Marks]***

Ans: Consider an object having non-zero initial velocity 'u', starting from point D. Its velocity goes on increasing with respect to time and becomes 'v' when it reaches point B as shown in the figure. The change in velocity is at uniform rate.



i. Velocity-time relation

From figure,

Acceleration, $a = \dfrac{AB}{t}$

$\therefore$ AB = CD = at

BE = AB + AE = AB + OD

$\therefore$ v = at + u

$\therefore$ **v = u + at**

This is first kinematical equation.

ii. Displacement-time relation

From figure, the distance travelled 's' is given by area enclosed within □DOEB.

$\therefore$ s = area of □DOEB + area of ΔDAB

$= (AE \times OE) + \dfrac{1}{2}(AB \times DA)$

But, OE = DA = t,

AE = u and AB = at

$\therefore$ $s = (u \times t) + \dfrac{1}{2} \times at \times t$

$\therefore$ $\mathbf{s = ut + \dfrac{1}{2}at^2}$

This is second kinematical equation.

iii. Displacement-velocity relation

s = Area of trapezium DOEB

$\therefore$ $s = \dfrac{1}{2}(OD + BE) \times OE$

But, OD = u, BE = v and OE = t

$\therefore$ $s = \dfrac{1}{2}(v + u) \times t$ ….(i)

Since, $a = \dfrac{v - u}{t}$

$\therefore$ $t = \dfrac{v - u}{a}$ ….(ii)

$\therefore$ From equations (i) and (ii), we get,

$s = \dfrac{1}{2}(v + u) \times \dfrac{(v - u)}{a}$

$\therefore$ $s = \dfrac{(v + u)(v - u)}{2a}$

$\therefore$ $2as = (v + u)(v - u) = v^2 - u^2$

$\therefore$ $\mathbf{v^2 = u^2 + 2as}$

This is third kinematical equation.

11. What factors cause a change in velocity? ***[1 Mark]***

Ans: Change in velocity is caused due to change in direction or magnitude of the velocity or both.

12. What is uniform circular motion? Obtain relation for speed of a particle performing uniform circular motion. ***[2 Marks]***

Ans:

i. When an object moves in a circular path with uniform speed, its motion is uniform circular motion.

ii. Speed of a particle performing uniform circular motion is given by

$v = \dfrac{\text{circumference of the circle}}{\text{time for one revolution of the particle}}$

$\therefore$ $v = \dfrac{2\pi r}{t}$

where 'r' is the radius of the circle.

13. Intext Question. ***(Textbook page no. 9)***

Can you give more examples of uniform circular motion?

OR

Give examples of uniform circular motion. ***[2 Marks]***

Ans: Examples of uniform circular motion:

i. The motion of blades of the windmills

ii. Motion of an artificial satellite orbiting the Earth

iii. Motion of a person sitting in a merry go round moving with uniform speed.

14. State the formula to determine the speed of an object moving along a circular path of radius 'r' taking time 't' to come back to its starting position. ***[1 Mark]***

Ans: The speed of an object moving along a circular path of radius 'r' can be determined by the formula, $v = \dfrac{\text{circumference}}{\text{time}} = \dfrac{2\pi r}{t}$

15. The forces of 15 N and 10 N are acting on a stone in north and south direction respectively.
i. Discuss, whether these forces are balanced or unbalanced.
ii. What is the effect of resulting force?
[HOTS] ***[2 Marks]***

Ans:

i. As the magnitudes of two forces are unequal and directions of application are opposite i.e., one along the north and other along the south, the two forces of 15 N and 10 N are unbalanced forces.

ii. Resulting force $F = F_1 + (-F_2)$
…(since direction is opposite)

$\therefore$ $F = 15 - 10 = 5$ N

This resulting force of magnitude 5 N moves the stone towards north direction.

16. Write a note on: Momentum ***[2 Marks]***

Ans:

i. Momentum (p) is the product of mass (m) and velocity (v) of an object i.e., p = mv
ii. It is a vector quantity with SI unit kg m/s and CGS unit g cm/s.
iii. Its direction is same as that of velocity of the object.
iv. When an unbalanced force applied on an object brings changes in its velocity, momentum of the object also changes.

Thus, unbalanced force is necessary to cause changes in momentum.

17. Derive the equation of force using Newton's second law of motion. ***[2 Marks]***

Ans:

i. Let a body of mass m, moving with velocity u be subjected to force F acting in the direction of motion. Consider v as the velocity of the body after time t.

ii. Total initial momentum of the body = mu and total final momentum of the body = mv

iii. Change in momentum
= Final momentum – initial momentum
= mv – mu

$\therefore$ Rate of change of momentum

$$= \frac{\text{Change in momentum}}{\text{time}} = \frac{mv - mu}{t} = \frac{m(v-u)}{t}$$

iv. But $\frac{v-u}{t} = a =$ acceleration

$\therefore$ Rate of change of momentum = ma

v. According to Newton's second law of motion,
Rate of change of momentum $\propto$ Force

$\therefore$ $ma \propto F$

$\therefore$ F = kma, where, k is a constant
If F = 1 N, m = 1 kg, a = 1 m/s^2 then, k = 1

$\therefore$ F = ma

$\therefore$ Force = mass $\times$ acceleration

18. For a body of certain mass and certain velocity
i. if mass is doubled and velocity is halved, is there any change in its momentum?
ii. if velocity and mass both become double, what will be its resulting momentum?
iii. if mass of a body is doubled, but velocity remains same, then what will be the resulting momentum? ***[3 Marks]***

Ans:

i. No, there is no change in momentum because mass and velocity both vary momentum directly.
ii. If mass and velocity both become double then resulting momentum will be 2 $\times$ 2 times i.e., 4 times that of initial momentum.
iii. If mass of a body is doubled but velocity remains same then its new momentum will be 2 $\times$ 1 times i.e., 2 times that of initial momentum.

19. Use your brain power!
(Textbook page no. 14)
i. While hitting a ball with a bat, the speed of the bat decreases.
ii. A gun recoils i.e., moves backwards when a bullet is fired.
iii. Mechanism of firing of a rocket.
How will you explain these with the help of Newton's third law of motion?
[2 Marks each]

Ans:

i. When a bat strikes a ball (force of action), the ball exerts an equal and opposite force of reaction on the bat. Hence, the speed of the bat decreases.

ii. a. When a bullet is fired from a gun, a force is exerted by the gun on the bullet.
b. At the same time the bullet also exerts an equal and opposite force on the gun.
Hence, a gun moves backwards (recoils) when a bullet is fired.

iii. a. The principle used for the motion of a rocket is based on Newton's third law of motion.
b. When the fuel in the rocket is ignited; it burns as a result of chemical reaction
c. The resultant compressed gases are thrown out with force through a small opening at the tail end of rocket in downward direction.

d. They exert an equal and opposite reaction force on the rocket in the upward direction.

e. This force is greater than the net downward force due to gravity and air resistance.

f. It is this reaction force which makes the rocket move in the forward direction.

20. Explain the principle of conservation of momentum. ***[3 Marks]***

Ans:

i. According to principle of conservation of momentum, the total momentum before collision of both the bodies is equal to the total momentum after collision.

ii. Consider two bodies A and B.

Let mass of A = m_1, initial velocity of A = u_1, final velocity of A = v_1 and force acting on A due to B = F_1.

Let mass of B = m_2, initial velocity of B = u_2, final velocity of B = v_2 and force acting on B due to A = F_2.

iii. When A and B collide, a force F_1 due to body B acts on A and the body A accelerates.

iv. According to Newton's third law, body A also exerts an equal and opposite force on body B.

v. Since these forces are opposite in direction,

$F_2 = -F_1$

$\therefore \quad m_2a_2 = -m_1a_1$

$\therefore \quad \dfrac{m_2(v_2 - u_2)}{t} = \dfrac{-m_1(v_1 - u_1)}{t}$

$\therefore \quad m_2(v_2 - u_2) = -m_1(v_1 - u_1)$

$\therefore \quad m_2v_2 - m_2u_2 = -m_1v_1 + m_1u_1$

$\therefore \quad m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2$

$\therefore$ Final momentum = Initial momentum.

Hence, total momentum in a collision is always conserved.

21. Explain in detail 2 examples of principle of conservation of linear momentum. ***[2 Marks]***

Ans: Examples:

i. When a person jumps from a boat, the boat is pushed away: When a person jumps from a small boat on the shore, he imparts an equal and opposite momentum to the boat. Therefore, the boat is pushed away backward.

ii. A hammer rebounds after hitting a nail into a wall: When a nail is driven into a wall by striking it with a hammer, the hammer is seen to rebound after striking the nail. This is because the hammer imparts a certain amount of momentum to the nail and the nail imparts an equal and opposite amount of momentum on the hammer.

22. Take 5 examples from your surroundings and give explanation based on Newton's laws of motion.** ***[2 Marks each]

Ans: Example 1:

When we are travelling by a bus, we experience backward jerk as the bus starts moving from rest. This is in accordance with Newton's first law of motion.

Explanation:

i. As the bus starts moving, the portion of our body which is in contact with the bus acquires velocity, but the upper part of the body tries to remain at rest.

ii. As a result, we exert inertia of rest and get a backward jerk, when the bus starts moving from rest.

Example 2:

A carpet when lifted up and given jerks, dust falls out of it. This is in accordance with Newton's first law of motion.

Explanation:

i. When we dust a carpet, by lifting it, the carpet is set into motion.

ii. While the dust remains in its state of rest due to inertia of rest.

iii. As a result, dust particles get separated from carpet, fall down under the effect of gravitational force and carpet becomes clean.

Example 3:

While catching a ball, cricketer moves his hands backwards. This is in accordance with Newton's second law of motion.

Explanation:

i. In the act of catching the ball, by drawing hands backward, cricketer allows longer time for his hands to stop the ball.

ii. By Newton's second law of motion, force applied depends on the rate of change of momentum.

iii. Taking longer time to stop the ball ensures smaller rate of change of momentum.

iv. Due to this, the cricketer can stop the ball by applying smaller amount of force and thereby not hurting his hands.

Example 4:
A book kept on a table remains stationary. This is in accordance with Newton's third law of motion.
Explanation:
i. A book kept on a table has some weight. This weight is the force acting on the table.
ii. By Newton's third law of motion, every action has an equal and opposite reaction.
iii. Thus, the table also exerts an upward force on the book and balances the weight.
iv. As, both the forces are balanced, there is no displacement.

Hence, a book kept on a table remains stationary.

Example 5:
An air filled balloon held in hand when released, moves forward. This is in accordance with Newton's third law of motion.
Explanation:
As air is released out in downward direction, it applies equal and opposite force on balloon pushing it forward.

23. Explain Newton's laws of motion with the help of one single example in daily life.

Ans: Newton's three laws can be explained with the help of a simple example of playing cricket.

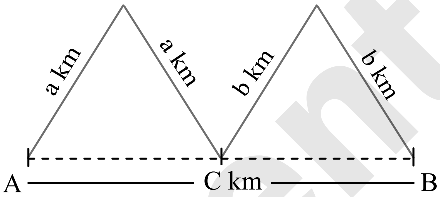
i Newton's first law of motion: An object continues to remain at rest or in a state of uniform motion along a straight line unless an external unbalanced force acts on it.
Explanation
When the bowler bowls the ball towards the batsmen, the ball continues in its state of motion until acted upon by an external unbalanced force (exerted by a bat).

ii Newton's second law of motion: The rate of change of momentum is proportional to the applied force and the change of momentum occurs in the direction of the force.
Explanation
When the batsman hits the ball bowled towards him, the change in velocity (momentum) of ball depends upon the force with which the batsman hits the ball.

iii Newton's third law of motion: Every action force has an equal and opposite reaction force which acts simultaneously.
Explanation
Refer Answer the following Q.19(i)

***24. Complete the sentences and explain them.**
i. The minimum distance between the start and finish points of the motion of an object is called the _______ of the object.
ii. Deceleration is _______ acceleration
iii. When an object is in uniform circular motion, its _______ changes at every point.
iv. During collision _______ remains constant.
v. The working of a rocket depends on Newton's _______ law of motion. ***[2 Marks each]***

Ans:
i. The minimum distance between the start and finish points of the motion of an object is called the **displacement** of the object.
Explanation:



Consider a person cycling from point A to point B through hills as shown in the figure above.
In the case, he covers distance 2a + 2b km but his displacement being minimum distance between points A and B equals to C km.

ii. Deceleration is **negative** acceleration.
Explanation:
When velocity of an object decreases with time, it is said to be decelerated motion and acceleration in such case is said to be deceleration. As final velocity of object is lesser than its initial velocity, i.e., $v < u$, from formula, acceleration, $a = \frac{v - u}{t}$ becomes negative.

iii. When an object is in uniform circular motion, its **velocity** changes at every point.
Explanation:
When an object performs uniform circular motion, its direction of motion changes continuously. Velocity being vector quantity depends on direction of motion and hence, changes as direction of motion changes.

iv. During collision **total momentum** remains constant.
Explanation:
According to law of conservation of momentum, the momentum gets redistributed between colliding objects. If momentum of one object decreases, momentum of second object increases.
As a result, during collision momentum remains constant.

v. The working of a rocket depends on Newton's **third** law of motion.
Explanation:
Refer Answer the following: Q.19 (iii)

Give reasons *[2 Marks each]*

***1. The velocity of an object at rest is considered to be uniform.**

Ans:

i. When an object is at rest, its velocity is zero.

ii. There is no change in velocity at rest.

Hence, the velocity of an object at rest can be considered to be uniform.

***2. When an object falls freely to the ground, its acceleration is uniform.**

Ans:

i. When an object falls freely, the only force acting on the object is the gravitational force of the earth.

ii. This force is nearly uniform near the surface of earth. Therefore, acceleration is uniform (F = ma)

Hence, when an object falls freely on the ground, its motion has a uniform acceleration.

3. When a scooter and a truck collide, the scooter is thrown away.

Ans:

i. When a scooter and a truck collide, they exert forces on each other according to Newton's third law of motion.

ii. These forces are equal in magnitude but opposite in direction.

iii. According to Newton's second law of motion, force = mass × acceleration.

iv. As the mass of the scooter is much less than that of a truck, the scooter recoils with much greater acceleration and is thrown away.

***4. It is easier to stop a tennis ball as compared to a cricket ball, when both are travelling with the same velocity.**

Ans:

i. Momentum is the product of mass of body and its velocity.

ii. Mass of a cricket ball is more than the mass of a tennis ball. Therefore, if both balls move with the same velocity, the momentum of cricket ball is more than the momentum of a tennis ball.

iii. As a result, more force is required to stop a cricket ball.

Hence, it is easier to stop a tennis ball than a cricket ball moving with the same velocity.

5. A bullet shot from a gun goes well inside a wooden block but a bullet thrown by hand does not.

Ans:

i. When a bullet is fired from gun it has very high velocity. Therefore, bullet exerts more force and penetrates well inside a wooden block.

ii. When we throw it by hand its velocity is very less. As a result, bullet exerts less force on wooden block and cannot go inside.

Hence, a bullet shot from a gun goes well inside a wooden block but a bullet thrown by hand does not.

6. When same force acts on two stationary objects for same time, lighter object gains higher velocity than heavier object but change in momentum is same for the two. *[HOTS]*

Ans:

i. As the two objects are at rest, they possess zero initial velocity and zero initial momentum.

ii. Force being product of mass and acceleration, for same value of force, lighter mass object gets accelerated more and attains higher velocity.

iii. Total change in their momentum equals product of force and time, (i.e., Ft) which is same for both the objects.

iv. As a result, change in momentum is same for both the objects.

Hence, when same force acts on two stationary objects for same time, lighter object gains higher velocity than heavier object but change in momentum is same for the two.

7. Use your brain power! ***(Textbook page no. 14)***

Why is there a thick bed of sand for a high jumper to fall on after his jump?

Ans:

i. When an athlete falls on a sand bed, it takes longer time for him to come to rest because the sand slides with athlete.

ii. This ensures the rate of change of momentum of athlete is less. As a result, a smaller stopping force acts on the athlete and the athlete does not get hurt.

Hence, there is a thick bed of sand for a high jumper to fall on after his jump.

***8. Even though the magnitudes of action force and reaction force are equal and their directions are opposite, their effects do not get cancelled.**

Ans: Action and reaction forces act on different objects. They do not act on the same object and hence cannot cancel each other's effect.

Distinguish between *[2 Marks each]*

*1. **Distance and displacement**

Ans:

	Distance	Displacement
i.	Distance is the length of the actual path travelled by an object in motion while going from one point to another.	Displacement is the minimum distance between the starting and finishing points of movement.
ii.	Distance traversed is always positive.	Displacement may be positive, negative or zero.
iii.	Distance is a scalar quantity.	Displacement is a vector quantity.
iv.	Distance is always greater than or equal to magnitude of displacement.	Displacement is always less than or equal to the magnitude of distance.

2. **Speed and velocity**

Ans:

	Speed	Velocity
i.	Speed is the distance travelled by a body in unit time.	Velocity is the distance travelled by the body in a given direction in unit time.
ii.	Speed is a scalar quantity.	Velocity is a vector quantity.
iii.	Speed = $\frac{\text{distance}}{\text{time}}$	Velocity = $\frac{\text{displacement}}{\text{time}}$
iv.	It is always positive or zero but never negative.	It may be positive, zero or negative.

*3. **Uniform motion and non–uniform motion**

Ans:

	Uniform motion	Non–uniform motion
i.	A body is said to have uniform motion if it covers equal distances in equal intervals of time.	A body is said to have non–uniform motion if it covers unequal distances in equal intervals of time.
ii.	The distance-time graph for uniform motion is a straight line.	The distance-time graph for a non uniform motion is not a straight line.
	E.g.: Soldiers marching in a parade.	**E.g.:** Motion of vehicles in a crowded street.

4. **Balanced force and unbalanced force**

Ans:

	Balanced force	Unbalanced force
i.	These forces do not change the state of rest or motion of a body.	These forces change the state of rest or motion of a body.
ii.	The net force acting on the body is zero.	The net force acting on the body is always non-zero.
	E.g.: Book placed on table.	**E.g.:** Boy kicking the football.

5. **Force and momentum**

Ans:

	Force	Momentum
i.	It is given by the product of mass and acceleration of an object.	It is given by the product of mass and velocity of an object.
ii.	It is measured in newton (N) or dyne.	It is measured in kg m/s or g cm/s.
iii.	Force may not be conserved.	Momentum is always conserved.

Complete the given chart/table

*1. **Complete the following table.** ***[1 Mark each]***

	u (m/s)	a (m/s^2)	t (sec)	v = u + at (m/s)
i.	2	4	3	______
ii.	______	5	2	20

	u (m/s)	a (m/s^2)	t (sec)	$s = ut + \frac{1}{2}at^2$ (m)
iii.	5	12	3	______
iv.	7	______	4	92

	u (m/s)	a (m/s^2)	s (m)	$v^2 = u^2 + 2as$ (m/s)^2
v.	4	3	____	8^2
vi.	______	5	8.4	10^2

Ans:

i. $v = u + at = 2 + (4 \times 3) =$ **14 m/s**

ii. $u = v - at = 20 - (5 \times 2) =$ **10 m/s**

iii. $s = ut + \frac{1}{2}at^2 = 5 \times 3 + \frac{1}{2} \times 12 \times 3^2$

$= 15 + 54 =$ **69 m**

iv. $a = \frac{2[92-(7\times4)]}{4^2} =$ **8 m/s^2**

v. $s = \frac{v^2-u^2}{2a} = \frac{8^2-4^2}{2\times3} =$ **8 m**

vi. $u^2 = v^2 - 2as = 10^2 - 2 \times 5 \times 8.4 = 16\ m^2/s^2$

$\therefore$ $u =$ **4 m/s**

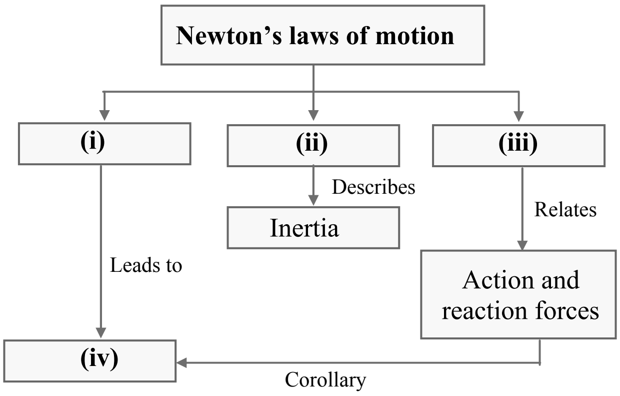
2. **Complete the following table.** ***[1 Mark]***

Mass	Acceleration	Force
80 kg	________	400 N

Ans: 5 m/s^2

[Solution: $a = \frac{F}{m} = \frac{400}{80} = 5\ m/s^2$***]***

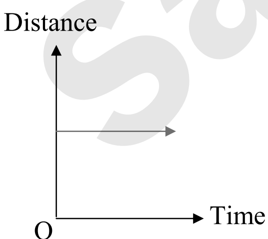
3. **Complete the following flow chart.** ***[2 Marks]***



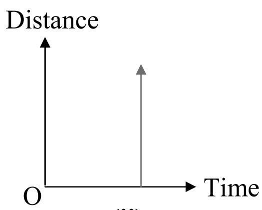
Ans:
i. Newton's second law of motion
ii. Newton's first law of motion
iii. Newton's third law of motion
iv. Law of conservation of momentum

Questions based on paragraph *[5 Marks]*

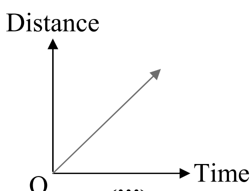
Teacher explained the terms distance, displacement, speed, velocity and acceleration. She also discussed different types of motion. Later as a class activity she asked Leela, Sahil and Mia to plot possible distance-time graphs to represent non-accelerated motion of an object. Leela plotted graph (i) while Sahil and Mia respectively plotted graphs (ii) and (iii) as shown below.



(i)



(ii)



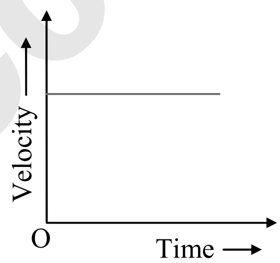
(iii)

Studying these graphs, answer the following questions.

i. Which of the graph/s correctly represent/s non-accelerated motion?
ii. Which of the graph is practically impossible? Why?
iii. What is the velocity of object if it has distance-time graph as represented in graph (i)?
iv. Plot corresponding velocity-time graph for graph (iii).
v. How would the nature of distance-time graph change if it were to represent accelerated motion of an object?

Answers:

i. Graphs (i) and (iii).
ii. Graph (ii) is practically impossible as graph represents an object being present at different distances at same time instant.
iii. As an object has not changed its position over a period of time, it has zero velocity.
iv.



v. The distance-time graph would be a non-linear plot instead of linear.

Graph based Questions

1. **Intext Question.** ***(Textbook page no. 5)***

The following table shows the distances covered by a car in fixed time intervals.

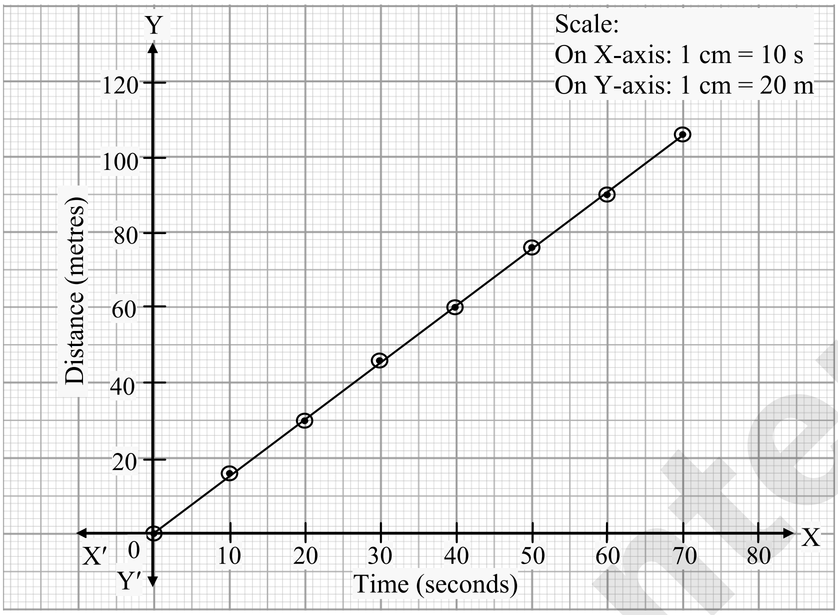
i. **Draw a graph of distance against time taking 'time' along the X-axis and 'distance' along the Y-axis.**

Time (seconds)	Distance (metres)
0	0
10	15
20	30
30	45
40	60
50	75
60	90
70	105

ii. Use your brain power! ***(Textbook page no. 6)***
In the distance-time graph above, what does the slope of the straight line indicate?

Ans:

i. Graph of distance versus time:



ii. Slope of graph = distance/time = speed. Therefore, the value of slope gives average speed of car during motion.

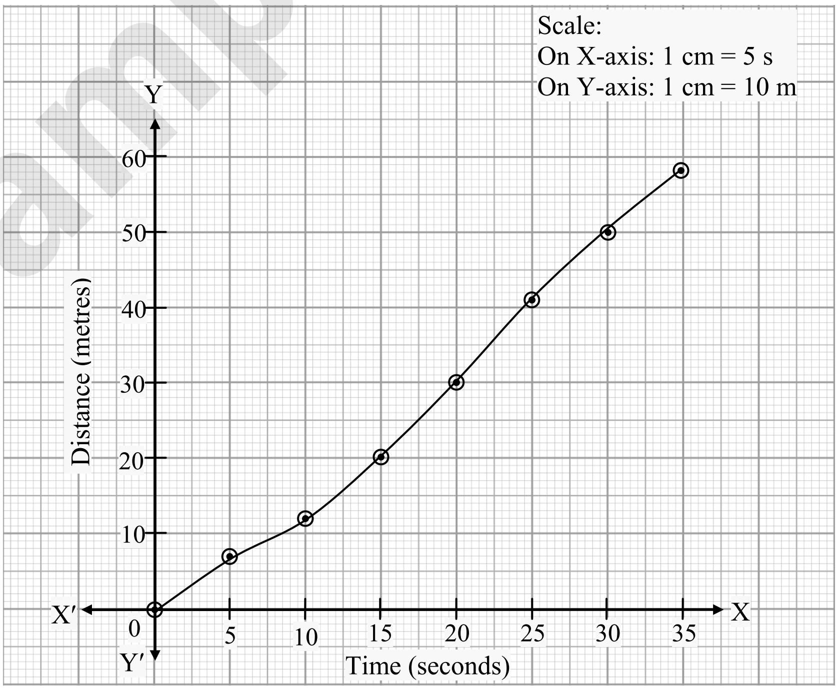
2. Intext Question. ***(Textbook page no. 6)***
The following table shows the distances covered by a bus in equal time intervals.

i. Draw a graph of distance against time taking the time along the X-axis and distance along the Y-axis.

ii. Does the graph show a direct proportionality between distance and time?

Time (second)	Distance (metre)	Time (second)	Distance (metre)
0	0	20	30
5	7	25	41
10	12	30	50
15	20	35	58

Ans: i. Graph of distance versus time:



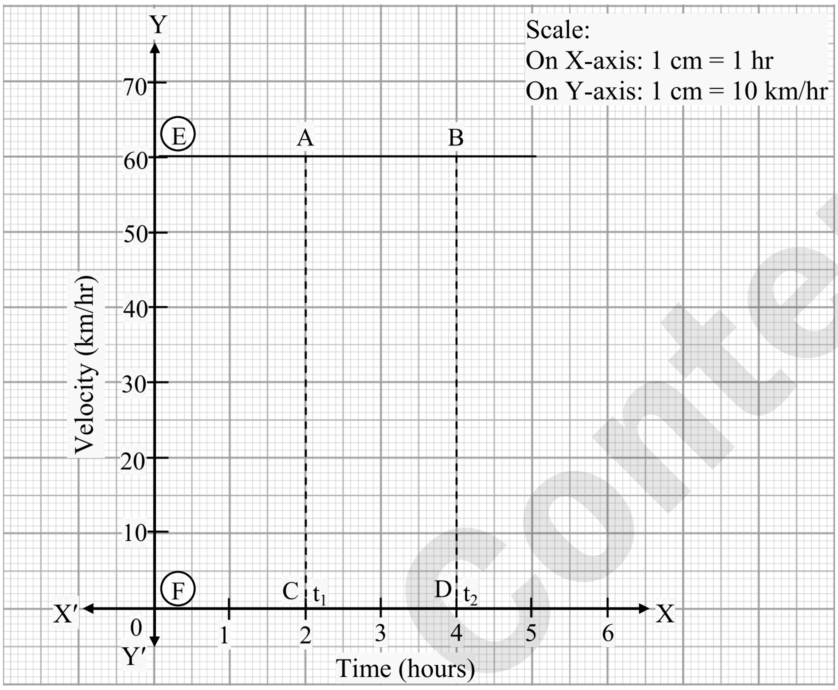
ii. No, the graph does not show a direct proportionality between distance and time.

3. **Intext Question.** *(Textbook page no. 6)*
A train is moving with a uniform velocity of 60 km/hour for 5 hours. The velocity-time graph for this uniform motion is shown below.

i. **With the help of the graph, how will you determine the distance covered by the train between 2 and 4 hours?**

ii. **Is there a relation between the distance covered by the train between 2 and 4 hours and the area of a particular quadrangle in the graph? What is the acceleration of the train?**

[2 Marks]



Ans: Let the point (0, 60) be denoted as E and (0, 0) as F.

i. Distance covered in time t_1 = 2 hrs equals area of □ EACF
Distance covered in time t_2 = 4 hrs equals area of □ EBDF

$\therefore$ Distance covered by train between 2 and 4 hrs = A(□ EBDF) − A(□ EACF)
= (60 × 4 − 60 × 2)
= 120 km

ii. Yes, area of particular quadrangle indicates distance covered by train during that specific time interval, i.e., A(□ ABDC) = 120 km = distance covered by train between 2 and 4 hrs.
As the train is moving with uniform velocity, acceleration of train is zero.

4. **Intext Question.** *(Textbook page no. 7)*
The changes in the velocity of a car in specific time intervals are given in the following table.

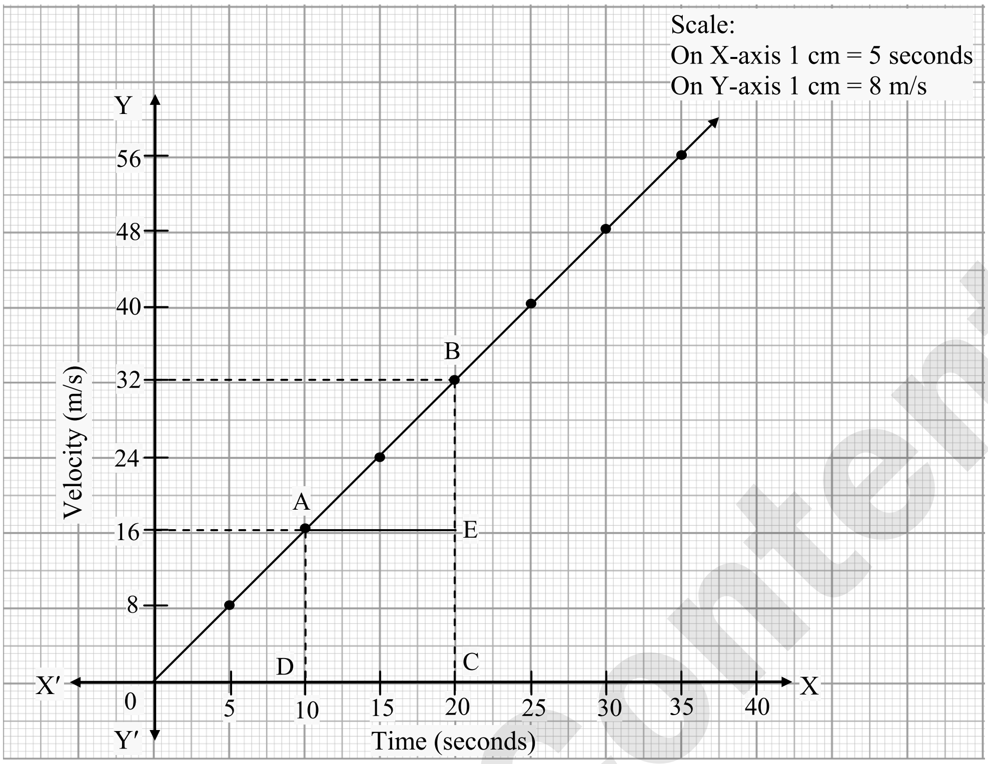
Time (seconds)	Velocity (m/s)
0	0
5	8
10	16
15	24
20	32
25	40
30	48
35	56

The velocity-time graph as given below shows that, the velocity changes by equal amounts in equal time intervals. Thus, this is uniform acceleration in accelerated motion.

i. **How much does the velocity change every 5 minutes?** *[1 Mark]*

ii. **Determine the distance covered by the car between the 10^{th} and the 20^{th} seconds.** *[2 Marks]*

iii. Check that, the distance covered is given by the area of quadrangle ABCD,
A (□ ABCD) = A (□ AECD) + A (ΔABE) ***[2 Marks]***



Ans:

i. Velocity change of 8 m/s is observed every 5 s.

∴ Change in velocity every 5 minutes = $\frac{8 \times (5 \times 60)}{2}$ = 480 m/s

ii. From the graph, the average velocity of the car for the period between 10^{th} and 20^{th} seconds can be calculated as, Average velocity = $\frac{32+16}{2}$ = 24 m/s

The time interval of 10^{th} to 20^{th} seconds is of 10 seconds. Hence, the distance covered will be given by,
Distance = speed × time = 24 × 10 = **240 m.**

iii. The distance covered during given time period can also be deduced from the area under the curve for that time period. i.e., distance covered between 10^{th} and 20^{th} seconds will be,
s = A (□ ABCD) = A (□ AECD) + A (ΔABE)

$$= (16 \times 10) + \left(\frac{1}{2} \times 10 \times 16\right) = 160 + 80 = \mathbf{240\ m.}$$

Numerical Section

Formulae

1. Speed:

i. Speed = $\frac{\text{distance}}{\text{time}}$

ii. Average speed = $\frac{\text{total distance travelled}}{\text{total time taken}}$

2. Velocity:

Velocity = $\frac{\text{displacement}}{\text{time}}$

3. Acceleration:

Acceleration (a) = $\frac{\text{change in velocity}}{\text{time}}$

4. Equations of motion:

i. $v = u + at$

where,
u = initial velocity, v = final velocity
t = time during which velocity has changed.

ii. $s = ut + \frac{1}{2}at^2$

where, s = distance covered by an object

iii. $v^2 = u^2 + 2as$

5. Force:

Force (F) = ma = $\dfrac{m(v-u)}{t}$

where,
m = mass,
t = time during which velocity has changed.

6. Momentum:

Momentum (p) = mass (m) × velocity (v)

7. Law of conservation of momentum:

Total initial momentum = Total final momentum

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

where, m_1 = mass of first object,
u_1 = initial velocity of first object,
v_1 = final velocity of first object,
m_2 = mass of second object,
u_2 = initial velocity of second object,
v_2 = final velocity of second object.

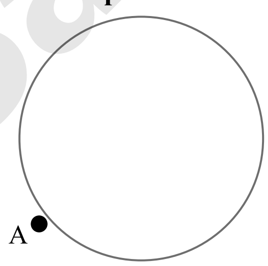
Solve the following problems

Type I — Distance & Displacement, Speed & Velocity

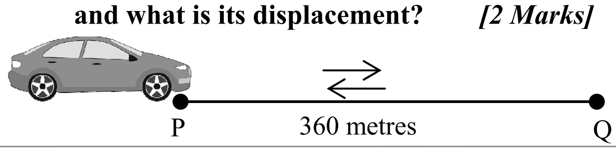
Formulae:
i. Speed = $\dfrac{\text{distance}}{\text{time}}$
ii. Average speed = $\dfrac{\text{total distance travelled}}{\text{total time taken}}$
iii. Velocity = $\dfrac{\text{displacement}}{\text{time}}$
iv. Acceleration (a) = $\dfrac{\text{change in velocity}}{\text{time}}$

1. Use your brain power! *(Textbook page no. 2)*

i. Every morning, Swaralee walks round the edge of a circular field having a radius of 100 m. As shown in the given figure, if she starts from the point A and takes one round, how much distance has she walked and what is her displacement?



ii. If a car, starting from point P, goes to point Q (see figure below) and then returns to point P, how much distance has it travelled and what is its displacement? ***[2 Marks]***



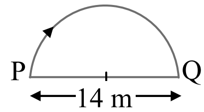
Solution:

i. Distance walked by Swaralee = $2\pi r$
= 2 × 3.142 × 100
= **628.4 m**
Displacement of Swaralee, as she returns to initial point, **is zero**.

ii. Distance travelled by car = d(PQ) + d(QP)
= 360 + 360
= **720 m**
Displacement of the car, as it returns to initial point, is **zero**.

Ans:
i. Distance walked by Swaralee is **628.4 m**. Her displacement is **zero**.
ii. Distance travelled by car is **720 m**. Its displacement is **zero**.

2. Two persons P and Q are at a distance of 14 m. P goes to Q following the semicircular path and Q goes to P in straight path as shown in figure.



i. What is the distance travelled by P?
ii. What is the distance travelled by Q?
iii. Find displacement of P and Q. ***[3 Marks]***

Solution:

i. Distance travelled by P = length of semicircular arc

$= \pi r = \pi \times \dfrac{d}{2}$

$= \dfrac{22}{7} \times \dfrac{14}{2} = $ **22 m**

ii. As Q travelled in a straight line,
∴ Distance travelled by Q
= Diameter of semicircle = **14 m**

iii. Displacement of P = Length of diameter
= **14 m**
Displacement of Q= **–14 m**
….(∵ direction of motion of Q is opposite to that of P)

Ans:
i. Distance travelled by P is **22 m.**
ii. Distance travelled by Q is **14 m**.
iii. Displacement of P and Q is **14 m** and **–14 m** respectively.

3. An object moves 18 m in the first 3 s, 22 m in the next 3 s and 14 m in the last 3 s. What is its average speed?** ***[2 Marks]

Solution:

Given: Distance covered in first three seconds (d_1) = 18 m, distance covered in next three seconds (d_2) = 22 m, distance covered in last three seconds (d_3) = 14 m
total time (t) = 3 + 3 + 3 = 9 s

To find: Average speed

Formula: Average speed = $\frac{\text{Total distance covered}}{\text{Total time}}$

Calculation: From formula,

Average speed = $\frac{18+22+14}{9} = \frac{54}{9}$

= **6 m/s**

Ans: Average speed of the object is **6 m/s**.

*4. **A person swims 100 m in the first 40 s, 80 m in the next 40 s and 45 m in the last 20 s. What is the average speed of the person?** ***[2 Marks]***

Solution:

Given: Distance swam in first 40 seconds (d_1) = 100 m, distance swam in next 40 seconds (d_2) = 80 m, distance swam in last 20 seconds (d_3) = 45 m, total time (t) = 40 + 40 + 20 = 100 s

To find: Average speed

Formula: Average speed = $\frac{\text{Total distance covered}}{\text{Total time}}$

Calculation: From formula,

Average speed = $\frac{100+80+45}{100}$

= $\frac{225}{100}$ = **2.25 m/s**

Ans: Average speed of the person is **2.25 m/s**.

+5. **An athlete is running on a circular track. He runs a distance of 400 m in 25 s before returning to his original position. What is his average speed and velocity?** ***[2 Marks]***

Solution:

Given: Total distance travelled = 400 m, Total displacement = 0, as he returns to his original position.
Total time = 25 s.

To find: i. Average speed
ii. Average velocity

Formulae:

i. Average speed = $\frac{\text{Total distance covered}}{\text{Total time taken}}$

ii. Average velocity = $\frac{\text{Total displacement}}{\text{Total time taken}}$

Calculation: From formula (i),

Average speed = $\frac{400}{25}$ = **16 m/s**

From formula (ii),

Average velocity = $\frac{0}{25}$ = **0 m/s**

Ans: i. Average speed of athlete is **16 m/s**.
ii. As the athlete returns to his original position, his average velocity is **zero**.

6. **Milkha Singh is running in a sprint on a straight track. He runs a distance of 400 m in 50 s and reaches finishing point of the track. What is his average speed and velocity?** ***[2 Marks]***

Solution:

Given: Total distance travelled = 400 m,
total displacement = 400 m
(∵ track is a straight path)
total time = 50 seconds.

To find: i. Average speed
ii. Average velocity

Formulae:

i. Average speed = $\frac{\text{Total distance covered}}{\text{Total time taken}}$

ii. Average velocity = $\frac{\text{Total displacement}}{\text{Total time taken}}$

Calculation: From formula (i),

Average speed = $\frac{400}{50}$

= **8 m/s**.

From formula (ii),

Average velocity = $\frac{400}{50}$

= **8 m/s**.

Ans: i. Average speed of Milkha Singh is **8 m/s**.
ii. Average velocity of Milkha Singh is **8 m/s**.

Type II Equations of motion

Formulae: i. $v = u + at$

ii. $s = ut + \frac{1}{2}at^2$

iii. $v^2 = u^2 + 2as$

+7. **An aeroplane taxies on the runway for 30 s with an acceleration of 3.2 m/s^2 before taking off. How much distance would it have covered on the runway?** ***[2 Marks]***

Solution:

Given: Acceleration (a) = 3.2 m/s^2,
time (t) = 30 s,
initial velocity (u) = 0

To find: Distance (s)

Formula: $s = ut + \frac{1}{2}at^2$

Calculation: From formula,

$s = 0 \times 30 + \frac{1}{2} \times 3.2 \times 30^2$

$= 1.6 \times 900$

= **1440 m**

Ans: Distance covered by the aeroplane is **1440 m**.

8. A body starts from rest and moves with uniform acceleration of 4 m/s². How much time will it take to cover a distance of 128 m? ***[2 Marks]***

Solution:

Given: Initial velocity (u) = 0 m/s, acceleration (a) = 4 m/s^2, distance (s) = 128 m.

To find: Time (t)

Formula: $s = ut + \frac{1}{2}at^2$

Calculation: From formula,

$$128 = 0 \times t + \frac{1}{2} \times 4 \times t^2$$

$$128 = 2t^2$$

$$\frac{128}{2} = t^2$$

$$64 = t^2$$

$$\therefore \quad t = \mathbf{8\ s}$$

Ans: To cover a distance of 128 m, the body takes **8 s**.

+9. A kangaroo can jump 2.5 m vertically. What must be the initial velocity of the kangaroo? ***[2 Marks]***

Solution:

Given: Acceleration (a) = 9.8 m/s^2, distance (s) = 2.5 m, final velocity (v) = 0

To find: Initial velocity (u)

Formula: $v^2 = u^2 + 2as$

Calculation: From formula,

$$(0)^2 = u^2 + 2 \times (-9.8)\ (2.5)$$

Here, negative sign indicates that acceleration and velocity are in the opposite direction.

$$\therefore \quad 0 = u^2 - 49$$

$$\therefore \quad u^2 = 49$$

$$\therefore \quad u = \mathbf{7\ m/s}$$

Ans: The initial velocity of kangaroo must be **7 m/s**.

10. In a performance a clown needs to jump 1 m vertically. What must be the initial velocity of the clown? ***[2 Marks]***

Solution:

Given: Acceleration (a) = 9.8 m/s^2, displacement (s) = 1 m final velocity (v) = 0

To find: Initial velocity (u)

Formula: $v^2 = u^2 + 2as$

Calculation: From formula,

$$(0)^2 = u^2 + 2 \times (-9.8)\ (1)$$

Negative sign indicates that the acceleration is in the direction opposite to that of velocity.

$$0 = u^2 - 19.6$$

$$u^2 = 19.6$$

$$u \approx \mathbf{4.43\ m/s}$$

Ans: The initial velocity of clown must be **4.43 m/s**.

+11. A motorboat starts from rest and moves with uniform acceleration. If it attains the velocity of 15 m/s in 5 s, calculate the acceleration and the distance travelled in that time. ***[3 Marks]***

Solution:

Given: Initial velocity (u) = 0, final velocity (v) = 15 m/s, time (t) = 5 s.

To find:
i. Acceleration (a)
ii. Distance (s)

Formulae:
i. $a = \frac{v - u}{t}$
ii. $s = ut + \frac{1}{2}at^2$

Calculation: From formula (i),

$$a = \frac{15}{5}$$

$$= \mathbf{3\ m/s^2}$$

From formula (ii),

$$s = 0 \times 5 + \frac{1}{2} \times 3 \times 5^2$$

$$= \mathbf{37.5\ m}$$

Ans:
i. Acceleration of motorboat is **3 m/s^2**.
ii. Distance travelled by motorboat is **37.5 m**.

Type III **Force**

Formula: $F = ma = \frac{m(v-u)}{t}$

12. An object of mass 16 kg is moving with an acceleration of 3 m/s². Calculate the applied force. If the same force is applied on an object of mass 24 kg, how much will be the acceleration?** ***[2 Marks]

Solution:

Given: Mass of first object, (m_1) = 16 kg, acceleration of first object (a_1) = 3 m/s^2, mass of second object (m_2) = 24 kg

To find:
i. Applied force (F),
ii. Acceleration of second object (a_2)

Formula: F = ma

Calculation: From formula,

i. $F = m_1a_1 = 16 \times 3 = \mathbf{48\ N}$

ii. $a_2 = \frac{F}{m_2} = \frac{48}{24} = \mathbf{2\ m/s^2}$

Ans:
i. The applied force is **48 N**.
ii. Acceleration of the second object is **2 m/s^2**.

13. A force of 280 N produces an acceleration of 7 m/s^2. If same body is accelerated by 2 m/s^2 on application of a certain force, find the magnitude of force in this case. ***[2 Marks]***

Solution:

Given: Acceleration in first case (a_1) = 7 m/s^2, acceleration in second case (a_2) = 2 m/s^2, force in first case (F_1) = 280 N

To find: Force in second case (F_2)

Formula: F = ma

Calculation: From formula,

$F \propto a$

$\therefore \quad \frac{F_1}{F_2} = \frac{a_1}{a_2}$

$\therefore \quad \frac{280}{F_2} = \frac{7}{2}$

$\therefore \quad F_2 = \frac{280 \times 2}{7}$

$= \frac{560}{7}$

$\therefore \quad F_2 = \mathbf{80\ N}$

Ans: The force acting on the body in second case is **80 N**.

14. A bus starts moving from rest and attains a velocity of 90 km/hr after 5 minutes. If the force exerted by engine is 540 N, then calculate the mass of the bus. ***[2 Marks]***

Solution:

Given: Initial velocity (u) = 0,

….($\because$ bus starts from rest)

final velocity (v) = 90 km/hr

$= 90 \times \frac{1000}{60 \times 60}\ \frac{m}{s}$

$= 90 \times \frac{5}{18}$ m/s

force (F) = 540 N,

time (t) = 5 min

= 5 × 60

= 300 s

To find: Mass (m)

Formula: F = ma

$F = \frac{m(v-u)}{t}$ ….($\because a = \frac{v-u}{t}$)

Calculation: From formula,

$540 = \frac{m(25-0)}{300}$

$\therefore \quad 25m = 540 \times 300$

$\therefore \quad m = \frac{540 \times 300}{25}$

$\therefore \quad m = \mathbf{6480\ kg}$

Ans: The mass of the bus is **6480 kg**.

Type IV Momentum and conservation of momentum

Formulae: i. $p = m \times v$ ii. $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

Illustrative Example:

+ **2 balls have masses of 50 gm and 100 gm and they are moving along the same line in the same direction with velocities of 3 m/s and 1.5 m/s respectively. They collide with each other and after the collision, the first ball moves with a velocity of 2.5 m/s. Calculate the velocity of the other ball after collision.**

Analyse

Step 1: Read the problem and make a list of what is given or can be inferred from the problem.

From the information given, we come to know,

Mass of first ball (m_1) = 50 g = 0.05 kg, Mass of the second ball (m_2) = 100 g = 0.1 kg,

initial velocity of the first ball (u_1) = 3 m/s, initial velocity of the second ball (u_2) = 1.5 m/s,

final velocity of the first ball (v_1) = 2.5 m/s

Step 2: Make a note of all the quantities which are required to be found.

Final velocity of the second ball (v_2)

Solve

Step 3: **Based on the information provided and the quantity to be found, find out the concept to be applied to solve.**
In the given case, the question is based on conservation of momentum.
'When two bodies collide, the total momentum before collision is equal to the total momentum after collision.'
Before collision, the total momentum is the sum of the momentum of both the balls.

Step 4: **Substitute known values into the equation and use appropriate algebraic steps to solve for the unknown quantity.**
Momentum of the first ball before collision = $m_1u_1 = 0.05 \times 3 = 0.15$ kg m/s
Momentum of the second ball before collision = $m_2u_2 = 0.1 \times 1.5 = 0.15$ kg m/s
$\therefore$ Total momentum before collision = 0.15 + 0.15 = 0.3 kg m/s
After collision, the total momentum is the sum of the momentum of both the balls.
Momentum of the first ball after collision = $m_1v_1 = 0.05 \times 2.5 = 0.125$ kg m/s
Momentum of the second ball after collision = $m_2v_2 = 0.1 \times v_2 = 0.1v_2$ kg m/s
$\therefore$ Total momentum after collision = $0.125 + 0.1v_2$ kg m/s
By principle of conservation of momentum, we have,
$\therefore$ $0.3 = 0.125 + 0.1v_2$
$\therefore$ $0.1v_2 = 0.3 - 0.125$
$\therefore$ $v_2 = \frac{0.175}{0.1} = \mathbf{1.75\ m/s}$

Step 5: **Check the final answer in terms of its magnitude, sign and unit.**

+**15. The mass of a cannon is 500 kg and it recoils with a speed of 0.25 m/s. What is the momentum of the cannon?** ***[2 Marks]***

Solution:

Given: Mass of the cannon (m) = 500 kg, recoil speed (v) = 0.25 m/s
To find: Momentum (p)
Formula: p = mv
Calculation: From formula,
p = 500 × 0.25 = **125 kg m/s**

Ans: Momentum of the cannon is **125 kg m/s**.

16. A bullet having a mass of 10 g and moving with a speed of 1.5 m/s, penetrates a thick wooden plank of mass 900 g. The plank was initially at rest. The bullet gets embedded in the plank and both move together. Determine their velocity.** ***[2 Marks]

Solution:

Given: Mass of bullet $(m_B) = 10\text{ g} = 1 \times 10^{-2}$ kg,
initial speed of bullet $(v_B) = 1.5$ m/s,
mass of wooden plank (m_W)
$= 900\text{ g} = 90 \times 10^{-2}$ kg
initial speed of plank, $(v_W) = 0$
To find: Velocity of plank embedded with bullet (v)
Formula: $m_Bv_B + m_Wv_w = (m_B + m_W)v$
Calculation: From formula,
$(1 \times 10^{-2} \times 1.5) + (90 \times 10^{-2} \times 0)$
$= (1 \times 10^{-2} + 90 \times 10^{-2})$ v
$\therefore$ $v = \frac{1.5 \times 10^{-2}}{91 \times 10^{-2}}$
$= \mathbf{0.016\ m/s}$

Ans: Velocity of plank embedded with bullet (v) is **0.016 m/s**.

[Note:** The above value of velocity is calculated using wooden plank of mass 900 g. If the mass of the plank is taken as 90 g, velocity of plank embedded with bullet will be 0.15 m/s.**]

Practice Problems

1. Two athletes are practicing for a running race. One athlete follows a circular track of circumference 500 m in 40 s and other athlete runs a straight path of 500 m in same time. Determine the difference in their average velocities. ***[2 Marks]***

Ans: 12.5 m/s

2. A car moving on a road covers first 10 km of total 30 km in traffic and takes 20 minutes. After 10 km, the car covers the rest of the distance in another 20 minutes. Calculate the average speed (in km/hr) of the car for total ride. ***[2 Marks]***

Ans: 45 km/hr

3. Formula rossa is the world's fastest roller coaster. It reaches the speed of 240 km/hr in 5 seconds. Calculate the acceleration (in m/s^2). ***[2 Marks]***

Ans: 13.33 m/s^2

4. A bus starting from rest moves with a uniform acceleration of 0.1 m/s^2 for two minutes. Find the distance travelled by the bus. ***[2 Marks]***

Ans: 720 m

5. An object of mass 25 kg is moving with an acceleration of 5 m/s^2. Calculate the applied force. If the same force is applied on an object of mass 50 kg, how much will be the acceleration? ***[2 Marks]***

Ans: 125 N, 2.5 m/s^2

6. A scooter of mass 110 kg travelling with speed of 36 km/hr comes to rest in 5 s after applying breaks. What is its deceleration? How much force has acted upon the scooter? ***[3 Marks]***

Ans: 2 m/s^2, –220 N

7. A copper sphere of mass 21 kg is moving in the north direction with a velocity of 36 km/hr. Find the momentum acquired by the sphere. ***[2 Marks]***

Ans: 210 kg m/s

8. A block starts from rest and moves with uniform acceleration of 8 m/s^2. How much time will it take to cover a distance of 324 m? ***[2 Marks]***

Ans: 9 s

9. A train starts moving from rest and attains a velocity of 90 km/hr after 2 minutes. If the force exerted by engine is 750 N, then calculate the mass of the train. ***[2 Marks]***

Ans: 3600 kg

10. A bullet having a mass of 20 g and moving with a speed of 2 m/s, penetrates a thick wooden plank of mass 60 g. The plank was initially at rest. The bullet gets embedded in the plank and both move together. Determine their velocity. ***[2 Marks]***

Ans: 0.5 m/s

11. A bullet having a mass of 10 g and moving with a speed of 1.5 m/s, penetrates a thick wooden plank of mass 90 g. The plank was initially at rest. The bullet gets embedded in the plank and both move together. Determine their velocity. ***[2 Marks]***

Ans: 0.15 m/s

Scan the given Q. R. Code in *Quill - The Padhai App* to view the Solutions to Practice Problems.

Apply your Knowledge

1. Can you tell? ***(Textbook page no. 1)***
In which of the following examples can you sense motion? How will you explain presence and absence of motion?

i. The flight of a bird
ii. A stationary train
iii. Leaves flying through air
iv. A stone lying on a hill

Ans: Amongst the given examples, motions that can be sensed by a stationary observer are the flight of a bird and leaves flying through air.
A body is said to be in motion, if it changes its position with respect to its surroundings.
Body at rest (i.e., it does not change its position with respect to its surroundings) indicates absence of motion.

Reading between the lines

This means, examples of a stationary train and a stone lying on a hill indicate absence of motion.

2. Intext Question. ***(Textbook page no. 1)***
Can you list other examples of motion, besides those given on textbook page no. 1?

Ans: Examples of motion are:
Waterfall, released arrow passing through air, a moving bus, a boy riding cycle etc.

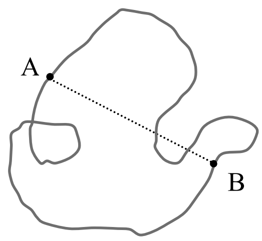
3. Think about it. ***(Textbook page no. 1)***

i. You are travelling in a bus. Is the person sitting next to you in motion?
ii. What do you take into consideration to decide if an object is moving or not?

Ans:

i. No, the person next to me is not in motion with respect to me.
ii. Motion is a relative concept. Hence, an object is moving or not is decided on the basis of whether it changes its position with respect to its surrounding or not.

4. Let's try this. ***(Textbook page no. 1)***



i. Measure the distance between points A and B in different ways as shown in the figure.
ii. Now measure the distance along the dotted line. Which distance is correct according to you and why?

Ans:

i. *[Students should measure the distance between points A and B on their own.]*

ii. If separation between two points A and B is considered, distance measured along the straight dotted line from A to B is correct. If motion of object is considered, the distance measured along the curved path including loop is correct.

5. Can you recall? *(Textbook page no. 2)*

i. What are vectors and scalars?

ii. Which of the quantities distance, speed, velocity, time and displacement are scalars and which are vectors?

Ans:

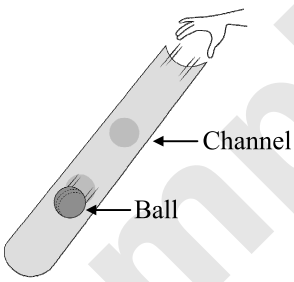
i. **Vectors:** Physical quantities which have magnitude as well as direction are called vectors.
Scalars: Physical quantities which have magnitude only and are specified completely by a number and unit are called scalars.

ii. Scalar quantities: distance, speed, time.
Vector quantities: velocity, displacement.

6. Let's try this. *(Textbook page no. 4)*

i. Take a 1 m long plastic tube and cut it lengthwise into two halves.

ii. Take one of the channel shaped pieces. Place one of its ends on the ground and hold the other at some height from the ground as shown in figure below.



iii. Take a small ball and release it from the upper end of the channel.

iv. Observe the velocity of the ball as it rolls down along the channel.

v. Is its velocity the same at all points?

vi. Observe how the velocity changes as it moves from the top, through the middle and to the bottom.

Ans: The velocity of the ball is continuously changing. Initially ball is dropped from rest, i.e., zero velocity. As it rolls down its velocity goes on increasing. When the ball hits the surface and stops, its velocity becomes zero again.

[Note: Students are expected to refer the accompanying Q. R. Code in *Quill - The Padhai App* for demonstration of the activity.**]**

7. Let's try this. *(Textbook page no. 9)*

Observe the tip of the second hand of a clock. What can you say about its velocity and speed?

Ans: The velocity of the tip of the second hand of a clock constantly changes while its speed remains constant.

8. Try out and think about it.

(Textbook page no. 10)

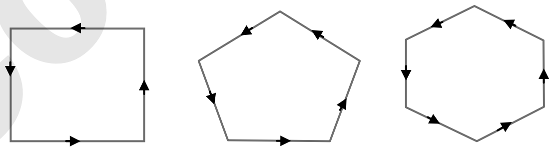
i. Draw a rectangular path as shown in figure below.

ii. Place the tip of your pencil on the middle of any side of the square path and trace the path.

iii. Note how many times you have to change the direction while tracing the complete path.

iv. Now repeat this action for a pentagonal, hexagonal, octagonal path and note the number of times you have to change direction.

v. If you increase the number of sides of the polygon and make it infinite, how many times will you have to change the direction? What will be the shape of the path?



Ans:

Shape of path	Number of times direction changed
Square/ Rectangle	4
Pentagonal	5
Hexagonal	6
Octagonal	8

For a polygon with infinite number of sides, one has to change direction infinite times. The shape of path will be evidently circular.

9. Research (*Textbook page no. 10*)

Find out more examples of circular motion in day to day life.

Ans: Examples of circular motion in everyday life:

i. Motion of tips of blades of fan

ii. Motion of keychain around finger

iii. Motion of any point on circumference of washing machine tub

iv. Motion of any point on wheel

v. Motion of any point on the rim of potter's wheel

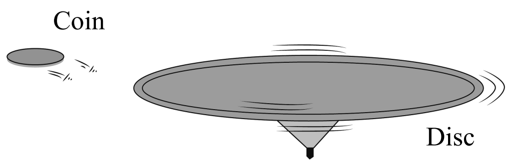
vi. Motion of a point on the rim of turntable in oven

vii. Motion of a communication satellite (a geostationary satellite used for communication) around the earth.

(Students can find out more examples and add to the above list.)

10. Let's try this. *(Textbook page no. 10)*

Take a circular disc and put a five rupee coin at a point along its edge. Make it move around its axis by putting a pin through it. When the disc is moved at higher speed, the coin will be thrown off as shown in figure.



Note the direction in which it is thrown off. Repeat the action placing the coin at different points along the edge of the circle and observe the direction in which the coin is thrown off.

Ans: The coin is thrown off tangentially. i.e., it moves in the direction perpendicular to the radius of the disc from its position.

The direction of the coin is different for different initial positions. This implies, the direction of motion of the coin during the circular motion is different at each point on the circular path.

[Note: Students are expected to refer the accompanying Q. R. Code in *Quill - The Padhai App* for demonstration of the activity.**]**

11. Let's try this. *(Textbook page no. 12)*

Fill a glass with sand. Keep a piece of cardboard on it. Keep a five rupee coin on the cardboard. Now strike the cardboard hard using your fingers. Observe what happens.

Ans: The cardboard on being struck, falls off the glass on the ground nearby, while the coin falls straight onto the sand inside the glass.

12. Let's try this. *(Textbook page no. 13)*

i. a. Ask your friend to drop one plastic and one rubber ball from the same height.

b. You catch the balls. Which ball was easier to catch and why?

ii. a. Ask your friend to throw a ball towards you at slow speed. Try to catch it.

b. Now ask your friend to throw the same ball at high speed towards you. Try to catch it. Which ball could you catch with greater ease? Why?

Ans:

i. The plastic ball was easier to catch as it has less mass than the rubber ball.

ii. For the same ball, ball thrown with less speed is easier to catch. This is because lesser amount of force is needed to stop the ball with less speed, making it easier to catch.

[Note: Students are expected to refer the accompanying Q. R. Code in *Quill - The Padhai App* for demonstration of the activity.**]**

13. Let's try this. *(Textbook page no. 14)*

i. Take a plastic boat and make a hole at its rear end.

ii. Inflate a balloon and fix it on the hole in the boat. Release the boat in water. What happens to the boat as the air in the balloon escapes slowly? Why?

Ans: The boat moves forward.

When air blows out of the balloon, it is released in backward direction with force through the hole. As a result, it exerts an equal and opposite reaction force on the boat. This makes the boat move in forward direction.

[Note: Students are expected to refer the accompanying Q. R. Code in *Quill - The Padhai App* for demonstration of the activity.**]**

***14. Project:**

Obtain information about commonly used gadgets or devices which are based on the principles of Newton's laws of motion.

Ans:

i. Seat belts are provided in vehicles in accordance with Newton's first law of motion. When vehicle is stopped abruptly, person tends to move forward due to inertia. Seat belts protect the person from falling and getting hurt.

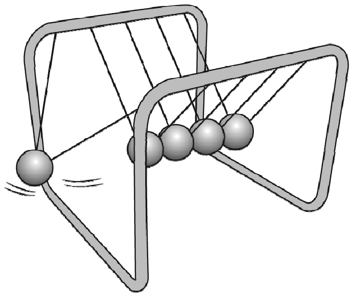
ii. Vehicles such as scooters, cars etc. are provided with shockers in accordance with Newton's second law of motion. When vehicles move over uneven road, large force is exerted in very short time on vehicles by road. The shockers increase the time of impact reducing the force or jerk experienced by rider.

iii. Rocket launching is based on Newton's third law of motion.

(Students are expected to find more information and add to the answer.)

15. Find out about Newton's cradle.

Ans: Newton's cradle is a device that demonstrates conservation of momentum and energy using a series of swinging spheres.



Newton's cradle

A typical cradle consists of a series of identical metal balls suspended in metal frame as shown in the above figure. Each ball just touches its neighbour. Each ball is attached to the frame by two equal length wire angled away from each other.

When a ball at any one of the ends is pulled sideways, attached string causes it to follow arched movement in upward direction. When it is released, it strikes its neighbouring ball and nearly comes to rest. The ball on the opposite side gains most of the velocity of the first ball as intermediate balls transfer momentum almost instantly. As a result, the last ball swings in an arc almost identical to the first ball.

This demonstrates that the last ball receives most of the momentum and energy of the first ball.

This verifies principle of conservation of momentum as well as energy.

Memory Map

Motion

Described with:

Distance
- Actual path followed by body
- Has only magnitude
- SI unit - m
  CGS unit - cm

Displacement
- Shortest distance between initial and final points
- Has magnitude and direction
- SI unit - m
  CGS unit - cm

Speed
- Distance covered in unit time
- Has magnitude only
- Speed = $\dfrac{\text{distance}}{\text{time}}$
- SI unit - m/s
  CGS unit - cm/s

Velocity
- Rate of change of displacement
- Has magnitude and direction
- Velocity = $\dfrac{\text{displacement}}{\text{time}}$
- SI unit - m/s
  CGS unit - cm/s

Acceleration
- Rate of change of velocity
- Has magnitude and direction
- Acceleration = $\dfrac{\text{Change in velocity}}{\text{time}}$
- SI unit - m/s^2
  CGS unit - cm/s^2

Types:
- Linear
  - Uniform
  - Non–uniform
- Circular
  - Uniform
  - Non–uniform

Equations of motion
(for uniformly accelerated linear motion)

- I: $v = u + at$
- II: $s = ut + \frac{1}{2}at^2$
- III: $v^2 = u^2 + 2as$

Force

- Mass × acceleration
- SI unit – N (newton) CGS unit – dyne
- Vector (Has magnitude and direction)

Types:

Balanced force
- Causes no change of state of rest or motion
- May cause rotational motion

Unbalanced force
- Causes change of speed or direction of motion or both

Explained through:

Newton's first law of motion
Describes: Inertia
Types:
- Inertia of rest
- Inertia of motion
- Inertia of direction

Newton's second law of motion
Explains: Rate of change of momentum (p) ∝ F where, p = mv
Leads to: Law of conservation of momentum

Newton's third law of motion
Relates: Action and reaction forces
Corollary: Law of conservation of momentum

Chapter Assessment

[Total Marks: 25]

Q.1. (A) Choose the correct alternative. **[4]**

i. If two solid balls identical in size but one made of plastic and other of copper are set into motion then,
   (A) plastic ball has higher inertia of rest than that of copper ball.
   (B) plastic ball has higher inertia of motion than that of copper ball.
   (C) copper ball has higher inertia of motion than that of plastic ball.
   (D) both balls have same inertia of motion.

ii. There is continuous change in the speed of a body due to the continuous application of _______.
   (A) inertia (B) balanced force
   (C) uniform force (D) unbalanced force

iii. A straight line in the distance-time graph shows that
   (A) the distance is increasing with time.
   (B) the velocity is increasing with time
   (C) velocity is decreasing with time
   (D) slope of the graph is constant.

iv. The forces of action and reaction have the same _______ and opposite _______.
   (A) unit, direction (B) direction, unit
   (C) momentum, inertia (D) inertia, momentum

(B) Answer the following. **[4]**

i. A man covers distance of 5 m in 2 seconds, taking a turn he covers 6 m in next 4 seconds and 3 m in another 6 seconds. Write the type of motion exhibited by the man.

ii. Match the columns.

	Column I		Column II
a.	Newton's first law of motion	1.	Describes the relationship between the forces on two interacting objects.
b.	Newton's third law of motion	2.	Gives an idea of effects of force.
		3.	Also called as law of inertia.

iii. State if following statement is true or false.
   Circular motion is an accelerated motion.

iv. Complete the analogy.
   First equation of motion: v = u + at :: second equation of motion : _______

Q.2. (A) Give scientific reasons. (Attempt Any One) **[2]**

i. There is a thick bed of sand for a high jumper to fall on after his jump.

ii. Even though the magnitudes of action force and reaction force are equal and their directions are opposite, their effects do not get cancelled.

(B) Answer the following. (Attempt Any Two) **[4]**

i. Give a short note on: Momentum

ii. For a body of mass m and velocity v
   a. if mass is halved and velocity is doubled, is there any change in its momentum?
   b. if velocity and mass both become half, what will be its resulting momentum?

iii. Complete the table.

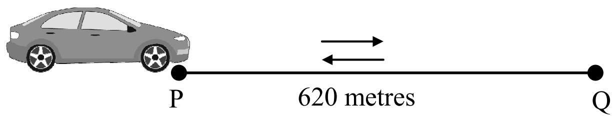
	u (m/s)	a (m/s^2)	t (s)	v (m/s)
a.	4	6	2	_______
b.	_______	5	2	40

Q.3. Answer the following. (Attempt Any Two) **[6]**

i. State Newton's second law of motion. Using this law, derive the equation of force.

ii. A body of mass 200 g initially at rest travels a distance of 100 m in 5 s with a constant acceleration. Calculate
   a. acceleration,
   b. final velocity
   c. final momentum at the end of 5 s

iii. a. Every morning, Sameer walks round the edge of a circular field having a radius of 50 m. If he takes one complete round, how much distance has he walked?
   b. If a car, starting from point P, goes to point Q (see figure below) and then returns to point P, how much distance has it travelled?

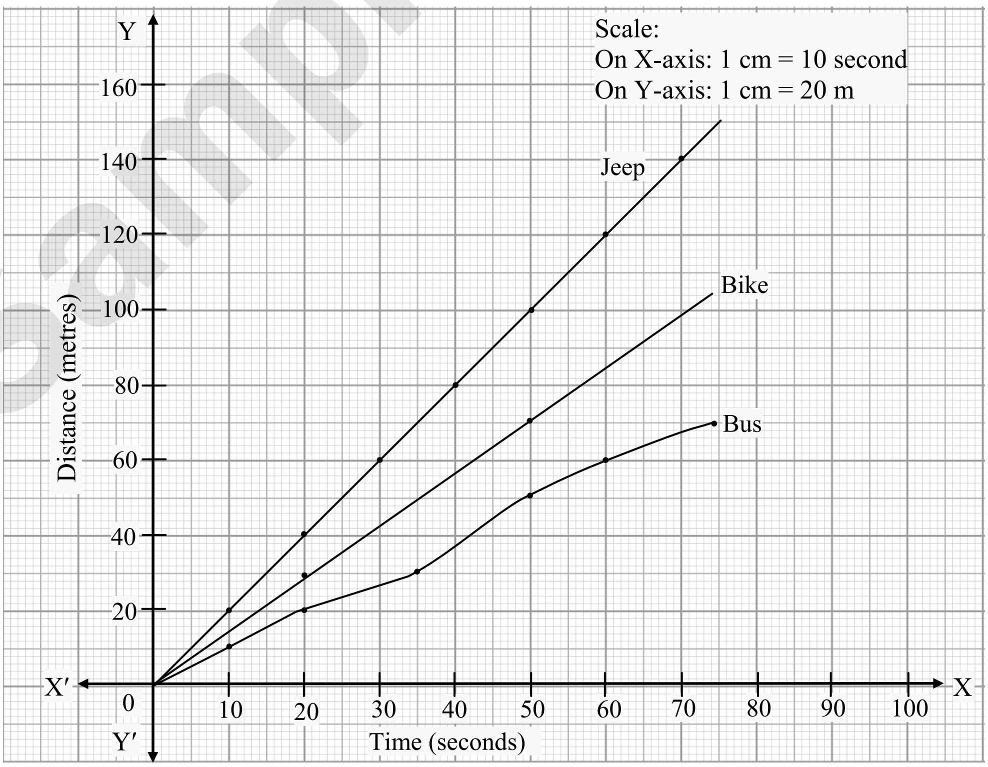


   c. Which is greater? Sameer's displacement or car's displacement?

Q.4. Answer the following. (Attempt Any One) **[5]**

i. Classify the given examples as uniform motion or non-uniform motion with proper explanation.
   a. Revolution of moon around the earth.
   b. Motion of flooded river water.
   c. A bicycle coming downhill freely under the influence of gravity along smooth ramp.
   d. Motion of a football kicked obliquely in air.
   e. Motion of a long distance bus travelling through a mountain pass.

ii. Given below are distance-time graphs for a bike, a jeep and a bus starting from the same spot at same time along straight road. Answer the following questions, studying the graph.



a. Which vehicle has maximum average speed?
b. What will be the nature of speed-time graph for the jeep?
c. What is the value of acceleration of the bike?
d. Assuming all the vehicles maintain the type of motion they are undergoing, for which vehicle we cannot find the distance covered after 150 seconds?
e. Assuming all the vehicles maintain the type of motion they are undergoing, what will be the distance between the bike and jeep at 120 seconds?

Scan the given Q. R. Code in *Quill - The Padhai App* to view the answers of the Chapter Assessment.

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