## ACADEMIC WORLD SCHOOLT

SESSION: 2023-24
CLASS: XII SCIENCE

## General Instructions:

1. Write in a clear and legible handwriting.
2. Complete all the homework in a separate subject Summer Vacation Homework Notebook.
3. DO NOT COPY AND PASTE FROM THE INTERNET. (Assignment will be rejected)
4. In case of reference from the internet, you may:
A. Read the content from the internet, if you wish and paraphrase (Rewrite in your own words)
B. Mention the source of your information by providing the link from the internet for the verification by the teachers.
5. Marks awarded will be counted in the final scores at the end of the session.
6. The Summer Vacation HW will be submitted immediately upon arrival to school after Summer Vacation.
7. For any assignment related query do post your question on E-Mail Id of respective subject teacher. List of Subject Teacher's E-Mail ID attached.

## Note for the Parents:

Parents are requested to guide his/her wards to complete their assignments honestly and submit by the due date.

## Class XII <br> Subject: English Core (301)

Q.1. You are Rachael, President of the Wellness Cell of your school. You have decided to organize a workshop, to raise awareness of the importance of mental health. This workshop would be conducted by the school counselor. Write a notice in about 50 words/, informing the students of class XI and XII about the workshop.
Q.2. You are the cultural secretary of your school. Write a notice in about 50 words inviting the names of students who would like to participate in the variety programme that you are planning in aid of an old age home in your city. Items may/be in the form of solo and group singing, mono acting, magic show, dance performance, etc. Trial for the most suitable participants will be held during the zero period every day.
Q.3. Read the two stories of your choice and interest and list the following:

Setting, Characters, Mood, Tone, Conflict, Plot, and Summary
Q.4. Read any two books from the list given below (or of your choice) and write the review on it.
(150-200)

- In Darkness by Nick Lake. ..
- The Things We Cannot Say by Kelly Rimmer.
- Things Fall Apart by Chinua Achebe. ...
- The Rector of Justin by Louis Auchincloss.
- The Underdogs by Mariano Azuela. ...
- Pilgrim at Tinker Creek by Annie Dillard.
- The Blithedale Romance by Nathaniel Hawthorne.
Q.5. What is the central topic of my piece? An article without a central focus is like a ship lost at sea... (words limit; 150-200)
- Who is my audience? ..
- What are the main points of this topic? ...
- What would make this article appeal to others? ...
- How should I structure this piece?

Keeping all things in your mind write an article on the topic of your interest after researching well. Also mention the Action Plan of our article.

## Format of Action Plan

- Topic
- Why you chose the topic
- Resource- (Interview based / Documentary based / or Any available resource with link)
Q.6. Explain the following poetic devices with proper examples-

Alliteration, Metaphor, Simile, Personification, Chremamorphism, Paradox, Pun, Hyperbole, Onomatopoeia, Imagery, Caesura and Enjambment, Juxtaposition and oxymoron, Allegory, Allusion, Apostrophe, Assonance, Blank Verse, Consonance, Anaphora, Repetition.

## Class- XII

Subject: Mathematics (041)

## TO BE DONE IN LAB MANUAL

## ACTIVITY 1 :

To verify that the relation R in the set L of all lines in a plane, defined by $\mathrm{R}=\{(l, m): l \perp m\}$ is symmetric but neither reflexive nor transitive.

## ACTIVITY 2 :

To demonstrate a function which is not one-one but is onto.

## ACTIVITY 3 :

To draw the graph of $\sin ^{-1} \mathrm{x}$, using the graph of $\sin \mathrm{x}$ and demonstrate the concept of mirror reflection (about the line $\mathrm{y}=\mathrm{x}$ ).

## ACTIVITY 4 :

To find analytically the limit of a function $f(x)$ at $x=c$ and also to check the continuity of the function at that point.

## ACTIVITY 5 :

To verify Rolle's Theorem.

## ACTIVITY 6 :

To understand the concepts of local maxima, local minima and point of inflection.
TO BE DONE IN STICK FILE
QUESTION : Write a brief description on any one topic given below (page limit at least 10)

1. RELATION
2. MATRICES
3. APPLICATION OF DERIVATIVES
4. PROBABILITY
5. APPLICATION OF INTEGRATION
6. LINEAR PROGRAMMING

## Activities for Class XII



The basic principles of learning mathematics are: (a) learning should be related to each child individually (b) the need for mathematics should develop from an intimate acquaintance with the environment (c) the child should be active and interested, (d) concrete material and wide variety of illustrations are needed to aid the learning process (e) understanding should be encouraged at each stage of acquiring a particular skill (f) content should be broadly based with adequate appreciation of the links between the various branches of mathematics, (g) correct mathematical usage should be encouraged at all stages.

- Ronwill


## Activity 1

## Objective

To verify that the relation R in the set L of all lines in a plane, defined by $\mathrm{R}=\{(l, m): l \perp m\}$ is symmetric but neither reflexive nor transitive.

## Material Required

A piece of plywood, some pieces of wires (8), nails, white paper, glue etc.

## Method of Construction

Take a piece of plywood and paste a white paper on it. Fix the wires randomly on the plywood with the help of nails such that some of them are parallel, some are perpendicular to each other and some are inclined as shown in Fig.1.


Fig. 1

## Demonstration

1. Let the wires represent the lines $l_{1}, l_{2}, \ldots, l_{8}$.
2. $l_{1}$ is perpendicular to each of the lines $l_{2}, l_{3}, l_{4}$. [see Fig. 1]
3. $l_{6}$ is perpendicular to $l_{7}$.
4. $l_{2}$ is parallel to $l_{3}, l_{3}$ is parallel to $l_{4}$ and $l_{5}$ is parallel to $l_{8}$.
5. $\left(l_{1}, l_{2}\right),\left(l_{1}, l_{3}\right),\left(l_{1}, l_{4}\right),\left(l_{6}, l_{7}\right) \in \mathrm{R}$

## Observation

1. In Fig. 1, no line is perpendicular to itself, so the relation $\mathrm{R}=\{(l, m): l \perp m\}$ $\qquad$ reflexive (is/is not).
2. In Fig. $1, l_{1} \perp l_{2}$. Is $l_{2} \perp l_{1}$ ? $\qquad$ (Yes/No)

$$
\therefore \quad\left(l_{1}, l_{2}\right) \in \mathrm{R} \Rightarrow\left(l_{2}, l_{1}\right) \ldots \mathrm{R}(\notin / \in)
$$

Similarly, $l_{3} \perp l_{1}$. Is $l_{1} \perp l_{3}$ ?

$$
\therefore \quad\left(l_{3}, l_{1}\right) \in \mathrm{R} \Rightarrow\left(l_{1}, l_{3}\right) \quad \mathrm{R} \quad(\notin \mid \in)
$$

Also,$\quad l_{6} \perp l_{7}$. Is $l_{7} \perp l_{6}$ ? $\qquad$ (Yes/No)
$\therefore \quad\left(l_{6}, l_{7}\right) \in \mathrm{R} \Rightarrow\left(l_{7}, l_{6}\right) — \mathrm{R} \quad(\notin / \in)$
$\therefore \quad$ The relation $\mathrm{R} . .$. symmetric (is/is not)
3. In Fig. $1, l_{2} \perp l_{1}$ and $l_{1} \perp l_{3}$. Is $l_{2} \perp l_{3}$ ? $\ldots$ (Yes/No)

$$
\text { i.e., } \quad\left(l_{2}, l_{1}\right) \in \mathrm{R} \text { and }\left(l_{1}, l_{3}\right) \in \mathrm{R} \Rightarrow\left(l_{2}, l_{3}\right) \quad \mathrm{R}(\notin / \in)
$$

$\therefore \quad$ The relation R .... transitive (is/is not).

## Application

This activity can be used to check whether a given relation is an equivalence relation or not.

Note

1. In this case, the relation is not an equivalence relation.
2. The activity can be repeated by taking some more wire in different positions.

## Activity 2

## Objective

To verify that the relation R in the set L of all lines in a plane, defined by $\mathrm{R}=\{(l, m): l \| m\}$ is an equivalence relation.

## Material Required

A piece of plywood, some pieces of wire (8), plywood, nails, white paper, glue.

## Method of Construction

Take a piece of plywood of convenient size and paste a white paper on it. Fix the wires randomly on the plywood with the help of nails such that some of them are parallel, some are perpendicular to each other and some are inclined as shown in Fig. 2.


Fig. 2

## Demonstration

1. Let the wires represent the lines $l_{1}, l_{2}, \ldots, l_{8}$.
2. $l_{1}$ is perpendicular to each of the lines $l_{2}, l_{3}, l_{4}$ (see Fig. 2).
3. $l_{6}$ is perpendicular to $l_{7}$.
4. $l_{2}$ is parallel to $l_{3}, l_{3}$ is parallel to $l_{4}$ and $l_{5}$ is parallel to $l_{8}$.
5. $\left(l_{2}, l_{3}\right),\left(l_{3}, l_{4}\right),\left(l_{5}, l_{8}\right), \in \mathrm{R}$

## Observation

1. In Fig. 2, every line is parallel to itself. So the relation $\mathrm{R}=\{(l, m): l \| m\}$ .... reflexive relation (is/is not)
2. In Fig. 2, observe that $l_{2} \| l_{3}$. Is $l_{3} \ldots l_{2}$ ? ( $\left.X / \|\right)$

So,

$$
\left(l_{2}, l_{3}\right) \in \mathrm{R} \Rightarrow\left(l_{3}, l_{2}\right) \ldots \mathrm{R}(\notin / \epsilon)
$$

Similarly, $l_{3} \| l_{4}$. Is $l_{4} \ldots l_{3}$ ? ( ( / \| ) So, $\left(l_{3}, l_{4}\right) \in \mathrm{R} \Rightarrow\left(l_{4}, l_{3}\right) \ldots \mathrm{R}(\notin / \in)$ and

$$
\left(l_{5}, l_{8}\right) \in \mathrm{R} \Rightarrow\left(l_{8}, l_{5}\right) \ldots \mathrm{R}(\notin / \in)
$$

$\therefore$ The relation R ... symmetric relation (is/is not)
3. In Fig. 2, observe that $l_{2} \| l_{3}$ and $l_{3} \| l_{4}$. Is $l_{2} \ldots l_{4}$ ? ( $\left.\|/\|\right)$

So,

$$
\left(l_{2}, l_{3}\right) \in \mathrm{R} \text { and }\left(l_{3}, l_{4}\right) \in \mathrm{R} \Rightarrow\left(l_{2}, l_{4}\right) \ldots \mathrm{R}(\in / \notin)
$$

Similarly, $l_{3} \| l_{4}$ and $l_{4} \| l_{2}$. Is $l_{3} \ldots l_{2}$ ? $(\mathbb{X}\|\|)$
So,

$$
\left(l_{3}, l_{4}\right) \in \mathrm{R},\left(l_{4}, l_{2}\right) \in \mathrm{R} \Rightarrow\left(l_{3}, l_{2}\right) \ldots \mathrm{R}(\in, \notin)
$$

Thus, the relation R ... transitive relation (is/is not)
Hence, the relation R is reflexive, symmetric and transitive. So, R is an equivalence relation.

## Application

This activity is useful in understanding the concept of an equivalence relation.

Note
This activity can be repeated by taking some more wires in different positions.

## Activity 3

## Objective

To demonstrate a function which is not one-one but is onto.

## Material Required

Cardboard, nails, strings, adhesive and plastic strips.

## Method of Construction

1. Paste a plastic strip on the left hand side of the cardboard and fix three nails on it as shown in the Fig.3.1. Name the nails on the strip as 1,2 and 3.
2. Paste another strip on the right hand side of the cardboard and fix two nails in the plastic strip as shown in Fig.3.2. Name the nails on the strip as $a$ and $b$.
3. Join nails on the left strip to the nails on the right strip as shown in Fig. 3.3.


Fig. 3.1


Fig. 3.2


Fig. 3.3

## Demonstration

1. Take the set $\mathrm{X}=\{1,2,3\}$
2. Take the set $\mathrm{Y}=\{a, b\}$
3. Join (correspondence) elements of X to the elements of Y as shown in Fig. 3.3

## Observation

1. The image of the element 1 of X in Y is $\qquad$ .
The image of the element 2 of X in Y is $\qquad$ .

The image of the element 3 of X in Y is $\qquad$ .

So, Fig. 3.3 represents a $\qquad$ .
2. Every element in $X$ has a $\qquad$ image in Y. So, the function is
$\qquad$ (one-one/not one-one).
3. The pre-image of each element of Y in X $\qquad$ (exists/does not exist). So, the function is $\qquad$ (onto/not onto).

## Application

This activity can be used to demonstrate the concept of one-one and onto function.

Demonstrate the same activity by changing the number of the elements of the sets X and Y .

## Activity 4

## Objective

To demonstrate a function which is one-one but not onto.

## Material Required

Cardboard, nails, strings, adhesive and plastic strips.

## Method of Construction

1. Paste a plastic strip on the left hand side of the cardboard and fix two nails in it as shown in the Fig. 4.1. Name the nails as $a$ and $b$.
2. Paste another strip on the right hand side of the cardboard and fix three nails on it as shown in the Fig. 4.2. Name the nails on the right strip as 1,2 and 3 .
3. Join nails on the left strip to the nails on the right strip as shown in the Fig. 4.3.


Fig. 4.1


Fig. 4.2


Fig. 4.3

## Demonstration

1. Take the set $\mathrm{X}=\{a, b\}$
2. Take the set $Y=\{1,2,3\}$.
3. Join elements of X to the elements of Y as shown in Fig. 4.3.

## Observation

1. The image of the element $a$ of X in Y is $\qquad$ .

The image of the element $b$ of X in Y is $\qquad$ .

So, the Fig. 4.3 represents a $\qquad$ .
2. Every element in $X$ has a $\qquad$ image in Y. So, the function is
$\qquad$ (one-one/not one-one).
3. The pre-image of the element 1 of Y in X $\qquad$ (exists/does not exist). So, the function is $\qquad$ (onto/not onto).

Thus, Fig. 4.3 represents a function which is $\qquad$ but not onto.

## Application

This activity can be used to demonstrate the concept of one-one but not onto function.

## Activity 5

## Objective

To draw the graph of $\sin ^{-1} x$, using the graph of $\sin x$ and demonstrate the concept of mirror reflection (about the line $y=x$ ).

## Material Required

Cardboard, white chart paper, ruler, coloured pens, adhesive, pencil, eraser, cutter, nails and thin wires.

## Method of Construction

1. Take a cardboard of suitable dimensions, say, $30 \mathrm{~cm} \times 30 \mathrm{~cm}$.
2. On the cardboard, paste a white chart paper of size $25 \mathrm{~cm} \times 25 \mathrm{~cm}$ (say).
3. On the paper, draw two lines, perpendicular to each other and name them $\mathrm{X}^{\prime} \mathrm{OX}$ and $\mathrm{YOY}^{\prime}$ as rectangular axes [see Fig. 5].


Fig. 5
4. Graduate the axes approximately as shown in Fig. 5.1 by taking unit on X -axis $=1.25$ times the unit of Y -axis.
5. Mark approximately the points
$\left(\frac{\pi}{6}, \sin \frac{\pi}{6}\right),\left(\frac{\pi}{4}, \sin \frac{\pi}{4}\right), \ldots,\left(\frac{\pi}{2}, \sin \frac{\pi}{2}\right)$ in the coordinate plane and at each point fix a nail.
6. Repeat the above process on the other side of the $x$-axis, marking the points $\left(\frac{-\pi}{6}, \sin \frac{-\pi}{6}\right),\left(\frac{-\pi}{4}, \sin \frac{-\pi}{4}\right), \ldots,\left(\frac{-\pi}{2}, \sin \frac{-\pi}{2}\right)$ approximately and fix nails on these points as $\mathrm{N}_{1}{ }^{\prime}, \mathrm{N}_{2}{ }^{\prime}, \mathrm{N}_{3}{ }^{\prime}, \mathrm{N}_{4}{ }^{\prime}$. Also fix a nail at O .
7. Join the nails with the help of a tight wire on both sides of $x$-axis to get the graph of $\sin x$ from $\frac{-\pi}{2}$ to $\frac{\pi}{2}$.
8. Draw the graph of the line $y=x$ (by plotting the points $(1,1),(2,2),(3,3), \ldots$ etc. and fixing a wire on these points).
9. From the nails $\mathrm{N}_{1}, \mathrm{~N}_{2}, \mathrm{~N}_{3}, \mathrm{~N}_{4}$, draw perpendicular on the line $y=x$ and produce these lines such that length of perpendicular on both sides of the line $y=x$ are equal. At these points fix nails, $\mathrm{I}_{1}, \mathrm{I}_{2}, \mathrm{I}_{3}, \mathrm{I}_{4}$.
10. Repeat the above activity on the other side of X - axis and fix nails at $\mathrm{I}_{1}^{\prime}, \mathrm{I}_{2}{ }_{2}, \mathrm{I}_{3}{ }^{\prime}, \mathrm{I}_{4}{ }^{\prime}$.
11. Join the nails on both sides of the line $y=x$ by a tight wire that will show the graph of $y=\sin ^{-1} x$.

## Demonstration

Put a mirror on the line $y=x$. The image of the graph of $\sin x$ in the mirror will represent the graph of $\sin ^{-1} x$ showing that $\sin ^{-1} x$ is mirror reflection of $\sin x$ and vice versa.

## Observation

The image of point $\mathrm{N}_{1}$ in the mirror (the line $y=x$ ) is $\qquad$ .

The image of point $\mathrm{N}_{2}$ in the mirror (the line $y=x$ ) is $\qquad$ .

The image of point $\mathrm{N}_{3}$ in the mirror (the line $y=x$ ) is $\qquad$ .

The image of point $\mathrm{N}_{4}$ in the mirror (the line $y=x$ ) is $\qquad$ .

The image of point $\mathrm{N}_{1}^{\prime}$ in the mirror (the line $y=x$ ) is $\qquad$ .

The image point of $\mathrm{N}_{2}^{\prime}$ in the mirror (the line $y=x$ ) is $\qquad$ .

The image point of $\mathrm{N}_{3}^{\prime}$ in the mirror (the line $y=x$ ) is $\qquad$ .

The image point of $\mathrm{N}_{4}^{\prime}$ in the mirror (the line $y=x$ ) is $\qquad$ .

The image of the graph of $\operatorname{six} x$ in $y=x$ is the graph of $\qquad$ , and the image of the graph of $\sin ^{-1} x$ in $y=x$ is the graph of $\qquad$ .

## Application

Similar activity can be performed for drawing the graphs of $\cos ^{-1} x, \tan ^{-1} x$, etc.

## Activity 6

## Objective

To explore the principal value of the function $\sin ^{-1} x$ using a unit circle.

## Method of Construction

1. Take a cardboard of a convenient size and paste a white chart paper on it.
2. Draw a unit circle with centre O on it.
3. Through the centre of the circle, draw two perpendicular lines $\mathrm{X}^{\prime} \mathrm{OX}$ and YOY' representing $x$-axis and $y$-axis, respectively as shown in Fig. 6.1.
4. Mark the points A, C, B and D, where the circle cuts the $x$-axis and $y$-axis, respectively as shown in Fig. 6.1.
5. Fix two rails on opposite sides of the cardboard which are parallel to $y$-axis. Fix one steel wire between the rails such that the wire can be moved parallel to $x$-axis as shown in Fig. 6.2.


Fig. 6.1
6. Take a needle of unit length. Fix one end of it at the centre of the circle and the other end to move freely along the circle Fig. 6.2.

## Demonstration

1. Keep the needle at an arbitrary angle, say $x_{1}$


Fig. 6.2 with the positive direction of $x$-axis. Measure of angle in radian is equal to the length of intercepted arc of the unit circle.
2. Slide the steel wire between the rails, parallel to $x$-axis such that the wire meets with free end of the needle (say $\mathrm{P}_{1}$ ) (Fig. 6.2).
3. Denote the $y$-coordinate of the point $\mathrm{P}_{1}$ as $y_{1}$, where $y_{1}$ is the perpendicular distance of steel wire from the $x$-axis of the unit circle giving $y_{1}=\sin x_{1}$.
4. Rotate the needle further anticlockwise and keep it at the angle $\pi-x_{1}$. Find the value of $y$-coordinate of intersecting point $\mathrm{P}_{2}$ with the help of sliding steel wire. Value of $y$-coordinate for the points $\mathrm{P}_{1}$ and $\mathrm{P}_{2}$ are same for the different value of angles, $y_{1}=\sin x_{1}$ and $y_{1}=\sin \left(\pi-x_{1}\right)$. This demonstrates that sine function is not one-to-one for angles considered in first and second quadrants.
5. Keep the needle at angles $-x_{1}$ and ( $-\pi+x_{1}$ ), respectively. By sliding down the steel wire parallel to $x$-axis, demonstrate that $y$-coordinate for the points $P_{3}$ and $\mathrm{P}_{4}$ are the same and thus sine function is not one-to-one for points considered in 3rd and 4th quadrants as shown in Fig. 6.2.
6. However, the $y$-coordinate of the points $P_{3}$ and $P_{1}$ are different. Move the needle in anticlockwise direction starting from $-\frac{\pi}{2}$ to $\frac{\pi}{2}$ and look at the behaviour of $y$-coordinates of points $\mathrm{P}_{5}$, $\mathrm{P}_{6}, \mathrm{P}_{7}$ and $\mathrm{P}_{8}$ by sliding the steel wire parallel to $x$-axis accordingly. $y$-coordinate of points $\mathrm{P}_{5}, \mathrm{P}_{6}, \mathrm{P}_{7}$ and $\mathrm{P}_{8}$ are different (see


Fig. 6.3 Fig. 6.3). Hence, sine function is one-to-one in the domian $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ and its range lies between -1 and 1 .
7. Keep the needle at any arbitrary angle say $\theta$ lying in the interval $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ and denote the $y$-coordinate of the intersecting point $\mathrm{P}_{9}$ as $y$. (see Fig. 6.4). Then $y=\sin \theta$ or $\theta=\operatorname{arc}$ $\sin ^{-1} y$ ) as sine function is one-one and onto in the domain $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ and range $[-1,1]$. So, its inverse arc sine function exist. The domain of arc sine function is $[-1,1]$ and


Fig. 6.4
range is $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$. This range is called the principal value of arc sine function (or $\sin ^{-1}$ function).

## Observation

1. sine function is non-negative in $\qquad$ and $\qquad$ quadrants.
2. For the quadrants 3 rd and 4 th, sine function is $\qquad$ .
3. $\theta=\operatorname{arc} \sin y \Rightarrow y=\ldots \theta$ where $-\frac{\pi}{2} \leq \theta \leq$ $\qquad$ .
4. The other domains of sine function on which it is one-one and onto provides
$\qquad$ for arc sine function.

## Application

This activity can be used for finding the principal value of arc cosine function ( $\cos ^{-1} y$ ).

## Activity 7

## Objective

To sketch the graphs of $a^{x}$ and $\log _{d} x$, $a>0, a \neq 1$ and to examine that they are mirror images of each other.

## Material Required

Drawing board, geometrical instruments, drawing pins, thin wires, sketch pens, thick white paper, adhesive, pencil, eraser, a plane mirror, squared paper.

## Method of Construction

1. On the drawing board, fix a thick paper sheet of convenient size $20 \mathrm{~cm} \times 20 \mathrm{~cm}$ (say) with adhesive.


Fig. 7
2. On the sheet, take two perpendicular lines $\mathrm{XOX}^{\prime}$ and $\mathrm{YOY}^{\prime}$, depicting coordinate axes.
3. Mark graduations on the two axes as shown in the Fig. 7.
4. Find some ordered pairs satisfying $y=a^{x}$ and $y=\log _{a} x$. Plot these points corresponding to the ordered pairs and join them by free hand curves in both the cases. Fix thin wires along these curves using drawing pins.
5. Draw the graph of $y=x$, and fix a wire along the graph, using drawing pins.

## Demonstration

1. For $a^{x}$, take $a=2$ (say), and find ordered pairs satisfying it as

| $x$ | 0 | 1 | -1 | 2 | -2 | 3 | -3 | $\frac{1}{2}$ | $-\frac{1}{2}$ | 4 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :--- |
| $2^{x}$ | 1 | 2 | 0.5 | 4 | $\frac{1}{4}$ | 8 | $\frac{1}{8}$ | 1.4 | 0.7 | 16 |

and plot these ordered pairs on the squared paper and fix a drawing pin at each point.
2. Join the bases of drawing pins with a thin wire. This will represent the graph of $2^{x}$.
3. $\log _{2} x=y$ gives $x=2^{y}$. Some ordered pairs satisfying it are:

| $x$ | 1 | 2 | $\frac{1}{2}$ | 4 | $\frac{1}{4}$ | 8 | $\frac{1}{8}$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $y$ | 0 | 1 | -1 | 2 | -2 | 3 | -3 |

Plot these ordered pairs on the squared paper (graph paper) and fix a drawing pin at each plotted point. Join the bases of the drawing pins with a thin wire. This will represent the graph of $\log _{2} x$.
4. Draw the graph of line $y=x$ on the sheet.
5. Place a mirror along the wire representing $y=x$. It can be seen that the two graphs of the given functions are mirror images of each other in the line $y=x$.

## Observation

1. Image of ordered pair $(1,2)$ on the graph of $y=2^{x}$ in $y=x$ is $\qquad$ . It lies on the graph of $y=$ $\qquad$ .
2. Image of the point $(4,2)$ on the graph $y=\log _{2} x$ in $y=x$ is $\qquad$ which lies on the graph of $y=$ $\qquad$ .

Repeat this process for some more points lying on the two graphs.

## Application

This activity is useful in understanding the concept of (exponential and logarithmic functions) which are mirror images of each other in $y=x$.

## Activity 8

## Objective

To establish a relationship between common logarithm (to the base 10) and natural logarithm (to the base $e$ ) of the number $x$.

## Material Required

Hardboard, white sheet, graph paper, pencil, scale, log tables or calculator (graphic/scientific).

## Method of Construction

1. Paste a graph paper on a white sheet and fix the sheet on the hardboard.
2. Find some ordered pairs satisfying the function $y=\log _{10} x$. Using log tables/ calculator and draw the graph of the function on the graph paper (see Fig. 8)


Fig. 8
3. Similarly, draw the graph of $y^{\prime}=\log _{\mathrm{e}} x$ on the same graph paper as shown in the figure (using log table/calculator).

## Demonstration

1. Take any point on the positive direction of $x$-axis, and note its $x$-coordinate.
2. For this value of $x$, find the value of $y$-coordinates for both the graphs of $y=\log _{10} x$ and $y^{\prime}=\log _{e} x$ by actual measurement, using a scale, and record them as $y$ and $y^{\prime}$, respectively.
3. Find the ratio $\frac{y}{y^{\prime}}$.
4. Repeat the above steps for some more points on the $x$-axis (with different values) and find the corresponding ratios of the ordinates as in Step 3.
5. Each of these ratios will nearly be the same and equal to 0.4 , which is approximately equal to $\frac{1}{\log _{e} 10}$.

## Observation

| S.No. | Points on the $x$-axis | $y=\log _{10} x$ | $y^{\prime}=\log _{\mathrm{e}} x$ | Ratio $\frac{y}{y^{\prime}}$ (approximate) |
| :---: | :---: | :---: | :---: | :---: |
| 1. | $x_{1}=\ldots$ | $y_{1}=$ | $y_{1}^{\prime}=$ | -- |
| 2. | $x_{2}=\ldots$ | $y_{2}=$ | $y_{2}^{\prime}=$ | $-$ |
| 3. | $x_{3}=$ | $y_{3}=$ | $y_{3}^{\prime}=$ | ---------- |
| 4. | $x_{4}=$ | $y_{4}=$ | $y_{4}^{\prime}=$ | ------ |
| 5. | $x_{5}=$ | $y_{5}=$ | $y_{5}^{\prime}=$ | ---------- |
| 6. | $x_{6}=$ | $y_{6}=$ |  | ---------- |

2. The value of $\frac{y}{y^{\prime}}$ for each point $x$ is equal to $\qquad$ approximately.
3. The observed value of $\frac{y}{y^{\prime}}$ in each case is approximately equal to the value of $\frac{1}{\log _{e} 10} .(\mathrm{Yes} / \mathrm{No})$
4. Therefore, $\log _{10} x=\overline{\log _{e} 10}$.

## Application

This activity is useful in converting $\log$ of a number in one given base to $\log$ of that number in another base.

## Note

Let, $y=\log _{10} x$, i.e., $x=10^{y}$.

Taking logarithm to base $e$ on both the sides, we get $\log _{e} x=y \log _{e} 10$

$$
\begin{aligned}
& \text { or } y=\frac{1}{\log _{e} 10}\left(\log _{e} x\right) \\
& \Rightarrow \frac{\log _{10} x}{\log _{e} x}=\frac{1}{\log _{e} 10}=0.434294 \text { (using log tables/calculator). }
\end{aligned}
$$

## Activity 9

## Objective

To find analytically the limit of a function $f(x)$ at $x=c$ and also to check the continuity of the function at that point.

## Method of Construction

1. Consider the function given by $f(x)=\left\{\begin{array}{cc}\frac{x^{2}-16}{x-4}, & x \neq 4 \\ 10, & x=4\end{array}\right\}$
2. Take some points on the left and some points on the right side of $c(=4)$ which are very near to $c$.
3. Find the corresponding values of $f(x)$ for each of the points considered in step 2 above.
4. Record the values of points on the left and right side of $c$ as $x$ and the corresponding values of $f(x)$ in a form of a table.

## Demonstration

1. The values of $x$ and $f(x)$ are recorded as follows:

Table 1 : For points on the left of $c(=4)$.

| $x$ | 3.9 | 3.99 | 3.999 | 3.9999 | 3.99999 | 3.999999 | 3.9999999 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| $f(x)$ | 7.9 | 7.99 | 7.999 | 7.9999 | 7.99999 | 7.999999 | 7.9999999 |

2. Table 2: For points on the right of $c(=4)$.

| $x$ | 4.1 | 4.01 | 4.001 | 4.0001 | 4.00001 | 4.000001 | 4.0000001 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| $f(x)$ | 8.1 | 8.01 | 8.001 | 8.0001 | 8.00001 | 8.000001 | 8.0000001 |

## Observation

1. The value of $f(x)$ is approaching to $\qquad$ , as $x \rightarrow 4$ from the left.
2. The value of $f(x)$ is approaching to $\qquad$ , as $x \rightarrow 4$ from the right.
3. So, $\lim _{x \rightarrow 4} f(x)=$ $\qquad$ and $\lim _{x \rightarrow 4^{+}} f(x)=$ $\qquad$ .
4. Therefore, $\lim _{x \rightarrow 4} f(x)=$ $\qquad$ , $f(4)=$ $\qquad$
5. Is $\lim _{x \rightarrow 4} f(x)=f(4)$ $\qquad$ ? (Yes/No)
6. Since $f(c) \neq \lim _{x \rightarrow c} f(x)$, so, the function is $\qquad$ at $x=4$ (continuous/ not continuous).

## Application

This activity is useful in understanding the concept of limit and continuity of a function at a point.

## Activity 10

## Objective

To verify that for a function $f$ to be continuous at given point $x_{0}$,
$\Delta y=\left|f\left(x_{0}+\Delta x\right)-f\left(x_{0}\right)\right|$ is
arbitrarily small provided. $\Delta x$ is sufficiently small.

## Material Required

Hardboard, white sheets, pencil, scale, calculator, adhesive.

## Method of Construction

1. Paste a white sheet on the hardboard.
2. Draw the curve of the given continuous function as represented in the Fig. 10.
3. Take any point $\mathrm{A}\left(x_{0}, 0\right)$ on the positive side of $x$-axis and corresponding to this point, mark the point $\mathrm{P}\left(x_{0}, y_{0}\right)$ on the curve.


Fig. 10

## DEMONSTRATION

1. Take one more point $\mathrm{M}_{1}\left(x_{0}+\Delta x_{1}, 0\right)$ to the right of A , where $\Delta x_{1}$ is an increment in $x$.
2. Draw the perpendicular from $\mathrm{M}_{1}$ to meet the curve at $\mathrm{N}_{1}$. Let the coordinates of $N_{1}$ be $\left(x_{0}+\Delta x_{1}, y_{0}+\Delta y_{1}\right)$
3. Draw a perpendicular from the point $\mathrm{P}\left(x_{0}, y_{0}\right)$ to meet $\mathrm{N}_{1} \mathrm{M}_{1}$ at $\mathrm{T}_{1}$.
4. Now measure $\mathrm{AM}_{1}=\Delta x_{1}$ (say) and record it and also measure $\mathrm{N}_{1} \mathrm{~T}_{1}=\Delta y_{1}$ and record it.
5. Reduce the increment in $x$ to $\Delta x_{2}$ (i.e., $\Delta x_{2}<\Delta x_{1}$ ) to get another point $M_{2}\left(x_{0}+\Delta x_{2}, 0\right)$. Get the corresponding point $N_{2}$ on the curve
6. Let the perpendicular $\mathrm{PT}_{1}$ intersects $\mathrm{N}_{2} \mathrm{M}_{2}$ at $\mathrm{T}_{2}$.
7. Again measure $\mathrm{AM}_{2}=\Delta x_{2}$ and record it. Measure $\mathrm{N}_{2} \mathrm{~T}_{2}=\Delta y_{2}$ and record it.
8. Repeat the above steps for some more points so that $\Delta x$ becomes smaller and smaller.

## Observation



| 6. | $\left\|\Delta x_{6}\right\|=$ | $\left\|\Delta y_{6}\right\|=$ |
| :---: | :--- | :--- |
| 7. | $\left\|\Delta x_{7}\right\|=$ | $\left\|\Delta y_{7}\right\|=$ |
| 8. | $\left\|\Delta x_{8}\right\|=$ | $\left\|\Delta y_{8}\right\|=$ |
| 9. | $\left\|\Delta x_{9}\right\|=$ | $\left\|\Delta y_{9}\right\|=$ |

2. So, $\Delta y$ becomes $\qquad$ when $\Delta x$ becomes smaller.
3. Thus $\lim _{\Delta x \rightarrow 0} \Delta y=0$ for a continuous function.

## Application

This activity is helpful in explaining the concept of derivative (left hand or right hand) at any point on the curve corresponding to a function.

## Activity 11

## Objective

To verify Rolle's Theorem.

## Material Required

A piece of plywood, wires of different lengths, white paper, sketch pen.

## Method of Construction

1. Take a cardboard of a convenient size and paste a white paper on it.
2. Take two wires of convenient size and fix them on the white paper pasted on the plywood to represent $x$-axis and $y$-axis (see Fig. 11).
3. Take a piece of wire of 15 cm length and bend it in the shape of a curve and fix it on the plywood as shown in the figure.


Fig. 11
4. Take two straight wires of the same length and fix them in such way that they are perpendicular to $x$-axis at the points A and B and meeting the curve at the points C and D (see Fig.11).

## Demonstration

1. In the figure, let the curve represent the function $y=f(x)$. Let $\mathrm{OA}=a$ units and $\mathrm{OB}=b$ units.
2. The coordinates of the points A and B are $(a, 0)$ and $(b, 0)$, respectively.
3. There is no break in the curve in the interval $[a, b]$. So, the function $f$ is continuous on $[a, b]$.
4. The curve is smooth between $x=a$ and $x=b$ which means that at each point, a tangent can be drawn which in turn gives that the function $f$ is differentiable in the interval $(a, b)$.
5. As the wires at A and B are of equal lengths, i.e., $\mathrm{AC}=\mathrm{BD}$, $\operatorname{so} f(a)=f(b)$.
6. In view of steps (3), (4) and (5), conditions of Rolle's theorem are satisfied. From Fig.11, we observe that tangents at P as well as Q are parallel to $x$-axis, therefore, $f^{\prime}(x)$ at P and also at Q are zero.

Thus, there exists at least one value $c$ of $x$ in $(a, b)$ such that $f^{\prime}(c)=0$.
Hence, the Rolle's theorem is verified.

## Observation

From Fig. 11.

$$
a=\ldots \ldots, b=
$$

$\qquad$

$$
f(a)=\ldots, f(b)=\ldots \text { Is } f(a)=f(b) ?(\mathrm{Yes} / \mathrm{No})
$$

Slope of tangent at $\mathrm{P}=$ $\qquad$ , so, $f(x)($ at P$)=$

## Application

This theorem may be used to find the roots of an equation.

## Activity 12

## Objective

To verify Lagrange's Mean Value Theorem.

## Material Required

A piece of plywood, wires, white paper, sketch pens, wires.

## Method of Construction

1. Take a piece of plywood and paste a white paper on it.
2. Take two wires of convenient size and fix them on the white paper pasted on the plywood to represent $x$-axis and $y$-axis (see Fig. 12).
3. Take a piece of wire of about 10 cm length and bend it in the shape of a curve as shown in the figure. Fix this curved wire on the white paper pasted on the plywood.


Fig. 12
4. Take two straight wires of lengths 10 cm and 13 cm and fix them at two different points of the curve parallel to $y$-axis and their feet touching the $x$-axis. Join the two points, where the two vertical wires meet the curve, using another wire.
5. Take one more wire of a suitable length and fix it in such a way that it is tangential to the curve and is parallel to the wire joining the two points on the curve (see Fig. 12).

## Demonstration

1. Let the curve represent the function $y=f(x)$. In the figure, let $\mathrm{OA}=a$ units and $\mathrm{OB}=b$ units.
2. The coordinates of A and B are $(a, 0)$ and $(b, 0)$, respectively.
3. MN is a chord joining the points $\mathrm{M}(a, f(a)$ and $\mathrm{N}(b, f(b))$.
4. PQ represents a tangent to the curve at the point $\mathrm{R}(c, f(c))$, in the interval ( $a, b$ ).
5. $f^{\prime}(c)$ is the slope of the tangent PQ at $x=c$.
6. $\frac{f(b)-f(a)}{b-a}$ is the slope of the chord MN .
7. MN is parallel to PQ , therefore, $f^{\prime}(c)=\frac{f(b)-f(a)}{b-a}$. Thus, the Langrange's Mean Value Theorem is verified.

## Observation

1. $a=$ $\qquad$ , $b=$ $\qquad$ ,
$f(a)=$ $\qquad$ , $f(b)=$ $\qquad$ .
2. $f(a)-f(b)=$ $\qquad$ ,
$b-a=$ $\qquad$ ,
3. $\frac{f(b)-f(a)}{b-a}=\square=$ Slope of MN.
4. Since $\mathrm{PQ} \| \mathrm{MN} \Rightarrow \quad$ Slope of $\mathrm{PQ}=f^{\prime}(c)=\frac{f(a)-f(a)}{b-a}$.

## Application

Langrange's Mean Value Theorem has significant applications in calculus. For example this theorem is used to explain concavity of the graph.

## Activity 13

## Objective

To understand the concepts of decreasing and increasing functions.

## Method of Construction

1. Take a piece of plywood of a convenient size and paste a white paper on it.
2. Take two pieces of wires of length say 20 cm each and fix them on the white paper to represent $x$-axis and $y$-axis.
3. Take two more pieces of wire each of suitable length and bend them in the shape of curves representing two functions and fix them on the paper as shown in the Fig. 13.

4. Take two straight wires each of suitable length for the purpose of showing tangents to the curves at different points on them.

## Demonstration

1. Take one straight wire and place it on the curve (on the left) such that it is
tangent to the curve at the point say $\mathrm{P}_{1}$ and making an angle $\alpha_{1}$ with the positive direction of $x$-axis.
2. $\alpha_{1}$ is an obtuse angle, so $\tan \alpha_{1}$ is negative, i.e., the slope of the tangent at $P_{1}$ (derivative of the function at $\mathrm{P}_{1}$ ) is negative.
3. Take another two points say $P_{2}$ and $P_{3}$ on the same curve, and make tangents, using the same wire, at $P_{2}$ and $P_{3}$ making angles $\alpha_{2}$ and $\alpha_{3}$, respectively with the positive direction of $x$-axis.
4. Here again $\alpha_{2}$ and $\alpha_{3}$ are obtuse angles and therefore slopes of the tangents $\tan \alpha_{2}$ and $\tan \alpha_{3}$ are both negative, i.e., derivatives of the function at $\mathrm{P}_{2}$ and $\mathrm{P}_{3}$ are negative.
5. The function given by the curve (on the left) is a decreasing function.
6. On the curve (on the right), take three point $\mathrm{Q}_{1}, \mathrm{Q}_{2}, \mathrm{Q}_{3}$, and using the other straight wires, form tangents at each of these points making angles $\beta_{1}, \beta_{2}$, $\beta_{3}$, respectively with the positive direction of $x$-axis, as shown in the figure. $\beta_{1}, \beta_{2}, \beta_{3}$ are all acute angles.
So, the derivatives of the function at these points are positive. Thus, the function given by this curve (on the right) is an increasing function.

## Observation

1. $\alpha_{1}=$ $\qquad$ , $>90^{\circ} \alpha_{2}=$ $\qquad$ , $\alpha_{3}=$ $\qquad$ $\tan \alpha_{1}=\ldots, \quad$ (negative) $\tan \alpha_{2}=\ldots,(\ldots), \tan \alpha_{3}=$
$\qquad$ , ( $\qquad$ ). Thus the function is $\qquad$ .
2. $\beta_{1}=$ $\qquad$ $<90^{\circ}, \beta_{2}=$ $\qquad$ , < $\qquad$ , $\beta_{3}=$ $\qquad$ , < $\qquad$ $\tan \beta_{1}=\longrightarrow$, (positive), $\tan \beta_{2}=\longrightarrow$, ( $\quad$ ), $\tan \beta_{3}=$
$\qquad$ ). Thus, the function is $\qquad$ .

## Application

This activity may be useful in explaining the concepts of decreasing and increasing functions.

## Activity 14

## Objective

To understand the concepts of local maxima, local minima and point of inflection.

## Material Required

A piece of plywood, wires, adhesive, white paper.

## Method of Construction

1. Take a piece of plywood of a convenient size and paste a white paper on it.
2. Take two pieces of wires each of length 40 cm and fix them on the paper on plywood in the form of $x$-axis and $y$-axis.
3. Take another wire of suitable length and bend it in the shape of curve. Fix this curved wire on the white paper pasted on plywood, as shown in Fig. 14.


Fig. 14
4. Take five more wires each of length say 2 cm and fix them at the points $\mathrm{A}, \mathrm{C}$, $\mathrm{B}, \mathrm{P}$ and D as shown in figure.

## Demonstration

1. In the figure, wires at the points $\mathrm{A}, \mathrm{B}, \mathrm{C}$ and D represent tangents to the curve and are parallel to the axis. The slopes of tangents at these points are zero, i.e., the value of the first derivative at these points is zero. The tangent at P intersects the curve.
2. At the points $A$ and $B$, sign of the first derivative changes from negative to positive. So, they are the points of local minima.
3. At the point C and D , sign of the first derivative changes from positive to negative. So, they are the points of local maxima.
4. At the point $P$, sign of first derivative does not change. So, it is a point of inflection.

## Observation

1. Sign of the slope of the tangent (first derivative) at a point on the curve to the immediate left of A is $\qquad$
2. Sign of the slope of the tangent (first derivative) at a point on the curve to the immediate right of A is
3. Sign of the first derivative at a point on the curve to immediate left of $B$ is $\qquad$ -.
4. Sign of the first derivative at a point on the curve to immediate right of $B$ is $\qquad$
5. Sign of the first derivative at a point on the curve to immediate left of C is $\qquad$ .
6. Sign of the first derivative at a point on the curve to immediate right of C is $\qquad$ .
7. Sign of the first derivative at a point on the curve to immediate left of $D$ is $\qquad$ .
8. Sign of the first derivative at a point on the curve to immediate right of $D$ is $\qquad$ .
9. Sign of the first derivative at a point immediate left of P is $\qquad$ and immediate right of P is $\qquad$ .
10. A and B are points of local $\qquad$ .
11. C and D are points of local $\qquad$ .
12. P is a point of $\qquad$ .

## Application

1. This activity may help in explaining the concepts of points of local maxima, local minima and inflection.
2. The concepts of maxima/minima are useful in problems of daily life such as making of packages of maximum capacity at minimum cost.

## Activity 15

## Objective

To understand the concepts of absolute maximum and minimum values of a function in a given closed interval through its graph.

## Material Required

Drawing board, white chart paper, adhesive, geometry box, pencil and eraser, sketch pens, ruler, calculator.


Fig 15

## Method of Construction

1. Fix a white chart paper of convenient size on a drawing board using adhesive.
2. Draw two perpendicular lines on the squared paper as the two rectangular axes.
3. Graduate the two axes as shown in Fig. 15.
4. Let the given function be $f(x)=\left(4 x^{2}-9\right)\left(x^{2}-1\right)$ in the interval $[-2,2]$.
5. Taking different values of $x$ in $[-2,2]$, find the values of $f(x)$ and plot the ordered pairs $(x, f(x))$.
6. Obtain the graph of the function by joining the plotted points by a free hand curve as shown in the figure.

## Demonstration

1. Some ordered pairs satisfying $f(x)$ are as follows:

| $x$ | 0 | $\pm 0.5$ | $\pm 1.0$ | 1.25 | 1.27 | $\pm 1.5$ | $\pm 2$ |
| :--- | :--- | :--- | :--- | :---: | :---: | :---: | :---: |
| $f(x)$ | 9 | 6 | 0 | -1.55 | -1.56 | 0 | 21 |

2. Plotting these points on the chart paper and joining the points by a free hand curve, the curve obtained is shown in the figure.

## Observation

1. The absolute maximum value of $f(x)$ is $\qquad$ at $x=$ $\qquad$ .
2. Absolute minimum value of $f(x)$ is $\qquad$ at $x=$ $\qquad$ .

## Application

The activity is useful in explaining the concepts of absolute maximum / minimum value of a function graphically.

## Note

Consider $f(x)=\left(4 x^{2}-9\right)\left(x^{2}-1\right)$
$f(x)=0$ gives the values of $x$ as $\pm \frac{3}{2}$ and $\pm 1$. Both these values of $x$ lie in the given closed interval [-2,2].
$f^{\prime}(x)=\left(4 x^{2}-9\right) 2 x+8 x\left(x^{2}-1\right)=16 x^{3}-26 x=2 x\left(8 x^{2}-13\right)$
$f^{\prime}(x)=0$ gives $x=0, x= \pm \sqrt{\frac{13}{8}}= \pm 1.27$. These two values of $x$ lie in $[-2,2]$.
The function has local maxima/minima at $x=0$ and $x= \pm 1.27$, respectively.

## Activity 16

## Objective

To construct an open box of maximum volume from a given rectangular sheet by cutting equal squares from each corner.

## Material Required

Chart papers, scissors, cellotape, calculator.

## Method of Construction

1. Take a rectangular chart paper of size $20 \mathrm{~cm} \times 10 \mathrm{~cm}$ and name it as ABCD .
2. Cut four equal squares each of side $x \mathrm{~cm}$ from each corner $\mathrm{A}, \mathrm{B}, \mathrm{C}$ and D .
3. Repeat the process by taking the same size of chart papers and different values of $x$.
4. Make an open box by folding its flaps using cellotape/adhesive.


Fig. 16

## Demonstration

1. When $x=1$, Volume of the box $=144 \mathrm{~cm}^{3}$
2. When $x=1.5$, Volume of the box $=178.5 \mathrm{~cm}^{3}$
3. When $x=1.8$, Volume of the box $=188.9 \mathrm{~cm}^{3}$.
4. When $x=2$, Volume of the box $=192 \mathrm{~cm}^{3}$.
5. When $x=2.1$, Volume of the box $=192.4 \mathrm{~cm}^{3}$.
6. When $x=2.2$, Volume of the box $=192.2 \mathrm{~cm}^{3}$.
7. When $x=2.5$, Volume of the box $=187.5 \mathrm{~cm}^{3}$.
8. When $x=3$, Volume of the box $=168 \mathrm{~cm}^{3}$.

Clearly, volume of the box is maximum when $x=2.1$.

## Observation

1. $\mathrm{V}_{1}=$ Volume of the open box $($ when $x=1.6)=$ $\qquad$
2. $\mathrm{V}_{2}=$ Volume of the open box $($ when $x=1.9)=$ $\qquad$
3. $\mathrm{V}=$ Volume of the open box $($ when $x=2.1)=$ $\qquad$
4. $\mathrm{V}_{3}=$ Volume of the open box $($ when $x=2.2)=$ $\qquad$
5. $\mathrm{V}_{4}=$ Volume of the open box ( when $x=2.4$ ) $=$ $\qquad$
6. $\mathrm{V}_{5}=$ Volume of the open box ( when $x=3.2$ ) $=$ $\qquad$
7. Volume $V_{1}$ is $\qquad$ than volume V .
8. Volume $\mathrm{V}_{2}$ is $\qquad$ than yolume V .
9. Volume $V_{3}$ is $\qquad$ than volume V .
10. Volume $\mathrm{V}_{4}$ is $\qquad$ than volume V .
11. Volume $\mathrm{V}_{5}$ is $\qquad$ than volume V .

So, Volume of the open box is maximum when $x=$ $\qquad$ .

## Application

This activity is useful in explaining the concepts of maxima/minima of functions. It is also useful in making packages of maximum volume with minimum cost.

Let V denote the volume of the box.
Now $V=(20-2 x)(10-2 x) x$
or $V=200 x-60 x^{2}+4 x^{3}$
$\frac{d \mathrm{~V}}{d x}=200-120 x+12 x^{2}$. For maxima or minima, we have,
$\frac{d \mathrm{~V}}{d x}=0$, i.e., $3 x^{2}-30 x+50=0$
i.e., $x=\frac{30 \pm \sqrt{900-600}}{6}=7.9$ or 2.1

Reject $x=7.9$.
$\frac{d^{2} \mathrm{~V}}{d x^{2}}=-120+24 x$

When $x=2.1, \frac{d^{2} \mathrm{~V}}{d x^{2}}$ is negative.

Hence, V should be maximum at $x=2.1$.

## Activity 17

## Objective

To find the time when the area of a rectangle of given dimensions become maximum, if the length is decreasing and the breadth is increasing at given rates.

## Material Required

Chart paper, paper cutter, scale, pencil, eraser, cardboard.

## Method of Construction

1. Take a rectangle $R_{1}$ of dimensions $16 \mathrm{~cm} \times 8 \mathrm{~cm}$.
2. Let the length of the rectangle is decreasing at the rate of $1 \mathrm{~cm} /$ second and the breadth is increasing at the rate of $2 \mathrm{~cm} /$ second.
3. Cut other rectangle $\mathrm{R}_{2}, \mathrm{R}_{3}, \mathrm{R}_{4}, \mathrm{R}_{5}, \mathrm{R}_{6}, \mathrm{R}_{7}, \mathrm{R}_{8}, \mathrm{R}_{9}$, etc. of dimensions $15 \mathrm{~cm} \times$ $10 \mathrm{~cm}, 14 \mathrm{~cm} \times 12 \mathrm{~cm}, 13 \mathrm{~cm} \times 14 \mathrm{~cm}, 12 \mathrm{~cm} \times 16 \mathrm{~cm}, 11 \mathrm{~cm} \times 18 \mathrm{~cm}$, $10 \mathrm{~cm} \times 20 \mathrm{~cm}, 9 \mathrm{~cm} \times 22 \mathrm{~cm}, 8 \mathrm{~cm} \times 24 \mathrm{~cm}$ (see Fig.17).
4. Paste these rectangles on card board.


Fig. 17

## Demonstration

1. Length of the rectangle is decreasing at the rate of $1 \mathrm{~cm} / \mathrm{s}$ and the breadth is increasing at the rate of $2 \mathrm{~cm} / \mathrm{s}$.
2. (i) Area of the given rectangle $\mathrm{R}_{1}=16 \times 8=128 \mathrm{~cm}^{2}$.
(ii) Area of rectangle $\mathrm{R}_{2}=15 \times 10=150 \mathrm{~cm}^{2}$ (after 1 sec ).
(iii) Area of rectangle $\mathrm{R}_{3}=168 \mathrm{~cm}^{2}$ (after 2 sec ).
(iv) Area of rectangle $\mathrm{R}_{4}=182 \mathrm{~cm}^{2}$ (after 3 sec ).
(v) Area of rectangle $R_{5}=192 \mathrm{~cm}^{2}$ (after 4 sec ).
(vi) Area of rectangle $\mathrm{R}_{6}=198 \mathrm{~cm}^{2}$ (after 5 sec ).
(vii) Area of rectangle $\mathrm{R}_{7}=200 \mathrm{~cm}^{2}$ (after 6 sec ).
(viii) Area of rectangle $R_{8}=198 \mathrm{~cm}^{2}$ (after 7 sec ) and so on.

Thus the area of the rectangle is maximum after 6 sec.

## Observation

1. Area of the rectangle $R_{2}($ after 1 sec$)=$ $\qquad$ .
2. Area of the rectangle $R_{4}($ after 3 sec$)=$ $\qquad$ .
3. Area of the rectangle $R_{6}($ after 5 sec$)=$ $\qquad$ .
4. Area of the rectangle $R_{7}($ after 6 sec$)=$ $\qquad$ .
5. Area of the rectangle $R_{8}($ after 7 sec$)=$ $\qquad$ .
6. Area of the rectangle $\mathrm{R}_{9}($ after 8 sec$)=$ $\qquad$ .
7. Rectangle of Maximum area (after ..... seconds) $=$ $\qquad$ .
8. Area of the rectangle is maximum after $\qquad$ sec.
9. Maximum area of the rectangle is $\qquad$ .

## Application

This activity can be used in explaining the concept of rate of change and optimisation of a function.

The function has local maxima/minima at $x=0$ and $x= \pm 1.27$, respectively.

Let the length and breadth of rectangle be $a$ and $b$.
The length of rectangle after $t$ seconds $=a-t$.
The breadth of rectangle after $t$ seconds $=b+2 t$.
Area of the rectangle $($ after $t \mathrm{sec})=\mathrm{A}(t)=(a-t)(b+2 t)=a b-b t+2 a t-2 t^{2}$ $\mathrm{A}^{\prime}(t)=-b+2 a-4 t$

For maxima or minima, $\mathrm{A}^{\prime}(t)=0$.
$\mathrm{A}^{\prime}(t)=0 \Rightarrow t=\frac{2 a-b}{4}$
$\mathrm{A}^{\prime \prime}(t)=-4$
$\mathrm{A}^{\prime \prime}\left(\frac{2 a-b}{4}\right)=-4$, which is negative

Thus, $\mathrm{A}(t)$ is maximum at $t=\frac{2 a-b}{4}$ seconds.
Here, $a=16 \mathrm{~cm}, b=8 \mathrm{~cm}$.

Thus, $t=\frac{32-8}{4}=\frac{24}{4}=6$ seconds
Hence, after 6 second, the area will become maximum.

## Activity 18

## Objective

To verify that amongst all the rectangles of the same perimeter, the square has the maximum area.

## Material Required

Chart paper, paper cutter, scale, pencil, eraser cardboard, glue.

## Method of Construction

1. Take a cardboard of a convenient size and paste a white paper on it.
2. Make rectangles each of perimeter say 48 cm on a chart paper. Rectangles of different dimensions are as follows:


Fig. 18
$\mathrm{R}_{1}: 16 \mathrm{~cm} \times 8 \mathrm{~cm}, \quad \mathrm{R}_{2}: 15 \mathrm{~cm} \times 9 \mathrm{~cm}$
$\mathrm{R}_{3}: 14 \mathrm{~cm} \times 10 \mathrm{~cm}, \quad \mathrm{R}_{4}: 13 \mathrm{~cm} \times 11 \mathrm{~cm}$
$\mathrm{R}_{5}: 12 \mathrm{~cm} \times 12 \mathrm{~cm}, \quad \mathrm{R}_{6}: 12.5 \mathrm{~cm} \times 11.5 \mathrm{~cm}$
$\mathrm{R}_{7}: 10.5 \mathrm{~cm} \times 13.5 \mathrm{~cm}$
3. Cut out these rectangles and paste them on the white paper on the cardboard (see Fig. 18 (i) to (vii)).
4. Repeat step 2 for more rectangles of different dimensions each having perimeter 48 cm .
5. Paste these rectangles on cardboard.

## Demonstration

1. Area of rectangle of $\mathrm{R}_{1}=16 \mathrm{~cm} \times 8 \mathrm{~cm}=128 \mathrm{~cm}^{2}$

Area of rectangle $\mathrm{R}_{2}=15 \mathrm{~cm} \times 9 \mathrm{~cm}=135 \mathrm{~cm}^{2}$
Area of $\mathrm{R}_{3}=140 \mathrm{~cm}^{2}$
Area of $\mathrm{R}_{4}=143 \mathrm{~cm}^{2}$
Area of $\mathrm{R}_{5}=144 \mathrm{~cm}^{2}$
Area of $\mathrm{R}_{6}=143.75 \mathrm{~cm}^{2}$
Area of $\mathrm{R}_{7}=141.75 \mathrm{~cm}^{2}$
2. Perimeter of each rectangle is same but their area are different. Area of rectangle $R_{5}$ is the maximum. It is a square of side 12 cm . This can be verified using theoretical description given in the note.

## Observation

1. Perimeter of each rectangle $R_{1}, R_{2}, R_{3}, R_{4}, R_{4}, R_{6}, R_{7}$ is $\qquad$ .
2. Area of the rectangle $R_{3}$ $\qquad$ than the area of rectangle $\mathrm{R}_{5}$.
3. Area of the rectangle $R_{6}$ $\qquad$ than the area of rectangle $\mathrm{R}_{5}$.
4. The rectangle $R_{5}$ has the diamensions $\qquad$ $\times$ $\qquad$ and hence it is a
$\qquad$ _.
5. Of all the rectangles with same perimeter, the $\qquad$ has the maximum area.

## Application

This activity is useful in explaining the idea of Maximum of a function. The result is also useful in preparing economical packages.

Let the length and breadth of rectangle be $x$ and $y$.
The perimeter of the rectangle $\mathrm{P}=48 \mathrm{~cm}$.
$2(x+y)=48$
or $x+y=24$ or $y=24-x$
Let $\mathrm{A}(x)$ be the area of rectangle, then

$$
\begin{aligned}
\mathrm{A}(x) & =x y \\
& =x(24-x) \\
& =24 x-x^{2} \\
\mathrm{~A}^{\prime}(x) & =24-2 x \\
\mathrm{~A}^{\prime}(x) & =\Rightarrow 24-2 x=0 \Rightarrow x=12 \\
\mathrm{~A}^{\prime \prime}(x) & =-2 \\
\mathrm{~A}^{\prime \prime}(12) & =-2, \text { which is negative }
\end{aligned}
$$

Therefore, area is maximum when $x=12$

$$
y=x=24-12=12
$$

So, $x=y=12$
Hence, amongst all rectangles, the square has the maximum area.

## Activity 19

## Objective

To evaluate the definite integral $\int_{a}^{b} \sqrt{\left(1-x^{2}\right)} d x$ as the limit of a sum and verify it by actual integration.

## Material Required

Cardboard, white paper, scale, pencil, graph paper

## Method of Construction

1. Take a cardboard of a convenient size and paste a white paper on it.
2. Draw two perpendicular lines to represent coordinate axes $\mathrm{XOX}^{\prime}$ and $\mathrm{YOY}^{\prime}$.
3. Draw a quadrant of a circle with O as centre and radius 1 unit ( 10 cm ) as shown in Fig. 19.

The curve in the 1st quadrant represents the graph of the function $\sqrt{1-x^{2}}$ in the interval $[0,1]$.


## Demonstration

1. Let origin O be denoted by $\mathrm{P}_{0}$ and the points where the curve meets the $x$-axis and $y$-axis be denoted by $\mathrm{P}_{10}$ and Q , respectively.
2. Divide $\mathrm{P}_{0} \mathrm{P}_{10}$ into 10 equal parts with points of division as, $\mathrm{P}_{1}, \mathrm{P}_{2}, \mathrm{P}_{3}, \ldots, \mathrm{P}_{9}$.
3. From each of the points, $\mathrm{P}_{i}, i=1,2, \ldots, 9$ draw perpendiculars on the $x$-axis to meet the curve at the points, $\mathrm{Q}_{1}, \mathrm{Q}_{2}, \mathrm{Q}_{3}, \ldots, \mathrm{Q}_{2}$. Measure the lengths of $\mathrm{P}_{0} \mathrm{Q}_{0}, \mathrm{P}_{1} \mathrm{Q}_{1}, \ldots, \mathrm{P}_{9} \mathrm{Q}_{9}$ and call them as $y_{0}, y_{1}, \ldots, y_{9}$ whereas width of each part, $\mathrm{P}_{0} \mathrm{P}_{1}, \mathrm{P}_{1} \mathrm{P}_{2}, \ldots$, is 0.1 units.
4. $y_{0}=\mathrm{P}_{0} \mathrm{Q}_{0}=1$ units
$y_{1}=\mathrm{P}_{1} \mathrm{Q}_{1}=0.99$ units
$y_{2}=\mathrm{P}_{2} \mathrm{Q}_{2}=0.97$ units
$y_{3}=P_{3} Q_{3}=0.95$ units
$y_{4}=P_{4} \mathrm{Q}_{4}=0.92$ units
$y_{5}=P_{5} \mathrm{Q}_{5}=0.87$ units
$y_{6}=\mathrm{P}_{6} \mathrm{Q}_{6}=0.8$ units
$y_{7}=\mathrm{P}_{7} \mathrm{Q}_{7}=0.71$ units
$y_{8}=\mathrm{P}_{8} \mathrm{Q}_{8}=0.6$ units
$y_{9}=\mathrm{P}_{9} \mathrm{Q}_{9}=0.43$ units
$y_{10}=\mathrm{P}_{10} \mathrm{Q}_{10}=$ which is very small near to 0 .
5. Area of the quadrant of the circle (area bounded by the curve and the two axis) $=$ sum of the areas of trapeziums.

$$
=\frac{1}{2} \times 0.1\left[\begin{array}{l}
(1+0.99)+(0.99+0.97)+(0.97+0.95)+(0.95+0.92) \\
+(0.92+0.87)+(0.87+0.8)+(0.8+0.71)+(0.71+0.6) \\
+(0.6+0.43)+(0.43)
\end{array}\right]
$$

$$
\begin{aligned}
& =0.1[0.5+0.99+0.97+0.95+0.92+0.87+0.80+0.71+0.60+0.43] \\
& =0.1 \times 7.74=0.774 \text { sq. units.(approx.) }
\end{aligned}
$$

6. Definite integral $=\int_{0}^{1} \sqrt{1-x^{2}} d x$

$$
=\left[\frac{x \sqrt{1-x^{2}}}{2}+\frac{1}{2} \sin ^{-1} x\right]_{0}^{1}=\frac{1}{2} \times \frac{\pi}{2}=\frac{3.14}{4}=0.785 \text { sq.units }
$$

Thus, the area of the quadrant as a limit of a sum is nearly the same as area obtained by actual integration.

## Observation

1. Function representing the arc of the quadrant of the circle is $y=$ $\qquad$ .
2. Area of the quadrant of a circle with radius 1 unit $=\int_{0}^{1} \sqrt{1-x^{2}} d x=$ $\qquad$ . sq. units
3. Area of the quadrant as a limit of a sum $=$ $\qquad$ sq. units.
4. The two areas are nearly

## Application

This activity can be used to demonstrate the concept of area bounded by a curve. This activity can also be applied to find the approximate value of $\pi$. by drawing the circle $x^{2}+y^{2}=9$ and find the area between $x=1$ and $x=2$.

## Activity 20

## Objective

To verify geometrically that $\vec{c} \times(\vec{a}+\vec{b})=\vec{c} \times \vec{a}+\vec{c} \times \vec{b}$

## Material Required

Geometry box, cardboard, white paper, cutter, sketch pen, cellotape.

## Method of Construction

1. Fix a white paper on the cardboard.
2. Draw a line segment OA ( $=6 \mathrm{~cm}$, say) and let it represent $\vec{c}$.
3. Draw another line segment OB ( $=4 \mathrm{~cm}$, say) at an angle (say $60^{\circ}$ ) with OA . Let $\overrightarrow{\mathrm{OB}}=\vec{a}$


Fig. 20
4. Draw BC ( $=3 \mathrm{~cm}$, say) making an angle (say $30^{\circ}$ ) with $\overrightarrow{\mathrm{OA}}$. Let $\overrightarrow{\mathrm{BC}}=\vec{b}$
5. Draw perpendiculars $\mathrm{BM}, \mathrm{CL}$ and BN .
6. Complete parallelograms OAPC, OAQB and BQPC.

## Demonstration

1. $\overrightarrow{\mathrm{OC}}=\overrightarrow{\mathrm{OB}}+\overrightarrow{\mathrm{BC}}=\vec{a}+\vec{b}$, and let $\angle \mathrm{COA}=\alpha$.
2. $|\vec{c} \times(\vec{a}+\vec{b})|=|\vec{c}||\vec{a}+\vec{b}| \sin \alpha=$ area of parallelogram OAPC.
3. $|\vec{c} \times \vec{a}|=$ area of parallelogram OAQB.
4. $|\vec{c} \times \vec{b}|=$ area of parallelogram BQPC .
5. Area of parallelogram OAPC $=(\mathrm{OA})(\mathrm{CL})$

$$
\begin{aligned}
& =(\mathrm{OA})(\mathrm{LN}+\mathrm{NC})=(\mathrm{OA})(\mathrm{BM}+\mathrm{NC}) \\
& =(\mathrm{OA})(\mathrm{BM})+(\mathrm{OA})(\mathrm{NC}) \\
& =\text { Area of parallelogram } \mathrm{OAQB}+\text { Area of parallelogram BQPC } \\
& =|\vec{c}+\vec{a}|+|\vec{c} \times \vec{b}|
\end{aligned}
$$

So, $|\vec{c} \times(\vec{a}+\vec{b})|=|\vec{c} \times \vec{b}|+|\vec{c} \times \vec{b}|$
Direction of each of these vectors $\vec{c} \times(\vec{a}+\vec{b}), \vec{c} \times \vec{a}$ and $\vec{c} \times \vec{b}$ is perpendicular to the same plane.

So, $\vec{c} \times(\vec{a}+\vec{b})=\vec{c} \times \vec{a}+\vec{c} \times \vec{b}$.

## Observation

$$
\begin{aligned}
& |\vec{c}|=|\overrightarrow{\mathrm{OA}}|=\mathrm{OA}= \\
& |\vec{a}+\vec{b}|=|\overrightarrow{\mathrm{OC}}|=\mathrm{OC}= \\
& \mathrm{CL}= \\
& |\vec{c} \times(\vec{a}+\vec{b})|=\text { Area of parallelogram OAPC }
\end{aligned}
$$

$$
\begin{equation*}
=(\mathrm{OA})(\mathrm{CL})= \tag{i}
\end{equation*}
$$

$\qquad$ sq. units
$|\vec{c} \times \vec{a}|=$ Area of parallelogram OAQB

$$
=(\mathrm{OA})(\mathrm{BM})=\square \times \square=
$$

$|\vec{c} \times \vec{b}|=$ Area of parallelogram BQPC

$$
\begin{equation*}
=(\mathrm{OA})(\mathrm{CN})=\times \tag{iii}
\end{equation*}
$$

From (i), (ii) and (iii),
Area of parallelogram $\mathrm{OAPC}=$ Area of parallelgram $\mathrm{OAQB}+$ Area of Parallelgram $\qquad$ .

Thus $\quad|\bar{c} \times|(\bar{a}+\bar{b}|=|\vec{c} \times \vec{a}|+|\vec{c} \times \vec{b}|$
$\vec{c} \times \vec{a}, \vec{c} \times \vec{b}$ and $\vec{c} \times(\vec{a}+\vec{b})$ are all in the direction of $\qquad$ to the plane of paper.

Therefore $\quad \vec{c} \times(\vec{a}+\vec{b})=\vec{c} \times \vec{a}+$ $\qquad$ .

## Application

Through the activity, distributive property of vector multiplication over addition can be explained.

> NoTE
> This activity can also be performed by taking rectangles instead of parallelograms.

## Class 12

Subject: Physics (042)

Complete lab manual from Experiment No 1 to Experiment No 5, Observation table should not be filled, it will be completed when school reopen ,only after taking observation in laboratory.

1. Prepare one Investigatory Project File based on any one topic mentioned below :
A. To investigate the dependence of the angle of deviation on the angle of incidence using a hollow prism filled one by one, with different transparent fluids.
B. To estimate the charge induced on each one of the two identical Styrofoam (or pith) balls suspended in a vertical plane by making use of Coulomb's law.
C. To find the refractive indices of (a) water (b) oil (transparent) using a plane mirror, anequi-convex lens (made from a glass of known refractive index) and an adjustable object needle.
D. To study various factors on which the internal resistance/EMF of a cell depends.
2. Find cbse board questions from, 2015 to 2022 of following chapters and solve it . 1 Electric Charge and Field .
2 Electric Potential and Capacitance.
3. Solve all numericals of Chapter 1 and Chapter 2 from NCERT Exercise Questions..

## Directions: READ THE FOLLOWING QUESTIONS AND CHOOSE :

(a) If both Assertion(A) and Reason(R) are true and Reason(R) is correct explanation of Assertion(A)
(b) If both Assertion(A) and Reason(R) are true but Reason( $(R)$ is not correct explanation of Assertion(A)
(c) If Assertion(A) is true but Reason( R ) is false
(d) If Assertion(A) is false and Reason( $R$ ) is true.

1. A. If there exists coulomb attraction between two bodies, both of them may not be charged.
R. They will be oppositely charged.
2. A. Electric force acting on a proton and an electron, moving in a uniform electric field is same, whereas acceleration of electron is 1836 times that of a proton.
R. Electron is lighter than proton.
3. A. The surface densities of two spherical conductors of radii r 1 and r 2 are equal. Then the electric field intensities near their surface are also equal.
R. Surface density = charge/area
4. A. Three equal charges $(+q)$ are situated on a circle of radius $r$ such that they form an equilateral triangle, then the electric field intensity at the centre is zero.
R. The forces on unit positive charge at the centre, due to the three equal charges are represented by the three sides of a triangle taken in the same order. Therefore, electric field intensity at the centre is Zero.
5. A. If a conducting medium is placed between two charges, then electric force between them becomes zero.
R. For conductors, $\mathrm{K}=\infty \therefore \mathrm{F}=1 / \infty=0$, hence zero. .
6. A. A charge $q$ is lying at the centre of the line joining two similar charges $Q$ each. The system will be in equilibrium if $\mathrm{q}=-\mathrm{Q} / 4$.
R. For Q to be in equilibrium, sum of the forces on Q due to rest of the two charges must be zero.
7. A. An electric dipole is placed in uniform external field along field, Net Torque and net force on the dipole will be zero .
R. $F=q E$, so $F=0$ torque is also zero.
8. A. Mass of a body decreases slightly when it is negatively charged.
R. Charging is due to actual transfer of electrons.
9. A. The surface of a conductor is an equipotential surface.
R. Conductor allows the flow of charge.
10. A. Electric current will not flow between two charged bodies when connected if their charges are same.
R. Current is rate of flow of charge.
11. A. Work done in carrying $+q$ charge from one surface $A$ to another surface $B$ at the same potential is zero.
R. $\mathrm{W}=\mathrm{q}(\mathrm{V} 2-\mathrm{V} 1)=0$
12. A. The value of V and E at the middle point of the line joining an electron and a proton is zero.
R. V is a scalar and E is a vector.
13. A. When initial velocity of an electron is at right angles to the electric field, then the path of electron in this field will be a parabola.
R. Acceleration of electron will be in a direction opposite to electric field. The electron acts like a projectile whose path is a parabola.
14. A. Electrons move away from a region of lower potential to a region of higher potential.
R. Since an electron has a negative charge.
15. A. The electric flux emanating out and entering a closed surface are $8 \times 10^{3}$ and $2 \times 10^{3}$ volt metre respectively. The charge enclosed by the surface is $0.053 \mu \mathrm{C}$.
R. Gauss's theorem in electrostatics may be applied to verify.
16. A. A point charge $q$ is lying at the centre of a cube of each side $L$. The electric flux emanating from each surface of the cube is $q / 6 € 0$.
R. According to Gauss's theorem in electrostatic $\varphi=\mathrm{q} / € 0$.

## Class -XII <br> Subject-Chemistry (043)

## Ch-1.Solutions

I.1. Calculate the molarity of each of the following solutions:
(a) 30 g of $\mathrm{Co}\left(\mathrm{NO}_{3}\right)_{2} .6 \mathrm{H}_{2} \mathrm{O}$ in 4.3 L of solution
(b) 30 mL of $0.5 \mathrm{M} \mathrm{H}_{2} \mathrm{SO}_{4}$ diluted to 500 mL .
2. Calculate the mass of urea $\left(\mathrm{NH}_{2} \mathrm{CONH}_{2}\right)$ required in making 2.5 kg of 0.25 molal aqueous solution.
3. Calculate (a) molality (b) molarity and (c) mole fraction of KI if the density of $20 \%$ (mass $/ \mathrm{mass}$ ) aqueous KI is $1.202 \mathrm{~g} \mathrm{~mL}^{-1}$.
4. $\mathrm{H}_{2} \mathrm{~S}$, a toxic gas with rotten egg like smell, is used for the qualitative analysis. If the solubility of $\mathrm{H}_{2} \mathrm{~S}$ in water at STP is 0.195 m , calculate Henry's law constant.
5. Vapour pressure of pure water at 298 K is 23.8 mm Hg .50 g of urea $\left(\mathrm{NH}_{2} \mathrm{CONH}_{2}\right)$ is dissolved in 850 g of water. Calculate the vapour pressure of water for this solution and its relative lowering.
6. Boiling point of water at 750 mm Hg is $99.63^{\circ} \mathrm{C}$. How much sucrose is to be added to 500 g of water such that it boils at $100^{\circ} \mathrm{C}$. Molal elevation constant for water is $0.52 \mathrm{~K} \mathrm{~kg} \mathrm{~mol}^{-1}$.
7. Calculate the mass of ascorbic acid (Vitamin C, $\mathrm{C}_{6} \mathrm{H}_{8} \mathrm{O}_{6}$ ) to be dissolved in 75 g of acetic acid to lower its melting point by $1.5^{\circ} \mathrm{C} . K_{f}=3.9 \mathrm{~K} \mathrm{~kg} \mathrm{~mol}^{-1}$.
8. Calculate the osmotic pressure in pascals exerted by a solution prepared by dissolving 1.0 g of polymer of molar mass 185,000 in 450 mL of water at $37^{\circ} \mathrm{C}$.
9. Define the following terms:
(i) Mole fraction
(ii) Molality
(iii) Molarity
(iv) Mass percentage.
10. A sample of drinking water was found to be severely contaminated with chloroform $\left(\mathrm{CHCl}_{3}\right)$ supposed to
be a carcinogen. The level of contamination was 15 ppm (by mass):
(i) express this in percent by mass
(ii) determine the molality of chloroform in the water sample.
11. What is meant by positive and negative deviations from Raoult's law and how is the sign of $\Delta_{\text {sol }} H$ related
to positive and negative deviations from Raoult's law?
12. Calculate the amount of benzoic acid $\left(\mathrm{C}_{6} \mathrm{H}_{5} \mathrm{COOH}\right)$ required for preparing 250 mL of 0.15 M solution in
methanol.
13. Vapour pressure of pure acetone and chloroform at 328 K are 741.8 mm Hg and 632.8 mm Hg respectively. Assuming that they form ideal solution over the entire range of composition, plot $p_{\text {total }}$, $p_{\text {chloroform' }}$ and $p_{\text {acetone }}$ as a function of $x_{\text {acetone }}$. The experimental data observed for different compositions
of mixture is.

| $100 \times x_{\text {acetone }}$ | 0 | 11.8 | 23.4 | 36.0 | 50.8 | 58.2 | 64.5 | 72.1 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $p_{\text {acetone }} / \mathrm{mm}$ <br> Hg | 0 | 54.9 | 110.1 | 202.4 | 322.7 | 405.9 | 454.1 | 521.1 |
| $p_{\text {chloroform }} / \mathrm{mm}$ <br> Hg | 632.8 | 548.1 | 469.4 | 359.7 | 257.7 | 193.6 | 161.2 | 120.7 |

## Ch-2. Chemical Kinetics

1. In a reaction, $2 \mathrm{~A} \rightarrow$ Products, the concentration of A decreases from $0.5 \mathrm{~mol} \mathrm{~L}^{-1}$ to $0.4 \mathrm{~mol} \mathrm{~L}^{-1}$ in 10 minutes. Calculate the rate during this interval?
2. The conversion of molecules $X$ to $Y$ follows second order kinetics. If concentration of $X$ is increased to three times how will it affect the rate of formation of Y ?
3. The rate of the chemical reaction doubles for an increase of 10 K in absolute temperature from 298 K.

Calculate $E_{\mathrm{a}}$.
4. In a pseudo first order hydrolysis of ester in water, the following results were obtained:

| $\mathrm{t} / \mathrm{s}$ | 0 | 30 | 60 | 90 |
| :---: | :---: | :---: | :---: | :---: |
| ${\text { [Ester] }] \mathrm{mol} \mathrm{L}^{-1}}^{2}$ | 0.55 | 0.31 | 0.17 | 0.085 |

(i) Calculate the average rate of reaction between the time interval 30 to 60 seconds.
(ii) Calculate the pseudo first order rate constant for the hydrolysis of ester.
5. Calculate the half-life of a first order reaction from their rate constants given below:
(i) $200 \mathrm{~s}^{-1}$
(ii) $2 \mathrm{~min}^{-1}$
(iii) 4 years $^{-1}$
6. The half-life for radioactive decay of ${ }^{14} \mathrm{C}$ is 5730 years. An archaeological artifact containing wood Had only $80 \%$ of the ${ }^{14} \mathrm{C}$ found in a living tree. Estimate the age of the sample.
7. For a first order reaction, show that time required for $99 \%$ completion is twice the time required for The completion of $90 \%$ of reaction.
8. For the decomposition of azo isopropane to hexane and nitrogen at 543 K , the following data are obtained.

| $t(\mathrm{sec})$ | $\mathrm{P}(\mathrm{mm}$ of Hg$)$ |
| :---: | :---: |
| 0 | 35.0 |
| 360 | 54.0 |
| 720 | 63.0 |

Calculate the rate constant.
9. The rate constant for the decomposition of hydrocarbons is $2.418 \times 10^{-5} \mathrm{~s}^{-1}$ at 546 K . If the energy of activation is $179.9 \mathrm{~kJ} / \mathrm{mol}$, what will be the value of pre-exponential factor.
10. Consider a certain reaction $\mathrm{A} \rightarrow$ Products with $k=2.0 \times 10^{-2} \mathrm{~s}^{-1}$. Calculate the concentration of $A$ remaining after 100 s if the initial concentration of $A$ is $1.0 \mathrm{~mol} \mathrm{~L}^{-1}$.
11. Sucrose decomposes in acid solution into glucose and fructose according to the first order rate law, With $t_{1 / 2}=3.00$ hours. What fraction of sample of sucrose remains after 8 hours?

## Ch-3 Halo Alkanes and Arenes

1. Write structures of the following compounds:
(i) 2-Chloro-3-methylpentane
(ii) 1-Chloro-4-ethylcyclohexane
(iii) 4-tert. Butyl-3-iodoheptane
(iv) 1,4-Dibromobut-2-ene
(v) 1-Bromo-4-sec. butyl-2-methylbenzene
2. Why is sulphuric acid not used during the reaction of alcohols with KI?
3. Write structures of different dihalogen derivatives of propane.
4. Among the isomeric alkanes of molecular formula $\mathrm{C}_{5} \mathrm{H}_{12}$, identify the one that on photochemical chlorination yields
(i) A single monochloride.
(ii) Three isomeric monochlorides.
(iii) Four isomeric monochlorides.
5. Draw the structures of major monohalo products in each of the following reactions:
(i)

(ii)

(iii)

(iv)

(v)

(vi)

6. In the following pairs of halogen compounds, which compound undergoes faster $\mathrm{S}_{\mathrm{N}} 1$ reaction?
(i)

(ii)

7. Give the IUPAC names of the following compounds:
(i) $\mathrm{CH}_{3} \mathrm{CH}(\mathrm{Cl}) \mathrm{CH}(\mathrm{Br}) \mathrm{CH}_{3}$
(ii) $\mathrm{CHF}_{2} \mathrm{CBrClF}$
(iii) $\mathrm{ClCH}_{2} \mathrm{C} \equiv \mathrm{CCH}_{2} \mathrm{Br}$
(iv) $\left(\mathrm{CCl}_{3}\right)_{3} \mathrm{CCl}$
8. Which one of the following has the highest dipole moment?
(i) $\mathrm{CH}_{2} \mathrm{Cl}_{2}$
(ii) $\mathrm{CHCl}_{3}$
(iii) $\mathrm{CCl}_{4}$
9. What are ambident nucleophiles? Explain with an example.
10. How will you bring about the following conversions?
(i) Ethanol to but-1-yne
(ii) Ethane to bromoethene
(iii) Propene to 1-nitropropane
(iv) Toluene to benzyl alcohol
11. Explain why
(i) the dipole moment of chlorobenzene is lower than that of cyclohexyl chloride?
(ii) alkyl halides, though polar, are immiscible with water?
(iii) Grignard reagents should be prepared under anhydrous conditions?
II. Complete the investigatory project allotted to you \& submit it after summer vacation in a proper file.

# Class- XII <br> Subject: Biology (044) 

## Note-

1. Section A contains Investigatory Project
2. Section B contains worksheet
3. Make Investigatory project in a Proper File
4. Write worksheet question answer either in fair note book or in assignment copy

## SECTION- A (Investigatory Project)

1. Make an investigatory project based on any one topic of your choice .
2. The following points are to be taken care while preparing project-
a) Relevant topic must be chosen from the text book
b) Project must be handwritten.
c) Proper evidences (Data, pictures etc.) are to be produced in favour.
d) Project should not be copied from any source rather put your own effort.
e) Use internet for more information.
f) You may choose other relevant topics of your choice other than suggested.

Suggested topics

1. Any human disease can be taken as a topic and collect the complete information with statistical data and a support of statistical analysis about the same questioners.
2. Study about sleep walking and sleep paralysis.
3. Cancer.
4. Genetic and chromosomal disorders.
5. Study of locomotion in fishes, importance of different fins in balancing and steering the body. (M.R.a fish tank, live fishes, scissors, petridishes, cotton).
6. Effects on plant movement (effects of light and effects of gravity). (M.R.- a potted plant, maize grains / bean / green gram seeds, petridishes, cotton).
7. Medicinal plants and their benefits.
8. Environmental Pollution
9. Infertility and steps that can be taken to overcome infertility problems.
10. To study the variation in the rate of mitotic cell division in the root tips of onion.
11. Effect of Plant growth regulators in development of plants
12. Effect of salinity of water on the growth of one type of plant.
13. Conduct a survey of pesticides at your local nursery, garden supplies shop or supermarket. Construct a table in which to record:
a. the names of commercial brands of insecticides
b. the target organisms
c. the active chemical ingredients
d. information given about safety precautions.
14. Stages of fetal development.
15. Find out how ants follow a trail, and how and why birds migrate?
16. Find out some of the innate behaviors of babies. Why might they be useful to a baby?
17. Investigate the statement "Too much adrenaline can cause stress-related diseases".
18. Design an experiment to compare the pH of various brands of toothpaste. What does the pH of toothpaste suggest about tooth decay?
19. What causes pimples? Why are they so difficult to prevent or cure?
20.Tobacco and its side effect.
20. STDs(symptoms, prevention \& cure)

## SECTION - B

Q 1. In angiosperms, zygote is diploid while primary endosperm cell is triploid. Explain?
Q 2. In a young anther, a group of compactly arranged homogenous cells were observed in the centre of each microsporangium. What is the name given to these cells?
Q 3. (a) Name the organic material exine of the pollen grain is made up of. How is this material advantageous to pollen grain?
(b) Still it is observed that it does not form a continuous layer around the pollen grain. Give reason.
(c) How are' pollen banks' useful?

Q 4. (a) Can a plant flowering in Mumbai be pollinated by pollen grains of the same species growing in New Delhi? Provide explanations to your answer.
(b) Draw the diagram of a pistil where pollination has successfully occurred.

Q 5. Label the parts involved in reaching the male gametes to its desired destination. During the reproductive cycle of
a human female, when, where and how does a placenta develop? What is the function of placenta during pregnancy and embryo development?
Q 6. (a) Where do the signals for parturition originate from in humans?
(b) Why is it important to feed the newborn babies on colostrum?

Q 7. (a) Draw a diagrammatic sectional view of the female reproductive system of human and label the parts (i) where the secondary oocytes develop
(ii) which helps in collection of ovum after ovulation
(iii) where fertilization occurs
(iv) where implantation of embryo occurs.
(b) Explain the role of pituitary and the ovarian hormones in menstrual cycle in human females.

Q 8. The following is the illustration of the sequence of ovarian events in a human female.

A. Identify the figure answer the following question
(i) Name the ovarian hormone and the pituitary hormone that have caused the above-mentioned event.
(ii) Explain the changes that occur in the uterus simultaneously in anticipation.
(iii) Draw a labelled sketch of the structure of a human ovum prior to fertilization.

Q 9. (i)When and where are primary oocytes formed in a human female? Trace the development of these oocytes till ovulation (in menstrual cycle). Gonadotrophin
(ii) How do gonadotropins influence this developmental process?

Q 10.(a) Where does fertilization occur in humans? Explain the events that occur during this process.
(b) A couple where both husband and wife are producing functional gametes, but the wife is still unable to conceive, is seeking medical aid. Describe any one method that you can suggest to this couple to become happy parents.

