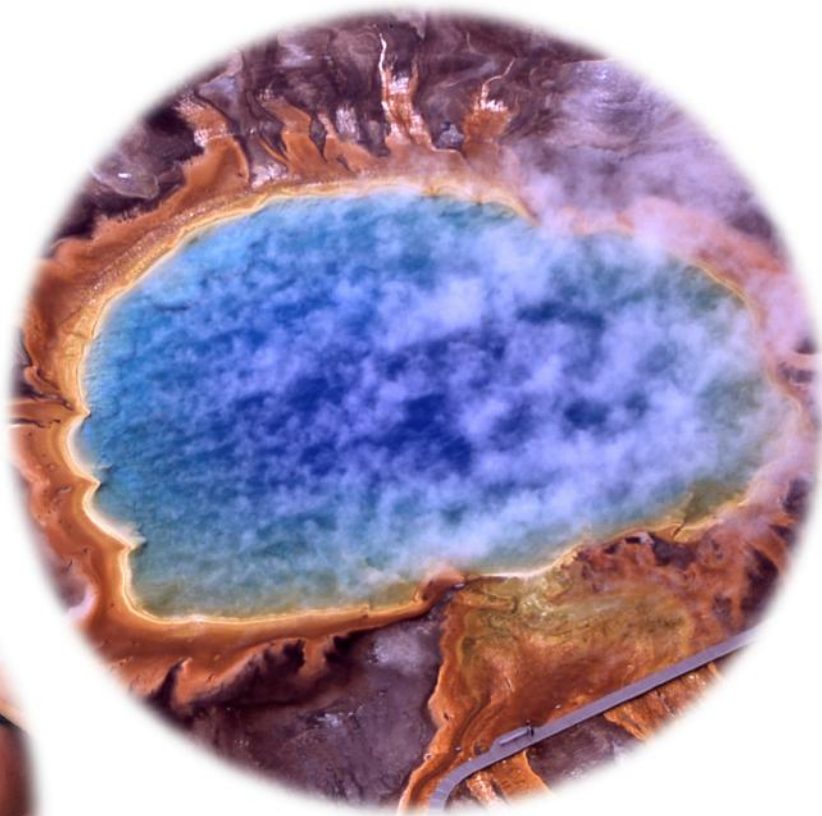




Raquel Manso Escudra
Alicia Sampedro Montañés

Physics & Chemistry

Teacher's book



ESO



Adaptado a la LOMCE

Physics and Chemistry

3º ESO

Teacher's book

Autoras: Raquel Manso Escuadra

Alicia Sampedro Montañés

Primera edición, 2015

Autoras: Raquel Manso Escuadra, Alicia Sampedro Montañés

Maquetación: Daniela Vasilache

Diseño portada: Susana Arroyo Hernández

Edita: Educàlia Editorial.

Imprime: ULZAMA DIGITAL S.A

ISBN: 978-84-944619-1-0

Depòsit Legal: V-2793-2015

Printed in Spain/Impreso en España.

Todos los derechos reservados. No está permitida la reimpresión de ninguna parte de este libro, ni de imágenes ni de texto, ni tampoco su reproducción, ni utilización, en cualquier forma o por cualquier medio, bien sea electrónico, mecánico o de otro modo, tanto conocida como los que puedan inventarse, incluyendo el fotocopiado o grabación, ni está permitido almacenarlo en un sistema de información y recuperación, sin el permiso anticipado y por escrito del editor.

Alguna de las imágenes que incluye este libro son reproducciones que se han realizado acogiendo al derecho de cita que aparece en el artículo 32 de la Ley 22/18987, del 11 de noviembre, de la Propiedad intelectual. Educàlia Editorial agradece a todas las instituciones, tanto públicas como privadas, citadas en estas páginas, su colaboración y pide disculpas por la posible omisión involuntaria de algunas de ellas.

Educàlia Editorial

C/ Av. de las Jacarandas, 2, loft 327 - 46100 Burjassot

Tel: 963273517

E-Mail: educaliaeditorial@e-ducalia.com

<http://www.e-ducalia.com/material-escolar-colegios-ies.php>

INDEX

Unit 1: Introduction to the Scientific Method.

1. The Scientific Method. Its Steps.....	7
2. Reading comprehension: Galileo and falling bodies.....	7
3. Measurements and Magnitudes. International Units System. Multiples and Submultiples. Scientific notation.....	8
4. Sensitivity and precision. Significant Digits.....	11
5. Measurements errors.....	12
6. Data Analysis in charts and graphs.....	13
7. Laboratory activity: Measurement errors.....	14
8. Working in the Lab. Laboratory material.....	15
9. Development of a research progress.....	15
10. Scientific method. Vocabulary.....	16
11. Final Activities.....	16

Unit 2. Matter. Properties of matter

1. Matter. Properties of matter. Density.....	24
2. States of aggregation of matter: solid, liquid and gas.....	27
3. Kinetic molecular theory.....	28
4. Conditions of a material system. Temperature and pressure.....	30
5. Gas laws.....	32
6. Laboratory activity I: measuring densities of solids.....	34
7. Laboratory activity 2: An easy way to observe gas laws.....	34
8. Vocabulary review.....	35
9. Reading comprehension: Contrails.....	35
10. Final activities.....	35

Unit 3. Pure substances and mixtures. Elements and compounds

1. Pure substances and mixtures.....	43
2. Solutions: Concentration of a chemical solution.....	44
3. Separation of mixtures.....	46
4. Laboratory activity: Separation of mixtures.....	46
5. Laboratory activity: Working with solutions.....	47
6. Reading comprehension. Alcoholic drinks.....	47
7. Vocabulary review.....	48
8. Final Activities.....	48

Unit 4. The atom and the Periodic Table

1. Reading Comprehension: History of atomic models.....	55
2. Atomic models: From Democritus to Rutherford.....	55
3. Atomic structure. Subatomic particles.....	55
4. Atomic and mass number.....	55
5. Chemical elements and isotopes.....	56

6. Electron configuration. Ion formation.....	58
7. Periodic Table of the Elements. Periodic properties.....	60
8. Laboratory activity: Differences between metals and non-metals.....	61
9. Vocabulary review.....	61
10. Final activities.....	62

Unit 5. Chemical bonds

1. Reading Comprehension: Bonds between atoms.....	67
2. Chemical bonds between atoms: Molecules and crystals.....	68
3. Properties of substances and particles behaviour.....	68
4. Ionic bonds. Ionic substances.....	69
5. Covalent bonds. Atomic and molecular substances.....	69
6. Metallic bonds. Metallic substances.....	69
7. Atomic and molecular mass.....	71
8. The mole. Molar mass.....	71
9. Laboratory activity: Chemical bonds properties.....	73
10. Vocabulary review.....	73
11. Final activities.....	73

Unit 6. Chemical reactions

1. Physical mixture and Chemical reaction. Mass conservation.....	77
2. Balance on Chemical equations.....	77
3. Molar, mass and volume calculations in chemical equations.....	78
4. Laboratory activity 1: Physical or chemical process.....	80
5. Laboratory activity 2: Observation of chemical reactions.....	80
6. Reading comprehension: Chemical reactions in our live.....	80
7. Vocabulary review.....	81
8. Final activities.....	81

Unit 7. Chemistry and society

1. Chemistry and medicine.....	86
2. Chemistry and Industry: Fractionation of petroleum.....	86
3. Chemistry and environment: Hydrogen fuel cells.....	87
4. Chemistry and development: Selective adsorption with carbon molecular sieves.....	88
5. Chemistry and environment: Acid rain, greenhouse effects and ozone layer destruction	89

Unit 8: Introduction to the study of motion

1. Kinematics. General study of a body in motion.....	90
2. Velocity of light.....	93
3. Uniform rectilinear motion.....	93
4. Acceleration.....	95
5. Reading comprehension. Road safety.....	96
6. Vocabulary review.....	96
7. Final activities.....	96

Unit 9: Introduction to the study of forces. Gravitational Force

1. Interactions between bodies: Forces. Types of forces.....	103
2. Vectorial representation of forces. Free-body diagrams.....	103
3. Dynamic Laws.....	104
4. Newton's law of gravitation.....	105
5. Weight on falling bodies.....	105
6. The speed of light and the distance between astronomical objects.....	106
7. Reading comprehension: the structure of the universe.....	106
8. Final activities.....	107

Unit 10. Electrical Force

1. Reading comprehension: Electricity in history.....	110
2. Material electrification. Conductors and insulators.....	110
3. Electric charges and its interaction. Coulomb's law.....	111
4. Electric field.....	111
5. Electric potential energy and electric potential.....	112
6. Laboratory activity: Checking coulomb's law.....	113
7. Final activities.....	113

Unit 11. Electromagnetism

1. Magnetization.....	116
2. Magnetic field.....	116
3. Laboratory activity: Electromagnetic experiments.....	116
4. Reading comprehension: Electrical machines.....	116
5. Fundamental forces of nature.....	117
6. Final activities.....	117

Unit 12. Energy

1. Energy. Forms of energy.....	119
2. Energy conservation.....	119
3. Energy sources.....	119
4. Conventional energies.....	119
5. Alternative energies.....	119
6. Laboratory activity: Building a wind generator.....	119
7. Reading comprehension: It all comes from the sun.....	120
8. Final activities.....	121

Unit 13. Electrical Current

1. Electrical current. Resistor. Ohm's law.....	124
2. Electrical circuits.....	124
3. Energy and electrical power. Joule's law.....	128
4. Laboratory activity: Checking ohm's law.....	130
5. Electronics. Electronic components and their applications.....	131
6. Electrical installations at home.....	131
7. Reading comprehension: Electricity at home. Energy saving.....	132
8. Final activities.....	132

Appendix: Inorganic formulation

1. Final exercises.....	144
-------------------------	-----

UNIT 1: Introduction to the Scientific Method.

1. THE SCIENTIFIC METHOD. ITS STEPS.

Se recomienda comenzar el tema con una lluvia de ideas, “brainstorming”, sobre el trabajo del científico. El profesor puede plantear preguntas como:

“What do you think scientists do during their working day in a laboratory?”

“Tell me verbs related to a scientist work”

“How does a scientist develop a research?”

En este debate saldrán dudas sobre vocabulario. El profesor puede aprovechar para comenzar a introducir terminología como “to investigate, research, to measure, measurements, to analyze, conclusión, theory o hypothesis”.

Se organiza la información que van dando los alumnos y se completa, resumiendo las etapas del método científico en la pizarra.

A continuación, se recomienda terminar la clase con una actividad en grupos que implique el ordenamiento de etapas en un caso de investigación concreto. Para ello, se pueden entregar por grupos oraciones en las que se resuman cada una de las fases del método científico aplicadas a un estudio experimental concreto. Por grupos tienen que ordenarlas y nombrar la etapa correspondiente.

2. READING COMPREHENSION: GALILEO AND FALLING BODIES.

Se recomienda que los alumnos trabajen la lectura con tranquilidad en casa, tras haber visto en clase las etapas del método científico. Requiere que le dediquen tiempo para poder elaborar las respuestas. Son posibles respuestas:

Answer the next questions about the text:

1. Identify the different steps of the scientific method in Galileo's history.

Ask a question: Paragraph three “... Galileo Galilei, was not very convinced that mass and velocity where proportional, ...”

Plan the experiment: Paragraph three “he designed an experiment to prove it”

Perform the experiment: Paragraph four “he made build a 7 meter slide (very well polished to avoid friction) and let different balls fall”

Draw a conclusion: Paragraph five “when there is no friction, mass and velocity are independent and two bodies with different shapes and masses will fall within the same time.”

2. What does it mean that mass and velocity are proportional?

The more mass a body has, the more velocity it moves with.

3. Describe how you think a water watch works.

It consists in a system of water falling down into a container at a constant velocity.

4. If mass and velocity are actually independent, why a piece of paper fall slower than a stone?

A piece of paper falls slower than a stone due to the bigger air friction on its surface.

Podemos aprovechar estas respuestas para introducir estructuras gramaticales como comparativos “slower than”, “consist in”, “due to” o el uso de “the more ... the more”.

3. MEASUREMENTS AND MAGNITUDES. INTERNATIONAL UNITS SYSTEM. MULTIPLES AND SUBMULTIPLES. SCIENTIFIC NOTATION.

El siguiente paso en el proceso enseñanza-aprendizaje es introducir el concepto de magnitud. Podemos hacerlo con alguna pregunta como:

“Do you remember what’s the most important work scientists do during the experimentation step?”

“What can be measured?” o “Tell me what can be measured during experimentation”

Se pueden ir ordenando las magnitudes en dos columnas en función de que se trate de fundamentales y derivadas. Si no conocen los términos en inglés, como es lógico, se puede dejar que las enumeren en español y se van escribiendo los términos en inglés.

Terminado el listado, se puede indicar:

“All these properties that can be measured are called magnitudes.”

“Why do you think I have ordered them in two different columns?”

Muy probablemente no lo sabrán. Entonces podemos preguntar por las unidades:

“In what unit is length/mass/surface/expressed?”

Ayudándose de las unidades es más fácil que vean como efectivamente las magnitudes derivadas dependen de las fundamentales y se introduce la clasificación.

1. Convert the following measurements to meters using conversion factors:

a. 100 mm

$$100mm \cdot \frac{1m}{10^3mm} = 0,1m$$

b. 23 cm

$$23cm \cdot \frac{1m}{10^2cm} = 0,23m$$

c. 40 fm

$$40fm \cdot \frac{1m}{10^{15}fm} = 4 \cdot 10^{-14}m$$

d. 100 km

$$100km \cdot \frac{10^3m}{1km} = 100.000m$$

e. 12 pm

$$12pm \cdot \frac{1m}{10^{12}pm} = 1,2 \cdot 10^{-11}m$$

f. 45 μm

$$45\mu m \cdot \frac{1m}{10^6\mu m} = 4,5 \cdot 10^{-5}m$$

g. 3 Gm

$$3Gm \cdot \frac{10^9m}{1Gm} = 3 \cdot 10^9m$$

2. Convert the following measurements to square meters using conversion factors:

a. 40 cm^2

$$40 \text{ cm}^2 \cdot \frac{1 \text{ m}^2}{10^4 \text{ cm}^2} = 4 \cdot 10^{-3} \text{ m}^2$$

b. 3500 mm^2

$$3500 \text{ mm}^2 \cdot \frac{1 \text{ m}^2}{10^6 \text{ mm}^2} = 3,5 \cdot 10^{-3} \text{ m}^2$$

c. 3 km^2

$$3 \text{ km}^2 \cdot \frac{10^6 \text{ m}^2}{1 \text{ km}^2} = 3000000 \text{ m}^2$$

d. 3500 nm^2

$$3500 \text{ nm}^2 \cdot \frac{1 \text{ m}^2}{10^{18} \text{ nm}^2} = 3,5 \cdot 10^{-15} \text{ m}^2$$

3. Convert the following measurements to cubic meters using conversion factors:

a. 45 dm^3

$$45 \text{ dm}^3 \cdot \frac{1 \text{ m}^3}{10^3 \text{ dm}^3} = 0,045 \text{ m}^3$$

b. 3500 hm^3

$$3500 \text{ hm}^3 \cdot \frac{10^6 \text{ m}^3}{1 \text{ hm}^3} = 3,5 \cdot 10^9 \text{ m}^3$$

c. 35 L

$$35 \text{ L} = 35 \text{ dm}^3 \cdot \frac{1 \text{ m}^3}{10^3 \text{ dm}^3} = 0,035 \text{ m}^3$$

d. 460 mL

$$460 \text{ mL} = 460 \text{ cm}^3 \cdot \frac{1 \text{ m}^3}{10^6 \text{ cm}^3} = 4,6 \cdot 10^{-4} \text{ m}^3$$

e. 460 mm^3

$$460 \text{ mm}^3 \cdot \frac{1 \text{ m}^3}{10^9 \text{ mm}^3} = 4,6 \cdot 10^{-7} \text{ m}^3$$

4. Make the following time conversions using conversion factors:

a. 4500 s to hours

$$4500 \text{ s} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 1,25 \text{ h}$$

b. 5 h to min

$$5 \text{ h} \cdot \frac{60 \text{ min}}{1 \text{ h}} = 300 \text{ min}$$

- c. 45 s to min

$$45s \cdot \frac{1min}{60s} = 0,75min$$

- d. 4500 ms to hours

$$4500ms \cdot \frac{1s}{1000ms} \cdot \frac{1h}{3600s} = 1,25 \cdot 10^{-3}h$$

5. Make the following mass conversions using conversion factors:

- a. 4500 kg to g

$$4500kg \cdot \frac{1000g}{1kg} = 4.500.000g$$

- b. 3700 mg to kg

$$3700mg \cdot \frac{1kg}{10^6mg} = 3,7 \cdot 10^{-3}kg$$

- c. 600 Tg to Kg

$$600Tg \cdot \frac{10^9kg}{1Tg} = 6 \cdot 10^{11}kg$$

- d. 40 dag to Kg

$$40dag \cdot \frac{1kg}{10^2dag} = 0,4kg$$

- e. 280 dg to mg

$$280dg \cdot \frac{10^2mg}{1dg} = 28.000mg$$

6. Make the following conversions using conversion factors:

- a. 5 cm to inches

$$5cm \cdot \frac{1m}{100cm} \cdot \frac{1inch}{0,0254m} = 1,97inches$$

- b. 4 km to miles

$$4km \cdot \frac{10^3m}{1km} \cdot \frac{1mile}{1609,3m} = 2,49miles$$

- c. 25 feet to meters

$$25feet \cdot \frac{0,305m}{1foot} = 7,62m$$

- d. 15 yards to km

$$15yards \cdot \frac{0,91m}{1yard} \cdot \frac{1km}{1000m} = 0,014km$$

- e. 2 pints to liters

$$2pints \cdot \frac{568,26mL}{1pint} \cdot \frac{1L}{1000mL} = 1,14L$$

- f. 30 pounds to kg

$$30pounds \cdot \frac{453,59g}{1pound} \cdot \frac{1kg}{10^3g} = 13,60kg$$

1. Rewrite this numbers using scientific notation: (leave two decimals behind the coma)

- | | |
|-----------------------------------|-------------------------------------|
| a. $0,003 = 3 \cdot 10^{-3}$ | j. $8567985 = 8,57 \cdot 10^6$ |
| b. $125,45 = 1,25 \cdot 10^2$ | k. $0,000006 = 6 \cdot 10^{-6}$ |
| c. $345720,56 = 3,46 \cdot 10^5$ | l. $788566488,57 = 7,89 \cdot 10^8$ |
| d. $0,000023 = 2,3 \cdot 10^{-5}$ | m. $2,000004 = 2,00$ |
| e. $725654000 = 7,26 \cdot 10^8$ | n. $0,000024 = 2,4 \cdot 10^{-5}$ |
| f. $245 = 2,45 \cdot 10^2$ | o. $987654 = 9,88 \cdot 10^5$ |
| g. $8540 = 8,54 \cdot 10^3$ | p. $4156,354 = 4,16 \cdot 10^3$ |
| h. $30000000 = 3 \cdot 10^7$ | q. $0,025 = 2,5 \cdot 10^{-2}$ |
| i. $0,00025 = 2,5 \cdot 10^{-4}$ | |

2. Rewrite these numbers into decimal notation:

- | | |
|--------------------------------------|---------------------------------------|
| a. $2 \cdot 10^{-5} = 0,00002$ | d. $4,56 \cdot 10^9 = 4.560.000.000$ |
| b. $5,35 \cdot 10^{-6} = 0,00000535$ | e. $2,4 \cdot 10^{-9} = 0,0000000024$ |
| c. $6,7 \cdot 10^3 = 6.700$ | |

3. Solve the next operations:

- $(10^3)^5 = 10^{15}$
- $(10^2)^3 = 10^6$
- $(10^2 \cdot 10^5)^3 = 10^{21}$
- $10^3 \cdot 10^{-3} = 10^0 = 1$
- $10^3 + 10^2 = 1000 + 100 = 1100$
- $(10^5 + 10^6)/100 = (100.000 + 1.000.000)/100 = 1.100.000/100 = 110.000$
- $(10^5 \cdot 10^6)/100 = 10^{11}/10^2 = 10^9 = 1.000.000.000$

4. SENSITIVITY AND PRECISION. SIGNIFICANT DIGITS.

Se recomienda el manejo de diferentes instrumentos de medida con escala analógica y digital para que comprendan estos conceptos. Se debe aprovechar cada práctica de laboratorio para volver a ellos y que no los olviden.

1. How many significant digits are there in the next numbers?

- 3400**
Two significant digits
- 0,000078**
Two significant digits
- 0,340**
Two significant digits
- 123,00**
Three significant digits
- 240**
Two significant digits
- 12302,02**
Seven significant digits
- 23,002**
Five significant digits

2. Round off the next numbers so they have 4 significant digits:

Example: 1,8359 = 1,836

- a. 23,5 = 23,50
- b. 0,023456 = 0,02346
- c. 23,456 = 23,46
- d. 12,03 = 12,03

3. Solve the next operations leaving the result with the appropriate number of digits:

- a. $45 \cdot 125 = 5620$
- b. $123,4 + 13,4567 = 136,9$
- c. $12,34 \cdot 34,5 + 123 = 426 + 123 = 549$
- d. $1,56 + 12,3 \cdot 4,5 = 1,56 + 55,4 = 57,0$

5. MEASUREMENTS ERRORS.

1. Five people in your class have measured the height of one of your classmates and they have obtained these five different results:

1,65 m ; 1,57 m; 1,63 m; 1,67 m; 1,68 m;

a) What height will you take as the most likely?

The average of all heights:

$$\bar{x} = \frac{1,65m + 1,57m + 1,63m + 1,67m + 1,68m}{5} = 1,64m$$

b) What absolute error has made each of your classmates?

$$\begin{aligned}\varepsilon_{a1} &= |1,65m - 1,64m| = 0,01m \\ \varepsilon_{a2} &= |1,65m - 1,57m| = 0,08m \\ \varepsilon_{a3} &= |1,65m - 1,63m| = 0,02m \\ \varepsilon_{a4} &= |1,65m - 1,67m| = 0,02m \\ \varepsilon_{a5} &= |1,65m - 1,68m| = 0,03m\end{aligned}$$

c) What is the average of that absolute error?

$$\overline{\varepsilon_a} = \frac{0,01m + 0,08m + 0,02m + 0,02m + 0,03m}{5} = 0,03m$$

Remember that in the result there can't be more decimal digits than in the wording of the problem.

d) How will you write the final result of this experiment?

$(1,64 \pm 0,03) \text{ m}$

e) What relative error has been made?

$$\varepsilon_r = \frac{0,03m}{1,64m} \cdot 100 = 1,83\%$$

f) Has it been a precise experiment?

It has been a precise enough experiment, as the relative error is close to one.

2. Your partners have made a race and you are helping with other 3 people to measure the time. For the first, you have measured the next times:

45,6 s; 47,5 s; 48,2 s; 43,1 s;

- a) What time will you take as the most accurate?

The average of all times:

$$\bar{x} = \frac{45,6s + 47,5s + 48,2s + 43,1s}{4} = 46,1s$$

- b) What absolute error have you and your mates made?

$$\varepsilon_{a1} = |46,1s - 45,6s| = 0,5s$$

$$\varepsilon_{a2} = |46,1s - 47,5s| = 1,4s$$

$$\varepsilon_{a3} = |46,1s - 48,2s| = 2,1s$$

$$\varepsilon_{a4} = |46,1s - 43,1s| = 3s$$

- c) What is the average of that absolute error?

$$\overline{\varepsilon_a} = \frac{0,5s + 1,4s + 2,1s + 3s}{4} = 1,8s$$

- d) How will you write the final result of the race?

46,1 ± 1,8 s

- e) What relative error has been made?

$$\varepsilon_r = \frac{1,8s}{46,1s} \cdot 100 = 3,9\%$$

- f) Has it been a precise experiment?

Not really

6. DATA ANALYSIS IN CHARTS AND GRAPHS.

El objetivo que se persigue es que comprendan que un gráfico relaciona dos magnitudes, que sepan construirlo a partir de una tabla de datos y que interpreten uno dado.

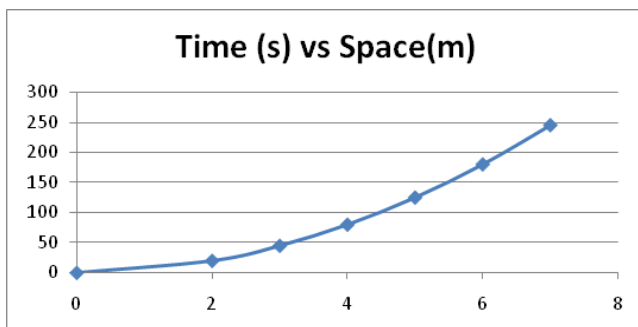
Se puede aprovechar para practicar expresiones gramaticales como:

“The bigger..... The bigger”, “The smaller The smaller” que son muy útiles en la materia.

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	45	80	125	180	245

- a) Draw a graph with these data.



b) **What kind of graph is it?**

It is a quadratic function.

c) **How many meters will have run at 10 seconds?**

Around 500 meters

d) **How much time will it take to run 300 meters?**

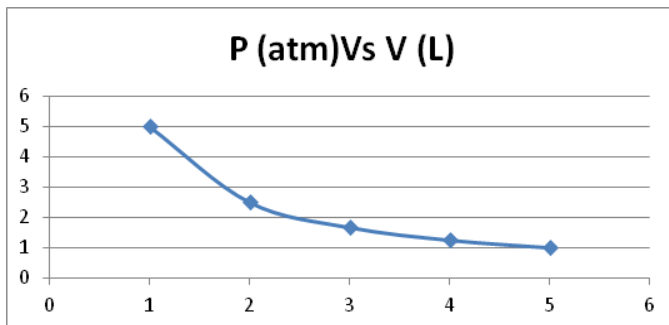
Around 8 seconds.

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.**

The graph should be something like this:



b) **What kind of graph is it?**

It represents an inverse proportion

c) **At what pressure the balloon will have a volume of 6 liters?**

According to the graph, it will be around 0,5 atm.

7. LABORATORY ACTIVITY: MEASUREMENT ERRORS.

Esta actividad se puede realizar en clase. Es en realidad otro modo de repetir algún problema más sobre cálculo de errores. Pero para los estudiantes el simple hecho de modificar el ritmo resulta motivador.

Perseguimos el objetivo de que los alumnos observen que en realidad se cometen errores al medir y que cuanto menor sea la medida mayor será el error cometido al utilizar un instrumento de medida de la misma precisión.

Se elige una práctica de medida de tiempos porque claramente los resultados dependen de la habilidad del investigador.

Se piden voluntarios. Cuatro alumnos medirán los tiempos y transmitirán los resultados a un quinto alumno que tomará nota en la pizarra. Se recomienda comenzar con la medida de tiempos menor para evitar que al ir adquiriendo habilidad no podamos llegar a proponer una hipótesis. Previo al comienzo de la medida se practica con ellos hasta que se vea que las medidas van siendo razonables.

Realizada la parte experimental, se divide la clase en tres grupos. Cada grupo debe efectuar los cálculos en un experimento concreto y completar la parte correspondiente de la tabla del encerado.