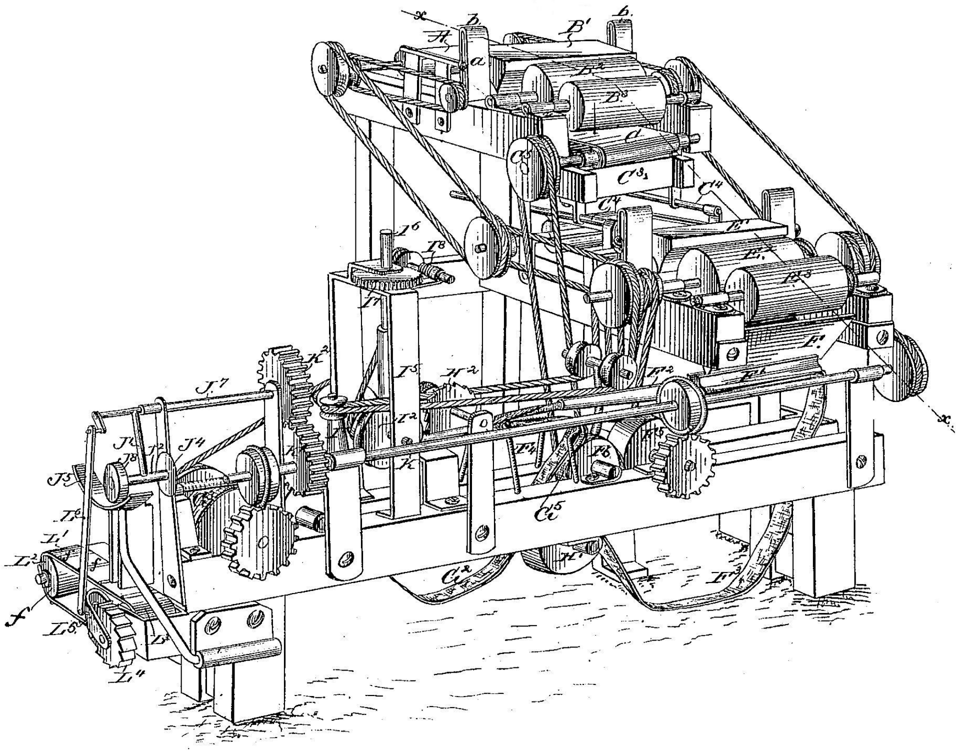
Simple Machines

Student's worksheets



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CLIL Course

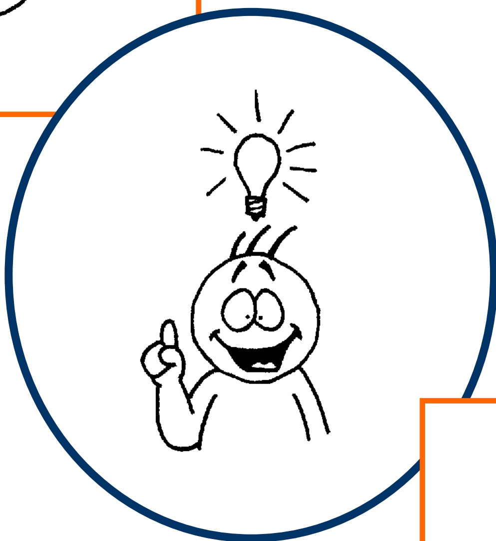
Norwich Institute for Language Education

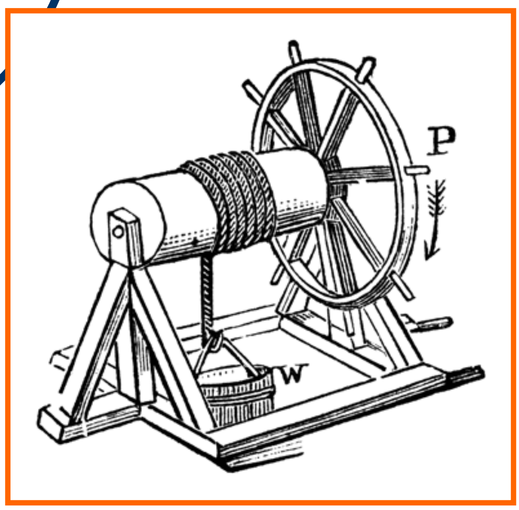
January – March 2010

CONTENTS

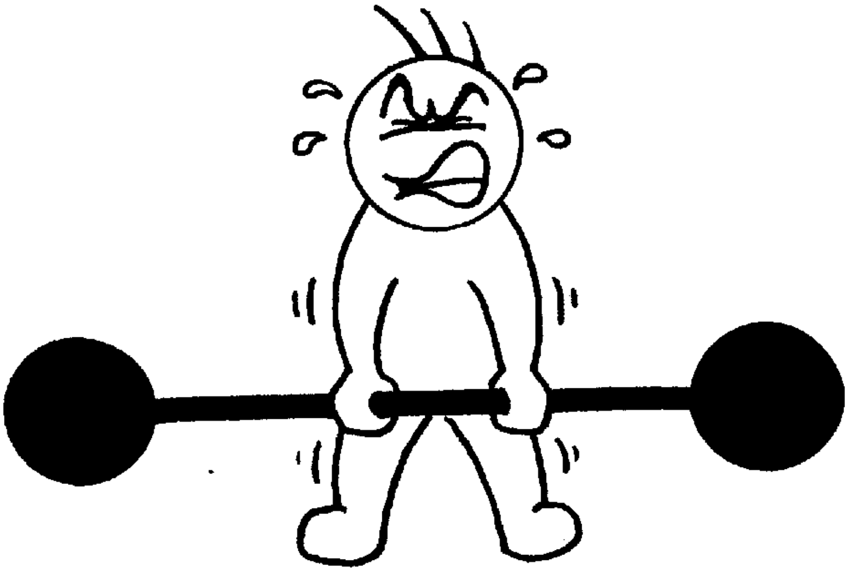
Unit 1

Force, work and machines





Lesson 1: **Force**



Worksheet 1: **Introduction**	
Name:	
Group:	**Date:**

Activity 1: *Look at the picture and try to answer the following questions.*

a) What is the man trying to move?

b) Who was he?

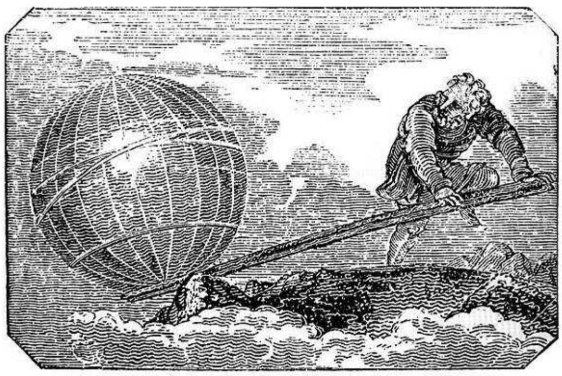
c) Where was he from?

d) When did he live?

e) Why was he famous?

f) What kind of object is he using?

g) Why is he using that object?



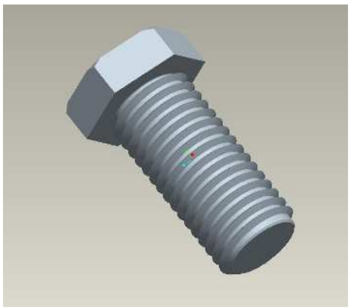
"Give me a place to stand and I will move the Earth"

__Activity 2__: *The pictures show different simple machines. Match the pictures with the names.*

inclined plane

wheel

lever



pulley

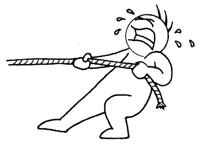
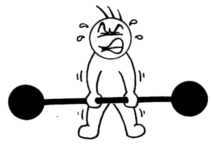
screw

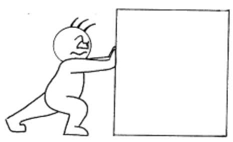
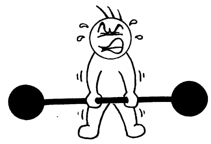
wedge

Worksheet 2: **Force**	
Name:	
Group:	**Date:**

Activity 3: *Put the letters in order to find the words and write the correct word below the drawings.*

Letters	→	**Word**
shup	→	
lulp	→	
crefo	→	

When we		we make a	

When we		we make a	

Activity 4: *Rewrite the following sentences using the synonyms in the box.*

A force is any cause that can...	(1) …increase the speed of an object. (2) …decrease the speed of an object. (3) …change the trajectory of an object. (4) …change the shape of an object.

divert decelerate deform accelerate

A force is any cause that can...	(1) …____________________ an object. (2) …____________________ an object. (3) …____________________ an object. (4) …____________________ an object.

Activity 5: *Using the cards, construct the puzzle with your classmates and then fill in the table.*

QUANTITY	QUANTITY SYMBOL	UNIT OF MEASUREMENT	UNIT SYMBOL
length			
time			
mass			
force			

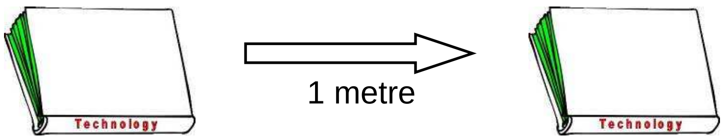
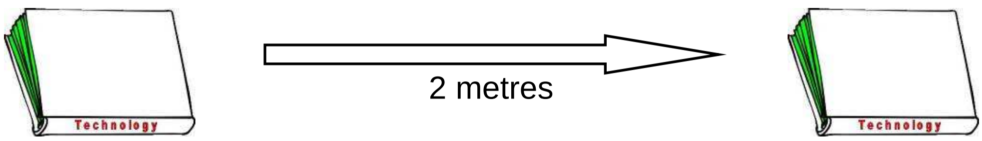
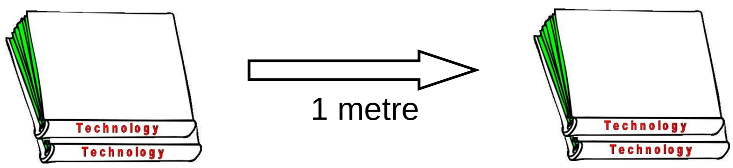
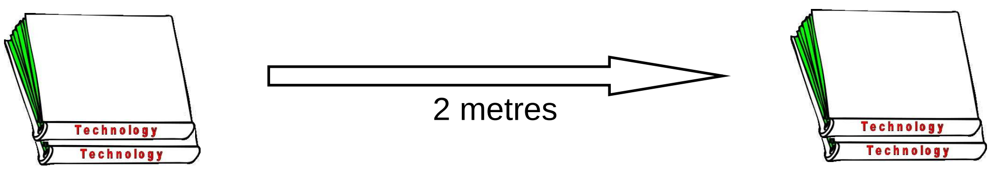
Given to students cut up

QUANTITY	QUANTITY SYMBOL	UNIT OF MEASUREMENT	UNIT SYMBOL
length	l	metre	m
time	t	second	s
mass	m	kilogram	kg
force	F	Newton	N

Lesson 2: **Work and energy**

Worksheet 3: **Work and energy**	
Name:	
Group:	**Date:**

Activity 6: *Let's review the concept of work in physics. Follow the instructions.*

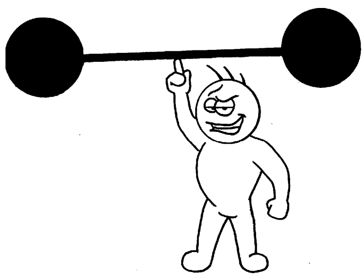
Student A	 "Take one book and move it one metre"
Student B	 "Take one book and move it two metres"
Student C	 "Take two books and move them one metre"
Student D	 "Take two books and move them two metres"

Think about the work you have done.

Use the table below as in the example to write sentences comparing the work each of you has done.

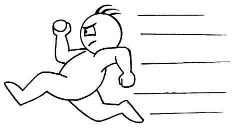
<table>
<tr><td rowspan="2">Student</td><td rowspan="2">B
C
D</td><td rowspan="2">did</td><td colspan="2">the same work as</td><td rowspan="2">student</td><td rowspan="2">A
B
D</td></tr>
<tr><td>double
half
four times</td><td>the work of</td></tr>
</table>

Student A & Student B	*Student A did half the work of student B*
Student B & Student A	
Student C & Student A	
Student D & Student A	
Student B & Student D	
Student C & Student B	



Activity 7: *Machines use energy to do work. Fill in the boxes with the words given.*

wind, run, electricity, phone, petrol, food, transport, generate electricity

ENERGY	→	MACHINE	→	WORK
	→		→	
	→		→	
	→		→	
	→		→	

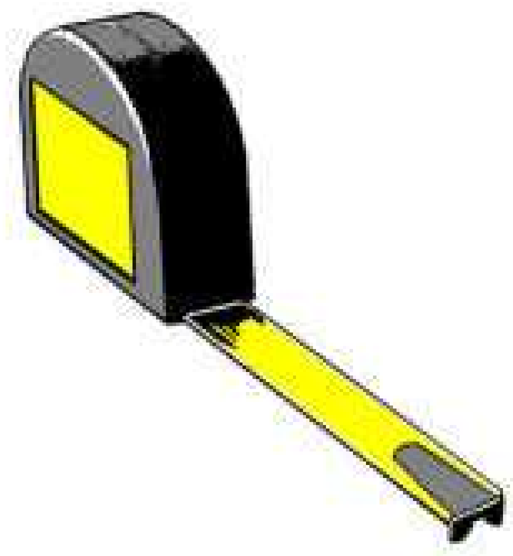
Now order the following words to find the definition of energy:

ability	is	Energy	the	work	do	to

Energy…

Activity 8: *Using the cards, construct the puzzle with your classmates and then fill in the table.*

QUANTITY	QUANTITY SYMBOL	UNIT OF MEASUREMENT	UNIT SYMBOL
length			
time			
mass			
force			
work			
energy			



Given to students cut up

QUANTITY	QUANTITY SYMBOL	UNIT OF MEASUREMENT	UNIT SYMBOL
length	l	metre	m
time	t	second	s
mass	m	kilogram	kg
force	F	Newton	N
work	W	Joule	J
energy	E	Joule	J

Worksheet 4: Work problems 1	
Name:	
Group:	**Date:**

Activity 9: *Listen and fill the gaps.*

Problem A

A man ______ a box for ____. To ____ the box, the man _____ a _____ _____. Find the ____ done in the _______.

Problem B

A person _____ a ____ to ____ an object from the floor. The ______ reached is ____ and the _____ done is ______. Determine the ______ necessary to ____ the object.

Problem C

A _____ _____ is _______ to move a _________ doing ________ of ____ in the _______. Find the ________ the _________ has been moved.

Answer the following questions choosing the appropriate option. Find the answers in the text above.

1. A road vehicle with two wheels is a…
- **a)** car
- **b)** motorbike
- **c)** trolley
- **d)** lorry

2. What's the name of the distance between the ground and something above it?
- **a)** height
- **b)** weight
- **c)** tall
- **d)** high

3. If you …….. something, you elevate it.
- **a)** gift
- **b)** mist
- **c)** lift
- **d)** shift

4. It is a thick cord or wire.
- **a)** root
- **b)** rote
- **c)** cuerd
- **d)** rope

5. A ………….. is a series of actions which are executed in order to achieve a result.
- **a)** promise
- **b)** success
- **c)** process
- **d)** goodness

6. A ………….. is any cause that can change the movement or the shape of an object.
- **a)** force
- **b)** power
- **c)** energy
- **d)** work

7. When you move something making a force, you are doing…
- **a)** job
- **b)** work
- **c)** wok
- **d)** walk

8. To use force in order to move something towards you.
- **a)** To rule
- **b)** To brush
- **c)** To push
- **d)** To pull

9. To use force to make something move away from you.
- **a)** To rule
- **b)** To brush
- **c)** To push
- **d)** To pull

Worksheet 5: **Work problems 2**	
Name:	
Group:	**Date:**

Activity 10: *Solve the problems.*

Problem A

A man pushes a box for 10 m. To move the box, the man makes a 200 N force. Find the work done in the process.

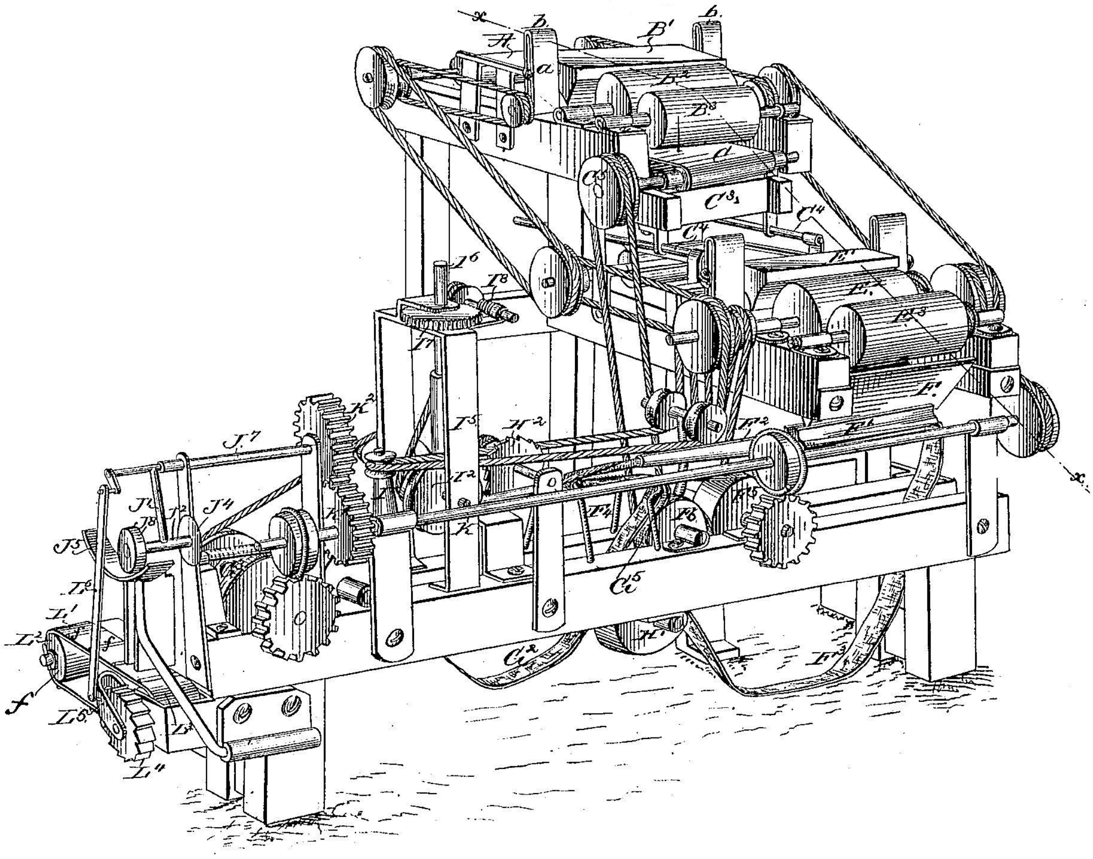
Problem B

A person pulls a rope to lift an object from the floor. The height reached is 15 m and the work done is 4500 J. Determine the force necessary to lift the object.

Problem C

A 400 N force is applied to move a motorbike doing 20000 J of work in the process. Find the distance the motorbike has been moved.

Lesson 3: **Machines**



Worksheet 6:	**Machines**
Name:	
Group:	**Date:**

Activity 11: *Write the names of the following machines and copy the letters in the numbered cells to find out the definition of a machine.*

A

B

C

D

E

F

G

H

I

A									
	10		26	34			1	24	37

B						
	33	35	6		27	31

C								
		36	2		21	19	22	32

D							
		16	38	12			8

E										
	15		11	28	40		3	39		

F					
			9		

G									
					13			14	

H					
	17			4	

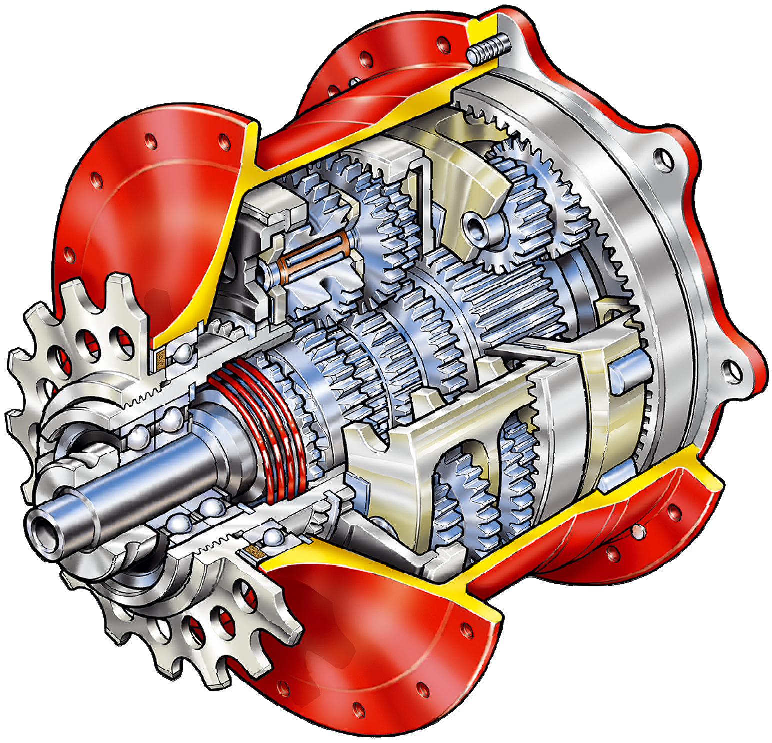
I									
	20	25		18	30	5	29	7	23

What's a machine?

												s										
1		2	3	4	5	6	7	8		9			10	11	12		13	14	15	16	17	18

						s		s											
19	5	3	20		21		22			23	24	25	26	27	12		28	29

								s												
30	31	32	33	34	35	2			36	2	37		1	38	39	40	15	40	20	12



Worksheet 7: **Simple machines**	
Name:	
Group:	**Date:**

Activity 12: *Listen to the teacher and write the number of the correct sentence below each picture.*

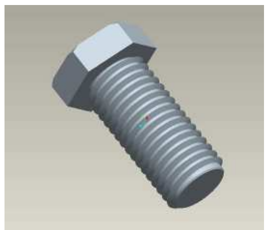
A: sentence ____

B: sentence ____

C: sentence ____

D: sentence ____

E: sentence ____



F: sentence ____

Write down the name of the six simple machines:

A: ______________________________ **D:** ______________________________

B: ______________________________ **E:** ______________________________

C: ______________________________ **F:** ______________________________

Activity 13: *Listen to your partners and write down the questions and the answers on the appropriate order. Complete the tree diagram using the last three answers.*

1. ____

2. ____

3. ____

4. ____

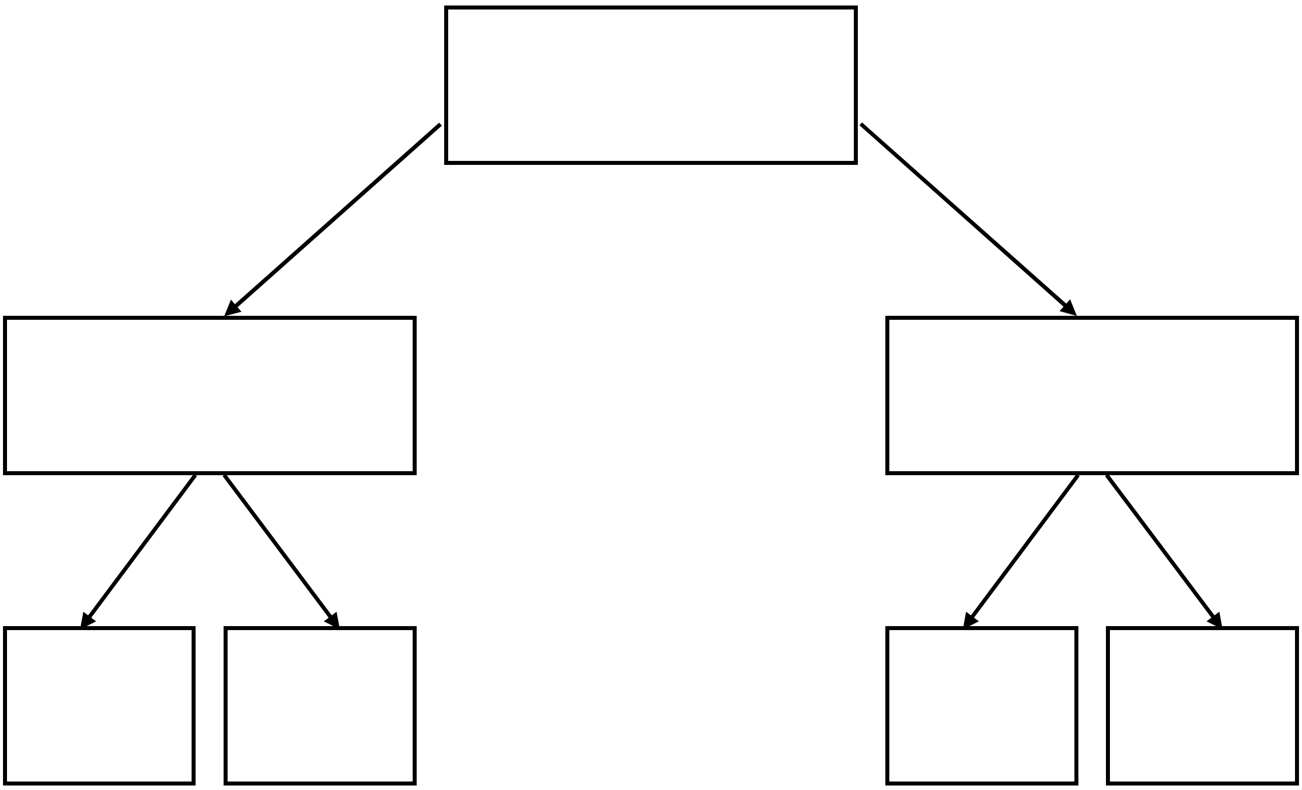
5. ____

6. ____

7. ____

8. ____

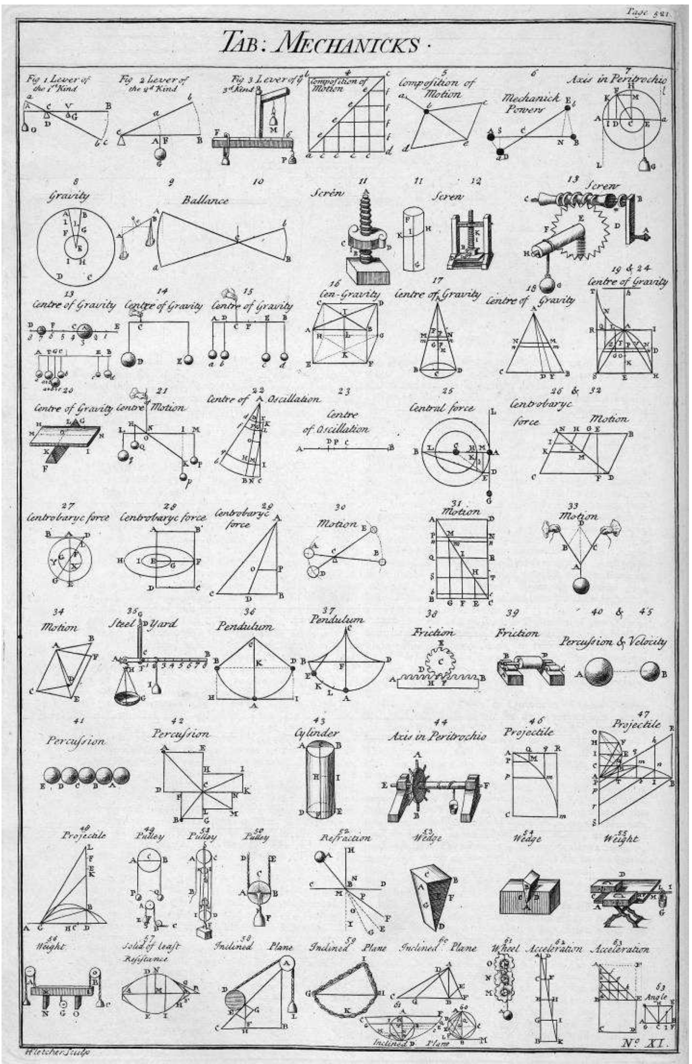
9. ____



Given to students cut up

A	The wheel and axle and the pulley are variants on the lever. **What is a simple machine?**
B	A simple machine has got few or no moving parts. **Why is learning the basics of simple machines important?**
C	Simple machines can be thought of as building blocks for more complicated machines. **Which are the two basic simple machines?**
D	Simple machines are useful because they make work easier. **How does a simple machine work?**
E	The two basic simple machines are the inclined plane and the lever. **What devices are variants on the inclined plane?**
F	A simple machine is a device that changes the direction or the magnitude of a force. **Why are simple machines useful?**
G	The screw and the wedge are variants on the inclined plane. **What devices are variants on the lever?**
H	Learning the basics of simple machines is fundamental to understanding more intricate mechanisms. **What's the relationship between simple machines and more complicated machines?**
I	A simple machine works by using a single applied force to do work against a load. **How many moving parts has a simple machine got?**

Lesson 4: **Mechanical advantage**



Worksheet 8: Mass versus weight	
Name:	
Group:	Date:

Activity 14: *Read the following text and circle T or F to state if the sentences on next page are true or false.*

In practical or everyday applications, we give to weight the same meaning as we gave to mass in physics. In modern scientific usage, however, weight and mass are fundamentally different quantities: mass is an intrinsic property of matter, whereas weight is a force that results from the action of gravity on matter: it measures how strongly gravity pulls on that matter.

However, the recognition of this difference is historically a relatively recent development and in many everyday situations the word "weight" continues to be used when, strictly, "mass" is meant. For example, most people would say that an object "weighs one kilogram", even though the kilogram is a unit of mass.

The distinction between mass and weight is unimportant for many practical purposes because the strength of gravity is very similar everywhere on the surface of the Earth. In such a constant gravitational field, the gravitational force exerted on an object (its weight) is directly proportional to its mass. For example, object "A" weighs 10 times as much as object "B", so therefore the mass of object "A" is 10 times greater than that of object "B".

The difference between mass and weight is apparent when, for example objects are compared in different gravitational fields. For example, on the surface of the Moon, gravity is only about one-sixth as strong as on the surface of the Earth. A one-kilogram mass is still a one-kilogram mass (as mass is an intrinsic property of the object) but the downward force due to gravity is only one-sixth of what the object would experience on Earth. So the weight of the object on the moon will be one-sixth of what it would have on Earth.

To convert between weight (force) and mass, Newton's second law of "force = mass × acceleration" ($F = m \cdot a$) is used. Here, "F" is the force (weight) due to gravity, "m" is the mass of the object in question, and "a" is the acceleration due to gravity, on Earth approximately 9,81 m/s^2. For example, a mass of 2 kg experiences a weight force of 2 kg × 9,81 m/s^2 = 19,62 N.

Adapted from Wikipedia

	True	**False**	
1)	T	F	In science weight means the same as mass.
2)	T	F	Weight and mass are forces.
3)	T	F	Weight is a force.
4)	T	F	An object with one kilogram mass weighs one kilogram.
5)	T	F	The kilogram is a unit of mass.
6)	T	F	Sometimes the distinction between mass and weight is unimportant.
7)	T	F	Gravity on the Earth is different depending on the country.
8)	T	F	The weight of an object is directly proportional to its mass.
9)	T	F	The weight is 10 times greater than the mass.
10)	T	F	It's easy to understand the difference between mass and weight comparing the same object on different planets.
11)	T	F	On the Moon gravity is stronger than on Earth.
12)	T	F	The mass of an object is the same on the Moon as on Earth.
13)	T	F	The weight of an object is the same on the Moon as on Earth.
14)	T	F	We can know the weight of a mass using Newton's second law.
15)	T	F	On Earth the weight of a 5 kg mass is 37 N.

Worksheet 9:	**Conservation of energy principle**
Name:	
Group:	**Date:**

***Activity 15*:** *Find the card with the concept related to your definition. Dictate it to the members of your group and write all of them on your worksheet.*

a)	**Conservation of energy principle:**	____________________ ____________________
b)	**Friction:**	____________________ ____________________
c)	**Frictionless system:**	____________________ ____________________
d)	**Ideal machine:**	____________________ ____________________
e)	**Actual machine:**	____________________ ____________________
f)	**Efficiency:**	____________________ ____________________

<u>Given to students cut up</u> (one card to each member of the group except to the runner).

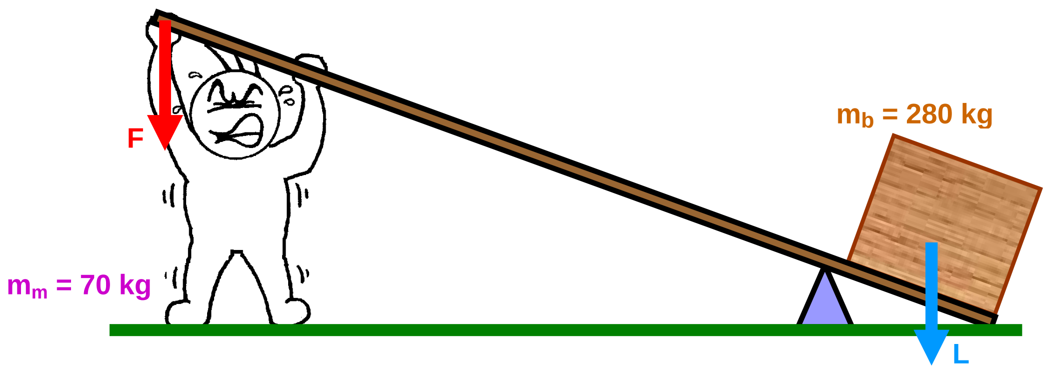
Conservation of energy principle
Friction
Frictionless system
Ideal machine
Actual machine
Efficiency

Cards cut up on a table

Energy can neither be created nor destroyed; it can only be transformed from one state to another.
Force that makes the relative motion between two objects more difficult.
Ideal system with no friction forces within it.
Theoretical machine in which there is no loss of energy (e.g., because of the friction).
Machine in which there is loss of energy (i.e., real machine)
Is the ratio of energy used by a machine to the useful work the machine has done.

Worksheet 10: Mechanical advantage 1	
Name:	
Group:	Date:

Activity 16: *Listen to the teacher and take notes about mechanical advantage.*



Worksheet 11: **Mechanical advantage 2**	
Name:	
Group:	**Date:**

Activity 17: *Answer the following questions. Use the answers from activities 15 and 16.*

1. *Do simple machines multiply energy?*

2. *What's the relationship between the input energy and the output work in an actual machine? Why?*

3. *What's the relationship between the input energy and the output work in an ideal machine? Why?*

4. *What principle related to energy do simple machines violate?*

5. *What's the cost of making less force with a simple machine to get the same energy?*

____

____

____

____

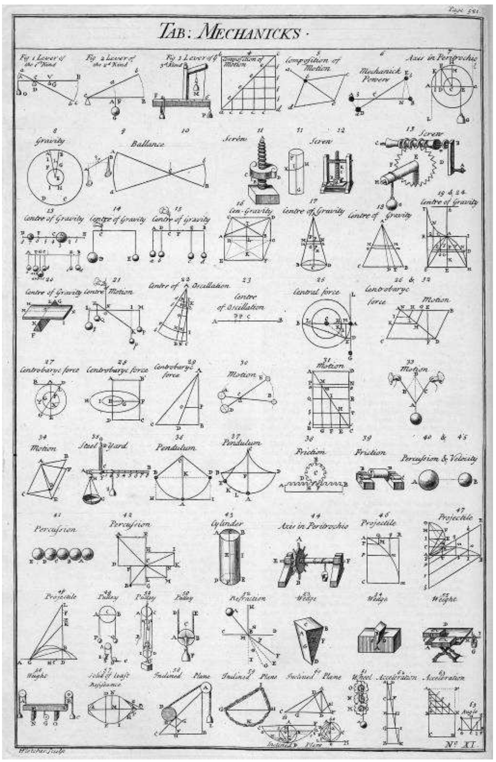
6. *How can we get the mechanical advantage formula?*

____

____

____

____



Worksheet 12: MA problems	
Name:	
Group:	**Date:**

Activity 18: *Solve the following problems.*

Problem A

A man is lifting a cupboard with a simple machine. The mass of the cupboard is m_c = 50 kg. To move cupboard, the man makes a 250 N force. Find the mechanical advantage of the machine.

Problem B

A person weighing 800 N moves an object with a simple machine using all his weight. The mechanical advantage of the machine is MA = 5. Determine the mass of the object.

Problem C

A car has a 1000 kg mass. We want to move it with a machine able to multiply the force applied 8 times. Calculate the effort we have to do to move the car.

Lesson 5: **Assessment**

Worksheet 13: **Assessment (Unit 1)**	
Name:	
Group:	**Date:**

Activity 19

1. *The pictures show different simple machines. Match the pictures with the names.*


inclined plane

wheel


lever

pulley


screw

wedge

2. *Fill in the table.*

QUANTITY	QUANTITY SYMBOL	UNIT OF MEASUREMENT	UNIT SYMBOL
length			
time			
mass			
force			
work			
energy			

3. *Match each of the following six concepts with its definition.*

Machine	Energy
Work	Force
Mechanical advantage	Simple machine

a) ____________________: any cause that can accelerate, decelerate, divert or deform an object.

b) ____________________: machine that changes the direction or the magnitude of a force.

c) ____________________: factor by which a machine multiplies the force applied to it.

d) ____________________: result of making a force over a distance.

e) ____________________: any device that uses energy to perform an activity.

f) ____________________: the ability to do work.

4. *Circle T or F to state if the sentences are true or false.*

a) T F In science weight means the same as mass.

b) T F Weight and mass are forces.

d) T F An object with one kilogram mass weighs one kilogram.

e) T F The weight of an object is directly proportional to its mass.

f) T F The mass of an object is the same on the Moon as on Earth.

g) T F On Earth the weight of a 5 kg mass is 37 N.

5. *Answer the following questions choosing the appropriate option.*

- The bigger the distance,…
  a) the bigger the force.
  b) the bigger the work.
  c) the bigger the speed.
  d) the bigger the acceleration.

- How many moving parts has a simple machine got?
  a) 10
  b) 15
  c) 20
  d) A simple machine has got few or no moving parts.

- Which are the two basic simple machines?
  a) The wheel and the wedge.
  b) The inclined plane and the screw.
  c) The inclined plane and the lever.
  d) The pulley and the wheel.

- What devices are variants on the inclined plane?
  a) The pulley and the wheel.
  b) The wedge and the hydraulic press.
  c) The wheel and the lever.
  d) The screw and the wedge.

- What devices are variants on the lever?
  a) The pulley and the wheel.
  b) The wedge and the hydraulic press.
  c) The wheel and the inclined plane.
  d) The screw and the wedge.

- When we say “energy can neither be created nor destroyed” we are stating…
  a) the simple machines’ principle.
  b) the conservation of energy principle.
  c) Newton’s second law.
  d) the simple machines’ law

- We can know the weight of a mass using….
  a) the simple machines’ principle.
  b) the conservation of energy principle.
  c) Newton’s second law.
  d) the simple machines’ law

6. *Using the words in the box, explain the difference between and an ideal machine and an actual machine.*

friction	frictionless system
theoretical	loss of energy
real	efficiency

___

___

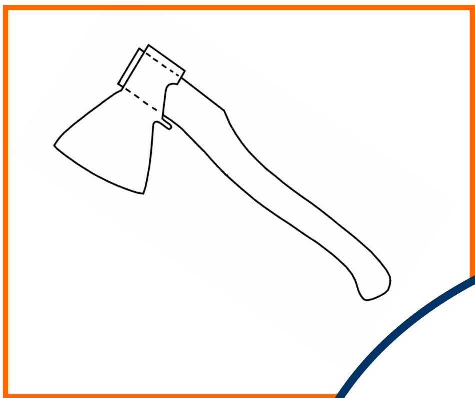
___

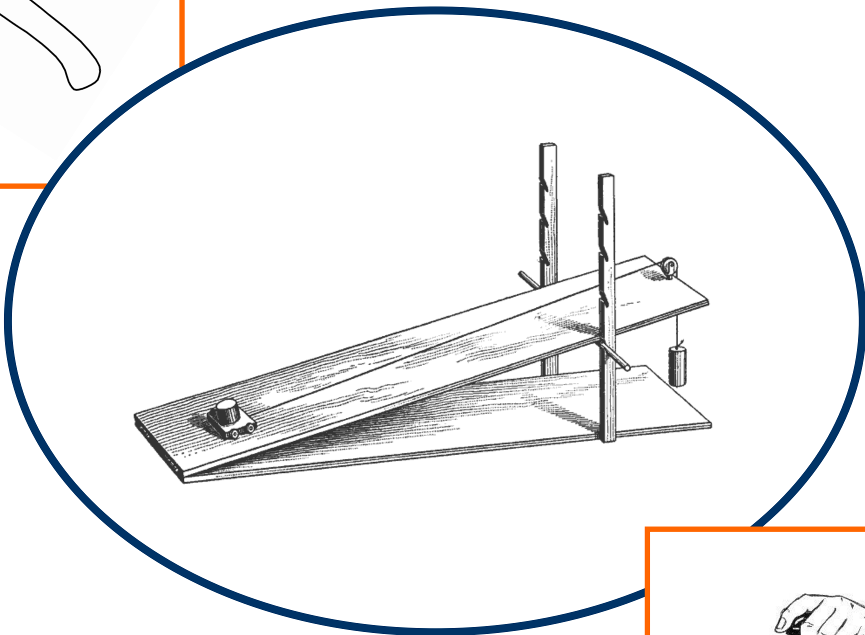
7. *A person drives a car over 50 m. The engine of the car makes a 1200 N force. Find the work done in the process.*

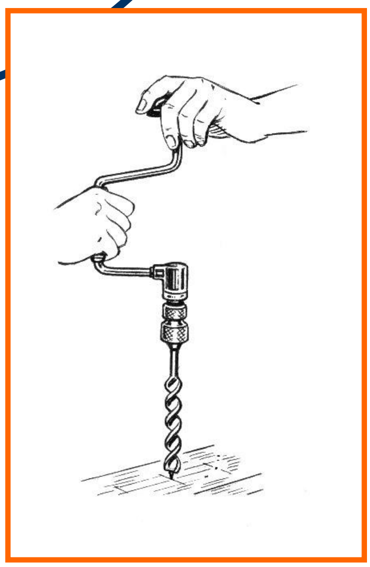
8. *A cupboard has a 60 kg mass. We want to move it with a machine able to multiply the force applied 3 times. Calculate the effort we have to do to move the cupboard.*

Unit 2

Inclined planes







Lesson 1: **The inclined plane**

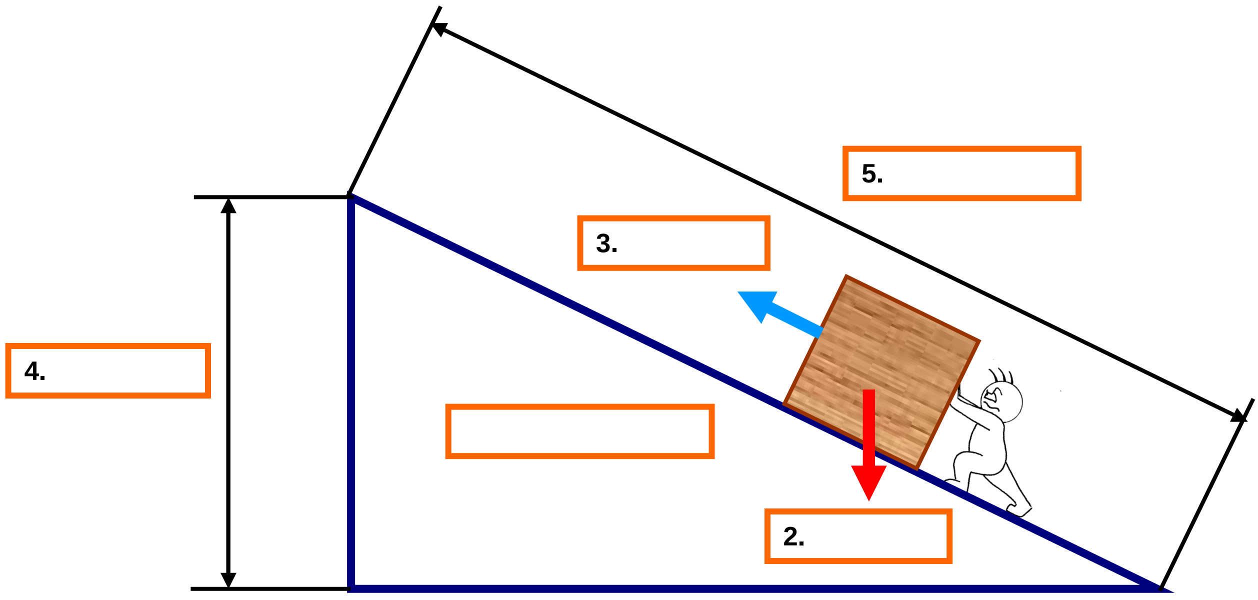
Worksheet 14: **The inclined plane 1**	
Name:	
Group:	**Date:**

Activity 20: *Each paragraph is an application of the inclined plane. Read the text and draw the different devices.*

1. It is a pipe with a wide mouth. It is used to channel liquid into bottles.	
2. It is a truck used to move furniture from one place to another. Portable ramps allow easy loading and unloading of this kind of trucks.	
3. It is a construction designed to bridge a large vertical distance by dividing it into smaller vertical distances, called steps.	
4. It is a truck used for transporting loose material (such as sand) for construction. It has an open-box which can be lifted up to allow the contents to be unloaded easily.	
5. It is a sport in which skiers go down a take-off ramp, jump, and attempt to land the furthest down on the hill below.	
6. It can be found in parks and schools. The user climbs to the top of it via a ladder or stairs, sits down on the top of it and slides down.	

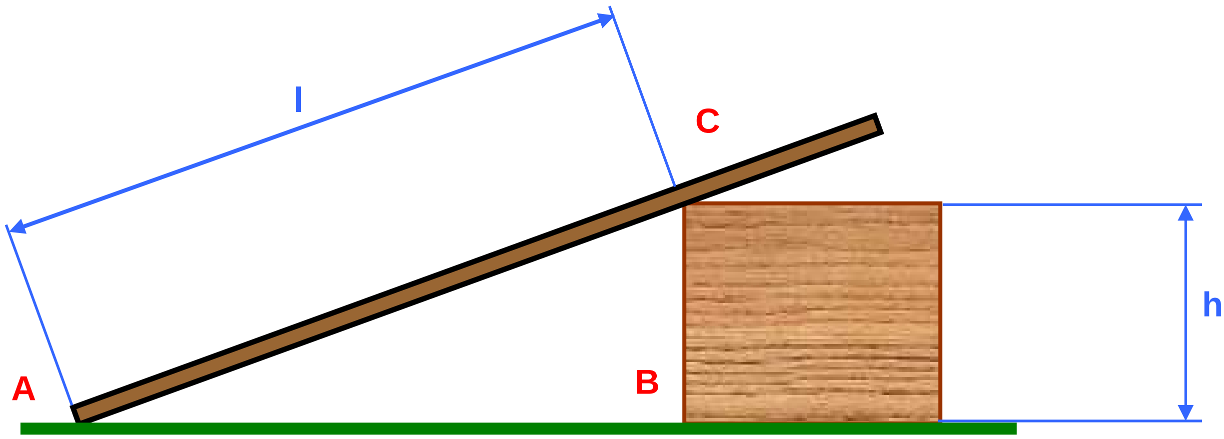
Activity 21: *Fill in the gaps with the appropriate letter (**e**, **n** or **t**). Then read the text and label the drawing.*

A_ i_cli__d pla__ is a fla_ surfac_ whos_ __dpoi__s ar_ a_ diff_r___ h_igh_s. By movi_g a_ obj_c_ up a_ i_cli__d pla__ ra_h_r _ha_ compl___ly v_r_ically, _h_ amou__ of forc_ r_quir_d is r_duc_d, a_ _h_ _xp__s_ of i_cr_asi_g _h_ dis_a_c_ _h_ obj_c_ mus_ _rav_l. W_ call _h_ w_igh_ of _h_ obj_c_ _h_ load a_d i_ ca_ b_ id___ifi_d wi_h _h_ l____r L. _h_ _ffor_ w_ hav_ _o apply _o mov_ _h_ obj_c_ is _h_ forc_ F. _h_ h_igh_ of _h_ i_cli__d pla__ is _h_ v_r_ical dis_a_c_ b__w___ _h_ low_s_ a_d _h_ high_s_ poi__s of _h_ ramp. W_ r_pr_s___ _his dis_a_c_ wi_h a_ h. _h_ pa_h _h_ obj_c_ mus_ follow if w_ wa__ _o us_ _his simpl_ machi__ is _h_ l__g_h (l) of _h_ i_cli__d pla__.



Worksheet 15: The inclined plane 2	
Name:	
Group:	Date:

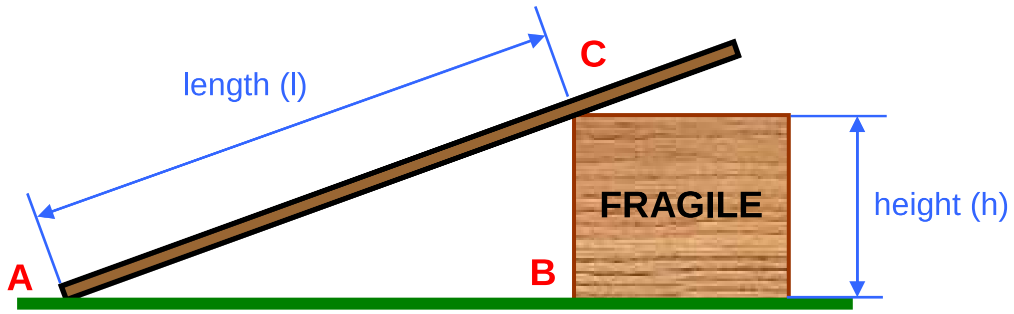
Activity 22: *Listen to the teacher and take notes about inclined plane.*



Worksheet 16:	**Constructing an inclined plane**
Name:	
Group:	**Date:**

Activity 23: *Follow the instructions to construct an inclined plane and check how it works.*

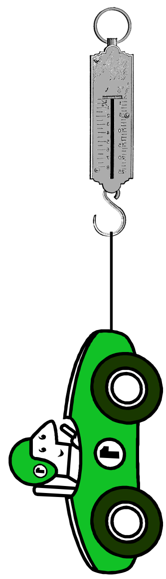
a) *Using the material provided prepare an inclined plane like in the figure.*



b) *Measure the length (l) and the height (h) of the plane with a measuring tape.*

	**l (m)**	**h (m)**

c) *Weigh the toy car with a dynamometer and calculate the work (W_h) to move it from B to C.*



L (N)	*This is the force we have to make to lift the car vertically from B to C*

***W_h* =**

d) *Considering an ideal system, the work to move the car from B to C (W_h) and the work to move it from A to C (W_l) are the same ($W_l = W_h$). Determine the theoretical force (F_t) needed to pull the car from A to C.*

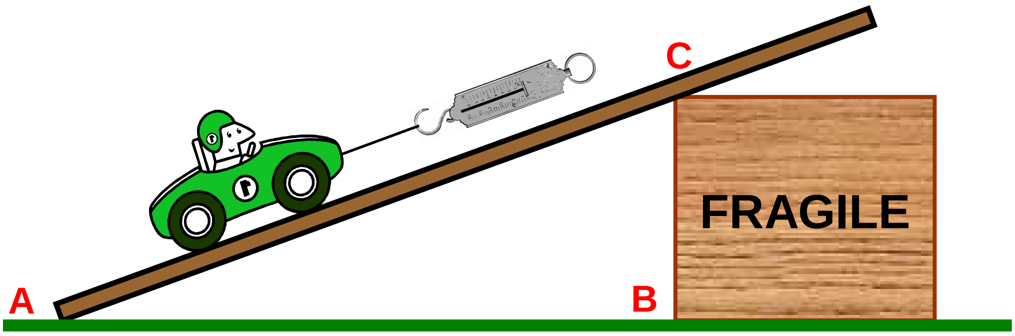
W_l = $\rightarrow$ **F_t =**

F_t (N)	*This is the theoretical force we should make to move the car from A to C.*

e) *Work out the theoretical mechanical advantage of the inclined plane (MA_t).*

MA_t =

f) *Put the car on the inclined plane and pull it from A to C. Read the actual force (F_a) you are making on the dynamometer's scale.*



Fa (N)	*This is the actual force we have to make to move the car from A to C.*

g) *Why is the actual force bigger than the theoretical force ($F_a > F_t$)?*

h) *Determine the actual mechanical advantage (MA_a).*

MA_a =

i) *Find out the actual work (W_a) we have to do to move the car from A to C.*

W_a =

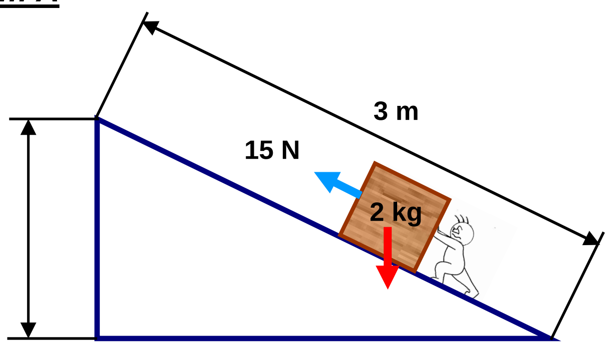
Worksheet 17: **Inclined plane problems**	
Name:	
Group:	**Date:**

Activity 24: *Solve one of the following problems with your group and explain it to the rest of the class. Listen to the other groups and write down all the problems.*

You may need this vocabulary:

First we calculate…	Then we…	After that…
The answer is…	The unknown is…	We isolate…
equals / is equal to	times / multiplied by	over / divided by
If we want to work out X…	If we want to find out Y…	

Problem A



Mass of the object:

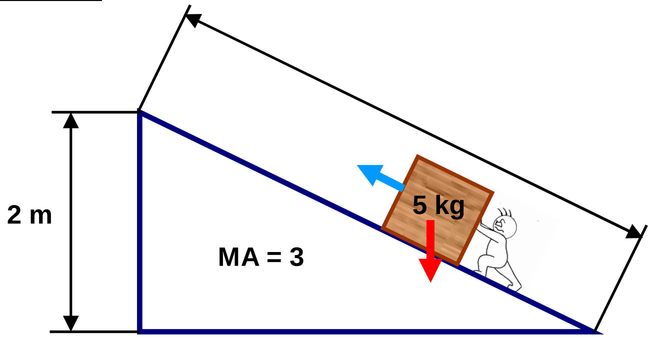
Length of the ramp:

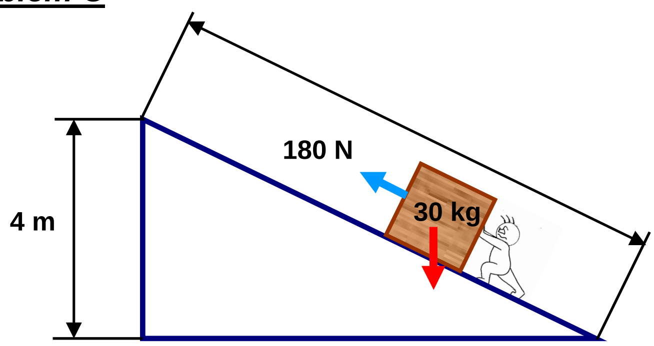
Force we have to make:

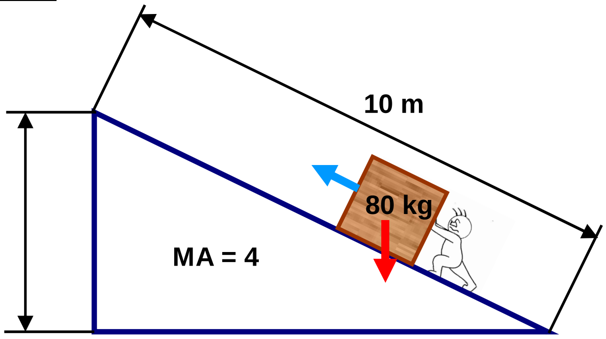
Load we want to move:

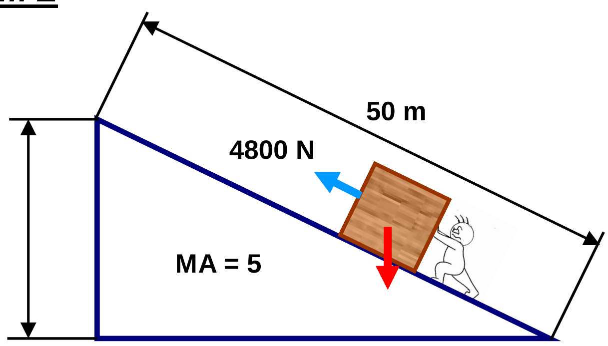
Mechanical advantage:

Height of the inclined plane:

Problem B	Mass of the object: Height of the inclined plane: Mechanical advantage: Load we want to move: Force we have to make: Length of the ramp:
	

Problem C	Mass of the object: Height of the inclined plane: Force we have to make: Load we want to move: Mechanical advantage: Length of the ramp:
	

Problem D	Mass of the object: Length of the ramp: Mechanical advantage: Load we want to move: Force we have to make: Height of the inclined plane:
	

Problem E	Length of the ramp: Force we have to make: Mechanical advantage: Load we want to move: Mass of the object: Height of the inclined plane:
	

<table>
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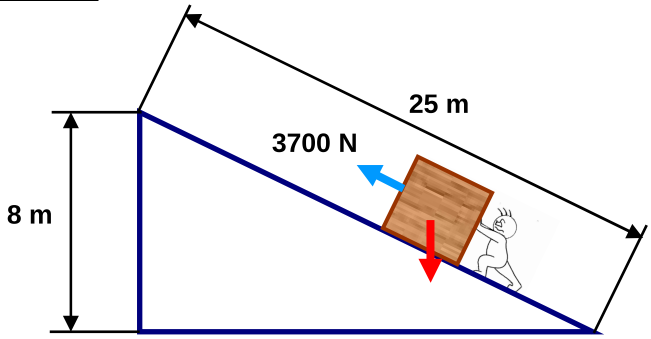
Problem F



</td><td>

Length of the ramp:

Height of the inclined plane:

Force we have to make:

Mechanical advantage:

Load we want to move:

Mass of the object:

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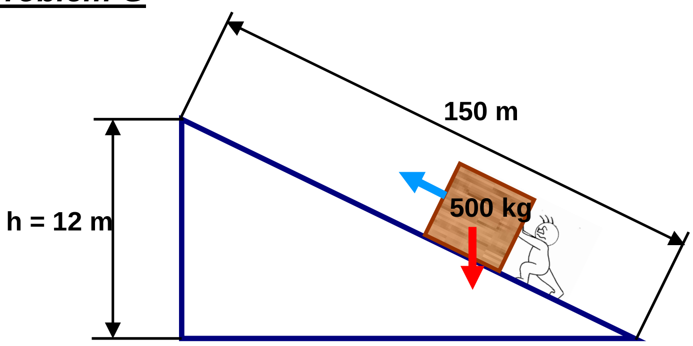
Problem G



</td><td>

Mass of the object:

Length of the ramp:

Height of the inclined plane:

Mechanical advantage:

Load we want to move:

Force we have to make:

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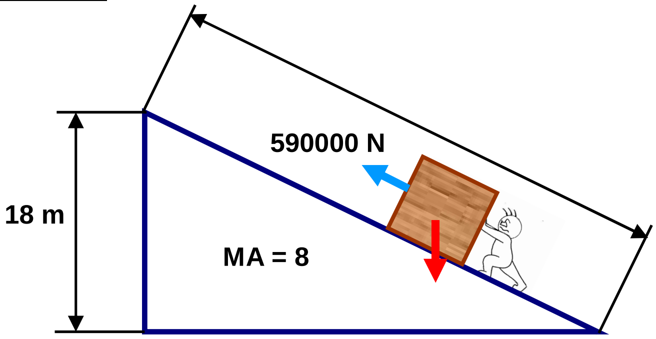
<u>Problem H</u>



</td><td>

Height of the inclined plane:

Force we have to make:

Mechanical advantage:

Load we want to move:

Mass of the object:

Length of the ramp:

</td></tr>
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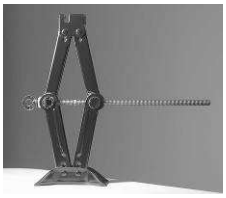
</table>

Worksheet 18: **Screws and wedges**	
Name:	
Group:	**Date:**

Activity 25: *Write the name of the following objects below their pictures and classify them between wedges and screws using the table in next page. If you think a device can be both simple machines, consider just the screw.*

1: ________________

2: ________________



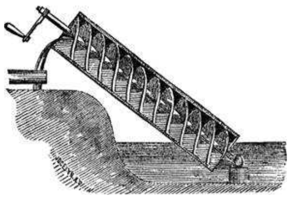
3: ________________

4: ________________

5: ________________

6: ________________

7: ________________



8: ________________

9: ________________

10:________________

11:________________

12:________________

13:________________

14:________________

15:________________

WEDGE	SCREW

***Activity 26*:** *Complete the crossword. All the words are items based on the wedge or the screw. Pictures from activity 25 can help you.*

Across

4. With this device we can make a hole in the ground.

5. Thanks to this item we can see in the dark.

7. We use it to eat what we cut with number 2.

8. If you turn it properly you can join two objects.

10. In the middle ages it used to be a weapon.

12. Machine for perforating materials.

13. With its teeth we can cut wood.

14. It can be full of honey, for example.

Down

1. It is a tool for opening wine bottles.

2. We use it to cut food.

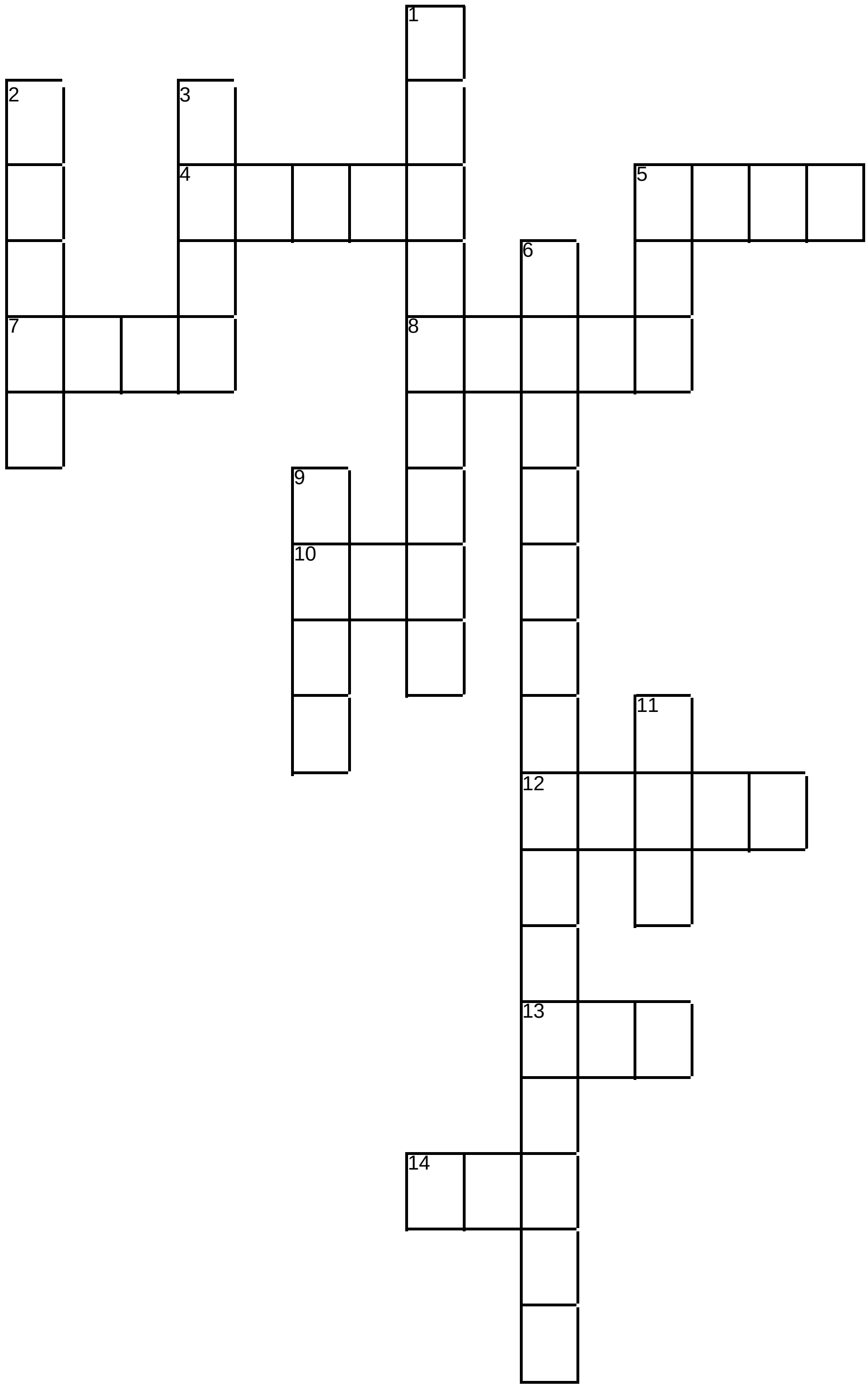
3. It is very useful when you have to change a wheel.

5. It is the front of a ship.

6. With this machine you can push water up (two words).

9. If you hit it with a hammer you can join two objects.

11. It can be used to fasten a poster to the wall.



Lesson 2: **The wedge**

Worksheet 19: The wedge 1	
Name:	
Group:	**Date:**

Activity 27: *Order the following words in each sentence and put the sentences into the correct sequence to obtain an explanation about the wedge and its shape.*

Student A

the	of	nail.	Round	tip	a	like

Student B

also	a	can	wedge	round.	be	But

Student C

meet	sharp	planes	a	and	edge.	These	form

Student D

of	The	inclined	is	adaptation	an	plane.	wedge	the

Student E

adaptation	back	back.	to	consists	This	inclined	planes	of	two	joined

Student F

In that case, wedges can be seen as many inclined planes beside each other around an axis.

Correct sentences

Student A:	
Student B:	
Student C:	
Student D:	
Student E:	
Student F:	In that case, wedges can be seen as many inclined planes beside each other around an axis.

Correct sequence

Sentence 1:	
Sentence 2:	
Sentence 3:	
Sentence 4:	
Sentence 5:	
Sentence 6:	In that case, wedges can be seen as many inclined planes beside each other around an axis.

Activity 28: *The following statements are similarities and differences between wedges and single inclined planes. Listen to the teacher and choose the appropriate underlined word to complete each sentence.*

A. The input force is applied thickness/parallel/perpendicular to the ramp of an inclined plane, while the input force is applied thickness/parallel/perpendicular to the thickness/parallel/perpendicular of the wedge.

B. Inclined/split/Instead of helping you to move things to a higher level as inclined/split/instead planes do, normally wedges help you to inclined/split/instead things apart.

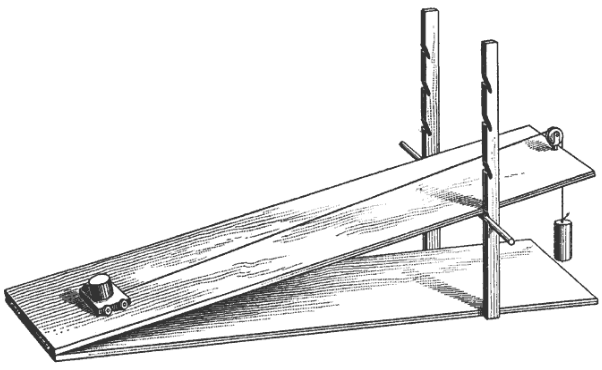
C. Although the wedge/both/machines is an adaptation of the inclined plane wedge/both/machines of them are simple wedge/both/machines.

D. The mechanical advantage of inclined planes and wedges is the output/input/ratio of the output/input/ratio force to the output/input/ratio force.

E. In both machines the bigger/angle/smaller the bigger/angle/smaller, the bigger/angle/smaller the mechanical advantage.

F. In use/remains/moves, an inclined plane use/remains/moves stationary while the wedge use/remains/moves.

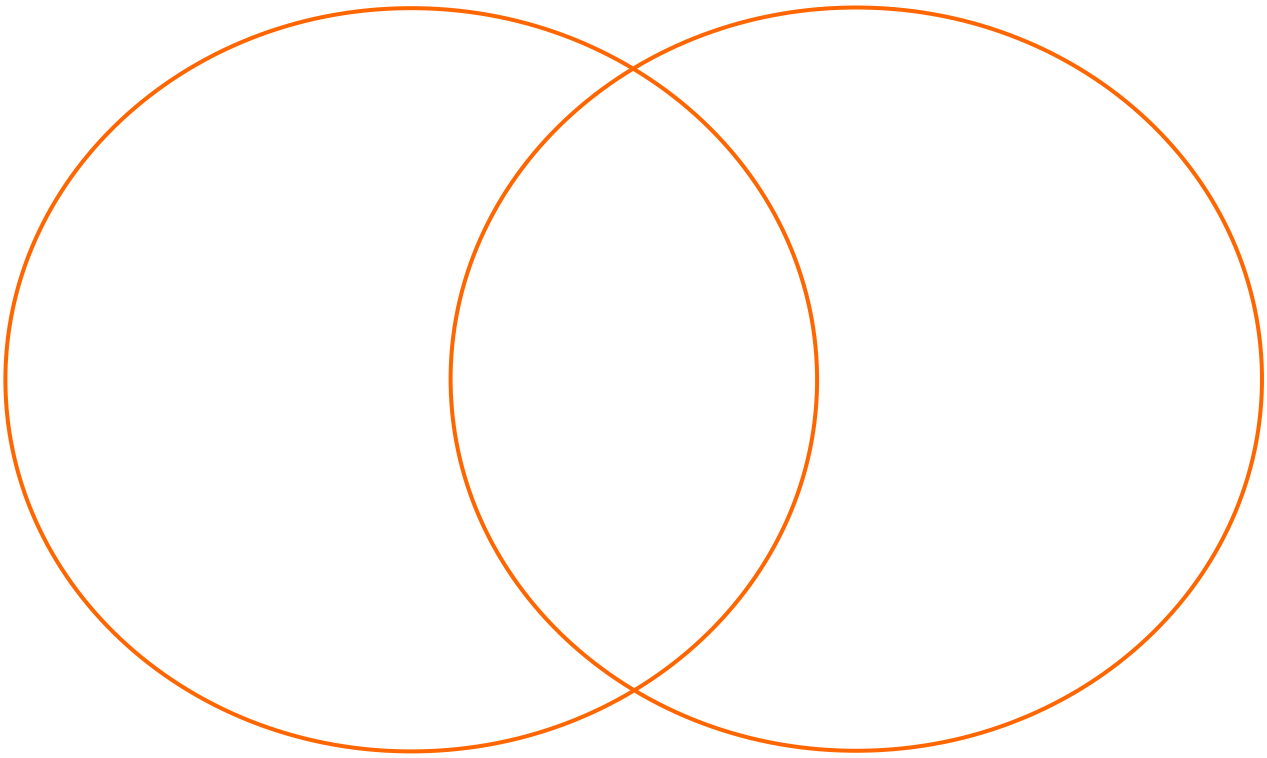
G. Inclined force/energy/planes and wedges multiply force/energy/planes but they don't multiply force/energy/planes.



Inclined plane

Wedge

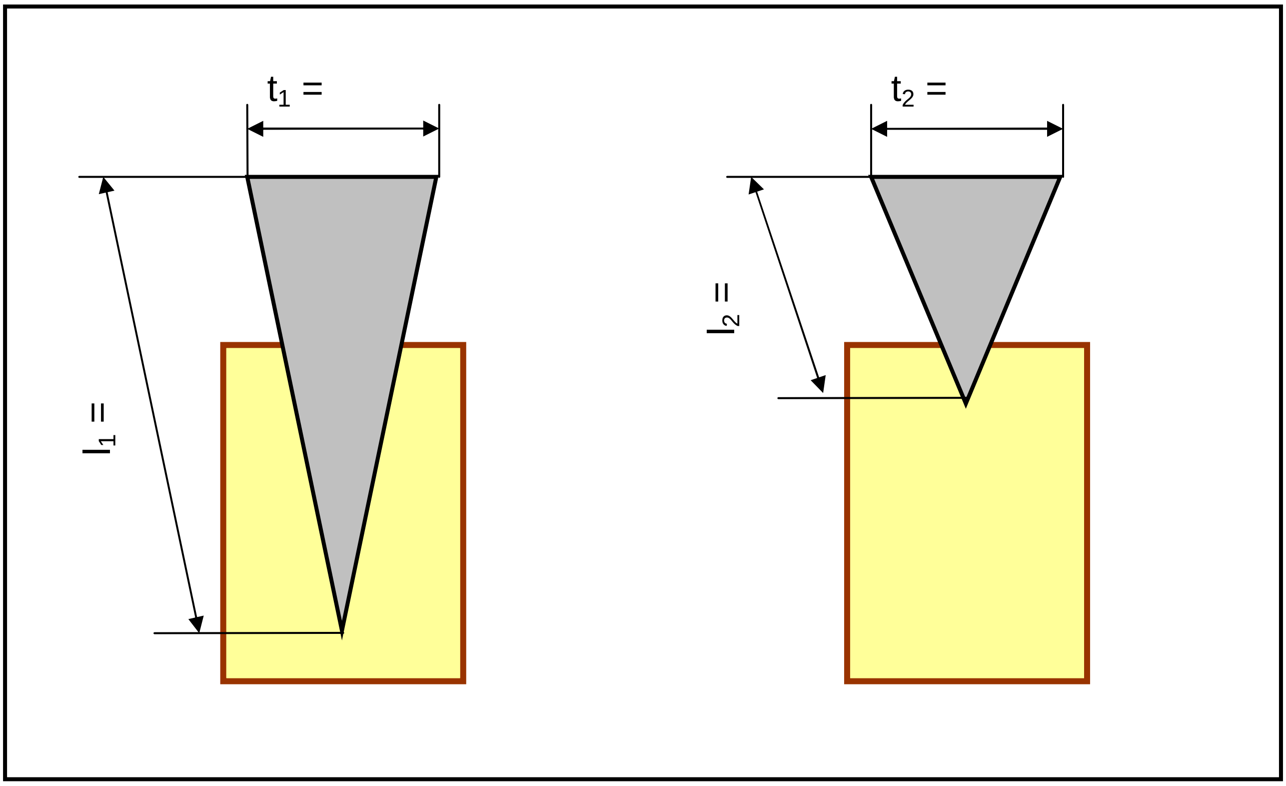
Use the information above to fill in the Venn diagram with similarities and differences about the inclined plane and the wedge.



Inclined plane **Wedge**

Worksheet 20: **The wedge 2**	
Name:	
Group:	**Date:**

Activity 29: *The mechanical advantage of a wedge can be calculated by dividing the length of the slope by its thickness (MA = l / t). Use a ruler to measure the dimensions of the wedges, find the mechanical advantage in both cases and answer the questions.*



Wedge 1	**Wedge 2**
MA_1 =	MA_2 =

1. *With which of the two wedges will be easier to split the rectangle apart? Why?*

2. *What output force (L) will we get with the first wedge if we hit its thick side (t) with a 500 N force (F)? And with the second one?*

3. *How deep do we have to drive the first wedge in to open a 2,5 cm crack in the rectangle? And the second one?*

4. *We have seen that usually inclined planes are used to move things to a higher level and wedges are used to split things apart. Think about another application of inclined planes and wedges and give some examples.*

Lesson 3: **The screw**

Worksheet 21: **The screw 1**	
Name:	
Group:	**Date:**

Activity 30: *Look up in the dictionary the following words and write the meaning in the boxes.*

Cathetus:

Hypotenuse:

Thread:

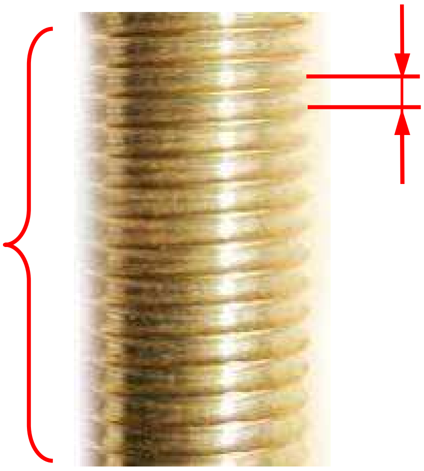
Screw:

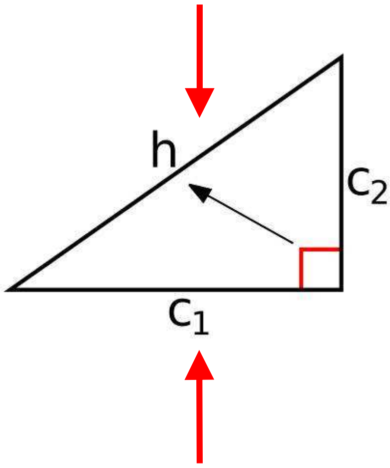
Bolt:

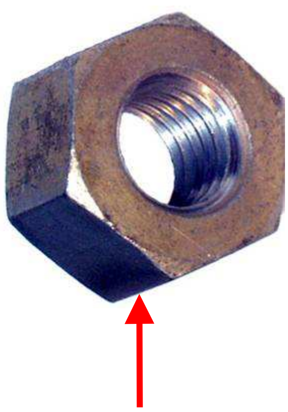
Nut:

Pitch:

Activity 31: *Find in the following pictures the words you have learnt in activity 30. Each word must be written just once.*







Worksheet 22: **The screw 2**	
Name:	
Group:	**Date:**

Activity 32: *If you put a metal screw beside a ramp it may be hard to see the similarities, but the screw is actually just another kind of inclined plane. Follow the instructions to get a screw from an inclined plane.*

a) *Cut a right-angled triangle from a sheet of paper. The dimensions of the minor cathetus should be 10 cm and the length of the major cathetus should be 15 cm.*

b) *Use a marker to colour the hypotenuse of the triangle.*

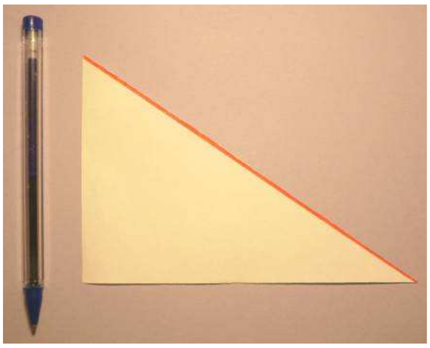
c) *Position the minor cathetus of the triangle along the side of a pen.*

d) *Fasten the minor cathetus to the pen with a piece of adhesive tape.*

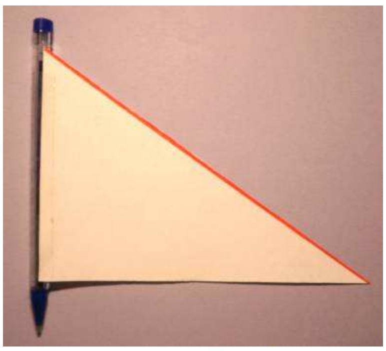
e) *Wrap the paper around the pen by rolling the pen.*

f) *Fasten the end of the triangle with a piece of adhesive tape.*

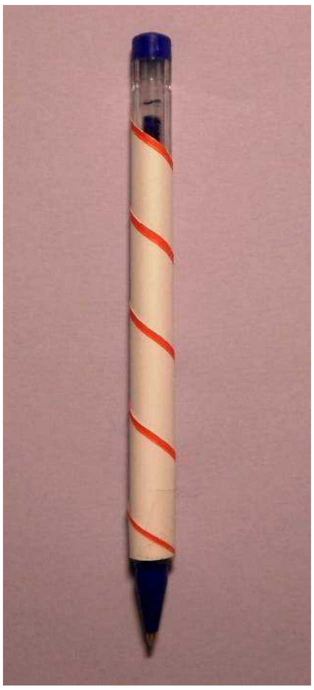
a) + b)



c) + d)



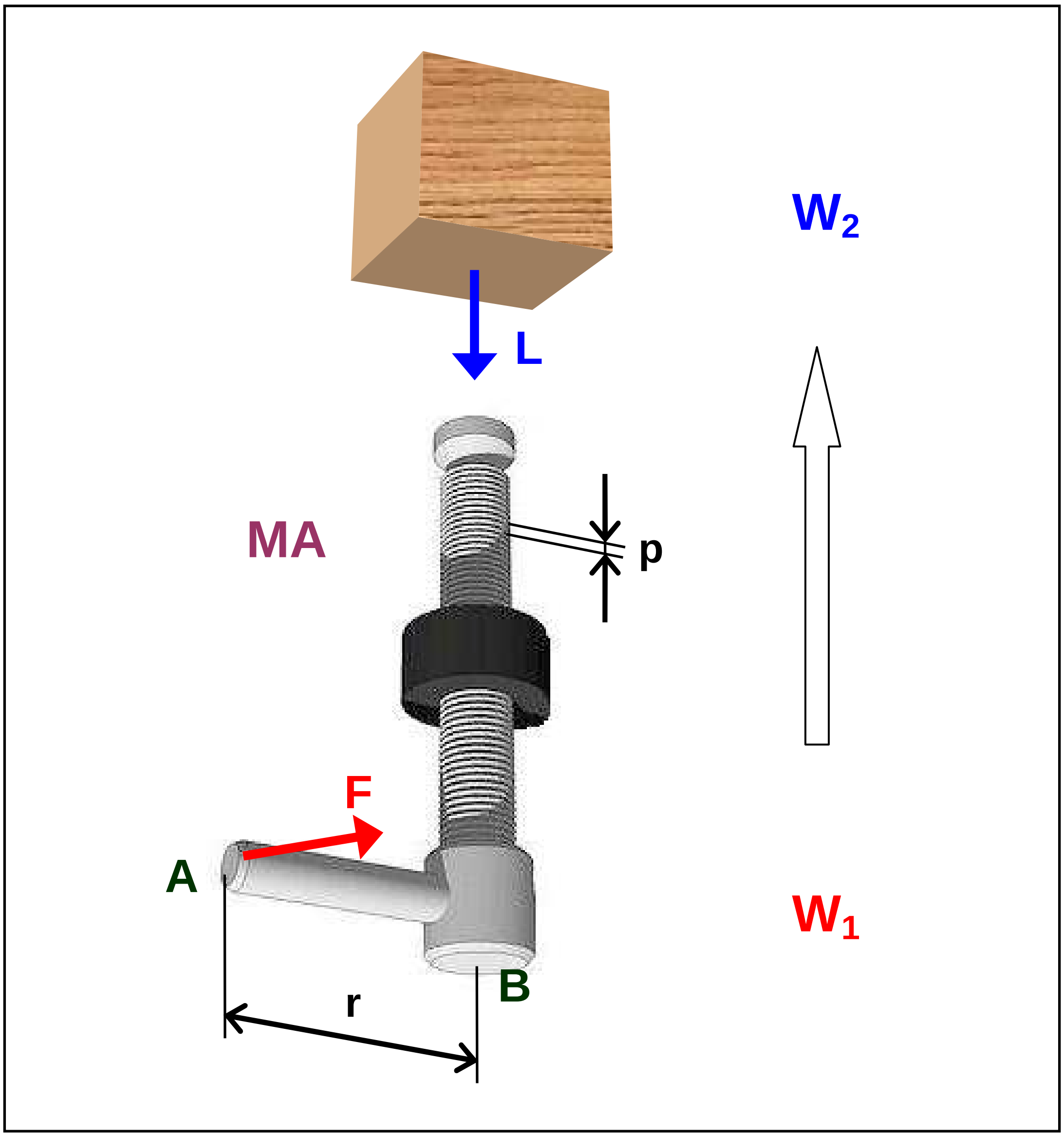
e) + f)



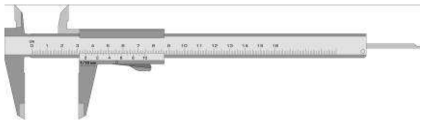
Activity 33: *To study the mechanical advantage of the screws take a bench vice, a c-clamp or any similar device. Imagine you want to use this tool to raise something up the same way we use a jack to lift a car. Look at the pictures and follow the instructions.*

Bench vice

C-clamp



a) *Measure the length (r) of the handle (the distance from A to B) using a ruler, a measuring tape or a calliper.*

 Measuring tape	 Calliper	**r (m)**

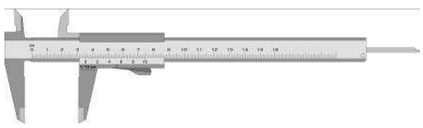
b) *If you turn the handle a complete round making a force (F), point A will describe a circumference. Work out the length of the circumference (remember: $l_c = 2 \cdot \pi \cdot r$)*

l_c =

c) *Find out the work (W_1) you will do if you turn the handle a complete round making a 100 N force (F).*

W_1 =

d) *Measure the pitch (p) of the screw using a ruler, a measuring tape or a calliper. The pitch is the distance you lift the box (L) each time you turn the handle a complete round.*

 Measuring tape	 Calliper	**p (m)**

e) *Conservation of energy principle says that the input work of a machine (W_1) must be equal to the output work of that machine (W_2). Considering an ideal system (no loss of energy) W_2 will be...*

W_2 =

f) *"W_2" is the needed work to move the load (L) a distance "p". Find out the maximum weight (L) we could lift with the screw making a 100 N force. Calculate also the maximum mass (m).*

W_2 =	$\rightarrow$	**L =**
L =	$\rightarrow$	**m =**

g) *Work out the mechanical advantage of the screw (MA).*

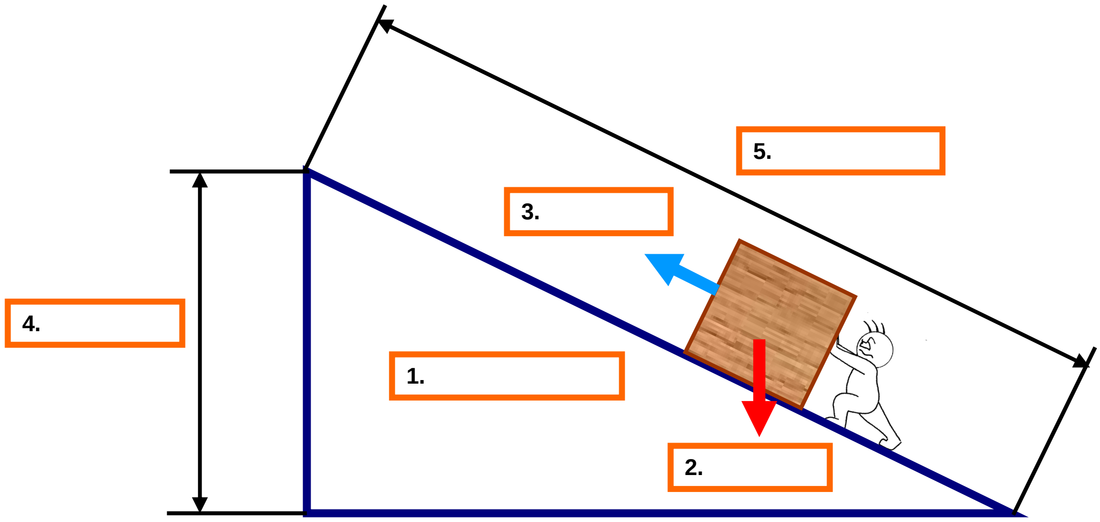
MA =

Lesson 4: **Assessment**

Worksheet 23: **Assessment (Unit 2)**	
Name:	
Group:	**Date:**

Activity 34

1. *Fill in the boxes of the drawing with the appropriate names.*



2. *A person wants to build an inclined plane to move a box to a higher lever. The height he wants to reach is 3 m. The mass of the box is 85 kg and he is able to push with a 500 N force. Work out the needed length of the ramp and the mechanical advantage of the inclined plane.*

3. *Write down the name of the following devices and classify them between single inclined planes, wedges and screws.*

1: ________________

2: ________________

3: ________________

4: ________________

5: ________________

6: ________________

7: ________________

8: ________________

9: ________________

INCLINED PLANE	WEDGE	SCREW

4. Match each of the following six concepts with its definition.

Cathetus	Bolt
Pitch	Nut
Thread	Hypotenuse

a) ____________________: the longest side of a right-angled triangle, the side opposite the right angle.

b) ____________________: helical structure used to convert between rotational and linear movement or force.

c) ____________________: screw intended to be tightened or released by torquing a nut.

d) ____________________: in a right-angled triangle either of the sides that are adjacent to the right angle.

e) ____________________: a type of fastener with a threaded hole.

f) ____________________: the distance from the crest of one thread to the next.

5. Circle T or F to state if the sentences are true or false.

a) T F The input force is applied perpendicular to the ramp of an inclined plane.

b) T F In use, an inclined plane remains stationary while the wedge moves.

d) T F Inclined planes multiply force and wedges multiply energy.

e) T F Wedges can't help you to split things apart.

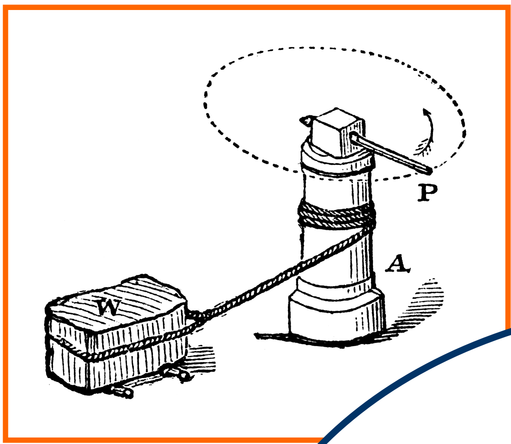
f) T F The wedge is and adaptation of the inclined plane.

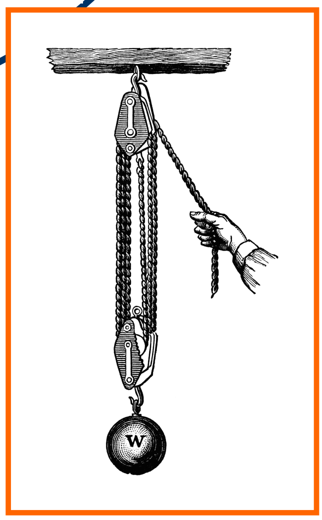
g) T F Wedges can be round.

6. *A car weighs 12000 N. To change a wheel we have to lift half of the car with a jack. The pitch of the screw is 1 cm and the length of the handle is 20 cm. Find out the force needed to lift the car and determine the mechanical advantage of the jack.*

Unit 3

Levers





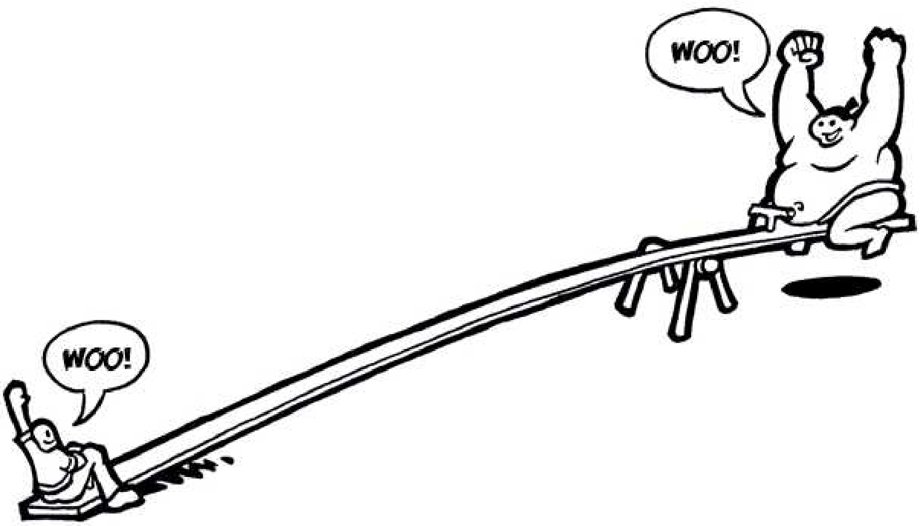
Lesson 1: **The lever**

Worksheet 24: **The lever**	
Name:	
Group:	**Date:**

Activity 35: *The following pictures show two seesaws. The seesaw is an application of the lever. Look at the pictures, discuss with your partner and answer the questions on the next page.*

Seesaw 1

Seesaw 2



1. *In the first picture, why is the man up and the girl down?*

2. *Think about three different ways the man and the girl could balance the seesaw?*

3. *In the second picture, why is the small man down and the big man up?*

4. *What would happen if the small man moved closer to the pivoting point of the seesaw?*

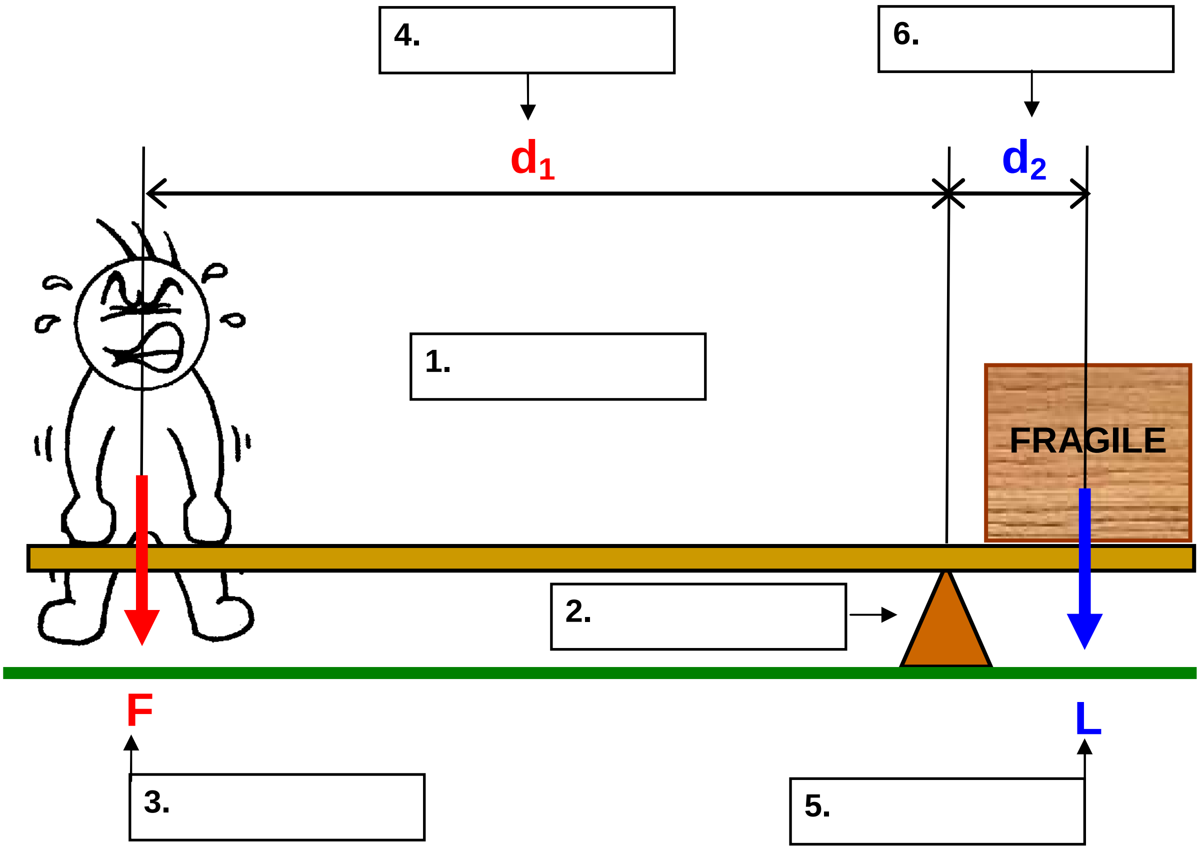
Activity 36: *Listen to the teacher and fill in the gaps with the words from the box. Then read the text and label the drawing.*

pivot	*fulcrum*	*force*	*lever*	*arm*	*load*

A .... is a simple machine that consists of a rigid bar that rotates about a fixed .... point called the .... If you apply a .... to a .... it will rotate about the ....

The effort .... is exerted upon one ...., called .... The .... is the perpendicular distance between the .... and the ....

The resisting weight or .... is exerted upon the other ...., which we will call .... The .... is the perpendicular distance between the .... and the ....



Worksheet 25: The law of the lever	
Name:	
Group:	**Date:**

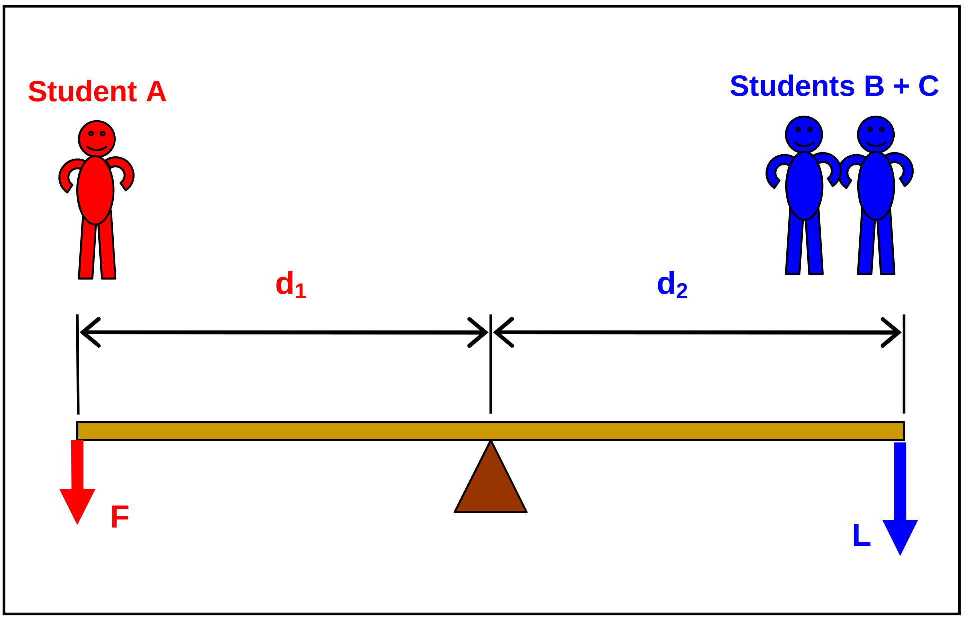
Activity 37: *Follow the instructions to study the law of the lever. Take photos of all the process.*

a) *Student A will be the <u>force</u> (**F**) and students B and C together will be the <u>load</u> (**L**). Be sure that students B and C together are heavier than student A.*

b) *Weigh yourself using a bathroom scale.*

	Mass (kg)	**Weigh (N)**	**Force (A)**	**Load (B+C)**
Student A	m_A =	mg_A =	F =	----------------------
Student B	m_B =	mg_B =	----------------------	L =
Student C	m_C =	mg_C =	----------------------	

c) *Go to a playground where you can find a seesaw. Take a measuring tape with you.*



d) *Using the measuring tape, measure the distance between both seats and the centre of the seesaw. These distances will be the <u>force arm</u> (**d_1**) and the <u>load arm</u> (**d_2**).*

Force arm (m)	**Load arm (m)**
d_1 =	d_2 =

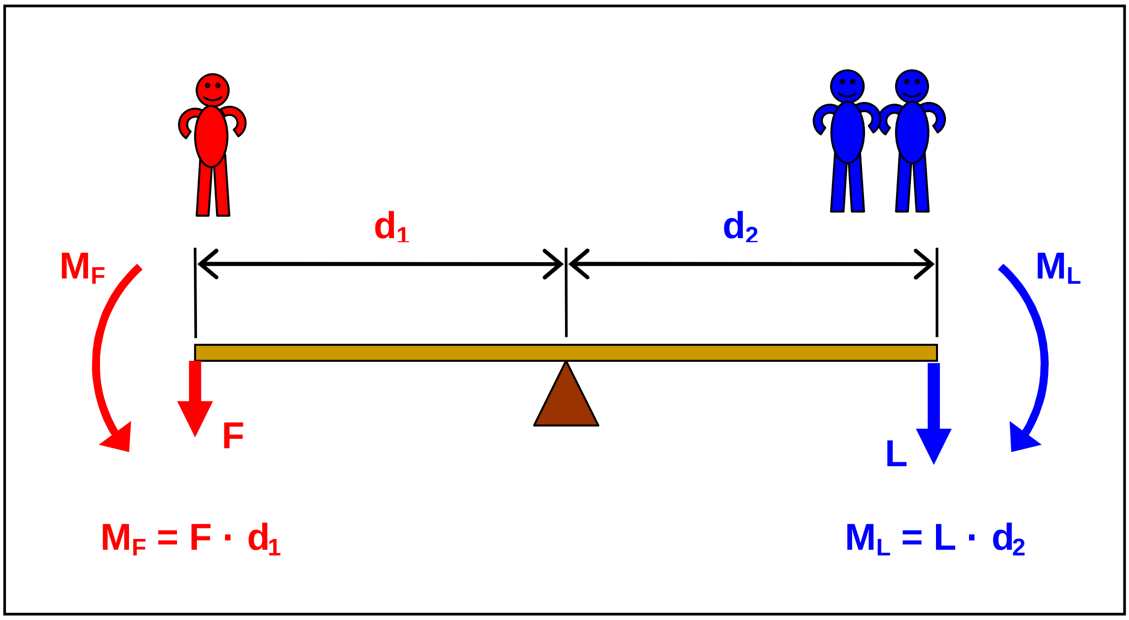
e) *Each student sits on their seat. Students B and C try to sit as close as possible to each other. What happens to the seesaw?*

____

____

____

f) *In the picture below, the force F tries to turn the seesaw anticlockwise and the load L tries to turn it clockwise. Remember that this tendency of a force to rotate an object around an axis is called the **<u>moment of force</u>**.*



Multiply force F by its arm d_1 and you will get the moment of force (M_F). Multiply load L by its arm d_2 and you will get the moment of load (M_L).

Moment of force	M_F =
Moment of load	M_L =

Choose the correct sentence and write it under the table:

Student A goes	up because $\mathbf{M_F}$ is	bigger than (>)	$\mathbf{M_L}$
----------------------------		equal to (=)	
Students B and C go		smaller than (<)	

Correct sentence: ____

g) *To get the seesaw balanced, both moments should be equal:*

$$M_F = M_L$$

so:

$$\boxed{F \cdot d_1 = L \cdot d_2}$$

This equation is called ***the law of the lever***

Mathematically, it is the same to write:

$$\frac{d_1}{d_2} = \frac{L}{F}$$

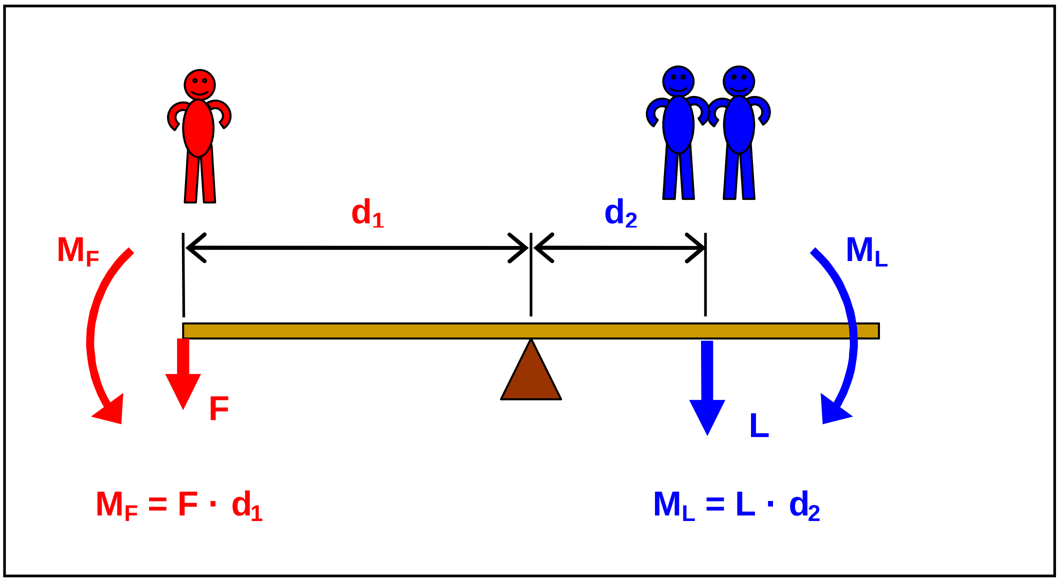
But the ratio of load to force is the mechanical advantage of a simple machine. So:

$$\boxed{MA = \frac{d_1}{d_2} = \frac{L}{F}}$$

h) *Isolate d_2 in the law of the lever and you will find out the distance you have to locate the load to balance the seesaw.*

d_2 =

i) *Check the result changing the position of students B and C to the new distance d_2.*



j) *Work out the mechanical advantage of the seesaw with the new distance d_2.*

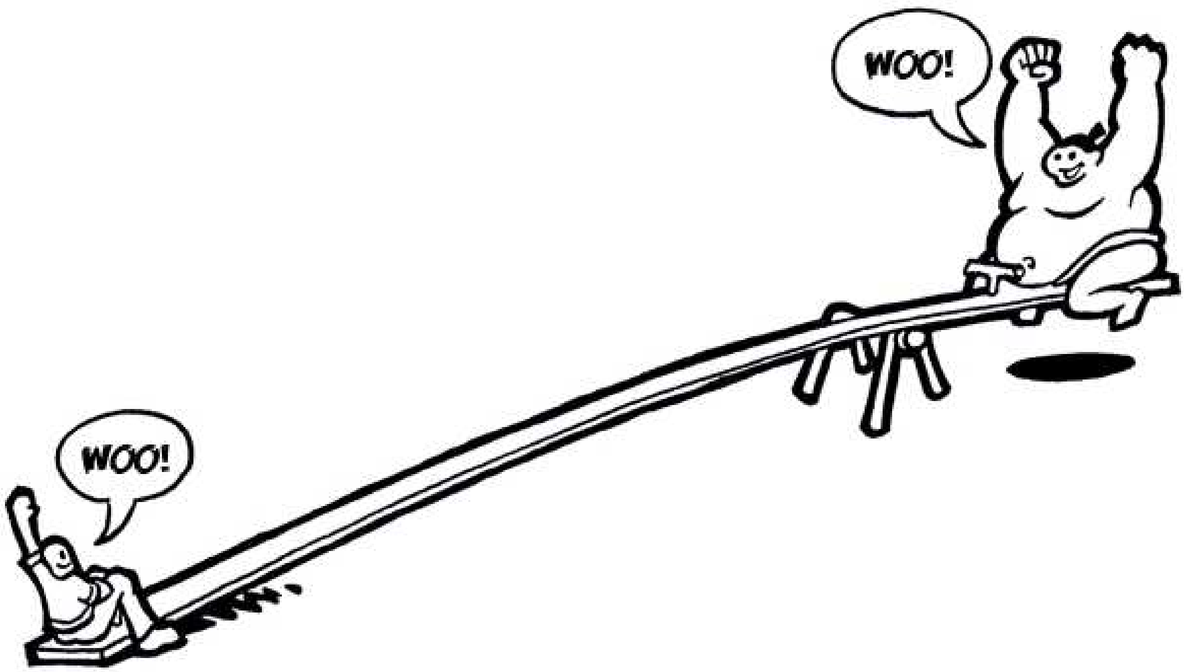
MA =

k) *Fill in the gaps with the appropriate words and you will get some conclusions:*

Thanks to the .... we can move a big .... (students B and C) making a small .... (student A) because the force .... (d_1) is much longer than the load .... (d_2).
The shorter the load .... (d_2), the smaller the .... (F) needed to lift the ....(L). The longer the force .... (d_1), the bigger the .... (L) we can lift.
The .... (MA) of a .... is the ratio of the .... arm (d_1) to the load .... (d_2).

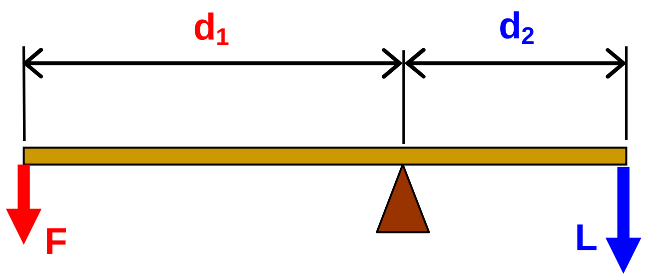
l) *Using the pictures you have taken and the results of the activity, prepare a 5 minute slideshow for the following day*

Lesson 2: **Classes of levers**



Worksheet 26: **Classes of lever**	
Name:	
Group:	**Date:**

Activity 38: *Levers are divided into three classes, according to the relative situation of the fulcrum, the load and the force. Look at the pictures and answer the questions below.*



First class lever

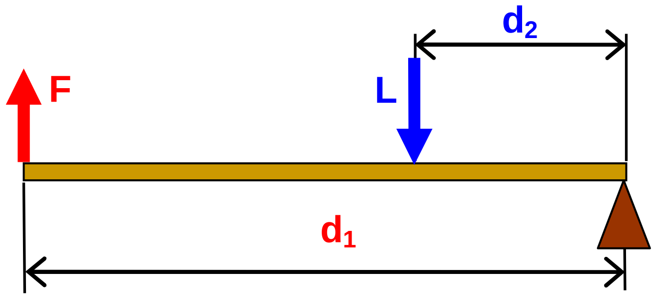
1. Draw on the photo of the seesaw all the elements of the lever (fulcrum, force, load, force arm and load arm)

2. In a first class lever…
- **a)** the load is situated between the fulcrum and the force.
- **b)** the fulcrum is situated between the force and the load.
- **c)** the force is situated between the load and the fulcrum.

3. In a first class lever…
- **a)** the force arm is never smaller than the load arm.
- **b)** the force arm is never bigger than the load arm.
- **c)** the force arm can be bigger, equal to or smaller than the load arm

4. In a first class lever…
- **a)** the mechanical advantage could be bigger than 1, smaller than 1 or 1.
- **b)** the mechanical advantage is never bigger than 1.
- **c)** the mechanical advantage is never smaller than 1.

5. With a first class lever we can…
- **a)** multiply just distance and speed.
- **b)** multiply force or distance and speed.
- **c)** multiply just force.



Second class lever

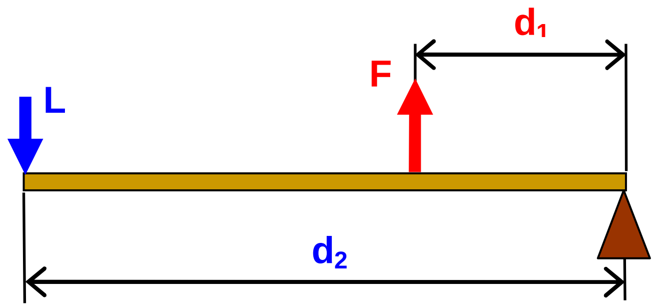
1. Draw on the photo of the wheelbarrow all the elements of the lever (fulcrum, force, load, force arm and load arm).

2. In a second class lever…
   a) the load is situated between the fulcrum and the force.
   b) the fulcrum is situated between the force and the load.
   c) the force is situated between the load and the fulcrum.

3. In a second class lever…
   a) the force arm is never smaller than the load arm.
   b) the force arm is never bigger than the load arm.
   c) the force arm can be bigger, equal to or smaller than the load arm

4. In a second class lever…
   a) the mechanical advantage could be bigger than 1, smaller than 1 or 1.
   b) the mechanical advantage is never bigger than 1.
   c) the mechanical advantage is never smaller than 1.

5. With a second class lever we can…
   a) multiply just distance and speed.
   b) multiply force or distance and speed.
   c) multiply just force.



Third class lever

1. Draw on the photo of the <u>fishing rod</u> all the elements of the lever (fulcrum, force, load, force arm and load arm).

2. In a third class lever…
   a) the load is situated between the fulcrum and the force.
   b) the fulcrum is situated between the force and the load.
   c) the force is situated between the load and the fulcrum.

3. In a third class lever…
   a) the force arm is never smaller than the load arm.
   b) the force arm is never bigger than the load arm.
   c) the force arm can be bigger, equal to or smaller than the load arm.

4. In a third class lever…
   a) the mechanical advantage could be bigger than 1, smaller than 1 or 1.
   b) the mechanical advantage is never bigger than 1.
   c) the mechanical advantage is never smaller than 1.

5. With a third class lever we can…
   a) multiply just distance and speed.
   b) multiply force or distance and speed.
   c) multiply just force.

Worksheet 27: Examples of levers	
Name:	
Group:	**Date:**

Activity 39: *The following items are examples of levers. Use the dictionary to translate them into Catalan.*

ENGLISH	CATALAN	ENGLISH	CATALAN
Scissors		Paper cutter	
Hole punch		Tweezers	
Broom		Crowbar	
Pincers		Shovel	
Scales		Can opener	
Wheelbarrow		Stapler	
Tongs		Bicycle brake	
Nutcracker		Seesaw	
Pliers		Oar	
Fishing rod		Bottle opener	
Fire extinguisher handle		Arm lifting a weight	

Activity 40: *Choose five devices which are levers or can be used as levers and that we can find at home, at school or somewhere else. Take a picture of them. Prepare a 5 minute slideshow presentation for the following day. You need to explain what class of lever your items are. You also have to show on the pictures all the elements of the levers (fulcrum, force, load, force arm and load arm).*

Activity 41: *Classify the levers from activity 39 according to the class of lever they are. Some of the examples can be different classes of lever depending on the way we use them.*

First class levers	Second class levers	Third class levers

Worksheet 28: **Lever problems**	
Name:	
Group:	**Date:**

Activity 42: *Solve the following problems.*

You may need this vocabulary:

First we calculate…	Then we…	After that…
The answer is…	The unknown is…	We isolate…
equals / is equal to	times / multiplied by	over / divided by
If we want to work out X…	If we want to find out Y…	

Problem A

The force arm of a lever is 4 m long and the length of the load arm is 1 m. Calculate the force F needed to lift a 1000 N load and find out the mechanical advantage of the lever.

Problem B

The force arm of a lever is 2 m long and the length of the load arm is 80 cm. Work out the weight we can lift making a 200 N force and calculate the mechanical advantage of the lever.

Problem C
The force arm of a lever is 1,5 m long. We want to lift a 2500 N weight applying a 1200 N force. Find out the length of the load arm needed and work out the mechanical advantage of the lever.

Problem D
The load arm of a lever is 0,5 m long. We want to lift a 4000 N weight applying a 500 N force. Find out the length of the force arm needed and work out the mechanical advantage of the lever.

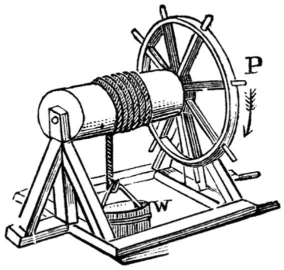
Lesson 3: **Wheel and axle**

Worksheet 29: **Wheel and axle**	
Name:	
Group:	**Date:**

Activity 43: *The pictures show different applications of the simple machine called wheel and axle. Match the pictures with the names.*

steering wheel

bicycle

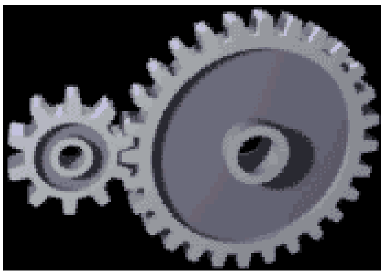


windlass

coffee grinder

pepper mill

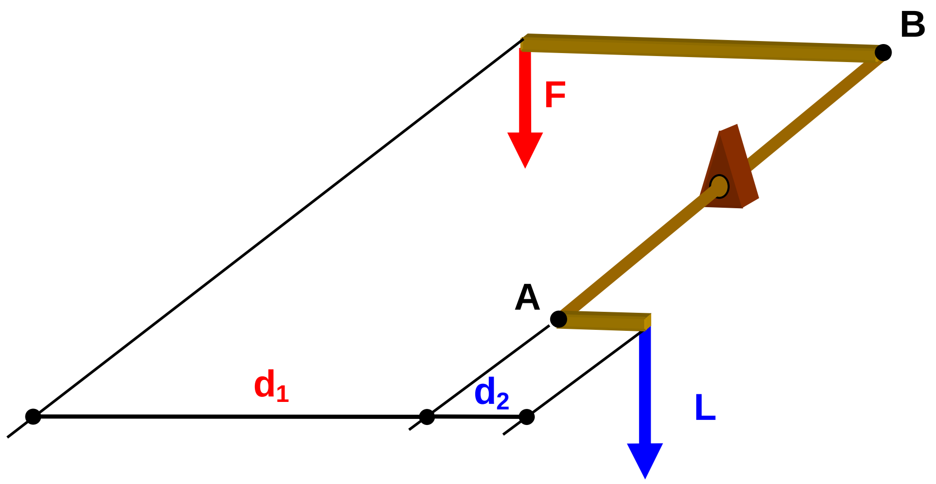
water tap



gears

Ferris wheel

Activity 44: *The bended bar can turn around the hole of the triangle. A force (F) is applied to lift a load (L). The distance between the force and the fulcrum is d_1. The distance between the load and the fulcrum is d_2.*



a) *What kind of simple machine is it?*

---

b) *How could you find out its mechanical advantage?*

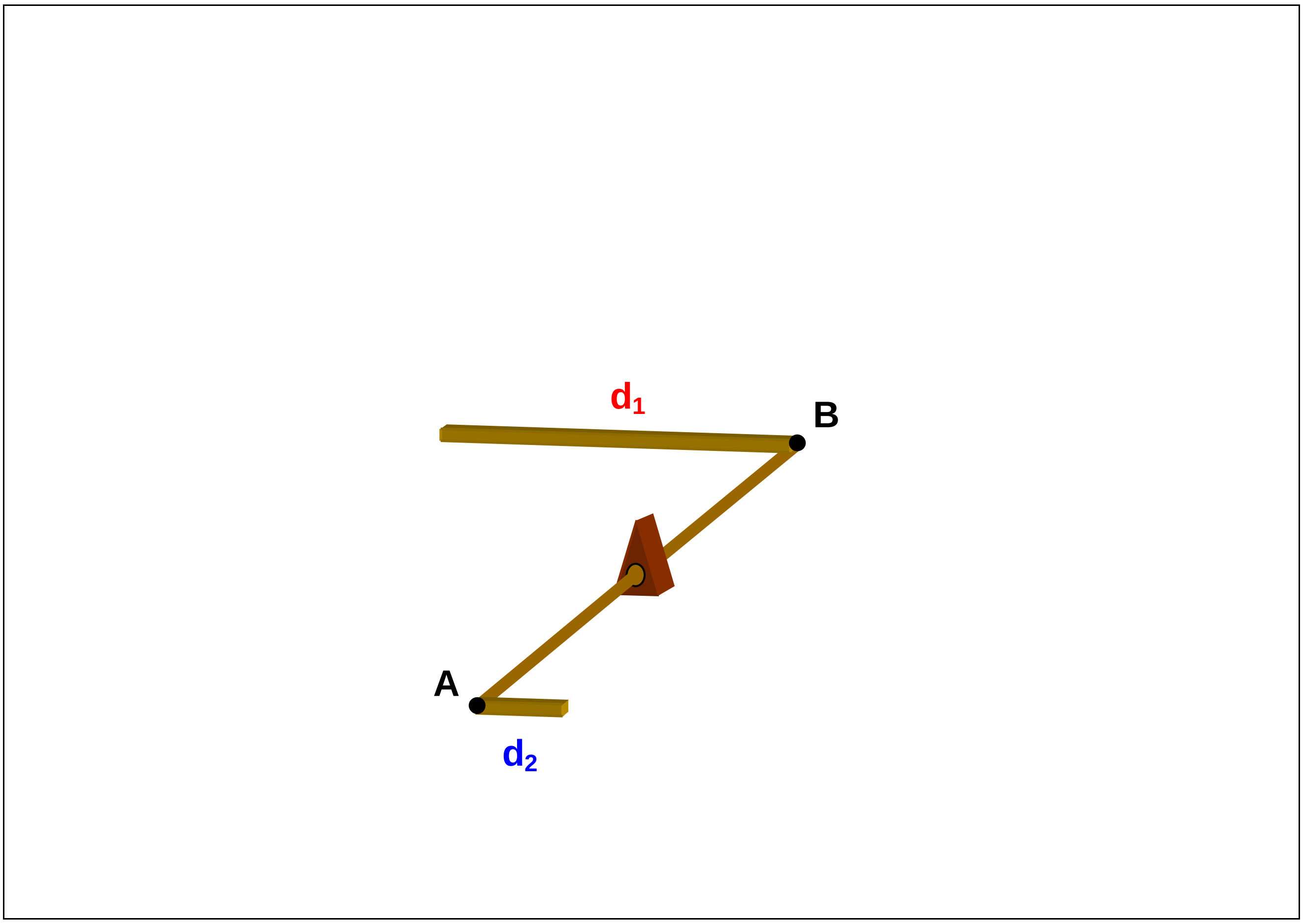
---

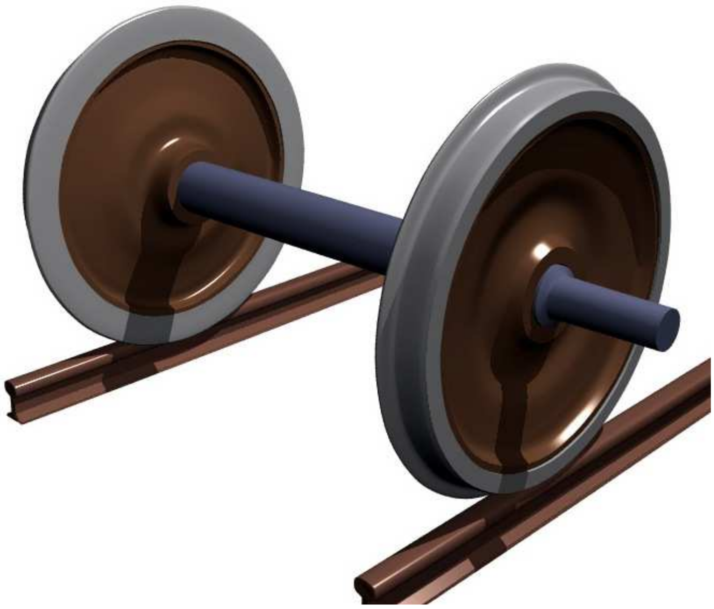
c) *Follow the instructions to obtain the simple machine called <u>wheel and axle</u>. Draw it on next page.*

- *Draw two circumferences with a compass. The centre of the first circumference should be point B and its radius should be equal to d_1. The centre of the second circumference should be point A and its radius should be equal to d_2.*

- *Give some thickness to the big circumference (2 or 3 cm). This circumference will be the <u>wheel</u>.*

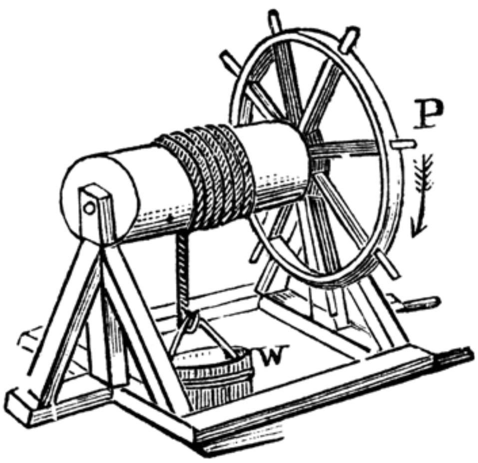
- *Enlarge the small circumference as a cylinder till it reaches the big one. The cylinder will be the <u>axle</u>.*


d1
B
A
d2



Activity 45: *Find and write down the end of the sentences by asking to your partners.*

a) *The wheel and axle is a…*
b) *The wheel and axle is a simple machine consisting…*
c) *When the wheel turns,…*
d) *If the wheel turns and the axle remains stationary, …*
e) *When the force is applied…*
f) *The mechanical advantage of a wheel and axle is…*
g) *Some examples of the wheel and axle are…*



<u>Given to students cut up</u> *(one card to each member of the group)*

…first class lever that can turn 360º.
…of a big wheel rigidly attached to a smaller wheel called an axle.
…the axle also turns, and vice versa.
…it is not a wheel and axle machine.
…to the wheel in order to turn the axle, force is increased and distance and speed are decreased.
…the ratio of the radius of the wheel to the radius of the axle.
…a door knob, a screwdriver, and the steering wheel of an automobile.

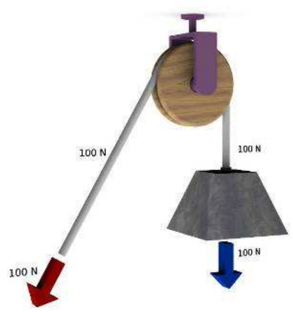
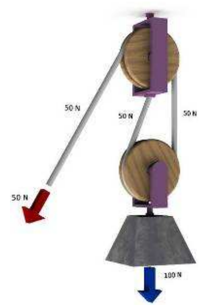
Lesson 4: **Pulleys**

Worksheet 30: The pulley	
Name:	
Group:	**Date:**

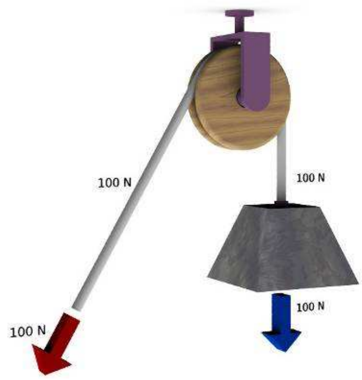
Activity 46: *Listen to the teacher and take notes about the pulley.*

What is a pulley?

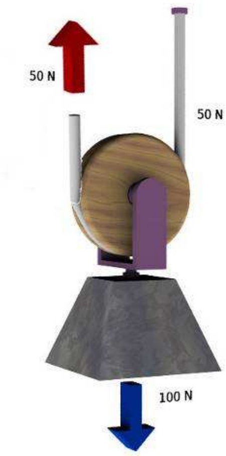

Examples of pulleys			
			

Different types of pulleys		
		

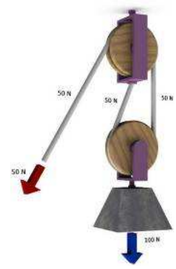
Fixed pulley

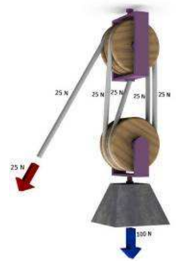


Movable pulley



Compound pulley





$$MA = \frac{L}{F} = n$$

Activity 47: *Solve the following problems.*

You may need this vocabulary:

First we calculate…	Then we…	After that…
The answer is…	The unknown is…	We isolate…
equals / is equal to	times / multiplied by	over / divided by
If we want to work out X…	If we want to find out Y…	

Problem A

A block and tackle has two movable pulleys. Calculate the force needed to lift a 1600 N weight and find out the mechanical advantage of the machine.

Problem B

A block and tackle has three movable pulleys. Find out the load we can lift applying a 600 N force and work out the mechanical advantage of the machine.

Problem C

We want to lift a 8200 N weight applying a 820 N force. Find out the mechanical advantage needed. How many movable pulleys will we need?

Lesson 5: **Assessment**

Worksheet 31: **Assessment (Unit 3)**	
Name:	
Group:	**Date:**

Activity 48: *Discuss with your partner, design a new corkscrew and write a report by answering the questions below.*

1. *To open a bottle of wine with this corkscrew we use more than one simple machine. Identify in the picture four different simple machines.*

2. *To open bottles more easily we could improve the mechanical advantage of the corkscrew. Explain what changes you would make to the simple machines involved in order to get a bigger mechanical advantage.*

3. *Draw your new corkscrew. Write down the size of all its parts.*

4. *Calculate the mechanical advantage of three simple machines of your corkscrew.*

5. *What problems could we have if we try to get a too big mechanical advantage?*