

# Presentation Template

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## 1 Problem

## 2 Solution

- Usage of variables
- Parametric form
- Row Reduction
- Balanced Equation

## Problem Statement

Show that the point  $\begin{pmatrix} x \\ y \end{pmatrix}$  given by  $x = \frac{2at}{1+t^2}$  and  $y = \frac{a(1-t^2)}{1+t^2}$  lies on a circle for all real values of  $t$  such that  $-1 \leq t \leq 1$ , where  $a$  is any given real number.

# Usage of variables

S.No	variables used	description
1	$t$	a variable which takes the real values in the range $(-1, 1)$
2	$a$	it is a fixed real number
3	$\mathbf{A}(t)$	it is a transformation matrix of parameter $t$
4	$\mathbf{v}(t)$	it represent the parameter $t$ and allows to define $x$ and $y$
5	$\mathbf{p}(t)$	a point with coordinates $x$ and $y$ .

## Parametric form

Given  $x$  and  $y$  in the parametric form,

$$x = \frac{2at}{1+t^2}, \quad (3.1)$$

$$y = \frac{a(1-t^2)}{1+t^2} \quad (3.2)$$

Let  $\mathbf{p}(t)$  be equal to,

$$\mathbf{p}(t) = \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} \frac{2at}{1+t^2} \\ \frac{a(1-t^2)}{1+t^2} \end{pmatrix}. \quad (3.3)$$

## Verification

The transformation matrix  $\mathbf{A}(\mathbf{t})$  with parameter  $t$  is,

$$\mathbf{A}(t) = \begin{pmatrix} \frac{2a}{1+t^2} & 0 \\ 0 & \frac{a(1-t^2)}{1+t^2} \end{pmatrix}, \quad (3.4)$$

Then, we get  $\mathbf{p}(\mathbf{t})$ , (3.5)

$$\mathbf{p}(t) = \begin{pmatrix} \frac{2a}{1+t^2} & 0 \\ 0 & \frac{a(1-t^2)}{1+t^2} \end{pmatrix} \begin{pmatrix} t \\ 1 \end{pmatrix}, \quad (3.6)$$

That implies, we get (3.7)

$$\mathbf{p}(t)^T \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \mathbf{p}(t) = a^2 \quad (3.8)$$

Therefore, we can say that (3.9)

$$x^2 + y^2 = a^2. \quad (3.10)$$

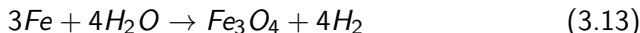
## Balanced Equation

Thus,

$$x_1 = \frac{3}{4}x_4, x_2 = x_4, x_3 = \frac{1}{4}x_4 \quad (3.11)$$

$$\Rightarrow \mathbf{x} = x_4 \begin{pmatrix} \frac{3}{4} \\ 1 \\ \frac{1}{4} \\ 1 \end{pmatrix} = \begin{pmatrix} 3 \\ 4 \\ 1 \\ 4 \end{pmatrix} \quad (3.12)$$

upon substituting  $x_4 = 4$ . (??) then becomes



The codes in

<https://github.com/DESABOINASRISATHWIK/EE1030/blob/main/presentation/codes/plot.py>  
<https://github.com/DESABOINASRISATHWIK/EE1030/blob/main/presentation/codes/code.c>

verifies (??).