

UNIT 2. – FORCES AND MOMENTS

SESSION 1

1. –



If you think of the word “Force”, what comes to your *mind*?

Make a list of all the ideas that you have, it can be just a word, a sentence ... (e.g. : what *effects they have*, *where can you note them*, *where they act*, *how they act*, *how you represent them* ...).

Brainstorm¹ for ideas.

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2.- Power point



Pay attention to the following information.

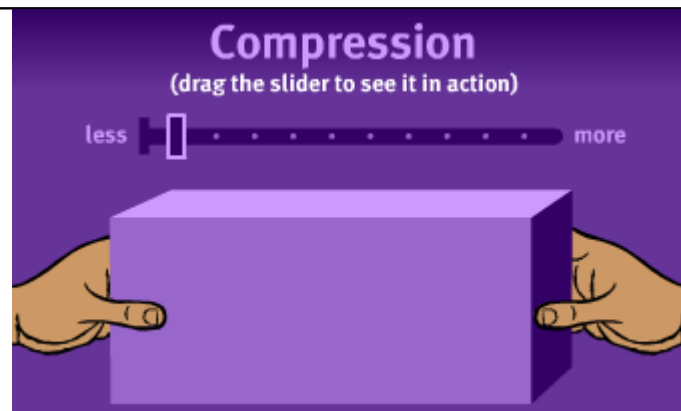
p.p.: forces

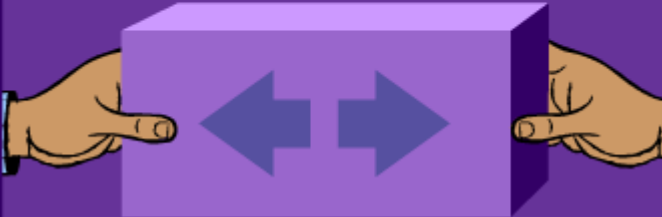
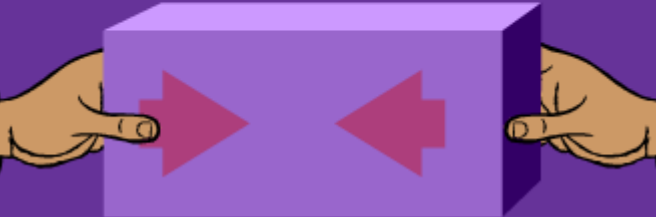
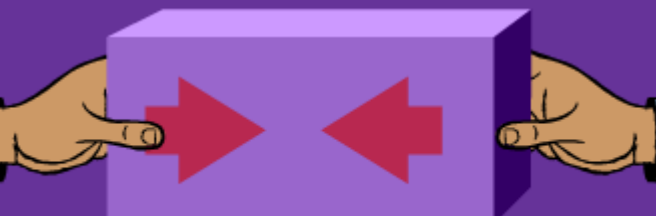
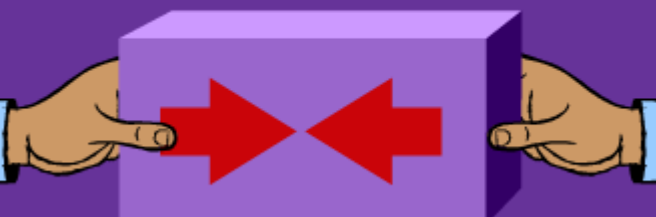


Tension is a force that *stretches* material apart. When a material is in tension, it *tends* to become longer.

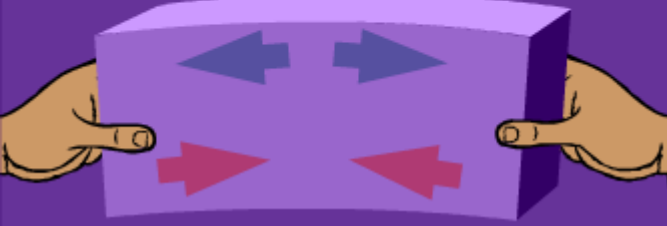
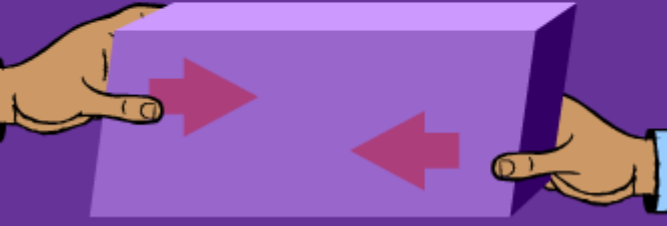
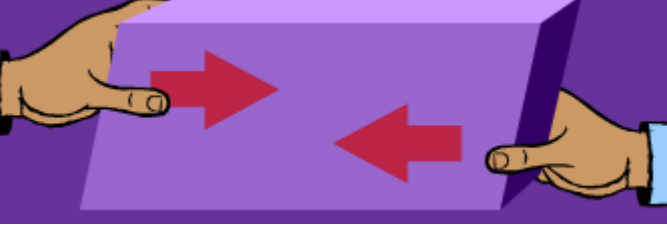
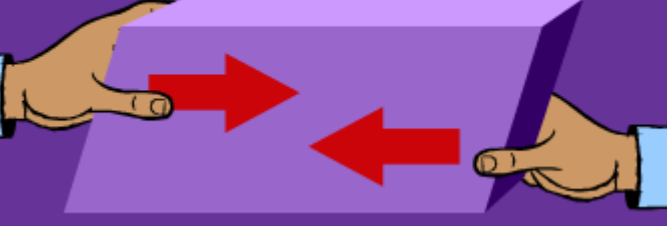


Compression is a force that *squeezes* a material together. When a material is in compression, it *tends* to become shorter.



Tension (drag the slider to see it in action) less  more 	Compression (drag the slider to see it in action) less  more 
Tension (drag the slider to see it in action) less  more 	Compression (drag the slider to see it in action) less  more 
less  more 	less  more 

 BENDING Bending: When a <i>straight</i> material becomes curved, one side <i>squeezes</i> together and the other side <i>stretches</i> apart.	 SLIDING Shear is a force that causes parts of a material to <i>slide</i> past one another in opposite directions.
Bending (drag the slider to see it in action) less  more 	Shear (drag the slider to see it in action) less  more 

Bending (drag the slider to see it in action) less  more 	Shear (drag the slider to see it in action) less  more 
Bending (drag the slider to see it in action) less  more 	Shear (drag the slider to see it in action) less  more 
less  more 	less  more 



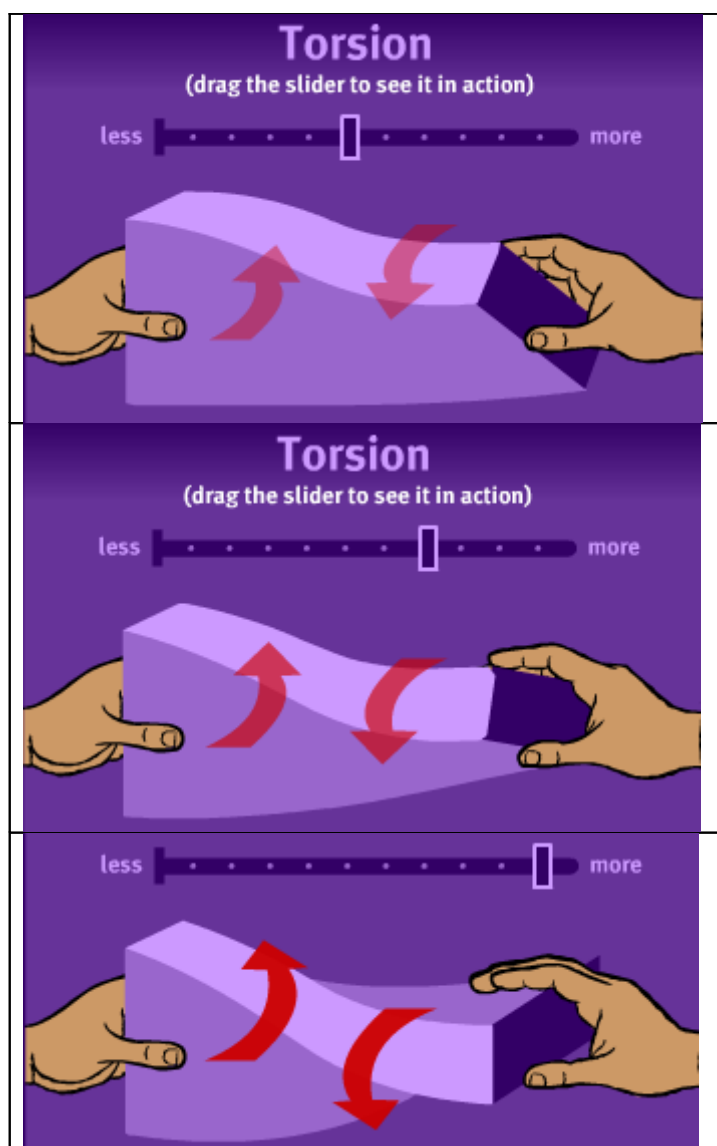
TWISTING

Torsion is an action that *twists* a material.

Torsion
(drag the slider to see it in action)

less  more





3. –

Bending / twisting.

Listen to your teacher's explanation.

Bending: a combination of forces that causes one part of a material to be in compression and another part to be in tension.



Twist: a *twisting* that can result from an *unevenly placed load*



4.– Homework



Someone stole the.....

**Oh dear! The vowel thief has struck again!
Can you put the vowels back in these words?**

Vowels : A,E,I,O,U

str__ght m_t_r__l T_ squ__z_

T_ str_tch

Sh__r

T_ tw_st

Sl_d_ng

Sh_rt

F_rc_

T_ b_nd

C_mpr_ss__n

L__d

C_rv_d m_t_r__l

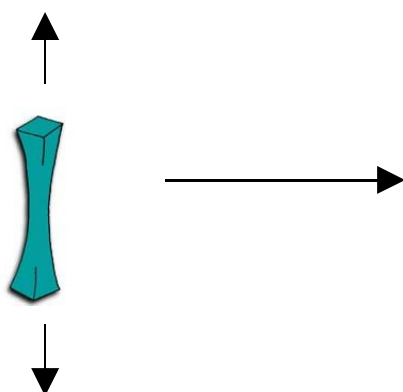


SESSION 2

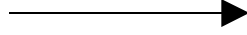
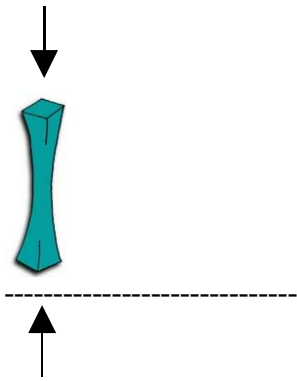
5.-



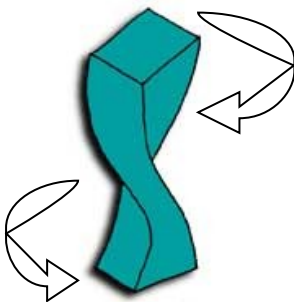
Write *beside* each drawing, the name of the corresponding force.



NAME OF THE FORCE







6. –



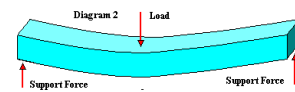
Understanding textbook language.

Fill in the gaps with the name of the force and the effect produced.

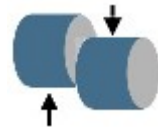
-----: a *stretching* force that *pulls* on a material.



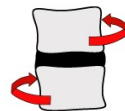
----- occurs when a *straight* material becomes curved.



A ----- force is created where two *opposite* forces try to cut, *tear* or *rip* something in two.



----- happens when the ends of a member *are turned* in *opposite* directions.



----- is the name for the *pushing forces* on parts of a structure. The consequence is that the *shape* will *become* ----- in the middle as you *push*.



Word bank

Bending
shear

torsion
compression

fatter
tension

7.- Homework



Name that load.

Make a list of the different loads affecting your bedroom.

Loads create a force on a structure.

Dead load: the *weight* of the permanent, non moveable parts of a structure, such as the towers, cables and roadway of a bridge.

Live load: the *weight* of a structure's non permanent moveable parts, contents or "users", such as the traffic, people and *seagulls* on a bridge. *Environmental* loads, such as wind, rain and *earthquakes*, that can affect a structure temporarily are also live loads.

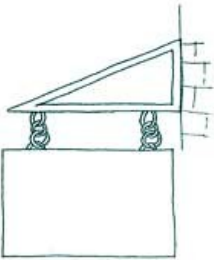
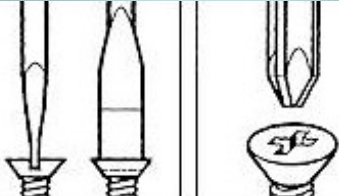
OBJECT AFFECTED	TYPE OF LOAD (dead / live)

SESSION 3

8-



Fill in the *gaps* with the name of the force that is acting.

	PART OF THE DRAWING	TYPE OF FORCE
	<i>Chains that join the block with the triangular structure.</i>	tension
	<i>Diving board</i>	
	<i>screw</i>	
	columns	
	paper	

9.-



Understanding textbook language.
Listen to your teacher's explanations, then fill in the gaps with an appropriate word from the word bank.

FORCES AND STRUCTURES

List of key words and phrases that may be in the text:

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Common Units of force

SI:

newton (N)
 $1 \text{ N} = 0.225 \text{ lb}$

English:

Pound (lb)
 $1 \text{ lb} = 4.448 \text{ N}$

SESSION 4

10. –



With your *partner*, make a list of elements which you think are/work in tension and compression. *Check* your notes with other *partners*. Then, make sentences.

Elements that work in TENSION	Elements that work in COMPRESSION
A rope pulling a car	Legs of a chair

A/ an (.....) works in (.....).

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Remember:

1. To change the verb properly in Simple Present if you are using the third person of singular .
i.e.: a column works in ...
2. An “a” is written if the following word starts by a consonant
An “an” is written if the following word starts by a vowel.
i.e.: a natural structure
an architectural structure

11.-

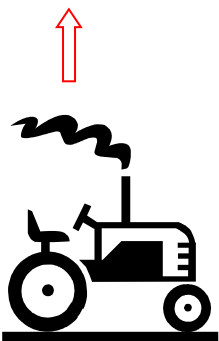


Balanced or not?

Underneath each of the illustrations below write either “balanced” or “not balanced” to describe the forces.

a)

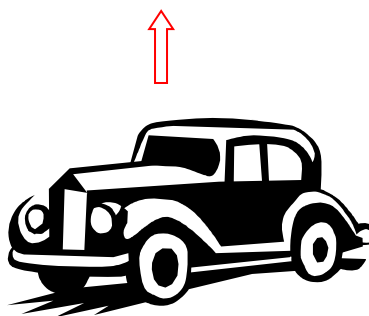
5000 N



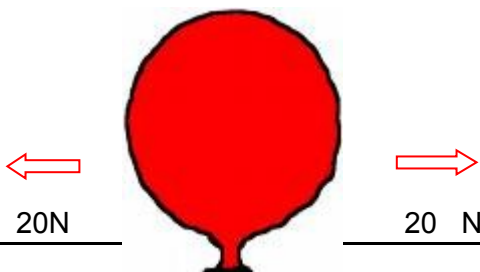
6500 N

b)

8000 N



8000 N



d)

4000 N



3500 N

12. -



Pay attention to the following information.
p.p: (Forces over structures)

SESSION 5

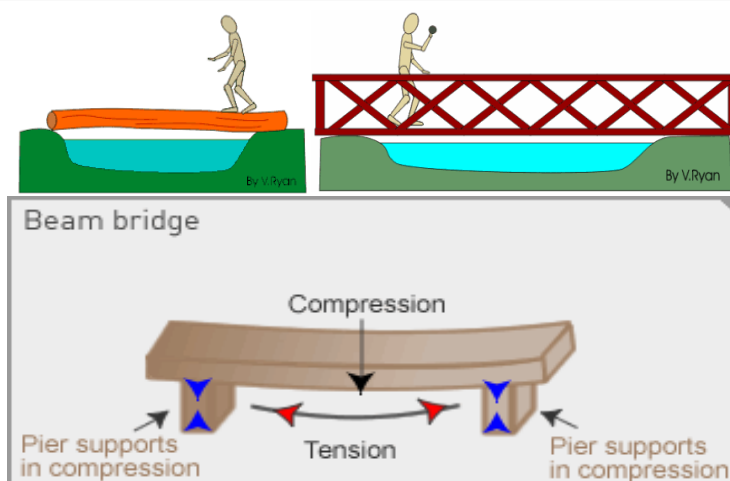
13 -



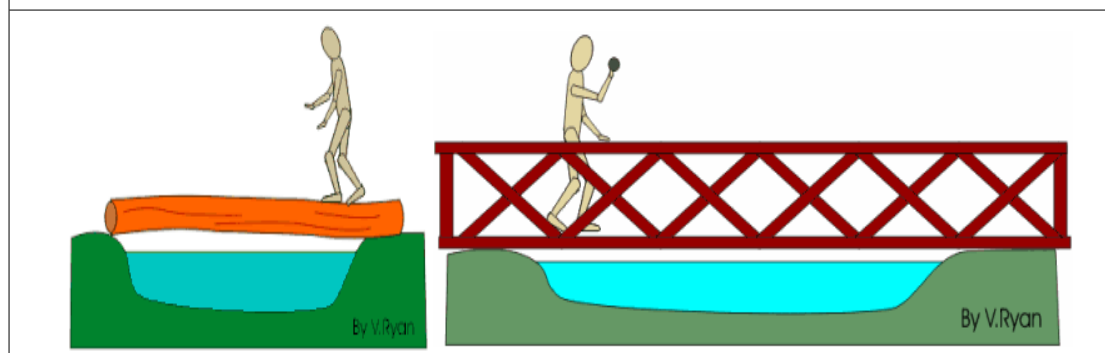
Engineers must consider many things –like the distance to be spanned and the types of material available – before determining the size, shape and overall look of a bridge. Can you draw the different forces that act on these bridges? Help with the drawings.

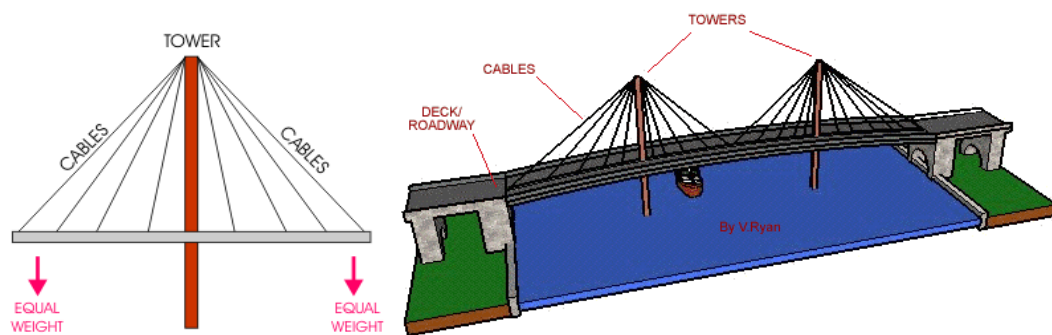
Beam bridge: forces

When something pushes down on the beam, the beam *bends*. Its *top edge* is pushed together, and its *bottom edge* is pulled apart.

**Truss/ Cable stay bridge: forces**

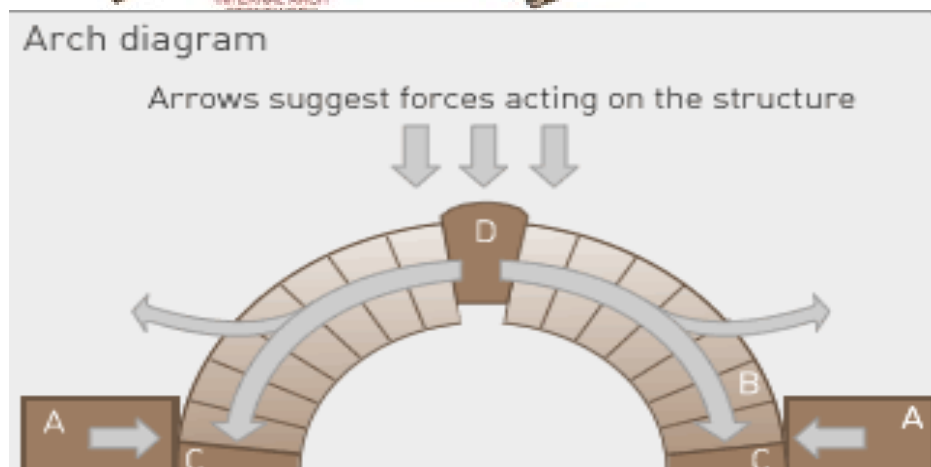
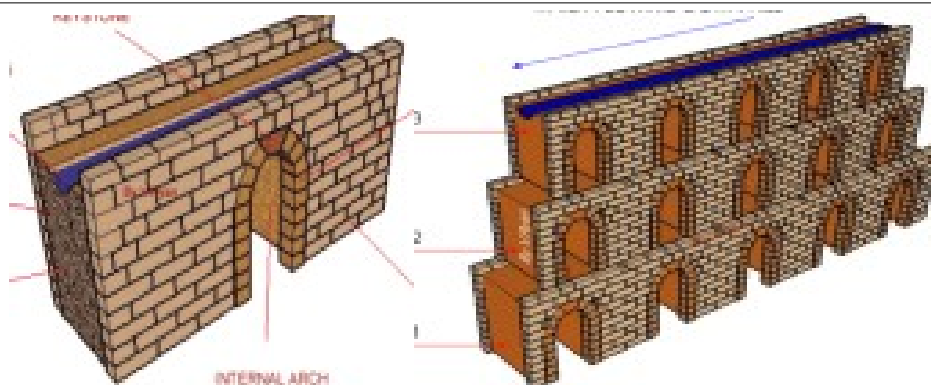
They do not need anchor blocks. The cables are fixed to either side of each tower - this means that the weight of each side of the bridge counter balances the opposite side.





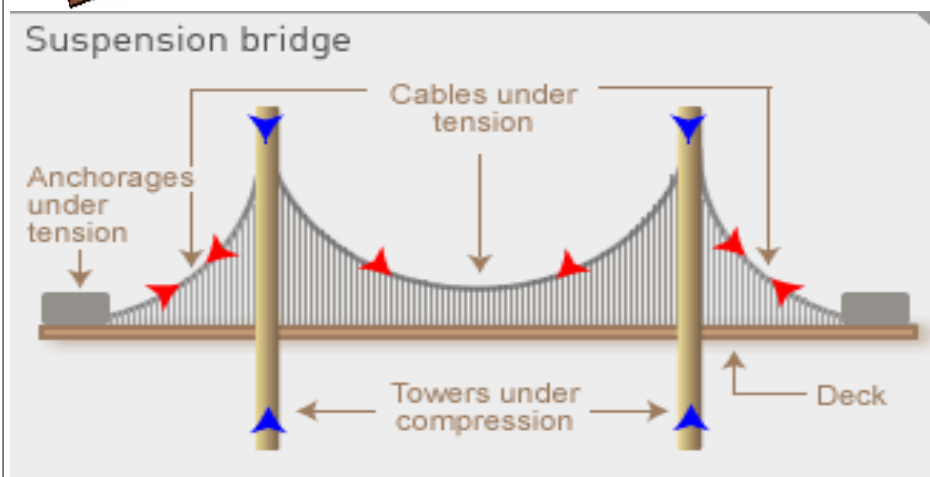
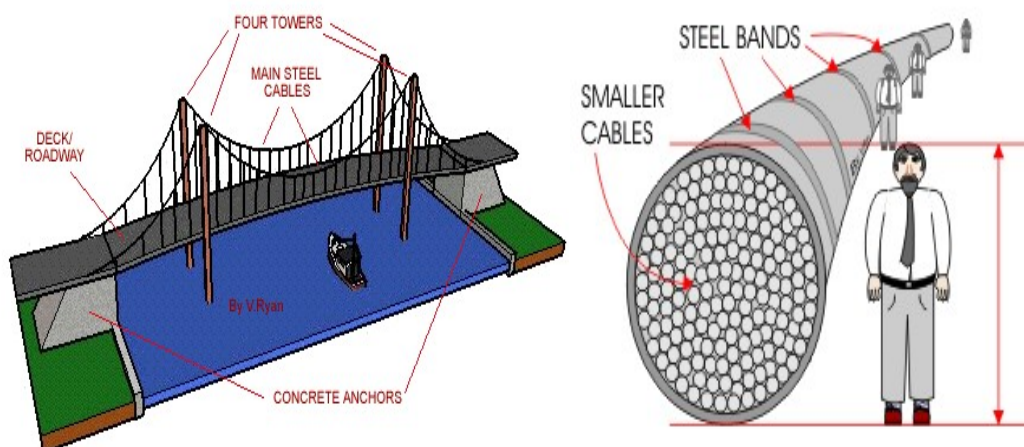
Arch bridge: forces.

The arch is *squeezed* together, and this *squeezing* force is carried *outward* along the curve to the supports at each end. The supports, called *abutments*, push back on the arch and prevent the ends of the arch from *spreading* apart.



Suspension bridge: forces

The roadway *hang* from massive *steel* cables, which are *draped over* two towers and secured into solid *concrete* blocks on both ends of the bridge. The cars push down on the roadway, but because the roadway is suspended, the cables transfer the *load* into compression in the two towers. The two towers support most of the bridge's weight.



SESSION 6

14.-



Spot the sentence.

A **force** is a measurable action which moves an object in a particular direction or that tries to change its *shape*.

Moments and *torques* are measured as a force multiplied by a distance so they have units *such as* newton-metre (N·m).

When a *bending* moment exists in a structural element it induces *tensile stresses* and *compressive stresses* in the element. Tensile stresses and compressive stresses increase proportionally with bending moment.

The forces and moments on *either* side of the section must be equal in order to *counteract* each other and maintain a state of equilibrium so the same bending moment will result from summing the moments, *regardless* of which side of the section is selected.

Moments are calculated by multiplying the external vector forces (*loads* or reactions) by the vector distance at which they are applied

Main ideas:

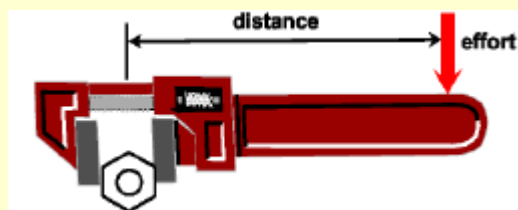
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Key words of the exercise and the unit (and their translation)

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Torque /moment (turning force)

The turning force of a lever, e.g. *spanner*, is larger when the effort is further away from the fulcrum. You can get more torque from a spanner with a long handle, than one with a short one.



$$\text{Torque} = \text{Effort (newtons)} * \text{Distance (metres)}$$

15.-



Fill in the **gaps** with the words from the word bank.

..... is a that tends to or turn things. You generate a torque any time you apply a force using a *Tightening the lug nuts* on your wheels is a good example. When you use a *wrench*, you apply a to the *handle*. This force creates a *torque* on the *lug nut*, which tends to turn the *lug nut*.

..... units of *torque* are pound-inches or pound-feet; the is the Newton-meter. Notice that the *torque* units contain a and a force.

Word bank

Force, *Torque*, distance, English, *wrench*, force, rotate, SI units

Main ideas:

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Key words of the exercise and the unit (and their translation)

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Common Units of moment/TorqueSI:

Newton meter (Nm)

1 Nm = 0.737 lb-ft

English:

Pound-inch (lb-in)

1 lb-in = 0.113 Nm

Pound-foot (lb-ft)

1 lb-ft = 1.356 Nm

SESSION 7

16. -

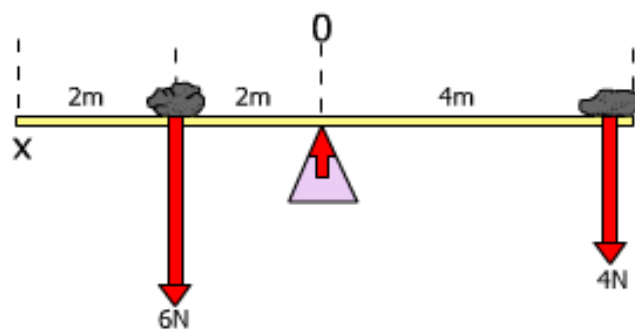


Pay attention to the following information.
p.p.: moments

17. -



What extra force is needed at X to balance the *plank*?
Choose one of the following answers.



4N



2N



3N



1N



16N



Calculations done:

Remember:

You will need sentences like:

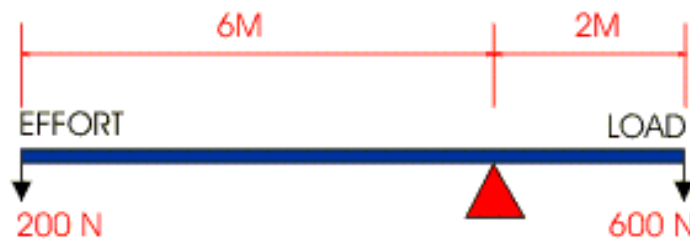
- You have to multiply (this force) by (this distance)
- You have (....) in a clockwise direction, so you need (....) in an anti-clockwise sense.
- I think it is not right because ...

18.- Homework



Is the bar in equilibrium?.

The diagram below show a lever where a force of 200 N balances a load of 600 N. The effort force is 6 metres from the *fulcrum*. The load force is 2 metres from the *fulcrum*.

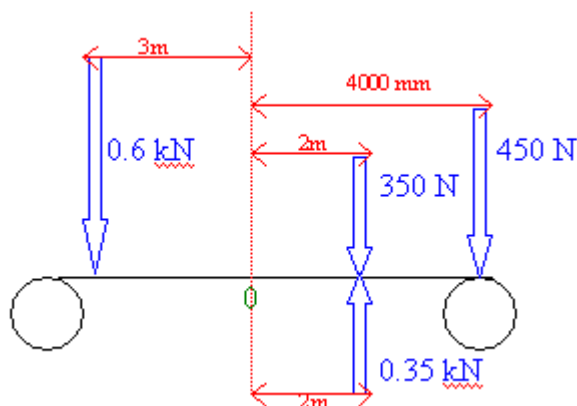


SESSION 8

19.-



Calculate the following moments in the bar, and draw their direction.



Possible directions:

- Clockwise
- Anti-clockwise

Remember:

$$1\text{N} = 0.22481\text{ lb}_f$$

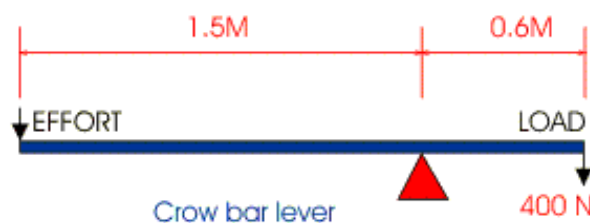
Force	Force (N)	Force (lb _f)	Distance (m)	Moment (N*m)	Sense
0.6 kN	600				
350 N	350				
0.35 kN	350				
450 N	450				

Calculations done:

20.- Homework



In the [diagram](#) below a crow-bar is used to move 400 N load. What effort is required to move the load?



21.- “Mind Map”



Home

Here, in this section, the pupil has to make up his/her Mind Map about the unit contents. You will need some coloured pencils.

22. – “My own glossary”



Home

Here, in this section, the pupil has to make up a list of the worksheet words that he/she doesn't understand.

23.– Glossary of words

ENGLISH	DEFINITION	CATALAN TRANSLATION
abutment	The supports of an arch bridge	contraforts
Beam bridge	Bridge made of long pieces of wood, metal ... used to support weight	Pont fet amb vigues
bending	To force something that was straight into an angle or a curve	flexió
besides	In addition, also	A més de
Bottom edge	The outside inferior limit of an object	La part de baix
buckling	To become crushed or bent under a weight or force	doblegament
chains	A series of connected metal rings, used for pulling or fastening things	cadena
cantilever	A long piece of metal or wood that sticks out from a wall to support the end of a bridge or other structure	Pont voladís
Compressive stresses	Pushing pressures put on something that can damage it or make it lose its shape	Forces de compressió
concrete	Building material that is made by mixing together cement, sand, small stones and water	formigó
counteract	To do something to reduce or prevent the bad or harmful effects of something	contrarrestar
design	The general arrangement of the different parts of something that is made, such as a building, book, machine ...	disseny
Diving board	A board at the side of or above a swimming pool from which people can jump or dive into the water	trampolí
earthquakes	A sudden, violent shaking of the earth's surface.	terratremols
either	One or the other of two	qualsevol
environmental	Connected with the natural conditions in which people, animals and plants live; connected with the environment.	mediambiental
gap	A space between two things or in the middle of something	espai
Handle (pp)	The part of a door, drawer, window... that you use to open it	Asa, mango, manivela
knowledge	The information, understanding and skills that you gain through education or experience	coneixement
load	The amount of weight that is pressing down on something	càrregues

lug	A part of something that sticks out, used as a handle or support	agarradera
mind	Your ability to think and reason	ment
Nut (pp)	A small piece of metal with a hole through the centre that is screwed onto a bolt to hold pieces of wood, machinery... together	cargol
opposite	Same directions but other sense	contrari
outward	Going away from a particular place.	exterior
partners	A person that you are doing an activity with	company
plank	A long narrow flat piece of wood that is used for making floors...	taula
Pushing forces	Physical strength applied in a way that reduces the length of the object above which it is done	Forces de compressió
Regardless	Paying no attention to something	Malgrat tot / tenint en compte
safely	Without being harmed, damaged or lost	Amb seguretat
screw	A thin pointed piece of metal like a nail with raised spiral line along it and a line or cross cut into its head. Screws are turned and pressed into wood, metal... with a screwdriver in order to fasten two things together.	cargol
seagull	A bird with long wings and usually white and grey or black feathers that lives near the sea	gavina
Self-weight	A measure of how heavy oneself is	el seu propi pes
serviceability	Suitable to be used	Pràctic, resistent
shape	The form of the outer edges or surfaces of something	forma
shear	When a force acts upon an object and breaks it under pressure	cisallament
Snapping (ex.8)	To break something suddenly with a sharp noise	"snapping"
Spanner (pp)		
steel	A strong hard metal that is made of a mixture of iron and carbon	acer
straight	Not in a curve or at an angle	recte
strength	The ability that something has to resist force or hold heavy weights without breaking or being damaged	resistència
such as	Of the type already mentioned	Tal com
through	From one end or side of something to the other	A través de
Tensile stresses	Pulling pressures put on something that can damage it or make it lose its shape	Forces de tensió
To become	To start to be	Arribar a ser
To be able to	Used to say that is possible for somebody/ something to do something	Ser capaç de
To be spanned	The width of something from one side to the other	Ser abarcat
To be turned	To be moved or made something move around a central point	Ser girat

To check	To examine something to see if it is correct	comprovar
To drape over	To allow part of your body to rest on something in a relaxed way	cobrir
To fulfil	To do or achieve what was hoped for or expected	Complir amb/ dur a terme
To hang	To attach something, or to be attached, at the top	penjar
To join	To fix or connect two or more things together	unir
To pull	To hold something firmly and use force in order to move it or try to move it towards yourself	tirar
To rip	To tear something or to become torn, often suddenly or violently	Rasgar, trencar
To slide	To move easily over a smooth or wet surface	Deslligar-se
To spread	To open something that has been folded so that it covers a larger area than before	Extendre's,
To squeeze	To press something firmly	apretar
To stretch	To make something longer, wider or looser by pulling it.	estendre
To tear	To damage something by pulling it apart or into pieces	desgarrar
To tend	To be likely to do something	Tendir a
To tighten	To become or make something tight or tighter	Ajustar, tensar
To twist	To bend or turn something into a shape or position that is not normal or natural	Girar, retorcer, enrollar
To understand	To know or realize how or why something happens, how it works or why it is important	comprendre
Top edge	The outside superior limit of an object	La part de dalt
torque	A twisting force that causes machinery to rotate	Parell de torsió
Truss bridge	A sort of bridge made of pieces of wood or metal	Pont d'armadura
Turning point (pp)		Punt sobre el que gira
unevenly	Not following a regular pattern: not having a regular size and shape	De forma poc uniforme o de manera irregular
weight	How heavy somebody/something is, which can be measured in, for example, kilograms or pounds	Massa (pes col.loquialment)
Wrench (noun)	A metal tool with a specially shaped end for holding and turning things, including one which can be adjusted to fit objects of different sizes.	Clau anglesa
Wrench (verb)	To pull or twist something suddenly or violently	gir