

LECTURE NOTE ON GRAPHS AND TRANSFORMATION OF EQUATIONS IN EXPERIMENTAL PHYSICS

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**TOPIC: GRAPHS AND TRANSFORMATION OF EQUATIONS IN
EXPERIMENTAL PHYSICS**

LEARNING OUTCOME:

At the end of this lesson, the students should be able to a given equation into the general form of the equation of a straight line and use it to solve problems.

GRAPHS AND TRANSFORMATION EQUATIONS IN EXPERIMENTAL PHYSICS

WHAT IS A GRAPH

A graph is a pictorial analysis of the several results which may be obtained from a given measurement in experimental physics. The purpose of graphing in experimental physics is that it is not accurate to rely upon only one measurement for calculating a given quantity. Therefore, in order to obtain accurate results, several measurements are made and suitable graphs are plotted. Several numbers of different shapes of graphs exist some of which are the straight line graphs and the parabolas, hyperbolas and exponential curves.

THE STRAIGHT LINE GRAPH

The most general equation of a straight line is $y = mx + cy$

where c and m are constants and x and y are the variables. While the constant m , is called the slope or gradient of the line, the constant c is on the other hand is called the intercept. See the figure below.

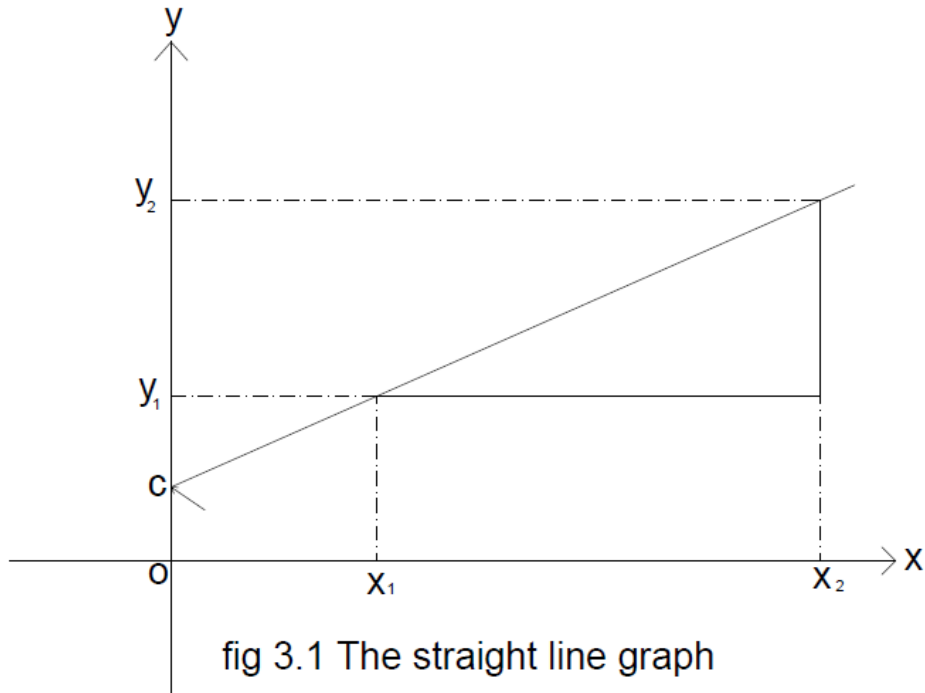


Fig 3.1 The straight line graph from figure 3.1 above, the gradient or slope of the line is given by

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

EXAMPLE 1

The equation of a straight line is given as $2y = 5x - 3$

Determine the slope of the line and the intercepts on the y and x – axes.

Solution

Given $2y = 5x - 3$,

$$y = \frac{5}{2}x - \frac{3}{2} \Leftrightarrow y = mx + c$$

$$\therefore m = \frac{5}{2} = \text{slope}$$

$$C = -3/2 = y \text{ intercept}$$

To find the x-intercept, put $y = 0$ in the original equation and solve for x

$$2(0) = 5x - 3$$

$$5x = 3$$

$$X = 3/5 = x - \text{intercept}$$

Example 2

If (2, 0) and (-2, 2) at two points on a line, find the slope of the line and hence write down the equation of the line

Solution

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$m = \frac{2-0}{-2-2} = \frac{2}{-4} = \frac{-1}{2}$$

The equation of the line is given by

$$\frac{y-y_1}{x-x_1} = \frac{y_2-y_1}{x_2-x_1}$$

$$\frac{y-0}{x-2} = \frac{-1}{2}$$

$$\therefore 2y = -x + 2$$

Example 3

1. The equation $E = I(R+r)$ relates the e.m.f of a battery E, with resistance R and current I; r being the internal resistance. Transform this equation to form of a straight line.

Solution

$$E = I(R + r)$$

$$I = \frac{E}{R + r}$$

$$\frac{1}{I} = \frac{R + r}{E}$$

$$\frac{1}{I} = \frac{R}{E} + \frac{r}{E}$$

$$\frac{1}{I} = \left(\frac{1}{E} \right) R + r \Leftrightarrow y = mx + c$$

Thus, $\frac{1}{I} = y$; $\frac{1}{E} = m$

$R = x$ and $\frac{r}{E} = c$

Thus, a plot of $\frac{1}{I}$ against R will produce a straight line whose gradient is $\frac{1}{E}$ and vertical intercept is $\frac{r}{E}$