

Teacher's
book

Physics & Chemistry



Raquel Manso Escudra
Alicia Sampedro Montañés

LOMCE Edition



ESO



Physics and chemistry

Workbook 4^o eso

Teacher's book

**Autoras: Raquel Manso Escudra
Alicia Sampedro Montañés**

Primera edición, 2015

Autoras: Raquel Manso Escudra, Alicia Sampedro Montañés

Ilustración portada: Susana Arroyo Hernández

Maquetación: Daniela Vasilache

Edita: Educàlia Editorial.

Imprime: ULZAMA DIGITAL S.A.

ISBN: 978-84-944619-0-3

Depòsit Legal: V-2693-2015

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 acogiéndose 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.	7
1. MAGNITUDES AND MEASUREMENTS. CLASSIFICATION OF MAGNITUDES.	7
2. INTERNATIONAL SYSTEM OF UNITS. MULTIPLES AND SUBMULTIPLES. CONVERSION FACTORS.	7
3. SCIENTIFIC NOTATION.	8
4. MEASURING DEVICES.	9
5. MEASUREMENT ERRORS.	10
6. ANALYSIS OF DATA.	10
7. WORKING IN THE LABORATORY. SCIENTIFIC METHOD. STUDY OF A PENDULUM LIKE MOTION.	12
8. WORKING IN THE LABORATORY. SECURITY RULES AND LABORATORY REPORT.	12
9. LABORATORY ACTIVITY: CALCULATING THE DENSITY OF A SUBSTANCE GRAPHICALLY.	12
10. FINAL ACTIVITIES.	12
UNIT 2. INTRODUCTION TO THE STUDY OF MOTION.	17
1. KINEMATICS. GENERAL STUDY OF A BODY IN MOTION.	17
2. UNIFORM RECTILINEAR MOTION.	20
3. UNIFORMLY ACCELERATED RECTILINEAR MOTION.	25
4. FREE FALLING MOTION.	28
5. UNIFORM CIRCULAR MOTION.	30
6. WORKING IN THE LABORATORY. STUDY OF A UNIFORMLY ACCELERATED MOTION.	33
7. READING COMPREHENSION. RELATIVE MOTION.	33
8. READING COMPREHENSION. ROAD SAFETY.	34
9. VOCABULARY REVIEW.	35
10. FINAL ACTIVITIES.	35
UNIT 3. FORCES AND EQUILIBRIUM.	47
1. INTRODUCTION TO VECTORS.	47
2. INTERACTIONS BETWEEN BODIES: FORCES. TYPES OF FORCES.	51
3. VECTORIAL REPRESENTATION OF FORCES. FREE-BODY DIAGRAMS.	52
4. DYNAMIC LAWS.	53
5. COMPOSITION AND DECOMPOSITION OF FORCES.	54
6. EQUILIBRIUM OF FORCES.	59
7. FORCES AND DEFORMATIONS. HOOKE'S LAW.	59
8. LABORATORY ACTIVITY. MEASURING FORCES.	60
9. READING COMPREHENSION: ACTION-REACTION.	60
10. VOCABULARY REVIEW.	61
11. FINAL ACTIVITIES.	61

UNIT 4. ASTRONOMY.	72
1. INTRODUCTION TO ASTRONOMY.	72
2. READING COMPREHENSION: GEOCENTRIC AND HELIOCENTRIC MODELS.	72
3. READING COMPREHENSION: GALILEO'S TELESCOPE AND ITS IMPORTANCE.	72
4. MOTION OF PLANETS AND SATELLITES. KEPLER'S LAWS.	73
5. NEWTON'S LAW OF GRAVITATION.	75
6. WEIGHT ON FALLING BODIES.	76
7. READING COMPREHENSION: CONTEMPORARY COSMOLOGY.	77
8. ARTIFICIAL SATELLITES AND ITS APPLICATIONS.	77
9. LABORATORY ACTIVITY: MEASURING THE GRAVITY CONSTANT OF THE EARTH.	78
10. VOCABULARY REVIEW.	78
11. FINAL ACTIVITIES.	78
UNIT 5. FORCES IN FLUIDS.	85
1. DEFINITION OF PRESSURE.	85
2. HYDROSTATIC PRESSURE. APPLICATIONS.	86
3. PASCAL'S PRINCIPLE.	88
4. ATMOSPHERIC PRESSURE.	88
5. ARCHIMEDES PRINCIPLE. FLOATING AND SINKING. BUOYANCY.	89
6. SURFACE TENSION.	91
7. LABORATORY ACTIVITY. ARCHIMEDES PRINCIPLE TO CALCULATE THE DENSITY OF SUBSTANCES.	91
8. READING COMPREHENSION: MEASURING PRESSURE.	92
9. VOCABULARY REVIEW.	92
10. FINAL ACTIVITIES.	92
UNIT 6. WORK, POWER AND MECHANICAL ENERGY.	102
1. DEFINITION OF ENERGY AND WORK. UNITS.	102
2. MECHANICAL WORK. ITS APPLICATION TO MACHINES AND TOOLS.	103
3. DEFINITION OF POWER. UNITS.	104
4. MECHANICAL ENERGY.	105
5. WORK AS A TRANSFER OF MECHANICAL ENERGY.	106
6. CONSERVATION OF MECHANICAL ENERGY.	106
7. ENERGY SOURCES: ADVANTAGES AND DISADVANTAGES OF THE DIFFERENT ENERGY SOURCES.	107
8. LABORATORY ACTIVITY: MEASURING THE COEFFICIENT OF FRICTION.	108
9. READING COMPREHENSION: NUCLEAR ENERGY IN OUR LIFE.	108
10. VOCABULARY REVIEW.	109
11. FINAL ACTIVITIES.	109

UNIT 7. HEAT AND THERMAL ENERGY.	116
1. DEFINITION OF TEMPERATURE. THERMAL ENERGY	116
2. READING COMPREHENSION: THERMOMETERS AND TEMPERATURE SCALES.	116
3. ENERGY EXCHANGE DUE TO TEMPERATURE DIFFERENCES. THERMAL EQUILIBRIUM.	117
4. HEAT EFFECTS.	117
5. SPECIFIC HEAT.	117
6. HEAT AND PHASE CHANGES. LATENT HEAT.	118
7. HEAT TRANSFERENCE.	119
8. LABORATORY ACTIVITY.	120
9. VOCABULARY REVIEW.	120
10. FINAL ACTIVITIES.	120
 UNIT 8. ENERGY OF WAVES. LIGHT AND SOUND.	 126
1. DEFINITION OF WAVE. TYPES OF WAVES.	126
2. PROPERTIES OF A WAVE.	126
3. ENERGY TRANSPORT ON WAVES.	127
4. LIGHT AND SOUND. PROPERTIES.	127
1.1 Light.	128
1.2 Sound.	128
5. LABORATORY ACTIVITY. RIPPLE TANK.	128
6. READING COMPREHENSION: THE ELECTROMAGNETIC SPECTRUM.	128
7. VOCABULARY REVIEW.	129
8. FINAL ACTIVITIES.	129
 UNIT 9. THE ATOM AND PROPERTIES OF SUBSTANCES.	 133
1. ATOMIC STRUCTURE.	133
2. PERIODIC TABLE OF THE ELEMENTS. CLASSIFICATION OF SUBSTANCES ACCORDING TO THEIR PROPERTIES.	136
3. CHEMICAL BONDS BETWEEN ATOMS: IONIC, COVALENT AND METALLIC.	137
4. READING COMPREHENSION: RADIOACTIVITY.	139
5. LABORATORY ACTIVITY: CLASSIFICATION OF SUBSTANCES ACCORDING TO THEIR PROPERTIES.	140
6. VOCABULARY REVIEW.	140
7. FINAL ACTIVITIES.	140

UNIT 10. CHEMICAL REACTIONS.	146
1. CHEMICAL REACTION.	146
2. THE MOLE. MOLAR MASS.	146
3. STOICHIOMETRY ON CHEMICAL EQUATIONS.	148
4. MOLAR, MASS AND VOLUME CALCULATIONS IN CHEMICAL EQUATIONS.	149
5. CLASSIFICATION OF CHEMICAL REACTIONS.	151
6. HEAT ON CHEMICAL REACTIONS. EXOTHERMIC AND ENDOTHERMIC REACTIONS.	152
7. RATE ON CHEMICAL REACTIONS.	152
8. LABORATORY ACTIVITY: COMPARING CHEMICAL REACTION RATE.	152
9. READING COMPREHENSION: SOME INDUSTRIAL REACTIONS.	152
10. VOCABULARY REVIEW.	153
11. FINAL ACTIVITIES.	153
UNIT 11. CHEMISTRY OF ORGANIC COMPOUNDS.	163
1. CARBONS AS THE BASE OF LIVING THINGS.	163
2. PROPERTIES OF CARBON COMPOUNDS.	163
3. HYDROCARBONS. STRUCTURE AND PROPERTIES AS ENERGY SOURCES.	163
4. ALCOHOLS.	165
5. CARBOXYLIC ACIDS.	165
6. SYNTHETIC POLIMERS.	166
7. FABRICATION AND RECYCLING OF PLASTICS.	166
8. MACROMOLECULES COMPRISING LIVING THINGS.	166
9. READING COMPREHENSION: ORIGIN AND DEVELOPMENT OF LIVE.	167
10. LABORATORY ACTIVITY: MAKING SOAP.	167
11. FINAL ACTIVITIES.	167
UNIT 12. SCIENCE AND ENVIRONMENT.	171
1. GREENHOUSE EFFECT.	171
2. CLIMATE CHANGE, LACK OF RESOURCES, REDUCTION OF BIODIVERSITY.	171
3. SUSTAINABILITY. CONTRIBUTION OF SCIENCE AND TECHNOLOGY TO SUSTAINABILITY.	171
4. CLEAN ENERGIES.	171
APPENDIX. INORGANIC FORMULATION.	172
PRACTICE WITH THE FOLLOWING EXERCISES.	172

Unit 1. Introduction to the Scientific Method.

1. MAGNITUDES AND MEASUREMENTS. CLASSIFICATION OF MAGNITUDES

Se comienza con un recordatorio del método científico y al entrar en la etapa de la experimentación y teniendo en cuenta que experimentar consiste fundamentalmente en medir magnitudes, se clasifican las magnitudes. Los estudiantes deben tener claro lo que es una magnitud fundamental y derivada, pero la clasificación en magnitud escalar y vectorial es nueva para ellos.

Se plantean unos ejercicios básicos sobre magnitudes para asentar conocimientos.

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

	Fundamental	Derived
Scalar	Mass Temperature Current intensity Length Time Amount of substance	Volume Surface Density
Vector		Force Acceleration Velocity

2. Complete:

There are seven fundamental magnitudes: mass, length, time, temperature, luminous intensity, current intensity and amount of substance.

Density is a derived magnitude which depends on mass and length.

Acceleration is a derived magnitude which depends on length and time.

Surface is a derived magnitude which depends on length.

Three scalar magnitudes are mass, volume and length. All of them are defined by a value and a unit.

Three vector magnitudes are velocity, acceleration and force. They need also the direction in order to be completely defined.

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

Se recuerdan las unidades en el Sistema Internacional de magnitudes fundamentales y derivadas y se trabaja con la escala de múltiplos y submúltiplos y el uso de los factores de conversión.

3. SCIENTIFIC NOTATION

También este punto es un recordatorio de la expresión de una magnitud en notación científica para que la utilicen siempre que sea conveniente.

Se plantean ejercicios para practicar el uso de los factores de conversión y la notación científica.

EXERCISES

1. Convert the following measurements to the correspondent SI unit using conversion factors and express the results using scientific notation:

a. 1300 pm $1300 \text{ pm} \cdot \frac{1 \text{ m}}{10^{12} \text{ pm}} = 1,3 \cdot 10^{-9} \text{ m}$

b. 4500 μm $4500 \text{ μm} \cdot \frac{1 \text{ m}}{10^6 \text{ μm}} = 4,5 \cdot 10^{-3} \text{ m}$

c. 5 Tm $5 \text{ Tm} \cdot \frac{1 \text{ Tm}}{10^{12} \text{ m}} = 5 \cdot 10^{-12} \text{ m}$

d. 3600 dg $3600 \text{ dg} \cdot \frac{1 \text{ kg}}{10^4 \text{ dg}} = 3,6 \cdot 10^{-1} \text{ kg}$

e. 8700 mm² $8700 \text{ mm}^2 \cdot \frac{1 \text{ m}^2}{10^6 \text{ mm}^2} = 8,7 \cdot 10^{-3} \text{ m}^2$

f. 6 km² $6 \text{ km}^2 \cdot \frac{10^6 \text{ m}^2}{1 \text{ km}^2} = 6 \cdot 10^6 \text{ m}^2$

g. 3500 nm² $3500 \text{ nm}^2 \cdot \frac{1 \text{ m}^2}{10^{18} \text{ nm}^2} = 3,5 \cdot 10^{-15} \text{ m}^2$

h. 3 hm³ $3 \text{ hm}^3 \cdot \frac{10^6 \text{ m}^3}{1 \text{ hm}^3} = 3 \cdot 10^6 \text{ m}^3$

i. 87 L $87 \text{ L} \cdot \frac{1 \text{ m}^3}{10^3 \text{ L}} = 8,7 \cdot 10^{-2} \text{ m}^3$

j. 540 mL $540 \text{ mL} \cdot \frac{1 \text{ m}^3}{10^6 \text{ mL}} = 5,4 \cdot 10^{-4} \text{ m}^3$

k. 720 mm³ $720 \text{ mm}^3 \cdot \frac{1 \text{ m}^3}{10^9 \text{ mm}^3} = 7,2 \cdot 10^{-7} \text{ m}^3$

2. Make the following time conversions using conversion factors:

a. 3300 s to hours $3300 \text{ s} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 0,92 \text{ h}$

b. 7 h to min $7 \text{ h} \cdot \frac{60 \text{ min}}{1 \text{ h}} = 420 \text{ min}$

c. 340 s to min $340 \text{ s} \cdot \frac{1 \text{ min}}{60 \text{ s}} = 5,7 \text{ min}$

d. 4500 ms to s $4500 \text{ ms} \cdot \frac{1 \text{ s}}{10^3 \text{ ms}} = 4,5 \text{ s}$

e. 3hm/s to km/h $\frac{3 \text{ hm}}{1 \text{ s}} \cdot \frac{1 \text{ km}}{10 \text{ hm}} \cdot \frac{3600 \text{ s}}{1 \text{ h}} = 1080 \text{ km/h}$

- f. 345 mm/min to m/s $\frac{345 \text{ mm}}{1 \text{ min}} \cdot \frac{1 \text{ m}}{10^3 \text{ mm}} \cdot \frac{1 \text{ min}}{60 \text{ s}} = 5,75 \cdot 10^{-3} \text{ m/s}$
- g. 47 km/h to m/s $\frac{47 \text{ km}}{1 \text{ h}} \cdot \frac{10^3 \text{ m}}{1 \text{ km}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 13,1 \text{ m/s}$
- h. 100 km/h to m/s $\frac{100 \text{ km}}{1 \text{ h}} \cdot \frac{10^3 \text{ m}}{1 \text{ km}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 27,8 \text{ m/s}$
- i. 32 dam/min to m/s $\frac{32 \text{ dam}}{1 \text{ min}} \cdot \frac{10 \text{ m}}{1 \text{ dam}} \cdot \frac{1 \text{ min}}{3600 \text{ s}} = 0,09 \text{ m/s}$
- j. 7 m/s to km/h $\frac{7 \text{ m}}{1 \text{ s}} \cdot \frac{1 \text{ km}}{10^3 \text{ m}} \cdot \frac{3600 \text{ s}}{1 \text{ h}} = 25,2 \text{ km/h}$
- k. 72 km/h to m/s $\frac{72 \text{ km}}{1 \text{ h}} \cdot \frac{10^3 \text{ m}}{1 \text{ km}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 20 \text{ m/s}$
- l. 324 kg/m³ to g/cm³ $\frac{324 \text{ kg}}{1 \text{ m}^3} \cdot \frac{10^3 \text{ g}}{1 \text{ kg}} \cdot \frac{1 \text{ m}^3}{10^6 \text{ cm}^3} = 0,324 \text{ g/cm}^3$
- m. 56 dg/cm³ to kg/m³ $\frac{56 \text{ dg}}{1 \text{ cm}^3} \cdot \frac{1 \text{ kg}}{10^4 \text{ dg}} \cdot \frac{10^6 \text{ cm}^3}{1 \text{ m}^3} = 5,6 \cdot 10^3 \text{ kg/m}^3$
- n. 2,3 g/cm³ to kg/m³ $\frac{2,3 \text{ g}}{1 \text{ cm}^3} \cdot \frac{1 \text{ kg}}{10^3 \text{ g}} \cdot \frac{10^6 \text{ cm}^3}{1 \text{ m}^3} = 2,3 \cdot 10^3 \text{ kg/m}^3$
- o. 1200 kg/m³ to g/cm³ $\frac{1200 \text{ kg}}{1 \text{ m}^3} \cdot \frac{10^3 \text{ g}}{1 \text{ kg}} \cdot \frac{1 \text{ m}^3}{10^6 \text{ cm}^3} = 1,2 \text{ g/cm}^3$

3. Make the following conversions using conversion factors:

- a. 62 mm to inches $62 \text{ mm} \cdot \frac{1 \text{ inch}}{25,4 \text{ mm}} = 2,44 \text{ inch}$
- b. 58 hm to miles $58 \text{ hm} \cdot \frac{1 \text{ mile}}{16,09 \text{ hm}} = 3,6 \text{ miles}$
- c. 32 feet to meters $32 \text{ feet} \cdot \frac{0,3048 \text{ m}}{1 \text{ foot}} = 9,754 \text{ m}$
- d. 7 yards to hm $7 \text{ yards} \cdot \frac{0,9144 \text{ m}}{1 \text{ yard}} \cdot \frac{1 \text{ hm}}{10^2 \text{ m}} = 6,4 \cdot 10^{-2} \text{ hm}$
- e. 4 pints to liters $4 \text{ pints} \cdot \frac{0,568 \text{ L}}{1 \text{ pint}} = 2,272 \text{ L}$
- f. 37 pounds to kg $37 \text{ pounds} \cdot \frac{453,592 \text{ g}}{1 \text{ pound}} \cdot \frac{1 \text{ kg}}{10^3 \text{ g}} = 16,78 \cdot k$

4. MEASURING DEVICES

Este punto se puede trabajar a base de preguntas a modo de "Brainstorming" ya que los alumnos el curso anterior han trabajado en el laboratorio y han utilizado instrumentos de medida. Se pueden llevar a clase algunos instrumentos, recordar su nombre y determinar su sensibilidad.

Lo más importante es que ellos mismos manejen los instrumentos de medida y que al hacerlo se les indique que comparen sensibilidades. Tenemos distintas oportunidades a lo largo de la unidad. Durante el trabajo de laboratorio de estudio del movimiento del péndulo se trabaja con cronómetros y metros. En la práctica de laboratorio de determinación gráfica de la densidad trabajarán con el calibre y las balanzas.

5. MEASUREMENT ERRORS

Resulta interesante que los alumnos resuelvan algún problema sobre tratamiento de errores antes de tener que enfrentarse a una práctica real en el laboratorio. Por ello se resume el método y se proponen dos problemas básicos.

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?

$$\bar{L} = \frac{4,64\text{cm} + 4,67\text{cm} + 4,63\text{cm} + 4,65\text{cm}}{4} = 4,65\text{ cm}$$

b. What is the absolute error of the measurement?

$$E_1 = |L_1 - \bar{L}| = |4,64\text{ cm} - 4,65\text{ cm}| = 0,01\text{ cm}$$

$$E_2 = |L_2 - \bar{L}| = |4,67\text{ cm} - 4,65\text{ cm}| = 0,02\text{ cm}$$

$$E_3 = |L_3 - \bar{L}| = |4,63\text{ cm} - 4,65\text{ cm}| = 0,02\text{ cm}$$

$$E_4 = |L_4 - \bar{L}| = |4,65\text{ cm} - 4,65\text{ cm}| = 0,00\text{ cm}$$

$$E_A = \frac{0,01\text{cm} + 0,02\text{cm} + 0,02\text{cm} + 0,00\text{cm}}{4} = 0,1\text{ cm}$$

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

$$L = 4,65 \pm 0,01\text{ cm}$$

d. What relative error has been made?

$$E_R = \frac{0,01\text{cm}}{4,65\text{cm}} \cdot 100 = 0,22\%$$

e. Has it been a precise experiment?

Yes, it can be considered precise because the relative error is smaller than 1%

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

The measured density is between $1,28\text{g/cm}^3$ and $1,38\text{g/cm}^3$

6. ANALYSIS OF DATA.

Este es un punto en el que debemos centrar nuestros esfuerzos ya que este curso los alumnos están preparados para profundizar en el análisis de gráficos y además lo van a tener que poner en práctica a lo largo del curso en diferentes ocasiones. Sobre todo es muy importante que entiendan el interés de la pendiente de la recta y que practiquen y tengan claro su cálculo.

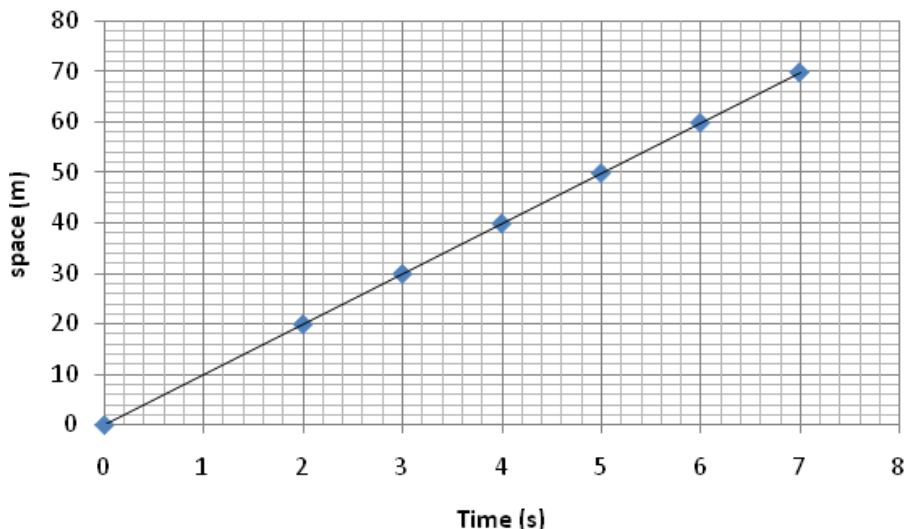
Se proponen dos ejercicios sobre el análisis de gráficos que ellos mismos tienen que dibujar a partir de una tabla de datos.

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?

It is a proportional graph

c) How many meters it will have run at 10 seconds

It will have run 100 m

d) How much time will it take to run 120 meters?

It will take 12 seconds

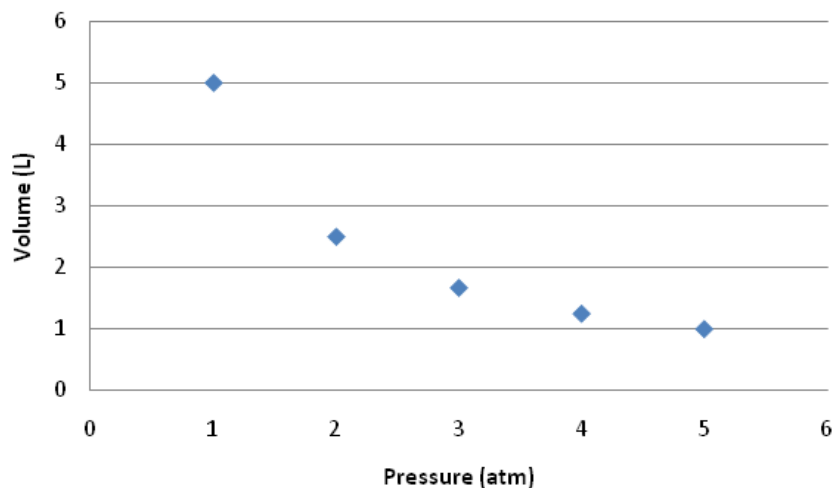
e) Calculate the gradient of the line. What magnitude does it represent?

$$\frac{\Delta s}{\Delta t} = \frac{70 \text{ m}}{7 \text{ s}} = 10 \text{ m/s}$$

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?

It is an inverse proportion graph

c) At what pressure the balloon will have a volume of 4,5 liters?

$$V \cdot P = 5 = 4,5L \cdot P$$

$$P = 1,11 \text{ atm}$$

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

Esta es una práctica pensada para que pongan en práctica las etapas del método científico, planteando hipótesis y comprobando experimentalmente si son ciertas o no.

Para no demorar el desarrollo de las clases, se recomienda plantear las hipótesis en el grupo de clase y repartir por grupos la comprobación de cada una de las hipótesis. Finalmente, tras hacer el informe, cada grupo puede contar al resto en un "congreso en el aula" los resultados de su experimentación.

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

Este punto tiene como objetivo tanto que los alumnos conozcan las normas fundamentales de trabajo en el laboratorio como explicarles cómo deben realizar su informe de laboratorio.

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

Esta es una práctica similar a la que se propone en el libro de tercero ya que experimentalmente tienen que medir la masa y el volumen de una serie de piezas.

La diferencia radica en que al representar los resultados en un gráfico los puntos deben salir alineados si están hechas del mismo material.

El profesor debe elegir una serie de piezas distintas del mismo material y una de material diferente para que el alumno vea que el punto que la representa en el gráfico no pertenece a la recta común a los demás puntos. Finalmente el alumno debe determinar la pendiente de la recta y ver que por las unidades de la magnitud corresponden a las de la densidad, por lo que está calculando la densidad de la sustancia que compone los cuerpos.

10. FINAL ACTIVITIES

1. Make the following change of units:

$$\text{a) } 120 \text{ Km/h to m/s} \quad \frac{120 \text{ km}}{1 \text{ h}} \cdot \frac{10^3 \text{ m}}{1 \text{ km}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 33,3 \text{ m/s} \cdot \text{kg}$$

$$\text{b) } 720 \text{ m}^2 \text{ to Km}^2 \quad 720 \text{ m}^2 \cdot \frac{1 \text{ km}^2}{10^6 \text{ m}^2} = 7,2 \cdot 10^{-4} \text{ km}^2$$

$$\text{c) } 475 \text{ m}^3 \text{ to L} \quad 475 \text{ m}^3 \cdot \frac{10^3 \text{ L}}{1 \text{ m}^3} = 4,75 \cdot 10^5 \text{ L}$$

$$\text{d) } 2,5 \text{ hm/s to Km/h} \quad \frac{2,5 \text{ hm}}{1 \text{ s}} \cdot \frac{1 \text{ km}}{10 \text{ hm}} \cdot \frac{3600 \text{ s}}{1 \text{ h}} = 900 \text{ km/h}$$

$$\text{e) } 1,6 \text{ g/cm}^3 \text{ to Kg/m}^3 \quad \frac{1,6 \text{ g}}{1 \text{ cm}^3} \cdot \frac{1 \text{ kg}}{10^3 \text{ g}} \cdot \frac{10^6 \text{ cm}^3}{1 \text{ m}^3} = 1,6 \cdot 10^3 \text{ kg/m}^3$$

$$\text{f) } 23 \text{ L to cm}^3 \quad 23 \text{ L} \cdot \frac{10^3 \text{ cm}^3}{1 \text{ L}} = 2,3 \cdot 10^4 \text{ cm}^3$$

2. Express the next measurements in the International System of units:

a) **3,7 Gm** $3,7 \text{ Gm} \cdot \frac{10^9 \text{ m}}{1 \text{ Gm}} = 3,7 \cdot 10^9 \text{ m}$

b) **540 L** $540 \text{ L} = 540 \text{ dm}^3 \cdot \frac{1 \text{ m}^3}{10^3 \text{ dm}^3} = 0,54 \text{ m}^3$

c) **300 pg** $30 \text{ pg} \cdot \frac{1 \text{ kg}}{10^{15} \text{ pg}} = 3 \cdot 10^{-13} \text{ kg}$

d) **124 dam/h** $\frac{124 \text{ dam}}{1 \text{ h}} \cdot \frac{10 \text{ m}}{1 \text{ dam}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 0,34 \text{ m/s}$

e) **48 g/L** $\frac{48 \text{ g}}{1 \text{ L}} \cdot \frac{1 \text{ kg}}{10^3 \text{ g}} \cdot \frac{10^3 \text{ L}}{1 \text{ m}^3} = 48 \text{ kg/m}^3$

f) **5 Kg/L** $\frac{5 \text{ kg}}{1 \text{ L}} \cdot \frac{10^3 \text{ L}}{1 \text{ m}^3} = 5 \cdot 10^3 \text{ kg/m}^3$

g) **77000 ns** $77000 \text{ ns} \cdot \frac{1 \text{ s}}{10^9 \text{ ns}} = 7,7 \cdot 10^{-5} \text{ s}$

h) **8500 μg** $8500 \text{ μg} \cdot \frac{1 \text{ kg}}{10^9 \text{ μg}} = 8,5 \cdot 10^{-6} \text{ kg}$

i) **1,3 Mm** $1,3 \text{ Mm} \cdot \frac{10^6 \text{ m}}{1 \text{ Mm}} = 1,3 \cdot 10^6 \text{ m}$

j) **8600 pm** $8600 \text{ pm} \cdot \frac{1 \text{ m}}{10^{12} \text{ pm}} = 8,6 \cdot 10^{-9} \text{ m}$

k) **2,43 Mg** $2,43 \text{ Mg} \cdot \frac{10^3 \text{ kg}}{1 \text{ Mg}} = 2,43 \cdot 10^3 \text{ kg}$

l) **0,241 Gs** $0,241 \text{ Gs} \cdot \frac{10^9 \text{ s}}{1 \text{ Gs}} = 2,41 \cdot 10^8 \text{ s}$

m) **30 μs** $30 \text{ μs} \cdot \frac{1 \text{ s}}{10^6 \text{ μs}} = 3 \cdot 10^{-5} \text{ s}$

3. Rewrite the next measurements into the International System of units:

a. **42 inch** $42 \text{ inch} \cdot \frac{0,0254 \text{ m}}{1 \text{ inch}} = 1,067 \text{ m}$

b. **76 ft** $76 \text{ feet} \cdot \frac{0,3048 \text{ m}}{1 \text{ foot}} = 23,16 \text{ m}$

c. **840 yd** $840 \text{ yd} \cdot \frac{0,9144 \text{ m}}{1 \text{ yd}} = 768,1 \text{ m}$

d. **7 pt** $7 \text{ pt} \cdot \frac{4,546 \cdot 10^{-3} \text{ m}^3}{1 \text{ pt}} = 3,18 \cdot 10^{-2} \text{ m}^3$

e. **35 oz** $35 \text{ oz} \cdot \frac{0,028 \text{ kg}}{1 \text{ oz}} = 0,14 \text{ kg}$

f. **71 lb** $71 \text{ lb} \cdot \frac{0,0454 \text{ kg}}{1 \text{ lb}} = 3,22 \text{ kg}$

g. **45 mph (miles/hour)** $\frac{45 \text{ miles}}{1 \text{ h}} \cdot \frac{1609,34 \text{ m}}{1 \text{ mile}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 20,12 \text{ m/s}$

4. Measuring the volume of the liquid contained in a fizzy drink tin the following values were found $330,0 \text{ cm}^3$, $330,9 \text{ cm}^3$ y $329,4 \text{ cm}^3$. Calculate:

a. The average volume measurement

$$\bar{V} = \frac{330,0 \text{ cm}^3 + 330,9 \text{ cm}^3 + 329,4 \text{ cm}^3}{3} = 330,1 \text{ cm}^3$$

b. The absolute error in the measurements

$$E_1 = |V_1 - \bar{V}| = |330,0 \text{ cm}^3 - 330,1 \text{ cm}^3| = 0,01 \text{ cm}^3$$

$$E_2 = |V_2 - \bar{V}| = |330,9 \text{ cm}^3 - 330,1 \text{ cm}^3| = 0,08 \text{ cm}^3$$

$$E_3 = |V_3 - \bar{V}| = |329,4 \text{ cm}^3 - 330,1 \text{ cm}^3| = 0,07 \text{ cm}^3$$

$$E_A = \frac{0,1 \text{ cm}^3 + 0,8 \text{ cm}^3 + 0,7 \text{ cm}^3}{3} = 0,5 \text{ cm}^3$$

c. The scientific value of the measurements done

$$V = 330,1 \pm 0,5 \text{ cm}^3$$

d. The relative error of the measurement

$$E_R = \frac{0,5 \text{ cm}^3}{330,1 \text{ cm}^3} \cdot 100 = 0,15\%$$

e. The sensitivity of the measuring instrument

Sensitivity is $0,01 \text{ cm}^3$

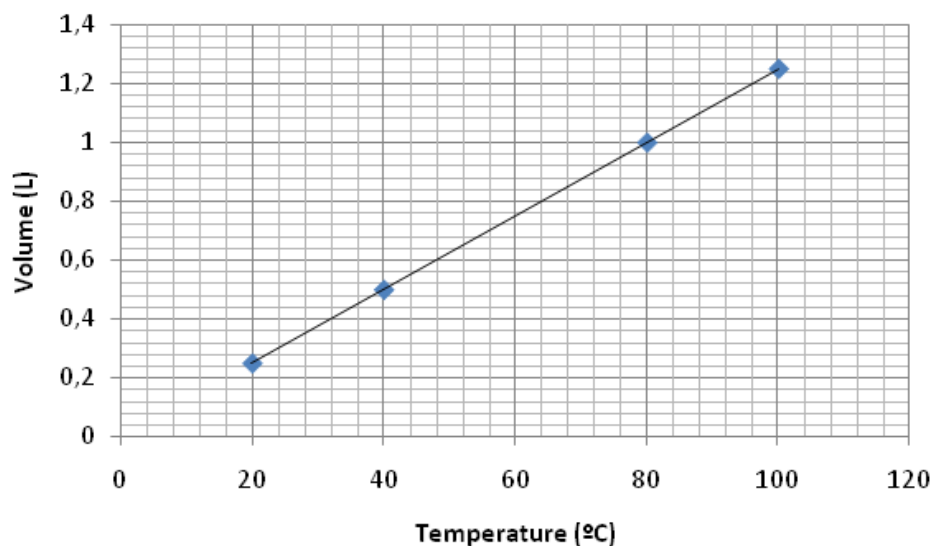
f. Is this measuring method precise?

Yes, it can be considered very precise because the relative error is much lower than 1%

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 (°C)	20	40	80	100

a) Draw a graph with these data.



b) What kind of graph is it?

It is a proportional graph

c) If the balloon explodes when its volume it's 3L, at what temperature will it happen?

$$\frac{20^{\circ} C}{0,25 L} = \frac{T}{3 L}$$

$$T = 240^{\circ} C$$

d) Calculate de gradient of the line a interpret its meaning

$$\frac{\Delta V}{\Delta T} = \frac{1,25 L - 0,25 L}{100^{\circ} C - 20^{\circ} C} = 0,0125 L/^{\circ} C$$

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, dynamometre.

Scalar magnitude	Vector magnitude	International System Unit	Other units	Measuring instrument
time		second	hour	chronometer
temperature		kelvin	Celsius degree	thermometer
volume		Cubic metre	decilitre	Pipette, burette
mass		kilogram	microgram	Weighting scale
	acceleration	Metre by squared second	Kilometre by squared hour	
	force	newton		dynamometer
	velocity	Metre by second	Kilometre by hour	speedometer

2. Make the following change of units and express the result in scientific notation :

a. 3267 Mm to dm $3267 Mm \cdot \frac{10^7 dm}{1 Mm} = 3,267 \cdot 10^{10} dm$

b. 234 mm² to dam² $234 mm^2 \cdot \frac{1 dam^2}{10^8 mm^2} = 2,34 \cdot 10^{-6} dam^2$

c. 4213 mm³ to L $4213 mm^3 \cdot \frac{1 dm^3}{10^6 mm^3} = 4,213 \cdot 10^{-3} dm^3 = 4,213 \cdot 10^{-3} L$

d. 0,034 kL to mm³ $0,034 kL \cdot \frac{10^9 mm^3}{1 kL} = 3,4 \cdot 10^7 mm^3$

e. 13 hm/h to m/s $\frac{13 hm}{1 h} \cdot \frac{10^2 m}{1 hm} \cdot \frac{1 h}{3600 s} = 0,36 m/s$

f. 750 dam/min to m/s $\frac{750 dam}{1 min} \cdot \frac{10 m}{1 dam} \cdot \frac{1 min}{60 s} = 1,25 \cdot 10^2 m/s$

g. 56 dam/min to km/h $\frac{56 dam}{1 min} \cdot \frac{1 km}{10^2 dam} \cdot \frac{60 min}{1 h} = 33,6 km/h$

h. 1238 kg/m³ to g/cm³ $\frac{1238 kg}{1 m^3} \cdot \frac{10^3 g}{1 kg} \cdot \frac{1 m^3}{10^6 cm^3} = 1,238 g/cm^3$

i. $2,7 \text{ g/cm}^3$ to kg/m^3

$$\frac{2,7 \text{ g}}{1 \text{ cm}^3} \cdot \frac{1 \text{ kg}}{10^3 \text{ g}} \cdot \frac{10^6 \text{ cm}^3}{1 \text{ m}^3} = 2700 \text{ kg/m}^3 = 2,7 \cdot 10^3 \text{ kg/m}^3$$

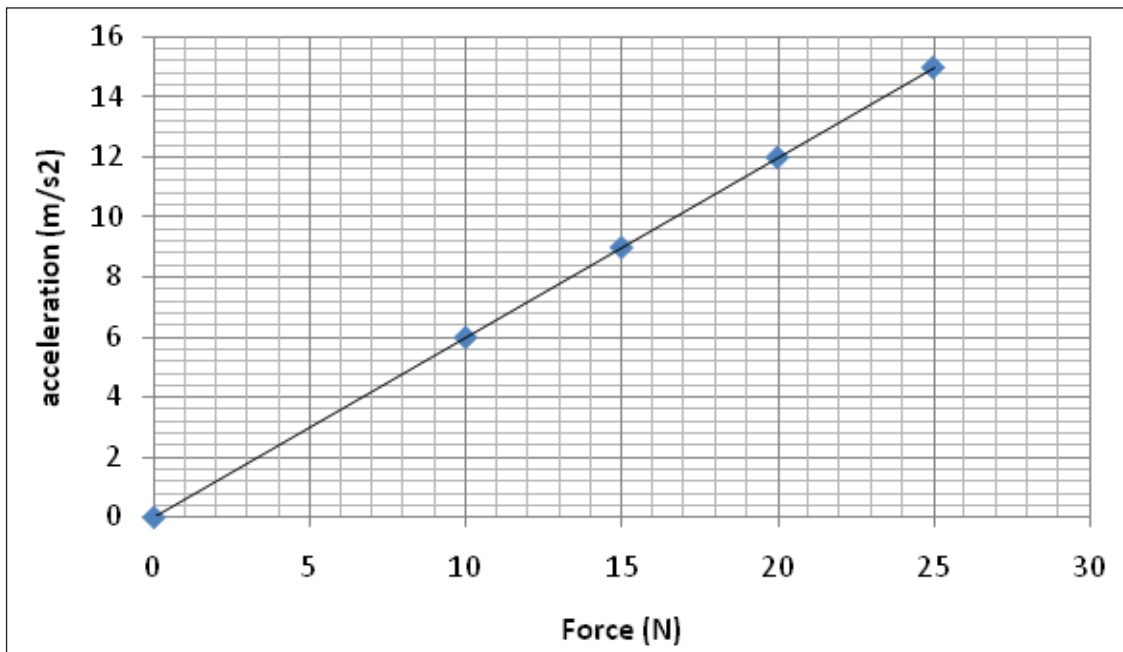
j. 3 dg/mm^3 to kg/m^3

$$\frac{3 \text{ dg}}{1 \text{ mm}^3} \cdot \frac{1 \text{ kg}}{10^4 \text{ dg}} \cdot \frac{10^9 \text{ mm}^3}{1 \text{ m}^3} = 3 \cdot 10^5 \text{ kg/m}^3$$

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	9	15

a) Draw a graph with these data.



b) What kind of graph is it?

It is a proportional graph

c) Which force will produce an acceleration of 5 m/s^2 in the object?

$$\frac{6 \text{ m/s}^2}{10 \text{ N}} = \frac{5 \text{ m/s}^2}{F}$$

$$F = 8,3 \text{ N}$$

d) Calculate the gradient of the line and interpret its meaning

$$\frac{\Delta a}{\Delta F} = \frac{14 \text{ m/s}^2 - 4 \text{ m/s}^2}{23 \text{ N} - 6,5 \text{ N}} = 0,6 \text{ m/s}^2/\text{N}$$

The gradient of the line represents the acceleration produced by a force of 1 N.