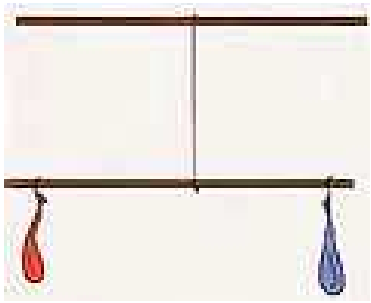
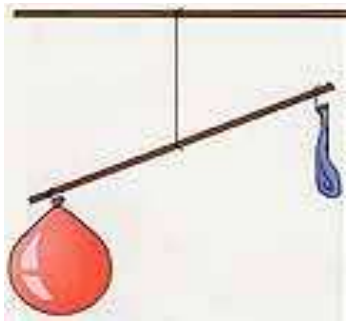
UNIT 12 MATTER AND ITS PROPERTIES

Matter is everything that occupies ***space*** and can be ***weighed.***
Everything is made of matter; rocks, pens, trees, books, the human body and the things we make are made of matter.
Even ***gases,*** like the air, are made of matter because they occupy a ***space*** and can be ***weighed***.

We want to test if the ***balloon*** is heavier or lighter (or the same weight) after you blow air into it. To do this, tie a piece of string around the middle of a stick or a piece of cane so that it balances. Then tie an empty balloon to each end of the cane. What happens? The two balloons should balance evenly at each end.



Now remove one balloon and blow air into it. When you have done that, tie it back onto the end of the cane. Is there any change? That's right, the end with the blown-up balloon on it should go downwards. This is because the air in the balloon is making it heavier.



- **General properties**. These are the properties ***common*** to all matter. ***Mass***, ***volume***, ***weight*** and ***density***.

- **Specific properties**. These are the characteristics that ***different*** one kind of matter from another. They are ***colour***, ***shape***, ***size***, ***texture***, ***hardness***, etc. They can be used to ***identify*** and ***describe*** matter.

The International System of Measurements

Magnitudes

Everything that we can ***measure*** is called ***magnitude***. How long, how tall or how wide a table is, are ***lengths***, that is the distance between two points that you can measure. That is a magnitude

Magnitudes. A magnitude is a ***property*** of the material that we can ***measure***. For example, we can measure the mass of a stone. So the mass of a stone is a ***magnitude***. We can measure the volume of a stone. So the volume of a stone is a magnitude
We measure the mass with a ***scale***. We measure the volume with a ***test-tube*** or a ***measuring cylinder***. Beauty or knowledge are not magnitudes. We cannot measure them with an instrument or with a machine.
.
All the ***magnitudes*** and their ***units*** are ***gathered*** in a common set called the ***International System***. Scientists choose an arbitrary number of magnitudes. They are most important. These ones are called ***fundamental magnitudes***. The rest of the magnitudes are called ***derived magnitudes***
:

- **Fundamental magnitudes**. There are seven ***fundamental*** magnitudes of the ***International System***, but we will only study four of them: ***Length***, ***Time***, ***Mass***, and ***Temperature***

- **Derived magnitudes.**The rest of the magnitudes are called ***derived***. Every derived magnitude is defined from fundamental magnitudes. In the ***International System*** the most used derived magnitudes are: For example, the ***volume***, the ***density*** or the ***speed*** , that is the space divided by the time.

Units

To ***measure*** matter, many types of units can be used.
To compare ***measurements***, however, everyone needs to use the same ***units***.
The most common system is the ***International System of Units***. There are seven ***fundamental units***. All other units are combination of these fundamental units.

Fundamental units are used to measure length, mass, time, temperature etc. These units are the metre, the kilogram, the second, etc.

Some fundamental units

	Lenght	**Mass**	**Time**	**Temperature**
Unit	metre	kilogram	second	kelvin
Symbol	m	kg	s	K

Derived units are obtained from a combination of the base units. They are used to measured surface area, volume, density, etc. These units are the square metre, cubic metre, kilogram/cubic metre, etc

Some derived units

	Surface area	**Volume**	**Density**
Unit	square metre	cubic metre	kilogram/cubic metre
Symbol	m^2	m^3	kg/ m^3

(Vocabulary: *to weigh: pesar, medir / weight: peso / to measure: medir / scale: balanza / test-tube: tubo de ensayo / measuring cylinder: probeta / to gather: reunir / set: conjunto / to choose: elegir /**)***

Match the words on the left column with the sentences on the right

1. General properties	A. These are the characteristics that different one kind of matter from another
2. Matter	B. It is the distance between two points
3. Density	C. It is everything that we can measure
4. Specific properties	D. These are the properties common to all matter
5. Hardness	E. It is everything that occupies space and can be weighed
6. Magnitude	F. It is a specific property of matter
7. Length	G. It is a general property of matter
8. Derived magnitude	H. It is defined from a fundamental magnitude such as density
9. Volume	I . It is a derived unit

Answers: 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 .....

Fill the gaps with the following words from the list

magnitude distance air density metres matter base texture general properties weighed shape volume specific properties

.....is everything that occupies space and can be weighed.

Even gases like the..... are made of matter because they occupy a space and can be.....
The properties that are common to all matter are called..... such as nass, ..., weight and.....

The characteristics that different one kind of matter from another are called ..... They are colour, ..., size, ..., hardness, etc. They can be used to identify and describe matter

Everything that we can measure is called..... How long, how tall or how wide a table is are lengths, that is the..... between two points that you can measure.

Length is a .....unit. In the International System of Units, length is measured in .....

Answer the following questions

1. What is matter?.....
2. Write down three things made of matter .....
3. Why is the air considered matter? .....
4. What are the general properties of matter? .....
5. Write down three exemples of general properties of matter .....
6. What are the specific properties of matter? .....
7. Write down three examples of specific properties of matter .....
8. What is a magnitude? .....
9. Is volume a magnitude? Why? .....
10. Is colour a magnitude? Why? .....
11. Is length a magnitude? Why? .....
12. Is the metre a magnitude? Why? .....
13. Is beauty a magnitude? Why? .....
14. Is density a magnitude? Why? .....

Length

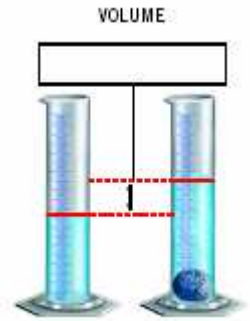
Length is the ***distance*** between two points.

Length is a ***fundamental magnitude***. In the ***International System of Units***, length is measured in ***metres***

This bar of ***platinum*** and ***iridium*** was used as the ***International Prototype*** to define the ***metre*** as the international unit of length. It is displayed in the **International Bureau of Weights and Measures, Paris**

Volume.

The volume of a solid is the ***amount*** of ***space*** it occupies. It is a ***derived magnitude*** from length. Volume is measured in ***cubic metres*** (***m^3***)



To measure the volume of:

- **Regular geometric solids**. Use the corresponding ***mathematical formula***. For example, to find the volume of a box, multiply the base (length x width) by the height.
- **Irregular-shaped solids**.Use a ***measuring cylinder*** to measure the volume. ***Submerge*** the body in water, then measure the ***amount*** of water ***displaced***.
- **Liquids**. Use a ***measuring cylinder*** to measure the volume.
- **Gases**. Fill a ***measuring cylinder*** with water. Place it ***upside down*** in a dish

water. Mark the water level in the cylinder: ***initial volume***. Blow air through a tube into the cylinder. The air displaces some water. Mark the new water level: ***final volume***. The difference between the two levels is the volume of gas added to the cylinder.

Capacity

The ***volume*** of a ***liquid*** can be calculated by measuring the capacity of its ***container***.
Capacity is the ***amount*** of liquid a ***container*** can hold when is ***full***. For example, a bowl can hold more water than a cup. Capacity is measured in ***litres*** (***L***)

(Vocabulary: *lengh: longitud / to display: exhibir, mostrar / measuring cylinder: probeta / to submerge: sumergir / amount: cantidad / to displace: desplaza / upside down: boca abajo / dish: plato / to blow: soplar / to held (hold, hold): contener / full: lleno / bowl: cuenco / cup: taza* / *container: recipiente* ***)***

Match the words on the left column with the sentences on the right

1. Volume	A It is the distance between two points
2. Metre	B. It is used for mesauring volume of irregular-shaped solids
3. Measuring cylinder	C. It is the unit for lenght in the International System of Units
4. Mathematical formula	D. It is the amount of liquid a container can hold when is full
5. Cubic metre	E. It is the amount of space that a piece of matter occupies
6. Litres	F. It is used for mesauring volume of liquids
7. Length	G. It is the unit for volume in the International System of Units
8. Capacity	H. It is the unit for mesauring capacity
	I. It is used for mesauring regular geometric solids

Answers: 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 .....

Fill the gaps with the following words from the list

mathematical formula displaced litres cubic metres amount distance length magnitude metres irregular-shaped capacity full

Length is the .....between two points. It is a fundamental ....., and in the International System of Units is measured in .....

The volume of a solid is the .....of space it occupies. It is a derived magnitude from .....
Volume is measured in .....(m^3)
To measure the volume of regular geometric solids we use the corresponding.....
To measure the volume of .....solids we use a measuring cylinder. We submerge the body in water, then measure the amount of water .....
The volume of a liquid can be calculated by measuring the .....of its container. It is is the amount of liquid a container can hold when is . Capacity is measured in .....(L)

Answer the following questions

1. What is lengh? .....
2. How is length measured in the International System of Units?.....
3. What is volume? .....
4. How is volume measured in the International System of Units? .....
5. Are both lengh and volume fundamental magnitudes? .....
6. How is the volume of regular geometric solids measured? .....
7. What instrument is used to measure the volume of irregular-shaped solids and liquids?.....
8. What is the difference between measuring irregular-shaped solids and liquids by using a measuring cylinder? .....
9. How do we place a measuring cylinder to measure the volume of gases? .....

10. What is capacity? .....

11. How is capacity measured in the International System of Units? .....

Mass

Mass is the ***amount*** of ***matter*** in a body. Mass is a ***fundamental magnitude***. Mass is measured in ***kilograms*** (***kg***).

Scales are used to measure mass

This prototype of the kilogram is in the international Bureau of Weights and measures in Paris. The kilogram is the unit of mass

Measuring mass

We use a scale and some weights to measure mass. We put the body on one side of the scale. Then we put the weights on the other side of the scale. When the two sides are balanced, the mass of the body is equal to the sum of the masses of the weights

Density

Density is the ***relationship*** between the ***mass*** and the ***volume*** of a body. It says how concentrated the mass is in a specific volume.

Density is mass / volume and is measured in kg/m^3 or g/cm^3

If we compare two bodies with the same mass but different volumes, the body with less volume is denser than the body with more volume

The ***relationship*** between mass and volume:

- The ***greater*** the mass is, the ***greater*** the density.
- The ***greater*** the volume is, the ***smallest*** the density.

Density is a ***specific property*** of matter. It helps differentiate one substance from another

Generally speaking, ***solids*** have a ***higher*** density than ***liquids***. ***Liquids*** have a ***higher*** density than ***gases***. For example, air weighs very little because it has little mass: it feels light for its size.

Oil floats on water because it is less dense.

For the same volume of oil and water, water has more matter than oil. This is the property of density

Densities of some substances (room temperature)

Substance	Density (g/cm^3)	Substance	Density (g/cm^3)
Water	1.0	Iron	7.9
Oil	0.9	Mercury	13.5
Petrol	0.7	Aluminiun	2.7
Lead	11.3	Wood	0.6
Gold	19.3	Platinum	21.5

Calculating density

We can calculate the density of a solid body by measuring its mass and volume and then by dividing the mass of a body by its volume.

Measuring mass

We use a scale and some weights to measure mass. We put the body on one side of the scale. Then we put the weights on the other side of the scale. When the two sides are balanced, the mass of the body is equal to the sum of the masses of the weights.

Measuring volume

We can measure the volume of a solid with water and a measuring cylinder. Pour some water into a measuring cylinder. Write down the volume of the water in the cylinder; V_1. Now put the solid body into the measuring cylinder. Look at the volume in the cylinder and write it down; V_2.

The second volume is the sum of the volume of the water and the volume of the solid body. Substract the volume of the water from the volume of the water plus the volume of the solid body. The result is the volume of the solid body

$$V_{solid\ body} = V_2 - V_1$$

Finally, to work out the density of the solid body, we divide its mass by the volume it occupies

$$D_{solid\ body} = m_{solid\ body} / V_{solid\ body}$$

Match the words on the left column with the sentences on the right

1. Scales	A. It is the amount of matter in a body
2. Density	B. It is the unit for density in the International System of Units
3. Mass	C. It is a derived magnitude
4. g/cm^3	D. It can float both on oil and on water
5. Kilogram	E. It is a fundamental unit to measuring mass
6. Wood	F. It is a fundamental magnitude
7. Petrol	G. It is a solid body less dense than water
8. Oil	H. It is the relationship between the mass and the volume of a body
	I. It is an instrument for measuring mass
	J. It can float only on water

Answers: 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 .....

Fill the gaps with the following words from the list

substance less kg/m³ matter kilograms gases higher scales mass volume more specific

Mass is the amount of .....in a body, and is measured in .....(kg).
To measure mass it is used an instrument called .....
Density is the relationship between the..... and the..... of a body, and is measured in..... or g/cm^3 .
If we compare two bodies with the same mass but different volumes, the body with .....volume is denser than the body with..... volume
Density is a .....property of matter. It helps differentiate one..... from another
Generally speaking, solids have a .....density than liquids. Liquids have a higher density than.....

Answer the following questions

1. What is mass? .....
2. How is mass measured in the International System of Units?.....
3. What instrument is used for measuring mass? .....
4. What is density? .....
5. How is density measured in the International System of Units? .....

6. Are both mass and density fundamental magnitudes? .....
7. Why is density considered a specific property of matter? .....
8. If we compare two bodies with the same mass but different volumes, which of them is denser? .....
9. If we compare two bodies with the same volume but different masses, which of them is less dense?.....
10. Generally speaking, have solids got higher or lower density than liquids?.....
11. Generally speaking, have liquids got higher or lower density than gases?.....
12. Generally speaking, have gases got higher or lower density than solids?.....
13. Why does oil float on water? .....
14. Why does wood float on water? .....
15. What happens if you put a piece of iron inside a container full of water? Why? .....
16. What happens if you put a piece of iron inside a container full of mercury? Why?.....
17. Which of them have got higher mass, a ball of gold of $10cm^3$ of volume or a ball of platinum of the same volume? Why?.....
18. Why cannot you put out petrol burning with water? .....

Problems

1. In this measuring cylinder we pour some water. Then we put a some in the measuring cylinder too.

- What is the capacity of the measuring cylinder in cm^3?
- What is the volume of the stone in cm^3?

2. In the measuring cylinder we pour some water. Then we put a stone into it. The mass of the stone is 225 g.

- What is the capacity of the measuring cylinder in cm^3?
- What is the volume of the stone in cm^3?
- What is the density of the stone in g/cm^3?

3. We put a solid body that weighs 10g into a measuring cylinder. Then we put a solid body that also weighs 10g, but it has got a different shape, into a different cylinder. The first measuring cylinder now has a volume of $70cm^3$. The second measuring cylinder has a volume of $80cm^3$

- Draw the two measuring cylinders.
- Which of the two bodies has the highest density?

4. In a $200cm^3$ measuring cylinder we pour some water until $150cm^3$. Then we put a stone with a mass of 80g. The level of the water goes up to $180cm^3$.

- Which is the volume of the stone?
- Which is the density of the stone?

5. A $250cm^3$ measuring cylinder contains water until $120cm^3$. We put twelve coins that weigh 129g each one, and the level of the water goes up to 200.

- Which is the volume of the coin?
- What type of metal is it? (*see the table of densities*)