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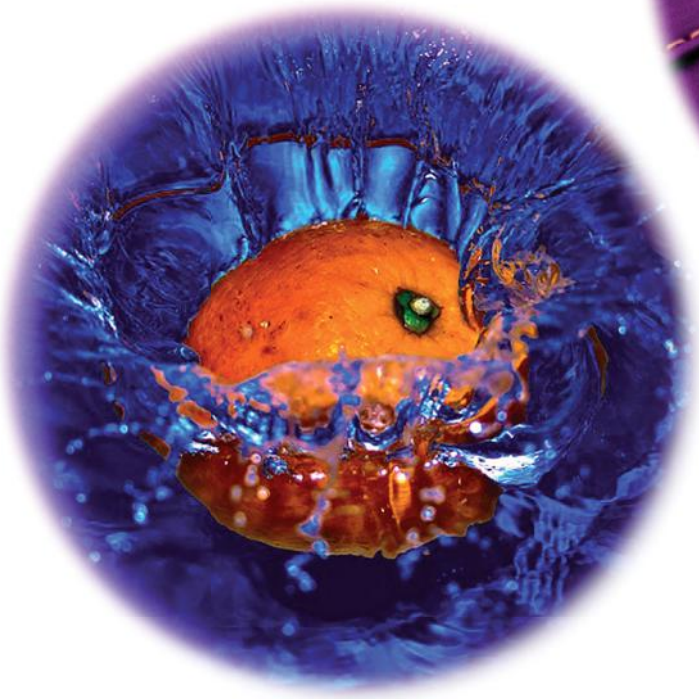

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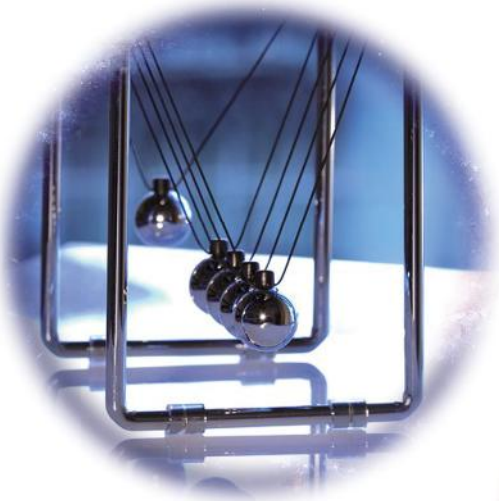
Physics & Chemistry



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ESO

LOMCE Edition

Physics and Chemistry Workbook

4º ESO

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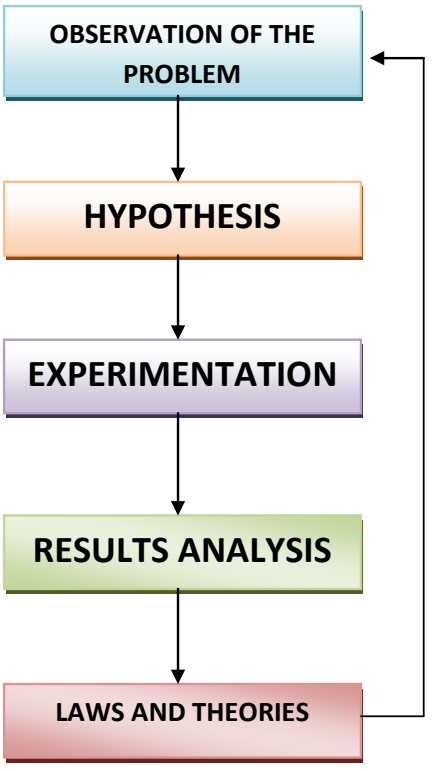
A los alumnos de la primera promoción bilingüe
del IES Cardenal Pardo de Tavera (Toro)

INDEX

Unit 1. Introduction to the Scientific Method.

1. MAGNITUDES AND MEASUREMENTS. CLASSIFICATION OF MAGNITUDES

Remember that the scientific method is a set of techniques used by the scientist to construct knowledge. It consists in a relation of different steps:



Experimentation may be considered the fundamental and longest step during which scientist have to make **measurements of magnitudes**.

A Physical Magnitude is any property that can be measured. For example, temperature and volume are magnitudes but beautiful or happiness are not.
A lot of magnitudes are commonly used such as mass, volume, length, time, temperature or velocity and you have worked with some others such as density and surface.

To measure a magnitude is to compare it with another that we have chosen as unit to determine how many times the magnitude contains the unit. Therefore, to measure we always need a **unit**.
Think about some of the units used to measure the magnitudes mentioned above.
A magnitude may be classified in two different ways:

1. **Fundamental magnitude or derived magnitude:**
   a. It is considered that a **fundamental magnitude** is independent. There are seven fundamental magnitudes by convention: mass, length, time, temperature, current intensity, luminous intensity and amount of substance.
   b. **Derived magnitudes** depend on fundamental ones and they are formed by combining fundamental magnitudes. Some examples are volume which depends on length, density which depends on length and mass or velocity which depends on length and time.
2. **Scalar magnitude and vector magnitude:**
   a. A **scalar magnitude** is completely defined expressing the numerical value of the measure following by the unit. When it is said that a body has a mass of 15 kg, all the information is given and nobody needs more information to completely understand the message.
   b. A **vector magnitude** is only fully defined expressing not only the numerical value and the unit but also the direction. To completely know the velocity of a body, the direction of the motion needs to be given. For example "A car is moving at a velocity of 30m/s to the east."

Practice the classification of magnitudes solving the following questions:

1. Classify the following magnitudes into fundamental, derived, scalar or vector magnitudes:

mass	force	volume	acceleration	temperature	Current intensity
surface	length	density	time	Amount of substance	velocity

2. Complete:

There are seven fundamental magnitudes: ....., ..., ..., ..., ..., and .....

Density is a ..... magnitude which depends on ..... and .....

Acceleration is a ..... magnitude which depends on ..... and .....

Surface is a ..... magnitude which depends on .....

Three scalar magnitudes are ....., ... and ..... All of them are defined by a ..... and a .....

Three vector magnitudes are ....., ... and ..... They need also the ..... In order to be completely defined.

2. INTERNATIONAL SYSTEM OF UNITS. MULTIPLES AND SUBMULTIPLES. CONVERSION FACTORS

The International System of Units, universally abbreviated as SI, is the modern system of measurement, created to avoid misunderstandings among scientist from different countries.
According to it, the main units are the following:

UNIT	ABBREVATION	Fundamental Magnitude
METRE	m	Length
KILOGRAM	kg	Mass
SECOND	s	Time
AMPERE	A	Current
KELVIN	K	Temperature
MOLE	Mol	Amount of substance
CANDELA	cd	Luminous intensity

Notice that the International System Units for measuring derived magnitudes depend on the units of the fundamental magnitudes. For example the SI unit for measuring surfaces is the square meter (m^2) and the SI unit for measuring volumes is the cubic meter (m^3) although the most used unit for volumes is the liter (L) which is the same as 1 dm^3

However, in some countries, like the English ones, other units are used:

UNIT	ABBREVATION	Magnitude
INCH	in	Length
FOOT	ft	Length
YARD	yd	Length
MILE	mi	Length
QUART	qt	Volume
GALLON	gal	Volume
PINT	pt	Volume
OUNCE	oz	Mass
POUND	lb	Mass
FAHRENHEIT	ºF	Temperature

The equivalence between our system and the English one is:

1 inch = 0.0254 m.
1 foot = 0.3048 m.
1 yard = 0.9144 m.
1 mile = 1609.344 m.
1 quart = 1136.5225 mL.
1 gallon = 4546.09 mL.
1 pint = 568.2612 mL.
1 ounce = 28.349 g.
1 pound = 453.592 g.

Sometimes, for measuring very large or very small quantities, it is useful to use different units than the ones of the International System. For that reason, we use the multiples and submultiples than can be seen in the next table:

MULTIPLES AND SUBMULTIPLES		
FACTOR	**PREFIX**	**SYMBOL**
10^{1}	deca	da
10^{2}	hecto	h
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	mili	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

Length, surface and volume. Charts of units

LENGTH UNITS	
	Equivalence with the International System Unit
Tm	1 Tm = 10^{12} m
Gm	1 Gm = 10^{9} m
Mm	1 Mm = 10^{6} m
Km	1 km = 10^{3} m
hm	1 hm = 10^{2} m
dam	1 dam = 10 m
m	IS Unit
dm	10 dm = 1 m
cm	10^{2} cm = 1 m
mm	10^{3} mm = 1 m
µm	10^{6} µm = 1 m
nm	10^{9} nm = 1 m
pm	10^{12} pm = 1 m
fm	10^{15} fm = 1 m
am	10^{18} am = 1 m

SURFACE UNITS	
	Equivalence with the International System Unit
Tm^2	1 Tm^2 = 10^{24} m^2
Gm^2	1 Gm^2 = 10^{18} m^2
Mm^2	1 Mm^2 = 10^{12} m^2
km^2	1 km^2 = 10^{6} m^2
hm^2	1 hm^2 = 10^{4} m^2
dam^2	1 dam^2 = 10^{2} m^2
m^2	IS Unit
dm^2	10^{2} dm^2 = 1 m^2
cm^2	10^{4} cm^2 = 1 m^2
mm^2	10^{6} mm^2 = 1 m^2
$µm^2$	10^{12} $µm^2$ = 1 m^2
nm^2	10^{18} nm^2 = 1 m^2
pm^2	10^{24} pm^2 = 1 m^2
fm^2	10^{30} fm^2 = 1 m^2
am^2	10^{36} am^2 = 1 m^2

VOLUME UNITS		
	Equivalence with the International System Unit	**Equivalence with Capacity units**
Tm^3	$1\ Tm^3 = 10^{36}\ m^3$	
Gm^3	$1\ Gm^3 = 10^{27}\ m^3$	
Mm^3	$1\ Mm^3 = 10^{18}\ m^3$	
km^3	$1\ km^3 = 10^{9}\ m^3$	
hm^3	$1\ hm^3 = 10^{6}\ m^3$	
dam^3	$1\ dam^3 = 10^{3}\ m^3$	
m^3		$1\ kL = 1\ m^3$
dm^3	$10^3\ dm^3 = 1\ m^3$	$1L = 1\ dm^3$
cm^3	$10^6\ cm^3 = 1\ m^3$	$1\ mL = 1\ cm^3$
mm^3	$10^9\ mm^3 = 1\ m^3$	
μm^3	$10^{18}\ \mu m^3 = 1\ m^3$	
nm^3	$10^{27}\ nm^3 = 1\ m^3$	
pm^3	$10^{36}\ pm^3 = 1\ m^3$	
fm^3	$10^{45}\ fm^3 = 1\ m^3$	
am^3	$10^{54}\ am^3 = 1\ m^3$	

To change from one unit to another we use **conversion factors**. A conversion factor is a fraction that expresses the equivalence between two units. Remember how to use a conversion factor:

How many meters correspond to 25 mm?

$$25\ mm \cdot \frac{1m}{10^3 mm} = \frac{25\ mm \cdot 1m}{10^3 mm} = \frac{25m}{10^3} = 25 \cdot 10^{-3} m$$

How many hours are 60 s?

$$60\ s \cdot \frac{1h}{3600s} = \frac{60s \cdot 1h}{3600s} = \frac{60h}{3600} = 0{,}016\ h$$

If we have to make more than one change we use more than one fraction

How many km/h are 20 m/s?

$$20\frac{m}{s} \cdot \frac{1km}{10^3 m} \cdot \frac{3600s}{1h} = \frac{20m \cdot 1km \cdot 3600s}{1s \cdot 10^3 mm \cdot 1h} = \frac{72000km}{1000h} = 72\ km/h$$

Express 1,3 g/cm³ in the SI unit:

$$1{,}3\frac{g}{cm^3} \cdot \frac{1kg}{10^3 g} \cdot \frac{10^6 cm^3}{1m^3} = \frac{1{,}3g \cdot 1kg \cdot 10^6 cm^3}{1g \cdot 10^3 \cdot 1m^3} = \frac{1{,}3 \cdot 10^6 kg}{10^3 \cdot m^3} = 1300\ kg/m^3$$

3. SCIENTIFIC NOTATION

In Physics and Chemistry we may find very long numbers, as the velocity of light which is 299792458 meters per second and very small numbers as the proton's mass, which is 0,000000000000000000000000000167 kg. These numbers have to be expressed in Scientific notation.

Remember that to write numbers in scientific notation the following process has to be followed:

HOW TO WRITE NUMBERS IN SCIENTIFIC NOTATION:

You should leave just one number before the coma.

- *If the number is bigger than one:*
  - *Multiply for 10 powered to the number of places you move to the coma*

    Example: $299292458 \text{ m/s} = 2{,}99 \cdot 10^{8} \text{m/s}$

- *If the number is smaller than one:*
  - *Multiply for 10 powered to minus the number of places you move the coma (remember that multiplying for a negative power is the same as dividing for it):*

$$2 \cdot 10^{-3} = \frac{2}{10^{3}} = \frac{2}{1000} = 0{,}002$$

Example: $0{,}00000000000000000000000000167 \text{ kg} = 1{,}67 \cdot 10^{-27} \text{kg}$

EXERCISES

1. Convert the following measurements to the correspondent IS unit using conversion factors and express the results using scientific notation:
   a. 1300 pm
   b. 4500 µm
   c. 5 Tm
   d. 3600 dg
   e. 8700 mm^2
   f. 6 km^2
   g. 3500 nm^2
   h. 3 hm^3
   i. 87 L
   j. 540 mL
   k. 720 mm^3

2. Make the following conversions using conversion factors:
   a. 3300 s to hours
   b. 7 h to min
   c. 340 s to min
   d. 4500 ms to s
   e. 3hm/s to km/h
   f. 345 mm/min to m/s
   g. 47 km/h to m/s
   h. 100 km/h to m/s
   i. 32 dam/min to m/s
   j. 7 m/s to km/h
   k. 72 km/h to m/s
   l. 324 kg/m^3 to g/cm^3
   m. 56 dg/cm^3 to kg/m^3
   n. 2,3 g/cm^3 to kg/m^3
   o. 1200 kg/m^3 to g/cm^3

3. Make the following conversions using conversion factors:
   a. 62 mm to inches
   b. 58 hm to miles
   c. 32 feet to meters
   d. 7 yards to hm
   e. 4 pints to liters
   f. 37 pounds to kg

4. MEASURING DEVICES

To measure we use a measuring instrument which gives a direct measurement of a magnitude. Some measuring devices are shown in the following table:

Magnitude	Measuring instrument	Image	characteristics
length	Tape measure		
	Ruler		
	Caliper		Higher sensitivity
mass	Balance scale		
	Electronic weighing scale		More precise
time	Analytical chronometer		
	Digital chronometer		Higher sensitivity

A measuring device has certain sensitivity and precision:

- **Sensitivity** is the smallest change unit that an instrument can detect. For example a caliper detects 0,1 millimeters while a tape measure can detect 1 millimeter. As a consequence the caliper has a higher sensitivity than a tape measure.
- **Precision** is the degree to which repeated measurements under the same conditions show the same results. The most precise instrument gives the same value for the same measurement of a magnitude.

Therefore, when we talk about measurements, we have to considerate the sensitivity of the measuring instruments. The results of our calculations should never have more digits than the sensitivity of the instrument used.

5. MEASUREMENT ERRORS

When we measure, as we are humans, we make errors. We can classify errors into two groups:

- Random errors are always present in every measurement. They are unpredictable and unavoidable.
- Systematic errors are caused by a bad measurement or for a bad calibration of the measuring instrument. So this kind of errors can be avoidable.

As we cannot avoid random errors we have to keep them in mind when we measure. The best way to minimize them is to make as many measurements as possible and, in this way, we can consider the average of our result as the best value:

$$\overline{x} = \frac{x_1 + x_2 + \cdots + x_n}{n}$$

Being n the number of measurements taken and x_i the value of each measurement.

But then, what is the error of our measurement? We have two ways of measuring errors:

- **Absolute error**: $\varepsilon_{ai} = |\overline{x} - x_i|$ gives as the error for each measurement compared with the average(always positive)
- The **average of the absolute error** is the one that we usually take as the error of the measure, although if this average is lower than the sensitivity of the measurement instrument, we should take this sensitivity as the final error.

  For example, the correct value of a mass measurement expressed as **1,234 ± 0,003 g**, means that the measurement value is between 1,231g and 1,237g.
- **Relative error:** is calculated by division of the absolute error into the average measurement. To express percentage, it is multiplied by a hundred. For example, if the correct value of a measurement is expressed as **2,345 ± 0,003 g** it is known that:
  a. The average mass is 2,345 g
  b. The absolute error is 0,003 g

The relative error is calculated: $\varepsilon_r = \frac{\varepsilon_a}{\overline{x}} \cdot 100$

In the previous example $\varepsilon_r = \frac{0{,}003\text{g}}{2{,}345\text{g}} \cdot 100 = 0{,}128\%$

A relative error under 1% means a good precision in the measuring method.

A relative error over 10% implies a no precise measuring method.

EXAMPLE:

In the lab, we have been measuring the temperature of boiling water. With a digital thermometer we have measured the next temperatures:

100,1 ºC	98,7 ºC	99,2 ºC	101,2 ºC	100,0 ºC

1. What is the sensitivity of the thermometer?

   $0{,}1\ ^{o}C$

2. What is the average of the measure?

$$\overline{x} = \frac{100{,}1ºC + 98{,}7ºC + 99{,}2ºC + 101{,}2ºC + 100{,}0ºC}{5} = 99{,}8ºC$$

3. What is the absolute error of each measure?

$\varepsilon_{a1} = |99{,}8^{o}C - 100{,}1^{o}C| = 0{,}3^{o}C$

$\varepsilon_{a2} = |99{,}8^{o}C - 98{,}7^{o}C| = 1{,}1^{o}C$

$\varepsilon_{a3} = |99{,}8^{o}C - 99{,}2^{o}C| = 0{,}6^{o}C$

$\varepsilon_{a4} = |99{,}8^{o}C - 101{,}2^{o}C| = 1{,}4^{o}C$

$\varepsilon_{a5} = |99{,}8^{o}C - 100{,}0^{o}C| = 0{,}2^{o}C$

4. What is the average of the absolute error?

$$\varepsilon_a = \frac{0{,}3^{o}C + 1{,}1^{o}C + 0{,}6^{o}C + 1{,}4^{o}C + 0{,}2^{o}C}{5} = 0{,}7^{o}C$$

5. What is the relative error of this measure?

$$\varepsilon_r = \frac{0{,}7\ ^{o}C}{99{,}8\ ^{o}C} \cdot 100 = 0{,}7\%$$

6. How should we write the result of our experiment?

Temperature $= (99{,}8 \pm 0{,}7)\ ^{o}C$

7. Has it been a precise experiment?

Yes, as the relative error is lower than 1%

Practice doing the following exercises:

1. Using a caliper, the following measurements of the length of a metallic piece have been obtained:

   4,64 cm ; 4,67 cm; 4,63 cm; 4,65 cm

   a. What length will you take as the most likely?

   b. What is the absolute error of the measurement?

   c. How will you write the final result of this experiment?

   d. What relative error has been made?

   e. Has it been a precise experiment?

2. The density of a substance was measured and it resulted: 1,33 ± 0,05 g/cm^3 What does this expression mean?

6. ANALYSIS OF DATA.

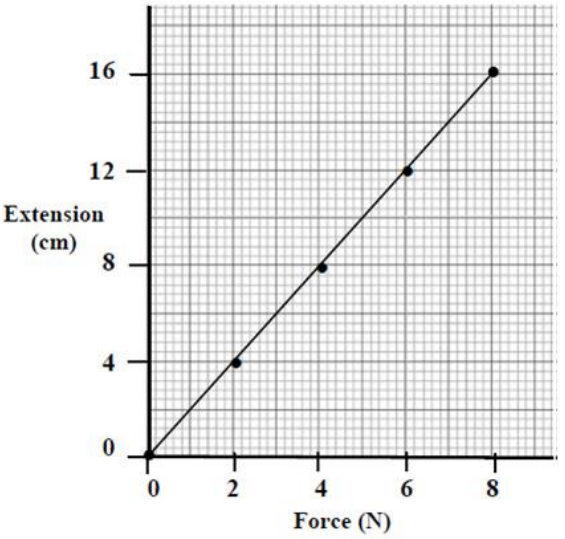
Once scientists have made their experiment and have taken measurements, data are interpreted so laws and theories can be made.

To organize and analyze data scientists use charts and graphs which also are used to make predictions.

There are several types of graphs, this year we will see just the most important ones that are:

6.1 Proportional graph

- It has the equation y = ax +b



Usually the gradient of the line "a" gives to scientists, relevant information for the research.
For that reason, you must learn to obtain its value, following the steps:

A. Choose two points from the line, A and B, different from the experimental ones.

B. Define their coordinate points (X_A,Y_A) and (X_B, Y_B)

C. The gradient of the line is calculated with the formula:

$$a = \frac{Y_B - Y_A}{X_B - X_A}$$

As an example, if masses of different objects made of the same substance, (M) are represented on the ordinate axis (Y) while their volumes (V) are represented on the abscissa axis (X), the gradient of the line represents the density of the substance (d).

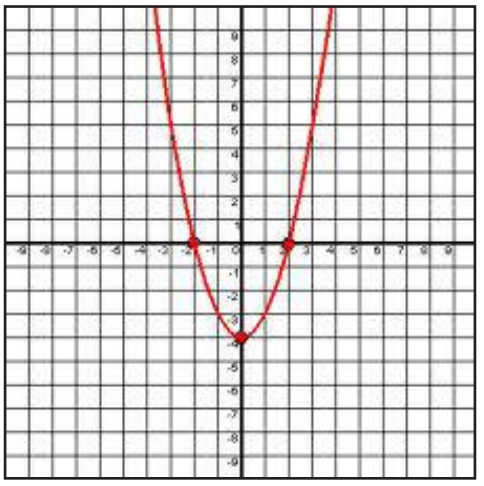
$$d = \frac{M_B - M_A}{V_B - V_A}$$

When length covered by a body in movement (S) is represented on the ordinate axis (Y) while time inverted in the process is represented on the abscissa axis (X), the gradient of the line represents the velocity of the body (v).

$$v = \frac{S_B - S_A}{t_B - t_A}$$

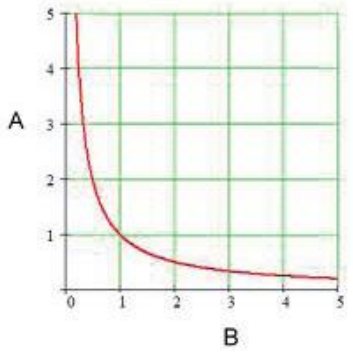
6.2 Quadratic graph

- It has the equation $y = ax^2 + b$



6.3 Inverse proportion

- It has the equation y= 1/x



We can see how it works in the next example:

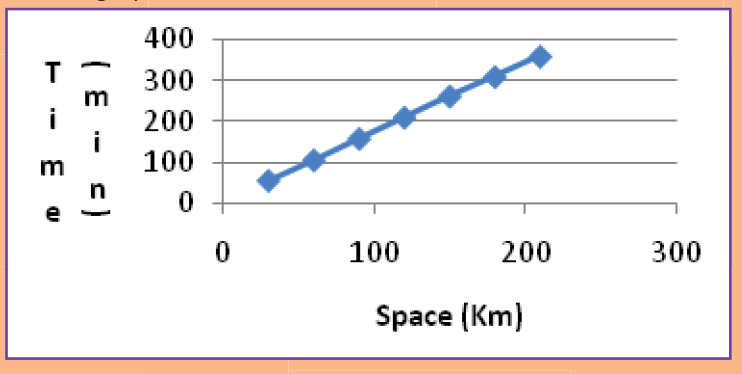
EXAMPLE:

Jesús is travelling in a car from Madrid to Valencia. To amuse himself he writes how many kilometers he makes every thirteen minutes. He made 7 measures: 55 km; 105 km; 158 km; 210 km; 262 km; 310 km; 360 km.

a) Made a chart with the results:

Time (min)	30	60	90	120	150	180	210
Space (km)	55	105	158	210	262	310	360

b) Draw a graph



c) How many km had he made when he had travelled for 100 minutes?

If we follow the lines in the graph we can see that he had travelled 175 km. approximately.

d) What kind of function does it represents?

Proportional function

EXERCISES

1. A vehicle starts to move. Time and space are measured obtaining the next results:

Time (s)	0	2	3	4	5	6	7
Space (m)	0	20	30	40	50	60	70

a) Draw a graph with these data.
b) What kind of graph is it?
c) How many meters will have run at 8 seconds?
d) How much time will it take to run 45 meters?
e) Calculate the gradient of the line. What magnitude does it represent?

2. In the laboratory, we have measured the pressure and the volume of a balloon, obtaining the next results:

Pressure (atm)	1	2	3	4	5
Volume(L)	5,00	2,50	1,67	1,25	1,00

a) Draw a graph with these data.

b) What kind of graph is it?

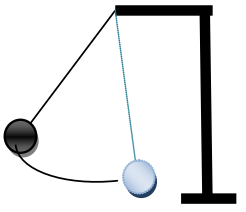
c) At what pressure the balloon will have a volume of 4 liters?

7. WORKING IN THE LABORATORY. SCIENTIFIC METHOD. STUDY OF A PENDULUM LIKE MOTION

As a younger scientific, you are going to follow the different steps of a scientific study. In order to put into practice your knowledge about scientific method and its steps, we will study the movement of a pendulum.
A pendulum has a going and coming movement. The time spent in going and coming once is called period and it is represented by "T". The period of a pendulum depends on several variables. We will investigate which are the variables or magnitudes the period of a pendulum depends on and how is the dependence with these variables.

QUESTION

Does the period of a pendulum depend on any magnitude?



HYPOTHESIS

Remember that a hypothesis is an explanation for a phenomenon that can be tested by investigation.
Make your own hypothesis. Observe the pendulum motion, think and write the name of the magnitudes or variables the pendulum period can depend on.

1. .....
2. .....
3. .....

PLANNING THE EXPERIMENT

We have to plan three different experiments for investigating the dependence of the period on the three variables. For doing the planning, take in mind that measuring one period is difficult so you need to measure several periods and afterwards, to divide the measured time into the number of periods you have measured.

EXPERIMENTAL WORK

Study the dependence of the pendulum period (dependable variable) on one of the variables (independent variable). Measure time taken by the pendulum in doing a concrete number of periods and complete the table. Remember that it is necessary to repeat the same measurement at least three times.

- We will measure time taken in doing ..... Periods.
- Note down the measurements in the following table:

Variable of study	t_1	t_2	t_3	$t_{average}$	T

Repeat this table for studying the period dependence on the three hypothesised magnitudes.

ANALYSE THE DATA

a. Represent on a graph each variable of study ..... on the abscissa axis and ***T*** on the ordinate axis and analyze if there is any dependence.

b. Do the study of errors and decide if the used method is precise.

CONCLUSIONS

Analyse the graphs with the help of your teacher and note down your conclusions.

REPORT RESULTS

Prepare a summary of your work and results. You need to use pass tenses and passive voice. It is shown some possible expressions:

- Three measurements of time were done
- Data were represented in graphs
- Four different pendulums were used

8. WORKING IN THE LABORATORY. SECURITY RULES AND LABORATORY REPORT

Before doing any experimental work in the laboratory some important rules have to be known:

1. Concentrate in your teacher explanation about the steps you have to follow during your work. In addition, read carefully the printed instructions. It is the first step toward avoiding accidents.
2. Avoid getting distracted by the tools and supplies you will find in the laboratory and mainly, never touch that tools and devices you are not going to use.
3. It's essential to ask any questions you need to understand the experimental work. These questions can bring up important safety topics that the teacher can have forgotten.
4. Get ready all the material you are going to use during your experimental work. This will avoid comes and goes in the laboratory and wastes of time.
5. Follow the steps printed on the instructions sheet.
6. Observe the reactant labels and follow the recommended security rules while you are using them. Be especially careful with the corrosive substances and wear security glasses and globes.
7. To avoid accidental intoxication, never eat or drink in the laboratory.
8. Be careful with glass tools. If they are crashed you can be injured. What is more, it's impossible to notice if they are hot and you will be burnt when you touch them.
9. After finish the activity tidy and clean your working table, following the instructions of your teacher.
10. Never pour liquid remains through the sink. They may be dangerous to the environment.
11. Solid remains should be left in the laboratory bins.
12. Before leaving the laboratory wash your hand with soap and water.

After doing research, it has to be communicated to the scientific community through a scientific report. As a young scientist, you need to learn how to write your scientific report in which the following points have to be included:

1. Title
2. The name of the components in the working group
3. The objectives of the experimental study. Infinitive tenses must be used, such as:
   "To investigate the properties of the matter"
4. A review of the theory related to the work. As an example, giving definition of the most important concepts related to the experimental work.
5. Material used in the experimental work. Information about the sensitivity of the measuring devices and a drawing of the materials should be included.
6. Experimental work: you have to write everything you have done and you have observed during your experimental work. Use past tenses
7. Charts and graphics with the measurement of magnitudes
8. Conclusion of your work.

9. READING COMPREHENSION. SEARCH OF INFORMATION USING THE INFORMATION AND COMMUNICATION TECHNOLOGIES.

Nowadays, it is very common to search information using the web, for example on Google, Wikipedia or other sites.

But, it is also very common to lose a lot of time searching this information because we do not use this search engines properly. Google has certain tricks and it is be very helpful to know them. Here you have some tips for a better use of Google:

- Don't write the whole question you are looking for; write only the keywords of the sentence. It can be very helpful to underline the main words of the sentence before starting looking.
- If there are a group of words that should be together in the sentence, like "greenhouse effect" or "climate change", write them between quotation marks and Google will only show you results with the words together.
- Google can search with synonyms. For example if you want to search for movement but you also want to search for motion, you can write ~movement and Google will look for all words with the same meaning as motion.
- Google may be used to search not only web pages but also images, videos, maps and more. Use the advanced search tab to take advantage of all its features!!!!

AFTER READING THE TEXT ANSWER THE FOLLOWING QUESTIONS

1. Take your computer and look for Greenhouse Effect and "Greenhouse Effect". How many results do you obtain in both cases?
2. Take your computer and look for motion and ~motion. How many results do you obtain in both cases?
3. Answer the following questions using Google. Remember to underline the keywords before starting looking:
   a) Which are the gases responsible for the greenhouse effect?
   b) How many elementary particles exist on the universe?
   c) How old is our planet?
   d) In what year was Einstein born?

   Now, write the whole question in Google and think, how did you get you answer faster?

10. LABORATORY ACTIVITY: CALCULATING THE DENSITY OF A SUBSTANCE GRAPHICALLY.

OBJECTIVES:

1. To measure mass and volume in solids.
2. To use a calibre to measure lengths in solids.
3. To use the formulas of volume in some geometrical bodies.
4. To calculate density values of a substance using a graphic representation of mass and volume experimental measurements.

MATERIAL: *ELECTRONIC BALANCE, CALIPER, SOLID PIECES OF DIFFERENT SHAPES.*

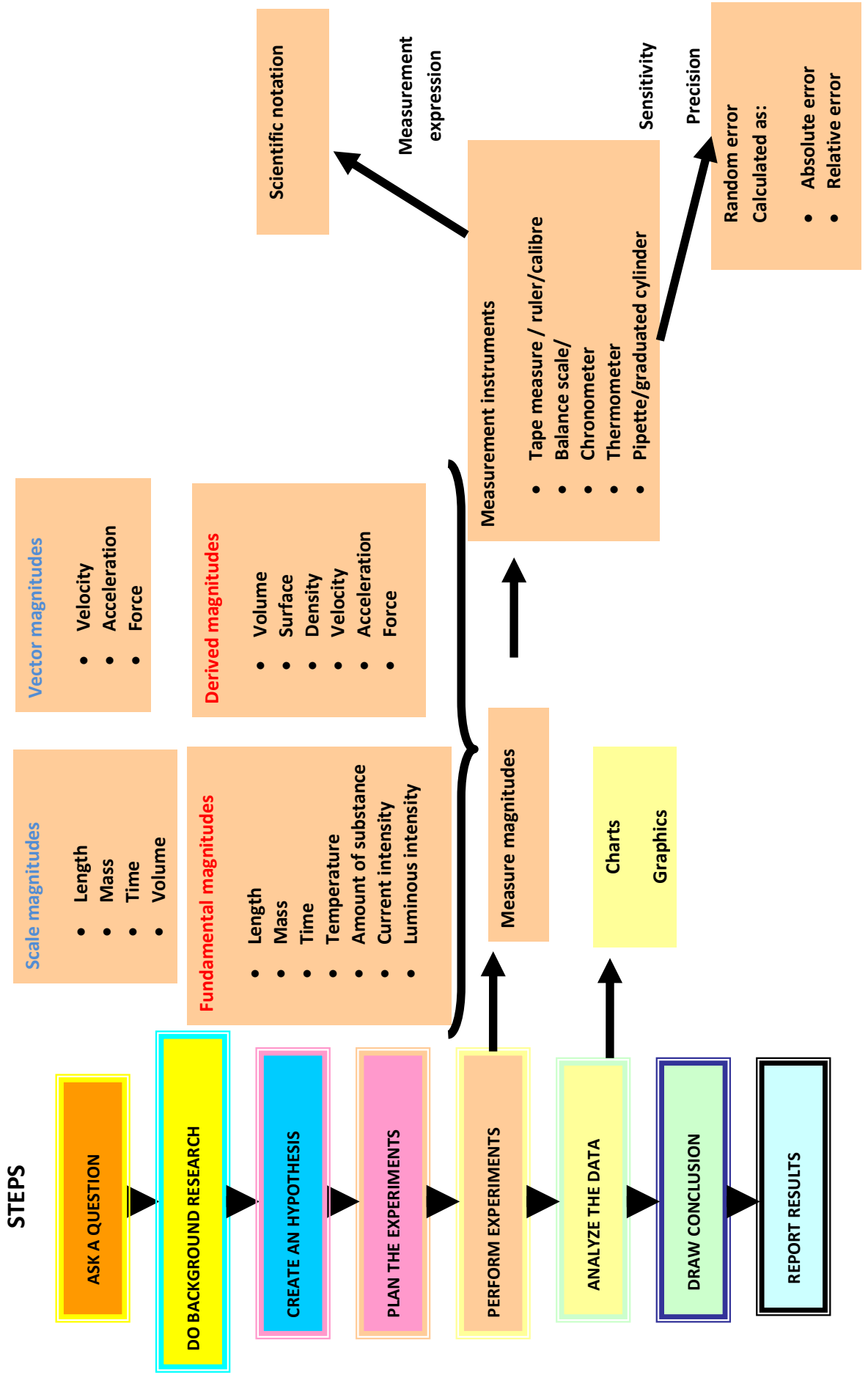
EXPERIMENTAL WORK:

1. **Mass measurement:** Measure the mass of the object, using an electronic balance. Observe and answer: Which is the sensitivity of the balance? ……..
2. **Volume measurement:** Allow the following methods:
   a. Measure the diameter or height in the object using the calibre
   b. Calculate its volume, using the corresponding formulas. Which is the calibre sensitivity? ……..
3. **Calculation of density:**

Represent mass and volume of each piece in a graphic. Masses must be represented on the ordinate axis (Y) while volumes must be represented on the abscissa axis (X). Draw the line $y = ax+b$ and calculate its gradient which represents the density of the substance.

4. Is there any piece made of a different material?
5. Write the scientific report of your experimental work.

11. VOCABULARY REVIEW



12. FINAL ACTIVITIES

1. Make the following change of units:
   a) 120 Km/h to m/s
   b) 720 m^2 to Km^2
   c) 475 m^3 to L
   d) 2,5 hm/s to Km/h
   e) 1,6 g/cm^3 to Kg/m^3
   f) 23 L to cm^3

2. Express the next measurements in the International System of units:
   a) 3,7 Gm
   b) 540 L
   c) 300 pg
   d) 124 dam/h
   e) 48 g/L
   f) 5 Kg/L
   g) 77000 ns
   h) 8500 µg
   i) 1,3 Mm
   j) 8600 pm
   k) 2,43 Mg,
   l) 0,241 Gs
   m) 30 µs.

3. Rewrite the next measurements into the International System of units:
   a. 42 inch
   b. 76 ft
   c. 840 yd
   d. 7 pt
   e. 35 oz
   f. 71 lb.
   g. 45 mph (miles/hour)

4. Measuring the volume of the liquid contained in a fizzy drink tin the following values were found
   330,0 cm^3, 330,9 cm^3 y 329,4 cm^3.
   Calculate:
   a. the average volume measurement
   b. the absolute error in the measurements
   c. the scientific value of the measurements done
   d. the relative error of the measurement
   e. the sensitivity of the measuring instrument
   f. Is this measuring method precise?

5. In the lab, we measure the volume and temperature of a balloon, obtaining the next results:

Volume (L)	0,25	0,50	1,00	1,25
Temperature (ºC)	20	40	60	80

   a) Draw a graph with these data.
   b) What kind of graph is it?
   c) If the balloon explodes when its volume it's 3L, at what temperature will it happen?
   d) Calculate de gradient of the line a interpret its meaning

How much have you learnt?

1. Classify and order the following nouns in the chart bellow and complete it with the information you know: *Metre, litre, microgram, acceleration, time, temperature, Kelvin, kilometre by hour, force, kilogram, decilitre, Celsius degree, velocity, dynamometer.*

Scalar magnitude	Vector magnitude	International System Unit	Other units	Measuring instrument

2. Make the following change of units and express the result in scientific notation:
   a. 3267 Mm to dm
   b. 234 mm^2 to dam^2
   c. 4213 mm^3 to L
   d. 0,034 kL to mm^3
   e. 13 hm/h to m/s
   f. 750 dam/min to m/s
   g. 56 dam/min to km/h
   h. 1238 kg/m^3 to g/cm^3
   i. 2,7 g/cm^3 to kg/m^3
   j. 3 dg/mm^3 to kg/m^3

3. Measuring force and acceleration in a moving object we obtain the following data:

Force (N)	10	15	20	25
Acceleration (m/s^2)	6	9	12	15

   a) Draw a graph with these data.
   b) What kind of graph is it?
   c) Which force will produce an acceleration of 5 m/s^2 in the object?
   d) Calculate the gradient of the line and interpret its meaning