

# Math Document Template

C ANISH

**Abstract**—This is a document explaining a question about the concept of sum of angles in a triangle.

Download all python codes from

```
svn co https://github.com/chakki1234/summer
-2020/trunk/linearalg/codes
```

and latex-tikz codes from

```
svn co https://github.com/chakki1234/summer
-2020/trunk/linearalg/figs
```

## 1 PROBLEM

In a  $\triangle ABC$ ,  $\angle C = 3\angle B = 2(\angle A + \angle B)$ . Find the three angles.

## 2 CONSTRUCTION

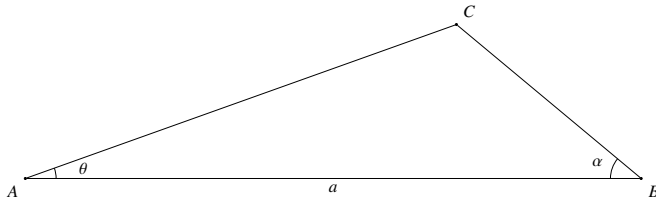


Fig. 2.0: Triangle by Latex-Tikz

2.1. The figure obtained looks like Fig. 2.0.

2.2. The design parameters used for construction See Table. 2.2.

Design Parameters	
Parameters	Value
a	10

TABLE 2.2: Triangle  $ABC$

2.3. To find the coordinates of  $C$  in Fig 2.0

**Solution:**

$$\mathbf{A} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \quad (2.3.1)$$

$$\mathbf{B} = \begin{pmatrix} b \\ 0 \end{pmatrix} \quad (2.3.2)$$

$$\mathbf{C} = \begin{pmatrix} x \\ y \end{pmatrix} \quad (2.3.3)$$

Finding the Scalar Products:

$$\frac{(\mathbf{B} - \mathbf{A})^T (\mathbf{C} - \mathbf{A})}{\|\mathbf{B} - \mathbf{A}\| \|\mathbf{C} - \mathbf{A}\|} = \cos \theta \quad (2.3.4)$$

$$\frac{(\mathbf{C} - \mathbf{B})^T (\mathbf{A} - \mathbf{B})}{\|\mathbf{C} - \mathbf{B}\| \|\mathbf{A} - \mathbf{B}\|} = \cos \alpha \quad (2.3.5)$$

On simplifying equation 2.3.4 and 2.3.5:

$$x^2 \tan^2 \theta = y^2 \quad (2.3.6)$$

$$(x - a)^2 = ((x - a)^2 + y^2) \cos^2 \alpha \quad (2.3.7)$$

Substituting 2.3.6 in 2.3.7:

$$x^2 (1 - \cos^2 \alpha - \tan^2 \theta \cos^2 \alpha) + x(2a \cos^2 \alpha - 2a) + a^2 \sin^2 \alpha = 0 \quad (2.3.8)$$

If  $\theta$  and  $\alpha$  are acute angles:

$$x = \frac{(-b - \sqrt{b^2 - 4ac})}{2a} \quad (2.3.9)$$

else:

$$x = \frac{(-b + \sqrt{b^2 - 4ac})}{2a} \quad (2.3.10)$$

The value of  $x$  can then be substituted in 2.3.6 to find the coordinates of  $C$

2.4. From the given information, The values are listed in 2.4 From the given information:

$$\frac{\angle C}{6} + \frac{\angle C}{3} + \angle C = 180^\circ \quad (5.2)$$

$$\therefore \angle C = 120^\circ \quad \angle A = 20^\circ \quad \angle B = 40^\circ$$

Output values	
Parameter	Value
<b>C</b>	$\begin{pmatrix} 7 \\ 2.5 \end{pmatrix}$

TABLE 2.4: Value of **C**

2.5. Draw Fig. 2.5.

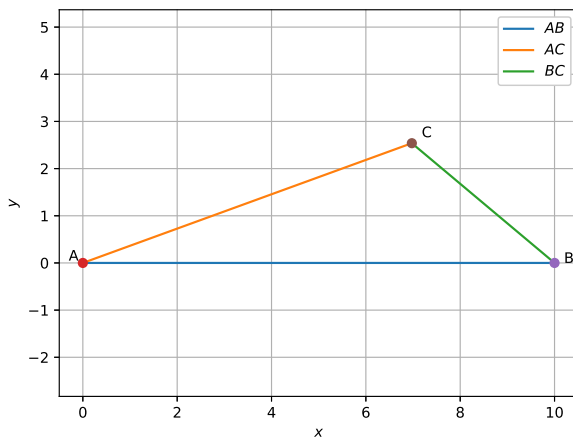


Fig. 2.5: Triangle generated using python

**Solution:** The following Python code generates Fig. 2.5

```
codes/triangle_linearlg.py
```

and the equivalent latex-tikz code generating Fig. 2.5 is

```
figs/triangle_fig.tex
```

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

```
figs/triangle_final.tex
```

### 3 SOLUTION

**Theorem 3.1.** *Sum of all angles in a triangle equals  $180^\circ$ .*

**Solution:** From theorem 3.1

$$\angle A + \angle B + \angle C = 180^\circ \quad (5.1)$$