Name : _____ ( ) Class : _____ Date: _____

Secondary 4 Science (Physics)
Topics : Practical Skill Worksheet

Making Observations and Presenting Data

1. Raw Data

Raw data are readings or measurements taken directly from a measuring instrument. This is expressed to a **fixed number of decimal places** dictated by the units and precision of the instrument. [Refer to table below]

Apparatus	Smallest Division	Examples
Half metre or metre rule	0.1 cm	8.4 cm, 12.1 cm
Vernier caliper	0.01 cm	2.75 cm, 5.38 cm
Micrometer screw gauge	0.01 mm	2.10 mm, 3.26 mm
Electronic balance	0.1 g	121.0 g, 86.2 g
	0.01 g	121.10 g, 86.21 g
Stopwatch (digital)	0.01 s	28.69 s
Thermometer (-10 ^{0}C to 110 ^{0}C)	**1.0** ^{0}C	23.0 ^{0}C, 29.5 ^{0}C
Measuring cylinder (100 cm^3)	**1.0** cm^3	18.0 cm^3, 7.5 cm^3
Spring balance (0 – 10 N)	0.1 N	3.**7** N, 5.**8** N
Ammeter (0 -1 A)	0.02 A	0.20 A, 0.54 A
Milliammeter (0 – 100 mA)	2 mA	20 mA, 35 mA
Voltmeter (0 – 5V)	0.1 V	2.**5** V, 3.**6** V

2. Tabulation

Example of Table with raw and processed data:

Independent Variable ← ***Dependent Variables*** →

***l* /m**	***Time for 20 oscillations***		**t_{ave} / s**	**T /s**	**T^2 / s^2**
	t_1 / s	**t_2 / s**			

← **Raw Data** → ← **Processed Data** →

Guidelines:

(a) **Correct symbols and appropriate units** are used for headings
eg. length *l* and its unit metres are written as ***l*/m and not as *l* (m)**.

(b) The **first column** of the raw data should be the **independent variable**.

(c) There should be a **minimum of 5 to 6 readings for a straight line and 8 readings for a curve**.

(d) The independent variables should be arranged in **increasing order and at regular intervals**.

(e) Measurements of dependent variable are repeated (where possible) to obtain an average value.

3. Processed Data

(i) Processed data are readings obtained from calculations (usually **multiplication or division**) of one or more sets of raw data.
For example, in the experiment to determine the period of a simple pendulum, a metre rule and a stopwatch are used to measure the length and time t_1 and t_2 of n oscillations of the pendulum. The values obtained are called **raw data**.
To determine the average time t_{ave} and the period T of the pendulum, the following mathematical operations are carried out:

$$t_{ave} = \frac{(t_1 + t_2)}{2} \quad \text{and} \quad T = \frac{t_{ave}}{n}$$ where n = number of oscillations

The average time t_{ave} and period T are called **processed data**.

(ii) The general guidelines in the **calculation of processed data** are illustrated in the table below.

Mathematical Operations	Guideline	Example
Addition: A + B = C	C will have the ***least number of decimal place*** (i.e. either A or B)	(i) 10.25 + 2.4 = **12.7** **(1 d.p.)** (ii) 2.432 + 1.72 = **4.15** **(2 d.p.)**
Subtraction: A – B = D	D will have the ***least number of decimal place*** (either A or B)	(i) 9.382 – 8.51 = **0.87** **(2 d.p.)** (ii) 120 – 18.3 = **102** **(no d.p.)**
Average: $\frac{A + B + C}{3} = D$	D will have the same number of ***decimal places*** as A, B or C.	$D = \frac{1.25 + 1.24 + 1.27}{3}$ = **1.25 (2 d.p.)**
Multiplication: A x B = C	C will have the ***least number of significant figures*** (either A or B).	16.42 x 0.211 = **3.46** **(3 s.f.)**
Division: $\frac{C}{D} = E$	E will have the ***least number of significant figures*** (either C or D).	$\frac{2.735}{0.328}$ = **8.34 (3 s.f.)**
Division: $T = \frac{t_{ave}}{n}$	T will have the ***significant figures of*** t_{ave}. The significant figures in n are not taken into account as it is a whole number with no inherent error.	$T = \frac{tave}{16} = \frac{22.0}{16}$ = **1.38** **(3 s.f.)**

Example of Table with raw and processed data:

Independent Variable ← ***Dependent Variables*** →

l /m	***Time for 20 oscillations***		t_{ave} ***/ s***	***T /s***	T^2 ***/ s²***
	t_1 ***/ s***	t_2 ***/ s***			

← **Raw Data** → ← **Processed Data** →

Handling Experimental Observations and Data

Characteristics of a Good Graph

1. Axes

(a) Axes must be labeled with the **correct physical quantity and unit**. The quantity and unit must be the same as the heading of the table of results.

(b) Values in decimal places must be written along the axes at **regular intervals** (eg. 1 cm or 2 cm apart).

(c) **Independent variable** is plotted along the **horizontal (x) axis** while the **dependent variable** is plotted along the **vertical (y) axis**.

2. Scales

(a) Choose a suitable scale in order to make full use of the graph paper. The span of the first to the last plotted points should be **greater than half the page**.

Example : Figure 1.1 (unacceptable) and Figure 1.2 (acceptable)

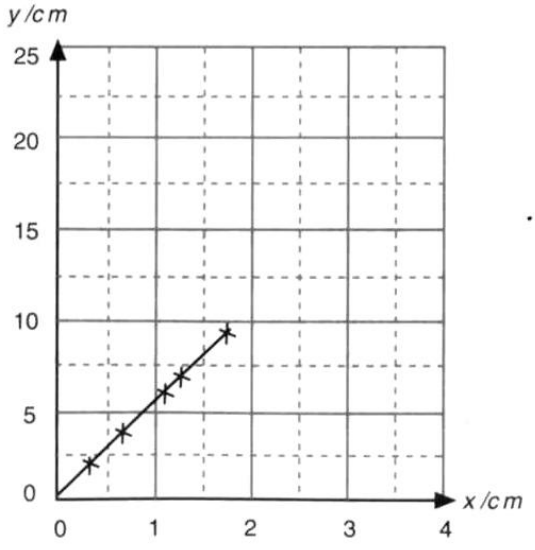


Figure 1.1

unacceptable

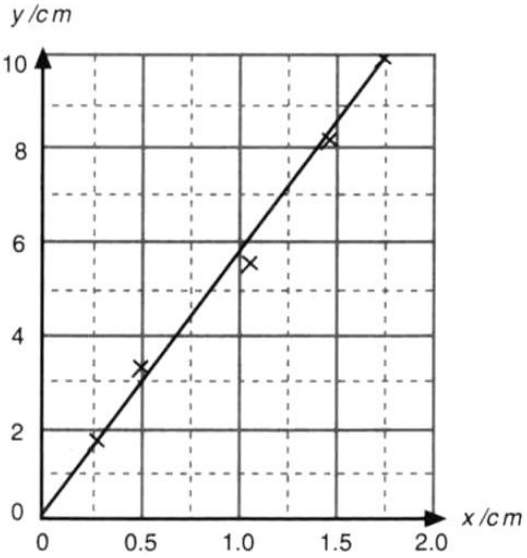


Figure 1.2

acceptable

(b) If points lie outside the graph grid as shown in Figure 1.3, the scale is incorrect and **has to be scaled down** so that all points lie within the graph grid.

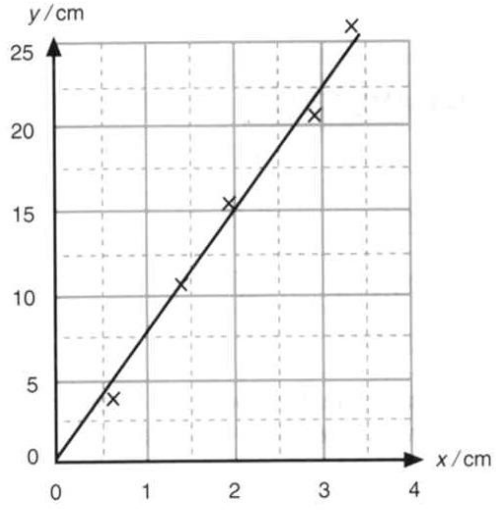


Figure 1.3

3. Plotting Points on the Graph

Data points must be clearly and accurately marked. Use **crosses (x) to plot the data points**.

4. Drawing the Best Fit Line or Curve

(a) Make sure that the **number of points on each side of the line is about the same** and that **they are close to the line** as possible.
Example: Figure 1.6 (acceptable) and Figure 1.7 (unacceptable).

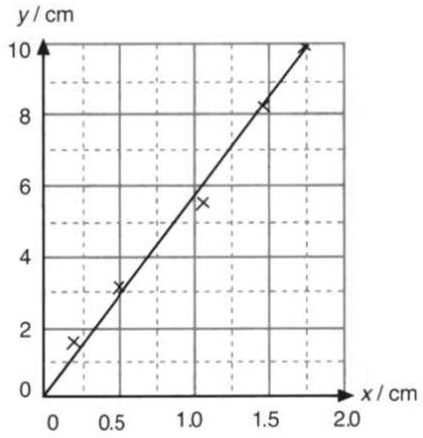


Figure 1.6

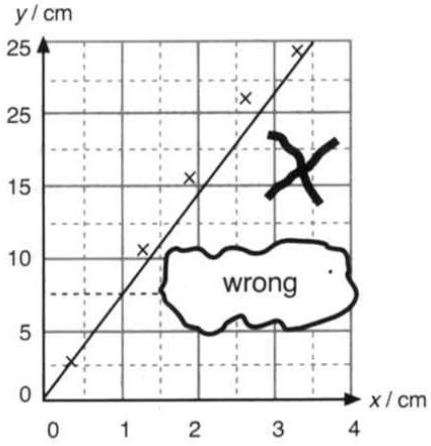


Figure 1.7

(b) If the graph is a curve, do not simply join one point to another point. Instead, draw a smooth curve through it. **- Buy a curve ruler.**

Example: Figure 1.8 (unacceptable) and Figure 1.9 (acceptable)

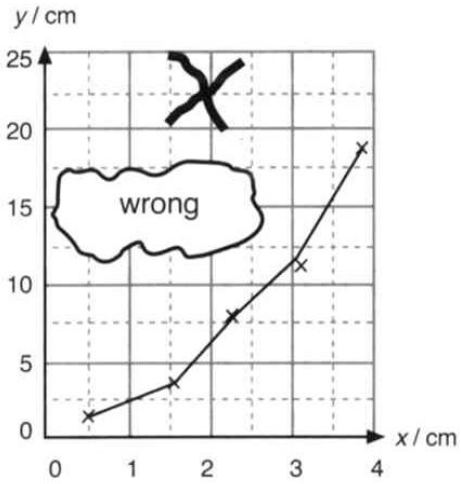


Figure 1.8
Unacceptable

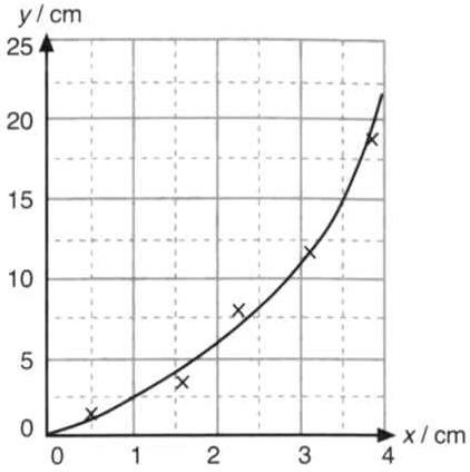


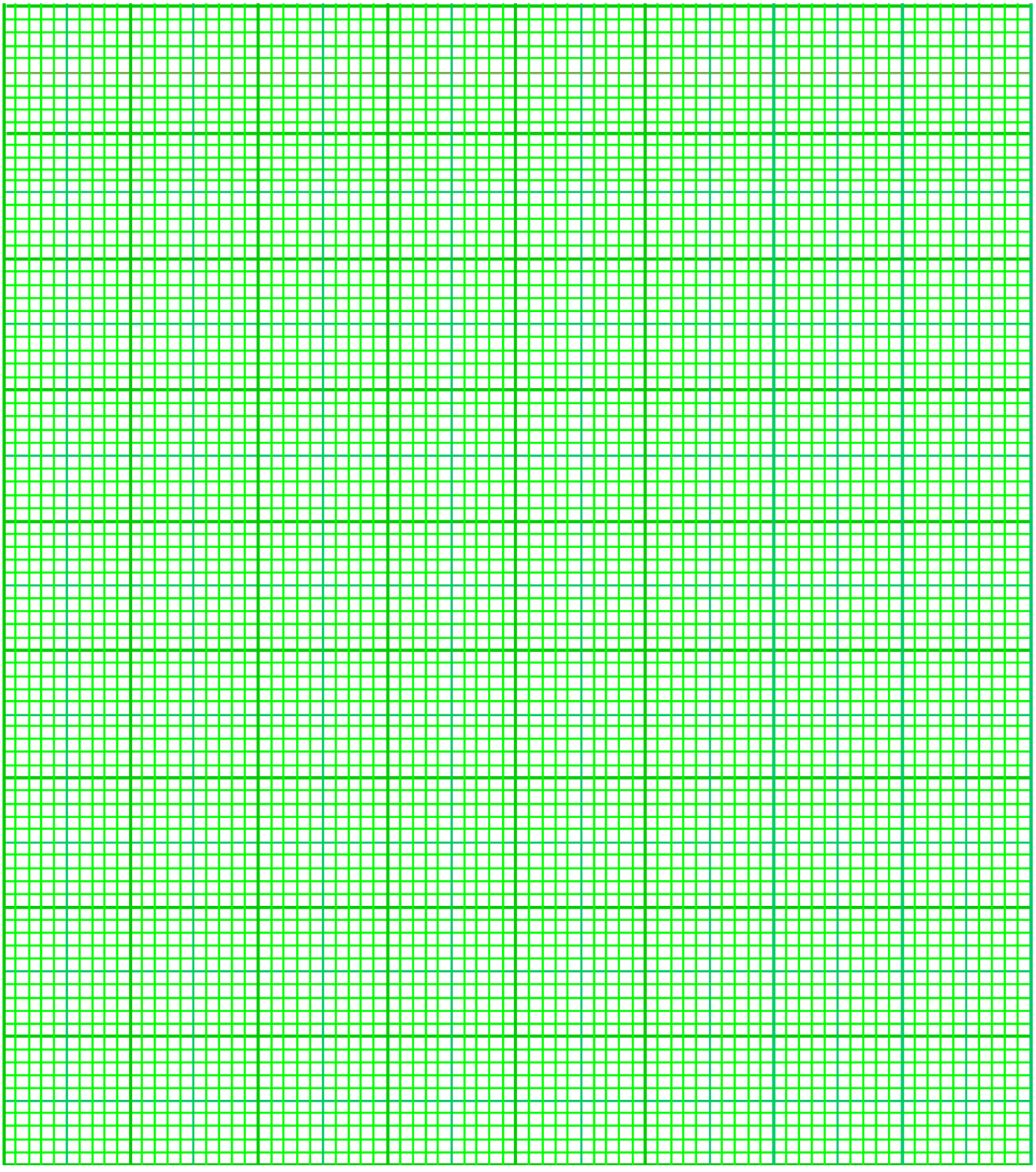
Figure 1.9
Acceptable

(c) The line or curve must be **thin** and **very neat**. Thick or kinked line or curve introduces errors in the calculations of gradients and intercepts.

Practice

1. Plot a graph of V (y-axis) against θ (x-axis) based on the values given in the table below. [4]

V / cm^3	θ / °C
7.0	7.0
7.2	14.0
7.6	20.0
8.2	37.0
8.8	45.0
9.6	55.0
10.5	64.0
12.2	70.0



2. Plot a graph of I_1 (y-axis) against I_2 (x-axis) based on the values given in the table below. [4]

I_1 / A	I_2 / A
0.50	0.10
0.42	0.12
0.33	0.14
0.25	0.16
0.18	0.18