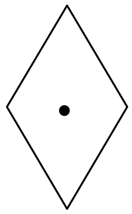
Chapter - 34 Circles

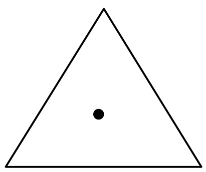
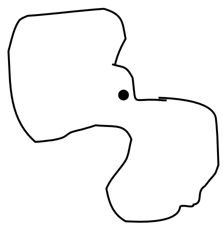
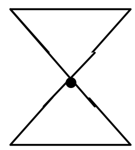
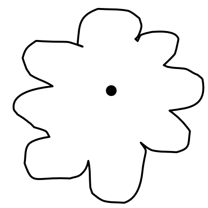
34.1 Is it not strange! Zero and Circle are similar! Something more strange:
Fix a rope with a nail at one end. Rotate the other end (rotate = go round and round) what do you get?

Take a stick: Fix in the middle. Hold the middle and rotate. What do you get?



Take a shape like this fix it at the dot. Rotate what do you get?

Do the same with: (any of these):

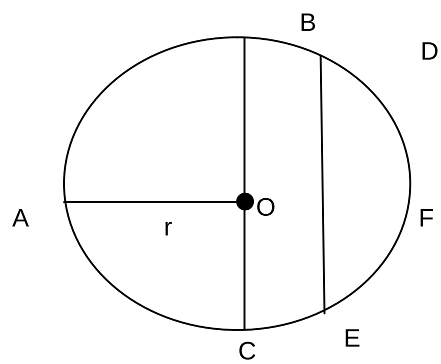
What?

Always a circle.

34.2 Parts of a circle

O CENTER
OA = radius = r
BOC = diameter = d
DE = chord
DFE = arc

(ABDFECA) = Circumference
= C (Our notation)

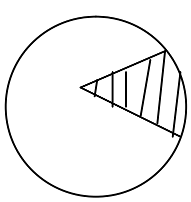


34.2.1 In any circle:
Diameter = 2 x radius i.e, d = 2 r
Diameter is the biggest chord. Circumference is directly related to radius.
C = $2\Pi r$
= Πd where $\Pi = \frac{22}{7}$

[Π is a constant (= it has a fixed value) It is approximately $\frac{22}{7}$ or 3.14]

Area of a circle, A = Πr^2

34.3 Sector



Sector of a circle is the area covered by 2 radii and an arc of the circle. (Radius – singular. Radii – plural).

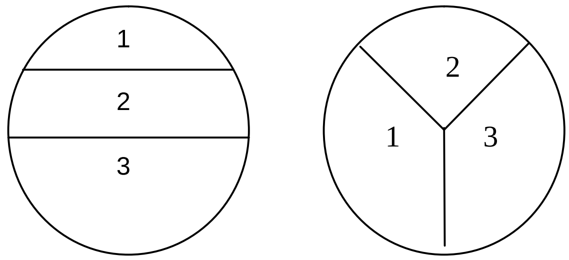
[Imagine pizzas, pies (cake like eatable famous in England), cakes, cut into equal pieces].

Activity:

1. Imagine a one by 4 dosa (or chapatti) how will you cut?

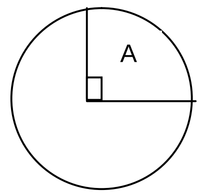
2. Imagine the same 1/3. How will you cut?

Cut paper



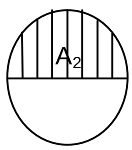
Which is better?

34.3.1 Area of a sector: See this figure:

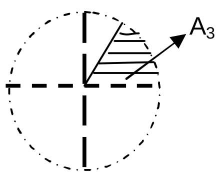


Area $A_1 = \frac{1}{4}$ (area of circle)

$= \frac{A}{4}$

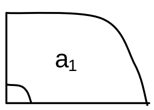
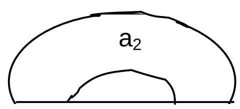
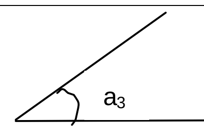


$A_2 = \frac{A}{2}$



$A_3 = \frac{1}{2} A_1 = \frac{1}{2} \times \frac{A}{4} = \frac{A}{8}$

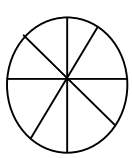
Now find the angles and compare:

 $a_1 = 90^o$	 $a_2 = 180^o$	 $a_3 = 45^o$
$\frac{a_1}{360} = \frac{1}{4}$	$\frac{a_2}{360} = \frac{1}{2}$	$\frac{a_3}{360} = \frac{1}{8}$
$\frac{A_1}{A} = \frac{1}{4}$	$\frac{A_2}{A} = \frac{1}{2}$	$\frac{A_3}{A} = \frac{1}{8}$

Conclusion: Area of sector is in the same ratio of angle of sector.

Thus $\frac{\text{Sector area}}{\text{Circle area}} = \frac{\text{Sector angle}}{360^0}$

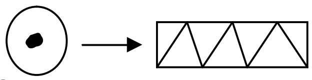
34.3.2 Exercises:

1.  Circle made into 8 equal parts. What is the sector angle?

2. A cake (circular shape) is to be shared by 6 people. How will you cut it?

3. Count the spokes in the Ashoka Chakra (of Indian flag) and then calculate the angle between 2 adjacent spokes. [Spoke = wire (or rods) in the middle of a wheel (eg: cycle wheel)].

34.4 Activity:
Take cardboard (or thick paper). Draw a circle. Cut into 16 or 24 equal sectors. Arrange them to make an approximate rectangle.
Knowing that circumference = $2\Pi r$
You can prove Area of a circle = Πr^2

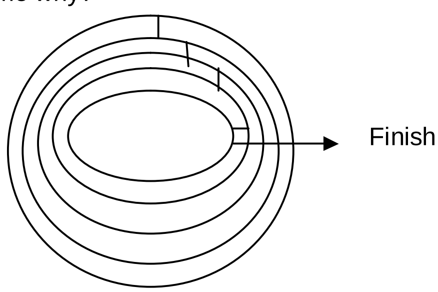
[i.e.,  Circle converted to rectangle]

34.5 Exercises:

1. Find the area of a circle 7 cm radius?
2. Area of a circle = 28.3 sq.m. What is its radius? [Clue: $28.3 \approx \frac{198}{7}$ $\Pi = \frac{22}{7}$].
3. In (1) & (2) what are the diameters?
4. If diameter increases to 3 times, what happens to the area?

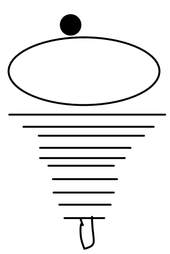
34.6 Exercises:

1. Tell me why?

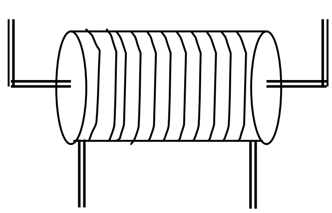


In a multitrack (many running paths) athletic field, for a 200 or 400 m. race the starting points on the lanes (=paths) are different. But finish line is the same why?

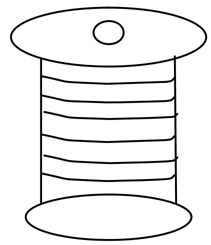
2a. Take a top (=spinning toy) count the groves (=cut lines on its sides) and thus guess how much string you will need.



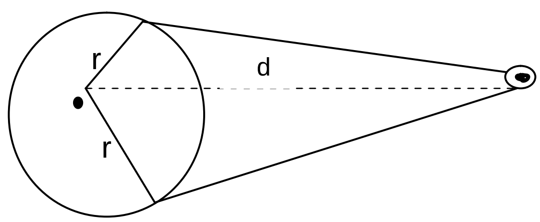
2b. In villages a wheel is used for drawing (=taking out) water from a well. Counting the grooves, can you find how many meters or rope is needed?



3. This is a cable roll. Can you guess the length of the cable in this roll?



4. A cycle wheel is 24" diameter. How much distance is covered in 10 revolutions?
5. 1 tin of paint was needed to paint a circular area of some diameter. If double the diameter area is to be painted. How many tins will be needed?
6. Which child is cleverer? The one who was happy with 2 dosas of a plate size or the one with a larger plate (double the diameter) only one dosa?
7.



Two shafts are connected by a belt. Can you calculate the length of the belt. d = 1m, r = 0.4 m

[Clue: assume the second roller has negligible radius. Assume the belt is like a tangent to the shaft (right angle is shown) approximate value is Ok].

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Chapter - 35 Cubes and Volume

35. Cube and Volume:
Let the students see a dictionary, just as they did for 'square'.
Let them get both the algebra meaning and the geometry meaning.

35.1 We have already seen in algebra that Cube is defined as "a number multiplied 3 times". Thus $x^3 = x \times x \times x$

Let the students create 1 to 9 and their cubes:

$1^3 = 1$
$2^3 = 8$ etc

[One thing] x [Same thing] x [Same thing] = $[\ ]^3$

How to write
$(10)^3$ or 10^3 3 should be small
$(x)^3$ or x^3 3 should be small

If more quantities are there bracket is a must (=necessary)

$10 + 2^3$ wrong $(10 + 2)^3$ – Right
$(x + y^3$ wrong $(x + y)^3$ - Right
10×2^3 wrong $(10 \times 2)^3$ - Right
xy^3 wrong $(x \times y)^3$ or $(xy)^3$ - Right

How to read:
$(10)^3$ or 10^3 as 'ten cube' [cubed not necessary]
$(a)^3$ or a^3 as a cube
$(10+2)^3$ as (10+2) whole cube [(10+2) cube wrong]

$(a+b)^3$ as (a+b) whole cube ['whole' saying is necessary]

35.2 Activity:
Let the students fold paper / cardboard & make cubes of different sizes. If uniformly many students make 1 cm side shapes, you will get many small cubes. Assemble them to make bigger cubes. Demolish those to prove the formula.

Volume of a cube = a^3
Where 'a' is the side of the cube.

If available, Rubik's cube can also be used. May be one can count the various colours.

35.3 Three Dimensions:
Introduce the concept of 3 dimensions.
One dimension: length – cm, m, km etc
Two dimensions: area- cm^2, m^2, km^2 etc
Three dimensions: volume – cm^3, m^3 etc
Area can be area of a rectangle A = l X b sq. cm
Where l = length in cm b = breadth in cm

It can also be written as A = a X b. Where a & b are the lengths of two adjacent sides of a rectangle.

A box (not exactly a cube) has a volume V

V = l b h Where l = length b = breadth h = height

If a, b, c are the sides of a box (the right word is **Parallelopiped** – should you use it?).
V = a b c

To demonstrate this also do as in 35.2 above. Cut the box into small **'CUBES'** and count the total number of cubes.

35.4 Exercises:

Formulas: for a cube V = a^3 (a = side).
For an oblong box V = lbh where l = length, b = breadth, h = height

1. What is the capacity of a square tank of 2m side and 2 m height?
   [$1m^3$ = 1000 liters]

2. If the tank was 1m by 2m and 4m height. What is its capacity?

3. A lorry is 10ft wide 20ft long and sand height can be 5ft. Is one lorry sand enough to cover a 40' x 60 ' site to a height of 1 ft?

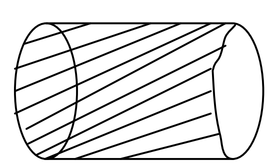
35.5 Activity with liquids:
The idea given in 35.2 above could be demonstrated using liquids (water). Take a plastic bag (called 'cover' in Mysore), big enough. Make a nice cardboard box whose inner dimensions are 10 cm X 10 cm X 10 cm. The height can be exactly 10 cm or even more up to 15 cm. Now fit the plastic 'cover' inside this cardboard box. Fit it tightly using wires or small sticks along the corners, such that the plastic also will be in the form of a 'box'. Take a 1-liter water bottle and gently empty the 1-liter of water into this plastic lined box. Measure the depth of water. Verify if the formula works.

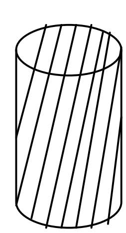
Do the same as above. Here let the box be of known length and breadth. After pouring measure the height of water.

35.6 Other Volumes: Cylinder
Cylinder is a figure whose cross section is a circle.

Solid cylinder: Full of same material.

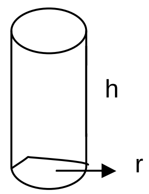
Eg: roller, road roller, rod, wire, pillar, tree (approximately), some crawlers (worms)! Some fat persons (approximately).





Hollow Cylinders: (Hallow means nothing inside)

Eg: Drum, pipe, conduits, some gutters, penstock pipes.



Area of the base of the cylinder = πr^2.
Where r = radius

Volume of the cylinder= $\pi r^2 h$ h = height or = $\frac{1}{4}\pi d^2 h$

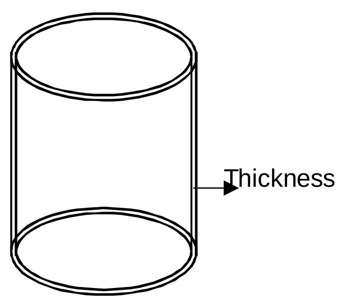
35.7 Activity:

Let the students do the same as in 30.5 above. They can make as given there. But not necessary. They can find all kinds of cylindrical glass, tins, many utensils for the experiment.
Let them verify: Volume = (area of the base) X height = $\pi r^2 h$
Where r is the radius, h is the height and π is a special constant.

Exercises:

1. Plastic water tanks are sold in markets outer measurements are made. Its circumference is 156 cm. Height is 50 cm. what is the maximum capacity in liters [1000 cc = 1 liter cc = cubic centimeter].

2. In (1) above, the tank is made up of very thick plastic. Thickness is 1 cm. Calculate the actual capacity of the tank. [Clue: 1 cm on both sides are less for diameter- one side for radius]. [1 cm taken for easiness].



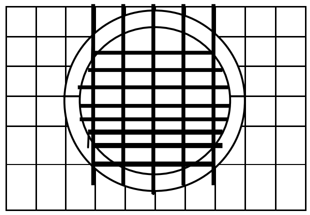
3. A community water tank is designed to serve 1000 family. A family needs 500 liters / day. Tank must have 2 days supply. Design a cylindrical tank of suitable size.

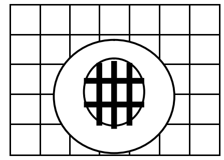
35.8 Activity: Water pipes

a) Let half of the class do 35.7. Let the other half go in search of long tubes of different diameters. Let them take 1 liter water and fill up the tubes and measure the length up to which water fills up. Make up the table as below:

S. No	Inner radius of the tube r	Area πr^2	Length of water h	Volume $\pi r^2 h$
1				
2				
3				
4				

b) Many tubes (plastic ones) may not be circular. They might have become mis-shaped to oval shape. In such case (including good circular ones) easier method of measuring area:





Tightly place the tube on a graph sheet and get the outline as shown. Count the small squares in the inner area. (Shown as dark).

Now the table:

S. No	Count of small squares	Area in (A) sq. cm	Length of water in cm (l)	Volume A X l
1 2 3 4				

35.8 Exercises:

1. Water is coming out of a dam through a big circular pipe of dia 2m. The speed of water coming out is 1 meter / min. how much water will be drained in 1 hour.
2. Water tap is kept open. Tap dia is 1 cm. Speed as (1) above. How much water is wasted in (a) 10 minutes (b) 1 hour?

35.9 Activity: Converse of water pipes:

Let some students do a variation of the experiment given in 30.7.3. Instead of filling 1 liter of water into a pipe, take whatever length & shape of pipes available. Find area as given in 30.7.3 (b). Measure total length. Fill up the tube with water. Now empty the water in a measuring jar (see note below). Find the volume in cc. Make table:

S. No	Count squares	Area in (A) cm^2	Length cm (l)	Volume A X l	Measuring jar value
1 2 3 4					

35.10 Activity:

Measuring jars or cylinders.
Teachers, show the students, if you can get hold of a regular measuring jar. Explain the capacities.

For fun they can measure many things:

a. The volume of a normal tea or coffee cup they use.
b. How much their Tiffin box can hold.
c. How much ink an old fashioned fountain pen can hold.
d. How little is a ballpoint refill's capacity.
e. Competitions on how much can one drink non-stop.
f. How much can one's mouth hold?
g. What is the volume of one's urine at a time?

If a measuring cylinder is not readily available, make one.
a. Using throw away bottles (plastics ok)
b. Using thick pipes (metal better or thick plastic > 2 mm)

In all the above teachers can impress upon the students the concepts of calibration, measurement etc and their importance.

35.11 Exercises:

1. Collect all the formulas given in this chapter.
2. Make your own formulas for the Total surface area of (1) cube (2) box (3) Cylinder (open both ends, open top, closed both ends).

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Chapter - 36 Measurements

36. Measurement: Measurements are important in science, engineering, commerce and any day-to-day transactions. They all involve some kind of simple maths.

36.1 Units of measurements:
Three basic measurements (also called 'dimensions' in physics) are length, mass & time.

36.2 Length:
Old system: inch, foot, yard, furlong, and mile.
New system: millimeter, centimeter, meter and kilometer.

(Teachers, conversion from one to other is very important. Even today in all civil & architectural drawings 3.1 meter is used. Why this funny .1 etc? Convert it to feet & see).

Your geometry box is the first step in measurement. Students start measuring length with a scale (called "foot – rule" in the British days; called inappropriately "straight-edge in USA). A scale usually has inches on one edge and centimeters on the other edge. You can measure a given length either in inches or cms [of course in fractions of inches or in millimeters] scales come in 2 sizes 6 inches or 12 inches. Next we see a tape in a tailor shop this usually has 36 inches (some have just 1 meter). Many tapes may be only in inches or only in centimeters. But tapes are available with inches on one side and cms on the reverse. They even have different colours for the sake of convenience.

36.2.1 Length related quantities:
Area – area is measured in length squared. Sq. cm or $(cm)^2$ or cm^2

Sq. ft is used very much in real estate (land measure) etc. it is also used by carpenters, civil maistries and others.

Acre is a measure of land. Hectare is now a days used in offices. Sq. km is for large areas like forests or huge cities etc.

Volume:
Volume also can be calculated using formulas for some well-known shapes.

Volume is given in cm^3 (some times cc, m^3 etc (cubic …., ….).

(Sometimes timber etc are sold in cft (i.e. cubic feet)

In the case of liquids, volume is expressed in liters = 1000 cc.
In such a case 1 cc = 1 ml also.

36.3 Mass:
In the old system: pound and ton. They are still being used.
In the new system: microgram, milligram, gram, kilogram, quintal and METRIC TON [are current].

Weight:
(For simple understanding, mass = weight) weight is measured in kg, gm etc.)
Quintal is used for grains and some commodities.

36.3.1 Length, volume, weight are all being used in commerce for thousands of year. So, many local systems also exist.

36.3.2 Weight-related quantities:

Density:
This quantity considers both the weight and volume at the same time.

It is $\text{Density} = \frac{\text{weight}}{\text{volume}}$

When weight is in grams and volume is in cubic centimeter, density is in gm / cc.
When weight is in kilograms and volume is in cubic meters, density is in kg / m^3.

Density of water:
It so happens that 1 cc of water weighs 1 gm (or) 1 liter of water weighs 1 kg.
[Perhaps, scientists manipulated definitions to come to this figure].

$\therefore \text{Density of water} = \frac{\text{Weight of 1cc of water}}{\text{Volume of 1 cc of water}} = 1 \text{ gm / cc}$

It is the same as 1 kg / liter

Specific Gravity (SG):
It is the density of substance as compared to water. But density of water = 1. Therefore SG of a substance is the same as its density. Only difference is density has units specific gravity is a ratio i.e., a number.

36.4 Time:
In this field, old system continues.
Second – minute – hour – day – week – month – year.

Just to feel the magnitude of the numbers let some bright students complete a chart (as the one given below:

	Sec	Minute	Hour	Day	Week	Month	Year
Sec	1						
Minute	60	1					
Hour	3600	60	1				
Day			24	1			1/365
Week				7	1		
Month				30	4	1	
Year				365	52	12	1

36.4.1 Time related quantities:

Speed or Velocity:

Distance traveled per unit time is speed. [For this book, there is no difference between speed & velocity]. Speed can be expressed in cm/sec, m/sec, km/hr, miles/hr etc.

$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$

Acceleration:
This has become a common word, since almost all teenagers drive some vehicle sometime. They use accelerator to feel great or to show off!

Acceleration is defined as rate of change of velocity.

$\text{Acc} = \frac{\text{Change in Speed}}{\text{Time}}$

[Time here is the duration in which speed changed].

Some explanation:

If you push accelerator, speed increases.
If you apply brake speed decreases.
[Decrease in speed is also called Deceleration].

36.5 Quantities Big and Small

36.5.1 **WE NEED BOTH**: We need big amounts sometimes and small amount some other times. We may need a ton of sand and can only afford a few grams of gold. We may use a liter of milk and a few spoons of sugar. Thus, a millimeter is important in its own region. A kilometer may have its own significance in some other place. So, we need to measure, talk about and measure both in small and big units.

36.5.2 Numbers Big and Small:
For increasing order, we have names viz unit (=one), ten, hundred, thousand, million, billion etc. These can be written as 1(=10^o), 10^1, 10^2, 10^3, 10^6, 10^9 etc. For fractions there are no names. But can be written as .1 (10^{-1}), .01 (=10^{-2}), .03 (10^{-3}) etc

36.5.3 Units Big and Small:
Increasing side has names like unit, kilo, mega, giga. These are 10^o, 10^3, 10^6, 10^9 respectively (= in that order). Unlikes numbers, decreasing side also is given names. i.e., fractions of units also have their special prefixes (prefix = a term or label attached to a word, before the word). Thus unit, milli, micro, nano, pico are 10^o, 10-^{3}, 10-^{6}, 10-^{9}, 10-^{12} respectively.

36.5.4 Table:
Attach the prefix in front of the unit. Thus nano second, microgram, millimeter etc. On the bigger side, kilogram, megaton etc.

	Multiplying Factor
Pico	$\frac{1}{10^{12}} or 10^{-12}$
Nano	$\frac{1}{10^{9}} or 10^{-9}$
Micro	$\frac{1}{10^{6}} or 10^{-6}$
Milli	$\frac{1}{10^{3}} or 10^{-3}$
Centi	$\frac{1}{100} or 10^{-2}$
Deci	$\frac{1}{10} or 10^{-1}$
	1
Deca	10
Kilo	1000 or 10^3
Mega	1000000 or 10^6

Students can start with [ ]

Gram or Liter or Meter or Second

Or any other unit they know.

36.5 Activity:

1. Length, mass, time are basic quantities. Many others are derived from these. Conversion tables are very important. It is nice to show to students some standard reference books containing these conversion tables.
   (Let students make their own general conversion tables of big & small quantities).
2. How many centimeters = 1 meter? How many millimeters = 1 meter?
3. In measuring meters, can you have an accuracy of 1% (i.e., errors less than 1%).
4. In measuring cms, if you want 1% accuracy what can you do? Discuss.
5. It may be interesting to see (a) a chemistry laboratory balance. (b) balance and weights used by gold dealers.

Chapter - 37 **Graphs - A**

37. Graphs are representation of two different things related to each other.

Some real life situations changing with time – They can be seen as a sequence. Can also be shown in a graph. Eg: Age Vs. Height

Those items which can be given a number (expressed quantitatively) can be shown in a graph.

37.1 Some simple illustrations

a. For Fun 1 2 3 4 5 …….

```
        0
      0 0
    0 0 0
  0 0 0 0
0 0 0 0 0
```

Show abacus if you like

b. Same idea as shown in a simple example.

Person	**Has**
A	2
B	4
C	6
D	8
E	10

```
            0
            0
         0  0
         0  0
      0  0  0
      0  0  0
   0  0  0  0
   0  0  0  0
0  0  0  0  0
0  0  0  0  0
A  B  C  D  E
```

c. Such representations are called by some: pictographs. We can see these in Newspaper articles, some economics books etc.

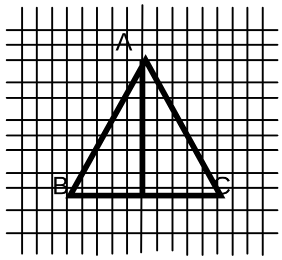
37.2 Graph Sheets:
A paper with ready made squares makes drawing graphs easier.

Activity:
Bring graph papers and discuss lengths.

37.2.1 Area estimation:
Graph sheet is a great way of estimating area. We have done it earlier as activities and exercises. It is nice to do them once again.

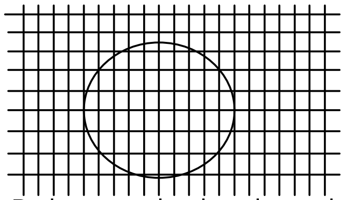
Activity & Exercise:

A.



Count the small squares inside ABC (less than ½ square is 0. More than ½ =1). From graph itself measure the lengths AC & AD (in small square). Use formula and verify your counting.

B.



Do as done for triangle above.

C. A & B above can be done by each student taking different sizes of triangles & circles.

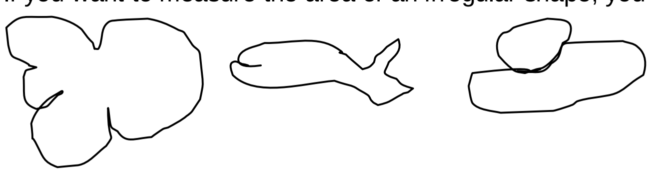
37.2.2 Some office procedures and secretarial practices:

Carbon paper: Typist in every office knows how to use a carbon paper. Students also can learn this and it will be useful. For us, for learning elementary maths also.

Tracing paper: This is also very useful for copying figures and maps. It helps to make a copy (approximately reproduce) a drawing, map, plan etc.

Scanner: This is a computer accessory, available in modernized offices. This is the best way of reproducing any figure. It has additional advantages of a computer; such as size reduction or enhancement.

37.2.3 If you want to measure the area of an irregular shape, you can use a graph sheet.

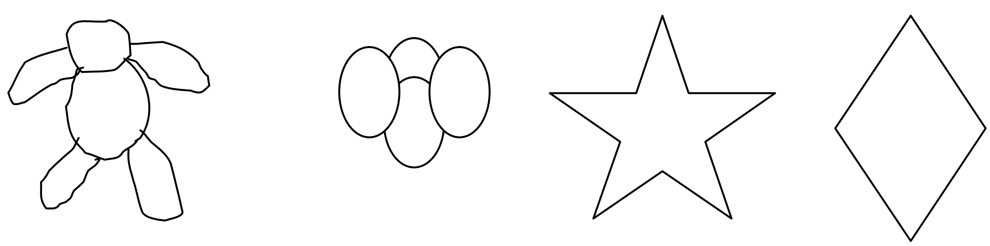


Irregular Shapes

Method: Use any of the methods given in 37.2.2 above and then reproduce the shape on a graph sheet.

Exercise:

Find the area of the given figures:



[Clue: Tracing paper is the best]

37.3 Area (surface) – Activity:

37.3.1 Suppose you want to know the surface area of a tough surface (for painting purpose, or for any other reason). Tough surface can be shape wise extremely irregular, or it is connected, erected, embedded etc into a structure or having surfaces not accessible (=reach) for measurement. The following method is using a graph sheet is quite useful.

A. Spread a thick (=non stretching) plastic sheet, or cardboard, or paper on to the surface (call this 'transfer sheet'). Poring this transfer sheet to graph paper draw the outline and count squares on the graph sheet.

B. If the transfer sheet is too big, you can cut them into small manageable size pieces and count each piece and then add them all up.
C. In (B) above, if there is symmetry (i.e., if you can fold into smaller piece) count the folded version and multiply suitably.

37.3.2 Exercises and Activity:
Take one small object (Group A) and one large object (Group B). Find surface area by graphical method.

Group A: Pencil, pencil box, book notebook, belt, ribbon, phone – dial – surface, base of a cup/saucer/plate.
Group B: Table top, windows door, door barrel, surface of a grouted (=fixed) machine, seat of a motorbike, car (outside), steering wheel (of car, bus, truck), TV, Radio.

37.3.3 Strip method:
For group (b) paper strip method is very powerful. Keep a large number of paper strips of equal width (1" or 1 cm). Cover the area fully with these strips one strip just touching the next. Carefully take out one by one, numbering each one of them serially.
A. Now count of each strip – area using graph paper – Add them all up.
B. If some strips are too long, fold them by 2, 4 or 8 and count. After counting multiply by the folding factor.

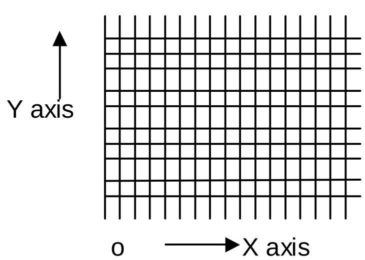
Exercise:
Do the exercise of 37.3.2 Group B, once by earlier method, next by strip method and compare.

37.3.4 Perimeter – strip method:
We saw just now how paper strips can be used for estimating area. The same could be used for assessing lengths (perimeter of irregular shapes) .

Exercise:
Use strip method (same as string method) to measure circumference / perimeter of bicycle wheel, cycle pedal, cycle axle, bicycle chain length, car tyre, steering wheel, boiler, barrel top, any big pipe. Body measurement (tailors work).

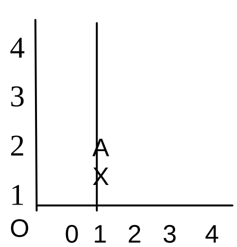
[Strip, string, tape are all ok. In fact cloth & metal tapes are often used and carried by engineers].

37.4 X, Y Axis:
A graph sheet has graduations (divisions) on both sides horizontally and vertically. You can choose a horizontal line as a reference line. It is called X axis. The starting point of X axis is the origin o. At o, if you draw a vertical line, this is called Y axis.



O is origin.
At o value of X axis is 0.
At o value of Y axis is 0
Therefore o is called (0,0).

37.4.1 Activity:
Take a graph sheet choose O near the left side bottom corner. Mark it O (0,0). Draw X axis,Y axis. Mark 1, 2, 3, 4 ….. on right side. Mark 1, 2, 3, 4 ….. on vertical side. A point P (x_1, y_1) on the graph sheet is at a distance of x_1 from O on the x-axis and at a distance of y_1 from O on the y-axis.



A here is (1,1) (x_1, y_1).
(1, 1) are called coordinates.
(x_1, y_1) values are called coordinates of that point.
X_1 is called x coordinates.
Y_1 is called y coordinates.

Given below H (0, 2) its x coordinates is 0 and its y coordinates is 2.

Exercise:

a. Mark	B(2, 2)	C(3, 3)	D(4, 4)	
b. Mark	G(0, 1)	H(0, 2)	I(0, 3)	j(0, 4)
c. Mark	P(1,0)	Q(2, 0)	R(3, 0)	S(4, 0)

37.5 Lines on Graph:

Exercise: First do the exercise of 37.4:

a. Take a scale and see whether B, C, D fall on straight line. If so, join. [If no, you have made a mistake, go back to 37.4 and do it right].
b. Join GHIJ
c. Join PQRS
d. Describe the line a, b, c. in other words, what do you know about them?
e. Draw any vertical line on your graph sheet. Take 4 or more points on this line. Write their coordinates.

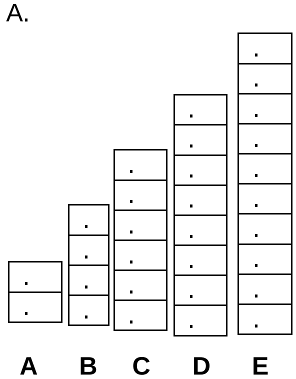
37.6 Pictographs

37.6.1 Pictographs on a graph sheet are neater and easier to read. Statistical data can be nicely shown on pictographs. Pictographs are also called Bar-Graphs or Bar-Charts. These do not even need any graph papers. [Go back to section 37.1 and see what we started with]. Let us put the same data on the bar graph.

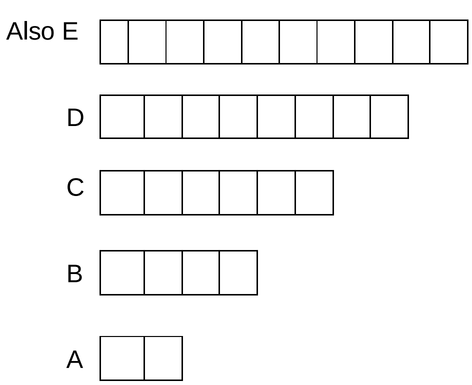
Person (X)	Age (Y)
A	2
B	4
C	6
D	8
E	10

This can be done in 2 ways.

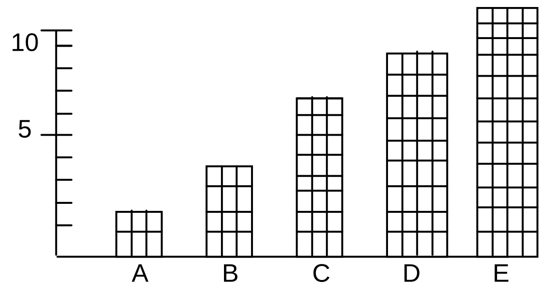
A.



B.



C. If you put them in X & Y axis the same will look like this:



37.6.2 Advantages of pictographs:

"Standing" pictographs as shown in (A) above are useful to visually see "high" and "low" values of an item.

"Horizontal" pictographs as shown in (B) above are nice in an article describing some aspects to be compared. These are easy on the eye and do not disturb a flowing matter. Thus these are seen in newspaper articles, reports etc.

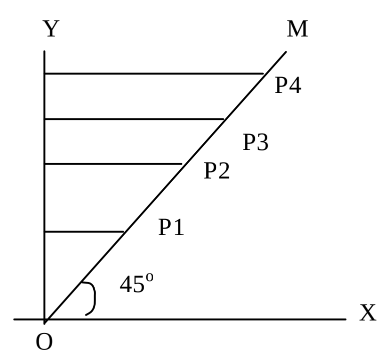
Bar-graphs as shown in (C) above are informative and quantitative. They can be used for 'discrete' quantities (i.e., unconnected items) or 'continuous' quantities. Thus bar graphs can show "variations" of a quantity with some parameter (Eg: item). They can also show maximum, minimum etc. For this reason they are useful in sciences, commerce and economics subjects.

37.7 Lines:

Go back to 37.5 exercise. We can discuss the answers now. Start with the reverse of the work done there.

37.7.1 a. Do this exercise. Let OM be drawn at 45^{o} to origin. Let coordinates of P1, p2, P3… be measured and tabulated.

	X	Y
0	0	0
P1		
P2		
P3		
⋮		



[Clue for those who need it: 45^{o} line is not difficult to draw. Use your set square].

b. Let another group to do as follows:

S. No	X	Y
1		
2		
3		
4		

Given Y = X. Let them give any integer values to X. Find Y. Tabulate.
Let (X1, Y1) be plotted as P1
Let (X2, Y2) be plotted as P2 etc
Join the points. Let the two groups compare their work.

37.7.2 [Note for teachers: y = x is the equation given above. X is the 'independent variable' i.e., item for which you give any value you want. Y is the dependent variable'. Value of y is not your will or wish. It depends on the value given to x. It has to be calculated. The author hopes you could convey this idea to the students. Please do not write any table of numbers to be copied].

37.7.3 Exercises:

1. $y = x$
2. $y = 2x$
3. $y = 3x$
4. $y = 4x$

After understanding these thoroughly, you can do:

5. $y = \frac{1}{2}x$ 6. $y = \frac{1}{3}x$ 7. $y = \frac{1}{4}x$ 8. $y = 0.1x$

9. $y = 0.4x$ 10. $y = 0.5x$ 11. $y = 0.8x$

[Help for those who have not yet started: say (12) y = 5x. First make a table. Start:

S. No.	x	y
1.	0	
2.	1	
3.	2	
4.	4	

S. No. 1: y = 5x = 5 x 0 = 0
S. No. 2: y = 5 x 1 = 5
S. No. 3: y = 5 x 2 = 10
S. No. 4: y = 5 x 4 = 20

These underlined values will go to next column.

With allotting values to x only. Now calculate y. The next step of the table will be like this:

S. No.	x	y
1.	0	0
2.	1	5
3.	2	10
4.	4	20

Next step

S. No.	x	y	(x, y)
1.	0	0	(0,0)
2.	1	5	(1, 5)
3.	2	10	(2, 10)
4.	4	20	(4, 20)

The last column is to be plotted

37.8 Plotting:
Marking points on a graph. Using the (x, y) coordinates of these points is called plotting. This is the first step in drawing graphs correctly. This what we did earlier (sec 37.4).

Exercises:

I. Plot these points. See what figure you get:

A (0, 8) B (6, 8) C (0, 7) D (6, 7) E (0, 6) F (6, 6) G (0, 5) H (6, 5) I (0,0)

II. For this exercise you should have both left side and right side of X axis so let your origin be in the center of the graph sheet.
RHS is +1, +2, +3 ………
LHS is –1, -2, -3, …..

A (-5, 10) B (5, 10) C (-7, 8) D (7, 8) E (-6, 8) F (6, 8) G (-6, 0)
H (-1, 0) I (1, 0) J (6, 0) K (-1, 4) L (1, 4)

Join AB, CD, AC, BD, EG, FH, HK, IL etc. What did you get?

III. Fun activity:

Students can make their own puzzles like I and II above and challenge the others to guess or plot.

37.9 Line y = mx + c

37.9.1 We have drawn y = x
Now let us take y = x + 1. How to do it. Give x different values. Calculate y. [Students! You should know substitution. If you are weak in this, go back and learn. No copying. No one will cook for you. You have to prepare what you need].

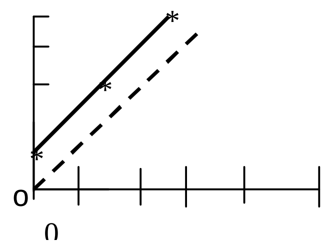
Let x = 0, then y = x +1 = 0 +1 = 1
Let x = 1, then y = x + 1= 1 +1= 2
Let x = 3, then y = x + 1= 3 +1= 4

Make a table.

	x	y	(x, y)
1.	0	1	(0, 1)
2.	12	(1, 2)	
3.	34	(3, 4)	

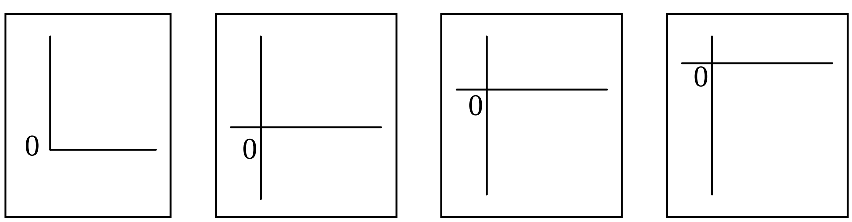
Plot these points.

Make a graph. Does it look like this?
Dotted line is our old friend y = x

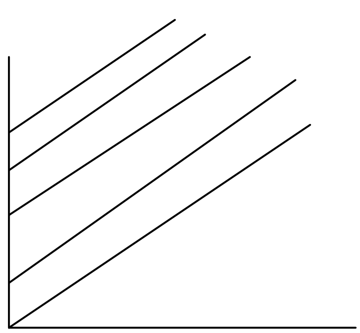


39.9.2 Y = x and y = x +1 plots were done. They look similar lines and parallel. This is because they are the same, only the starting point is different. If you shift the X axis a little higher, you will get dotted line coinciding with the thick line.

37.9.3 Activity:
The work given below will explain the concept of the earlier sections. This requires Do and Learn effort.
Make a group of 5 students. Give them a previously prepared set of 4 graph sheets. Prepare them as follows. One person is a coordinator.



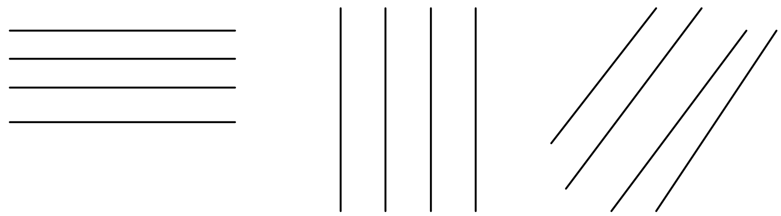
Let each of them draw the graph of $y = x$. Let the leader put them all together. (Transparent / translucent graph will be better).



Show that they are all parallel. Tell them what is 'C' in $y = mx + C$.

Other groups can be given other slopes

37.10 Slopes:

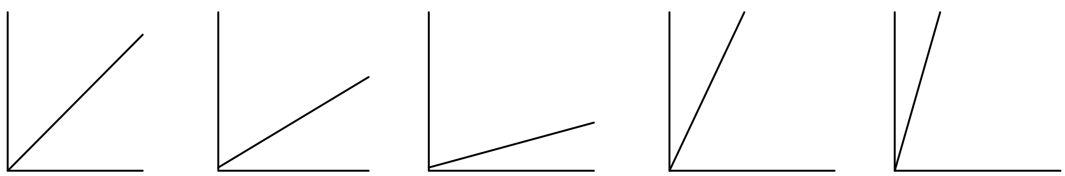


Look at these sets of lines. Each one set consists of parallel lines. This is the common quality of these 3 sets of lines. But one set of horizontal; another is a set of vertical lines. The third is a set if slanted lines. This is called slope.

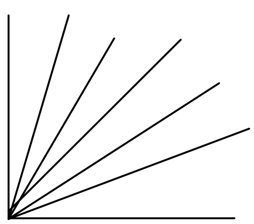
Mathematicians have no problems with 3 sets. For them (1) and (2) are the extremes of the slope. Thus (1) has zero (2) has infinite and (3) has some finite quantity of slope.

37.11 Go back to 37.7.3 Let each students bring his / her own graph and a leader assemble them.

Generate various graphs by different groups. Now put them all together



Now put them all together



(For this, transparent graph sheets – on tracing paper will be useful).
Now discuss this.

We got straight lines of different slopes equation of the first one was y = x.
i.e., if you write y = $\square$ x x

For the first line $\square$ was equal to 1.

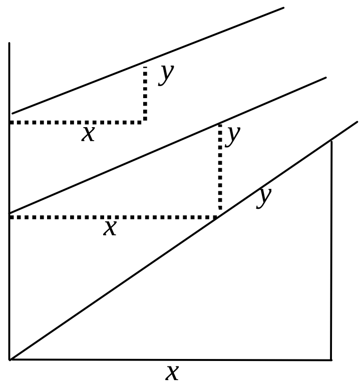
For the other lines $\square$ was different.

We can write it as $y = mx$ where m is the slope. For each m, we got one new line. If m was more we got a line of more slope.

37.12 Line $y = mx + C$

Now explain $y = mx + c$. To do this, use all the graphs made above, and draw parallel graphs, by shifting the origin of the y axis.

Using a graph sheet, one can easily measure the slope. (Teachers, DO NOT USE trigonometry at this stage. If the whole class is very bright you can say slope = tan θ. No sine or cosine – not needed).



Let the students measure the slope (not angle) of each line **slope =** $\frac{y}{x}$**.**

Say $y \,\&\, x$ can be measured at any convenient place. (It will be the same because the graph is a STRAIGHT LINE).

37.12.1 Lines & statements:

It is now the opportune time to explain statements (in science / social) subjects) like:

a. y increases linearly x or

b. y is directly proportional to x or

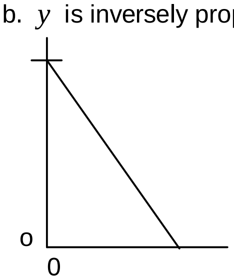
c. y increases as x increases. Graphical form helps here. a, b, c all mean the same thing. A graph with a positive slope also means the same.

37.12.2 We saw just now graphs and statements.

Similar statements:

a. y decreases as x increases or

b. y is inversely proportional to x . These deserve to be shown in a graph.



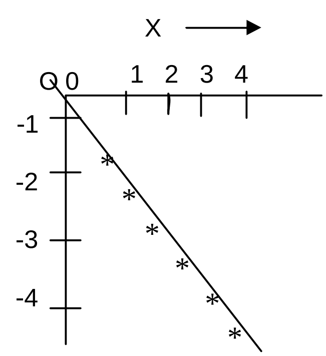
Nature of the graph. AT x = 0. It has y value
x > 0, y decreases.

y = x was seen by us earlier

y = - x really looks like given here.

It starts from zero and goes negative.

[Note to teacher: Just a mention of the above is enough. No more necessary. Real situation in science and engineering Are more like the earlier graph, with a negative slope].

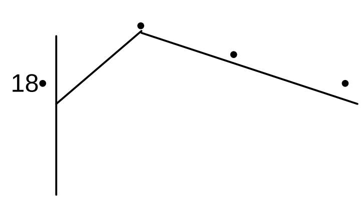


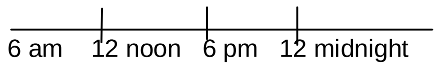
37.13 Data as a line graph:

In 37.12 we saw an equation of the form y = mx + c shown as a line graph. Now we shall see some data, which may change continuously or at some intervals.

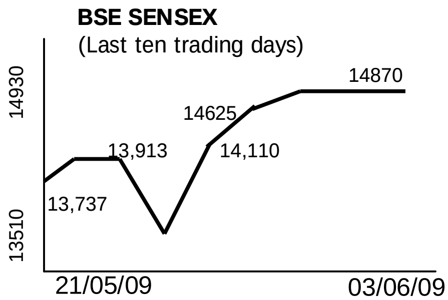
37.13.1 Temperature data at Mysore.

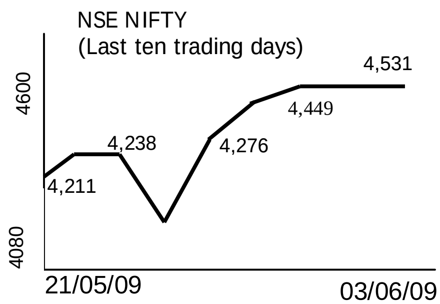
6 am 18^{o}C 12 noon 32^{o}C 6 pm 28^{o}C 12 midnight 20^{o}C





37313.2 From newspaper- Line Graph quantity changes with time.





37.14 Pie charts or sector graphs: Here the base scheme is not a square, no x or y axis. There is nothing changing. No dependent or independent variable. It is only representation of a given data, which has many parts.

37.14.1 Example: Household expenditure. In a family, assume a total income of 8000 rupees. Expenditure is put into some categories.

Food	Rs. 2000
Rent	Rs. 2000
Education	Rs. 1000
Transport	Rs. 1000
Fuel	Rs. 500
Entertainment	Rs. 500
All others	Rs. 1000

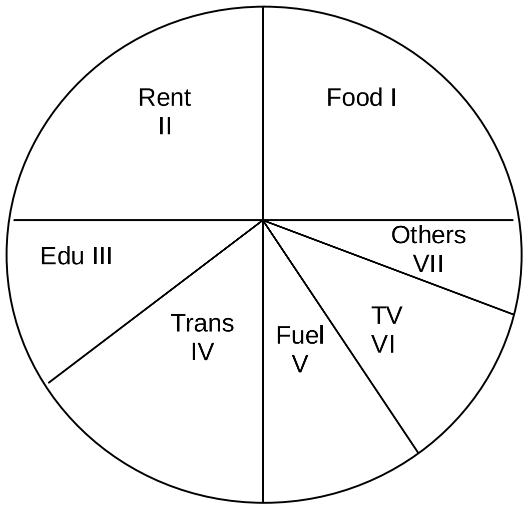
The total expenditure of Rs. 8000 can be put into a circle.
As we have seen earlier ("cake cutting"), the best method of dividing a circle into equal part is by sector method. For this purpose we use angle (at the center of the circle).

A circle has 360^o angle. In our example Rs. 8000 occupies (=covers) 360^o angle. Rs. 1000 will occupy $\frac{360}{8} = 45^0$. Let us now covert the expenditure (=spending) categories into a table of angles.

S. No.	Category	Rs.	In Angles	
I	Food	2000	$\frac{2000}{8000}$ x 360	$= 90^o$
II	Rent	2000		$= 90^o$
III	Education	1000		$= 45^o$
IV	Transport	1000		$= 45^o$
V	Fuel	500	$\frac{1000}{8000}$ x 360	
VI	TV	500		$= 22\frac{1^0}{2}$
VII	All others	1000	$\frac{500}{8000}$ x 360	

				$= 22\frac{1}{2}^0$ $= 45^o$
	Total	8000		360^o

Put them all in a circle:



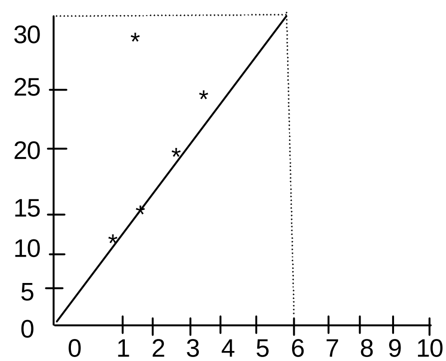
This is the pie chart or the pie graph or sector graph of this family budget.

[PIE – a cake –like eatable].

37.15.1 'Maggi' on a graph

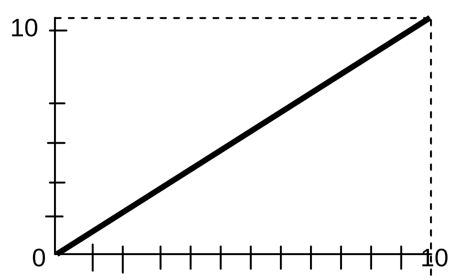
5 x 1 = 5
5 x 2 = 10
5 x 3 = 15
5 x 4 = 20
5 x 5 = 25
5 x 6 = 30

5 x 10 = 50
Let us put y = 5x



On the same lines any 'maggi' can be read out from a 45^o line.

Such graphs are sometimes called Ready Reckoners.



X axis will be 1 to 10. Y axis also be 1 to 10 (same scale).
Y axis will change as you wish. i.e., for 5 maggi it was 5, 10, 15 ……. For 7 it will be 7, 14, 21 …….

[For teachers; students can skip this].

37.15.2 Why always Maggi “tables” not “graphs”? The answer is very simple. Our education has always been geared towards “memorization”. Graphs cannot be memorized. Tables can be and they are made in order to memorize. This over insistence on memory (and less on thinking & logic) is the reason for the notoriety of mathematics and the ensuing enmity towards it].

37.15.3 Fun Activity:

A. Make your own “maggi” scales.
Take a difficult number like 13, 17 or 19. Write down 13, 26, 39 …… 130 at 1 cm intervals (=distance, space between two items). Write 1 2 3 ….. 10 at the same spacing. Put one of them in the x axis and the other on the y-axis of a graph paper. Draw a near 45^o line. You got your 13^{th} “maggi”.

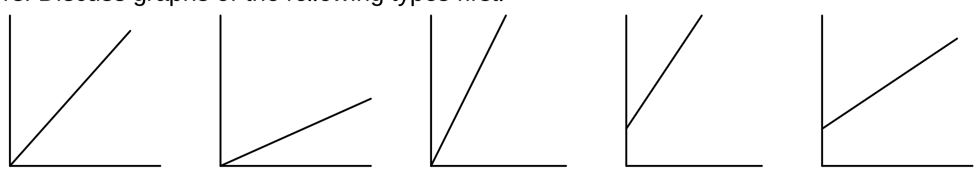
B. Like (A) above you can have a series of numbers while one axis (say y axis is fixed as 1, 2 …. To 10) the x axis can be replaced by these patties (patti-strip). You can “read out” your “maggi”.

C. Activity: One graph sheet could be cut and used to make 5 to 10 scales. Let the students make using carboard, wood, plastic or metal backing.

Some students with tailoring skill can do the activity to make measuring tapes – with suitable cloth, ribbon etc.

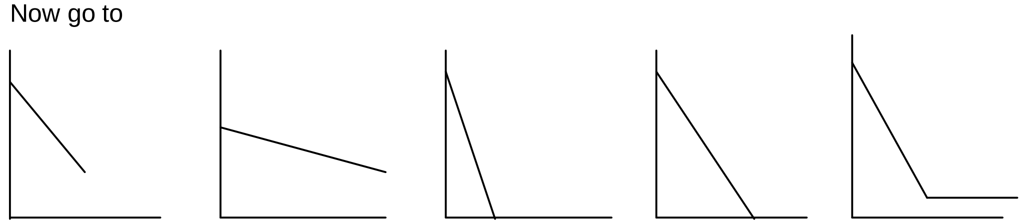
37.16 Describing the nature of a graph:
Teachers! Discuss graphs of the following types first.

a.



Important words: Linear, starting from, ….., small slope, large slope (=steep), increase etc.

b. Now go to



These were:

a. Ascending straight-line graph.
b. Descending straight-line graph. The words increases, decreases to describe.

We have seen that mathematical equations express an idea clearly and without ambiguity. Graphical representation clarifies information **qualitatively** and sometimes, when data is available, **quantitatively** also.