Experiment 1

Graphing

Objective:

1. Plotting data.
2. Determination of the slope.

Theory:

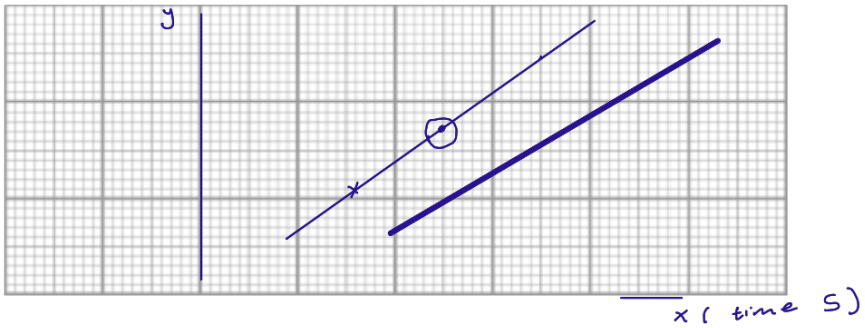
plotting a graph:

Graphing is a photographic way of representing relationships between various quantities, parameters, or measurable variables in nature. A graph basically summarizes how one quantity changes if another quantity that is related to it also changes. It is a very important and useful technique in experimental physics because they can summarize a LOT of information into one picture.

Steps for plotting a graph:

1) Kind of paper :

we have many kind of paper graph for example millimeter paper , loglog paper and semi-log paper . In our lab we used only millimeter paper which has 10 squares per centimeter as shown in the figure



2) The Axes

- ☒ Any plot or graph that has two axes is an x-y plot. One axis (generally, the horizontal one) is the "x-axis" and the other (the vertical one) is considered the "y-axis".
- ☒ The independent variable always belongs on the horizontal axis (x-axis) and the dependent variables (the part of the experiment under observation) always belongs on the vertical axis (y-axis)

3) The Scale

The scale for a variable is the amount of this variable which is presented in each centimeters of length of the graph paper.

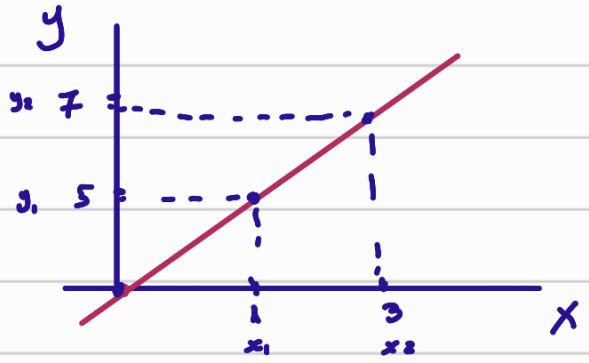
The scale should be chosen so that:

- ☒ It is convenient to you to locate the data points that you need to put in the graph.
- ☒ It is convenient for the reader to visualize the coordinates of each point in the graph.
- ☒ You nearly use the whole graph paper to plot your graph.

Graphing

$$y = mx + b$$

slope — y intercept



$b = 0$

$$y = mx$$

$$y = x$$

$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{7-5}{3-1} = 1$$

$$v = mt + b$$

$$\boxed{v = 3t + 2}$$

$$\text{Rough scale} = \frac{\text{اكبر قيمة في الجدول}}{\text{عدد المربعات}}$$

$$\text{Rough scale } x = \frac{6}{15} = 0.4$$

كل مربع كم x = 0.4

$$\text{Rough scale } y = \frac{61}{20} = 3.05 \approx 3$$

كل مربع كم محور y = 3

$$\text{Partial scale } x = \frac{0.4}{10} = 0.04$$

كل مربع صغير كم x = 0.04

$$\text{partial scal } y = \frac{3}{10} = 0.3$$

كل مربع صغير كم محور y = 0.3

☒ The best way to choose a suitable scale is demonstrated in the example below. Suppose you have done an experiment to measure distance L versus time t, and you have obtained this table:

T (sec)	1	2	3	4	5	6
L (m)	10	21	28	40	53	61

And also suppose that you want to plot your graph in an area (of the graph paper) which is 15 × 23 cm. This means that the dependent variable x will be plotted on a 20 cm-long axis, and the independent variable on a 15 cm-long axis. The first step is to find a "rough scale" from the equation:

$$\text{Rough scale}=\frac{\text{Largest value}}{\text{Number of centimeters}}$$

for the L, the largest value is 60 and the number of centimetres (or boxes) in graph paper is 23
so the

$$Rough\ scale\ for\ L = \frac{61}{20} = 3.05$$

This mean every 1cm in graph paper = 3.05 cm
This scale is hard to be used in plotting the data provided in the table. So, the result is approximated to higher values so that there is no loss in the number of readings. In our case that will be
4 is the suitable numbers. So, if we choose 4 for example the scale in y axis (4, 8, 12, 16, 20 , 24……)
Now, if we want to find the rough scale of t, we repeat the same steps that we did for L.
the largest value is 6 and the number of centimeters in graph paper is 15

$$Rough\ scale\ for\ t = \frac{6}{15} = 0.4$$

which is a suitable scale, so we use it directly. the scale in x - axis (0.4, 0.8, 1.2 , 1.6, 2 , 2.4 ……)

Partial reading: is the small scale of 1 mm (the small square). for I cm = 10 mm

$$Partial\ reading = \frac{Rough\ suitable\ scale}{10}$$

In the example above

$$Partial\ reading\ for\ L = \frac{4}{10} = 0.4$$

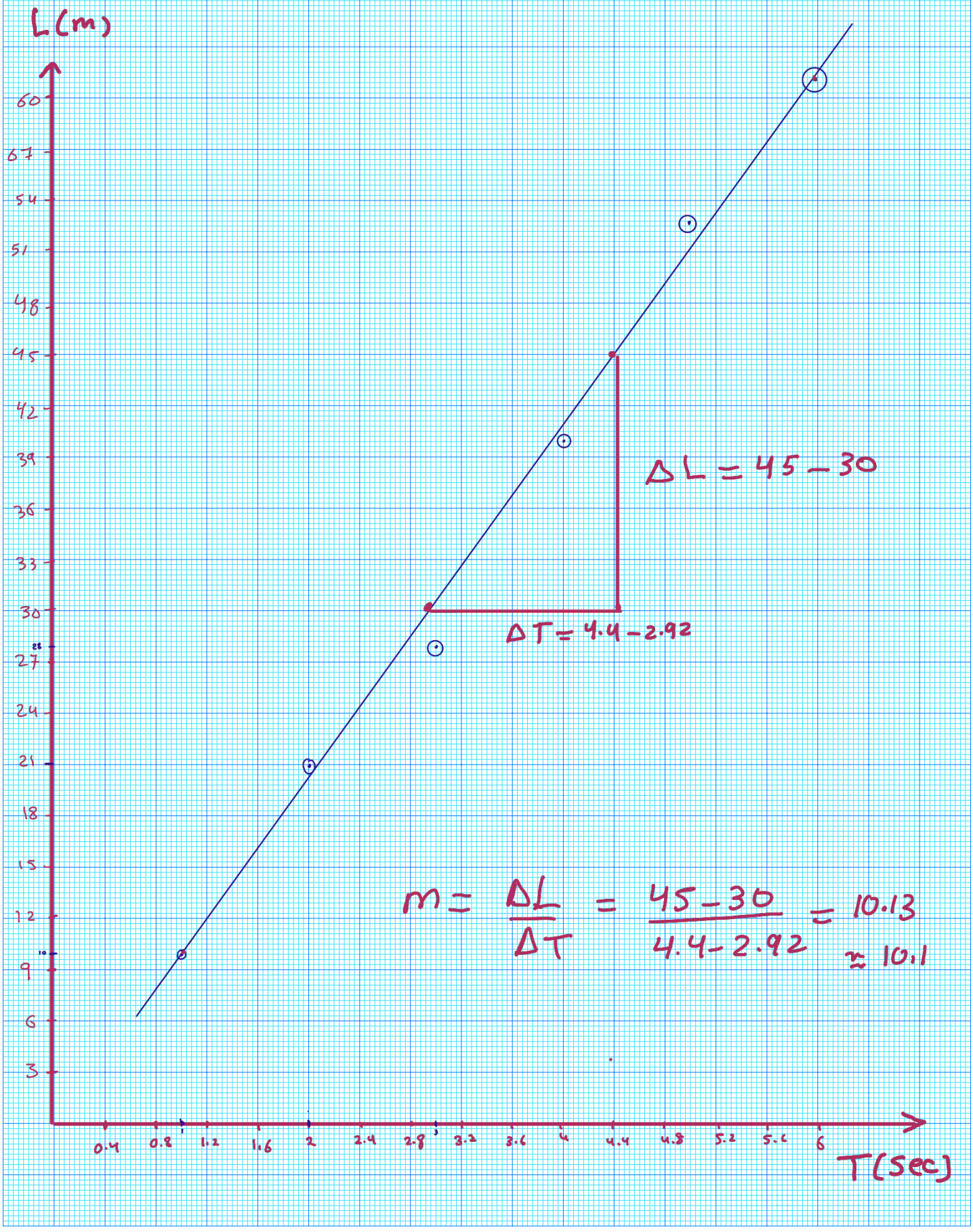
(0.4, 0.8 , 1.2 , 1.6, 2 , 2.4 ……)

$$Partial\ reading\ for\ t = \frac{0.4}{10} = 0.04$$

0.4 مربع كل X

3 مربع كل Y

T (sec)	1	2	3	4	5	6
L (m)	10	21	28	40	53	61



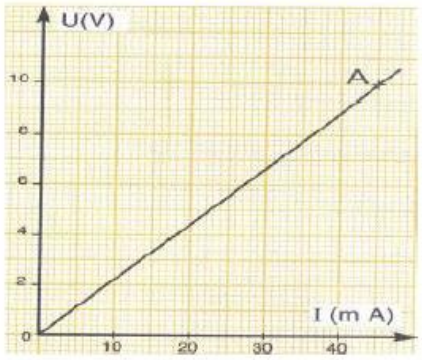
(0.04, 0.08 , 0.12 , 0.16, 0.2 , 0.24 ……)

Another example: From the graph the rough scale in x-axis is 10

The partial reading equal $\frac{10}{10} = 0.1$ i.e every small square equal 0.1

From the graph the rough scale in y-axis is 2

The partial reading equal $\frac{2}{10} = 0.2$ i.e every small square equal 0.2



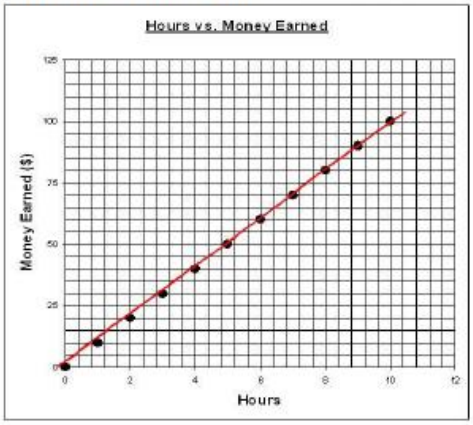
4) <u>Find each data point in your graph:</u>

Simply find each point in the graph by using the coordinates from the table of data. It is recommended to label your point by a dot inside a circle ⊙.

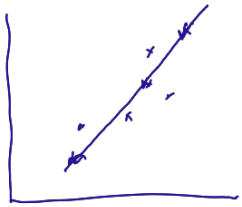
5) <u>Drawing a straight line through the data points:</u>

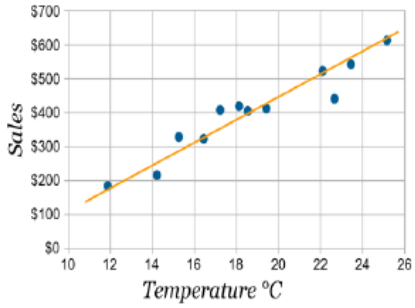
When the data fall on a straight line (or expected theoretically to do so), a ruler may be used to draw a straight line through the points.

☒ The line is drawn to match the data trend.



☒ For data with some scatter, balancing about an equal number of points above and below the line like a figure





6) Graphical analysis:

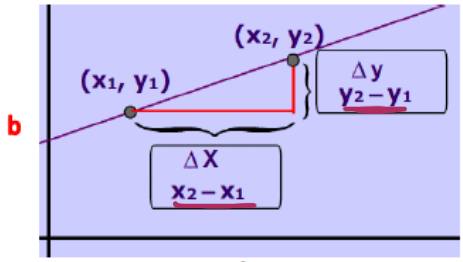
all the graphs should yield straight lines. As you may know that the general form of a straight line is

$$Y = mx + b$$

Where is m is the slope of the line, and b is intercept of $y - axis$

find the slope

We can find the slope by choosing any two points on the line itself (remember do not take any point from the table or your date) them use the equation.



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

Slope direction

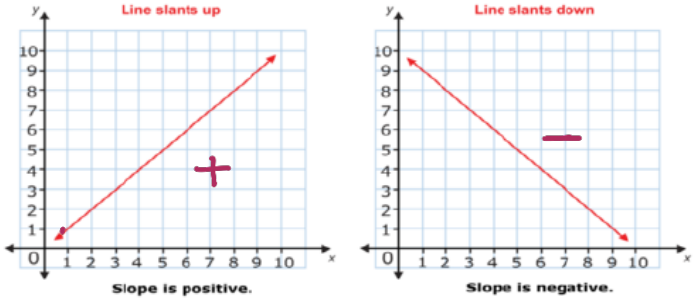
The slope of a line can positive or negative

Positive slope

Here, y increases as x increases, so the line slopes upwards to the right. The slope will be a positive number.

Negative slope

Here, y decreases as x increases, so the line slopes downwards to the right. The slope will be a negative number.



Procedure:

Example 1: A student hangs various masses M from spring and records the resulting the spring has stretched X as see in the table blew to study Hook's law (F = - K X)

M (kg)	0.12	0.15	0.22	0.27	0.35	0.40
X (m)	0.30	0.45	0.67	1.09	1.15	1.4
F = Mg (N)						

1) Calculate the force by using the equation F = Mg where g is the acceleration of gravity and equal 9.8 m/s^2.
2) Plot the relation between X and F (F as the vertical axis and X as the horizontal axis)
3) calculate the spring constant K where the spring constant is the slope of the line. Find the percentage error if the theoretical value of spring constant is 4.5 N/m

Example 2: The data set given in Table below is expected to obey a linear relation $v = v_o + at.$

Plot the relation between v and t, and from your analysis of the graph find the acceleration a and initial velocity v_o?

T (sec)	1	2	3	4	5	6	7	8	9
V(m/sec)	0.6	0.7	0.82	0.96	1.08	1.16	1.26	1.34	1.5