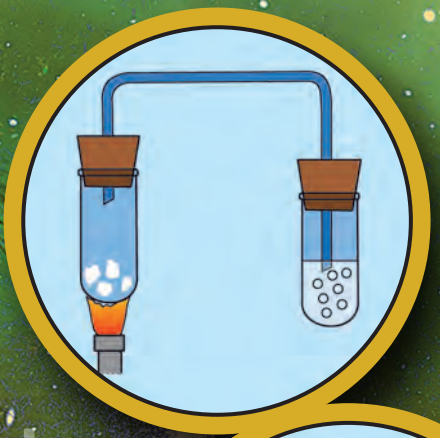
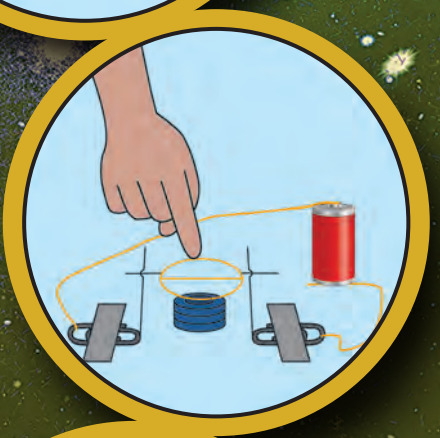
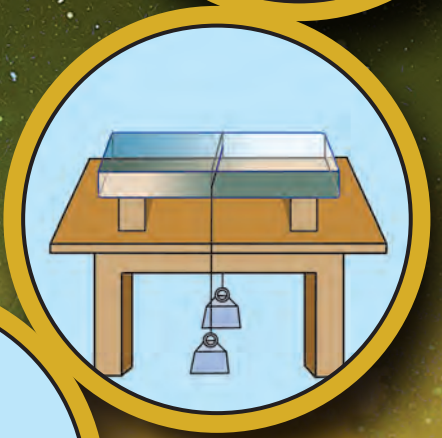
SCIENCE AND TECHNOLOGY

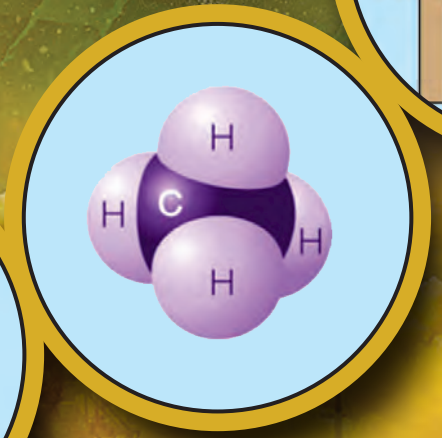
STANDARD TEN

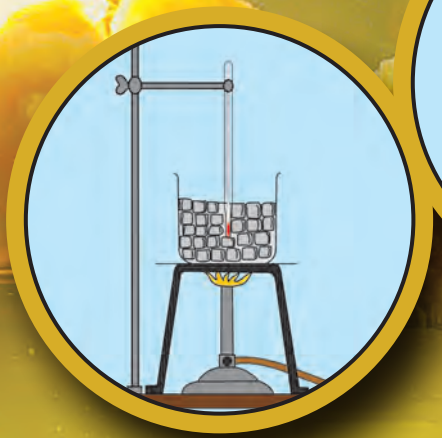
PART - 1











The Constitution of India

Chapter IV A

Fundamental Duties

ARTICLE 51A

Fundamental Duties- It shall be the duty of every citizen of India–

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities, to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures;

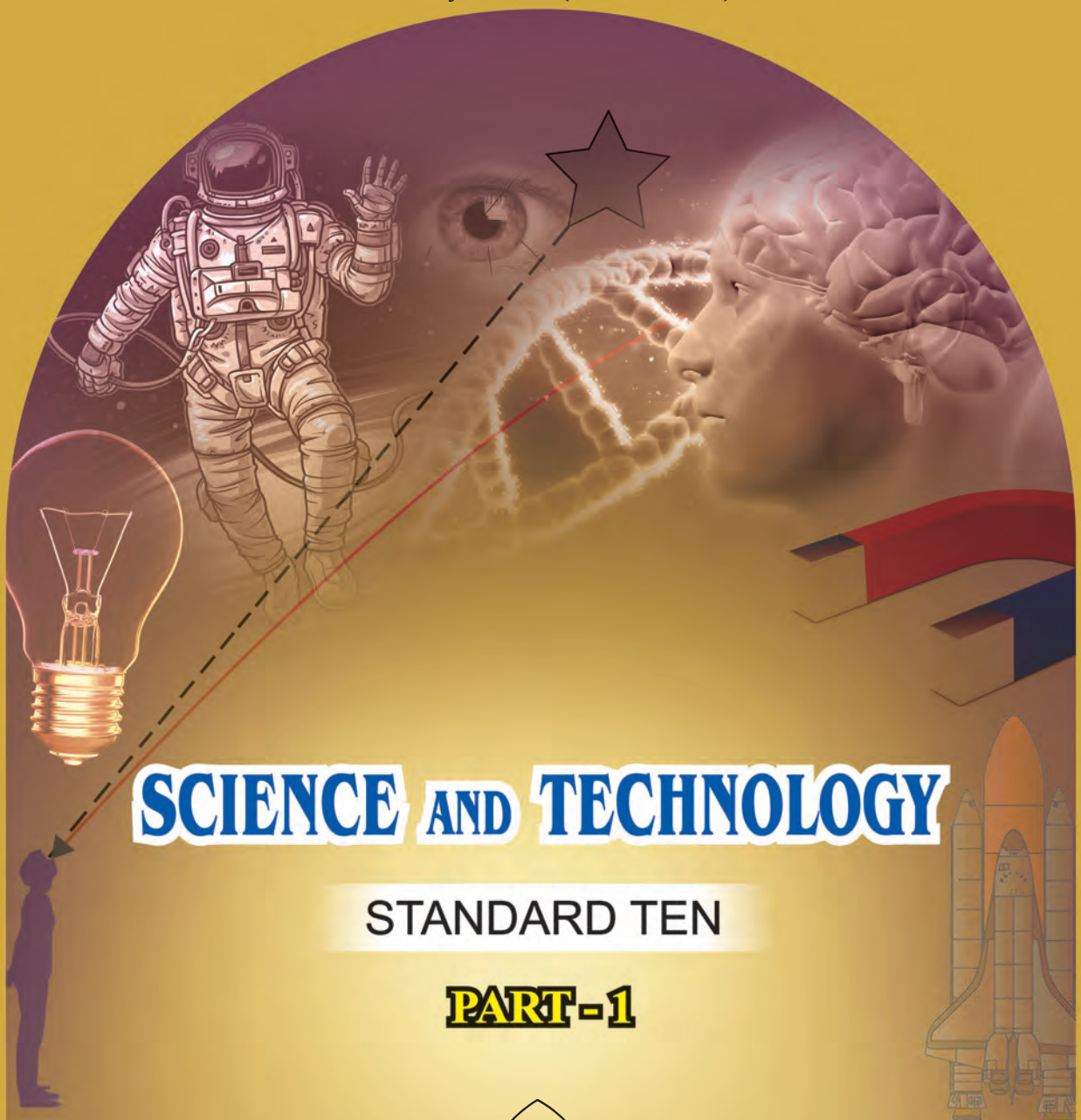
(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;

(k) who is a parent or guardian to provide opportunities for education to his child or, as the case may be, ward between the age of six and fourteen years.

Permission is granted for enforcing this textbook from the academic year 2018-19 in the meeting, held on the date 29.12.2017, of the coordination committee constituted by the Government resolution No: Abhyas-2116/(Pra.kra.43/16) S.D-4 dated 25.4.2016



SCIENCE AND TECHNOLOGY

STANDARD TEN

PART - 1

Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune.

The digital textbook can be obtained through DIKSHA App on your smartphone by using the Q.R.Code given on title page of the textbook and useful audio-visual teaching-learning material of the relevant lesson will be available through the Q.R. Code given in each lesson of this textbook.

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The Constitution of India

Preamble

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC and to secure to all its citizens:

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the unity and integrity of the Nation;

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.

NATIONAL ANTHEM

Jana-gana-mana-adhināyaka jaya hē
Bhārata-bhāgya-vidhātā,

Panjāba-Sindhu-Gujarāta-Marāthā
Drāvida-Utkala-Banga

Vindhya-Himāchala-Yamunā-Gangā
uchchala-jaladhi-taranga

Tava subha nāmē jāgē, tava subha āsisa māgē,
gāhē tava jaya-gāthā,

Jana-gana-mangala-dāyaka jaya hē
Bhārata-bhāgya-vidhātā,

Jaya hē, Jaya hē, Jaya hē,
Jaya jaya jaya, jaya hē.

PLEDGE

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect, and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

Preface

Dear students

Welcome to Std X. We have great pleasure in offering you this Science and Technology textbook based on the new syllabus. From the primary level till today, you have studied science from various textbooks. In this textbook, you will be able to study the fundamental concepts of science and technology from a different point of view through the medium of the different branches of Science.

The basic purpose of this textbook Science and Technology Part-1 can be said to be 'Understand and explain to others' the science and technology that relates to our everyday life. While studying the concepts, principles and theories in science, do make the effort to understand their connection with day to day affairs. While studying from this textbook, use the sections 'Can you recall?' and 'Can you tell?' for revision. You will learn science through the many activities given under the titles such as 'Observe and discuss' and 'Try this' or 'Let's try this. Make sure that you perform all these activities. Activities like 'Use your brain power!', 'Research', 'Think about it' will stimulate your power of thinking.

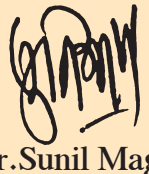
Many experiments have been included in the textbook. Carry out these experiments yourself, following the given procedure and making your own observations. Ask your teachers, parents or classmates for help whenever you need it. Interesting information which reveals the science underlying the events we commonly observe, and the technology developed on its basis, has been given in details in this textbook through several activities. In this world of rapidly developing technology, you have already become familiar with computers and smartphones. While studying the textbook, make full and proper use of the devices of information communication technology, which will make your studies easier. For more effective studies, you can avail additional audio-visual material for each chapter using the Q.R code through an App.This will definitely help you in your studies.

While carrying out the given activities and experiments, take all precautions with regard to handling apparatus, chemicals, etc. and encourage others to take the same precautions.

It is expected that while carrying out activities or observation involving plants and animals, you will also make efforts towards conservation of the environment. You must of course take all the care to avoid causing any harm or injury to them.

Do tell us about the parts that you like, as well as about the difficulties that you face as you read and study and understand this textbook.

Our best wishes for your academic progress.



(Dr.Sunil Magar)

Director
Maharashtra State Bureau of Textbook
and Curriculum Research, Pune

Pune
Date : 18 March 2018, Gudhipadva
Indian Solar Year : 27 Phalgun 1939

For Teachers

- In Standards I to V we have told the simple science in day to day life through the study of surroundings. In VI to VIII standard we have given brief introduction to science. In the textbook 'Science and Technology' for standard IX we have given the relation between science and technology.
- The real objective of science education is to learn to be able to think logically and with discretion about events that are happening around us.
- In view of the age group of Std X students, it would be appropriate, in the process of science education, to give freedom and scope to the students' own curiosity about the events of the world, their propensity to go looking for the causes behind them and to their own initiative and capacity to take the lead.
- As experimental skills are necessary for observation, logic, estimation, comparison and application of information obtained in science education, deliberate efforts must be made to develop these skills while dealing with laboratory experiments given in the textbook. All observations that the students have noted should be accepted, and then they should be helped to achieve the expected results.
- These two years in middle school lay the foundation of higher education in Science. Hence, it is our responsibility to enrich and enhance student's interest in science. You all will of course always actively pursue the objective of imbuing them with a scientific temper in them and developing their creativity and along with internet and skill.
- You can use 'Let's recall' to review the previous knowledge required for a lesson and 'Can you tell?' to introduce a topic by eliciting all the knowledge that the students already have about it from their own reading or experience. You may of course use any of your own activities or questions that occur to you for this purpose. Activities given under 'Try this' and 'Let's try this' help to explain the content of the lesson. The former are for students to do themselves and the latter are those that you are expected to demonstrate. 'Use your brain power!' is meant for application of previous knowledge for the new lesson, and 'Always remember' gives important suggestions/information or values. 'Research', 'Find out', 'Do you know?', 'Introduction to scientists' and 'Institutes at work' are meant to give some information about the world outside the textbook and to develop the habit of doing independent reference work to obtain additional information.
- This textbook is not only meant for reading and explaining in the classroom but is also for guiding students to learn the methods of gaining knowledge by carrying out the given activities. An informal atmosphere in the classroom is required to achieve the aims of this textbook. maximum number of students should be encouraged to participate in discussions, experiments and activities. Special efforts should be made to organise presentations or report-reading in the class based on students' activities and projects, besides observing of Science Day and other relevant occasions/ days.
- The science and technology content of the textbook has been complemented with Information Communication Technology. These activities are to be conducted under your guidance while learning various new scientific concepts.

Front and back covers : Pictures of various activities, experiments and concepts in the book.

Competency Statements

The students are expected to achieve the following competency level after studying the text book Science and Technology Part 1

Motion, Force and Machines

* To be able to explain the scientific reasons behind various phenomenal on the basis of relationship between gravitational force and motion.
* To be able to write formulae describing the relations between gravitation and motion and using these solve various numerical problems.

Energy

* To adapt an environment friendly lifestyle taking into account the grave effects of energy crisis and to encourage others to adapt it.
* To prepare , use and repair the equipments based on energy.
* To verify the laws of current electricity and to draw conclusions based on them
* To develop to solve numerical problems based on effects of current electricity.
* To observe various apparatus based on effects of current electricity and explain their functions with reasons.
* To give a scientific explanation of the images formed by lenses by drawing accurate ray diagrams.
* To explain properties of light, the images formed by lenses and their use in different equipments used in day to day life.
* To find out the focal length of a lens using given data.
* To study defects of vision in human eye and their remedies
* To draw neat and labelled diagram of human eye.

Substances in our use

* To explain systematic classifications of elements and their positions in the periodic table.
* To identify type of chemical reaction in two components.
* To verify chemical reaction experimentally and draw conclusions.
* To correct the chemicals equation which is incomplete or wrong.
* To verify the properties of carbon compounds through experiments.
* To take proper care while performing the experiments and handling of the apparatus considering the effects of chemical reactions on human health.
* To guide the society through scientific attitude about the use of carbon compounds in daily life.
* To understand the relationship between chemical reaction of metals in daily life and use them to solve various problem.

The Universe

* To analyse the information obtained from space research and remove superstitions prevailing in society.
* To review the contribution made by India to space research.
* To search for future opportunities in the field of space research.

Information Communication technology (ICT)

* To use information communication Technology in day today life.
* To share the information about science and technology by using the internet.
* To explain amazing that have occurred fields by using information communication technology

Index

Academic Planning

Two separate books have been prepared for Science and technology. Science and technology part 1 contains ten chapters mainly related to physics and chemistry. While thinking about science and technology, it is expected that an integrated approach will be taken while teaching and a connection will be made between different components of science and technology. In previous standards, we have studied various topics in science and technology together. For technical case two separate books science and technology part 1 and part 2 have been prepared, but it is necessary that an integrated perspective be taken while teaching.

Out of the ten chapters included in text book science and technology part 1, the first five chapters are expected to be taught in the first session while the next five chapters in the second session. At the end of a session a written examination for 40 marks and a practical examination for ten marks should be conducted. Exercises and projects have been given at the end of every chapters in the text book.

In view of evaluation, representative questions similar to those in the activity sheets of language books are given in exercises. You may make similar other questions for your use. The students should be evaluated based on these questions detailed information above to this will be given in separate evaluation scheme.

1. Gravitation

- Gravitation
- Circular motion and centripetal force
- Kepler's laws
- Newton's universal law of gravitation
- Acceleration due to the gravitational force of the Earth
- Free fall
- Escape velocity

Can you recall?

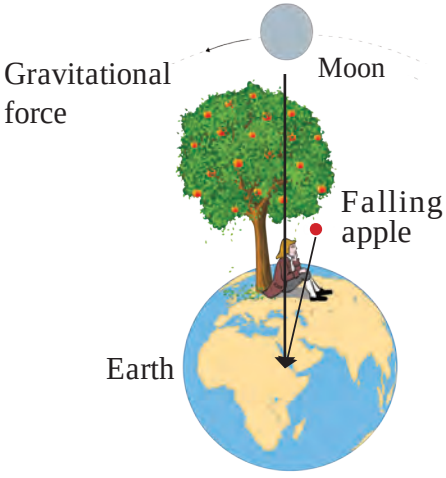
1. What are the effects of a force acting on an object?
2. What types of forces are you familiar with?
3. What do you know about the gravitational force?

We have seen in the previous standard that the gravitational force is a universal force and it acts not only between two objects on the earth but also between any two objects in the universe. Let us now learn how this force was discovered.

Gravitation

As we have learnt, the phenomenon of gravitation was discovered by Sir Isaac Newton. As the story goes, he discovered the force by seeing an apple fall from a tree on the ground. He wondered why all apples fall vertically downward and not at an angle to the vertical. Why do they not fly off in a horizontal direction?

After much thought, he came to the conclusion that the earth must be attracting the apple towards itself and this attractive force must be directed towards the center of the earth. The direction from the apple on the tree to the center of the earth is the vertical direction at the position of the apple and thus, the apple falls vertically downwards.



1.1 Concept of the gravitational force and the gravitational force between the earth and the moon.

Figure 1.1 on the left shows an apple tree on the earth. The force on an apple on the tree is towards the center of the earth i.e. along the perpendicular from the position of the apple to the surface of the earth. The Figure also shows the gravitational force between the earth and the moon. The distances in the figure are not according to scale.

Newton thought that if the force of gravitation acts on apples on the tree at different heights from the surface of the earth, can it also act on objects at even greater heights, much farther away from the earth, like for example, the moon? Can it act on even farther objects like the other planets and the Sun?

Use of ICT : Collect videos and ppts about the gravitational force of different planets.

Force and Motion

We have seen that a force is necessary to change the speed as well as the direction of motion of an object.

Can you recall? What are Newton's laws of motion?

Introduction to scientist

Great Scientists: Sir Isaac Newton (1642-1727) was one of the greatest scientists of recent times. He was born in England. He gave his laws of motion, equations of motion and theory of gravity in his book Principia. Before this book was written, Kepler had given three laws describing planetary motions. However, the reason why planets move in the way described by Kepler's laws was not known. Newton, with his theory of gravity, mathematically derived Kepler's laws.

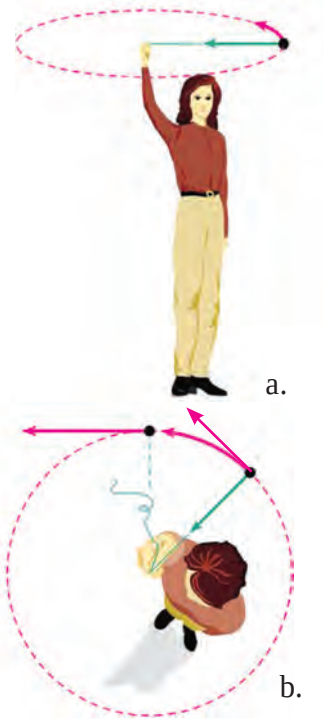
In addition to this, Newton did ground breaking work in several areas including light, heat, sound and mathematics. He invented a new branch of mathematics. This is called calculus and has wide ranging applications in physics and mathematics. He was the first scientist to construct a reflecting telescope.

Circular motion and Centripetal force

Try this

Tie a stone to one end of a string. Take the other end in your hand and rotate the string so that the stone moves along a circle as shown in figure 1.2 a. Are you applying any force on the stone? In which direction is this force acting? How will you stop this force from acting? What will be the effect on the stone?

As long as we are holding the string, we are pulling the stone towards us i.e. towards the centre of the circle and are applying a force towards it. The force stops acting if we release the string. In this case, the stone will fly off along a straight line which is the tangent to the circle at the position of the stone when the string is released, because that is the direction of its velocity at that instant of time (Figure 1.2 b). You may recall that we have performed a similar activity previously in which a 5 rupee coin kept on a rotating circular disk flies off the disk along the tangent to the disk. Thus, a force acts on any object moving along a circle and it is directed towards the centre of the circle. This is called the **Centripetal force.** 'Centripetal' means centre seeking, i.e. the object tries to go towards the centre of the circle because of this force.



1.2 A stone tied to a string, moving along a circular path and its velocity in tangential direction

You know that the moon, which is the natural satellite of the earth, goes round it in a definite orbit. The direction of motion of the moon as well as its speed constantly changes during this motion. Do you think some force is constantly acting on the moon? What must be the direction of this force? How would its motion have been if no such force acted on it? Do the other planets in the solar system revolve around the Sun in a similar fashion? Is similar force acting on them? What must be its direction?

From the above activity, example and questions it is clear that for the moon to go around the earth, there must be a force which is exerted on the moon and this force must be exerted by the earth which attracts the moon towards itself. Similarly, the Sun must be attracting the planets, including the earth, towards itself.

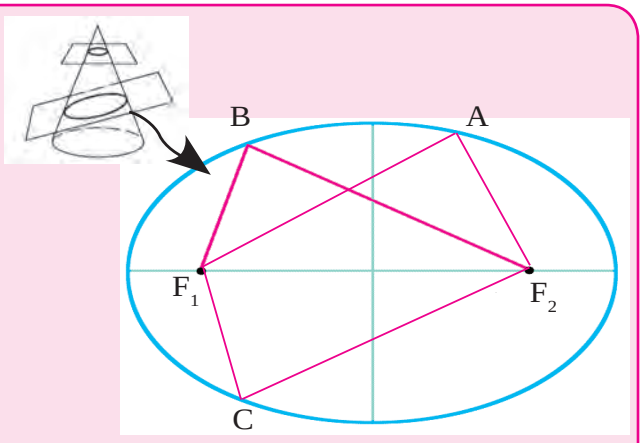
Kepler's Laws

Planetary motion had been observed by astronomers since ancient times. Before Galileo, all observations of the planet's positions were made with naked eyes. By the 16th century a lot of data were available about planetary positions and motion. Johannes Kepler, studied these data. He noticed that the motion of planets follows certain laws. He stated three laws describing planetary motion. These are known as Kepler's laws which are given below.

Do you know ?

An ellipse is the curve obtained when a cone is cut by an inclined plane. It has two focal points. The sum of the distances to the two focal points from every point on the curve is constant. F_1 and F_2 are two focal points of the ellipse shown in figure 1.3. If A, B and C are three points on the ellipse then,

$$AF_1 + AF_2 = BF_1 + BF_2 = CF_1 + CF_2$$



1.3 An ellipse

Kepler's first law :

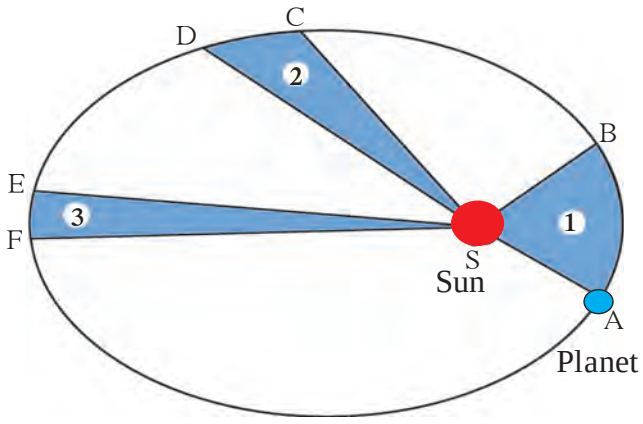
The orbit of a planet is an ellipse with the Sun at one of the foci.

Figure 1.4 shows the elliptical orbit of a planet revolving around the sun. The position of the Sun is indicated by S.

Kepler's second law :

The line joining the planet and the Sun sweeps equal areas in equal intervals of time.

AB and CD are distances covered by the planet in equal time i.e. after equal intervals of time, the positions of the planet starting from A and C are shown by B and D respectively.



1.4 The orbit of a planet moving around the Sun.

The straight lines AS and CS sweep equal area in equal interval of time i.e. area ASB and CSD are equal.

Kepler's third law :

The square of its period of revolution around the Sun is directly proportional to the cube of the mean distance of a planet from the Sun.

Thus, if r is the average distance of the planet from the Sun and T is its period of revolution then,

T^2 a r^3 i.e. $\frac{T^2}{r^3}$ = constant = K ..... (1)

Kepler obtained these laws simply from the study of the positions of planets obtained by regular observations. He had no explanation as to why planets obey these laws. We will see below how these laws helped Newton in the formulation of his theory of gravitation.

Use your brain power

If the area ESF in figure 1.4 is equal to area ASB, what will you infer about EF?

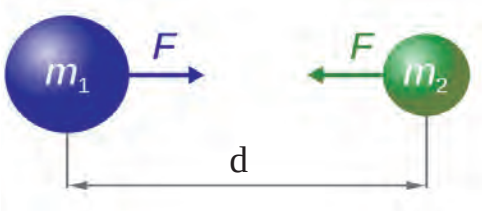
Newton's universal law of gravitation

All the above considerations including Kepler's laws led Newton to formulate his theory of Universal gravity. According to this theory, every object in the Universe attracts every other object with a definite force. This force is directly proportional to the product of the masses of the two objects and is inversely proportional to the square of the distance between them.

An introduction to scientists

Johannes Kepler (1571-1630) was a German astronomer and mathematician. He started working as a helper to the famous astronomer Tycho Brahe in Prague in 1600. After the sudden death of Brahe in 1601, Kepler was appointed as the Royal mathematician in his place. Kepler used the observations of planetary positions made by Brahe to discover the laws of planetary motion. He wrote several books. His work was later used by Newton in postulating his law of gravitation.

Figure 1.5 shows two objects with masses m_1 and m_2 kept at a distance d from each other. Mathematically, the gravitational force of attraction between these two bodies can be written as



1.5 Gravitational force between two objects

$$F \propto \frac{m_1 m_2}{d^2} \quad \text{or} \quad F = G\frac{m_1 m_2}{d^2} \quad \ldots\ldots (2)$$

Here, G is the constant of proportionality and is called the Universal gravitational constant.

The above law means that if the mass of one object is doubled, the force between the two objects also doubles. Also, if the distance is doubled, the force decreases by a factor of 4. If the two bodies are spherical, the direction of the force is always along the line joining the centres of the two bodies and the distance between the centres is taken to be d. In case when the bodies are not spherical or have irregular shape, then the direction of force is along the line joining their centres of mass and d is taken to be the distance between the two centres of mass.

From equation (2), it can be seen that the value of G is the gravitational force acting between two unit masses kept at a unit distance away from each other. Thus, in SI units, the value of G is equal to the gravitational force between two masses of 1 kg kept 1 m apart.

Use your brain power

Show that in SI units, the unit of G is Newton m^2 kg^{-2}. The value of G was first experimentally measured by Henry Cavendish. In SI units its value is 6.673×10^{-11} N m^2 kg^{-2}.

The centre of mass of an object is the point inside or outside the object at which the total mass of the object can be assumed to be concentrated. The centre of mass of a spherical object having uniform density is at its geometrical centre. The centre of mass of any object having uniform density is at its centroid.

Why did Newton assume inverse square dependence on distance in his law of gravitation? He was helped by Kepler's third law in this as shown below.

Uniform circular motion / Magnitude of centripetal force

Consider an object moving in a circle with constant speed. We have seen earlier that such a motion is possible only when the object is constantly acted upon by a force directed towards the centre of the circle. This force is called the centripetal force. If m is the mass of the object, v is its speed and r is the radius of the circle, then it can be shown that this force is equal to $F = m v^2/r$.

If a planet is revolving around the Sun in a circular orbit in uniform circular motion, then the centripetal force acting on the planet towards the Sun must be $F = mv^2/r$, where, m is the mass of the planet, v is its speed and r is its distance from the Sun.

$$\text{Speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

The speed of the planet can be expressed in terms of the period of revolution T as follows.

The distance travelled by the planet in one revolution =perimeter of the orbit $2\pi r$; r = distance of the planet from the Sun, Time taken = Period of revolution = T

$$v = \frac{\text{distance travelled}}{\text{time taken}} = \frac{2\pi r}{T}$$

$$F = \frac{mv^2}{r} = \frac{m\left(\frac{2\pi r}{T}\right)^2}{r} = \frac{4m\pi^2 r}{T^2}$$, multiplying and dividing by r^2 we get,

$F = \frac{4m\pi^2}{r^2} \times \left(\frac{r^3}{T^2}\right)$. According to Kepler's third law, $\frac{T^2}{r^3} = K$

$F = \frac{4m\pi^2}{r^2 K}$, But $\frac{4m\pi^2}{K}$ = Constant $\therefore F = \text{constant} \times \frac{1}{r^2}$ $\therefore F \propto \frac{1}{r^2}$

Thus, Newton concluded that the centripetal force which is the force acting on the planet and is responsible for its circular motion, must be inversely proportional to the square of the distance between the planet and the Sun. Newton identified this force with the force of gravity and hence postulated the inverse square law of gravitation. The gravitational force is much weaker than other forces in nature but it controls the Universe and decides its future. This is possible because of the huge masses of planets, stars and other constituents of the Universe.

Use your brain power

Is there a gravitational force between two objects kept on a table or between you and your friend sitting next to you? If yes, why don't the two move towards each other?

Solved examples

Example 1 : Mahendra and Virat are sitting at a distance of 1 metre from each other. Their masses are 75 kg and 80 kg respectively. What is the gravitational force between them?

Given : r = 1 m, m_1 = 75 kg, m_2 = 80 kg and G = 6.67 x 10^{-11} Nm^2/kg^2

According to Newton's law

$$F = \frac{G m_1 m_2}{r^2}$$

$$F = \frac{6.67 \times 10^{-11} \times 75 \times 80}{1^2} N$$

= 4.002 x 10^{-7} N

The gravitational force between Mahendra and Virat is 4.002 x 10^{-7} N

This is a very small force. If the force of friction between Mahendra and the bench on which he is sitting is zero, then he will start moving towards Virat under the action of this force. We can calculate his acceleration and velocity by using Newton's laws of motion.

Example 2 : In the above example, assuming that the bench on which Mahendra is sitting is frictionless, starting with zero velocity, what will be Mahendra's velocity of motion towards Virat after 1 s ? Will this velocity change with time and how?

Given: Force on Mahendra = F = 4.002 x 10^{-7} N, Mahendra's mass = m = 75 kg

According to Newton's second law, the acceleration produced by the force on Mahendra = m = 75 kg.

$$a = \frac{F}{m} = \frac{4.002 \times 10^{-7}}{75} = 5.34 \times 10^{-9} \ m/s^2$$

Using Newton's first equation, we can calculate Mahendra's velocity after 1s, Newton's first equation of motion is

v = u + a t;

As Mahendra is sitting on the bench, his initial velocity is zero (u=0)

Assuming the bench to be frictionless,

v = 0 + 5.34 x 10^{-9} x 1 m/s

= 5.34 x 10^{-9} m/s

Mahendra's velocity after 1 s will be 5.34 x 10^{-9} m/s .

This is an extremely small velocity. The velocity will increase with time because of the acceleration. The acceleration will also not remain constant because as Mahendra moves towards Virat, the distance between them will decrease, causing an increase in the gravitational force, thereby increasing the acceleration as per Newton's second law of motion.

Use your brain power !

Assuming the acceleration in Example 2 above remains constant, how long will Mahendra take to move 1 cm towards Virat?

Do you know ?

You must be knowing about the high and low tides that occur regularly in the sea. The level of sea water at any given location along sea shore increases and decreases twice a day at regular intervals. High and low tides occur at different times at different places. The level of water in the sea changes because of the gravitational force exerted by the moon. Water directly under the moon gets pulled towards the moon and the level of water there goes up causing high tide at that place. At two places on the earth at 90° from the place of high tide, the level of water is minimum and low tides occur there as shown in figure 1.6

1.6 Low and high tides