Enrichment Activities in Mathematics for Elementary Schools in Tamilnadu and Pondicherry

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***Introduction*:**

As we know all that the study of mathematics has been central to all learning systems from time immemorial. As a vital component of the '3R's, emphasis has always been laid on the basic skill and of numbers and their extensive use in giving a form ad name to several of the though patterns of human cognition and understanding. Over the centuries mathematics has developed as a discipline of study with a focus, a purpose and a scheme. The various inputs to learning of mathematics have aimed at developing certain basic and essential skills of its, use in daily life as well as in furtherance of knowledge.

Over the year, an apparent complexity seems to have appeared in the content and the processes involved in the learning of mathematics especially at the school level. Concepts of mathematics are seen as difficult to understand and appreciate, thanks to same myth associated in the transaction of the curriculum. Fear for the learning of the subject increases the resistance to the learning process.

In the early stage of school education, this type of fear in learning mathematics leads to increase the failure in that subject. Added to that, the lack of interest, non attractive way of transaction and bulky text books leads to hating the subject.

The remedy lies in creating of a right ambience for the learning of the subject. It lies in re-designing the transaction of the curriculum in which the paradigm of learning would help developing a familiarity and ownership of the subject. It lies in creating a conductive environment in the class room where the learner learn the basic and essential concepts and skills by doing simple activities in mathematics and are developed to facilitate the classroom transaction in a mere joyful and interesting way. We believe that the students exposed to think differently and approach propose without any fear and developing imagination power, when they are allowed to do enrichment activities in mathematics. Since, the learning by doing is one of the most effective ways a learning; it is in this context that the enrichment activities play a vital role in not only creating the interest of the learner but also in making the learning of mathematics more meaningful. In this process students also learn some applications of mathematics in real life situations. Hence the use of enrichment activities ensures better understanding among the students.

The following concepts are identified on which activities can be designed.

(A) **Number related concepts**

1) Process of counting and role of numbers.

2) Construction of numbers; formation of numbers, using digits, place value and face value of a digit in a numbers.

3) Operation on numbers; addition/subtraction/multiplication/division.

4) Number patterns

5) Bigger and smaller numbers

6) Concept of parts and wholes, halves and quarters

B) **Special Concepts**

1. Classification of objects: Solid, plane, figure and linear objects.
2. Shapes and size of objects
3. Comparison of sizes: (Bigger/Smaller), (larger/shorter) etc.
4. Standard Measures
5. Orientation of figures
6. Symmetrical plane figures: axes of symmetry
7. Pattern recognition and pattern formation

(C) **Applications of mathematics in daily life:**

1. Recognition of inter play between life situations and mathematics.
2. Measurements: Distance, length, Area, Value, Weight, Time and Money
3. Role of mathematics in (i) Business (ii) Time – distance problem (iii) Time-work problem
4. Geometrical problems: Constructions using instrument box

Some Illustrated Activities

Activity-1

Objective: To verify that addition and multiplication are commutative for whole numbers by paper cutting and pasting method.

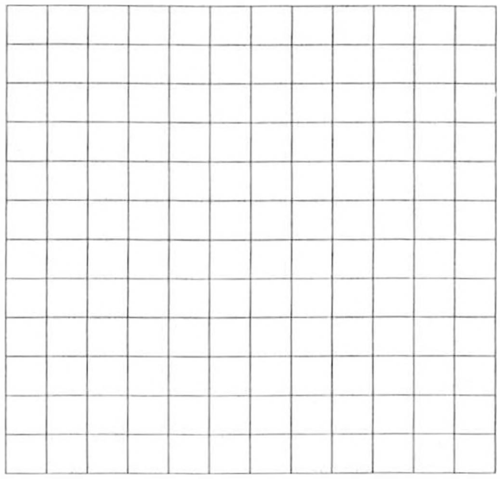
Pre-requisite knowledge: Addition and Multiplication of whole Numbers.

Materials Required: Geometry Box, Squared shape paper, white paper, colour pencils, Glue stick, scissors etc.

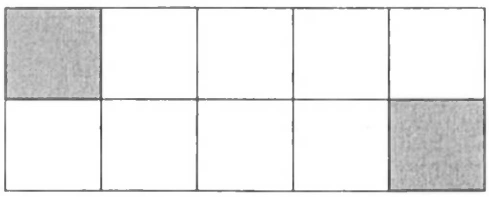
Procedure: (A) For addition

1. On the squared shape paper, coloured the strips of different lengths as follows:
   Two strips of length 1 unit - Blue
   Four strips of length 2 units - Red
   Two strips of length 3 units - Green
   Four strips of length 4 units - Yellow

Cut each strip carefully

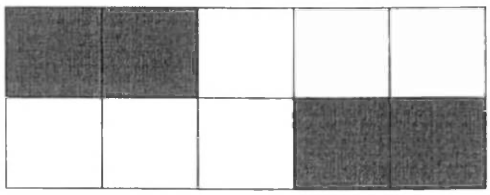


2. Take both the blue strips representing 1 and two strips representing 4 (yellow) and paste them on a plain sheet as shown below:



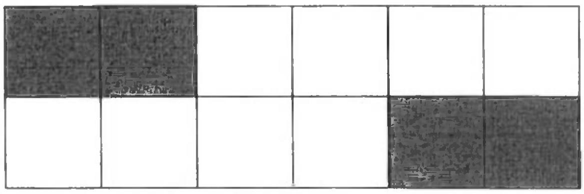
What do you observe?

3. Repeat the process by using strips of lengths 2 and 3 units.



Write your observations.

4. Do the same activity with strips representing 2 and 4 units.



Write your observations.

Observations:

a. In the second figure the total length of both the strips taken together is 5. That is, $1+4 = 4+1 = 5$.
b. In the third figure the total length of both the strips taken together is 5. That is, $2 + 3 = 3 + 2 = 5$.
c. In the fourth figure the total length of both the strips taken together is 6. That is, $2 + 4 = 4 + 2 = 6$.

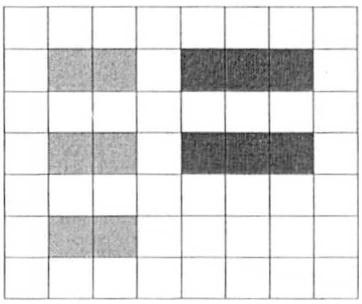
Thus when any two whole numbers are added in any order, their sum is the same. We say that the addition is commutative for whole numbers.

B. For Multiplication:

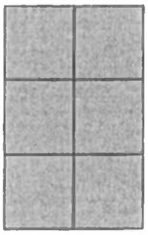
Pre-requisite Knowledge: Multiplication of whole numbers, Area of a rectangle.

Procedure:

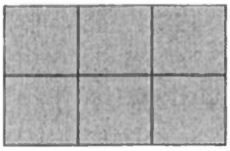
1. On a squared paper, mark the strips of 2 units and 3 units length and represent them as shown below:



2. Now cut the strips carefully ad paste them on a plain white sheet a shown below:



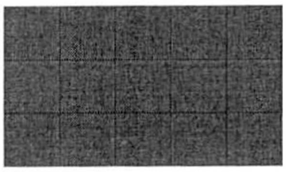
(3 strips of 2 units length)
3 x 2



(2 strips of 3 units length)
2 x 3

Find the area of each rectangle. What do you observe?

3.Now represent the strips of lengths 3 and 5 units on a square paper as shown below:



Find the area of each of the two rectangles. What do you observe?

Observations:

1. In the second figure, the area of each rectangle is 6 sq. units.
   That is 3 x 2 = 2 x 3 = 6
2. In the third figure the area of each rectangle is 15 sq.units
   That is 5 x 3 = 3 x 5 = 15

3. In the 1 and 2 above the results of the multiplications are the same irrespective of the order in which they are multiplied.
4. We say that the multiplication is commutative for whole numbers.

Conclusion: If a and b are two whole numbers then,

$$\mathbf{a + b = b + a}$$

$$\mathbf{a \times b = b \times a}$$

This is called the **commutative property** in addition and multiplication respectively for whole numbers.

<u>Activity : 2</u>

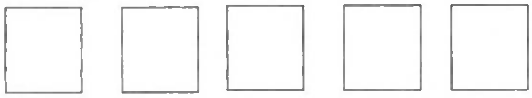
<u>Objective:</u> Making all possible shapes by using five squares.

<u>Prerequisite knowledge:</u> Area and perimeter of rectangle.

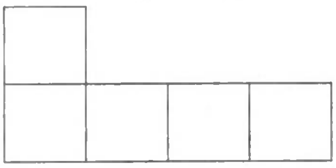
<u>Materials required:</u> Geometry box, squared paper, chart paper, colour pencils, glue stick, scissors.

Procedure:

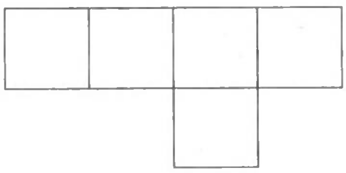
1. Prepare five equal squares of unit length each as shown below:

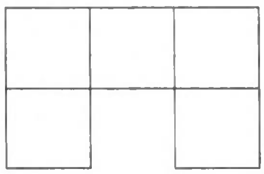


2. Join the squares together to form all the possible shapes. One such shape is given below.



Similarly some more are given below





3. Prepare all such different shapes with the help of these five unit squares. How many shapes are possible? (Ans : 12)

4. Draw all these figure on the grid paper and give them different Alphabets. Find the perimeter of each one of them. Are they equal or different? Record your observations.

5. Join all the 12 shapes in all possible ways to get different rectangles. One such rectangle so forms in given as below.

A	B	B	C	C	C
A	B	B	C	D	C
A	O	B	D	D	D
A	O	O	O	D	E
A	O	I	E	E	E
M	I	I	E	G	G
M	M	I	G	G	H
F	M	I	G	J	H
F	M	J	J	J	H
F	F	F	J	H	H

Perimeter of this rectangle is 32 units. Find the perimeter of other rectangles also.

6. Area of each rectangle is 60 sq. units. Find whether the perimeters are same or different.

Conclusion:

This activity illustrate that with a constant area different rectangles can be constructed whose perimeters are different.

Try the above activity with different numbers of square pieces.

Activity 3

Objective: Recalling objects around us and some geometric figures to identify symmetry about a line by paper folding activity.

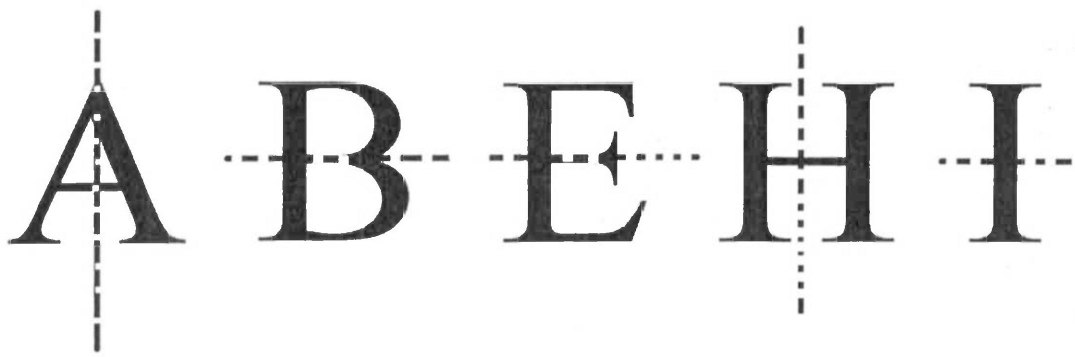
Pre requisite knowledge: Knowledge of symmetry, knowledge of geometrical figures.

Materials required: White sheet, tracing paper, pencil, scissors.

Procedure:

1. Observe the letters of English language displaying symmetry and the axes of symmetry.

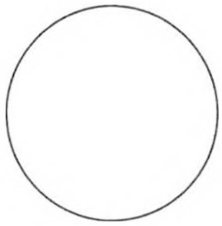
Eg:



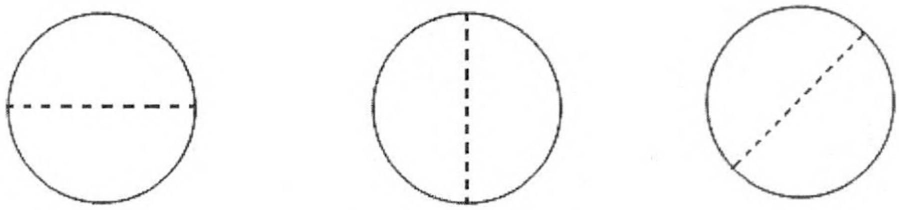
Do you find any letter of English language which is not symmetrical about a line? Identify them.

Can you do the same activity on the letters of your own language?

2. Take a circular shape white paper.



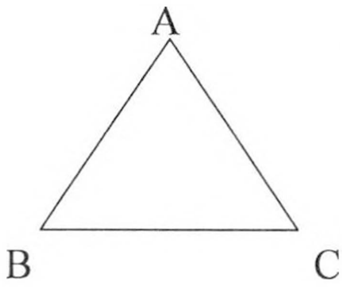
Fold it along its diameter at different positions. Then open it.



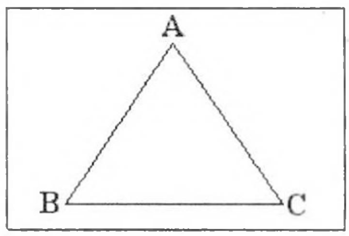
Along any diameter it is clear that the circular figure is symmetrical.

3. An isosceles triangle

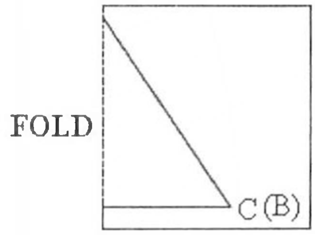
i. On a squared paper, draw an isosceles triangle ABC.



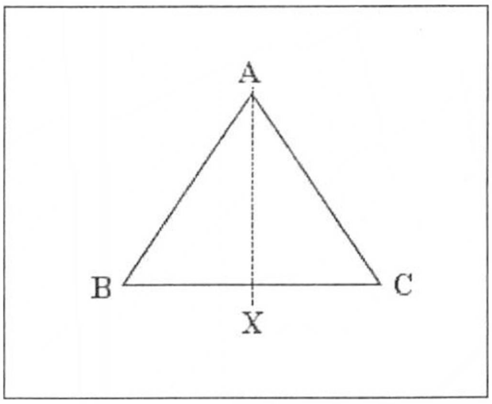
ii. Copy the triangle on a tracing paper.



iii. Now fold the triangle ABC along BC such that the Point B co-insides with point C. See that the fold contains the point A and AB falls on AC



iv. Open the fold and draw the line along the crease. The line intersects BC at a point mark this point as X



v. AX is the line of symmetry of the isosceles triangle ABC.

Now fold the triangle along AB and AC. What do you observe? Record your observations.

Similarly, find the line of symmetries for an equilateral triangle also.

Observations:

1. An isosceles triangle has only one line of symmetry. It is the line joining the vertex to the mid point of the base. The line of symmetry is perpendicular to the base.
2. There are three lines of symmetry in an equilateral triangle.

Suggested Activity: Extend the above activity for the plane figures like square, rectangle, rhombus… etc. and record the observations.

Activity 4

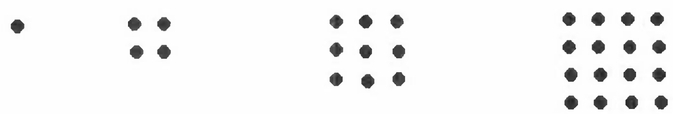
Objective: Recognizing the number patterns

Pre-requisite knowledge: Knowledge of numbers

Materials required: Grid sheets, white paper, pencil etc.

Procedure:

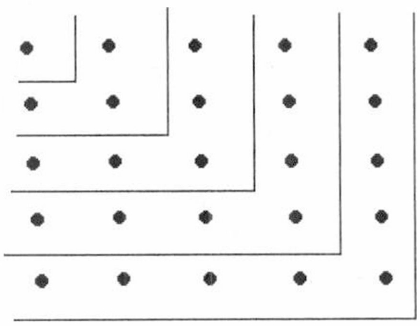
1. On a white sheet put the dots in a systematic manner so that the following pattern is obtain:



... and so on

Note that in the above series of the pattern each member represent a square number.

2. On a white sheet put the dots in a square manner and group them in a systematic manner so that the following pattern is obtained.



.... and so on

Note that in the above series of pattern each member represent odd number.

3. Pattern of multiplication table of 9
   9 X 1 = 09 (0 + 9 = 9)
   9 X 2 = 18 (1 + 8 = 9)
   9 X 3 = 27 (2 + 7 = 9)
   .
   .
   .
   9 X 9 = 81 (8 + 1 = 9)
   9 X 10 = 90 (9 + 0 = 9)

4. Powers of 11 Pattern

   $11^1 = 11$

   $11^2 = 121$

   $11^3 = 1331$

   $11^4 = 14641$

   ... and so on.

Note that in the above series of the pattern each member represents the powers of the terms obtained in the binomial expansion.

5. The following pattern gives the product of numbers having 1 as digit and 11 in the form of numbers having 1 and 2 as digits in a particular order!

   1 X 11 = 11
   11 X 11 = 121
   111 X 11 = 1221
   1111 X 11 = 12221
   11111 X 11 = 122221
   ... and so on.

6. The following pattern gives the sum of the cubes of numbers as the squares of the sum of those numbers.

$$1^3 = 1^2$$
$$1^3 + 2^3 = (1+2)^2$$
$$1^3 + 2^3 + 3^3 = (1+2+3)^2$$
$$1^3 + 2^3 + 3^3 + 4^3 = (1+2+3+4)^2$$

… and so on.

7. The following products gives wonderful number patterns having only one digit number!

12345679 X 9 = 111111111
12345679 X 18 = 222222222
12345679 X 27 = 333333333
12345679 X 36 = 444444444

… and so on.

8. The following sum patterns gives the square of the number.

$$1 = 1^2$$
$$1+2+1 = 2^2$$
$$1+2+3+2+1 = 3^2$$
$$1+2+3+4+3+2+1 = 4^2$$
$$1+2+3+4+5+4+3+2+1 = 5^2$$

… and so on.

9. If we express 1/ 81 in the repeating decimal form, we have a surprise pattern!

1/81=0.0123456789…

Activity- 5

Objective: Find the square of two digit numbers with a known beginning digit through pattern identification.

Pre-requisite knowledge: Number, product of numbers
Procedure:

1) **squaring a two digit number beginning with 1**
   a) Take a two digit number beginning with 1
   b) Square the second digit (keep the carry)

      – – X

   c) Multiply the second digit by 2 and add the carry (keep the next carry)

      – X –

   d) The first digit is 1 (plus the carry in the previous step)

      X – –

Example: Let the number is 16
Square the second digit. That is 6 x 6 = 36

– – 6

The carry is 3.
Multiply the second digit by 2 and add the carry 3
That is 2 x 6 + 3 = 15

– 5 –

The carry is 1
The first digit is 1 plus carry in the previous step i.e 1
That is 1 + 1 = 2

2 – –

Hence **16 x 16 = 256**

Similarly you can try to find the square of other two digit numbers beginning with one. The same pattern of multiplication works for these numbers also.

2. **Squaring a two digit number beginning with 5**
   a) Take a two digit number beginning with 5
   b) Square the first digit number
   c) Add this number to the second digit to find the first part of the answer.

      X X – –

   d) Square the second digit. This is the last part of the answer.

      – – X X

Example: Let the number is 58

Square the first digit 5. i.e 5 x 5 = 25

Add 25 to the second digit 8

i.e 25 + 8 = 33

This is the first part of the answer.

i.e **3 3** – –

Next square the second digit. i.e 8 x 8 = 64

This is the second part of the answer.

i.e – – 6 4

Hence, the answer is

58 x 58 = 3364

Similarly you can find the square of other two digit numbers beginning with 5. The same pattern of multiplication works for these numbers also. Note that, if the square of the second digit contains only one digit X, then you can write this has 0 X, which is the second part of the answer. **For example: 52 x 52 = 2704**.

3) **Squaring a two digit number beginning with 9**
   a) Take a two digit number beginning with 9

b) Subtract it from 100

c) Subtract the difference from the original number. This is the first part of the answer.

X X – –

d) Square the difference. This is the last part of the answer.

– – X X

Example: Let the number is 96. Subtract it from 100

i.e 100 – 96 = 4

Again subtract the difference 4 from 96

i.e 96 – 4 = 92.

This is the first part of the answer.

9 2 – –

Take the square of the first difference i.e 4

i.e 4 x 4 = 16

This is the second part of the answer.

– – 16

Hence we have, **96 x 96 = 9216**.

Similarly you can find the square of other two digit numbers beginning with 9. The same pattern of multiplication works for these numbers also.

Suggested Activity: Identify the pattern of multiplication of two digit numbers beginning with 2, 3 , 6 - - - - etc.,

Activity 6

Objective: Finding the square of two digit numbers with a known ending digit through pattern identification.
Pre-requisite knowledge: Knowledge of numbers and multiplication
Procedure: In this activity we are finding the square of a two digit numbers with a known ending digit through pattern identification.

1) **Squaring a two digit number ending in 1**
   a) Take a two digit number ending with 1
   b) Subtract 1 from the number
   c) Square the difference
   d) Add the difference twice to its square
   e) Add 1

Example: Let the number is 4. Subtract 1 from 41 ie **41 − 1 = 40**
Square the number 40. **i.e 40 x 40 = 1600**
Add the difference 40 twice to its square 1600
i.e 1600 + 40 + 40 = 1680
Add 1 to it. **i.e 1680 + 1 = 1681**
Hence **41 x 41 = 1681**

Similarly you can find the square of other two digit numbers ending with 1 with the same pattern of multiplication.

2) **Squaring a two digit number ending with 6**
   a) Take a two digit number ending with 6
   b) Square the second digit (keep the carry), the last digit of the answer is always 6 **i.e − − − 6**
   c) Multiply the first digit and 2 and add the carry (keep the next carry). This is the second digit in the answer
   i.e − − X −
   d) Multiply the first digit by the next consecutive number and add the carry. This product gives the first two digits in the answer. **i.e X X − −**

Example: a) Let the number is 46.

b) Square the second digit. **i.e 6 x 6 = 36**.

The last digit of the answer is 6 (keep the carry 3)

i.e – – – 6

c) Multiply the first digit 4 by 2 and add the carry 3 (keep the next carry)

i.e 4 x 2 = 8 and 8 + 3 + 11

The next digit of the number is 1 **i.e – – 16**

d) Multiply the first digit 4 by next consecutive number 5 and add the carry 1. **i.e 4 x 5 = 20 and 20 + 1 = 21**

Hence the first two digits of the answer is 21

i.e 21 – –

Hence we have,

46 x 46 = 2116

The same pattern of multiplication holds good for other two digit numbers ending with 6.

Suggested Activity: Find out the patterns of multiplication for squaring of two digit numbers ending with 2, 3, 4, 5, 7, 8 , 9 .

Activity- 7

Objective: Finding the square f numbers made up of same digits.
Pre-requisite knowledge:- Knowledge of numbers and multiplication
Procedure:

(1) **Squaring of numbers made up of 1's**

a) Choose a number made up of one's (up to 9 digits).
b) The answer will be a series of consecutive digits beginning with 1 up to the number of one's in the given number and back to 1

Example: Let the number is 111111 (6 digits)

Then we have, $\mathbf{(111111)^2 = 12345654321}$ (ie begin with 1,up to 6, then back to 1).

Similarly you can see that, $\mathbf{(111)^2 = 12321}$

$\mathbf{(1111)^2 = 1234321}$

… and so on.

2. **Squaring of numbers made up of 3's**

a. Choose a number made up of three's up to nine digits

b. The square is made up of :

(i) One fewer 1 then there are repeating 3's

(ii) The digit zero after the digit 3

(iii) One fewer 8 then there are repeating 3's

(iv)The last digit as 9

Example: Let the number to be squared is 33333

Then the square of this number has four 1's (one fewer than the digits in number)

i.e **1111** - - - - - -

Next digit is 0

i.e - - - - 0 - - - - -

four 8's (same number as 1's)

i.e - - - - - 8888 –

The final digit is 9

i.e - - - - - - - - - 9

So we have,

$$(33333)^2 = 1111088889$$

Similarly you can see that,

$$(333)^2 = 110889$$

$$(3333)^2 = 11108889$$

. . . and so on.

3) Squaring of numbers made up of 9's

a) Choose a umber made up of 9's (up to 9 digits)

b) The answer will have the digits 9 one less then the number of digits in the given number, one digit as 8, the same number of zeros as 9's and a final 1.

Example: Let the number be 99999

The square of this number has:

(i) The digits 9 one less than the total number of digits 5 in the given number.

i.e 9999 - - - - - -

(ii) One digit as 8 after 9's

i.e 99998 - - - - -

(iii) The same number of zero's as 9's

i.e **999980000** –

(iv) The final digit as 1

i.e **9999800001**

Hence we have,

$$(99999)^2 = 9999800001$$

Similarly we can find,

$$(999)^2 = 998001$$
$$(9999)^2 = 99980001$$

….. and so on.

Suggested Activity: Identify the pattern in squaring the number made up of 6's. What happens when other numbers taken as digits Record your observations.

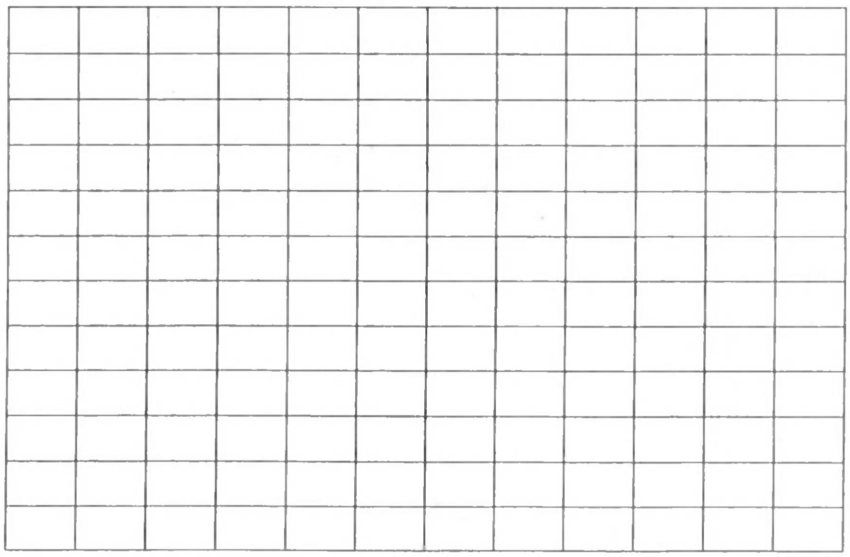
Activity 8

Objective : To find the least common multiple (LCM) of numbers
Prerequisite knowledge : Knowledge of numbers, multiples.
Materials required : Hard board, chart paper, scale, pencil, eraser, sketch pens, saw.

Procedure :

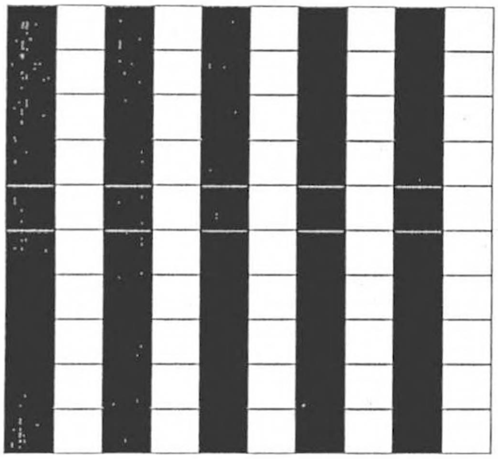
A) Preparation :

1) Cut a 12 x 12 units size hard board. This will be the base board.

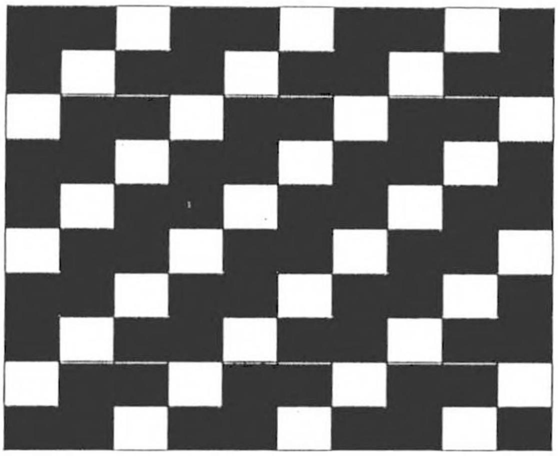


2) Cut 5 more boards of this measurements.
3) All the boards will have a margin of one unit width on all the four sides.
4) On a base board, make a 10 x 10 units square and make equal squares on it.
5) Paste the heading on top of the base board and write numbers 1to 100 on these squares.
6) On the other 5 boards make 100 equal squares leaving the margin

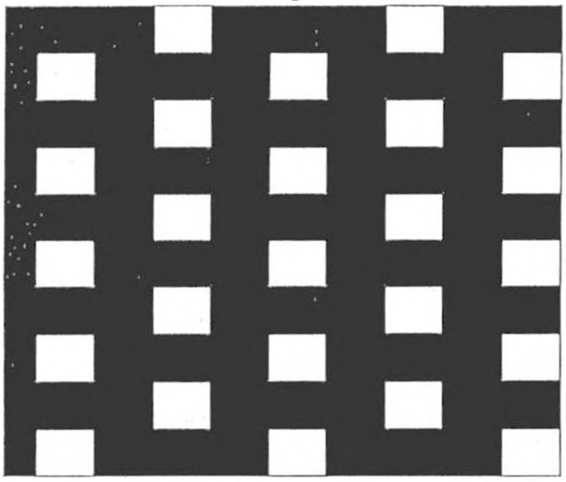
Multiples of 2



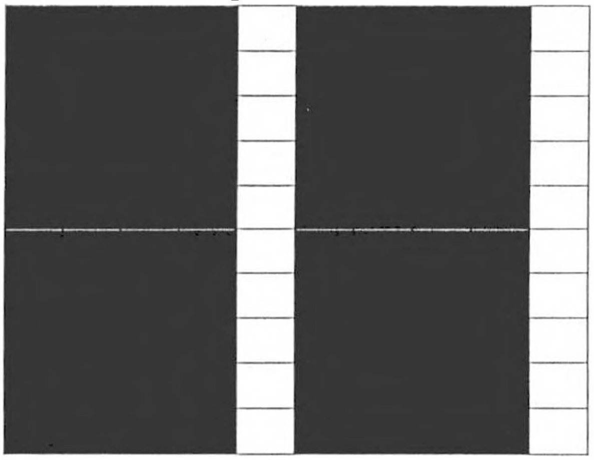
multiples of 3



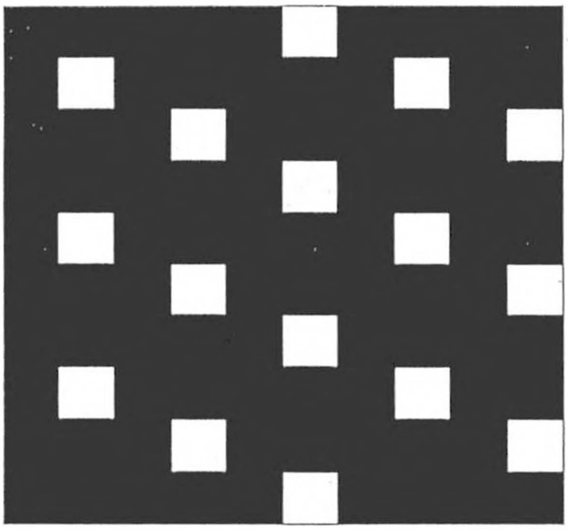
Multiples of 4



multiples of 5



Multiples of 6



7) Each board represent the multiples of different numbers such as 2,3,4,5.6 etc.
8) Drill the squares which represents the multiples of the number specified.
9) Paste to the respective headings written on the chart paper on these boards as , Multiples of 2, Multiples of 3, Multiples of 4, Multiples of 5, Multiples of 6 etc.

B) **Demonstration** :

1) Take the base board first.
2) Place the second board on it which shows the multiples of 2 on the top of the second board.
3) Now place the third board which shows the multiples of 3 on the top.
4) Now see the common multiples of 2 & 3 and we can see easily find the least common multiple of 2 and 3.
5) Similarly, place the next board i.e. the multiples of 4 on top of it.
6) Then place the boards containing multiples of 5, multiples of 6 etc.
7) We see that 60 is the least common multiple of 2,3,4,5 and 6.

Remark : This activity can be used in teaching the concept of multiples of specified numbers. It can also be used to find the least common multiples of two or more numbers.

Activity 9

Objective : TO find the highest common factor (H C F) by division method.

Prerequisite knowledge : Knowledge of numbers, common factors.

Materials required : Thrmocol sheet, one unit wide card board strips, color paper, glue, scissors, scale , pencil.

Procedure :

Preparation :

1) Take a thermocol sheet of about 50 x 50 units . Cover it with white paper.
2) Cut one unit wide card board strips to get 2 pieces of 35 units, 3 pieces of 20 units, 3 pieces of 15 units, 4 pieces of 5 units length.
3) Stick the card board strips as shown in the below figure;

```
--------------------------------------------------- 35
-------------------------------20
--------------------------------------------------- 35
---------------20--------------+-------15---------- 35
-------------------------------20
----------15--------+---5----20
----------------------15
---5---+--5--+--5---15
```

Demonstration :

1) The first set of strips represents the numbers 35 and 20 whose H C F is to be found.

2) The second set of strips shows the division of the larger number by the smaller number i.e. 35 = 20 x 1 + 15 .

```
20) 35 ( 1
    20
  --------
    15
```

3) The third set of strips shows the division of 20 by 15. Remainder 5 is the next divisor.

```
15 ) 20 ( 1
     15
  ----------
     05
```

4) The fourth set of strips shows the division of 15 by 5 i.e. 15 = 5 + 5 + 5

```
5 ) 15 ( 3
    15
  --------
    00
```

Thus the required H C F of 35 and 20 is 5 (i.e. the last divisor in the process when the remainder is zero)

5 units strips can measure 35 units and 20 units strips an exact number of times i.e. the numbers 20 and 35 are exactly divisible by 5.

Remark :

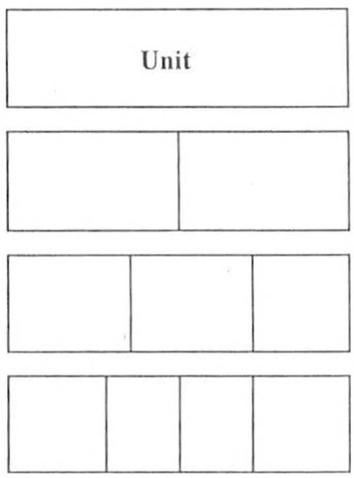
This activity can be used to explain the methods of finding H C F of two numbers by continued division. Similarly we can extend this activity to two or more numbers also.

Activity 10

Objective : To understand the concept of fractions , their comparison and operation on them through fractional kit.
Prerequisite knowledge : Knowledge of numbers, basic idea of fractions.
Materials required : Hard board, card board, glaze paper, adhesive, scale, sketch pen , scissors.
Procedure :
Preparation :

1) Cut out a rectangle from the card board sheet.
2) Paste a full card board sheet under the remaining portion of the card board taken above.
3) Cut out rectangle as a unit which can be fixed in the card board frame made in the above step.
4) With the help of card board, make different parts of the rectangular unit like half (vertically) , half (horizontally), one third, two thirds, one fourth, two fourths, three fourths, one sixth, two sixths, three sixths, like wise one eighth, two eighths,..etc

Unit and its parts inside



5) Make a pocket at the back of the model to keep parts of the model.

Demonstration :

This model demonstrates,

a) The verification of the result, 2/2 = 3/3 = 4/4 = 5/5 = 6/6 = ... = 1.
b) The concept af equivalent fractions like, ½ = 2/4 = 3/6 = 6/12 etc.
c) Addition and subtraction of fractions having same denominators like,
   ½ + ½ = 1 , 1/3 + 2/3 = 1 , etc.
d) Comparison of fractions like, ½ > 1/3 > ¼ > 1/5 ...etc.
e) Multiplication of fractions like, ½ x 1/3 = 1/6, ...etc.

And many other properties relating to fractions.

We will explain these through some examples as follows;

a) i) Take two halves of the unit.
   ii) Put both half parts simultaneously and show they and unit cover each other completely.
   iii) Since one part is one out of two equal parts, so it is one by two i.e. ½.
b) Two halves (½) cover the whole unit , i.e. 2/2 = 1
   Three one thirds (1/3) cover the whole unit , i.e. (3/3) = 1
   Four one fourths (1/4) cover the whole unit , i.e. (4/4) =1 and so on.

c) Take (½) of the unit. Put two (¼) of the unit on (½) unit as above. They will cover each other completely. This shows that ,
   ½ = ¼ + ¼ = 2/4.
   Like wise , we can show that, ½ = 1/6 + 1/6 + 1/6 = 3/6 and so on.

d) Take two one thirds and put them together i.e 1/3 + 1/3.
   These are two parts of three equal parts . So these are equal to 2/3.
   Hence 1/3 + 1/3 = 2/3 .
   Like wise ¼ + ¼ + ¼ = ¾ and so on.
e) Take ½ , 1/3 , ¼, 1/6, 1/8 and on comparing by placing one over the other, we find that , ½ > 1/3 > ¼ > 1/6 > 1/8 .
f) Take ½ of the unit 1/3.

See that $\frac{1}{2} \times 1/3$ = one half of one third i.e. one sixth = 1/6

Like wise we can show that,

$\frac{1}{2} \times \frac{1}{4} = 1/8$

$\frac{1}{2} \times 2/4 = 2/8$

$\frac{1}{2} \times \frac{3}{4} = 3/8$ and so on.

Remark : This activity can be used to explain the concepts of fractions, their comparisons and operations on them through visually.

Activity : 11

Objective : To understand the concept of percentage through geometrical visualization.

Prerequisite knowledge : Concept of number line, division.

Materials required : Circular pieces of paper, square piece of paper, graph paper, protractor, pencil.

Procedure :

Many students have trouble with percents both in the elementary and higher level schools. Heavy emphasis on computational algorithmic procedures often leaves the student without a solid understanding of the concept and with little skill in mental manipulation of percents. Many students cannot visually estimate percents because they seldom see the subject in a geometric light. Concrete aids, activities and manipulative experiences related to percent often clarify and reinforce the concept, which to many is extremely abstract. We discuss some of the activities in this background.

Activity A :

i) Cut out two circular pieces of paper of the same size but different in colour.

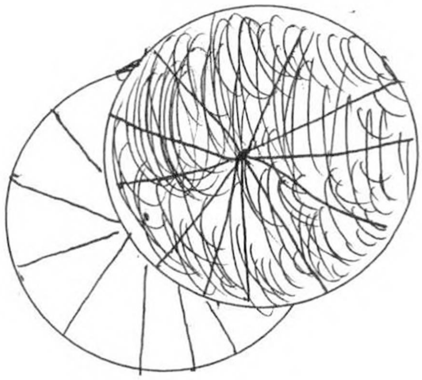
ii) Use a protractor to divide each into 10 equal sectors.

iii) Cut along one radius to the center of each circle.

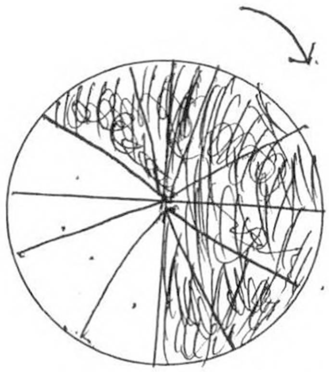
iv) Insert one circle inside the other so that it can rotate and exposing anything from 0% to 100% of that colour.

v) Using both marked sides, students can count off by 10% units to get a visual reinforcement of various percents.

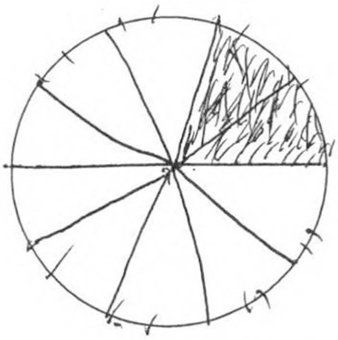
vi) Using the unmarked sides, students gain valuable experience in visual estimation.



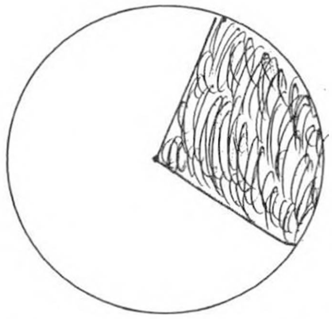
Insert one circle inside another



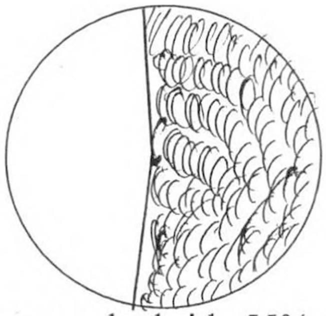
Rotate marked side 60% shades shaded



Rotate marked side 20% shades shaded



Rotate unmarked side 35% shaded



Rotate unmarked side 55% shaded

Activity B :

A number line can serve as a valuable model in doing percent problems mentally. For problems involving 25% , 50%, and 75% ,begin by dividing the number line in to four equal parts.

0% 25% 50% 75% 100%

/------------/.-------------/.-------------./-----------/

What is 75% 0f 12 ?

Place o under 0% and 12 under 100% . The number that would be under 75% is 9.

Note that the same picture can be used when mentally visualizing these problems as well,

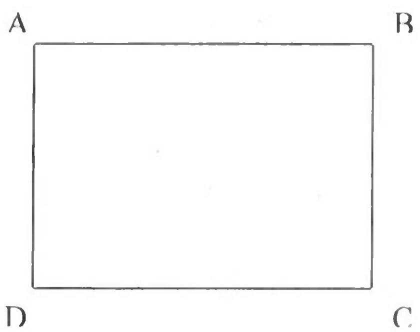
a) 9 is 75% of what number?
b) 9 is what percent of 12?

The goal here is to encourage the student to think on the number line mentally. Time spent reviewing simple percent problems with models can significantly improve the students understanding, comfort and mental dexterity with percents later on.

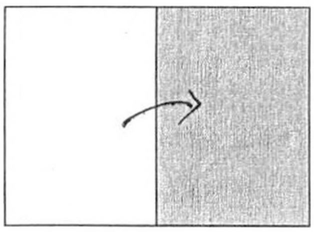
Activity C :

Concrete activities in the hands of students provide valuable experiences and allow to present using a geometric rather than as arithmetic model. This frequently leads to interesting problem solving situations.

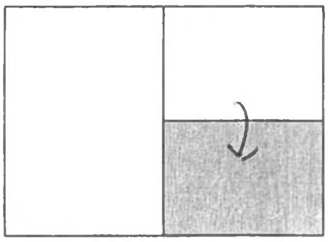
i) Give each student a square piece of paper and label the vertices in order A, b, C, and D.



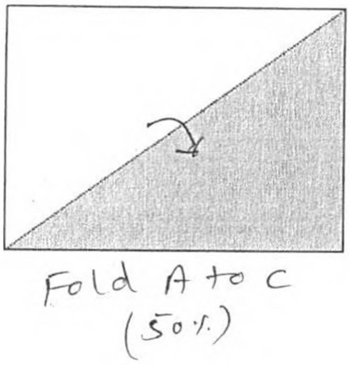
ii) Fold the square as indicated in the below figures,

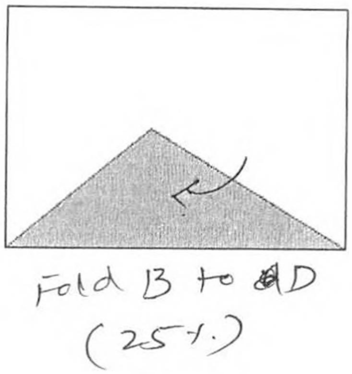


Fold A to B (50%)



Fold B to C (25%)





iii) Now see how many students can give the correct percent of the original square remaining in these cases without actually folding square as a check.

a) Fold A to the mid point of side AB (75%)
b) Fold A,B, C, and D to the center of the square (50%)
c) Fold A to C and then B to C (37 (1/2)%)

Remark :

These activities gives the enough exposure to the students in the process of understanding percents. Once the basic concepts visualized clearly, then the concept can be developed mathematically.

Activity 12

Objective : To represent decimals and their addition and multiplication ac a grid.

Prerequisite knowledge : Knowledge of decimals, converting decimals in to fractions with 100 as denominator.

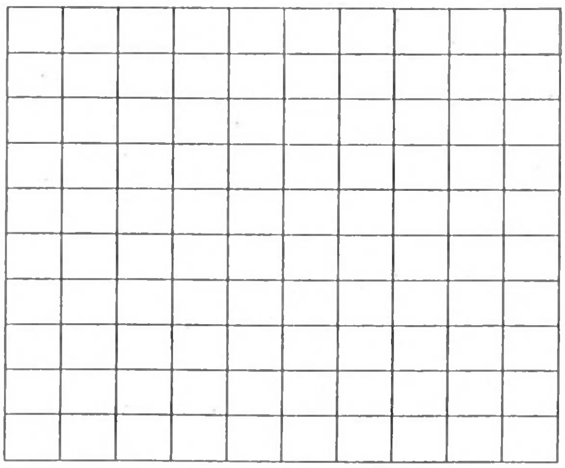
Materials required : Geometry box, squared paper, colour pencils, glue sticks.

Procedure :

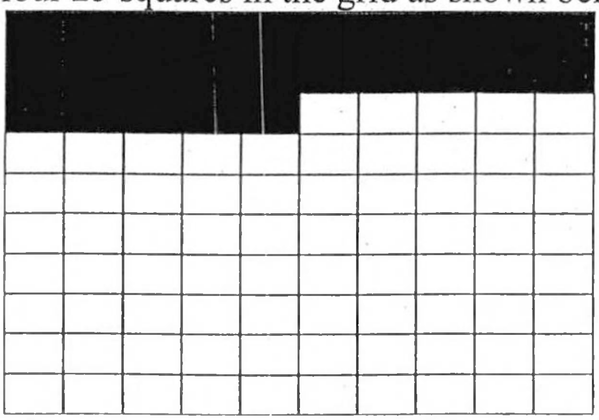
Part I : Let us represent decimal numbers a) 0.25 b) 0.5 c) 0.75 d) 0.68 on a grid.

a) To represent 0.25

1) Draw a 10 x 10 grid on a squared paper.



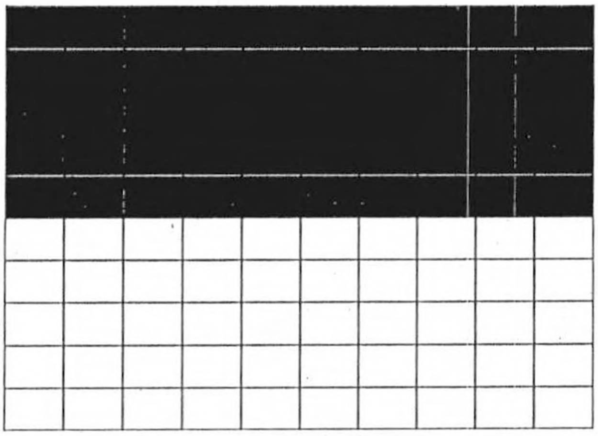
2) 0.25 can be written in fraction form as 25/100 , which means 25 out of 100. colour 25 squares in the grid as shown below.



The coloured portion represents 0.25 of the grid.

b) To represent 0.5 :

1) 0.5 is the same as 0.50.
2) 0.50 can be written in fraction form as 50/100 , which means 50 out of 100.
3) On the 10 x 10 grid , colour 50 squares to represent 0.5 as shown below.

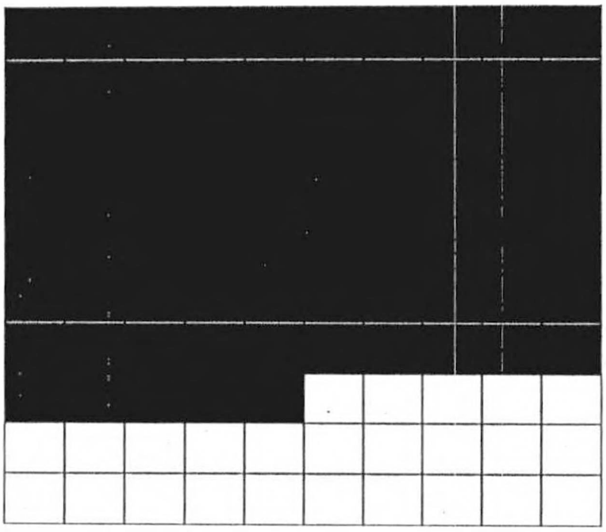


The coloured portion represents 0.5 of the 10 x 10 grid.

c) To represent 0.75 :

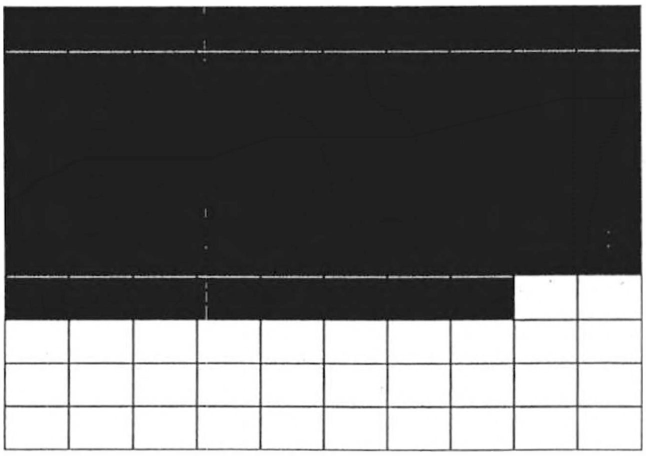
1)0.75 can be written in fraction form as75/100 , which means75 out of 100.

2) On the 10 x 10 grid , colour 75 squares to represent 0.75 as shown below.



The coloured portion represents 0.75 of the 10 x 10 grid.

1) 0.68 can be written in fraction form as68/100 , which means68 out of 100.
2) On the 10 x 10 grid , colour 68 squares to represent 0.68 as shown below.



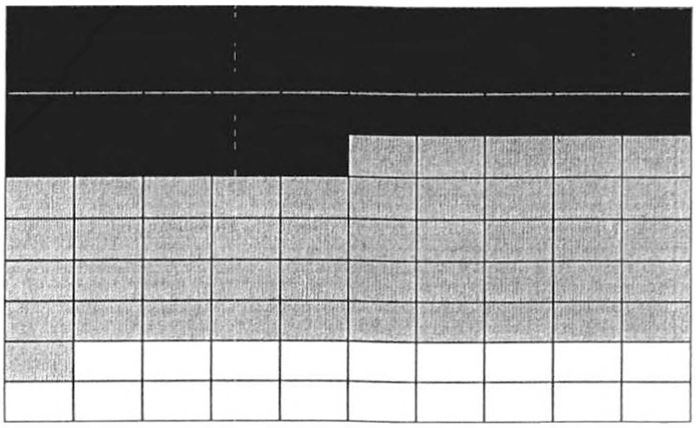
The coloured portion represents 0.68 of the 10 x 10 grid.

Part II : Let us represent the following addition and multiplication using a 10 x 10 grid **a) 0.35 + 0.46 b) 3 x 0.26 .**

a) To represent 0.35 + 0.46 :

Here 0.35 = 35/100 and 0.46 = 46/100

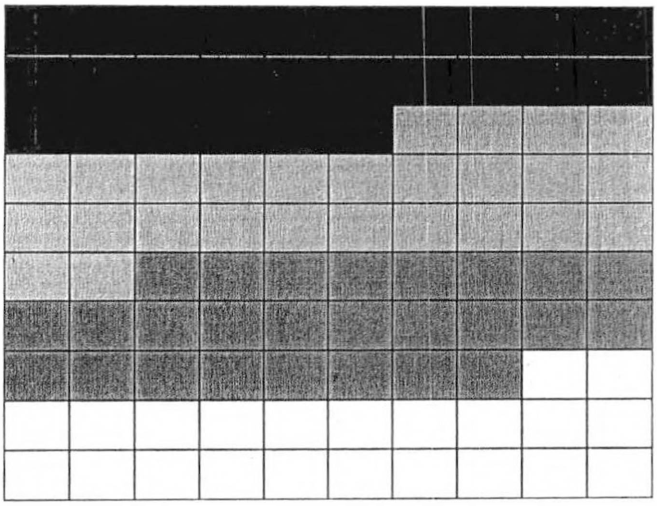
On a 10 x10 grid represent 0.35 as done in part I . This will require to colour 35 squares. on the sane grid colour further 46 squares to represent 0.46.



The total number of squares coloured is 81.
Thus the sum is 81/100 = 0.81.
There fore **0.35 + 0.46 = 0.81**

b) To Represent 3 x 0.26 :

Here 3 x 0.26 is same as 0.26 + 0.26 + 0.26 .
Then 3 x 0.26 can be represented by representing 0.26 + 0.26 + 0.26 using the method applied previously.



The total number of squares coloured is 78.
Thus 0.26 + 0.26 + 0.26 = 0.78.

Activity – 13

Topic : Concurrency properties of plane figures – a) triangle, b) parallelogram, c) circle

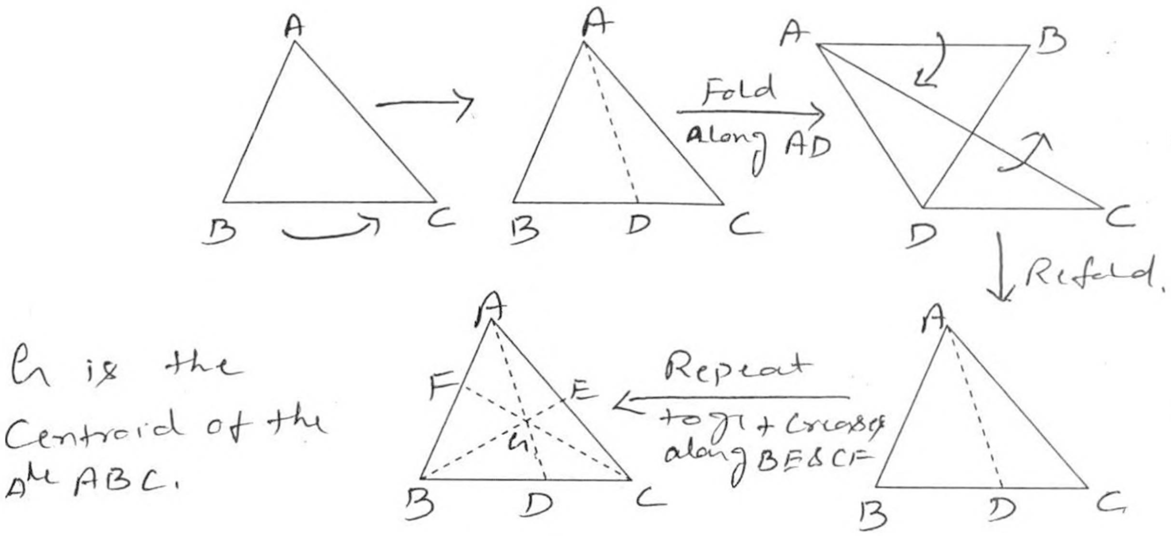
Objective : To understand that

(i) in a triangle, a) medians, b) altitudes and c) angle bisectors are concurrent.
(ii) In a parallelogram, the diagonals bisect each other.
(iii) In a circle, the perpendicular bisectors of chords are concurrent at the center.

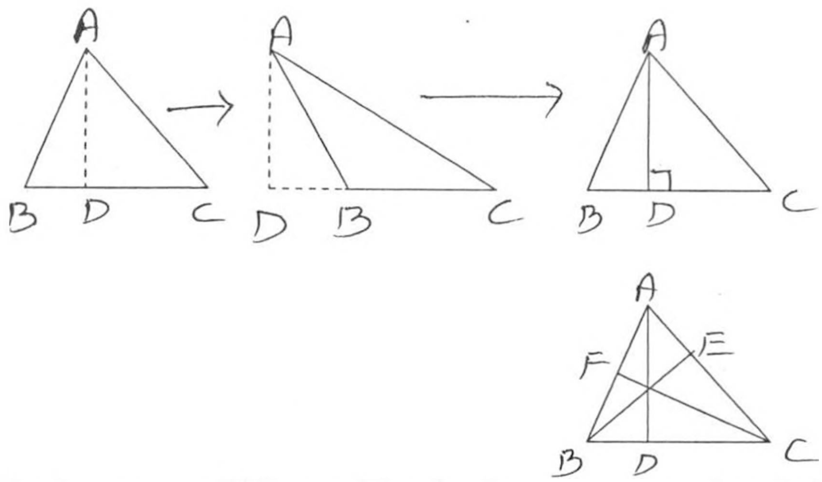
Previous Knowledge: Knowledge of plane figures like triangles, parallelogram and circle.

Material needed : Triangular and rectangular white paper sheets.

I. Cut out a triangular piece- ABC. Mark the midpoint of each sides as D,E,F. For this, bring B and C to coincidence along BC. The crease cuts BC at the midpoint and so on. Then fold along AD, BE and CF in succession.

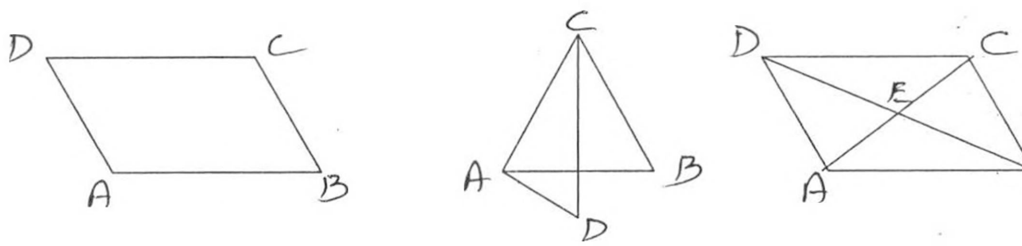


II. Cut out a triangle ABC. Fold the triangle bringing the segments of BC to coincidence so as to get the crease AD perpendicular to BC. AD is an altitude. Likewise, get the altitudes BE and CF. All these creases along the altitudes pass through a point O.

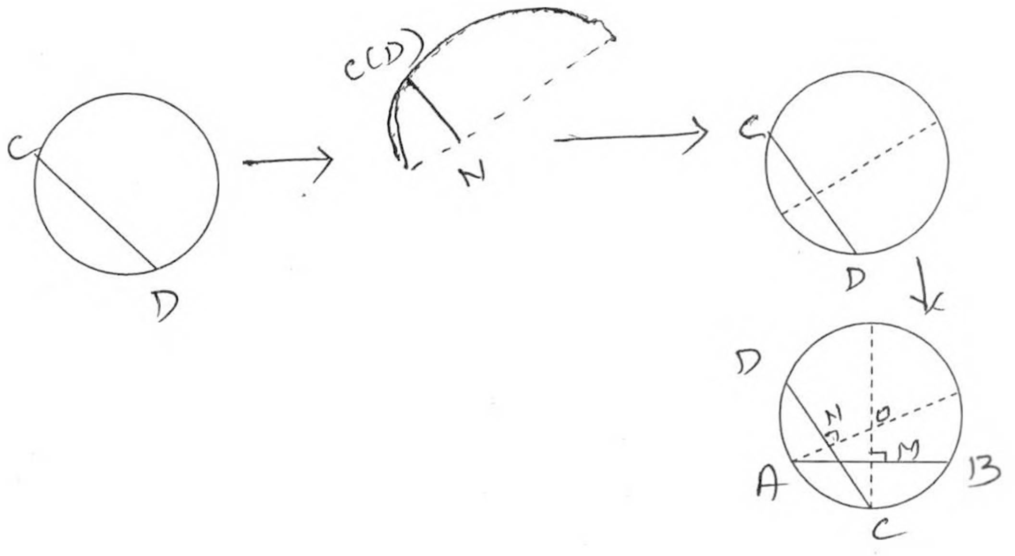


Ex : Design a paper folding activity for the concurrency of angle bisectors of a triangle.

III. Cut out a parallelogram ABCD. Fold along AC. Fold along BD. The creases along AC and BD are diagonals. They intersect at E. Verify that E is the midpoint of each diagonal – by first bringing A and C to coincidence so that the crease passes through E. And next, by bringing B and D to coincidence to see that the crease passes through E again.



IV. Cut out a circle. Fold it along a chord AB. Fold it perpendicular to AB by bringing A and B to coincidence. The crease so got is the perpendicular bisector of AB. Similarly, have another chord CD and its perpendicular bisector. The creases corresponding to the perpendicular bisectors of the chords are concurrent at the center of the circle – verify that the point so got is the center of the circle.


C
D
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N
C
D
D
N
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M
A
B
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Activity – 14

Topic : Geometry – Pythagoras Theorem

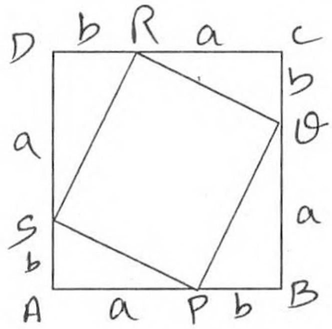
Objective : Verification of Pythagoras Theorem

Pre-knowledge: Knowledge of right angled triangle

Materials Needed: White paper sheets

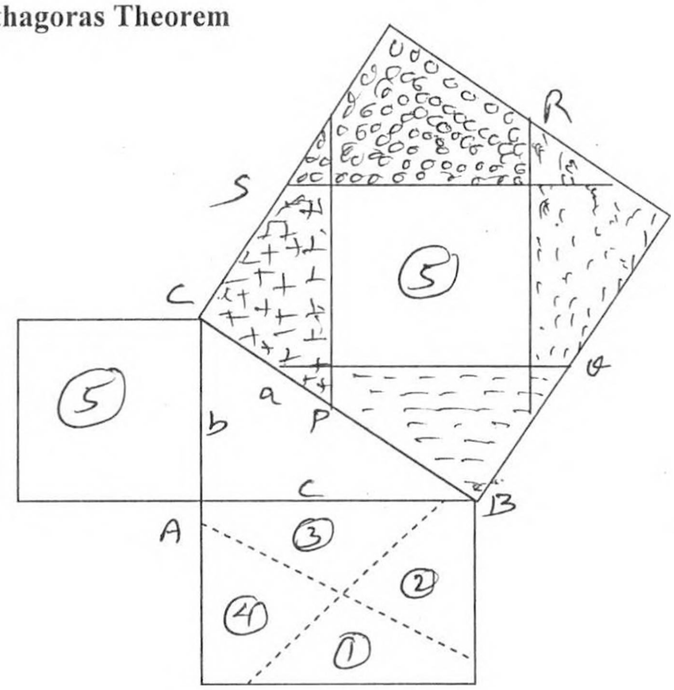
Activity : In the following figure, we find

$(a + b)^2 = 4\left(\frac{1}{2}ab\right) + c^2 \quad \Rightarrow \quad a^2 + b^2 + 2ab = 2ab + c^2 \quad \Rightarrow \quad c^2 = a^2 + b^2$



$\Rightarrow (a + b)^2 = 4\,(\tfrac{1}{2}ab)^2 + c^2$

Verification of Pythagoras Theorem



Construction : Construct a right angled triangle ABC. BC is the hypotenuse of the triangle so that $\hat{A} = 90^{o}$. Mark the mid points of the sides of the square on the hypotenuse BC say P, Q, R, S. P and R are midpoints of opposite sides parallel to BC, while Q and S are midpoints of the other parallel sides. Construct square on the other sides of the triangle ABC. Through P and R, draw parallels to AC. Through Q and S, draw parallel to AB. The lines so drawn divide the square on BC into 5 regions of which four are identical quadrilaterals (1), (2), (3) and (4) and a square (5). Square (5) is translated to the square on AC. The four quadrilaterals are fitted into the square on AB. Thus the pieces (1), (2), (3) and (4) together have the area of the square on AB and the area of the square (5) is equal to that of the square on AC.

$\therefore$ Square on AB + sq. on AC = sq. on AC

i.e. $c^2 + b^2 = a^2$ or $a^2 = b^2 + c^2$

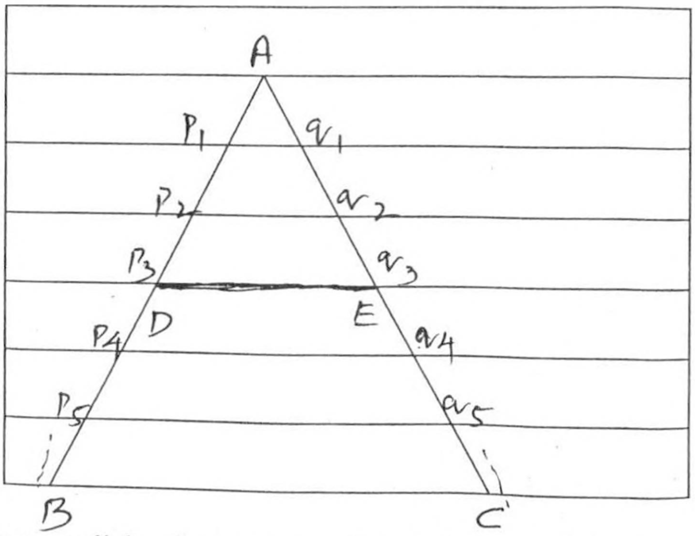
Activity – 15

Topic : Basic Proportionality Theorem in Triangles

Objective: To verify Basic Proportionality Theorem (Thales)

Pre-knowledge : Knowledge of parallel lines.

Materials Needed : A parallel line board consists of a number of parallel lines separated by the same (or unit) distances.



Fix one vertex A on a parallel and two vertices B and C on the different parallel. Join the vertices. ΔABC is got. Each side AB and AC is divided into equal segments and same number of segments. Any parallel DE to BC divides AB and AC in the same ratio.

Fix two scales one along AB and the other along BC. Then it can be easily seen that AB and AC are divided into the same number of equal segments.

Activity – 16

Topic : Properties of a Parallelogram

Objective : To understand that in a parallelogram,
i) the diagonal divides it into two congruent triangles.
ii) Opposite sides are equal.
iii) Opposite angles are equal.

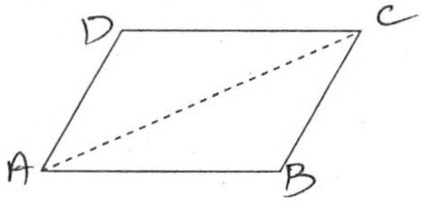
Pre-knowledge : Knowledge of terms associated with quadrilaterals, congruency of triangles.

Material Needed : Chart paper and Geometry Box.

Activities :

Paper cutting :

- Cut out a parallelogram ABCD from a sheet of paper.
- Join the diagonal AC.
- Cut it along the diagonal AC to get two triangles ΔABC and ΔADC.
- Place one triangle over the other so that they overlap. We can see that ΔABC coincides with the ΔCDA.



Observation :

- The triangles are overlapping. The triangles are congruent.
  $\Delta ABC \cong \Delta CDA$.
- AB = DC and AD = BC.
- $\angle B = \angle D$.

Conclusion

- The diagonal of a parallelogram divide it into two congruent triangles.
- In a parallelogram, opposite sides are equal.
- In a parallelogram opposite angles are equal.

Follow up activity : Perform the above activity in case of the following quadrilaterals and record your observations.
i) Rectangle
ii) Rhombus
iii) Square
iv) Trapezium
v) Kite

Activity – 17

Topic : Properties of a parallelogram

Objective : To verify that the diagonals of a parallelogram bisect each other.

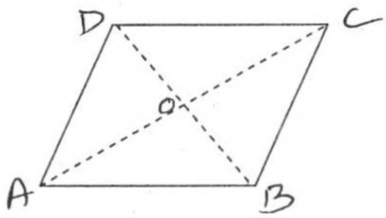
Pre-knowledge : Congruency of triangles.

Material Needed : Chart paper, geometry box.

Activities :

Paper cutting :

- Cut out a parallelogram ABCD from a sheet of paper.
- Draw the diagonals AC and BD to intersect at O.
- Cut the ΔAOB from the parallelogram.
- Place the triangular piece AOB over the triangle COD.



Observation :

- The Triangles are overlapping i.e. they are congruent. ΔAOB ≅ ΔCOD.
- OA = OC and OB = OD.
- O is the midpoint of AC and O is the mid point of BD.

Conclusion : Diagonals of a parallelogram bisect each other.

Follow up activity :

1. Suggest another activity to prove the above result by paper folding method.
2. Perform the activity for a square and rhombus.
3. What can you deduce from that activity?

~~Activity 5 :~~

~~(i) ΔADC ||| ΔCEB~~

~~(ii) ΔADC ||| ΔAEB~~

Activity – 13

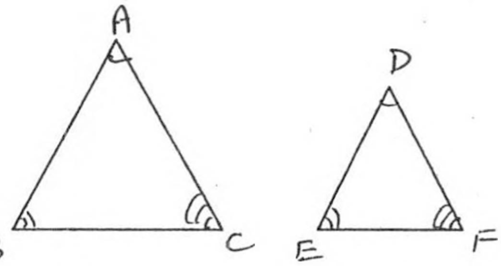
Topic : Similarity of Triangles

Objective : To understand the similarity of triangles.

Pre-knowledge : Concept of similarity in simple plane figures.

Materials Needed : White sheet pieces of triangular shape.

Activity No.1 :

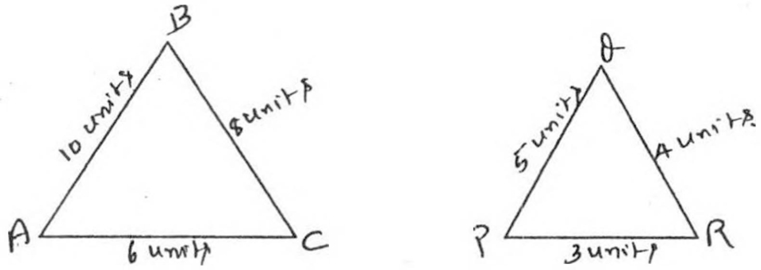


If ΔABC and ΔDEF are similar, then

- A corresponds to D
- B corresponds to E
- C corresponds to F

Symbolically, we write the similarities of these two triangles as,
ΔABC ~ ΔDEF and
read it as
Triangle ABC is similar to triangle DEF.
The symbol '|||' stands for "is similar to".
Recall that we have used for the symbol "≅" for is 'congruent'.

Activity 2:
Construct two triangles ABC and PQR as shown below.



In triangle ABC and triangle PQR,

$$\frac{AB}{PQ} = \frac{AC}{PR} = \frac{BC}{QR}$$

$$\frac{10}{5} = \frac{6}{3} = \frac{8}{4} = \frac{2}{1} = 2$$

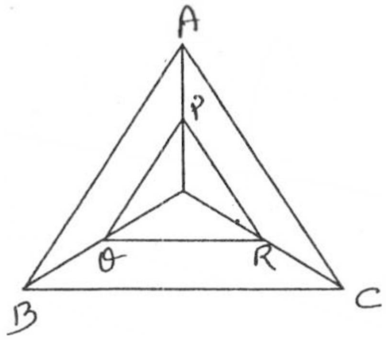
Here corresponding sides are in the same ratio
∴ ΔABC ||| ΔPQR

Exercise : Draw two triangles ABC and DEF such that AB = 3cm, BC = 6 cm, AC = 8 cm, DE = 4.5 cm, EF = 9 cm and FD = 12 cm and check the similarity by comparing the corresponding angles.

Activity 3 :

ΔABC ||| ΔPQR

Construction : Draw ΔABC and take one point inside the triangle and join the point with vertex of each side and then take midpoints PQR and join we get another triangle PQR then ΔABC ||| ΔPQR.



Activity 4 :

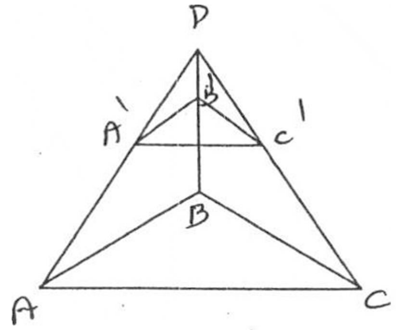
ΔABC ||| ΔA′B′C′.

Construction:

Draw ΔABC in big triangle ADC and join BD to get one pyramid.

Then take A′B′C′ on the triangle ADC and join to get ΔA′B′C′.

∴ ΔABC ||| Δ A′B′C′.



Activity 5 :

i) ΔADG ||| ΔGCF

ii) ΔADG ||| ΔFEB

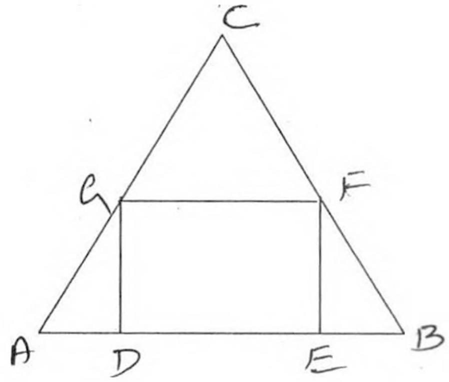
Construction:

m∠GDA = m∠GCB = 90°

∴ ΔADG ||| ΔGCF.

ΔADG ||| ΔFEB, ΔGCF.

∴ ΔADG ||| ΔFEB.



Activity 6 :

In ΔABC, the mid point of BC, CA, AB is D, E, F.

To join DEF to get ΔDEF.

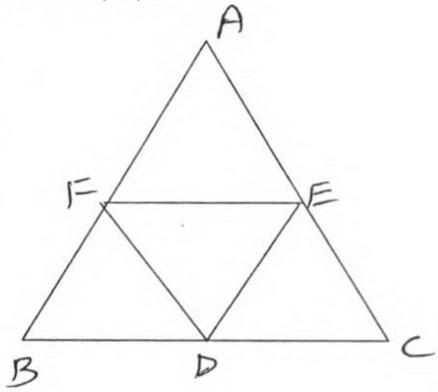
D, E are the midpoints of BC, CA

Or DE = ½ AB.

Similarly, EF = ½ BC, FD = ½ CA

$\therefore \quad \frac{DE}{AB} = \frac{EF}{BC} = \frac{FD}{CA} = \frac{1}{2}$ or

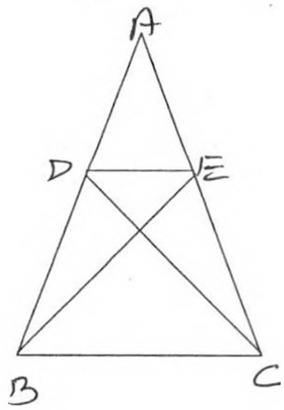
ΔDEF ||| ΔABC.



Exercise :

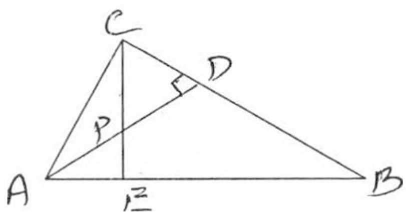
1. In Fig. If ΔABE ≡ ΔACD

Show that ΔADE ||| ΔABC.



2. In figure altitudes AD and CE of ΔABC intersect each other at the point P. Show that

   i) ΔAEP ||| ΔCDP
   ii) ΔABD ||| ΔCBE
   iii) ΔAEP ||| ΔADB
   iv) ΔPDC ||| ΔBEC



Activity – 18

Topic : Geometry

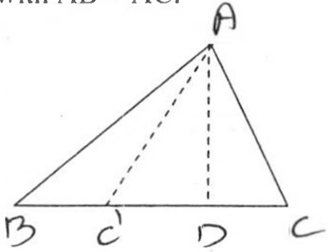
Objective : To verify that in a triangle, the angle opposite to the bigger side is bigger than the angle opposite to smaller side.

Pre-knowledge : Knowledge of angles of a triangle.

Material Needed : A triangular piece of paper.

Construction :

Mark a triangle ABC with AB > AC.



1. Fold the triangle ABD so that the crease passes through 'A' and perpendicular to BC. Let the crease intersect BC at D.
2. AC now takes the position AC′.
3. $A\hat{C}C' = A\hat{C'}C > A\hat{B}C$ as $A\hat{C'}C$ is the exterior angle of triangle ABC′.
4. $A\hat{C}B > A\ \hat{B}C$.

Suggested Activities : Do the above activity with different types of triangles and verify the result.

Activity – 19

Topic : Geometry

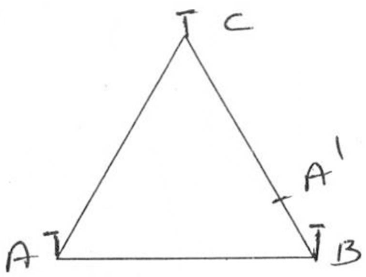
Objective : To see the validity of triangular inequality i.e. sum of any two sides of a triangle is greater than the third side and the difference of any two sides of a triangle is less than the third side.

Pre-knowledge : Knowledge of triangle

Material Needed : Drawing board and elastic strings with pins.

Construction :

1. Take a drawing board.
2. Mark two points A and B on it so that when the board is put in vertical position, AB is horizontal. Fix nails at A and B.



3. Mark another point C where C does not lie on the line AB and fix a nail at C.
4. Take an elastic string. Tie one end with A. Pass the string around the nail at C. Running along AC and bring it to B. The part of the string from A to B around C has length equal to AC + CB. Tie the other end to A. The part ACB looks like a garland shape and so we have
AC + CB > AB

Also if BC > AC, bring the part AC of the string ACB to the position along BC. Keeping the string around C, but removing the end at A. Now the string takes the position BCA′ (where CA = CA′).

Then BC – AC = BC - A′C = A′B < AB
∴ BC – AC < AB

Activity – 20

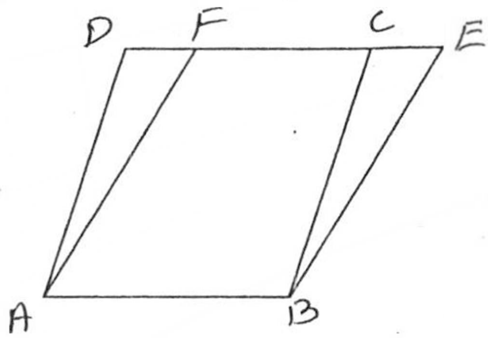
Topic: Geometry

Objective: To verify that parallelogram on the same base and between the same parallels (or with the same height) have equal area.

Pre knowledge: Knowledge of parallelogram

laterials needed: paper, scale, pencil, scissor & gum

Activity: Draw the parallelograms ABCD and ABEF on a common base A and etween the same parallels.



Cut Δ ADF and paste it on Δ BCE. It is seen that area of Δ ADF is same as rea of Δ BEC.
Thus area of parallelogram ABCD

= area of ABCF + area of Δ ADF
= area of ABCF + area of Δ BCE
= area of parallelogram ABEF

Activity – 21

Topic : Geometry

Objective : To verify concurrency theorem by activity.

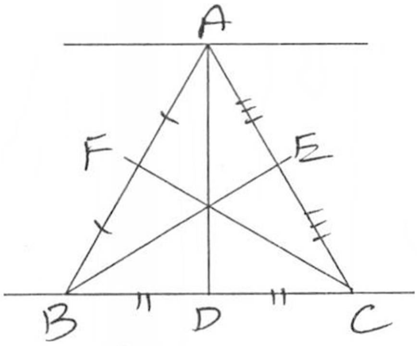
Pre-knowledge : In a triangle
a) the medians
b) the altitudes
c) the angle bisectors and
d) perpendicular bisectors

are all concurrent. Their points of concurrence are
1. the centroid (G)
2. the orthocenter (O)
3. the incentre (I) and
4. the circumference (S) of the triangle.

Material Needed : Drawing board and elastic strings.

Construction :

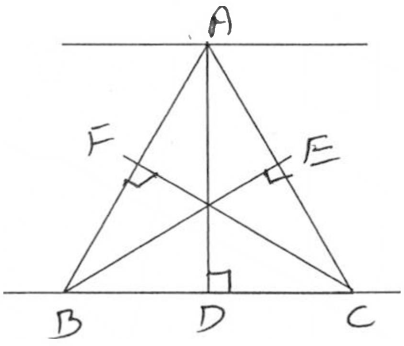
1. A. Physical Medal :
Mount a triangle on a drawing board with sides and vertices which can be verified as follows :



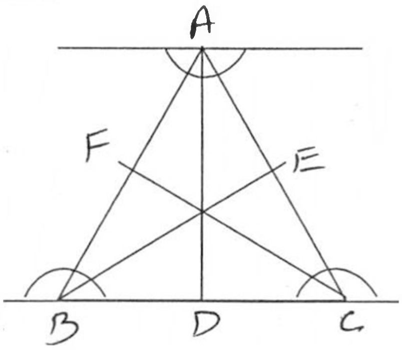
On the drawing board
- i) make a grove along a straight line
- ii) Fix a scale along grove. Any two points B and C are the vertices of triangle ABC.
- iii) The position of A can be varied along a parallel to BC.
- iv) A is connected to B and C by an elastic string AB and AC with marked midpoints in its natural position. The marked points continue to be midpoints of AB and AC in all its positions.
- v) B and C are also connected by an elastic string with midpoint marked in its natural position.
- vi) Each vertex is connected to the midpoints of the opposite side.

The strings AD, BE and CF are always concurrent at a point G called the 'centroid' of the triangle.

2. In the above model, bring the strings AD, BE and CF to the positions (perpendicular to the opposite sides) of the altitudes. The strings AD, BE and CF are concurrent at a point O called the orthocentre of the triangle.



3. Fixing protractor at the vertices, bring the strings AD, BE and CF to the position of angle bisectors.



The strings AD, BE and CF are concurrent at a point (I) called the incenter of the triangle.

Exercise :

i) Verify that I is equidistant from the sides.

ii) Can you inscribe a circle in the triangle?

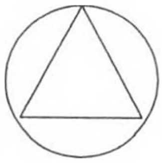
4. Through the midpoint D, E, F of the sides, draw perpendiculars to verify that they are concurrent. This point (S) when the perpendicular bisectors of the sides are concurrent is called the circumcentre of the triangle.

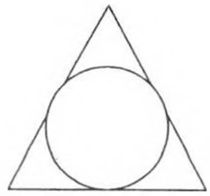
Exercise :

i) Verify that SA,SB, SC are equal.

ii) Can you ascribe a circle to the triangle ?

Note : 1. An explanation about 'inscribe' and 'ascribe'. If two figures P_1 and P_2 are fitted such that one (P_1 say) inside the other (P_2) then P_1 is inscribed in P and in turn P_2 is ascribed in P_1 (lies outside P_1).



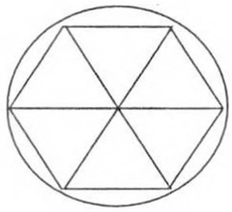


In (i) triangle is inscribed in the circle (fitted inside)
In (ii) triangle is ascribed the circle (fitted outside).

Note 2 : How to (a) inscribe and (b) ascribe a regular polygon in (or out) of a given circle ?

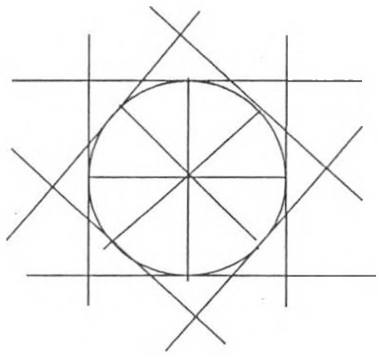
a) To inscribe a regular polygon (of n-sides) in a circle,

i) draw a circle
ii) divide the circle into n equal sector and with angle of each sector equal to $\frac{2\pi}{n}$
iii) Connect (or join) the vertices of the sector in order.



b) In ascribe, a regular polygon (of n-side) in a circle

i) draw the circle
ii) divide the circle into n-equal sectors.
iii) Draw the tangent to the circle at each vertex of the sector. They are perpendicular to the radii. These tangents form the ascribed polygon.



Activity – 22

Topic : Geometry

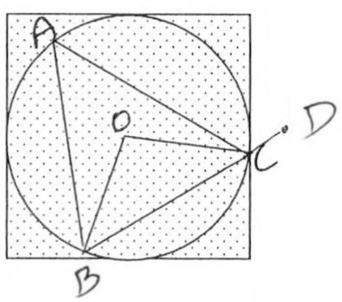
Objective : To verify the interior opposite angle theorem in a triangle.

Pre-knowledge : Concept of interior angle, angles made by an arc at the centre and on the circumference, central angle theorem.

Material Needed : Circle trig geoboard.

Construction :

Step 1 : Form a triangle using Circle Trig Geoboard as shown in the following figure.



Step 2 : Note that you have to verify that ∠CAB + ∠ABC = ∠ACD.

Step 3: Use a rubber band and anchor to the peg at the centre of the circle and pegs at A and C so as to form a triangle. Note that the angle made by the arc BD at the centre is equal to twice the angle made arc on the circumcentre of a circle.

Step 4 : Read ∠AOC. Now compute the angle ∠ABC as ½ of ∠AOC.

Step 5 : By repeating the step 3 for the pegs at A, B and B, C compute the angles ∠BCA and ∠CAB. Also obtain the exterior angle, ∠ACD which is equal to 180° - ∠BCA.

Step 6 : Now compute ∠CAB + ∠ABC and verify this value is equal to ∠ACD.

Activity – 243

Topic : Area of the circle

Objective : To know that the area of the circle.

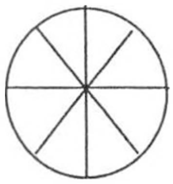
Pre-knowledge : 1. Knowledge of the terms associated with a rectangle.
2. In particular, if a and b are the sides of a rectangle, then a × b is the area of the rectangle.

Material Needed : A cardboard with circle and rectangle shape.

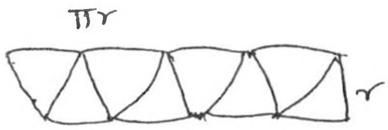
Construction :

i) Draw a circle with radius r.

ii) Cut the circle into large number of equal sectors as follows :



iii) Arrange the sectors as shown below.



If the number of sectors is very large, the resultant figure will be approximately a rectangle.

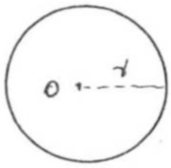
Length of the rectangle = Perimeter of the circle / 2

$$= \frac{2\pi r}{2}$$

$$= \pi r$$

The breadth will be r.

iv) Area of the circle = Area of the rectangle



Area of the rectangle = l × b

$= \pi r \times r$

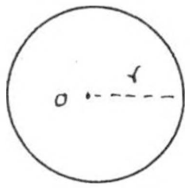
$= \pi r^2$ sq. units

= Area of the circle

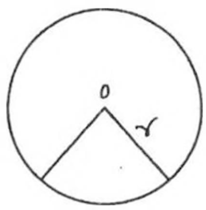
The area of the circle can also be found by considering the area of small sectors as follows.

Construction :

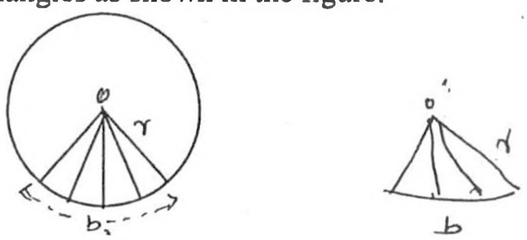
i) Take a circle of radius ‘r’ .



ii) Draw a sector of the circle.



iii) Divide the sector into ‘n’ thin triangles as shown in the figure.



Area of each triangle = ½ . b . r

The total area of the sector A = n × (½ . b . r)

= ½ r l (l = nb) length of the arc.

= ½ . r × (arc length of the sector)

The area of the circle= ½ r . circumference of circle

$= \frac{1}{2} \times r \times 2\pi r$

$= \pi r^2$

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Programme Title: *Development of Enrichment Activities in Mathematics for Elementary School Students of Tamilnadu and Puducherry*

Co-ordinator: Dr. V S Prasad　　　　Date: 27th to 31st December 2010

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