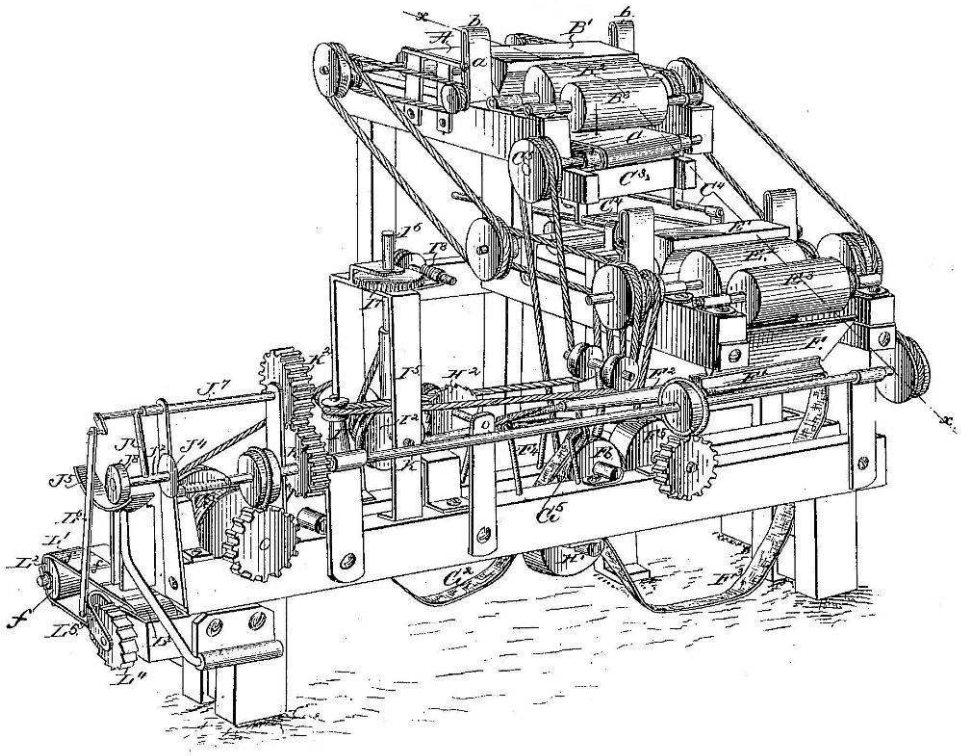
Simple Machines

Teaching notes



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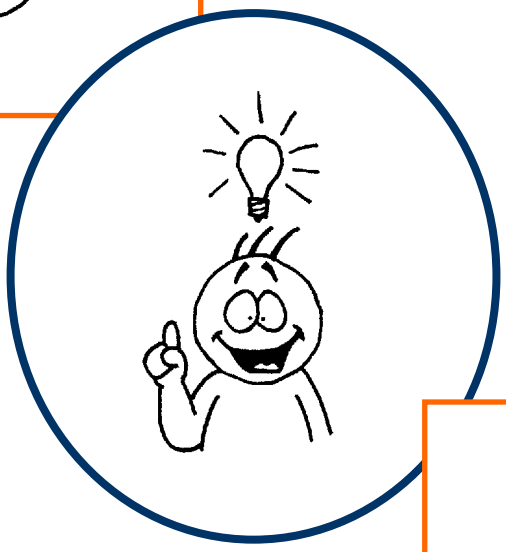
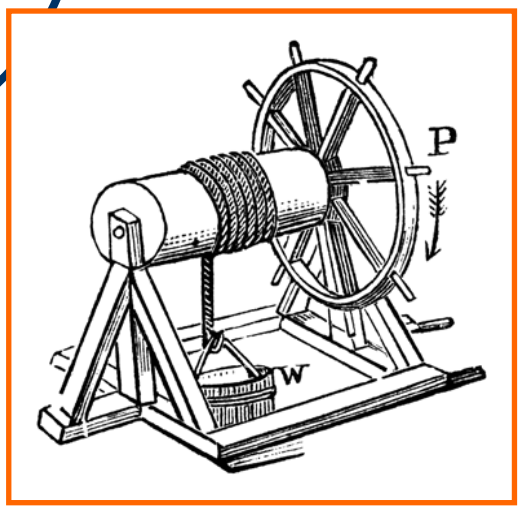
Unit 1
[5 hours]

Force, work and machines





TOPIC:	**Simple machines**		
UNIT 1:	Force, work and machines		
Lesson 1:	Force	**Timing:**	60’

ACTIVITY 1 (15 min)	
Management	**Interaction**
- Hand out worksheet 1. - Start PowerPoint presentation by showing the Archimedes’ picture on slide 1. - Write on the board the language students may need. - In pairs, students answer short questions about the picture. - Some students report their answers to the group. - Show the Archimedes’ quotation on slide 1. - Give the correct answers to the students. - Show the title of the unit.	Pairs Whole group
Language needed	**Resources**
He is +ing… He was… He lived… Because…	Worksheet 1 Slide 1

Answer Key

a) What is the man trying to move? He is trying to move the Earth.

b) Who was he? He was Archimedes of Syracuse.

c) Where was he from? He was from Syracuse (Greece).

d) When did he live? He lived between 287 BC and 212 BC.

e) Why was he famous? He was mathematician, physicist, inventor and astronomer.

f) What kind of object is he using? He is using a lever.

g) Why is he using that object? Because the lever helps him to move the Earth.

ACTIVITY 2 (10 min)	
Management	**Interaction**
- Students do activity 2 on worksheet 1. - Write on the board the language students may need. - Show slides 2 to 4 while some students report their answers to the group. - Students check the answers.	Individually Whole group
Language needed	**Resources**
This photo is a/an… That picture is a/an… First picture is a/an…	Worksheet 1 Slides 2 - 4

Answer Key

← lever

inclined planed →

← wheel

screw →

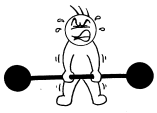
← wedge

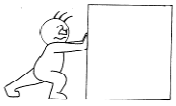
pulley →

ACTIVITY 3 (10 min)	
Management	**Interaction**
- Hand out worksheet 2. - Students do activity 3 on worksheet 2. - Write on the board the language students may need. - Show slide 5 while some students report their answers to the group. - Students check the answers	Individual Whole group
Language needed	**Resources**
The first/second/third word is… The first/second/third drawing means…	Worksheet 2 Slide 5

Answer Key

Letters	→	Word
shup	→	push
lulp	→	pull
crefo	→	force

When we		we make a	
	pull		force

When we		we make a	
	push		force

ACTIVITY 4 (10 min)	
Management	**Interaction**
- Students do activity 4 on worksheet 2. - Write on the board the language students may need. - Show slide 6 while some students report their answers to the group. - Students check the answers.	Individual Whole group
Language needed	**Resources**
The synonym for the first/second/… sentence is… Instead of… we can say…	Worksheet 2 Slide 6

Answer Key

A force is any cause that can...	(1) …accelerate an object. (2) …decelerate an object. (3) …divert an object. (4) …deform an object.

ACTIVITY 5 (15 min)	
Management	**Interaction**
- Make groups of 4 students. - Tell the students to read activity 5 on worksheet 2. - Students try to fill in the table before the cards are given to them. - Hand out 5 cards to each student (cards can be coloured for weaker students). - Write on board the language needed. - Give time to the students to do the puzzle and fill in the table. - Show slide 7 to the students for them to check the answers. - Students check the answers.	Groups of 4
Language needed	**Resources**
We need… Who's got…? Have you got…? We can put this one here… Letters Background Colours	Worksheet 2 Slide 7

Answer Key

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

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

TOPIC:	**Simple machines**		
UNIT 1:	Force, work and machines		
Lesson 2:	Work and energy	**Timing:**	70’

ACTIVITY 6 (15 min)	
Management	**Interaction**
- Hand out worksheet 3. - Make groups of 4 students. - Explain activity 6 to the students. - Students do activity 6. - Show slide 8 while some students report their answers to the group. - Students check the answers. - Write on board the language needed. - Ask to the students what happens to the work when the distance is longer. - Ask to the students what happens to the work when the weight is heavier. - Show and explain slide 9.	Groups of 4 Whole group
Language needed	**Resources**
Bigger/Smaller Longer/Shorter	Worksheet 3 Slides 8-9

Answer Key

Student A & Student B	Student A did half the work of student B
Student B & Student A	Student B did double the work of student A
Student C & Student A	Student C did double the work of student A
Student D & Student A	Student D did four times the work of student A
Student B & Student D	Student B did half the work of student D
Student C & Student B	Student C did the same work as student B

ACTIVITY 7 (10 min)	
Management	**Interaction**
- Students do activity 7. - Write on board the language needed. - Show slide 10 and 11 while some students report their answers to the group. - Students check the answers.	Individual Whole group
Language needed	**Resources**
What does a … need? It needs… What can you do with a …? You can … Vehicle / mobile phone / wind turbine	Worksheet 3 Slides 10-11

Answer Key

ENERGY	**MACHINE**	**WORK**
petrol		transport people
food		run
electricity		phone
wind		generate electricity

Energy…is the ability to do work

ACTIVITY 8 (15 min)	
Management	**Interaction**
- Make groups of 4 students. - Tell the students to read activity 8 on worksheet 3. - Students try to fill in the table before the cards are given to them. - Hand out 7 cards to each student (cards are not coloured). - Write on board the language needed. - Give time to the students to do the puzzle and fill in the table. - Show slide 12 to the students for them to check the answers. - Students check the answers.	Groups of 4
Language needed	**Resources**
We need… Who's got…? Have you got…? We can put this one here… Colours Background	Worksheet 3 Slide 12

Answer Key

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

ACTIVITY 9 (15 min)	
Management	**Interaction**
- Hand out worksheet 4. - Read the three problems. - Students listen to you and fill in the gaps on the worksheet. - Students answer the multiple choice questions. - Students check their answers with their partner. - Show slides 13 and 14 while some students report their answers to the group. - Students check the answers.	Individual Pairs Whole group
Language needed	**Resources**
Maybe some of the following words need to be explained to the students: trolley, lorry, height, weight, tall, high, gift, mist, lift, shift, root, rote, cuerd (it's not a word), rope, success, goodness, power, job, wok, to rule, to brush.	Worksheet 4 Slides 13-14

Answer Key

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.

Question	Answer
1	b
2	a
3	c
4	d
5	c
6	a
7	b
8	d
9	c

ACTIVITY 10 (15 min)	
Management	**Interaction**
- Hand out worksheet 5. - Show slide 15 to the students for them to remember the basic concepts. - Write on board the language needed. - Students solve the problems. - Students check their solutions with their partner. - Show slides 16 and 17 and explain the problems to the group. - Students check the solutions.	Individual Pairs Whole group
Language needed	**Resources**
If we want to work out W… equals / is equal to If we want to find out F… times / multiplied by over / divided by	Worksheet 5 Slides 15-17

Answer Key

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.

$W = F \cdot d = 200\ N \cdot 10\ m = 2000\ J$

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.

$F = W / d = 4500\ J / 15\ m = 300\ N$

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.

$d = W / F = 20000\ J / 400\ N = 50\ m$

TOPIC:	**Simple machines**		
UNIT 1:	Force, work and machines		
Lesson 3:	Machines	**Timing:**	45’

ACTIVITY 11 (15 min)	
Management	**Interaction**
- Hand out worksheet 6. - Show the beginning of slide 18 to the students for them to understand the activity. - Students in pairs do activity 11. - Show slides 18 to 20 while some students report their answers to the group. - Students check the answers.	Pairs Whole group
Language needed	**Resources**
aeroplane fridge computer bicycle ventilator drill bulldozer clock	Worksheet 6 Slide 18-20

Answer Key

A	a	e	r	o	p	l	a	n	e
	10		26	34			1	24	37

B	f	r	i	d	g	e	
	33	35	6		27	31	

C	c	o	m	p	u	t	e	r
		36	2		21	19	22	32

D	b	i	c	y	c	l	e	
		16	38	12			8	

E	v	e	n	t	i	l	a	t	o	r
	15		11	28	40		3	39		

F	d	r	i	l	l		
			9				

G	b	u	l	l	d	o	z	e	r
					13			14	

H	c	l	o	c	k		
	17			4			

I	t	e	l	e	p	h	o	n	e
	20	25		18	30	5	29	7	23

A	m	a	c	h	i	n	e	i	**s**	a	n	y	d	e	v	i	c	e
1	2	3	4	5	6	7	8	9		10	11	12	13	14	15	16	17	18

t	h	a	t	u	**s**	e	**s**	e	n	e	r	g	y	t	o
19	5	3	20	21		22		23	24	25	26	27	12	28	29

p	e	r	f	o	r	m	**s**	o	m	e	a	c	t	i	v	i	t	y
30	31	32	33	34	35	2		36	2	37	1	38	39	40	15	40	20	12

ACTIVITY 12 (15 min)	
Management	**Interaction**
- Hand out worksheet 7. - Write on board the language needed. - Read the sentences. - Students do activity 12. - Show slides 21 to 23 while some students report their answers to the group. - Students check the answers.	Individual Whole group
Language needed	**Resources**
slide down, ramp, join, car's jack well, logs, saw, split sledgehammer, wooden pallet, crowbar	Worksheet 7 Slides 21-23

Answer Key

Sentence 1: Usually cars have four wheels but motorbikes and bicycles have just two.

Sentence 2: To get high speed in ski jumping, skiers slide down a ramp or inclined plane.

Sentence 3: Screws can be used to join pieces but also to make moving devices like a car's jack.

Sentence 4: Taking water from a well is much easier if you have a rope and a pulley.

Sentence 5: You can cut logs with a saw or you can split them with a wedge and a sledgehammer.

Sentence 6: A wooden pallet is easier to break if you have a crowbar to use as a lever.

A: sentence **6**

B: sentence **4**

C: sentence **2**

D: sentence **1**

E: sentence **5**

F: sentence **3**

A: lever
B: pulley
C: inclined plane
D: wheel
E: wedge
F: screw

ACTIVITY 13 (15 min)	
Management	**Interaction**
- Make groups of 9 students. - Hand out worksheet 7 and a card with a question and an answer to each student. - Write on board the language needed. - Student with card "A" dictates the first question to their partners. - The student with the answer dictates their answer. - Students dictate their answers and questions to their partners following the loop. - Students write the questions and the answers on the worksheet. - Show slides 24 and 25 while some students report their answers to the group. - Explain the questions and the answers if it's necessary.	Groups of 9 Whole group
Language needed	**Resources**
Can you repeat that? What did you say? How do you spell that?	Worksheet 7 Slides 24-25

Answer Key

1. **What is a simple machine?**
   A simple machine is a device that changes the direction or the magnitude of a force.

2. **Why are simple machines useful?**
   Simple machines are useful because they make work easier.

3. **How does a simple machine work?**
   A simple machine works by using a single applied force to do work against a load.

4. **How many moving parts has a simple machine got?**
   A simple machine has got few or no moving parts.

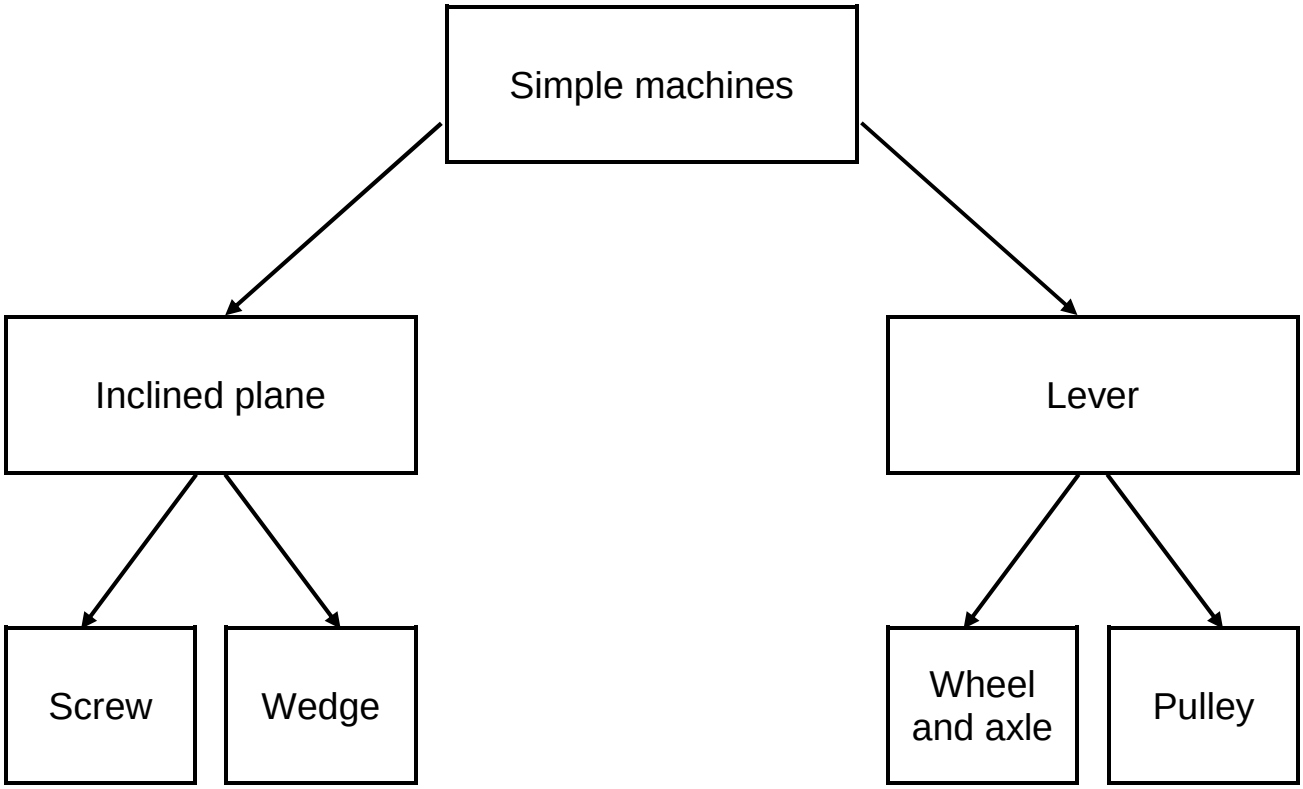
5. **Why is learning the basics of simple machines important?**
   Learning the basics of simple machines is fundamental to understanding more intricate mechanisms.

6. **What's the relationship between simple machines and more complicated machines?**
   Simple machines can be thought of as building blocks for more complicated machines.

7. **Which are the two basic simple machines?**
   The two basic simple machines are the inclined plane and the lever.

8. **What devices are variants on the inclined plane?**
   The screw and the wedge are variants on the inclined plane.

9. **What devices are variants on the lever?**
   The wheel and axle and the pulley are variants on the lever.


Simple machines
Inclined plane
Lever
Screw
Wedge
Wheel and axle
Pulley

TOPIC:	**Simple machines**		
UNIT 1:	Force, work and machines		
Lesson 4:	Mechanical advantage	**Timing:**	95’

ACTIVITY 14 (20 min)	
Management	**Interaction**
- Hand out worksheet 8. - Write on board the language needed. - Students do activity 14. Students help in pairs. - Show slides 26 and 27 while some students report their answers to the group. - Students check the answers.	Pairs Whole group
Language needed	**Resources**
What have you got for number 1? I’ve got… Do you agree?	Worksheet 8 Slide 26-27

Answer Key

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

ACTIVITY 15 (15 min)	
Management	**Interaction**
- Hand out worksheet 9. - Make groups of 7 students, one runner and six readers. - Put the cards with the definitions on a table at the end of the classroom. - Give one card with the concepts to each reader. - The runner runs to the table, takes one definition and shows it to the group. - If one reader recognizes his definition, he dictates it to the rest of the group. - If nobody recognizes the definition, the runner goes back to the table to change it. - When the reader finishes dictating his definition, the runner takes another one. - The winner is the first group that has all the definitions in the correct position. - Show slide 28 while some students report their answers to the group. - Students check the answers.	Groups of 7 Whole class
Language needed	**Resources**
Language provided on the cards.	Worksheet 10 Slide 28

Answer Key

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

ACTIVITY 16 (20 min)	
Management	**Interaction**
- Hand out worksheet 10. - Explain the first part of mechanical advantage to the students using slides 29 to 33. - While explaining, ask questions to the students. - Students take notes.	Whole class
Language needed	**Resources**
Language provided on the slides.	Worksheet 10 Slides 29-33

ACTIVITY 17 (20 min)	
Management	**Interaction**
- Hand out worksheet 11. - Make groups of three students. - Write on board the language needed. - Students try to answer the questions searching the answers in activities 15 and 16. - Show and explain slides 34 to 36 for them to check and understand the answers.	Groups of 3 Whole class
Language needed	**Resources**
I think… I guess…	Worksheet 11 Slides 34-36

Answer Key

1. **Do simple machines multiply energy?**
   No, simple machines do not multiply energy but force.

2. **What's the relationship between the input energy and the output work in an actual machine? Why?**
   The input energy of an actual machine is always bigger than its output work. The reason is that in actual machines there is always a loss of energy due to friction. The efficiency is not 100%.

3. **What's the relationship between the input energy and the output work in an ideal machine? Why?**
   The input energy of an ideal machine is equal to its output work. The reason is that in ideal machines there is no loss of energy due to friction. The efficiency is 100%.

4. **What principle related to energy do simple machines violate?**
   None because no energy is created by simple machines. They just multiply force. The conservation of energy principle cannot be violated.

5. **What's the cost of making less force with a simple machine to get the same energy?**
   To get the same energy with less force you have to apply the force over a longer distance.

   In the example, to move the box a short distance (d_b), the man had to move the other part of the lever a long distance (d_m).

6. **How can we get the mechanical advantage formula?**
   By applying the conservation of energy principle. The ratio of distances is equal to the ratio of forces. We call that ratio mechanical advantage.

ACTIVITY 18 (20 min)	
Management	**Interaction**
- Hand out worksheet 12. - Write on board the language needed. - Students solve the problems. - Students check their solutions with their partner. - Show slides 37 to 39 and explain the problems to the group. - Students check the solutions.	Individual Pairs Whole group
Language needed	**Resources**
If we want to work out MA… If we want to find out F… equals / is equal to times / multiplied by over / divided by	Worksheet 12 Slides 37-39

Answer Key

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.

$L = m_c \cdot g = 50\ kg \cdot 9{,}81\ m/s^2 = 490{,}5\ N$

$MA = L / F = 490{,}5\ N / 250\ N = 1{,}96$

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.

$L = F \cdot MA = 800\ N \cdot 5 = 4000\ N$

$m_o = L / g = 4000\ N / 9{,}81\ m/s^2 = 407{,}75\ kg$

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.

$L = m_c \cdot g = 1000\ kg \cdot 9{,}81\ m/s^2 = 9810\ N$

$F = L / MA = 9810\ N / 8 = 1226{,}25\ N$

TOPIC:	**Simple machines**		
UNIT 1:	Force, work and machines		
Lesson 5:	Assessment	**Timing:**	30’

ACTIVITY 19 (30 min)	
Management	**Interaction**
- Hand out worksheet 13. - Students do activity 19. - When time’s up, collect the worksheets.	Individual
Language needed	**Resources**
Language learnt during the unit.	Worksheet 13

Answer Key

1. The pictures show different simple machines. Match the pictures with the names.
See Activity 2

2. Fill in the table.
See Activity 8.

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

a) **Force:** any cause that can accelerate, decelerate, divert or deform an object.
b) **Simple machine:** machine that changes the direction or the magnitude of a force.
c) **Mechanical advantage:** factor by which a machine multiplies the force applied to it.
d) **Work:** result of making a force over a distance.
e) **Machine:** any device that uses energy to perform an activity.
f) **Energy:** the ability to do work.

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

a)		F	In science weight means the same as mass.
b)		F	Weight and mass are forces.
d)		F	An object with one kilogram mass weighs one kilogram.
e)	T		The weight of an object is directly proportional to its mass.
f)	T		The mass of an object is the same on the Moon as on Earth.
g)		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,…
  b) the bigger the work.

- How many moving parts has a simple machine got?
  d) A simple machine has got few or no moving parts.

- Which are two three basic simple machines?
  c) The inclined plane and the lever.

- What devices are variants on the inclined plane?
  d) The screw and the wedge.

- What devices are variants on the lever?
  a) The pulley and the wheel.

- When we say “energy can neither be created nor destroyed” we are stating…
  b) the conservation of energy principle.

- We can know the weight of a mass using….
  c) Newton’s second law.

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

An ideal machine is a theoretical machine in which there is no loss of energy. And ideal machine is a frictionless system. An actual machine is a real machine. The efficiency of actual machines is not 100% because there is loss of energy due to friction.

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.

$W = F \cdot l = 1200\ N \cdot 50\ m = 6000\ J$

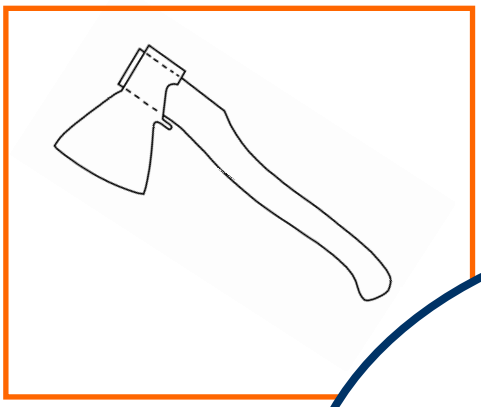
8. A cupboard has a 60 kg mass. We want to move it with a machine able to multiply the force applied 3 times. Calculate the effort we have to do to move the cupboard.

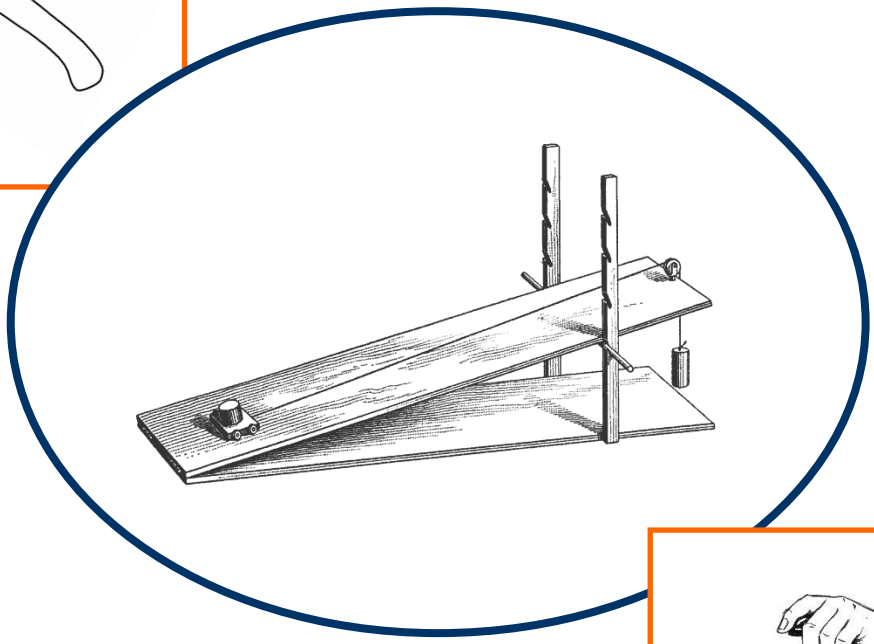
$L = m_c \cdot g = 60\ kg \cdot 9{,}81\ m/s^2 = 588{,}6\ N$

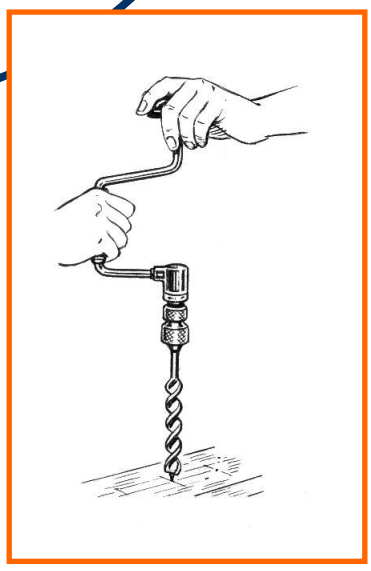
$F = L / MA = 588{,}6\ N / 3 = 196{,}2\ N$

Unit 2
[5 hours]

Inclined planes







TOPIC:	**Simple machines**		
UNIT 2:	Inclined planes		
Lesson 1:	The inclined plane	**Timing:**	175’

ACTIVITY 20 (15 min)	
Management	**Interaction**
- Hand out worksheet 13. - Students do activity 20. - Show slides 1 to 6 to the students for them to check the answers. - Tell the students to write the names of the examples on the worksheet.	Individual Whole group
Language needed	**Resources**
funnel tipper lorry moving lorry ski jumping stairway playground slide	Worksheet 13 Slides 1-6

Answer Key

1. It is a pipe with a wide mouth. It is used to channel liquid into bottles. **(Funnel)**

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. **(Moving lorry)**

3. It is a construction designed to bridge a large vertical distance by dividing it into smaller vertical distances, called steps. **(Stairway)**

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. **(Tipper lorry)**

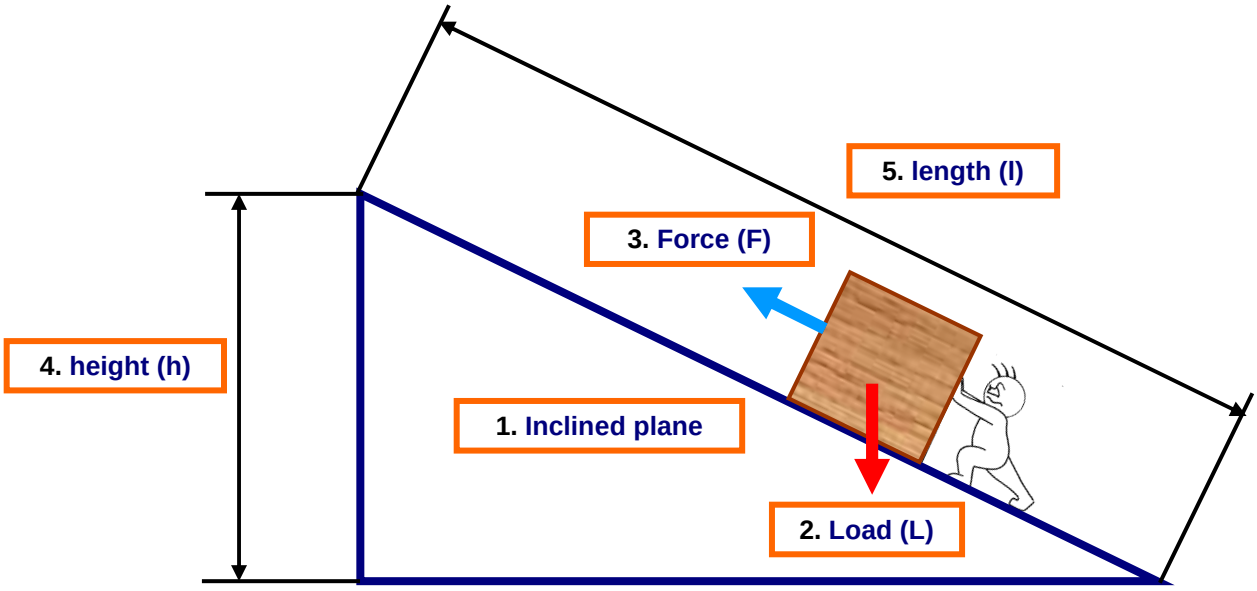
5. It is a sport in which skiers go down a take-off ramp, jump, and attempt to land the furthest down on the hill below. **(Ski jumping)**

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. **(Playground slide)**

ACTIVITY 21 (15 min)	
Management	**Interaction**
- Read the text to the students for them to fill in the gaps. - Write on the board the language students may need. - Students label the drawing in pairs. - Show slide 7 while some students report their answers to the group. - Students check the answers.	Individual Pairs Whole group
Language needed	**Resources**
Label one is…	Worksheet 13 Slide 7

Answer Key

An inclined plane is a flat surface whose endpoints are at different heights. By moving an object up an inclined plane rather than completely vertically, the amount of force required is reduced, at the expense of increasing the distance the object must travel. We call the weight of the object the load and it can be identified with the letter L. The effort we have to apply to move the object is the force F. The height of the inclined plane is the vertical distance between the lowest and the highest points of the ramp. We represent this distance with an h. The path the object must follow if we want to use this simple machine is the length (l) of the inclined plane.



ACTIVITY 22 (15 min)	
Management	**Interaction**
- Hand out worksheet 14. - Explain the inclined plane to the students using slides 8 and 9. - While explaining, ask questions to the students. - Students take notes.	Whole class
Language needed	**Resources**
Language provided on activity 21.	Worksheet 14 Slides 8-9

Answer Key

See PowerPoint.

ACTIVITY 23 (45 min)	
Management	**Interaction**
- Hand out worksheet 15. - Make groups of 4 students. - Give them the material needed to do the activity. - Students do activity 22. - Go around the class helping the students.	Groups of 4
Language needed	**Resources**
Language provided on worksheet.	Worksheet 15

Answer Key

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.

c) Weigh the car toy with a dynamometer and calculate the work (W_h) to move it from B to C.
$W_h = L \cdot h$

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.
$W_l = W_h = F_t \cdot l \rightarrow F_t = W_h / l$

e) Work out the theoretical mechanical advantage of the inclined plane (MA_t).
$MA_t = l / h$

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

g) Why is the actual force bigger than the theoretical force ($F_a > F_t$)?
Because of the friction.

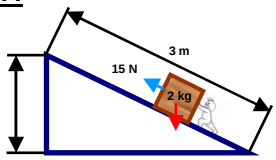
h) Determine the actual mechanical advantage (MA_a).
$MA_a = L / F_a$

i) Find out the actual work (W_a) we have to do to move the car from A to C.
$W_a = F_a \cdot l$

ACTIVITY 24 (45 min)	
Management	**Interaction**
- Hand out worksheet 16. - Make groups of 3 students. - Each group solves one problem and explains it on the board to the class. - Correct the problems. - Students write down all the problems.	Groups of 3 Whole class
Language needed	**Resources**
Language provided on worksheet.	Worksheet 16

Answer Key

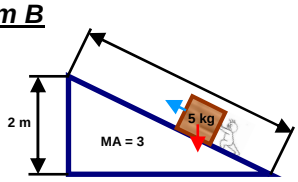
Problem A



Mass of the object:	m = 2 kg
Length of the ramp:	l = 3 m
Force we have to make:	F = 15 N
Load we want to move:	L = ?
Mechanical advantage:	MA = ?
Height of the inclined plane:	h = ?

$L = m \cdot g = 2\ kg \cdot 9{,}81\ m/s^2 = 19{,}62\ N$
$MA = L / F = 19{,}62\ N / 15\ N = 1{,}31$
$h = l / MA = 3\ m / 1{,}31 = 2{,}29\ m$

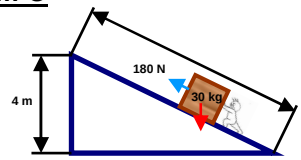
Problem B



Mass of the object:	m = 5 kg
Height of the inclined plane:	h = 2 m
Mechanical advantage:	MA = 3
Load we want to move:	L = ?
Force we have to make:	F = ?
Length of the ramp:	l = ?

$L = m \cdot g = 5\ kg \cdot 9{,}81\ m/s^2 = 49{,}05\ N$
$F = L / MA = 49{,}05 / 3 = 16{,}35\ N$
$l = MA \cdot h = 3 \cdot 2\ m = 6\ m$

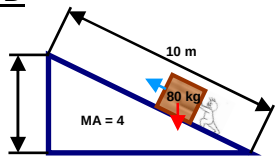
Problem C



Mass of the object:	m = 30 kg
Height of the inclined plane:	h = 4 m
Force we have to make:	F = 180
Load we want to move:	L = ?
Mechanical advantage:	MA = ?
Length of the ramp:	l = ?

$L = m \cdot g = 30\ kg \cdot 9{,}81\ m/s^2 = 294{,}3\ N$
$MA = L / F = 294{,}3\ N / 180\ N = 1{,}64$
$l = MA \cdot h = 1{,}64 \cdot 4\ m = 6{,}56\ m$

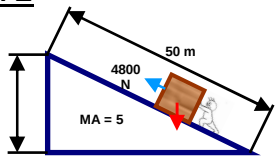
Problem D



Mass of the object:	m = 80 kg
Length of the ramp:	l = 10 m
Mechanical advantage:	MA = 4
Load we want to move:	L = ?
Force we have to make:	F = ?
Height of the inclined plane:	h = ?

$L = m \cdot g = 80\ kg \cdot 9{,}81\ m/s^2 = 784{,}8\ N$
$F = L / MA = 784{,}8\ N / 4 = 196{,}2\ N$
$h = l / MA = 10\ m / 4 = 2{,}5\ m$

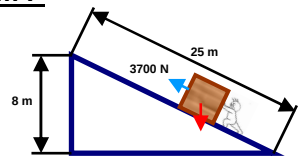
Problem E



Length of the ramp:	l = 50 m
Force we have to make:	F = 4800 N
Mechanical advantage:	MA = 5
Load we want to move:	L = ?
Mass of the object:	m = ?
Height of the inclined plane:	h = ?

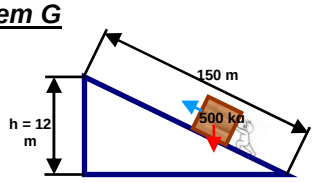
$L = MA \cdot F = 5 \cdot 4800\ N = 24000\ N$
$m = L / g = 24000\ N / 9{,}81\ m/s^2 = 2446{,}48\ kg$
$h = l / MA = 50\ m / 5 = 10\ m$

Problem F

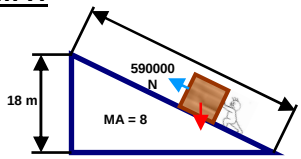


Length of the ramp:	l = 25 m
Height of the inclined plane:	h = 8 m
Force we have to make:	F = 3700 N
Mechanical advantage:	MA = ?
Load we want to move:	L = ?
Mass of the object:	m = ?

$MA = l / h = 25\ m / 8\ m = 3{,}13$
$L = MA \cdot F = 3{,}13 \cdot 3700\ N = 11581\ N$
$m = L / g = 11581\ N / 9{,}81\ m/s^2 = 1180{,}53\ kg$

Problem G		
	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:	m = 500 kg l = 150 m h = 12 m MA = ? L = ? F = ?

MA = l / h = 150 m / 12 m = 12,5
L = m · g = 500 kg · 9,81 m/s^2 = 4905 N
F = L / MA = 4905 N / 12,5 = 392,4 N

Problem H		
	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:	h = 18 m F = 590000 N MA = 8 L = ? m = ? l = ?

L = MA · F = 8 · 590000 N = 4720000 N
m = L / g = 4720000 N / 9,81 m/s^2 = 481141,69 kg
l = MA · h = 8 · 18 m = 144 m

ACTIVITY 25 (10 min)	
Management	**Interaction**
- Hand out worksheet 17. - Students do activity 26 using a dictionary. - Show slides 10 to 12 while some students report their answers to the group. - Students check the answers.	Individual Whole class
Language needed	**Resources**
Picture one is… nail drill jack corkscrew knife bulb fork Archimedes' screw axe saw pin bow jar auger	Worksheet 17 Slides 10-12

Answer Key

1: Nail

2: Drill

3: Jack

4: Corkscrew

5: Knife

6: Bulb

7: Fork

8: Archimedes' screw

9: Screw

10: Axe

11: Saw

12: Pin

13: Bow

14: Jar

15: Auger

WEDGE	SCREW
nail	drill
knife	jack
fork	corkscrew
axe	bulb
saw	Archimedes' screw
pin	screw
bow	jar
	auger

ACTIVITY 26 (15 min)	
Management	**Interaction**
- In pairs, students do activity 26. - Write on the board the language students may need. - Show slide 13 while some students report their answers to the group. - Students check the answers.	Pairs Whole class
Language needed	**Resources**
Number 4 across is… Number 2 down is…	Worksheet 17 Slide 13

Answer Key

Across

4. With this device we can make a hole in the ground. → **auger**
5. Thanks to this item we can see in the dark. → **bulb**
7. We use it to eat what we cut with number 2. → **fork**
8. If you turn it properly you can join two objects. → **screw**
10. In the middle ages it used to be a weapon. → **axe**
12. Machine for perforating materials. → **drill**
13. With its teeth we can cut wood. → **saw**
14. It can be full of honey, for example. → **jar**

Down

1. It is a tool for opening wine bottles. → **corkscrew**
2. We use it to cut food. → **knife**
3. It is very useful when you have to change a wheel. → **jack**
5. It is the front of a ship. → **bow**
6. With this machine you can push water up (two words). → **Archimedes' screw**
9. If you hit it with a hammer you can join two objects. → **nail**
11. It can be used to fasten a poster to the wall. → **pin**

TOPIC:	**Simple machines**		
UNIT 2:	Inclined planes		
Lesson 2:	The wedge	**Timing:**	60’

ACTIVITY 27 (20 min)	
Management	**Interaction**
- Hand out worksheet 18. - Make groups of 5 students. - Write on the board the language students may need. - Each student orders one sentence. They can help each other. - Students write the correct sentences in the first table. - When each sentence is ordered, all together find out the correct sequence. - Show slide 14 while some students report their answers to the group. - Students check the answers.	Groups of 5 Whole class
Language needed	**Resources**
Is this one before/after that one? tip sharp edge	Worksheet 18 Slide 14

Answer Key

Correct sentences

Student A: Round like the tip of a nail.
Student B: But a wedge can also be round.
Student C: These planes meet and form a sharp edge.
Student D: The wedge is an adaptation of the inclined plane.
Student E: This adaptation consists of two inclined planes joined back to back.
Student F: In that case, wedges can be seen as many inclined planes beside each other around an axis.

Correct sequence

Sentence 1: The wedge is an adaptation of the inclined plane.
Sentence 2: This adaptation consists of two inclined planes joined back to back.
Sentence 3: These planes meet and form a sharp edge.
Sentence 4: But a wedge can also be round.
Sentence 5: Round like the tip of a nail.
Sentence 6: In that case, wedges can be seen as many inclined planes beside each other around an axis.

ACTIVITY 28 (20 min)	
Management	**Interaction**
- Read the sentences to the students for them to complete the sentences. - Write on the board the language students may need. - In pairs, students fill in the Venn diagram. - Show slide 15 while some students report their answers to the group. - Students check the answers.	Individual Pairs Whole class
Language needed	**Resources**
Both the same different thickness	Worksheet 18 Slide 15

Answer Key

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

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

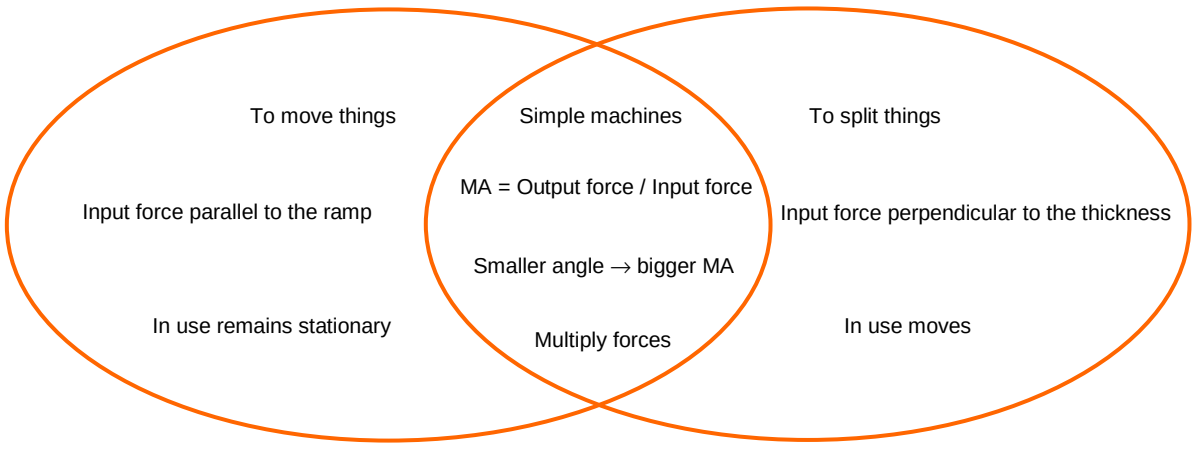
C. Although the wedge is an adaptation of the inclined plane both of them are simple machines.

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

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

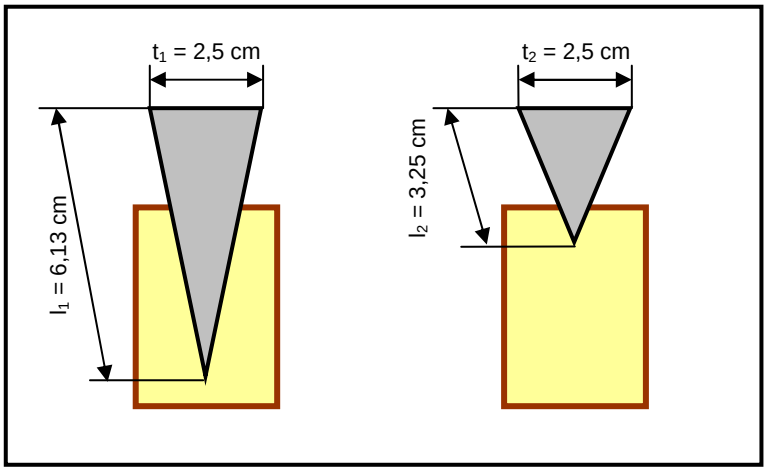
F. In use, an inclined plane remains stationary while the wedge moves.

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



ACTIVITY 29 (20 min)	
Management	**Interaction**
- Hand out worksheet 19. - Students do activity 29. - Show slide 16 and 17 while some students report their answers to the group. - Students check the answers.	Individual Whole class
Language needed	**Resources**
Language provided on worksheet.	Worksheet 19 Slides 16-17

Answer Key



Wedge 1	Wedge 2
$MA_1 = l_1 / t_1 = 6{,}13 \text{ cm} / 2{,}5 \text{ cm} = 2{,}45$	$MA_2 = l_2 / t_2 = 3{,}25 \text{ cm} / 2{,}5 \text{ cm} = 1{,}3$

1. With which of the two wedges will be easier to split the rectangle apart? Why?
With the first one because its mechanical advantage is bigger.

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?
$L_1 = MA_1 \cdot F = 2{,}45 \cdot 500 \text{ N} = 1225 \text{ N}$
$L_2 = MA_2 \cdot F = 1{,}3 \cdot 500 \text{ N} = 650 \text{ N}$

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?
The first one must be driven in 6 cm and the second one 3 cm (vertical length of the wedge; you can use the Pythagorean Theorem).

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 an example.
They can also be used as holding devices as, for example, a doorstop.

TOPIC:	**Simple machines**		
UNIT 2:	Inclined planes		
Lesson 3:	The screw	**Timing:**	60’

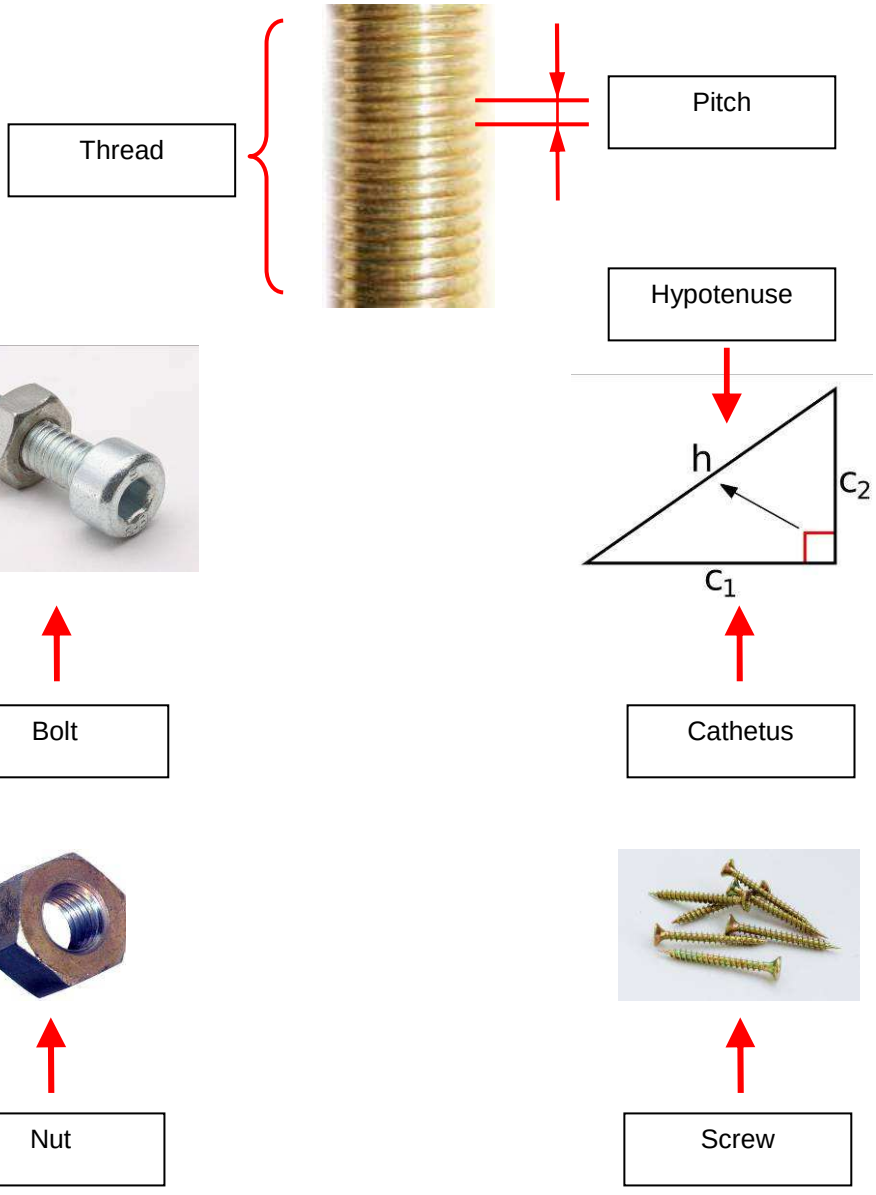
ACTIVITY 30 (20 min)	
Management	**Interaction**
- Hand out worksheet 20. - Students do activity 30. - Show slide 18 while some students report their answers to the group. - Students check the answers.	Individual Whole class
Language needed	**Resources**
cathetus, hypotenuse, thread, bolt, nut, pitch	Worksheet 20 Slide 18

Answer Key

Cathetus:	In a right-angled triangle, the cathetus (plural: catheti), commonly known as a leg, is either of the sides that are adjacent to the right angle.
Hypotenuse:	A hypotenuse is the longest side of a right-angled triangle, the side opposite the right angle.
Thread:	A screw thread, often abbreviated thread, is a helical structure used to convert between rotational and linear movement or force.
Screw:	A screw is an externally threaded fastener capable of being inserted into holes in assembled parts, of mating with a preformed internal thread or forming its own thread, and of being tightened or released by torquing the head.
Bolt:	A bolt is an externally threaded fastener designed for insertion through the holes in assembled parts, and is normally intended to be tightened or released by torquing a nut.
Nut:	A nut is a type of fastener with a threaded hole. Nuts are almost always used opposite a mating bolt to fasten two or more of parts together.
Pitch:	The pitch of a screw is the distance from the crest of one thread to the next.

ACTIVITY 31 (10 min)	
Management	**Interaction**
- In pairs, students do activity 31. - Show slide 19 while some students report their answers to the group. - Students check the answers.	Pairs Whole class
Language needed	**Resources**
Language provided on worksheet.	Worksheet 20 Slide 19

Answer Key



ACTIVITY 32 (10 min)	
Management	**Interaction**
- Hand out worksheet 21. - Students do activity 32.	Individual
Language needed	**Resources**
Imperative forms of verbs (see worksheet)	Worksheet 21

Answer Key

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 be15 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.

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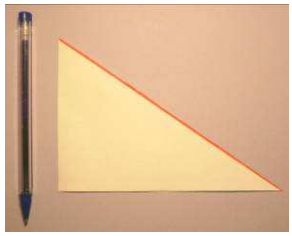
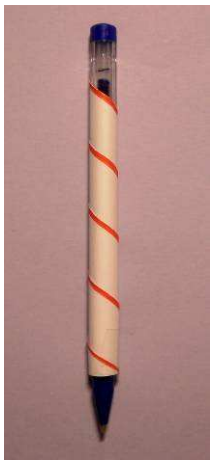
  </td><td rowspan="2">e) + f)
  </td></tr>
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 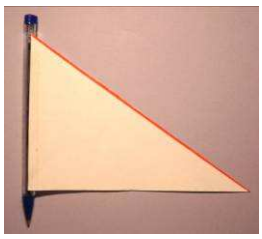 </td></tr>
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ACTIVITY 33 (20 min)	
Management	**Interaction**
- Give the material needed to do the activity. - Students do activity 33. - Go around the class helping the students.	Pairs
Language needed	**Resources**
Bench vice C-clamp Calipper Imperative forms of verbs (see worksheet)	Worksheet 21

Answer Key

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

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: $l_c = 2 \cdot \pi \cdot r$)
$l_c = 2 \cdot \pi \cdot r$

c) Find out the work (W_1) you will do if you turn the handle a complete round making a 100 N force (F).
$W_1 = F \cdot l_c = 100\ N \cdot l_c$

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.

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...
$W_2 = W_1$

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).
$W_2 = L \cdot p \rightarrow L = W_2 / p$
$L = m \cdot g \rightarrow m = L / g$

g) Work out the mechanical advantage of the screw (MA).
$MA = L / F = l_c / r$

TOPIC:	**Simple machines**		
UNIT 2:	Inclined planes		
Lesson 4:	Assessment	**Timing:**	20’

ACTIVITY 34 (20 min)	
Management	**Interaction**
- Hand out worksheet 22. - Students do activity 34. - When time’s up, collect the worksheets.	Individual
Language needed	**Resources**
Language learnt during the unit.	Worksheet 22

Answer Key

1. Fill in the boxes of the drawing with the appropriate names.
See activity 21.

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.

$L = m \cdot g = 85\ kg \cdot 9{,}81\ m/s^2 = 833{,}85\ N$
$l = L \cdot h / L = 833{,}85\ N \cdot 3\ m / 500\ N = 5\ m$
$MA = L / F = 833{,}85\ N / 500\ N = 1{,}67$

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


1: Axe


2: C-clamp


3: Funnel


4: Tipper lorry


5: Knife


6: Bulb


7: Corkscrew


8: Bow


9: Slide

INCLINED PLANE	WEDGE	SCREW
1	5	2
3	8	6
4	9	7

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

a) **Hypotenuse:** the longest side of a right-angled triangle, the side opposite the right angle.
b) **Thread:** helical structure used to convert between rotational and linear movement or force.
c) **Bolt:** screw intended to be tightened or released by torquing a nut.
d) **Cathetus:** in a right-angled triangle either of the sides that are adjacent to the right angle.
e) **Nut:** a type of fastener with a threaded hole.
f) **Pitch:** 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) F The input force is applied perpendicular to the ramp of an inclined plane.
b) T In use, an inclined plane remains stationary while the wedge moves.
d) F Inclined planes multiply force and wedges multiply energy.
e) F Wedges can't help you to split things apart.
f) T The wedge is and adaptation of the inclined plane.
g) T 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.

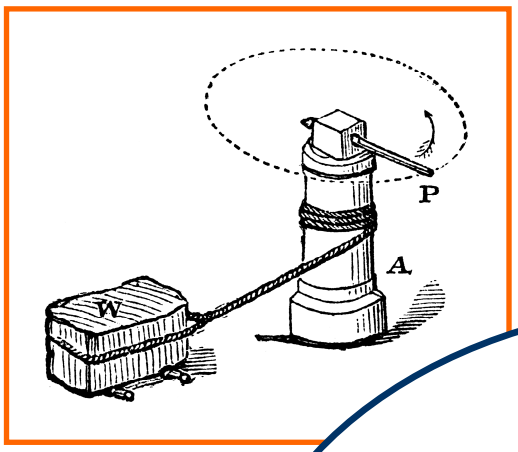
$l_c = 2 \cdot \pi \cdot r = 2 \cdot \pi \cdot 20 \text{ cm} = 125{,}66 \text{ cm}$

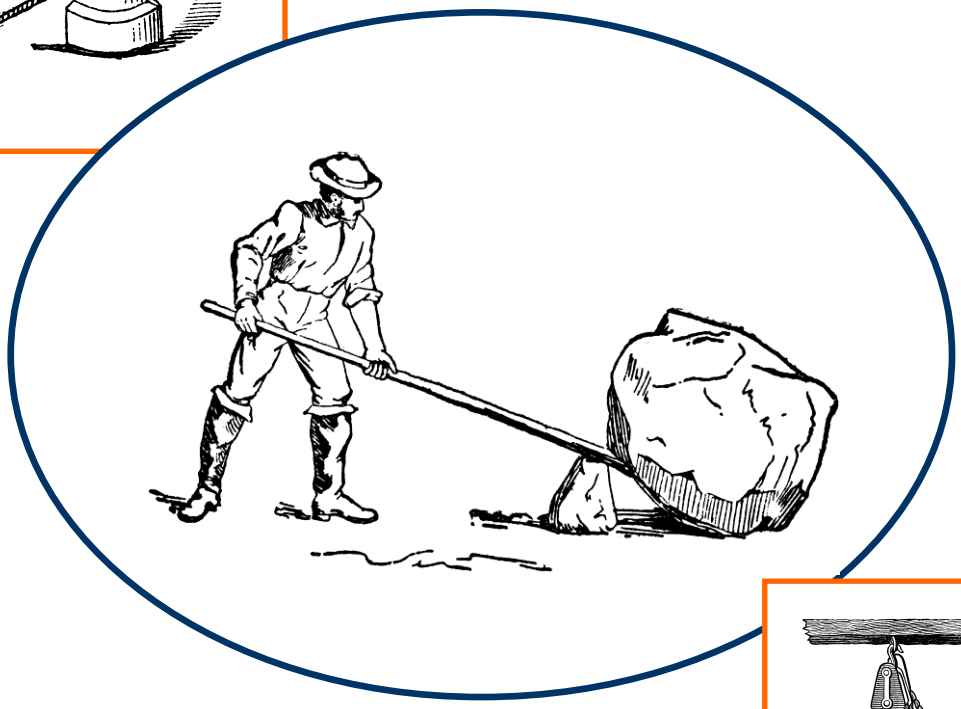
$F = L \cdot p / l_c = 6000 \text{ N} \cdot 1 \text{ cm} / 125{,}66 = 47{,}75 \text{ N}$

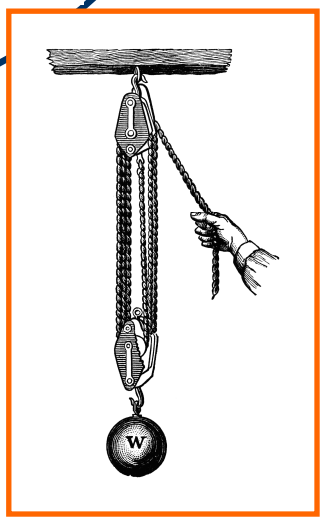
$MA = l_c / p = 125{,}66 \text{ cm} / 1 \text{ cm} = 125{,}66$

Unit 3
[5 hours]

Levers







TOPIC:	**Simple machines**		
UNIT 3:	Levers		
Lesson 1:	The lever	**Timing:**	80’

ACTIVITY 35 (15 min)	
Management	**Interaction**
- Hand out worksheet 23. - Write on the board the language students may need. - Students do activity 35. - Show slide 1 while some students report their answers to the group. - Explain the answers to the students.	Pairs Whole group
Language needed	**Resources**
to balance seesaw pivoting point Comparatives (heavier, longer…than) 2nd conditional: if + past simple, would + infinitive	Worksheet 23 Slide 1

Answer Key

1. In the first picture, why is the man up and the girl down?
Because the man is heavier than the girl.

2. Think about three different ways the man and the girl could balance the seesaw.
1st: somebody else could sit with the girl to increase the total weight on the right side of the seesaw.
2nd: the man could stretch the legs to reduce his weight on the seesaw.
3rd: the man could move himself to the centre of the seesaw.

3. In the second picture, why is the small man down and the big man up?
Because the distance between the small man and the pivoting point is much longer than the distance between the big man and the pivoting centre.

4. What would happen if the small man moved closer to the pivoting point of the seesaw?
At a certain point, the small man would go up and the big man would go down.

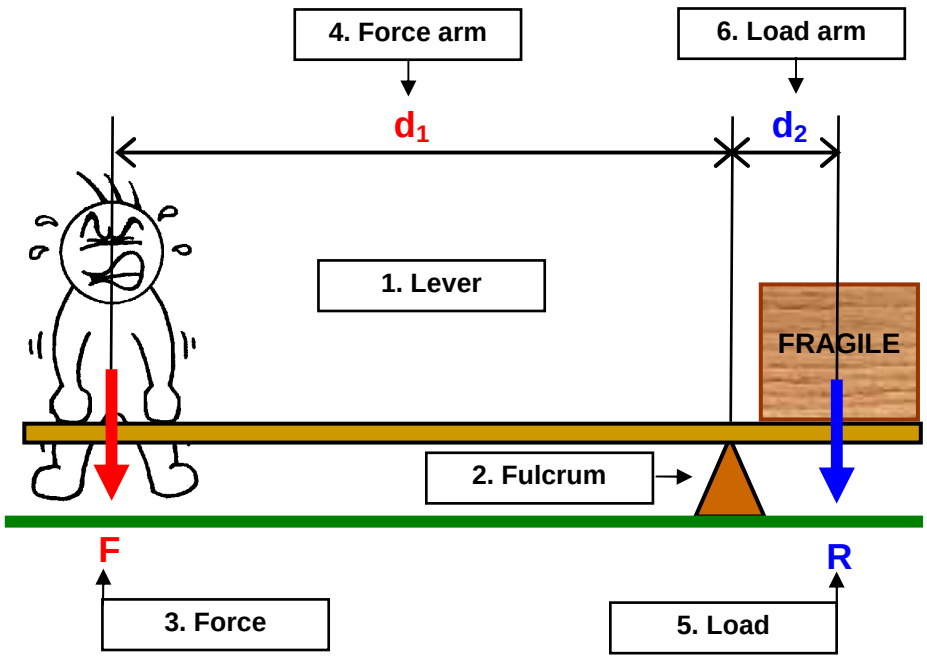
ACTIVITY 36 (15 min)	
Management	**Interaction**
- Read the text to the students for them to fill in the gaps. - Students label the drawing in pairs. - Show slide 2 while some students report their answers to the group. - Students check the answers.	Individual Pairs Whole group
Language needed	**Resources**
fulcrum lever arm Label one is…	Worksheet 23 Slide 2

Answer Key

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

The effort force is exerted upon one lever arm, called force arm. The force arm is the perpendicular distance between the force and the fulcrum.

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



ACTIVITY 37 (50 min)	
Management	**Interaction**
- Hand out worksheet 24. - Make groups of three students. - Explain activity 37 to the students. - Students do activity 37 as homework. - Students show their presentation the following day.	Groups of 3 Whole group
Language needed	**Resources**
moment of force clockwise anticlockwise to balance Imperative forms of verbs. Language provided on worksheet.	Worksheet 24

Answer Key

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?
The seesaw turns. Student A goes up and students B and C go down.

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 **moment of force**.

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	$M_F = F \cdot d_1 = \ldots$
Moment of load	$M_L = L \cdot d_2 = \ldots$

Choose the correct sentence and write it under the table:

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

Correct sentence: Student A goes up because M_F is smaller than M_L

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.

$d_2 = F \cdot d_1 / L = \ldots$

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

$MA = d_1 / d_2 = \ldots$

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

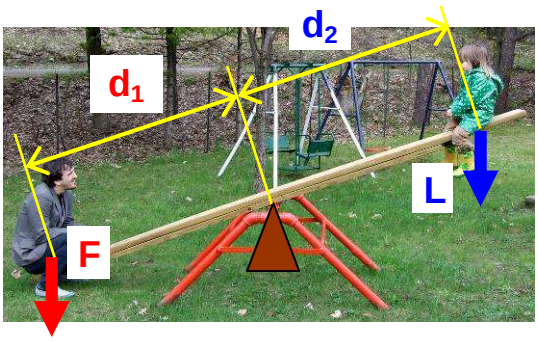
Thanks to the lever we can move a big load (students B and C) making a small force (student A) because the force arm (d_1) is much longer than the load arm (d_2).
The shorter the load arm (d_2), the smaller the force (F) needed to lift the load (L). The longer the force arm (d_1), the bigger the load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

TOPIC:	**Simple machines**		
UNIT 3:	Levers		
Lesson 2:	Classes of levers	**Timing:**	90’

ACTIVITY 38 (10 min)	
Management	**Interaction**
- Hand out worksheet 25. - In pairs, students do activity 38. - Show slides 3 to 5 while some students report their answers to the group. - Students check the answers.	Pairs Whole group
Language needed	**Resources**
wheelbarrow fishing rod	Worksheet 25 Slides 3 - 5

Answer Key

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



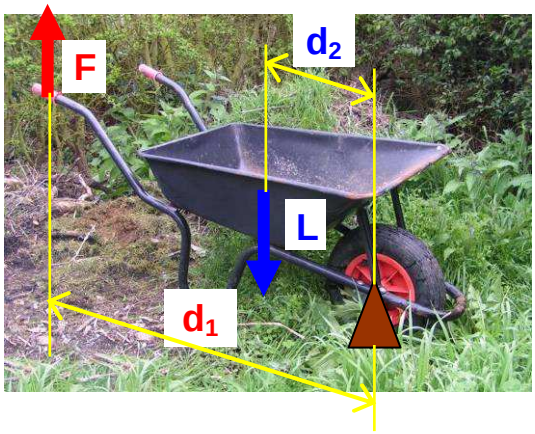
2. In a first class lever…
b) the fulcrum is situated between the force and the load.

3. In a first class lever…
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.

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

1. Draw on the photo of the <u>wheelbarrow</u> 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.

3. In a second class lever…
a) the force arm is never smaller than the load arm.

4. In a second class lever…
c) the mechanical advantage is never smaller than 1.

5. With a second class lever we can…
c) multiply just force.

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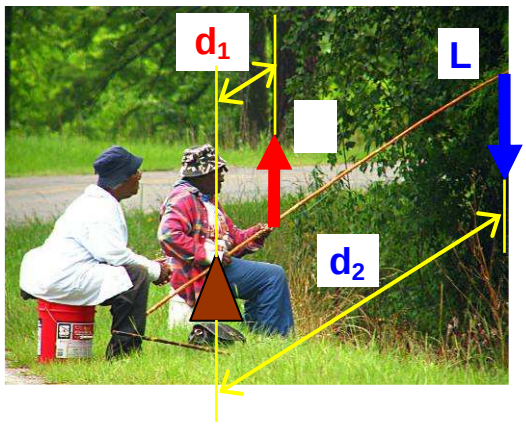
1. Draw on the photo of the <u>fishing rod</u> all the elements of the lever (fulcrum, force, load, force arm and load arm).



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

3. In a third class lever…
b) the force arm is never bigger than the load arm.

4. In a third class lever…
b) the mechanical advantage is never bigger than 1.

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

ACTIVITY 39 (10 min)	
Management	**Interaction**
- Hand out worksheet 26. - In pairs, students do activity 39. - Half of the students look up the words on the left and the other half on the right. - In pairs, students tell the words each other. - Show slide 6 while some students report their answers to the group. - Students check the answers.	Pairs Whole group
Language needed	**Resources**
Language provided on worksheet.	Worksheet 26 Slide 6

Answer Key

ENGLISH	CATALAN
Scissors	Tisores
Hole punch	Màquina de foradar (paper)
Broom	Escombra
Pincers	Tenalles
Scales	Balança
Wheelbarrow	Carretó
Tongs	Pinces (cuina)
Nutcracker	Trencanous
Pliers	Alicates
Fishing rod	Canya de pescar
Fire extinguisher handle	Mànec d'extintor

ENGLISH	CATALAN
Paper cutter	Cisalla
Tweezers	Pinces (pèls)
Crowbar	Palanqueta
Shovel	Pala
Can opener	Obrellaunes
Stapler	Grapadora
Bicycle brake	Fre de bicicleta
Seesaw	Gronxador
Oar	Rem
Bottle opener	Obridor
Arm lifting a weight	Braç aixecant un pes

ACTIVITY 40 (45 min)	
Management	**Interaction**
- Explain activity 40 to the students. - In pairs, students do activity 40 as homework. - Students show their presentation the following day.	Pairs Whole group
Language needed	**Resources**
Language provided on worksheet (activities 37 to 39).	Worksheet 26

ACTIVITY 41 (10 min)	
Management	**Interaction**
- Students do activity 41. - Show slide 7 while some students report their answers to the group. - Students check the answers.	Individual Whole class
Language needed	**Resources**
Language provided on worksheet.	Worksheet 26 Slides 7

Answer Key

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

ACTIVITY 42 (15 min)	
Management	**Interaction**
- Hand out worksheet 27. - Students solve the problems. - Students check their solutions with their partner. - Show slides 8 to 11 and explain the problems to the group. - Students check the solutions.	Individual Pairs Whole group
Language needed	**Resources**
Language provided on worksheet.	Worksheet 27 Slides 8-11

Answer Key

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.

$F = L \cdot d_2 / d_1 = 1000\ N \cdot 1\ m / 4\ m = 250\ N$

$MA = d_1 / d_2 = 4\ m / 1\ m = 4$

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.

$L = F \cdot d_1 / d_2 = 200\ N \cdot 2\ m / 0{,}8\ m = 500\ N$

$MA = d_1 / d_2 = 2\ m / 0{,}8\ m = 2{,}5$

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.

$d_2 = F \cdot d_1 / L = 1200\ N \cdot 1{,}5\ m / 2500\ N = 0{,}72\ m$

$MA = L / F = 2500\ N / 1200\ N = 2{,}08$

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.

$d_1 = L \cdot d_2 / F = 4000\ N \cdot 0{,}5\ m / 500\ N = 4\ m$

$MA = L / F = 4000\ N / 500\ N = 8$

TOPIC:	**Simple machines**		
UNIT 3:	Levers		
Lesson 3:	Wheel and axle	**Timing:**	50’

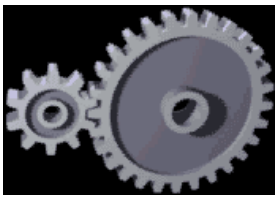
ACTIVITY 43 (10 min)	
Management	**Interaction**
- Hand out worksheet 28. - Students do activity 43. - Show slides 12 and 13 while some students report their answers to the group. - Students check the answers.	Individually Whole group
Language needed	**Resources**
This photo is a/an… That picture is a/an… The first/second/third/… picture is a/an…	Worksheet 28 Slides 12 - 13

Answer Key

← Coffee grinder

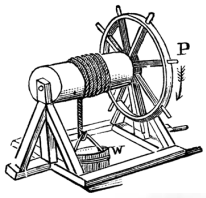
← Steering wheel

← Ferris wheel



← Gears

Windlass →



Water tap →

Bicycle →

Pepper mill →

ACTIVITY 44 (20 min)	
Management	**Interaction**
- Students do activity 43 on worksheet 28. - Show slides 14 and 15 for them to understand the drawing instructions. - Students check the answers.	Individually Whole group
Language needed	**Resources**
Language provided on worksheet.	Worksheet 28 Slides 14 - 15

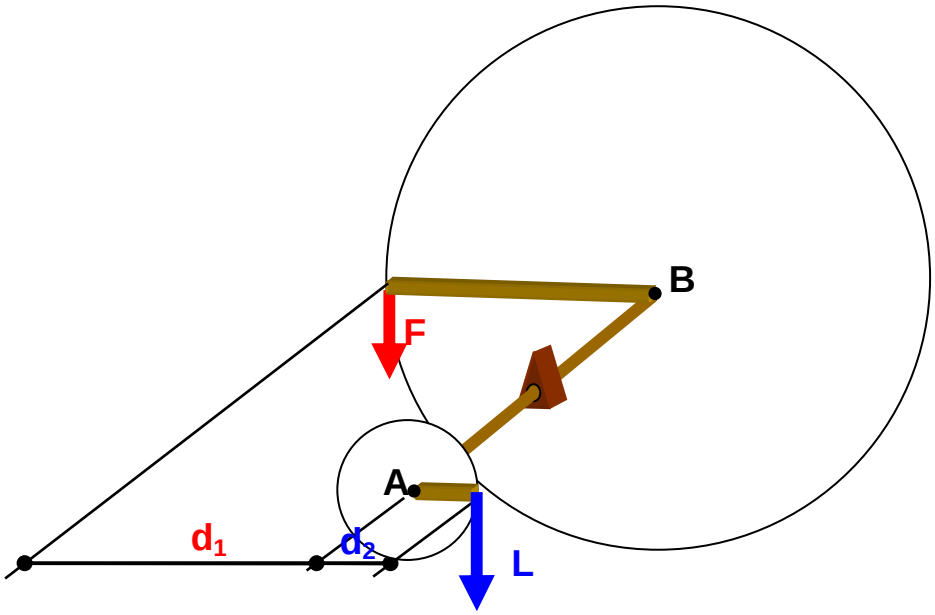
Answer Key

a) What kind of simple machine is it?
A lever.

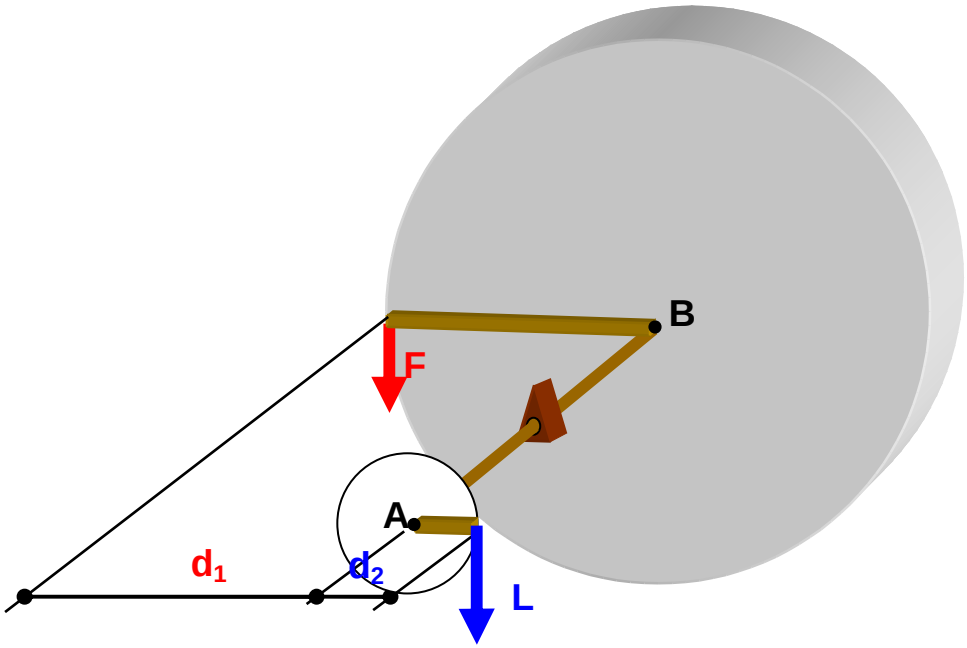
b) How could you find out its mechanical advantage?
MA = d_1 / d_2 = L / F

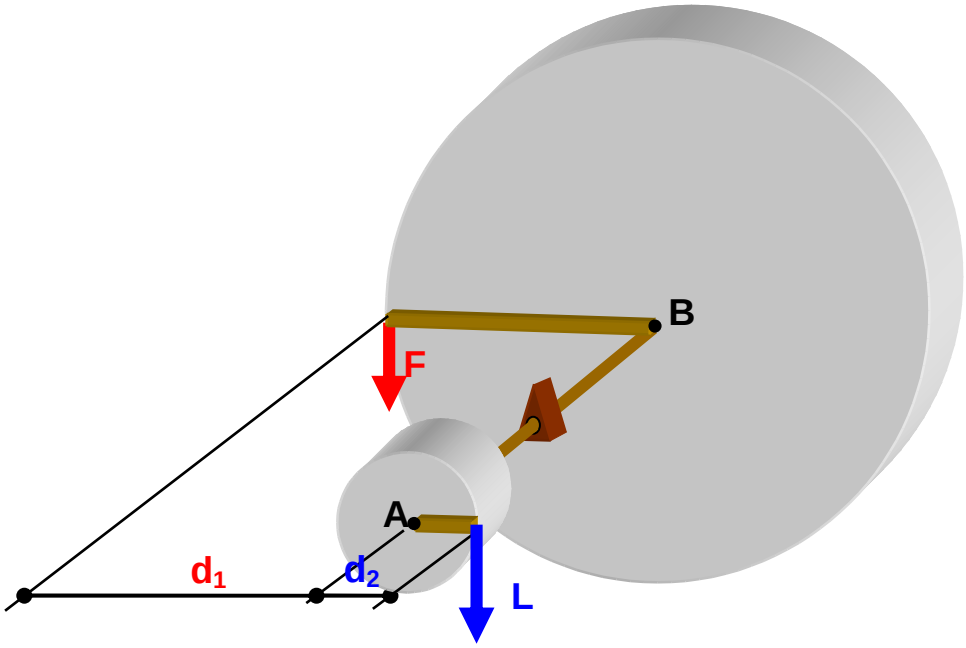
c) Follow the instructions to obtain the simple machine called wheel and axle. Draw it on next page.

- Draw two circumferences with a compass. The centre of the first circumference should be point B and its radius should be equal to d1. The centre of the second circumference should be point A and its radius should be equal to d2.

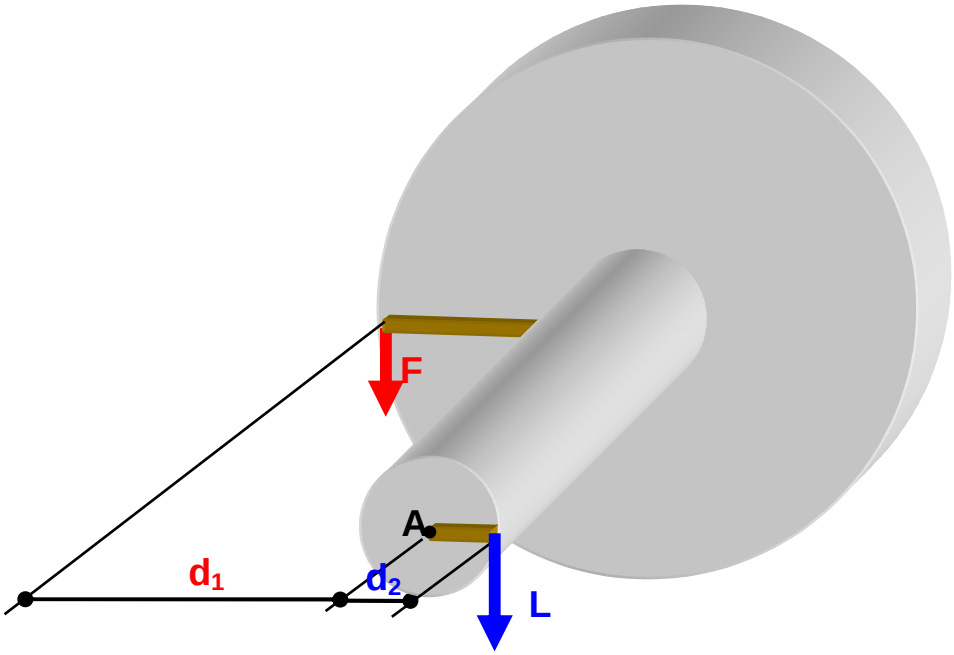


- Give some thickness to the big circumference (2 or 3 cm). This circumference will be the wheel.





- Enlarge the small circumference as a cylinder till it reaches the big one. The cylinder will be the axle.



ACTIVITY 45 (20 min)	
Management	**Interaction**
- Make groups of 7 students. - Give one card with the endings to each student. - Write on the board the language students may need. - Students ask to each other about their cards. - Students write down the endings on the worksheet. - Show slide 16 while some students report their answers to the group. - Students check the answers.	Groups of 7 Whole class
Language needed	**Resources**
What ending do you have? It could match with… Can you repeat?	Worksheet 28 Slide 16

Answer Key

a)	The wheel and axle is a first class lever that can turn 360º.
b)	The wheel and axle is a simple machine consisting of a big wheel rigidly attached to a smaller wheel called an axle.
c)	When the wheel turns, the axle also turns, and vice versa.
d)	If the wheel turns and the axle remains stationary, it is not a wheel and axle machine.
e)	When the force is applied to the wheel in order to turn the axle, force is increased and distance and speed are decreased.
f)	The mechanical advantage of a wheel and axle is the ratio of the radius of the wheel to the radius of the axle.
g)	Some examples of the wheel and axle are a door knob, a screwdriver, and the steering wheel of an automobile.

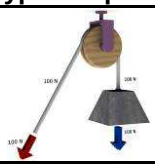
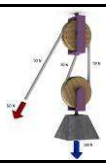
TOPIC:	**Simple machines**		
UNIT 3:	Levers		
Lesson 4:	Pulleys	**Timing:**	50’

ACTIVITY 46 (30 min)	
Management	**Interaction**
- Hand out worksheet 29. - Write on the board the language students may need. - Dictate and explain the pulleys to the students using the answer key. - Students take notes on the worksheet.	Whole class
Language needed	**Resources**
grooved rope well sailboat crane flag pole fixed movable compound attached Anchored block and tackle	Worksheet 29

Answer Key

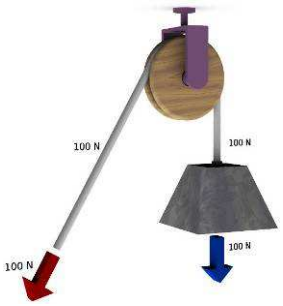
What is a pulley?
A pulley is a grooved wheel that turns around an axle with a rope passing through it.

Examples of pulleys			
			
Well	Sailboat	Crane	Flag pole

Different types of pulleys		
		
Fixed pulley	Movable pulley	Compound pulley

Fixed pulley

- A fixed pulley has a fixed axle.
- The axle is attached or anchored in place.
- A fixed pulley is used to change the direction of the force on a rope.
- A fixed pulley has a mechanical advantage of 1.
- A fixed pulley doesn't multiply force.

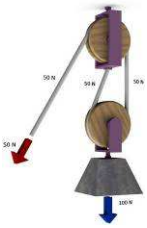


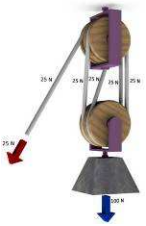
Movable pulley

- A movable pulley has a free axle.
- A movable pulley moves up and down with the load.
- One end of the rope is anchored and holds half of the load.
- Pulling on the other end of the rope we just have to apply a half of the load force.
- A movable pulley has a mechanical advantage of 2.
- A movable pulley multiplies force.

Compound pulley

- A compound pulley is a combination of a fixed and a movable pulley system.
- A compound pulley changes direction and multiplies force at the same time.
- A block and tackle is a compound pulley where several pulleys are mounted on each axle.
- Each movable pulley holds the load with two sections of rope.
- The more movable pulleys you have, the more sections of rope help you to hold the load.
- Mechanical advantage is determined by the number of supporting ropes (n) of the movable pulleys.
- Due to friction and the weight of the pulleys actual MA is quite smaller than ideal MA.





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

ACTIVITY 47 (20 min)	
Management	**Interaction**
- Students solve the problems on worksheet 29. - Students check their solutions with their partner. - Show slides 17 to 19 and explain the problems to the group. - Students check the solutions.	Individual Pairs Whole group
Language needed	**Resources**
Language provided on worksheet.	Worksheet 29 Slide 17 - 19

Answer Key

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.

$F = L / n = 1600\ N / 4 = 400\ N$

$MA = n = 4$

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.

$L = n \cdot F = 6 \cdot 600\ N = 3600\ N$

$MA = n = 6$

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?

$MA = L / F = 8200\ N / 820\ N = 10$

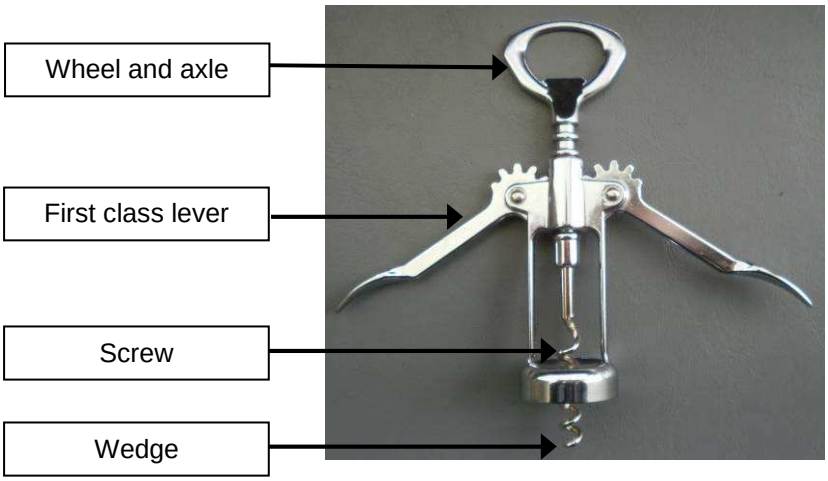
$n = 10 \rightarrow$ Movable pulleys = 5

TOPIC:	**Simple machines**		
UNIT 3:	Levers		
Lesson 5:	Assessment	**Timing:**	30’

ACTIVITY 48 (30 min)	
Management	**Interaction**
- Hand out worksheet 30. - Write on the board the language students may need. - In pairs students do activity 48. - When time’s up, collect the worksheets.	Pairs
Language needed	**Resources**
We could… If …. + past simple, …. would + infinitive Language learnt during the unit.	Worksheet 30

Answer Key

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.
Open answer. For example:
- Wheel and axle: we could make wheel wider, axle narrower or both.
- First class lever: we could make force arms longer, load arms shorter or both.
- Screw: we could make pitch smaller.
- Wedge: we could make the tip sharper.

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

4. Calculate the mechanical advantage of three simple machines of your corkscrew.
Open answer but they should calculate the mechanical advantage of the wheel and axle, the lever and the screw.

5. What problems could we have if we try to get a too big mechanical advantage?
Open answer. For example:
- Wheel too big or force arm too longs: the corkscrew would be too big, uncomfortable and expensive.
- Axle too narrow: it would be too weak.
- Pitch too small: it would take too many turns to perforate the cork.
- Tip too sharp: easy to break and dangerous.