Constructions using Python

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Contents

***Abstract*—This book introduces constructions in high school geometry using Python. The content and exercises are based on NCERT textbooks from Class 6-12. A simple introduction to Python and LaTeXfigures is provided in the process.**

Download all python codes from

```
svn co https://github.com/gadepall/school/trunk/
    ncert/constructions/codes
```

and latex-tikz codes from

```
svn co https://github.com/gadepall/school/trunk/
    ncert/constructions/figs
```

1 Examples

1.1. Draw Fig. 1.1.1 for $a = 4, c = 3$.

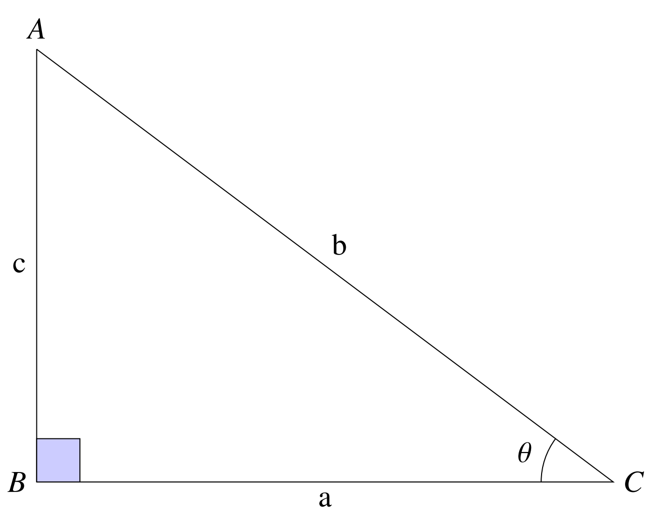

Fig. 1.1.1: Right Angled Triangle

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Solution: The vertices of $\triangle ABC$ are

$$\mathbf{A} = \begin{pmatrix} 0 \\ c \end{pmatrix} = \begin{pmatrix} 0 \\ 3 \end{pmatrix}, \mathbf{B} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{C} = \begin{pmatrix} a \\ 0 \end{pmatrix} = \begin{pmatrix} 4 \\ 0 \end{pmatrix} \tag{1.1.1}$$

The python code for Fig. 1.1.1 is

```
codes/triangle/tri_right_angle.py
```

and the equivalent latex-tikz code is

```
figs/triangle/tri_right_angle.tex
```

The above latex code can be compiled as a standalone document as

```
figs/triangle/tri_right_angle_alone.tex
```

1.2. Draw Fig. 1.2.1 for $a = 4, c = 3$.
Solution: The vertex $\mathbf{A}$ can be expressed in *polar coordinate form* as

$$\mathbf{A} = b \begin{pmatrix} \cos\theta \\ \sin\theta \end{pmatrix} \tag{1.2.1}$$

where

$$b = \sqrt{a^2 + c^2} = 5, \tan\theta = \frac{3}{4} \tag{1.2.2}$$

The python code for Fig. 1.2.1 is

```
codes/triangle/tri_polar.py
```

and the equivalent latex-tikz code is

```
figs/triangle/tri_polar.tex
```

1.3. Draw Fig. 1.3.1 with $a = 6$, $b = 5$ and $c = 4$.
Solution: Let the vertices of $\triangle ABC$ and $\mathbf{D}$ be

$$\mathbf{A} = \begin{pmatrix} p \\ q \end{pmatrix}, \mathbf{B} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{C} = \begin{pmatrix} a \\ 0 \end{pmatrix}, \mathbf{D} = \begin{pmatrix} p \\ 0 \end{pmatrix} \tag{1.3.1}$$

Then

$$AB = \|\mathbf{A} - \mathbf{B}\|^2 = \|\mathbf{A}\|^2 = c^2 \quad \because \mathbf{B} = \mathbf{0} \tag{1.3.2}$$

$$BC = \|\mathbf{C} - \mathbf{B}\|^2 = \|\mathbf{C}\|^2 = a^2 \tag{1.3.3}$$

$$AC = \|\mathbf{A} - \mathbf{C}\|^2 = b^2 \tag{1.3.4}$$

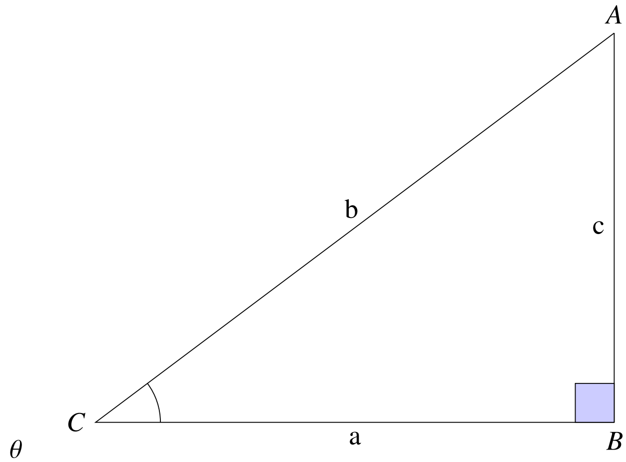

Fig. 1.2.1: Right Angled Triangle

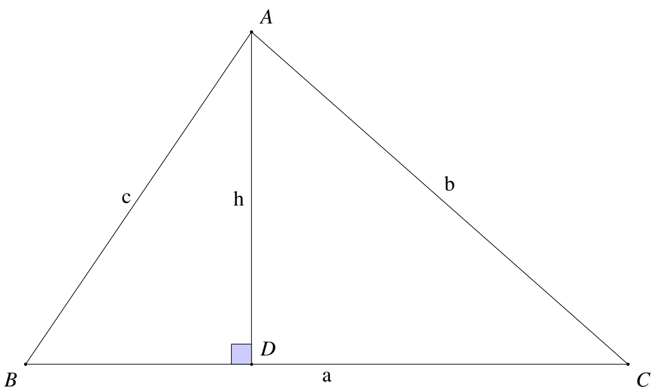

Fig. 1.3.1

From (1.3.4),

$$b^2 = \|\mathbf{A} - \mathbf{C}\|^2 = \|\mathbf{A} - \mathbf{C}\|^T \|\mathbf{A} - \mathbf{C}\| \tag{1.3.5}$$

$$= \mathbf{A}^T\mathbf{A} + \mathbf{C}^T\mathbf{C} - \mathbf{A}^T\mathbf{C} - \mathbf{C}^T\mathbf{A} \tag{1.3.6}$$

$$= \|\mathbf{A}\|^2 + \|\mathbf{C}\|^2 - 2\mathbf{A}^T\mathbf{C} \quad \left(\because \mathbf{A}^T\mathbf{C} = \mathbf{C}^T\mathbf{A}\right) \tag{1.3.7}$$

$$= a^2 + c^2 - 2ap \tag{1.3.8}$$

yielding

$$p = \frac{a^2 + c^2 - b^2}{2a} \tag{1.3.9}$$

From (1.3.2),

$$\|\mathbf{A}\|^2 = c^2 = p^2 + q^2 \tag{1.3.10}$$

$$\implies q = \pm\sqrt{c^2 - p^2} \tag{1.3.11}$$

The python code for Fig. 1.3.1 is

```
codes/triangle/tri_sss.py
```

and the equivalent latex-tikz code is

```
figs/triangle/tri_sss.tex
```

1.4. Construct parallelogram $ABCD$ in Fig. 1.4.1 given that $BC = 5, AB = 6, \angle C = 85°$.

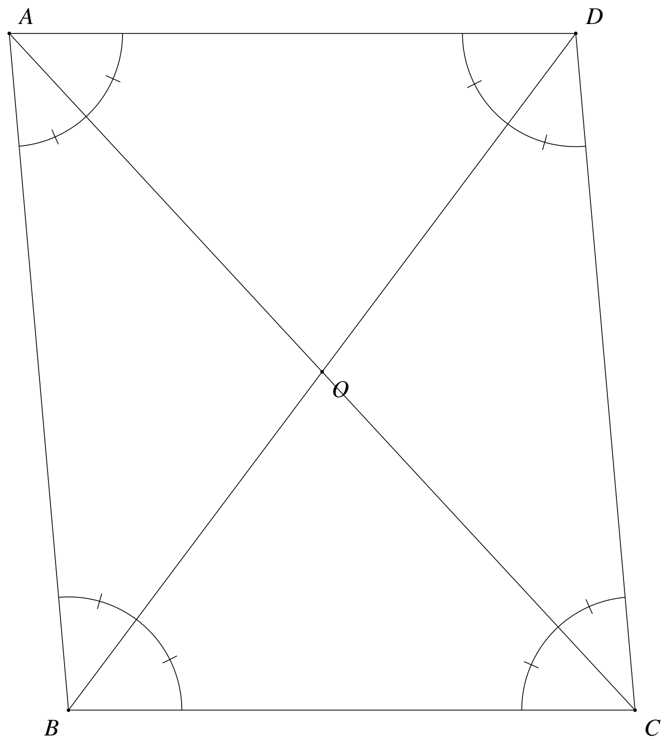

Fig. 1.4.1: Parallelogram Properties

Solution: BD is found using the cosine formula and $\triangle BDC$ is drawn using the approach in Construction 1.3 with

$$\mathbf{B} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{C} = \begin{pmatrix} 5 \\ 0 \end{pmatrix}, \tag{1.4.1}$$

Since the diagonals bisect each other,

$$\mathbf{O} = \frac{\mathbf{B} + \mathbf{D}}{2} \tag{1.4.2}$$

$$\mathbf{A} = 2\mathbf{O} - \mathbf{C}. \tag{1.4.3}$$

AB and AD are then joined to complete the $\|$gm. The python code for Fig. 1.4.1 is

```
codes/quad/pgm_sas.py
```

and The equivalent latex-tikz code is

```
figs/quad/pgm_sas.tex
```

1.5. Draw the $\|$gm $ABCD$ in Fig. 1.5.1 with $BC = 6, CD = 4.5$ and $BD = 7.5$. Show that it is a rectangle.

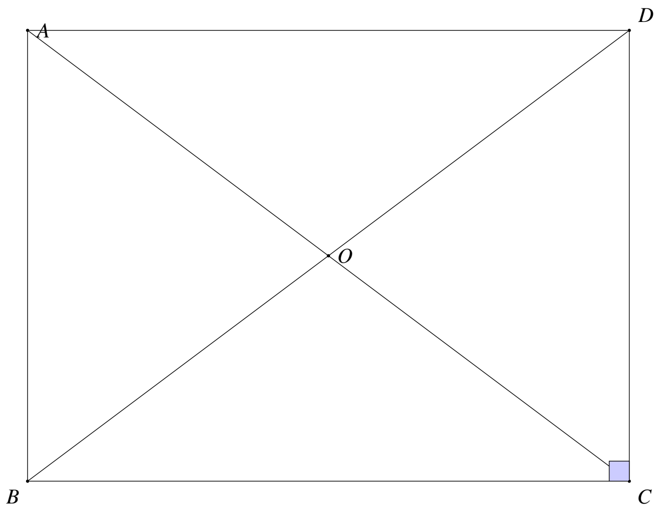

Fig. 1.5.1: Rectangle

Solution: It is easy to verify that

$$BD^2 = BC^2 + C^2 \tag{1.5.1}$$

Hence, using Baudhayana theorem,

$$\angle BCD = 90^\circ \tag{1.5.2}$$

and $ABCD$ is a rectangle.

$$\mathbf{A} = \begin{pmatrix} 0 \\ 4.5 \end{pmatrix} \mathbf{B} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \mathbf{C} = \begin{pmatrix} 6 \\ 0 \end{pmatrix} \mathbf{D} = \begin{pmatrix} 6 \\ 4 \end{pmatrix} \tag{1.5.3}$$

The python code for Fig. 1.5.1 is

```
codes/quad/pgm_sss.py
```

and the equivalent latex-tikz code is

```
figs/quad/pgm_sss.tex
```

1.6. Draw the rhombus $BEST$ with $BE = 4.5$ and $ET = 6$.
Solution: The coordinates of the various points in Fig. 1.6.1 are obtained as

$$\mathbf{O} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{B} = \begin{pmatrix} 0 \\ -4.5 \end{pmatrix} \tag{1.6.1}$$

$$\mathbf{E} = \begin{pmatrix} 3 \\ 0 \end{pmatrix}, \mathbf{S} = \begin{pmatrix} 4.5 \\ 0 \end{pmatrix}, \mathbf{T} = \begin{pmatrix} 0 \\ -3 \end{pmatrix} \tag{1.6.2}$$

1.7. A square is a rectangle whose sides are equal. Draw a square of side 4.5.
Solution: The coordinates of the various points

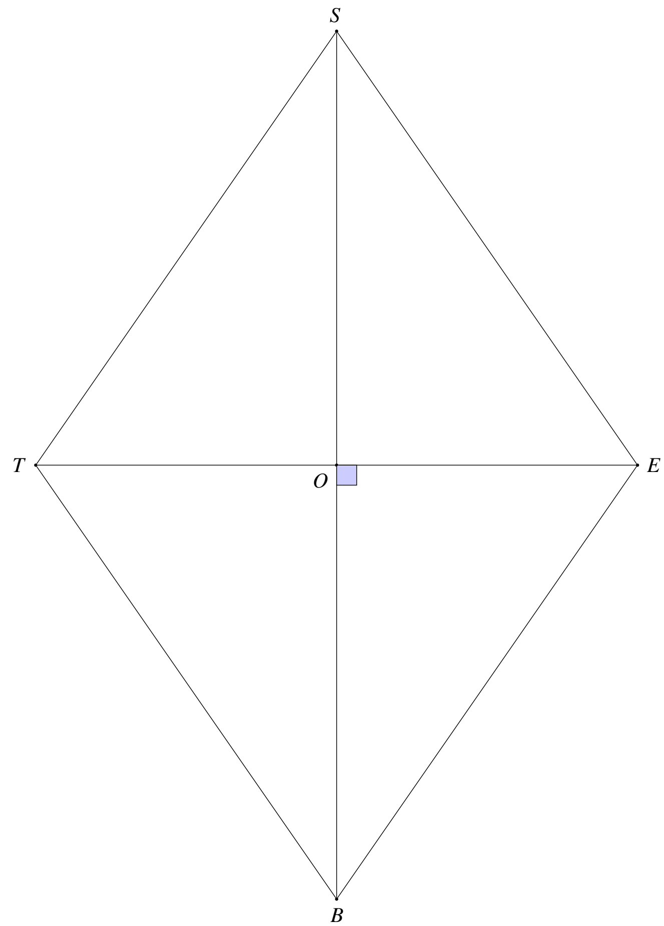

Fig. 1.6.1: Rhombus

in Fig. 1.7.1 are obtained as

$$\mathbf{A} = \begin{pmatrix} 0 \\ 4.5 \end{pmatrix} \tag{1.7.1}$$

$$\mathbf{B} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{C} = \begin{pmatrix} 4.5 \\ 0 \end{pmatrix}, \mathbf{D} = \begin{pmatrix} 4.5 \\ 4.5 \end{pmatrix} \mathbf{O} = \frac{\mathbf{B} + \mathbf{C}}{2} \tag{1.7.2}$$

2 Exercises

2.1. Construct a triangle of sides $a = 4$, $b = 5$ and $c = 6$.
2.2. Construct an isosceles triangle whose base is $a = 8$cm and altitude $AD = h = 4$cm
2.3. In $\triangle ABC$, given that $a+b+c = 11, \angle B = 45^\circ$ and $\angle C = 45^\circ$, find a, b, c and sketch the triangle.
2.4. Draw $\triangle ABC$ with $a = 6, c = 5$ and $\angle B = 60^\circ$.
2.5. Draw $\triangle ABC$ with $a = 7, \angle B = 45^\circ$ and $\angle A = 105^\circ$.

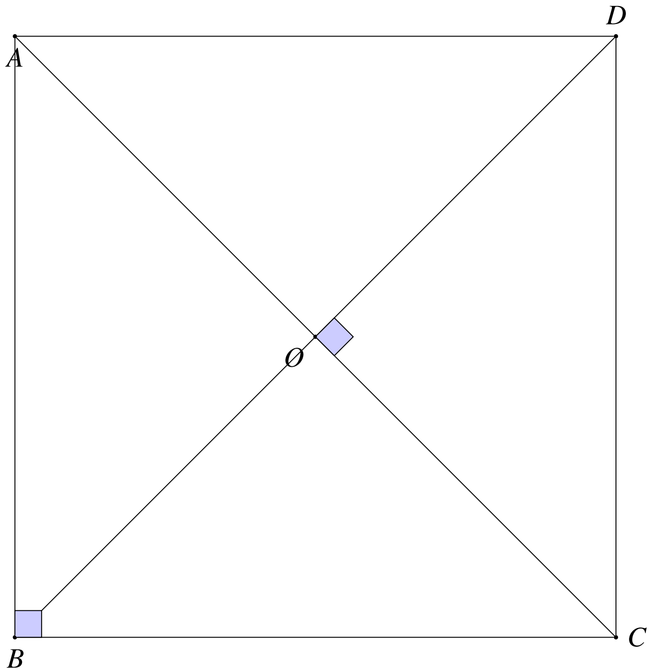

Fig. 1.7.1: Square

2.6. $\triangle ABC$ is right angled at **B**. If $a = 12$ and $b+c = 18$, find b, c and draw the triangle.
2.7. In $\triangle ABC$, $a = 8, \angle B = 45^{\circ}$ and $c - b = 3.5$. Sketch $\triangle ABC$.
2.8. In $\triangle ABC$, $a = 6, \angle B = 60^{\circ}$ and $b-c = 2$. Sketch $\triangle ABC$.
2.9. Draw $\triangle ABC$, given that $a+b+c = 11, \angle B = 30^{\circ}$ and $\angle C = 90^{\circ}$.
2.10. Construct $\triangle xyz$ where $xy = 4.5, yz = 5$ and $zx = 6$.
2.11. Draw an equilateral triangle of side 5.5.
2.12. Draw $\triangle PQR$ with $PQ = 4, QR = 3.5$ and $PR = 4$. What type of triangle is this?
2.13. Construct $\triangle ABC$ such that $AB = 2.5, BC = 6$ and $AC = 6.5$. Find $\angle B$.
2.14. Construct $\triangle PQR$, given that $PQ = 3, QR = 5.5$ and $\angle PQR = 60°$.
2.15. Construct $\triangle DEF$ such that $DE = 5, DF = 3$ and $\angle D = 90°$.
2.16. Construct an isosceles triangle in which the lengths of the equal sides is 6.5 and the angle between them is 110°.
2.17. Construct $\triangle ABC$ with $BC = 7.5, AC = 5$ and $\angle C = 60°$.
2.18. Construct $\triangle XYZ$ if $XY = 6, \angle X = 30°$ and $\angle Y = 100°$.
2.19. If $AC = 7, \angle A = 60°$ and $\angle B = 50°$, can you draw the triangle?
2.20. Construct $\triangle ABC$ given that $\angle A = 60°, \angle B = 30°$ and $AB = 5.8$.
2.21. Construct $\triangle PQR$ if $PQ = 5, \angle Q = 105°$ and $\angle R = 40°$.
2.22. Can you construct $\triangle DEF$ such that $EF = 7.2, \angle E = 110°$ and $\angle F = 180°$?
2.23. Construct $\triangle LMN$ right angled at M such that $LN = 5$ and $MN = 3$.
Solution:
Let

$$\mathbf{L} = \begin{pmatrix} 0 \\ l \end{pmatrix}, \mathbf{M} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{N} = \begin{pmatrix} 3 \\ 0 \end{pmatrix} \tag{2.23.1}$$

From the given information,

$$\|\mathbf{N} - \mathbf{M}\|^2 = \|\mathbf{N}\|^2 = 3^2 = 9 \tag{2.23.2}$$
$$\|\mathbf{L} - \mathbf{M}\|^2 = \|\mathbf{L}\|^2 = l^2 \tag{2.23.3}$$
$$\|\mathbf{L} - \mathbf{N}\|^2 = 5^2 = 25 \tag{2.23.4}$$

which can be expressed as

$$\|\mathbf{L} - \mathbf{N}\|^2 = (\mathbf{L} - \mathbf{N})^T(\mathbf{L} - \mathbf{N}) \tag{2.23.5}$$
$$= \|\mathbf{L}\|^2 + \|\mathbf{N}\|^2 - 2\mathbf{L}^T\mathbf{N} \tag{2.23.6}$$
$$\implies l^2 + 9 = 25 \tag{2.23.7}$$
$$\text{or, } l = \pm 4 \tag{2.23.8}$$

For l=4, $\triangle LMN$ is plotted in the first quadrant in Fig. 2.23.1.

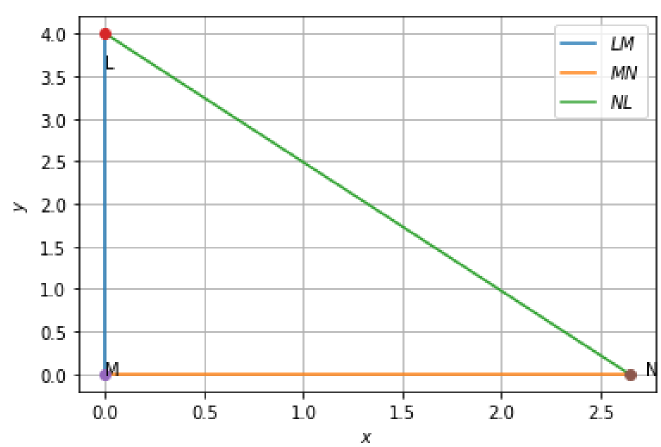

Fig. 2.23.1

2.24. Construct $\triangle PQR$ right angled at Q such that $QR = 8$ and $PR = 10$.
Solution: Let

$$\mathbf{Q} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{R} = \begin{pmatrix} 8 \\ 0 \end{pmatrix}, \mathbf{P} = \begin{pmatrix} 0 \\ p \end{pmatrix} \tag{2.24.1}$$

Then,

$$\|\mathbf{P}-\mathbf{R}\|^2 = (\mathbf{P}-\mathbf{R})^T(\mathbf{P}-\mathbf{R}) \tag{2.24.2}$$
$$= \|\mathbf{P}\|^2 + \|\mathbf{R}\|^2 \tag{2.24.3}$$
$$\because \mathbf{P}^T\mathbf{R} = \mathbf{R}^T\mathbf{P}, \mathbf{R}^T\mathbf{P} = 0 \tag{2.24.4}$$
$$= p^2 + 64 = 10^2 \tag{2.24.5}$$
$$\implies p = \pm 6 \tag{2.24.6}$$

Since positive area is considered here,only $p = 6$ is taken into consideration. Thus,

$$\mathbf{P} = \begin{pmatrix} 0 \\ 6 \end{pmatrix} \tag{2.24.7}$$

and the desired traingle is plotted in Fig. 2.24.1

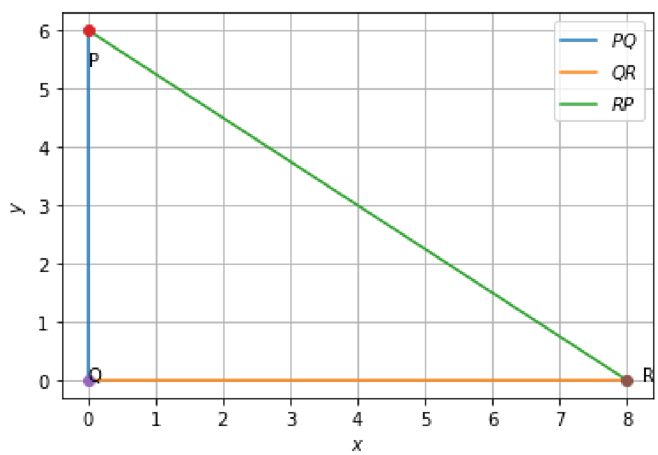

Fig. 2.24.1: Right Angle $\triangle PQR$

2.25. Construct right angled $\triangle$ whose hypotenuse is 6 and one of the legs is 4.
Solution: Let us consider $\triangle PQR$ right angled at Q and assume that we are restricted to first quadrant such that

$$\mathbf{Q} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{R} = \begin{pmatrix} 4 \\ 0 \end{pmatrix}, \mathbf{P} = \begin{pmatrix} 0 \\ p \end{pmatrix} \tag{2.25.1}$$

Then,

$$\|\mathbf{P}-\mathbf{R}\|^2 = 36 \tag{2.25.2}$$
$$\implies p^2 + 16 = 36 \tag{2.25.3}$$
$$\implies p = \pm 2\sqrt{5} \tag{2.25.4}$$

Since first quadrant was assumed here,only $p = +2\sqrt{5}$ is taken into consideration. So,the vertices of $\triangle PQR$ in Fig. 2.25.1 are

$$\mathbf{P} = \begin{pmatrix} 0 \\ 2\sqrt{5} \end{pmatrix}, \mathbf{Q} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{R} = \begin{pmatrix} 4 \\ 0 \end{pmatrix} \tag{2.25.5}$$

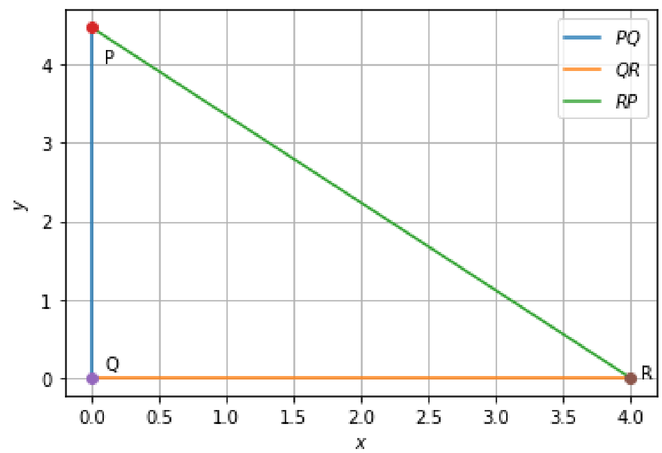

Fig. 2.25.1: Right Angled $\triangle PQR$

2.26. Construct an isosceles right angled $\triangle ABC$ right angled at C such $AC = 6$.
Solution:
$\because \triangle ABC$ is isosceles, its vertices are

$$\mathbf{C} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{A} = \begin{pmatrix} 6 \\ 0 \end{pmatrix}, \mathbf{B} = \begin{pmatrix} 0 \\ 6 \end{pmatrix} \tag{2.26.1}$$

which are used to plot the desired triangle in Fig. 2.26.1.

2.27. Construct the triangles in Table 2.27.1.

S.No	Triangle	Given Measurements		
1	△ABC	$\angle A = 85°$	$\angle B = 115°$	AB = 5
2	△PQR	$\angle Q = 30°$	$\angle R = 60°$	QR = 4.7
3	△ABC	$\angle A = 70°$	$\angle B = 50°$	AC = 3
4	△LMN	$\angle L = 60°$	$\angle N = 120°$	LM = 5
5	△ABC	BC = 2	AB = 4	AC = 2
6	△PQR	PQ = 2.5	QR = 4	PR = 3.5
7	△XYZ	XY = 3	YZ = 4	XZ = 5
8	△DEF	DE = 4.5	EF = 5.5	DF = 4

TABLE 2.27.1

2.28. Construct a quadrilateral $ABCD$ such that $AB = 5, \angle A = 50°, AC = 4, BD = 5$ and $AD = 6$.

2.29. Construct $PQRS$ where $PQ = 4, QR = 6, RS = 5, PS = 5.5$ and $PR = 7$.

2.30. Draw $JUMP$ with $JU = 3.5, UM = 4, MP = 5, PJ = 4.5$ and $PU = 6.5$

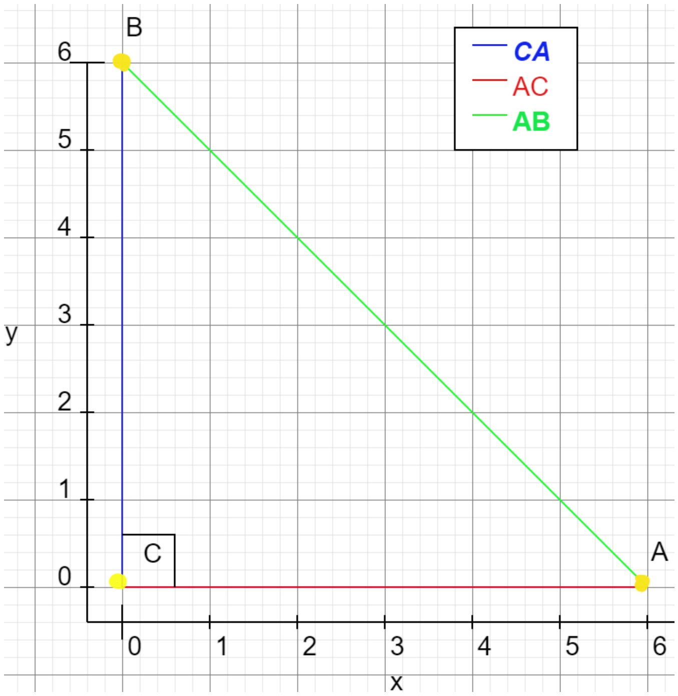

Fig. 2.26.1: Isosceles Right Angle $\triangle ABC$

2.31. Construct a quadrilateral $ABCD$ such that $BC = 4.5, AC = 5.5, CD = 5, BD = 7$ and $AD = 5.5$.

2.32. Can you construct a quadrilateral $PQRS$ with $PQ = 3, RS = 3, PS = 7.5, PR = 8$ and $SQ = 4$?

Solution: From the given information,

$$\|\mathbf{P} - \mathbf{Q}\| = 3 \tag{2.32.1}$$
$$\|\mathbf{R} - \mathbf{S}\| = 3 \tag{2.32.2}$$
$$\|\mathbf{P} - \mathbf{S}\| = 7.5 \tag{2.32.3}$$
$$\|\mathbf{P} - \mathbf{R}\| = 8 \tag{2.32.4}$$
$$\|\mathbf{S} - \mathbf{Q}\| = 4 \tag{2.32.5}$$

Let quadrilateral $PQRS$ be made up of two triangles $\triangle PSQ$ and $\triangle PSR$ on base PS.

a) In $\triangle PSR$,

$$\|\mathbf{P} - \mathbf{S}\| + \|\mathbf{R} - \mathbf{S}\| = 7.5 + 3 = 10.5 > \|\mathbf{P} - \mathbf{R}\| \tag{2.32.6}$$
$$\|\mathbf{P} - \mathbf{R}\| + \|\mathbf{R} - \mathbf{S}\| = 8 + 3 = 11 > \|\mathbf{P} - \mathbf{S}\| \tag{2.32.7}$$
$$\|\mathbf{P} - \mathbf{S}\| + \|\mathbf{P} - \mathbf{R}\| = 7.5 + 8 = 15.5 > \|\mathbf{R} - \mathbf{S}\| \tag{2.32.8}$$

$\therefore$ using triangle inequality, construction of $\triangle PSR$ is possible.

b) In $\triangle PSQ$,

$$\|\mathbf{P} - \mathbf{S}\| + \|\mathbf{S} - \mathbf{Q}\| = 7.5 + 4 = 11.5 > \|\mathbf{P} - \mathbf{Q}\| \tag{2.32.9}$$
$$\|\mathbf{P} - \mathbf{S}\| + \|\mathbf{P} - \mathbf{Q}\| = 7.5 + 3 = 10.5 > \|\mathbf{S} - \mathbf{Q}\| \tag{2.32.10}$$
$$\|\mathbf{P} - \mathbf{Q}\| + \|\mathbf{S} - \mathbf{Q}\| = 3 + 4 = 7 < \|\mathbf{P} - \mathbf{S}\| \tag{2.32.11}$$

which violates triangle inequality. $\therefore$ construction of $\triangle PSQ$ is not possible.

Fig. 2.32.1 highlights this.

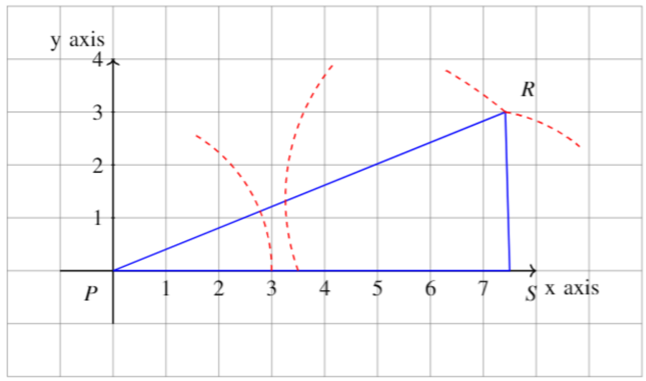

Fig. 2.32.1: Construction of quadrilateral $PQRS$

2.33. Construct $LIFT$ such that $LI = 4, IF = 3, TL = 2.5, LF = 4.5, IT = 4$.

2.34. Draw $GOLD$ such that $OL = 7.5, GL = 6, GD = 6, LD = 5, OD = 10$.

2.35. DRAW rhombus $BEND$ such that $BN = 5.6, DE = 6.5$.

2.36. construct a quadrilateral MIST where $MI = 3.5, IS = 6.5, \angle M = 75°, \angle I = 105°$ and $\angle S = 120°$.

2.37. Can you construct the above quadrilateral MIST if $\angle M = 100°$ instead of $75°$.

2.38. Can you constrcut the quadrilateral PLAN if $PL = 6, LA = 9.5, \angle P = 75°, \angle L = 150°$ and $\angle A = 140°$?

2.39. Construct $MORE$ where $MO = 6, OR = 4.5, \angle M = 60°, \angle O = 105°, \angle R = 105°$.

2.40. Construct $PLAN$ where $PL = 4, LA = 6.5, \angle P = 90°, \angle A = 110°$ and $\angle N = 85°$.

2.41. Draw rectangle $OKAY$ with $OK = 7$ and $KA = 5$.

2.42. Construct $ABCD$, where $AB = 4, BC = 5, Cd = 6.5, \angle B = 105°$ and $\angle C = 80°$.

2.43. Construct $DEAR$ with $DE = 4, EA = 5, AR =$

$4.5, \angle E = 60°$ and $\angle A = 90°$.

2.44. Construct $TRUE$ with $TR = 3.5, RU = 3, UE = 4 \angle R = 75°$ and $\angle U = 120°$.

2.45. Can you construct a rhombus $ABCD$ with $AC = 6$ and $BD = 7$?

2.46. Draw a square $READ$ with $RE = 5.1$.

2.47. Draw a rhombus who diagonals are 5.2 and 6.4.

2.48. Draw a rectangle with adjacent sides 5 and 4.

2.49. Draw a parallelogram $OKAY$ with $OK = 5.5$ and $KA = 4.2$.

2.50. Construct a kite $EASY$ if $AY = 8, EY = 4$ and $SY = 6$.

2.51. Draw a circle of diameter 6.1

2.52. With the same centre $\mathbf{O}$, draw two circles of radii 4 and 2.5

Solution:

All input values required to plot Fig. 2.52.1 are given in Table 2.52.1 as shown below

	Symbols	Circle1	Circle2
Centre	$\mathbf{O}$	$\begin{pmatrix}0\\0\end{pmatrix}$	$\begin{pmatrix}0\\0\end{pmatrix}$
Radius	r_1,r_2	2.5	4
Polar coordinate	$\mathbf{C}_1$,$\mathbf{C}_2$	$2.5\begin{pmatrix}\cos\theta\\\sin\theta\end{pmatrix}$	$4\begin{pmatrix}\cos\theta\\\sin\theta\end{pmatrix}$
Angle	θ	0-2π	0-2π

TABLE 2.52.1: Input values

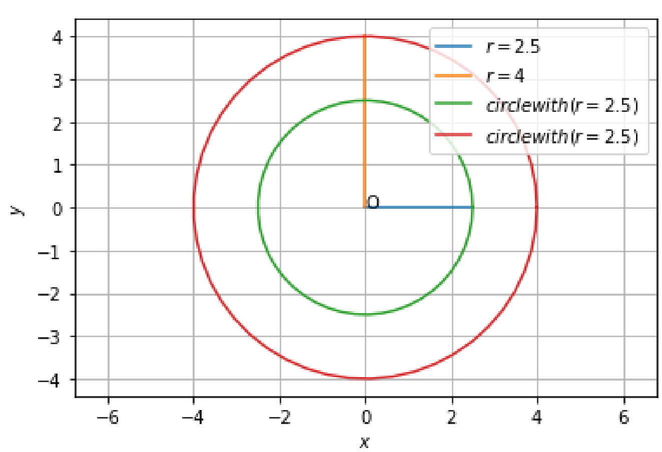

Fig. 2.52.1: Concentric circles with centre as origin and radii 2.5 and 4 respectively

2.53. Draw a circle with centre $\mathbf{B}$ and radius 6. If $\mathbf{C}$ be a point 10 units away from its centre, construct the pair of tangents AC and CD to the circle.

2.54. Draw a circle of radius 3 and any two of its diameters. Draw the ends of these diameters. What figure do you get?

2.55. Let $\mathbf{A}$ and $\mathbf{B}$ be the centres of two circles of equal radii 3 such that each one of them passes through the centre of the other. Let them intersect at $\mathbf{C}$ and $\mathbf{D}$. Is $AB \perp CD$?

2.56. Construct a tangent to a circle of radius 4 units from a point on the concentric circle of radius 6 units.

Solution: Take the centre of both circles to be at the origin.

2.57. Draw a circle of radius 3 units. Take two points $\mathbf{P}$ and $\mathbf{Q}$ on one of its extended diameter each at a distance of 7 units from its centre. Draw tangents to the circle from these two points $\mathbf{P}$ and $\mathbf{Q}$.

Solution: Take the diameter to be on the x-axis.

2.58. Draw a pair of tangents to a circle of radius 5 units which are inclined to each other at an angle of 60°.

Solution: The tangent is perpendicular to the radius.

2.59. Draw a line segment AB of length 8 units. Taking $\mathbf{A}$ as centre, draw a circle of radius 4 units and taking $\mathbf{B}$ as centre, draw another circle of radius 3 units. Construct tangents to each circle from the centre of the other circle.

Solution: Let

$$\mathbf{A} = \begin{pmatrix}0\\0\end{pmatrix}, \mathbf{B} = \begin{pmatrix}8\\0\end{pmatrix}. \tag{2.59.1}$$

2.60. Let ABC be a right triangle in which $a = 8, c = 6$ and $\angle B = 90^{\circ}$. BD is the perpendicular from $\mathbf{B}$ on AC (altitude). The circle through $\mathbf{B}, \mathbf{C}, \mathbf{D}$ (circumcircle of $\triangle BCD$) is drawn. Construct the tangents from $\mathbf{A}$ to this circle.

2.61. Draw a circle with centre $\mathbf{C}$ and radius 3.4. Draw any chord. Construct the perpendicular bisector of the chord and examine if it passes through $\mathbf{C}$