LESSON 1 WHAT IS PHYSICS?

- **Science**
- **Scientific Method**
- **Physics**
- **Physical and Chemical changes**
- **Newton & Einstein**
- **Mathematics (rounding, scientific notation, …)**

Let's start …. What is SCIENCE?

1.Here is the definition of SCIENCE. Let's read it aloud and then individually match the words below with the corresponding definitions.

Science (from the Latin *scientia*, 'knowledge') refers to a system of acquiring knowledge based on the Scientific Method. These groupings are empirical sciences, which mean knowledge must be based on observable phenomena and capable of being experimented for its validity by other researchers working under the same conditions.

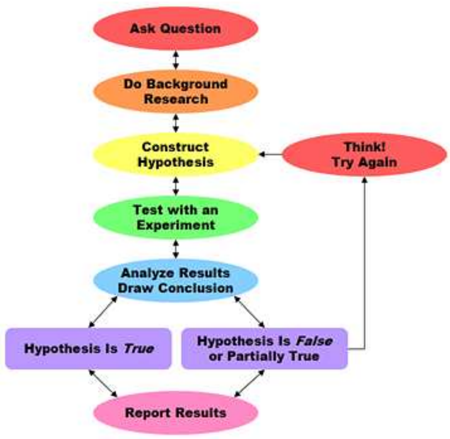
▫ Knowledge	▪means to know and understand something.
▫ Scientific method	▪means observable by the senses (you can see, touch, hear or smell it).
▫ Empirical	▪ is something that happens, e.g. the rain or the rainbow.
▫ Phenomena	▪ is the technique for studying science.

2. Fill in the gaps using the words given below.
(Discuss it in pairs and then correct it in plenary)

observation	phenomena	hypothesis	data	experimentation
knowledge	observable	theory	empirical	

Scientific method is a technique for investigating ……………………… (1) and acquiring new …………………………..(2). It is based on obtaining ……………………. (3), measurable and ……………………………(4) evidence of something. The scientific method consists of …………………… (5), formulation of .... (6), the collection of ……………. (7) through ……………………… (8) and at the end the conclusion or scientific …………………………(9).

3. Be curious! Put the sentences in order according to the diagram:



A. Why does a phenomenon happen?
B. Maybe it happens because …
C. Let's start again.
D. It happens because …
E. Let's go to the lab and experiment.
F. We were wrong.
G. We have the following data and we draw a graph.

4. Here is the definition of PHYSICS. Let's read it aloud and then individually match the words below with the sentences.

Physics is the science of matter *and its motion*, as well as *space and time*—the science that deals with concepts such as force, energy, mass, and charge. As an **experimental science**, its goal is to understand the natural world.

▪ Matter	• change in the position of a body relative to a reference point.
▪ Motion	• refers to one of many different quantities, such as the electric one.
▪ Charge	• is anything that takes up space and has mass.

5. With the help of the table below, make your own definitions of PHYSICAL and CHEMICAL changes. Indicate with an X in the column whether the change described is physical or chemical.

	Physical change	Chemical change
It involves changes in the identity of substances.		
It does the change without changing the identity of substances.		
It produces new substances.		
It doesn't create anything new.		
It only changes the appearance not the chemical composition.		
It creates different substances.		
Change of state of a substance (such as solid to liquid).		
Physical deformation (cutting, denting, stretching, etc.)		
Burning something is a chemical reaction called combustion.		
It produces bubbles (gases), colour change or formation of a precipitation.		
Physical relocation (moving an object).		

Write a paragraph about the difference between a chemical and a physical change.

Decide whether the following changes are physical or chemical:

1. Drops of water collect on the inside of the window when it is very cold outside.
2. Food that is eaten is changed by the body and energy is released.
3. Fireworks when a football team wins a match.
4. Gasoline changes into a gas and burns as it enters the cylinder of a car engine.
5. A lemon out of the fridge for days.
6. A balcony made from iron.
7. The ice in a drink.

Physical change	Chemical change

Choose from the list of changes above:
Which one is a/an …?

- condensation?
- combustion?
- digestion?
- explosion?
- food decomposition?
- oxidation?
- fusion?

6. Below are some examples of physical and chemical changes but they have suffered from a physical process of cutting and mixing up. Work with your partner to match them. Then decide what kind of change they are.

A	If a piece of paper is cut up into small pieces, it is still paper.
B	If a piece of paper is burned, the substance (matter) from which paper was made gains new properties, and loses old ones (it becomes an absolutely new substance: ash).
C	You can try to mix sugar with water to dissolve sugar in the water. It does not change what it is; it still has the same properties.
D	If we bake a cake with flour, water, sugar, and other ingredients, new substances would appear.

1	Burning is a change called combustion.
2	The substance remains the same, so this is a change in the shape and size of the paper.
3	Chemical reactions occur in the baking process.
4	The water could be evaporated and sugar crystals would reappear.

7. In pairs think of a change (chemical or physical, it doesn't matter) and write a short description of it. Then read it aloud and let your classmates guess which kind of change it is.

We are going to describe ……..

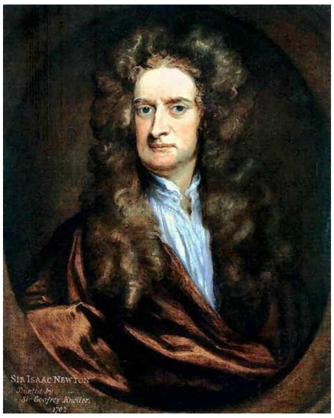
Description of the phenomenon

Description of the phenomenon	Hint <u>Object</u>: Egg water ice paper <u>Action</u>: Fry melt boil cut

It is a *physical*/*chemical* change because …………………..

8. Do some research … Remember to note the source.

- ✓ **Where does the word 'physics' come from? What does it mean?**
- ✓ **Here you have pictures of two important physicists. Look in the encyclopaedia and find out about them**



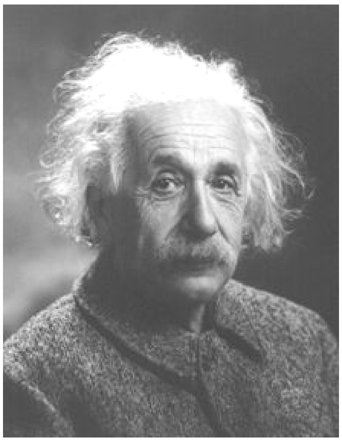
When was he born?

When did he die?

Which century does he belong to?

What was his nationality?

He is known because ….



When was he born?

When did he die?

Which century does he belong to?

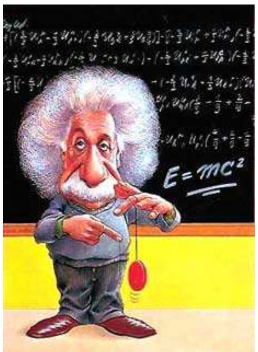
What was his nationality?

He is known because ….

Write a short report about the similarities and differences between them.

They both …. but …..
The main difference between them is that …
… is similar to ….. because …..
… is different from … because …
… compared with …., …

Which image is of Newton and which is of Einstein? Work in groups and describe both images.



9. We are going to study <u>Classical Mechanics</u> !!

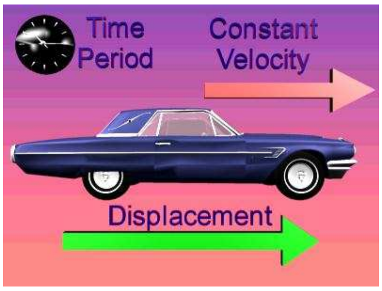
Classical Mechanics is a model of the physics of forces acting upon bodies.

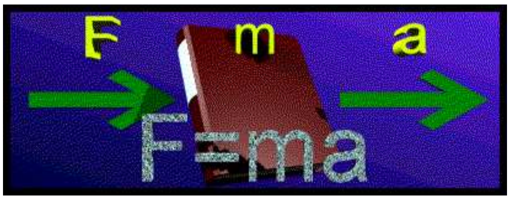
It is often referred to as "Newtonian mechanics" after Isaac Newton and his laws of motion. There are also special laws when you reach the speed of light or when physicists look at **atoms**. At very high speeds we need Einstein Physics.

Mechanics is subdivided into:

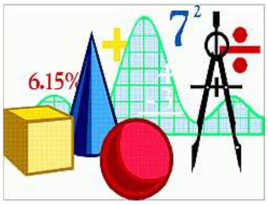
- <u>statics</u>, describes stationary objects ,
- <u>kinematics</u>, which describes objects in motion,
- <u>dynamics</u>, which describes objects subjected to forces.

Match each image with the part of the Mechanics they refer to:





Mathematics is the language in which Physics is formulated.



It is inevitable that mathematics is involved in physics. The level of mathematics in physics is low, so it will be helpful if you know some rudimentary algebra.
How to 'read' mathematics in English?
0.1 (nought) point one = 0,1 0,25 = 0.25 (nought) point two five
25,000 = 25 000 = 25.000 = 25 thousand
½ a half 1/3 a/one third ¼ a quarter 2/5 two fifths 1/8 an/one eighth

(2/5 x 3/8) **multiply** two <u>over</u> five **by** three <u>over</u> eight

Mathematical operators

+ plus	- minus	x times/multiplied by
: divided by	= equals	% per cent
3^2 three squared	5^3 five cubed	6^{10} six to the power of ten

Rounding

The following procedures are usually sufficient to round off significant figures:

- If the last significant digit on the right is less than 5, drop it.
  Example: 12,363 rounded to 4 significant figures is 12,36
- If the last significant digit is 5 or greater, drop it and increase the preceding digit by one.
  Example: 15,47 rounded to 3 significant figures is 15,5

Powers of Ten and Scientific Notation

Scientific notation is a method of saving time and space by counting zeros instead of writing them out. It is not really 'scientific' at all, but it is often used to describe things that are very large, such as the mass of the Earth ($6 \cdot 10^{22}$ kilograms), or very small, such as the mass of an electron ($9 \cdot 10^{-28}$ kilograms).

•Example: the average distance from the Sun to the Earth is 93,000,000 mi.
Using powers-of-ten notation, this can be written as

93.000.000 miles = 9,3 x 10^7 mi or $9,3 \times 10^7$ mi

(The symbol ^ is sometimes used to mean "raised to the power". So 10^2 is the same as 10^2 or "ten rose to the second power".)

Likewise, a very small number can be expressed using the powers-of-ten notation.

•For example, the thickness of a piece of paper is about 0.0001 m. This can be written as

0.0001 m = 1 x 10^-4 m or 1×10^{-4} m

Note that the exponent counts the number of spaces right or left of the first significant figure.

WORD SEARCH

PHYSICS	KINEMATICS	PHYSICALCHANGE	CHEMICALCHANGE	MOTION
MOVEMENT	COMBUSTION	SCIENCE	FORCE	VELOCITY
ACCELERATION	TIME	POSITION	SPEED	

K	N	M	W	F	P	I	W	K	J	F	Y	V	S	S	F
D	O	C	D	F	D	D	P	C	H	N	C	P	N	C	P
B	I	S	E	E	J	O	Z	C	O	K	A	H	V	L	Q
Y	T	C	L	B	C	Q	S	Y	D	I	N	Y	L	P	N
T	I	I	J	W	V	T	V	U	X	N	T	S	C	P	Z
I	S	E	N	P	R	B	D	E	M	E	M	I	K	T	M
C	O	N	N	O	I	T	S	U	B	M	O	C	U	M	O
O	P	C	Z	L	H	F	S	O	S	A	K	S	K	T	V
L	E	E	R	M	M	V	O	C	Y	T	F	O	R	C	E
E	E	G	N	A	H	C	L	A	C	I	S	Y	H	P	M
V	F	C	H	E	M	I	C	A	L	C	H	A	N	G	E
B	H	S	O	P	Z	Z	I	T	K	S	L	J	R	Q	N
E	F	C	J	C	N	O	K	U	Q	C	Z	D	G	I	T
M	F	O	F	J	X	N	K	P	L	V	Z	X	O	K	R
I	D	N	O	I	T	O	M	S	P	E	E	D	D	Z	W
T	N	O	I	T	A	R	E	L	E	C	C	A	T	Q	V

Write the definition of 10 words from above.

Word Scramble

1) SCISYHP

2) OMTOIN

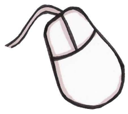
3) OEMNMTVE

4) ITCKMAISNE

5) CCNEIES

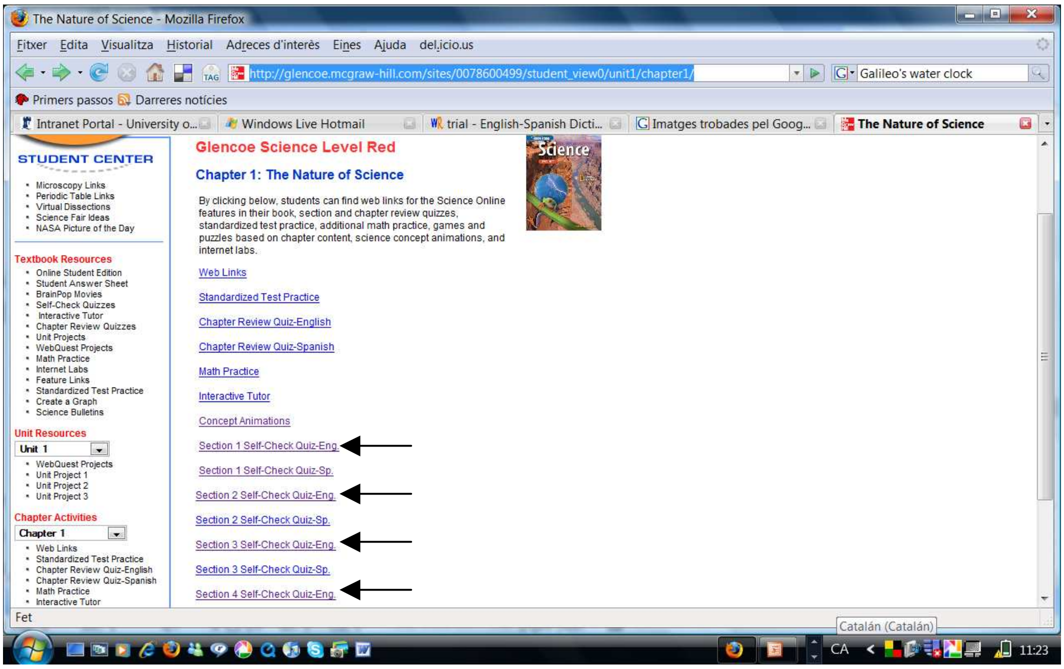
*Answers: *
1) PHYSICS
2) MOTION
3) MOVEMENT
4) KINEMATICS
5) SCIENCE

ICT Activity



Go to the website below:

http://glencoe.mcgraw-hill.com/sites/0078600499/student_view0/unit1/chapter1/



And now solve <u>Section 1</u>, <u>Section 2</u>, <u>Section 3</u> and <u>Section 4</u> Self-Check Quiz-English

http://glencoe.mcgraw-hill.com/sites/0078600499/student_view0/unit1/chapter1/section_1_self-check_quiz-eng_.html

http://glencoe.mcgraw-hill.com/sites/0078600499/student_view0/unit1/chapter1/section_2_self-check_quiz-eng_.html

http://glencoe.mcgraw-hill.com/sites/0078600499/student_view0/unit1/chapter1/section_3_self-check_quiz-eng_.html

http://glencoe.mcgraw-hill.com/sites/0078600499/student_view0/unit1/chapter1/section_4_self-check_quiz-eng_.html

LESSON 2 PHYSICAL MAGNITUDES

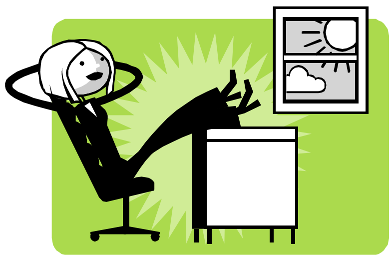
- **Motion**
- **Referent point**
- **Trajectory and types of trajectories**
- **Quick definition of position, speed and acceleration**
- **International System**
    - **Basic Units**
    - **Derived Units**
- **Conversion factors**
- **Speed and velocity**
- **Quizzes**
- **Lab activity**

Motion, Motion Everywhere!

Everything in the universe moves. It may only be a small amount and very slow, but movement does happen. Don't forget that even if you are standing still, the Earth is moving around the Sun and the Sun is moving around our galaxy. The movement never stops.

1. Is there motion in these pictures? Why?

What are these people doing?



2. Is there motion in this picture? Why?

Answer the following questions in pairs:

- Does the ship move? Is it changing its position?
- If you are sunbathing on a ship, are you moving? Is there motion?
- If you are pulling the rope of the sail, are you moving?

Describe the picture using the following sentences:

In the picture we can see ……..

There *is/isn't* motion because they are …….

The women are …. so they *move/don't* move.

The man *standing up/pulling the rope* is/isn't moving because he *changes/doesn't* change position.

3. Imagine you are sunbathing on the beach and you are watching the boat sailing in the sea, then …

- Are the women moving? Why?
- Are you moving? Why?

In Physics, **motion** means a continuous <u>change in the position</u> of a body in relation to a reference point, as measured by a particular observer in a particular <u>frame of reference</u>.

Let's check if you understand it …

4. Fill in the chart whether there is motion or not:

Observer	Black sailor	You on the coast	An astronaut on the moon
Are the women moving?			
Are you moving?			

An object is **in motion when its distance from another object changes**. Whether the object is moving or not depends on your point of view.

For example,

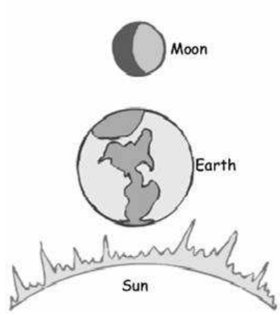
- A woman riding a bus, is she moving in relation to the seat she is sitting on?
- But is she moving in relation to the buildings the bus passes by?

A **<u>reference point</u>** is a place or object used for comparison to determine if something is in motion.

An object is in motion if it changes position in relation to a reference point. You assume that the reference point is stationary, or not moving.

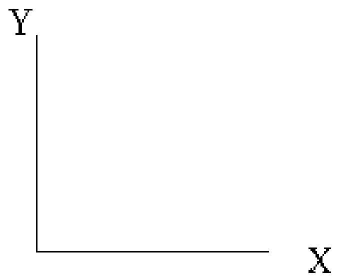
5. Let's check again …

- Do the women sunbathing move in relation to the ship?
- Do the women move in relation to the earth?
- Do you (sunbathing on the coast) move in relation to the earth?
- Do you move in relation to the moon (the observer would be an astronaut)?
- Is motion or movement relative (it depends on the observer) or absolute (it doesn't depend on the observer)?



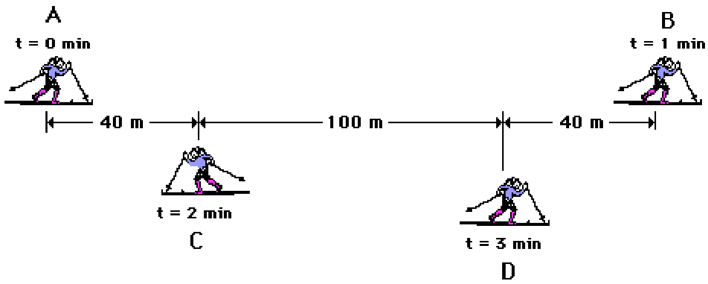
Kinematics studies how the position of an object changes with time.
Position is measured with respect to a set of coordinates (x and y axes).
Draw a fly in the position (3,2):

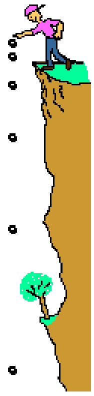
(3,2) means **x=3** and **y=2**



Cartesian Coordinate System

But to make movement easier we will only study motion in one dimension, whether **x axis** or **y axis**. Look at the images and decide which one is **X-motion** or **y-motion**.



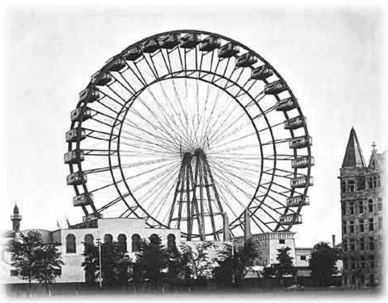


We live in a dynamic world where everything is in motion, or so it seems. But not everything is moving the same way.

- Some things move from one place to another describing a straight line. LINEAR MOTION
- Some things move from one place to another describing a curve. CURVY MOTION
- Some things move from one place to another describing a parabola. PARABOLIC MOTION
- Other things go round and round in a rotational motion describing a circumference. CIRCULAR MOTION
- Still other things are stationary, stable for a time. They are immobile or still. They rest. MOTIONLESS.

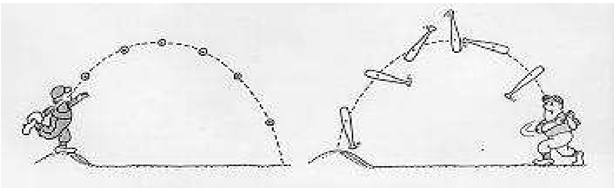
6. The trajectory is the path an object follows when it moves.
What is the trajectory of the moving object in each case?

(a) (b) (c) (d)



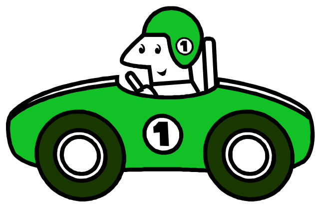
7. Work in pairs and decide what kind of trajectory each picture represents and why.

The In the	first second third fourth	image	represents … we can see …	because	the trajectory is a ….. it describes a … it moves describing a … it means to rest.




Learn about Position, Velocity, and Acceleration

If you want to understand how an object (like a car, ball, person, or rocket) moves, you have to understand three things about what it means "to be moving." These three things "stick" to any object that moves, and are numbers that scientifically describe just how an object's motion is working. These three things are:



Position. This is precisely *where* an object is located.
Speed or velocity. Precisely *how fast* an object is moving.
Acceleration. Precisely *how fast* an object's speed is changing.

8. <u>Units</u>: What are they good for?

If somebody tells you to walk 12, will you know how long you have to walk?
What will you ask?
OK, maybe you suppose you have to walk 12 metres. Would you walk 12 kilometres?
We all know how long one metre is, so it is easy for you to walk 12 metres.

This is why we are going to use the metric system: the **International System of Units (SI).**
There are 2 kinds of units: **Basic Units** and **Derived Units.**

a. <u>Basic Units</u>

- <u>Distance</u>: the unit that we measure distance in is metres. In most cases, we will use "m" for short.
- <u>Mass</u>: the unit that we measure mass in is kilograms. "kg" for short.
- <u>Time</u>: the unit that we measure time in is seconds. "s" for short.

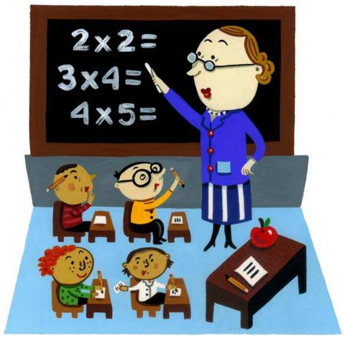
8. Fill in the grid:

	Units	SI Unit	SI Unit for short
o <u>distance</u>			
o <u>Mass</u>			
o <u>Time</u>			

b. <u>Derived Units</u>

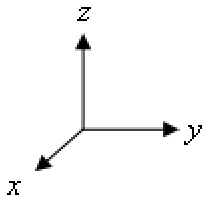
Derived Units derive from Basic Units. Let's see an example:

Which is the unit for area?



- How can you calculate the area of your classroom?
- What do you need to know?

(x axis) Length?
(y axis) Width?
(z axis) Height?



- The area of a rectangle is given by the formula: length · width (you have to multiply length by width).
- Which is the unit of length?
- And of width?
- Since length and width would just be measured in metres, the result is that the area has units of "m · m", i.e. "m^2". The unit of the area is derived because it derives from the measurement of 2 distances: length and width.

- And which unit describes the <u>volume</u> of your classroom? Work in pairs and write the procedure. Then we will check it in plenary.

- o **<u>Speed</u> is defined as distance over time.**
  The unit for distance is …………………. and the unit for time is ……….

The formula for speed is:

Then the unit for speed is …………………Which is the unit for velocity? ……………

Learn the difference between <u>speed</u> and <u>velocity</u>.

Imagine somebody tells you to take your motorbike and ride at 50Km/h. What additional information do you need?

You need to know a <u>direction</u> when we are talking about velocity. Therefore, both speed and velocity have the same units, namely "m/s".

9. Fill in the grid using the information below:

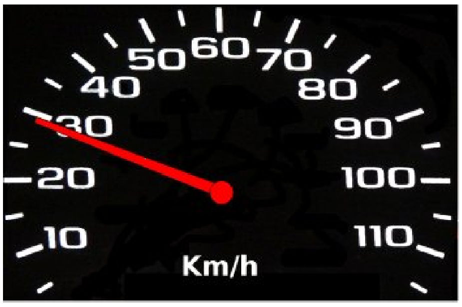
m/s^2	Newton(N)	second(s)	Kg/m^3	metre(m)
m/s	Joules(J)	Pascal(Pa)	m/s	

	SI Unit
Force	
Energy	
Acceleration	
Density	
Time	
Distance	
Speed	
Velocity	
Pressure	

Hint		
F = m·a	**a =** $\frac{v}{t}$	**d =** $\frac{m}{V}$

Converting Units

Look at the car speedometer and describe it:



- What is a speedometer?
- What does it measure?
- What is the current speed of the car? (more or less)
- Which unit is it?
- Is it a SI Unit? Why?
- How can you transform it into a S.I. Unit?

It is not easy, is it? Let's try to use **conversion factors**:

1 kilometre = ……… metres ⟷ conversion factors $\frac{1000m}{1km}$ or $\frac{1km}{1000m}$

1 hour = …….. minutes = ……… seconds ⟷ conversion factors $\frac{.....h}{.....s}$ or $\frac{.....s}{.....h}$

Converting units is not a hard thing to do. In fact, it really just involves multiplying and dividing. The procedure we follow here will be the general procedure used in converting units.

"The conversion factor basically tells us how to convert one unit into another."

<u>Example 1</u>: Convert 3,5 km into metres.

$$3{,}5\ \cancel{km}\cdot\frac{1000m}{1\cancel{km}} = 3{,}5\cdot 1000\ m\ \ \boxed{3.500\ m}\ =$$

<u>Example 2</u>: Convert 200 m into kilometres.

$$200\ m\cdot\frac{...............}{...............} = …………km\ = \boxed{…………..km}$$

Example 3: Convert 20 minutes into seconds.

$$20\ \text{min} \cdot \frac{\text{................}}{\text{................}} = \text{............}\ s = \boxed{\text{.............s}}$$

Example 4: Convert 1,5h into seconds.

$$1{,}5\ h \cdot \frac{\text{................}}{\text{................}} = \text{............}\ s = \boxed{\text{.............s}}$$

Example 5: Convert 1800 s into hours.

$$1800\ s \cdot \frac{\text{................}}{\text{................}} = \text{............}\ h = \boxed{\text{.............h}}$$

Example 6: Convert 90 km/h into m/s.

$$90\ \text{km/h} \cdot \frac{1000\text{m}}{1\text{km}} \cdot \frac{1\text{h}}{3600\text{s}} = \frac{90 \bullet 1000\text{m}}{3600\text{s}} = \boxed{25\ \text{m/s}}$$

Example 7: Convert 30 km/h into m/s.

$$30\ \text{km/h} \cdot \frac{\text{.............}}{\text{............}} \cdot \frac{\text{............}}{\text{.............}} = \frac{\text{............}m}{\text{............}s} = \boxed{\text{.............m/s}}$$

Example 8: Convert 20 m/s into km/h.

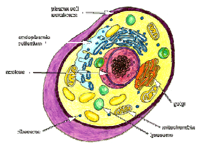
SI Prefixes

Number	Prefix	Symbol	Number	Prefix	Symbol
10^{1}	deka-	da	10^{-1}	deci-	d
10^{2}	hecto-	h	10^{-2}	centi-	c
10^{3}	kilo-	k	10^{-3}	milli-	m
10^{6}	mega-	M	10^{-6}	micro-	u (greek mu)
10^{9}	giga-	G	10^{-9}	nano-	n
10^{12}	tera-	T	10^{-12}	pico-	p
10^{15}	peta-	P	10^{-15}	femto-	f
10^{18}	Exa-	E	10^{-18}	atto-	A
10^{21}	zeta-	Z	10^{-21}	zepto-	Z
10^{24}	yotta-	Y	10^{-24}	yocto-	Y

10. Convert the following Units into SI Units using the table above (when necessary):

a. speed of light 300.000 km/s

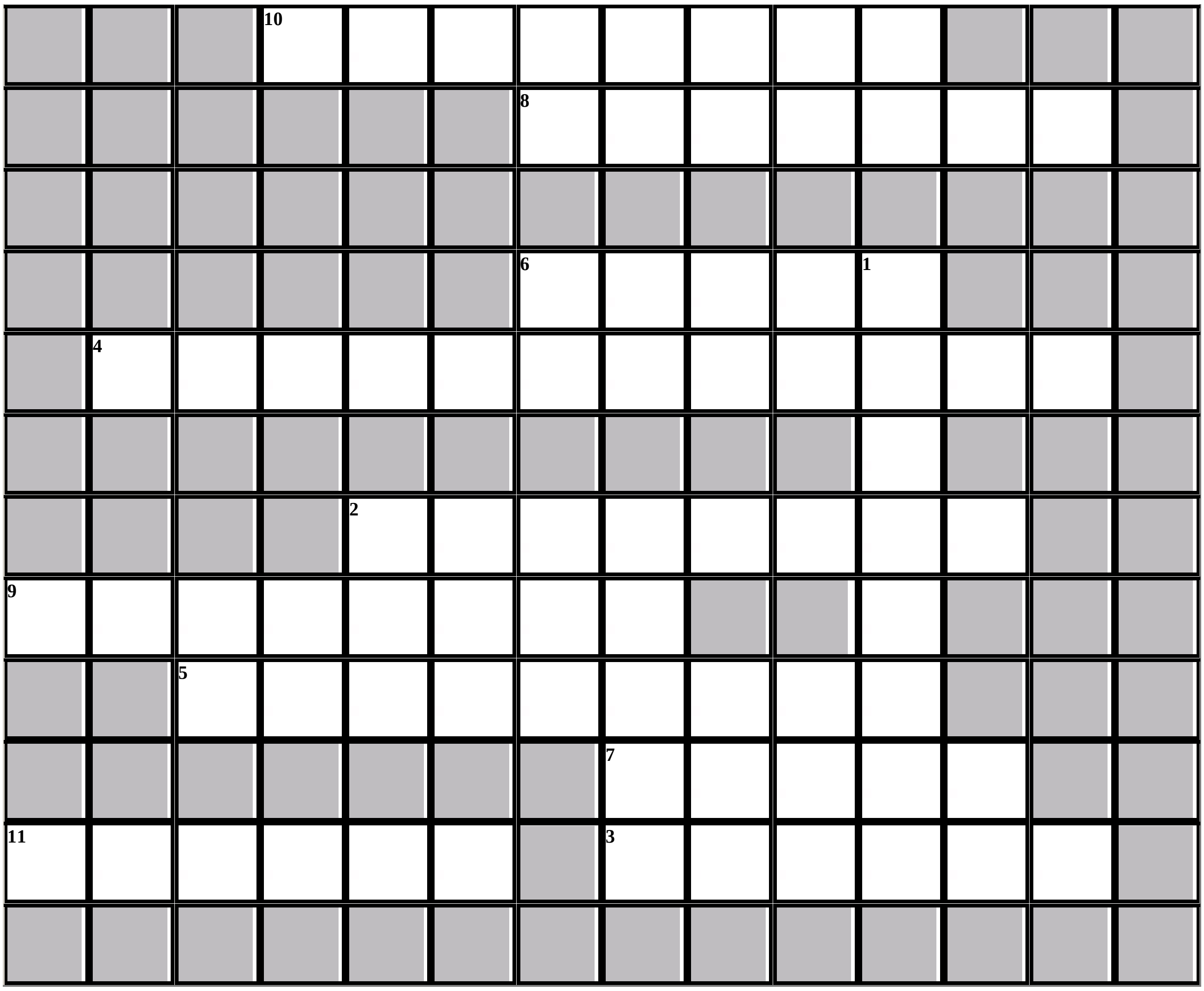
b. a typical cell size is 10 µm



c. a typical cell mass is 1 ng (nanogram)

d. 3 MW (Megawatt)

11. Complete the puzzle.



velocity   distance   meters   acceleration
direction   speed   force   rougher
friction   movement   motion

Down

1. Average speed can be calculated by dividing total ____ by total time.

Across

2. A measure of both the speed and direction of a moving object.
3. The SI unit for measuring speed is ____ per second.
4. The rate at which velocity changes.
5. The velocity of an object changes as the speed or ____ of the object changes.
6. A measure of how fast something moves over a distance.
7. An object that is in motion will continue to be in motion unless a ____ acts on it to change its motion.
8. The ____ the surface of one object touching another, the greater the friction between the surfaces.
9. The force of ____ opposes the motion of two objects that are rubbing against one another.
10. Speed measures the rate of ____ of an object.
11. A change in the position or place of something over time in comparison to a reference point.

12. Circle the correct word.

1.	motoon	mootion	motoin	motion
2.	gravehtee	gravuhtea	gravity	grevity
3.	frictoi	frictoin	fricteon	friction
4.	vuhlosuhte	velocity	vuhlosuhtea	veloccity
5.	megnuhtihzuhm	magnitism	magnetism	megnetism
6.	work	wuk	werk	wor
7.	speed	spaed	speedd	spead
8.	mos	mass	maass	maas
9.	niwten	newtan	nootun	newton
10.	forcee	force	foorce	forci
11.	matter	metter	mattre	mettre
12.	acciluratoin	acceleration	ecceleration	acceleratoin
13.	inirtia	inertia	inertea	inertai
14.	joo	joule	jouli	juole
15.	wayt	weyt	weight	wweight
16.	balane	belance	balance	bilanci

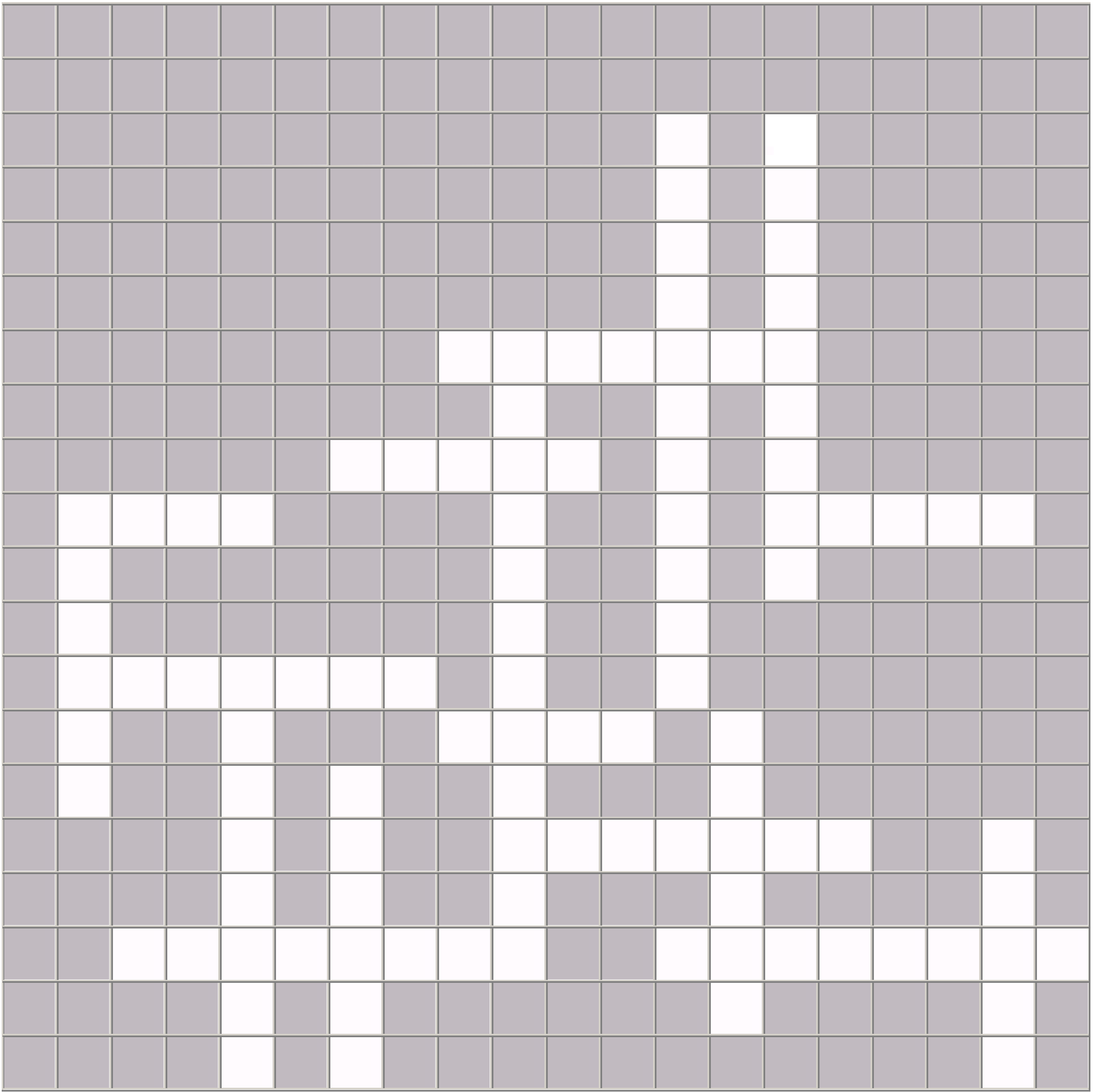
13. Match each definition with a word.

Acceleration	force	motion	speed	Newton	weight
Magnetism	gravity	mass	velocity	inertia	

1. The unit of work in the metric system. **<u>joule</u>**	2. The amount of matter that an object has. ________________
3. A measure of the force of gravity on an object. ________________	4. A force that pulls objects towards each other. ________________
5. A measure of how fast something moves over a distance. ________________	6. A measure of both the speed and direction of a moving object. ________________
7. The natural force produced by a magnetic field. ________________	8. The tendency of an object to resist a change in motion. ________________
9. The rate at which velocity changes. ________________ 11. A unit that is a measure of force. ________________	10. A change in the position or place of something over time in comparison to a reference point. ________________ 12. A device used for measuring mass. ________________

14. Forces and Motion

Fill all the words into this puzzle.
If you don't know the meaning of some of them, ask your teacher or look them up.



VELOCITY	SPRINGSCALE	BALANCE	WORK
INERTIA	MOMENTUM	FRICTION	FORCE
MOTION	SPEED	WEIGHT	MAGNETISM
ACCELERATION	JOULE	GRAVITY	NEWTON
MASS			

15. Select the definition that most closely defines the given word.

1. **motion**
   - (A) The natural force produced by a magnetic field.
   - (B) A measure of the force of gravity on an object.
   - (C) A device used for measuring weight.
   - (D) A change in the position or place of something over time in comparison to a reference point.

2. **Friction**
   - (A) A unit that is a measure of force.
   - (B) The unit of work in the metric system.
   - (C) Energy in the form of a push or a pull.
   - (D) A force that opposes motion between two surfaces that are touching.

3. **Speed**
   - (A) A measure of how fast something moves.
   - (B) A measure of the amount of force needed to move an object a certain distance.
   - (C) The rate at which velocity changes.
   - (D) A measurement of the length of something.

4. **inertia**
   - (A) A device used for measuring mass.
   - (B) A force that pulls objects towards each other.
   - (C) A measure of both the speed and direction of a moving object.
   - (D) The tendency of an object to resist a change in motion.

5. **joule**
   - (A) A measure of how fast something moves over a distance.
   - (B) The natural force produced by a magnetic field.
   - (C) A device used for measuring weight.
   - (D) The unit of work in the metric system.

6. **mass**
   - (A) A measure of the force of gravity on an object.
   - (B) The rate at which velocity changes.
   - (C) The amount of matter that an object has.
   - (D) A force that pulls objects towards each other.

7. **magnetism**
   - (A) The natural force produced by a magnetic field.
   - (B) A force that opposes motion between two surfaces that are touching.
   - (C) A device used for measuring mass.
   - (D) A unit that is a measure of force.

8. **motionless**
   - (A) Energy in the form of a push or a pull.
   - (B) Object with no motion.
   - (C) The unit of work in the metric system.
   - (D) The tendency of an object to resist a change in motion.

9. **acceleration**
   - (A) Energy in the form of a push or a pull.
   - (B) A measurement of the motion of something.
   - (C) The unit of work in the metric system.
   - (D) The rate at which velocity changes.

10. **velocity**

(A) The rate at which velocity changes.

(B) A measure of both the speed and direction of a moving object.

(C) A measure of how fast something moves over a distance.

(D) A force that opposes motion between two surfaces.

Lab Report

Title: **Taking measure of average speed**

Aim:
We want to calculate the average speed when we walk the dog.

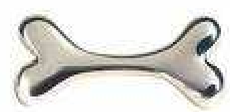
Material:
Tape measure, calculator and stopwatch

Procedure:

1. First we measure a distance of 3 metres with the tape measure.
2. Then we use the stopwatch to measure the time taken.
3. We calculate the average speed dividing the distance walked by the time taken to travel that distance.

Results:
Write down the data and the calculation
Distance =
Time =

Speed = ________ =



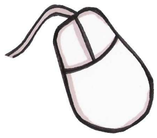
(Be careful: express the result properly!)

Conclusions:

This experiment has shown that when we walk our dog, the average speed is ……….

Questions:

1. If we are late for school, the average speed will be *slower/quicker*.
2. When we drive a car, the speed we see on the speedometer is the *average/instantaneous* speed.
3. Convert the average speed into *Km/h* using conversion factors.
4. Imagine your alarm clock didn't ring and you are late for school. Repeat the experience walking in a hurry.



ICT Activity

Go to the website below and solve the Self-Check Quiz. Then email the results to your teacher.

Section 1: What is motion?

http://glencoe.mcgraw-hill.com/sites/0078617707/student_view0/chapter1/section1/self-check_quiz-eng_.html

LESSON 3 LANGUAGE OF KINEMATICS

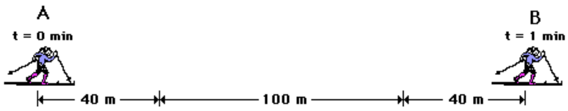
- Vectors and scalars
- Distance and displacement
- Average speed and instantaneous speed
- Acceleration
- Introduction to the use of data tables, ticker tape diagrams and equations
- Introduction to Uniform Motion and Uniformly Accelerated Motion
- Crossword puzzle

Describing Motion

Kinematics is the science of describing the motion of objects using words, diagrams, numbers, graphs, and equations. The goal of any study of kinematics is to develop sophisticated mental models which serve to describe (and ultimately, explain) the motion of real-world objects.

- **Describing Motion with Words.**
- **Describing Motion with Diagrams.**
- **Describing Motion with Equations.**
- **Describing Motion with Graphs.**
  - **Position vs. Time Graphs**
  - **Velocity vs. Time Graphs**

1. Link each word with its representation:



$$\text{Average Speed} = \frac{\text{Distance Traveled}}{\text{Time of Travel}}$$

An object moving with a constant speed of 6 m/s

Time (s)	Position (m)
0	0
1	6
2	12
3	18
4	24

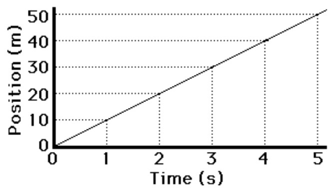
Diagram

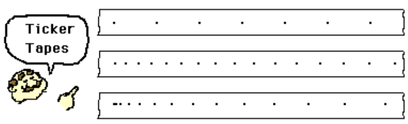
Graph

Equation

Data table

Ticker Tape Diagram





This lesson will investigate the words used to describe the motion of objects – that is, the **language of kinematics**. The words listed below are often used to describe the motion of objects.

2. Circle the words you still don't know.

Vectors, scalars, distance, displacement, velocity, speed, acceleration, time

Scalars and Vectors

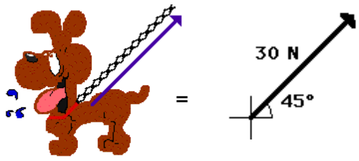
Physics is a mathematical science.
The motion of objects can be described by words - words such as distance, displacement, speed, velocity, and acceleration.
These mathematical quantities which are used to describe the motion of objects can be divided into two categories: a **vector** or a **scalar**.

- **Scalars** are quantities which are fully described by a magnitude alone (only value and no direction).
  For example: a distance of 5m (there is no direction)
- **Vectors** are quantities which are fully described by both a magnitude and a direction.
  For example: a distance of 5m, North (there is a direction)

3. Check Your Understanding

To test your understanding of this distinction, consider the quantities listed below. Categorize each quantity as being either a vector or a scalar.

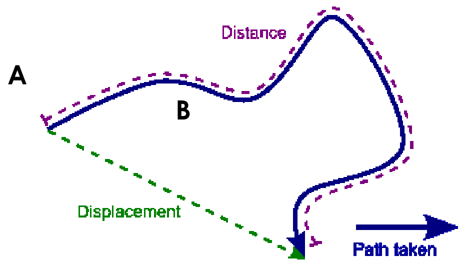
a). velocity of 30 m/s, East …………	b). Temperature of 20 degrees Celsius …………
c). energy of 4000 Calories…………	d). Speed of 30 m/s …………
e). time of 3 min …………	f). Force of 30N Northeast 45º …………



Distance and Displacement

4. Look at the picture and match each word with its definition:

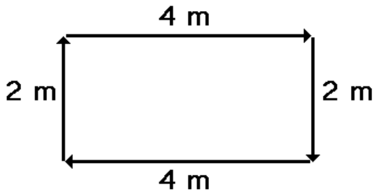
Origin = Starting position = A
End = Finishing position = B



- **Trajectory**
- **Displacement**
- **Distance**

- path traced by a moving object
- change of the position of a moving object from one position A to another position B.
- expresses the length travelled by the moving object.
- It is the vector that specifies the position of a point in reference to an origin.
- It is a scalar quantity.

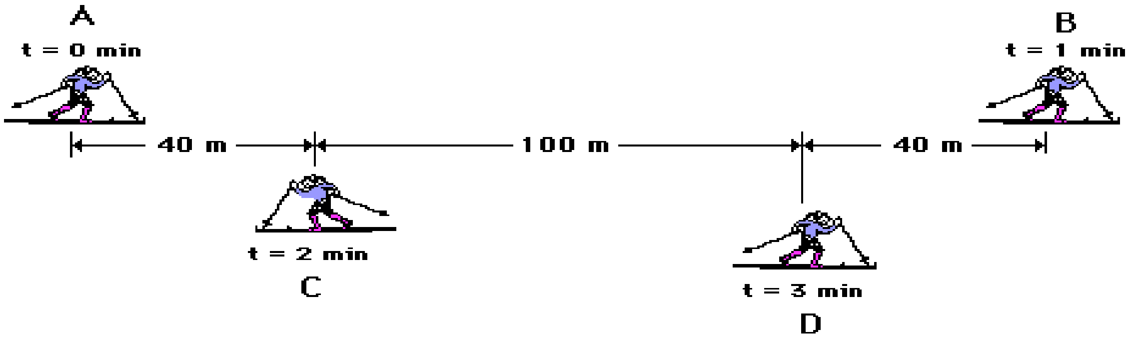
5. To test your understanding, consider the motion in the diagram below. A student walks 4 metres East, 2 metres South, 4 metres West, and finally 2 metres North.



Work in pairs.

- Write A at the initial point.
- What is the total distance he/she has walked?
- Write B at the final point.
- What is the displacement?
- Why is there no displacement?

6. The diagram below shows the position of a cross-country skier at various times. At each of the indicated times, the skier turns around and reverses the direction of travel. In other words, the skier moves from A to B to C to D. Use the diagram to determine the distance travelled by the skier and the resulting displacement during these three minutes.



	Time taken (s)	Distance travelled (m)	Displacement (m) Rightward / Leftward	Average speed (m/s)
From A to B				
From B to C				
From C to D				
From A to D				

Write a description of each way like the example given below. Work in pairs.

From A to B, the skier travels a distance of 180m in 1minute (60s). The displacement is the difference between the final position and the initial position: 180m – 0m = 180m right. We calculate the average speed dividing the distance by the time:

$$\text{speed} = \frac{distance}{time} = \frac{180m}{60s} = \mathbf{30\ m/s}$$

From B to C, …

From C to D, …

From A to D, ….

7. Check Your Understanding

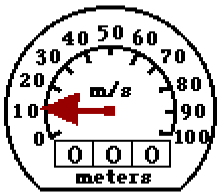
It is 8 o'clock in the morning; you go to school on foot. How far do you live from school?
At 2 pm you finish school and go home on foot.
Draw a diagram to show it as in exercise 6. Then explain it to your partner.

	▪ From home to school, I walk ……. metres and it takes me …… minutes. I walk the same distance and time to come back home from school. ▪ So I walk a distance of ……… but my displacement is …….. because I finish where I started.

Average speed and instantaneous speed

Since a moving object often changes its speed during its motion, it is common to distinguish between the **average speed** and the **instantaneous speed.**

- To describe the motion we need to know the distance travelled by the moving element and the time spent to move along this distance. To calculate the **average speed**, we simply divide the distance of travel by the time of travel.
- The **instantaneous speed** is the speed which the speedometer reads at any given instant in time.



8. Read the following sentences in pairs and write them down in the grid.

simply divide the distance of travel by the time of travel.
speed at any given instant in time.
It can't be calculated.

Average Speed	Instantaneous Speed

Constant Speed and changing speed

Moving objects don't always travel with erratic and changing speeds. Occasionally, an object will move at a steady rate with a constant speed. That is, the object will cover the same distance every regular interval of time.

- If the speed is **constant**, then the distance travelled every second is the same.
- An object with a **changing** speed would be moving a different distance each second.

9. The data tables below represent objects with constant and changing speeds. Decide which one is an object moving with: a <u>constant speed of 6m/s</u> or a <u>changing speed</u>.

Time (s)	Position (m)
0	0
1	6
2	12
3	18
4	24

Time (s)	Position (m)
0	0
1	1
2	4
3	9
4	16

I think the first one represents ……. because …

10. Go back to exercise 5 and determine the average speed and the average velocity if we know the student took 24 seconds to walk the distance. Then prepare your plenary explanation.

$$s = \frac{\text{distance}}{\text{time}}$$

$$v = \frac{\text{displacement}}{\text{time}}$$

To calculate the average speed, I have divided …… by ….. and I've got the result of ……
To calculate the average speed, I have divided …… by ….. and I've got the result of ……

Acceleration

11. Identify the data given in the car advertisement. What do they mean?

Top Speed 289 km/h / 180 mph
0-60 mph Acceleration 5.0 s

Do you think the acceleration data is correctly given? Why?

In fact, acceleration has a meaning quite different from the meaning of sports announcers: "**An object is accelerating if it is changing its velocity**".
If an object is not changing its velocity, then the object is not accelerating.

12. Is the data table below representative of an accelerating object? Discuss it in pairs.

Time (s)	Velocity (m/s)
0	0
1	10
2	20
3	30
4	40
5	50

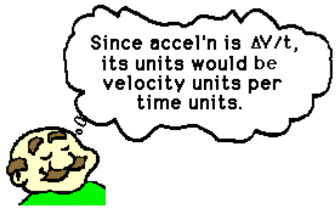
- Is the velocity changing with respect to time?
- Is the velocity changing by a constant amount? ……m/s in each second of time.
- Is this object accelerating?
- How much is the acceleration?(Be careful with the UNIT)

13. The data tables below represent motions of objects with a <u>constant acceleration</u> and with a <u>changing acceleration</u>. Decide which is each one and why?

Time (s)	Velocity (m/s)
0	0
1	4
2	8
3	12
4	16

Time (s)	Velocity (m/s)
0	0
1	1
2	4
3	5
4	7

The acceleration of an object is calculated using the equation:



$$\textbf{acceleration} = \frac{\Delta\textbf{velocity}}{\textbf{time}} = \frac{\textbf{v} - \textbf{v}_0}{\textbf{t}}$$

Δ (the Greek letter delta): is used in all kinds of mathematical descriptions to denote the change in a quantity, the difference: *final value – initial value*.

V = final velocity

V_0 = initial velocity

Δv = final velocity - initial velocity

This equation can be used to calculate the acceleration of the object whose motion is represented by the velocity-time data table from exercise 12. The velocity-time data in the table shows that the object has an acceleration of 10 m/s^2. The calculation is shown below:

$$\textbf{a} = \frac{\Delta\textbf{velocity}}{\textbf{time}} = \frac{\textbf{v} - \textbf{v}_0}{\textbf{t}} = \frac{50-0}{5} \Longrightarrow a = 10 \text{ m/s}^2$$

14. Check Your Understanding. Work in pairs.

To test your understanding of the concept of acceleration, consider the following problems and their corresponding solutions. Use the equation to determine the acceleration for the two motions below.

Practice A

Time (s)	Velocity (m/s)
0	0
1	2
2	4
3	6
4	8

Practice B

Time (s)	Velocity (m/s)
0	8
1	6
2	4
3	2
4	0

- Is there any difference between the acceleration for the two motions?
- What does a negative acceleration mean?

15. Calculate the acceleration of a car the moves from rest (0 m/s) to 10 m/s in 5 seconds.

Data

V_0 =

V_f =

t =

a = ?

equation

a =

LINEAR MOTION

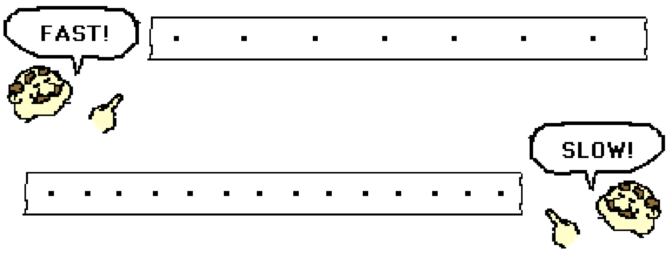
This is the simplest type of motion studied in Physics. The **trajectory** of this motion is a **straight line.** We will study 4 types of LINEAR movement:

Linear Motion

- **Constant speed** (**a = 0**) **Uniform Motion**
- **constant acceleration (a≠0)**
  - Speed increases (a>0)
  - Speed decreases (a<0)
  - Free Fall (g=9,8m/ s²)

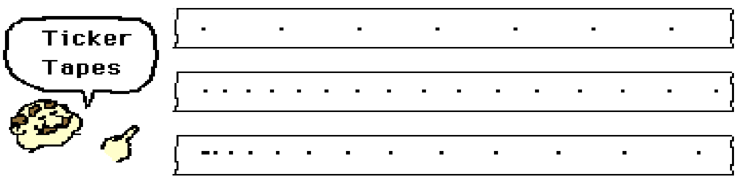
16. Look at the ticker tape diagrams and discuss which type of motion they represent:

a. The distance between dots on a ticker tape represents the object's position change during that time interval.



The *first* / *second* ticker tape diagram represents a *fast-moving* / *slow-moving* object because the distance between the dots is *large* / *small*.

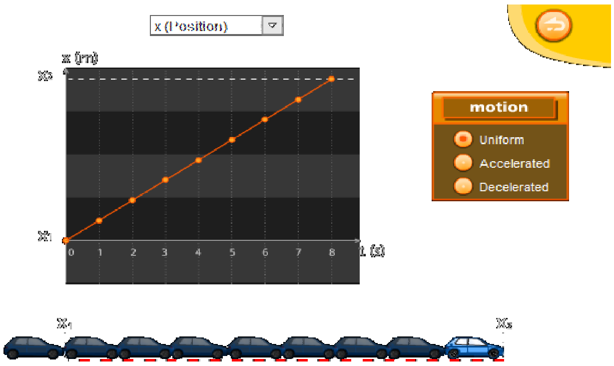
b. Ticker tapes for objects moving with a constant velocity and an accelerated motion are shown below.



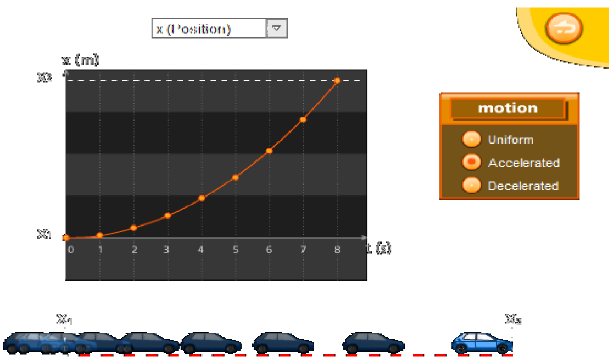
In the *first/second/third* diagram, the object is moving with a *constant velocity* / *changing velocity (accelerating)*. A *constant/changing* distance between dots indicates a *changing/constant* velocity and therefore there is *no* / *an* acceleration. If the distance between the dots increases fast, then the object has a *smaller/bigger* acceleration.

c. Draw the ticker tape for an object moving with a changing decreasing velocity (decelerating). Describe it.

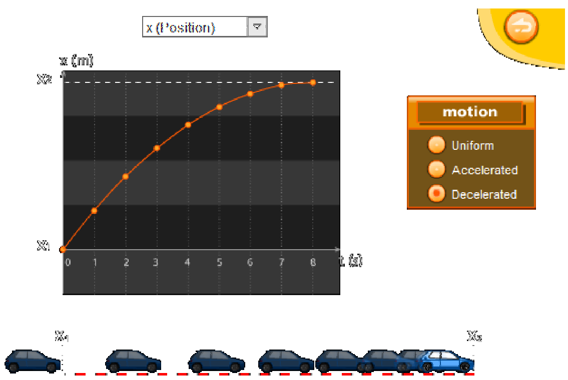
17. Look at the pictures carefully, answer the questions and then explain them in plenary. (Look at the PowerPoint slides if you can't see them very well).



- Is there motion?
- What kind of motion? Why?
- Which is the variable and unit in the X axis?
- Which is the variable and unit in the y axis?
- What kind of graph is there?(a straight line or a curve)
- Is the speed constant or changing?
- Is there acceleration? Why?
- Write down the conclusion of the plenary discussion:

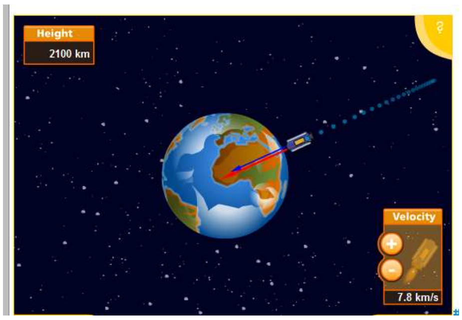


- Is there motion?
- What kind of motion? Why?
- Which is the variable and unit in the X axis?
- Which is the variable and unit in the y axis?
- What kind of graph is there?(a straight line or a curve)
- Is the speed constant or changing?
- Is there acceleration? Why?
- Write down the conclusion of the plenary discussion:



- Is there motion?
- What kind of motion? Why?

- Which is the variable and unit in the X axis?
- Which is the variable and unit in the y axis?
- What kind of graph is there?(a straight line or a curve)
- Is the speed constant or changing?
- Is there acceleration? Why?
- Write down the conclusion of the plenary discussion:



This is a satellite falling free down to the Earth.

- Is there motion?
- What kind of motion? Why?

- Is the speed constant or changing?
- Is there acceleration? Why?

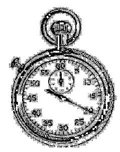
- Write down the conclusion of the plenary discussion:

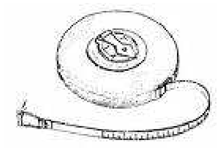
Lab Activity Describing Motion – Speed

Do the practical and then write your own report.

Purpose: To practice calculating speed.
Background Information: The speed of an object is determined by the amount of time it takes the object to move a particular distance. Another word for the distance an object moves is **displacement**. Speed can be calculated by using the formula S=D/T. Where D is the distance an object travelled and T is the time it took the object to travel that distance.

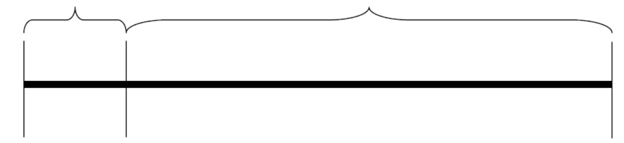
Materials:
Tape measure Stopwatch Toy car Calculator





Procedure:

1. Use the tape measure to make a 1,5 m straight track for your car on the ground. Label the starting line, timing line, and finish line as shown below:



2. Put the toy car at the starting line. Start the car.
3. Begin timing when the car crosses the Time Line.
4. Stop timing when the car crosses the Finish Line.
5. Record your data.
6. Repeat for a total of 5 trials.

Data:

Trial	Time in seconds
1	
2	
3	
4	
5	

Average time (s) = …………………..

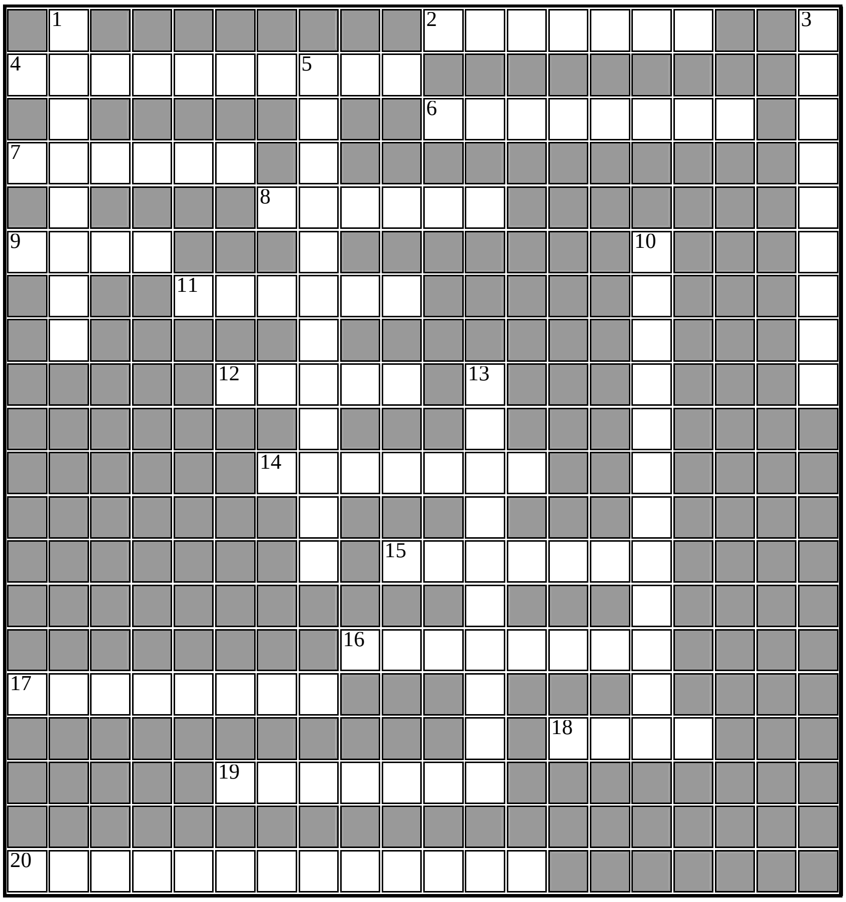
Calculate the speed of your car:

Speed = D/T

Questions:
<u>Answer using complete sentences.</u>
1. Why do you need to repeat your measurements (do more than one trial)?
2. Why did you let the car move for 0,5 m before starting to time?
3. Predict how many seconds it will take your car to move 150 cm. Test your prediction. Record your results.
4. Predict how many seconds it will take your car to move 75 cm. Test your prediction. Record your actual results.
5. Pick a TIME in seconds for your car to travel.
- **a.** Predict the DISTANCE your car will travel in that amount of time.
- **b.** Test your prediction. Describe what you did to test your prediction:
- **c.** How did your prediction compare with the actual distance the car moved?

Conclusions:
<u>Write your own conclusions.</u>

Your crossword puzzle



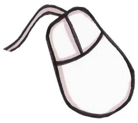
ACROSS

2. A movement with a constant speed.
4. To reduce the speed.
6. If speed is always the same, it is ...
7. It's a synonym of movement.
8. Velocity is not a scalar, it is a ....
9. It's a scalar quantity measured by a stopwatch.
11. If the trajectory is a straight line, motion is ...
12. A ... is a way to describe motion using coordinates.
14. A ticker tape ...
15. The ... speed means how fast we drive.
16. It means how far an object goes.
17. If the speed is not constant, it's ...
18. Information given in a numerical exercise.
19. Its acceleration is 9,8 m/s^2.
20. The ... speed is given by the speedometer.

DOWN

1. How fast an object moves giving a direction.
3. Action of doing a calculation.
5. Change in the speed.
10. Change of the position of a moving object.
13. The path a moving object follows is its ...

ICT Activity
Go to the websites below and solve the Self-Check Quiz.



http://glencoe.mcgraw-hill.com/sites/0078600499/student_view0/unit2/chapter5/section_1_self-check_quiz-eng_.html
http://glencoe.mcgraw-hill.com/sites/0078617707/student_view0/chapter1/section2/self-check_quiz-eng_.html

LESSON 4 DESCRIBING MOTION

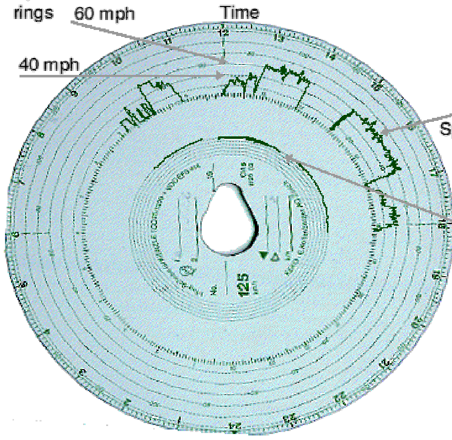
- Kinematics equations
- Uniform Motion
- Uniformly Accelerated Motion
- Short introduction to Free Fall
- Numerical Exercises & Graphs' interpretation
- ICT activity
- Lab activity

Kinematics Equations and Graphs

Can you think of examples of speed register?

Learn some of them …

Velocity / Time graphs in action - The Vehicle Tachograph

 A typical tachometer and chart used in most commercial vehicles. A school minibus may be fitted with this device - particularly if the minibus is used on European roads where the device is required.	 Sample tachograph chart taken from a minibus on a college field trip.
Order the words to make a sentence: *constantly The is as line on recorded the a chart speed.* ………………………………………………………… …………………………………………………………	**Order the words to make a sentence:** *vehicle speed line be The clearly by the on the seen can chart.* ………………………………………………………… …………………………………………………………
Why must buses use a tachometer? Discuss it in pairs and then in plenary.	**Tick the information recorded on the tachograph:** o Name of the bus driver o Speed o Time o Rest hours o Destination of the trip

RADAR - speed detection

Two conventional radar guns

Radar detector

Decide if the sentences are true or false:

- A radar gun can calculate how quickly a car is moving.
- It can register the name of the driver.
- The radar gun uses waves to measure the speed of a car.
- It is impossible to know where they are located.

Put the words in order to answer both sentences:
What is a radar detector? Who uses it?

*A **radar detector** is an electronic device used by motorists to determine a radar unit.*

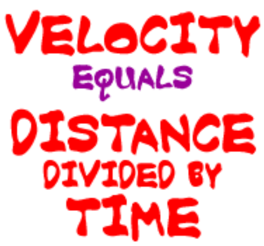
……………………………………………………………………
……………………………………………………………………

1. Do some research. Look for information about RADAR's history. Find out the answers of the following questions:

- RADAR are the initial letter of the words
………….. ……………... ……………… ……………… ………………..
- Who was the inventor?
- When was it invented?
- Why was it invented?
- Radar is a system that uses ……………………………….
- What can it identify?
- Some more information?

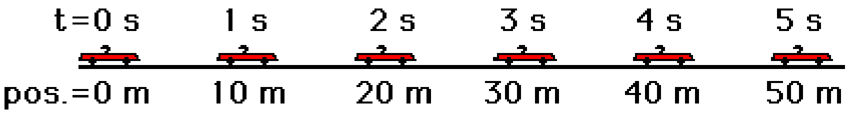
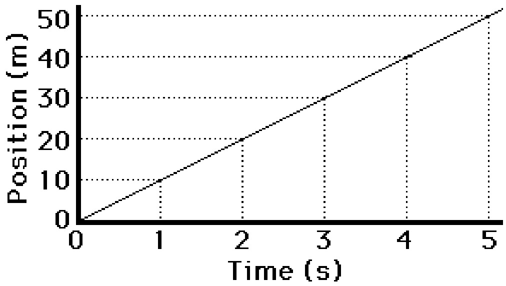
Is it possible to READ formulas, equations, diagrams or graphs? Try it in pairs.

Can you read this?



And this?

$$\text{Average Velocity} = \frac{\Delta\,\text{position}}{\text{time}} = \frac{\text{displacement}}{\text{time}}$$

Now try to read this equation. Write it down. $$v = \frac{\Delta x}{\Delta t}.$$	Can you read this diagram?  Can you find the speed?
Can you read a graph? Can you find the speed?	

Lesson 4 investigates the use of equations to describe and represent the motion of objects. Such equations are known as **kinematics equations**.

Kinematics equations are a set of equations which can be used to determine unknown information about an object's motion if other details are known.

The equations can be used for any motion described as being a:

- ✓ **<u>constant velocity motion</u>** (acceleration = 0 m/s^2)
- ✓ **<u>constant acceleration motion</u>**.

They can never be used for any time period during which:

- X **<u>acceleration is changing</u>**.

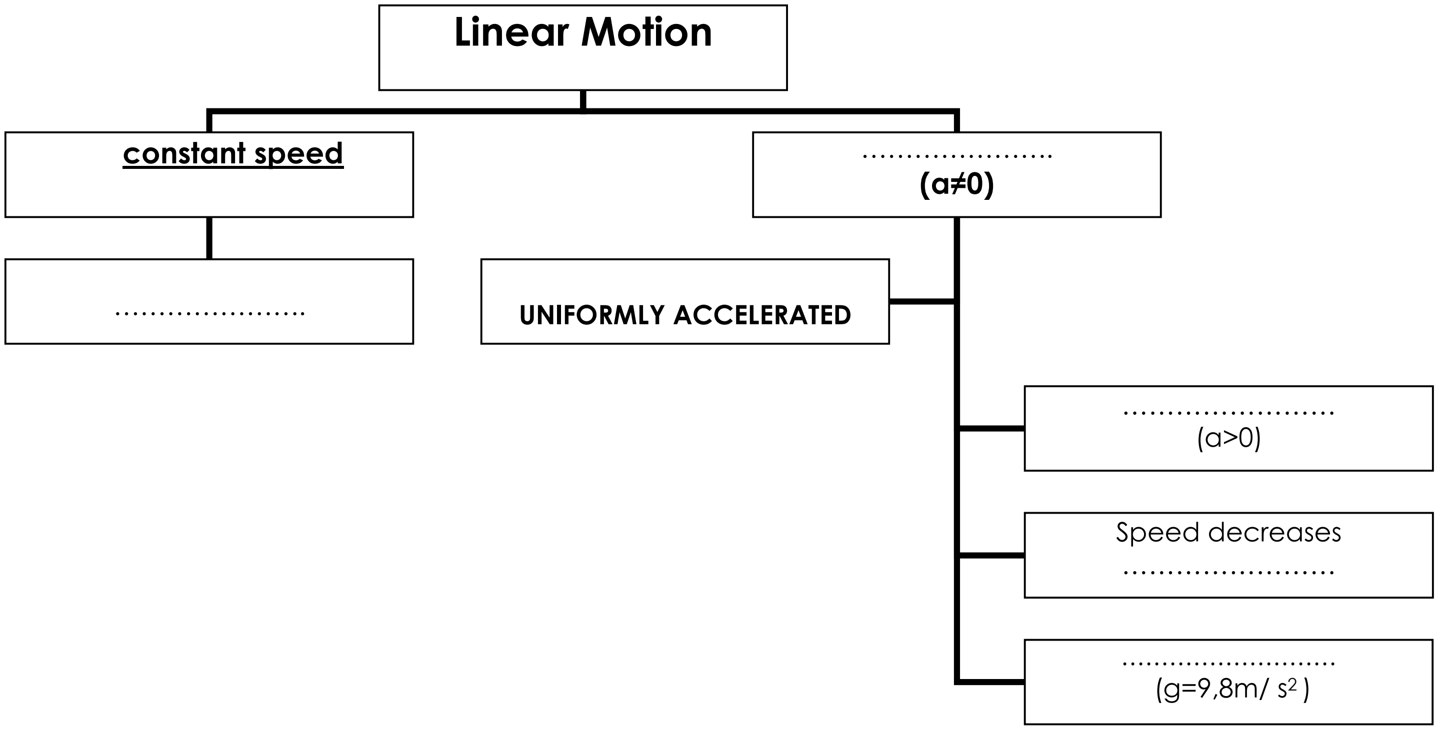
Once again, for simplicity, we will consider only motion in **one dimension**.

In essence, this is motion along a line: **LINEAR MOTION**.

In addition, we will also only consider the case of motion with a **constant acceleration**.

2. Look at the diagram below and fill in the gap with the phrases in the box.

Free Fall, <u>constant acceleration</u> , **(a = 0)**, speed increases , Uniform Motion , (a<0)



Use the substitution table below to write sentences about motion:
(Work in pairs and then we will correct it in plenary)

If When	trajectory speed acceleration	is …, are …, increases, decreases, changes,	then that means that is because	it is … the acceleration … there is …
We will study We won't study				

3. In pairs, decide if the following sentences are true or false, and correct the false ones:

- A motion is said to be uniformly accelerated, when starting from rest, it acquires, during equal time-intervals, equal increments of speed.

- In a uniformly accelerated motion speed increases, so acceleration is zero.

- ***In a linear motion the speed is constant***.

- If the velocity-time graph is a straight line going neither up nor down, motion is at a constant speed.

- If the position-time graph is a straight line going neither up nor down, motion is at a constant speed.

When we look at racing cars on a track we talk about the very high speeds of these cars. But notice that these cars do not move along a straight line, they do so only for short moments of time. Even if they move with constant speed their direction changes. So, <u>even if the speed is constant, the velocity may not be</u>. Speed is a commonly used parameter describing many types of physical phenomena.

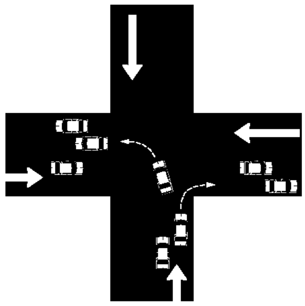
4. Imagine you drive a F1 car on the circuit below and the speedometer shows constantly 180km/h. Fill in the bubbles with the following sentences:

On the straight part of the track the F1 car is moving with constant velocity because the direction doesn't change but the speed is constant.
On the curves the velocity changes because the F1 car changes the direction but the speed is constant.

<u>Units</u>

- The unit for distances is …………………
- The unit for velocity is …………………
- The unit for acceleration is …………………..
- The unit for time is ……………………..

Mathematically, we can denote the two directions with a sign. The convention that we will use is as follows.



- <u>Horizontal Motion</u>
  1. Right is (+).
  2. Left is (-).
- <u>Vertical Motion</u>
  1. Up is (+).
  2. Down is (-).

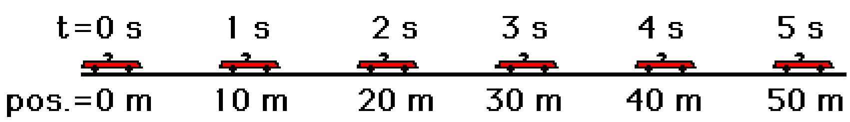
5. Write on the arrows above the direction they show:
To the right (rightward), to the left (leftward), up (upward), down (downward)

For instance, if we say that a car is moving at 30 m/s to the **left**, we can just write that the car's velocity is **-30 m/s.** Notice how this is considered a velocity now because the sign (whether it is (+) or (-)) tells us the direction of the car's motion. Remember that a velocity includes both speed and direction. **The number designates the speed, and the <u>sign designates the direction</u>.**

Let me give another example. If a rocket is moving **up** at the speed of 100 m/s, we can just write the rocket's velocity as **………….m/s.** If the rocket had been moving downward, then its velocity would have been **……..m/s**.

LINEAR UNIFORM MOTION ● ● ● ● ● ● ● ●

To begin, consider a car moving with a constant, rightward (+) velocity of 10 m/s.

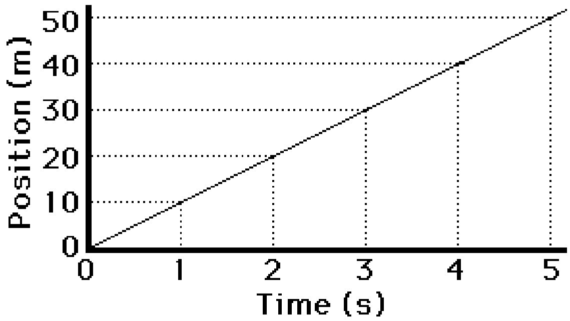


6. Explain the motion of the car (say the type of movement, the trajectory, the distance travelled every second, the time taken, the whole distance, the speed, the velocity and the acceleration). Work in pairs and then you will read it aloud.

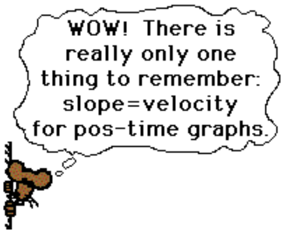
$$v = \frac{\Delta x}{\Delta t}$$

Create a <u>position-time data table</u>.

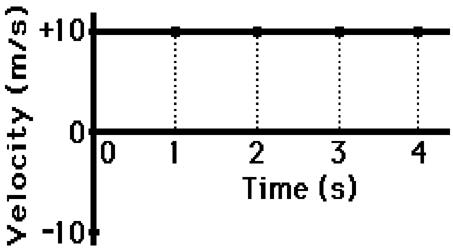
If the position-time data for such a car were graphed, the resulting graph would look like this one on the right?



Note that a motion with constant, positive velocity results in a line of constant and positive **<u>slope</u>** when plotted as a position-time graph.

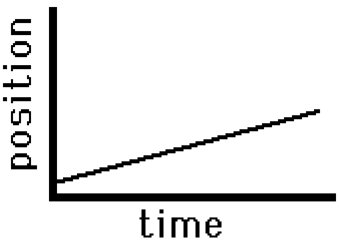


What does the slope in a position-time graph mean? ....
What information can you extract from the graph below?

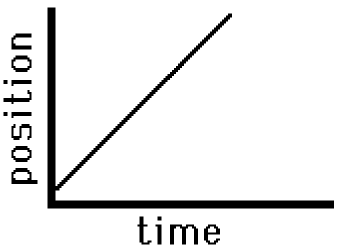


7. Consider the graphs below as examples of this principle concerning the slope of the line on a position vs time graph.

Slow, Rightward (+) Constant Velocity



Fast, Rightward (+) Constant Velocity



Work in pairs to compare them. Which are the similarities and the differences?

They both represent …. because the graph is a ……..

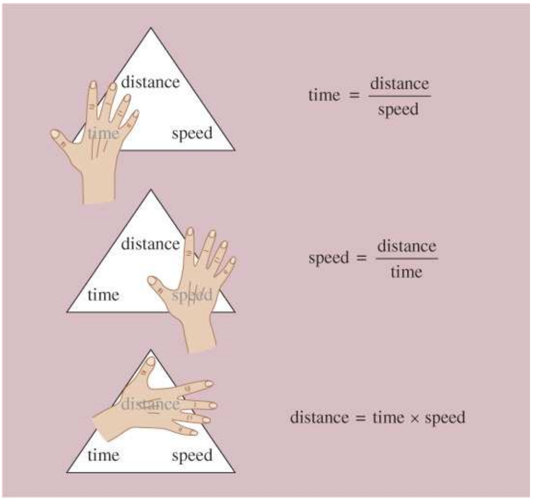
They are representative of an object which is moving with a *constant/changing* velocity, so the acceleration is ….. in both graphs.

However, the slope of the graph on the right is *larger/smaller* than that on the left and this is indicative of a *smaller/larger* velocity.

The object represented by the graph on the right is travelling *slower/faster* than the object represented by the graph on the left.

Let's work with formulas …

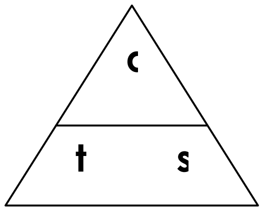
The **speed triangle** shows you how to create formulae:



t = d / s

s = d / t

d = t · s



speed = distance travelled / time taken

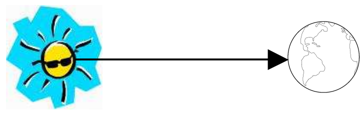
metres per sec (ms^{-1}) = metres / seconds

Let's practise with them …

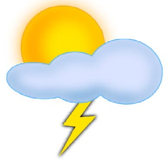
8. One example of a natural UNIFORM MOTION is the motion of <u>light.</u>

Light speed is 300,000,000 metres per second; the distance from the Earth to the Sun is 144,000,000,000 metres; so light takes 8 minutes (480 seconds) to travel from the Sun to the Earth.

Check it using the proper formula.

Data	Equation	(Diagram)
V = d = t = ?	Equation [ ] Resolution Result [ ]	

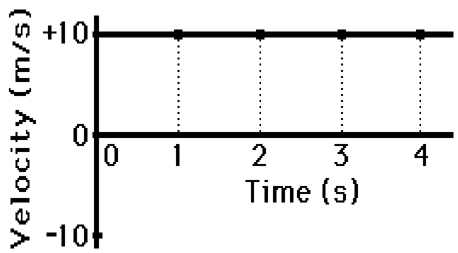
9. Do some research. Look for the speed of sound and compare it with the speed of light. Which travels faster? Relate it to TV broadcast (sound is delayed comparing to image) and to an electric storm (thunder and lightning).

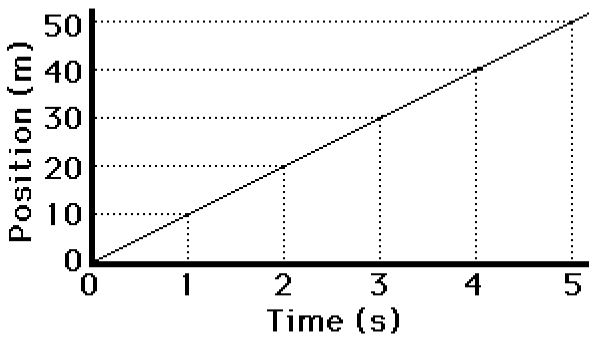


Speed, distance and time calculations

10. Questions:

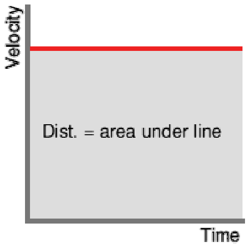
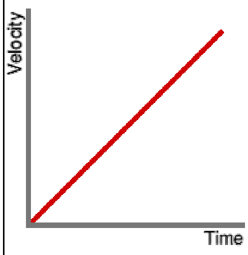
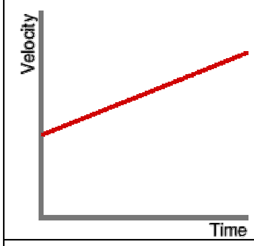
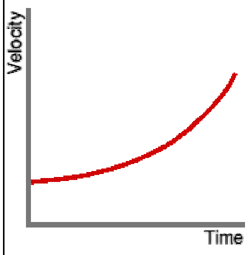
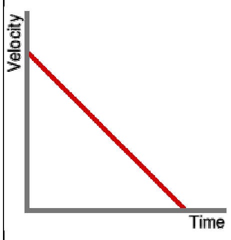
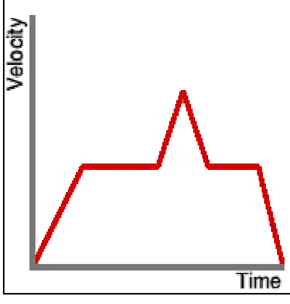
- **a)** How far does a bicycle travel at a speed of 15 ms $^{-1}$ for 15 seconds?
- **b)** If a train travels at a speed of 90 km/h, how far will it have travelled in 3 hours?
- **c)** If the speed of sound in air is 330 ms $^{-1}$, how far away will a cliff wall be if it returns an echo to an observer in a time of 0,5 seconds?
- **d)** If the distance between London and New York is 3600 miles, how long would you expect Concorde to take to fly the distance at a speed of 1200mph?
- **e)** A bullet fired from a rifle travels with a muzzle velocity of 500 ms $^{-1}$. How long will the bullet take to travel between the rifle and a target 100 m away?
- **f)** A speed camera photographs a car exceeding the speed limit. If the photograph shows the car to have travelled 13 m between two photographs taken 0,5 s apart, how fast was the car travelling?
- **g)** What is the average speed (SI Units) for a car journey of 120 km that began at 09.30 and finished at 12.00 noon?
- **h)** Travelling at the speed of light (300.000.000 ms $^{-1}$), how long does a photon take to pass through a sheet of 3mm glass?
- **i)** Which is the difference between the two graphs? Which is the similarity?





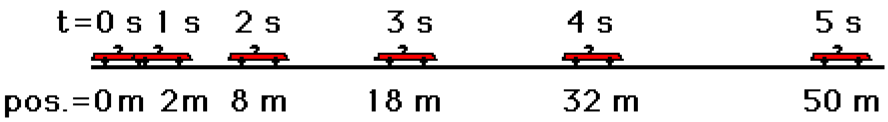
They both represent …. but the graph on the left is a …….. and the one on the right …….   They are representative of an object which is moving with a *constant/changing* velocity, so the acceleration is ….. in both graphs.   The object represented by the graph on the right is travelling *slower/faster/ at the same speed* than the object represented by the graph on the left.

11. Work in pairs. The graphs below represent velocity on the Y axis and time on the X-axis. Match each image with its description.

	Acceleration is increasing and velocity is also increasing at an increasing rate. Example: A rocket accelerating away from lift off, constant thrust but burning fuel means that rocket weighs less, so accelerates at a greater rate.
	Moving at a constant velocity. The distance travelled is shown by the **area** under the graph.
	Moving with constant acceleration, velocity is increasing at a steady rate from rest ($v_0 = 0$). Example: a typical car test trial car accelerating from 0 to 60 mph
	A car accelerates from rest, travels with a constant velocity, accelerates to overtake then drops back to the steady velocity before braking to a halt
	Moving with constant negative acceleration, velocity is decreasing at a steady rate. Example: A car braking from 60 mph to rest ($v_0 = 0$)
	Moving with constant acceleration, velocity is increasing at a steady rate from an initial velocity ($v_0 \neq 0$). Example: A car accelerating from 40 to 60 mph to overtake.

LINEAR UNIFORMLY ACCELERATED MOTION ● ● ● ● ●

Let me quote the formulae that we can derive from calculus concerning constant acceleration and motion in one dimension.
Now consider a car moving with a changing, rightward (+) velocity, that is, a car that is moving rightward and speeding up or accelerating.



12. Table the data and graph them.

time (s)	Position (m)

Position (m)

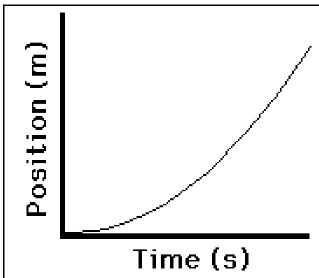
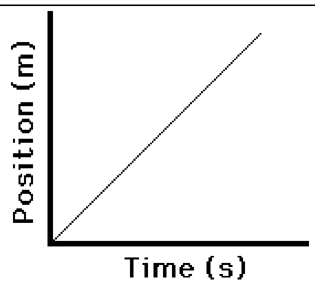
time (s)

- **a.** Describe the resulting graph.
- **b.** Is it a uniform motion? Why?
- **c.** How could you calculate the acceleration?
- **d.** Do it using the correct formula.

13. The two graphs below show the position vs. time for the two types of motion:

- **constant velocity / constant slope**
- **changing velocity / changing slope**

Work in pairs to write down the description:

What are the formulae for uniformly accelerated motion?

These formulae only apply to the case of a particle moving under constant acceleration. If this condition does not apply to the situation under consideration, then you cannot use these formulae.

There are a variety of symbols used in the equations below and each symbol has a specific meaning.

For the **position equation**:
(if the movement is horizontal)

$$x = x_0 + v_0 \cdot t + ½ \cdot a \cdot t^2$$

14. Relate each symbol to each meaning, question phrase and the SI Unit:

x	Initial position	How fast …?	
x_0	Initial velocity		s
v_0	Time	How long …?	m/s
v	Final velocity		
t	Final position	How far …?	m/s^2
a	Acceleration		

Now write down the information as shown in the example:

e.g. ***x*** *represents the* *final position* *and it is measured in* ***m.*** *How far* *will a runner go?*

Can you write the position equation for a vertical movement?

$$..... = ... + v_0 \cdot t + ½ \cdot a \cdot t^2$$

For the **velocity equation**:

$$v = v_0 + a \cdot t$$

For the **acceleration equation**:
Guess the formula …

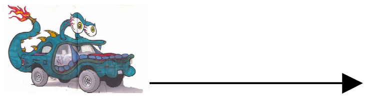
$$a =$$

The main condition to keep in mind when using this formula is that the object under consideration must be experiencing a C_ _ _ _ _ _ T (6 letters) **A_ _ _ _ _ _ _ _ _ _ N** (12 letters)

Remember, we are not just dealing with mathematics here. If the things we describe do not deal with what goes on in the real world, then we are not doing physics. The whole idea of physics is to predict and to describe the world around us.
We use mathematics only as a tool to help us describe the world around us.

Example 1

What is the velocity of an object initially at rest, if it experiences a constant acceleration of 10m/s² to the right after a period of 3 seconds?

Data	Equation	(Diagram)
$V_0 = 0$ t = ... a = ... v = ?	$v = v_0 + at$ Resolution Result	

Example 2

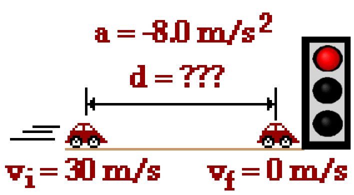
Assume there is a car moving to the right at an initial speed of 14 m/s. In addition, assume the car is experiencing a constant acceleration of 5,3m/s to the left. What will its velocity be at 1,7s?

Example 3

Consider a ball thrown upward with an initial velocity of 20 m/s. What will its velocity be after 3 seconds if it undergoes a constant acceleration of 10m/s downward?

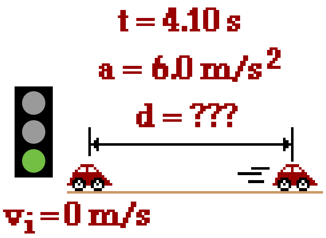
Example 3

Ima Hurryin approaches a stoplight in her car which is moving with a velocity of +30.0 m/s. The light turns yellow; Ima applies the brakes and skids to a stop. If Ima's acceleration is –8.00 m/s², determine the time taken and the displacement of the car during the skidding process.



Example 3

Ben Rushin is waiting at a stoplight in his car. When the light turns green, Ben accelerates from rest at a rate of a 6,0 m/s² for an interval of 4,10 seconds. Determine the time taken and the displacement of Ben's car during this time period.



Check Your Understanding

15. Do the following exercises:

a. If a car accelerates from 10 to 30 ms^{-1} in 10 seconds, find the acceleration and how far it travels.

b. What is the final velocity of a car that accelerates from rest at 4 ms^{-2} for a distance of 50m? How long does it take?

c. A car brakes hard and decelerates (negative acceleration) from 25 ms^{-1} to rest in 3 seconds. What is the value of the acceleration?

d. How far does the car travel while braking?

e. An average driver will take approximately 0.6 seconds to react to something happening in front. If the car above had been cruising at a steady speed of 25 ms^{-1} before being brought to rest, how far did the car travel between the driver recognising danger and the car coming to rest?

f. A racing car accelerates uniformly from 18.5 m/s to 46.1 m/s in 2.47 seconds. Determine the acceleration of the car and the distance travelled.

g. A bike accelerates uniformly from rest to a speed of 7.10 m/s over a distance of 35.4 m. Determine the acceleration of the bike. (0,71m/s²)

h. A car travelling at 22.4 m/s skids to a stop in 2.55 s. Determine the skidding distance of the car. (Assume uniform acceleration.) (28,6m)

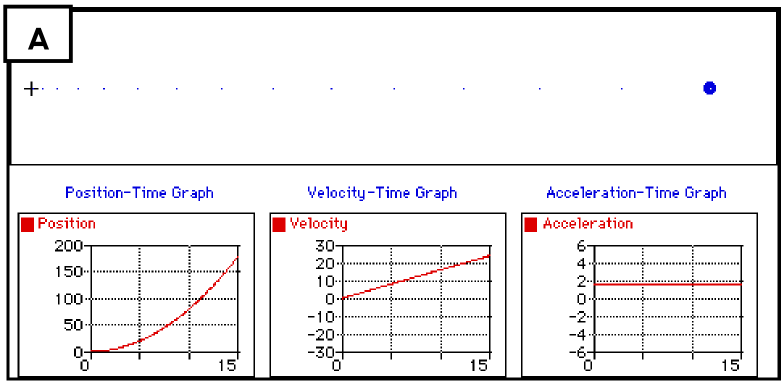
i. A kangaroo is capable of jumping to a height of 2.62 m. Determine the take-off speed of the kangaroo. (Gravity acceleration is -9,8m/²) (7,17m/s)

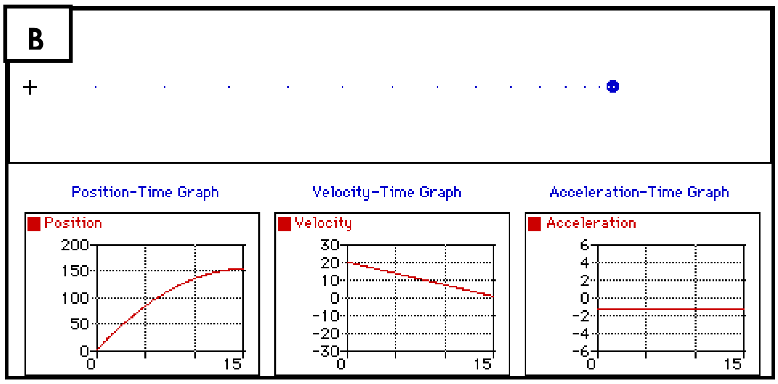
j. The observation deck of a skyscraper is 420 m above the street. Determine the time required for a penny to free-fall from the deck to the street below. (9,26s)

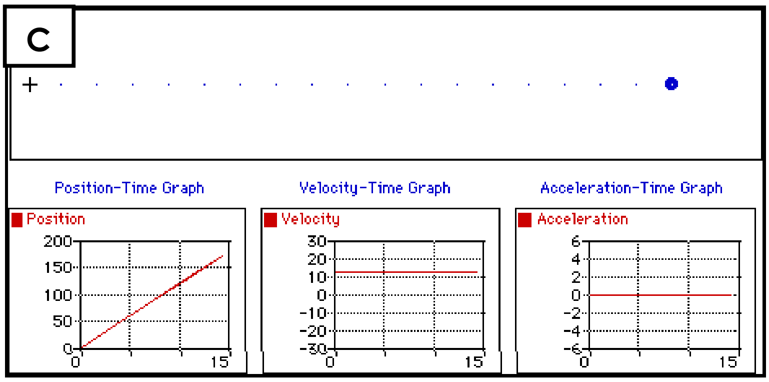
k. A car accelerates to a speed of 112 m/s over a distance of 398 m. Determine its acceleration. (Assume uniform acceleration.) (15,8m/s²)

Check Your Understanding

16. Extract as much information as you can from the diagrams and graphs below. Work in pairs.







Homework / Assignment / Review of Uniform Motion

1. **Define uniform motion and uniformly accelerated motion.**

2. **Which of the following are uniform motion and which are other types of motion (say what type)?**

   a. A car travels at 100 km/h south for 30 minutes.

   b. A car stops at a stop sign.

   c. A car accelerates away from the stop sign.

   d. A car turns a corner at 50 km/h.

   e. An object falls from the top of a building.

   f. Light travels through space at $3 \cdot 10^8$ m/s.

   g. The distance of a moving object is increasing every second.

   h. The distance of a moving object is decreasing every second.

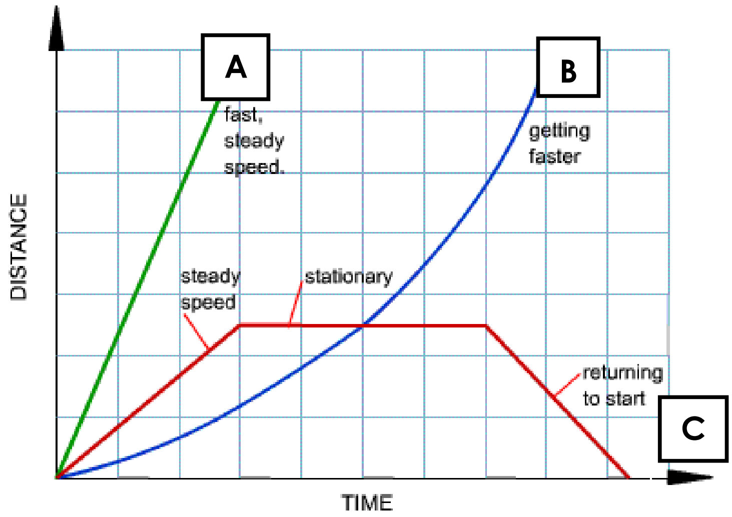
   i. The distance that an object travels every second is staying the same.

3. **a**. What is the speed of an object if it is moving uniformly over 30.0 m in 5.0 s?

   b. What distance will a ball go if it is moving uniformly at 25,0 m/s for 15,0 minutes?

   c. How long will it take a car moving at 100 km/h to go 100 m?

4. Look at the distance-time graph and describe the 3 movements:



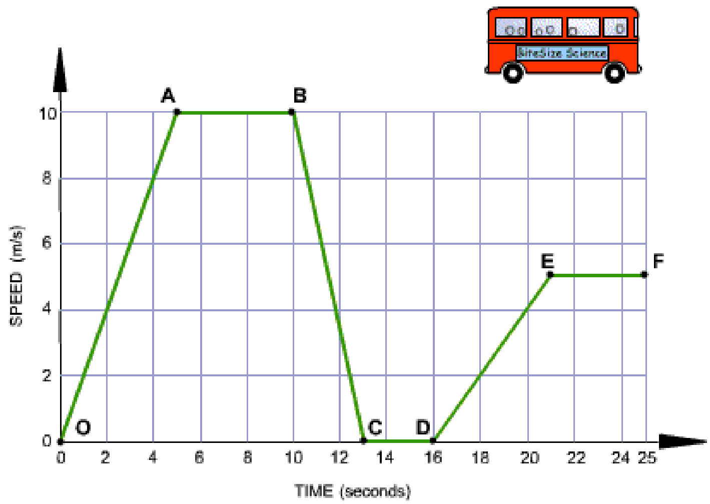
Description

A

B

C

5. Look carefully at the graph and transfer as much information as you can to a data table.



Data Table	Time (s)	V_0 (m/s)	V (m/s)	a (m/s²)	X (m)	Type of motion
From O to A						
From A to B						
From B to C						
From C to D						
From D to E						
From E to F						

Lab Activity Experimenting Motion

Purpose:
In this experiment we will study linear uniformly accelerated motion using the inclined plane. You will obtain experimental values on an incline and put data into a table. You will learn to draw a "best fit" or regression line of experimental data. You will verify predictions and discover that reaching conclusions about motion is not as easy as it seems at first.

Apparatus:
Ramp, marble, stopwatch, tape measure, protractor, wooden block

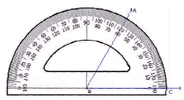
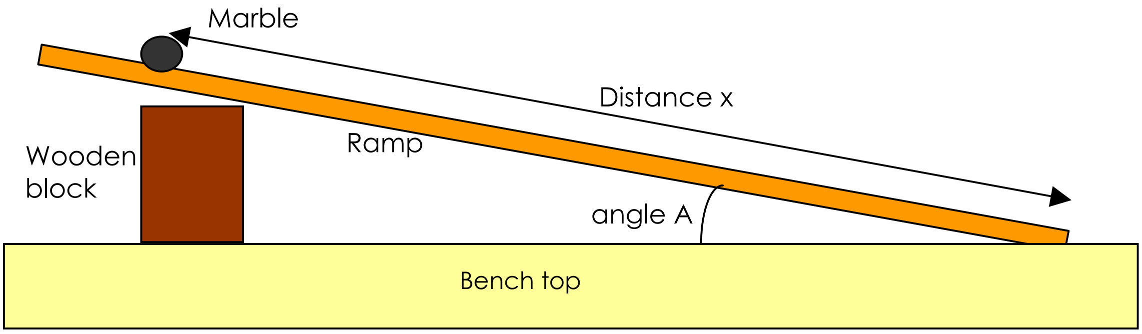


Diagram:



Procedure:
1. Set up the apparatus as shown above. The wooden block should be placed so that angle A is between 10° and 20°.

2. Place the marble so that **distance** x = 100cm.

3. Use the stopwatch to measure how long it takes the marble to roll down to the bottom of the ramp.

4. Repeat the above at least 4 more times and so obtain an average value for your timing.

5. Repeat stages 2, 3 & 4 for the following values of **distance x**:
80cm, 60cm, 50cm, 40cm, 30cm, 20cm

6. Present your results in a table.

7. Draw a graph of **distance x (cm)** [on the Y-AXIS] against **average time (seconds)** [on the X-AXIS]. Draw a best fit CURVED line on your graph.

8. Use your table and graph to answer the following questions:

(**a**) How does the time taken for the marble to roll down the slope change if distance x is increased?
(**b**) What would you expect the time to be for distance x = 55cm? Show your working on the graph.
(**c**) What value of **distance x** should have half the time for when distance x = 40cm? Show your working on the graph.
(**d**) A student predicted that if the distance was doubled then the time taken should also

double. Use your results to show whether or not this prediction has been verified.

9. What happens if the angle changes? Follow the instructions.

Procedure:

1. Set up the apparatus as shown above. Angle A is 20º to the bench top.
2. Place the marble so that it is 100cm from the bottom of the ramp.
3. Use the stopwatch to measure how long it takes the marble to roll down to the bottom of the ramp.
4. Repeat the above 4 more times and so obtain an average value for your timing.
5. Repeat stages 2, 3 & 4 for the following values of **angle A**:

5º, 10º, 15º, 25º, 30º, 35º, 40º, 45º, 50º

6. Present your results in a table.
7. Draw a graph of **angle A (in degrees)** [on the Y-AXIS] against **average time (seconds)** [on the X-AXIS]. Draw a best fit CURVED line on your graph.
8. Use your table and graph to answer the following questions:

(**a**) How does the time taken for the marble to roll down the slope change if angle A is increased?

(**b**) What would you expect the time to be for angle A = 22.5º? Show your working on the graph.

(**c**) What value of **angle A** should have twice the time for when angle A = 30º? Show your working on the graph.

(**d**) A student predicted that if the angle was doubled then the time taken should halve. Use your results to show whether or not this prediction has been verified.

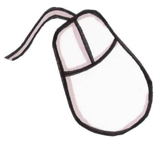
World of Physics

F	M	A	R	N	D	R	D	E	F	V	S	S	A	M	Y	R	X	S	F
A	I	O	V	O	O	I	I	A	S	P	O	T	S	G	E	N	E	P	L
X	I	R	M	E	L	I	U	I	P	D	L	S	R	A	O	C	Z	R	L
N	C	R	S	E	R	L	T	L	A	C	N	E	C	I	O	O	Y	I	W
O	Y	E	P	T	N	A	I	C	F	C	N	T	T	N	D	T	G	E	M
I	B	A	N	L	L	T	G	N	A	E	I	C	D	N	I	N	I	V	D
T	P	R	Q	T	A	A	U	E	G	O	I	L	O	C	I	G	M	D	M
A	S	E	J	A	E	N	W	M	N	R	A	C	O	N	H	I	P	X	N
R	C	X	Z	C	C	R	E	C	F	W	E	L	N	T	H	K	H	L	K
E	D	H	R	Y	W	R	O	E	X	S	E	U	H	N	Z	T	R	E	T
L	E	S	A	C	N	S	C	F	R	V	R	Z	S	S	O	I	N	T	R
E	E	U	C	O	C	N	B	E	G	D	Q	W	A	L	E	T	Q	A	A
C	P	P	I	I	A	A	P	T	W	R	I	T	A	I	I	C	W	R	T
C	S	T	S	T	L	S	Y	A	I	W	A	R	N	L	T	D	R	E	S
A	O	Y	S	A	R	T	L	W	J	O	X	V	E	A	D	R	I	O	N
M	H	I	N	E	I	K	T	I	M	E	S	S	I	C	T	R	E	N	F
P	D	C	T	V	I	X	O	U	G	L	L	U	P	T	T	S	I	N	G
P	E	E	A	N	U	N	B	A	L	A	N	C	E	D	Y	I	N	H	I
D	M	R	G	R	E	T	S	A	O	C	R	E	L	L	O	R	O	O	T
W	G	A	I	R	R	E	S	I	S	T	A	N	C	E	B	H	S	N	C

ACCELERATION	ACTION	AIR RESISTANCE	AIRPLANE
AVERAGE	BALANCED	CAR	CENTER OF GRAVITY
CONSTANT	DIRECTION	DISTANCE	ENERGY
FIRST LAW	FLUID	FORCES	FRICTION
GRAVITY	INERTIA	MASS	METERS PER SECOND
MOMENTUM	MOTION	MPH	NEWTON
PHYSICS	PULL	PUSH	RATE
REACTION	ROLLER COASTER	ROLLING	RUNNING
SECOND LAW	SLIDING	SPEED	START
STOP	THIRD LAW	TIME	UNBALANCED
VELOCITY	WALKING	WEIGHT	

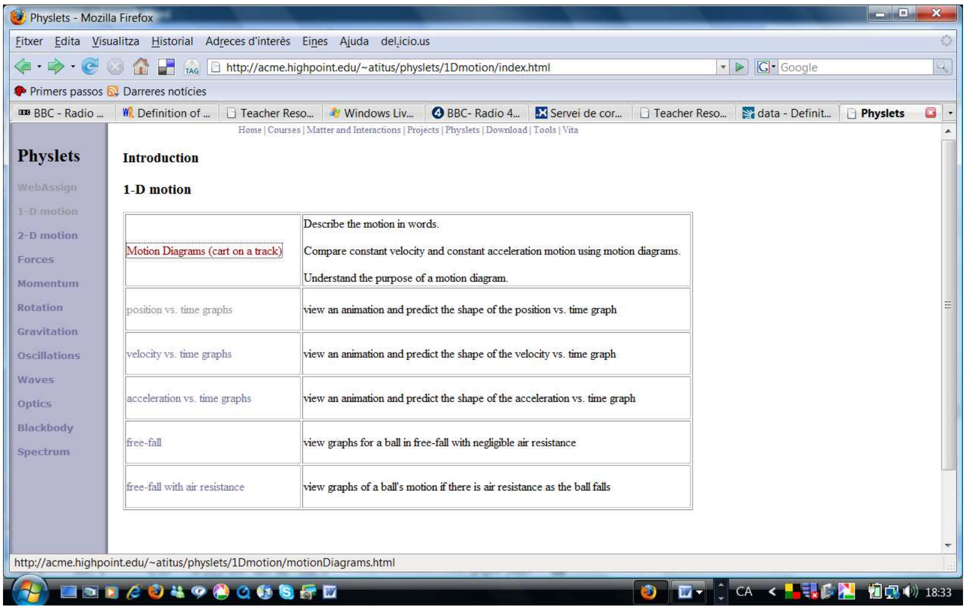
Select 10 words related with Kinematics.

ICT Activity:



1. Go to the following website

http://acme.highpoint.edu/~atitus/physlets/1Dmotion/index.html



Write a report of the results of each section:

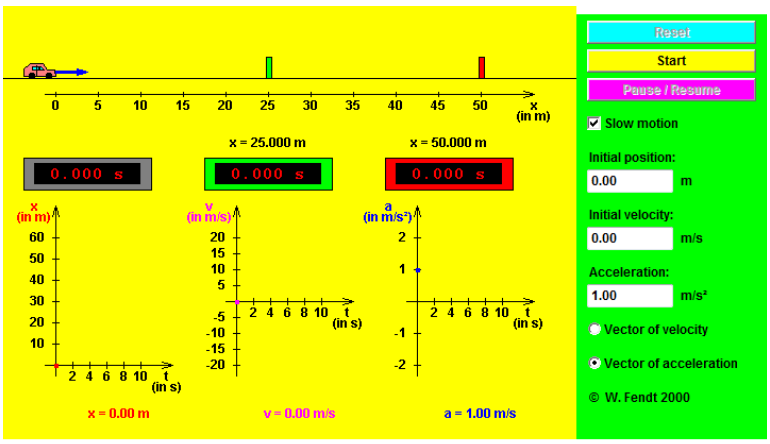
- Motion Diagrams
- Position vs time graphs
- Velocity vs time graphs
- Acceleration vs time graphs
- Free-fall
- Free fall with air resistance

2. As homework or to prepare the exam, go to the website below to see the problems with complete solutions. Firstly you have to fill in the missing data or ask it to put in numbers for you, secondly make your own calculations and finally check the result.

http://www.fearofphysics.com/Probs/One_Dimensional_Motion.html

3. This Java applet shows a car moving with Constant Acceleration

http://www.walter-fendt.de/ph11e/acceleration.htm



- Check you have the same data as shown below and draw the graphs you got.
- Then do the same changing data:

  V_0= 10 m/s

  a = -1m/s^2