

Solving Trigonometric Equations 1

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## Solving Trigonometric Equations

Recall solving an equation of the the following form,

$$x^2 - 3x - 4 = 0 \quad (1)$$

The goal when solving the above equation is to find the values for  $x$  that satisfy the equation or in other words, when the value for  $x$  is plugged into the left hand side of (1), it equals the right hand side of (1). The first step when solving an equation of the form in (1) is to *factor* the left hand side. Let's do this.

$$LHS = x^2 - 4x + 4 = (x - 4)(x + 1) \quad (2)$$

Next, when does a product equal zero? A product equals zero when at least one factor equals zero. So in our case (2) equals zero when,

$$x - 4 = 0 \text{ or} \quad (3)$$

$$x + 1 = 0 \quad (4)$$

Solving (3) and (4) for  $x$  we get,

$$x = 4 \text{ or } x = -1$$

So the solutions to the equation in (1) are  $x = 4$  or  $x = -1$ . The above thought process holds for every equation. Let's consider another example.

### Example

Solve the following equation,

$$\sin x + 2 = 3 \quad (5)$$

**Solution:** We need to find the values of  $x$  for which the equation (5) is satisfied. We are used to working with trigonometric functions equal to a single number such as,

$$\sin \theta = 1.$$

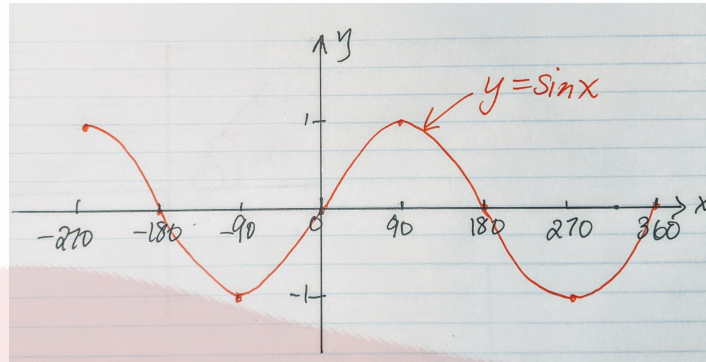
Let's see if we can rearrange equation (5) so we have something of this form, trigonometric function on one side of the equal sign and number on the other.

$$\sin x + 2 = 3$$

$$\sin x = 3 - 2$$

$$\sin x = 1$$

What angle values have a sine of 1? We can use the graph of sine if we don't already know what angle values,



We will consider the angle values between  $0^\circ$  and  $360^\circ$  since the sine function is a periodic function with period  $360^\circ$ . From the graph we see that at the angle value  $90^\circ$ ,  $\sin 90^\circ = 1$ . Therefore, when  $x = 90^\circ$ ,  $\sin x = 1$ . Therefore, our solution to the trigonometric function  $\sin x + 2 = 3$  is  $x = 90^\circ$ .

## Exercises

Solve the following equations,

a)  $\sin x = -\frac{1}{2}$

d)  $\cos(45^\circ - x) = 1$

b)  $\sin x = \frac{\sqrt{2}}{2}$

e)  $\sin(60^\circ - x) = -\frac{1}{2}$

c)  $\tan x = \frac{\sqrt{3}}{3}$

f)  $\sin(4x - 1) = 0$

g)  $3 \tan x - 1 = 2 \tan x$

l)  $\cos \frac{x}{4} = -1$

h)  $\sin 5x = 1$

m)  $\sin \left( \frac{x}{3} + 45^\circ \right) = \frac{\sqrt{2}}{2}$

i)  $\cos(2x) = 0$

n)  $\cot(2x - 1) = 1$

j)  $\tan 3x = \sqrt{3}$

o)  $\csc x = \frac{2}{\sqrt{3}}$

k)  $\cot \left( \frac{x}{2} \right) = 0$