- "The complexity of our present trouble suggests as never before that we need to change our present concept of education. Education is not properly an industry, and its proper use is not to serve industries, either by job-training or by industry-subsidized research….

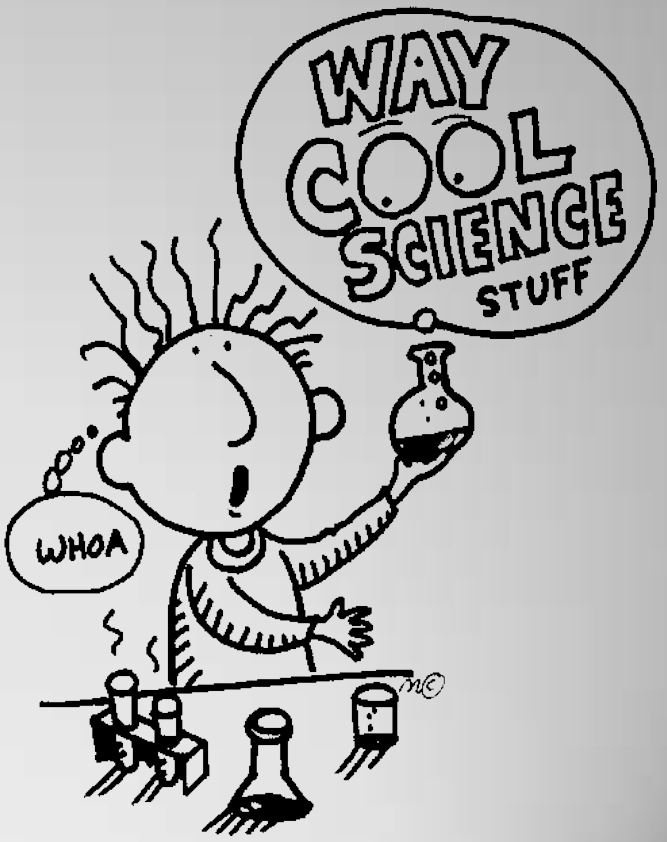
- …Its proper use is to enable citizens to live lives that are economically, politically, socially, and culturally responsible. This cannot be done by gathering or "accessing" what we now call "information" - which is to say facts without context and therefore without priority…

- …A proper education enables young people to put their lives in order, which means knowing what things are more important than other things; it means putting first things first." - Wendell Berry

"We are not raising children.
We are raising adults."
-Harmony West

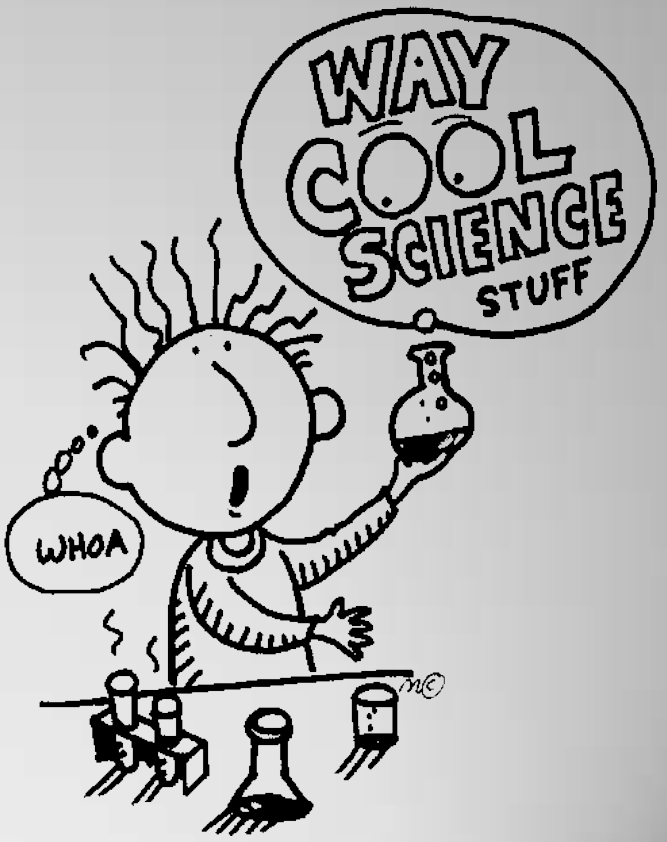
Science competitions give students a chance to…

- Explore their world.



Science competitions give students a chance to…

- Explore their world.
- Follow their interests and questions.



Science competitions give students a chance to…

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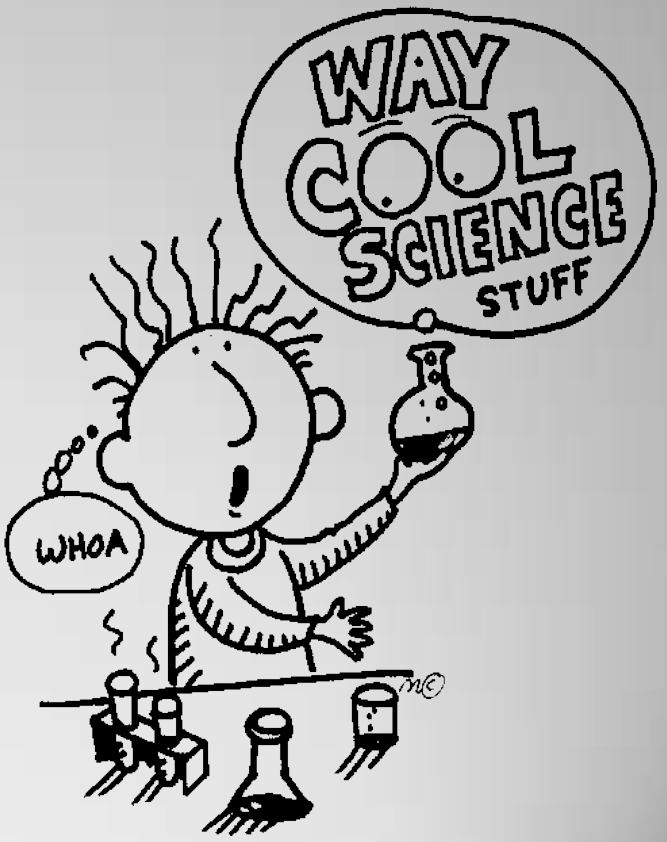

Science competitions give students a chance to…

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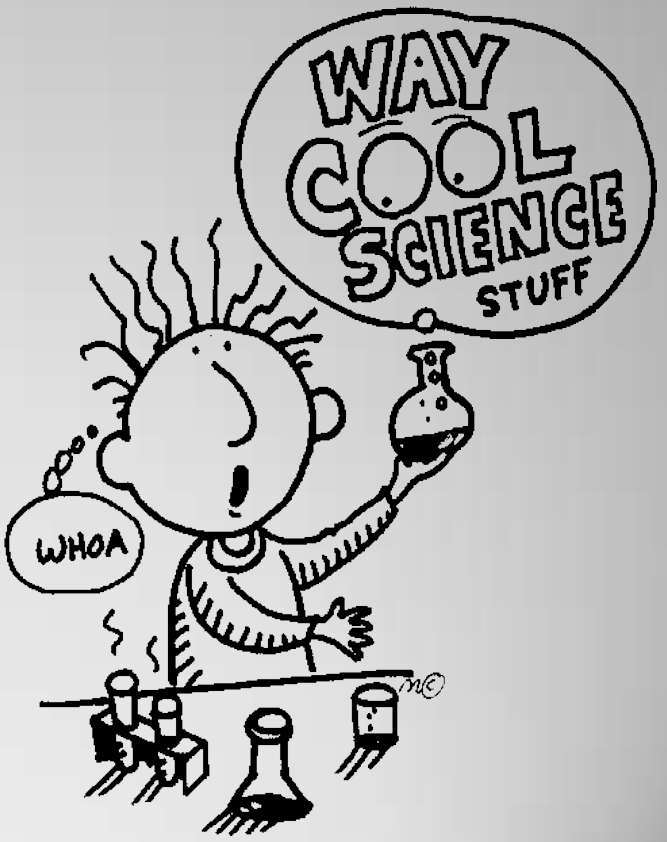
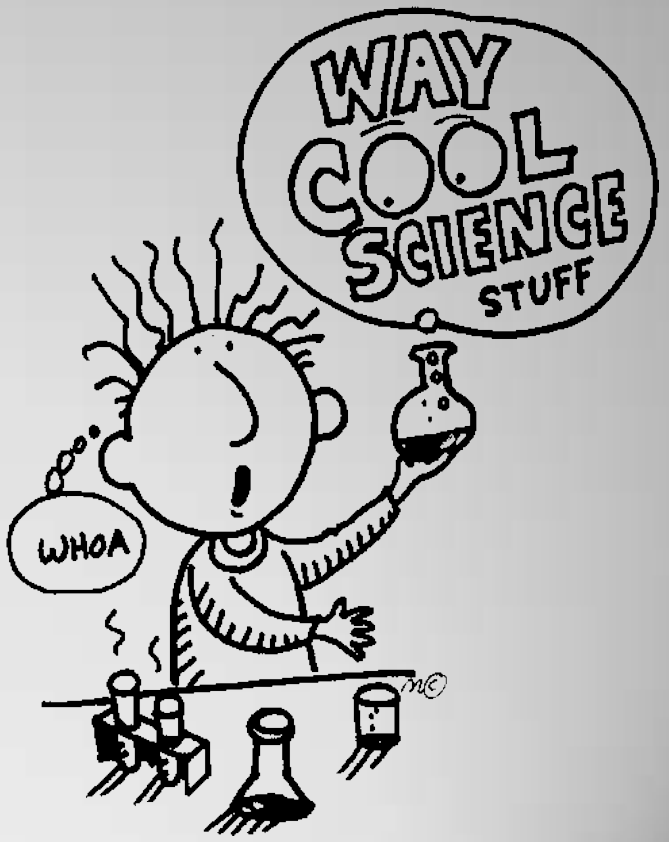


Science competitions give students a chance to…

- Explore their world.
- Follow their interests and questions.
- Work with their peers towards a common goal.
- Gain foundational scientific understandings on which they can build deeper knowledge and skills.
- Better appreciate their world.



Bridges

You may wonder...

Why are bridges used?

You may wonder...

Why are bridges used?
Where are bridges used?

You may wonder...

Why are bridges used?
Where are bridges used?
What are bridges made of?

You may wonder...

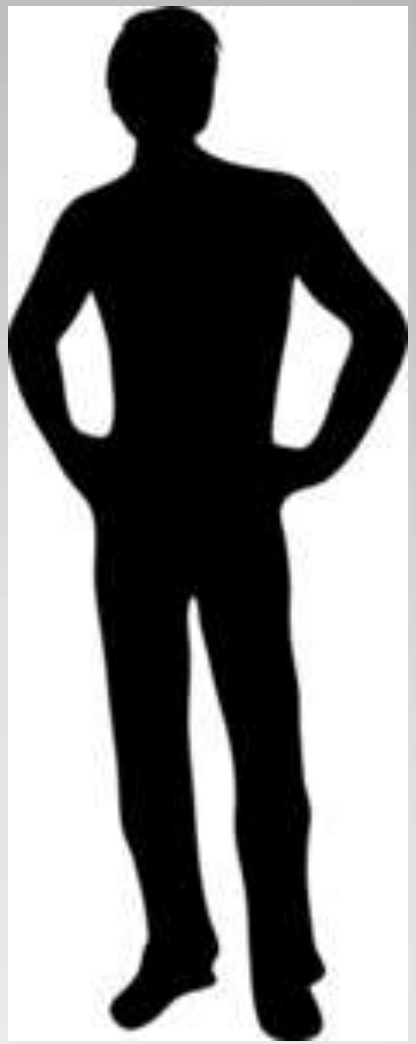
Why are bridges used?
Where are bridges used?
What are bridges made of?
What structural shapes are commonly found in bridges?

Get physical...

Stand up!

Can you find bridges in your body?

Get physical…



Get physical...

Stand up!

Feel the weight of your body at the point where your feet touch the ground.

Get physical...

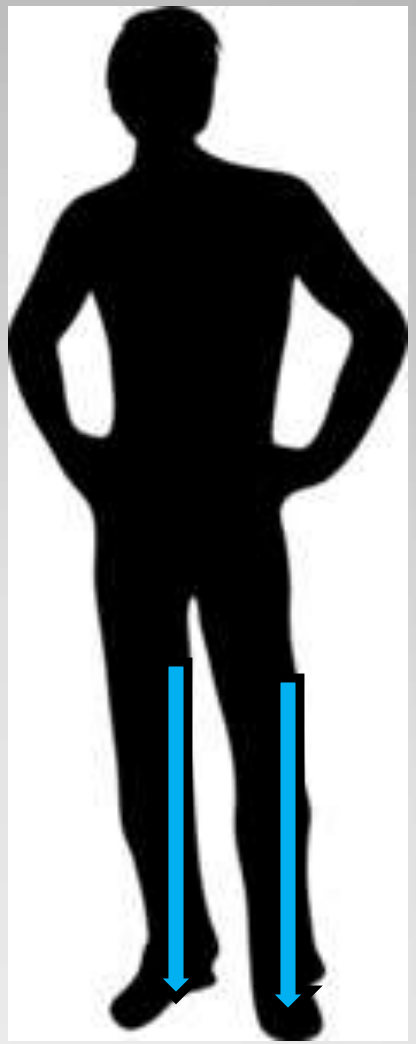
Stand up!

Feel the weight of your body at the point where your feet touch the ground.

- Where does that weight come from?

Get physical...

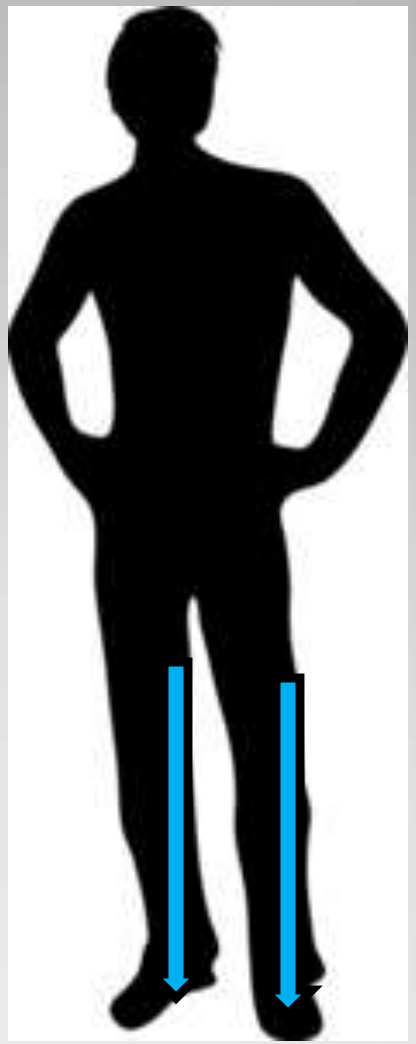
The weight of your body is sent to your feet.



Get physical...

Can you feel the ground pushing back?

Get physical...



NMMESA

Get physical...

Is rubber elastic?

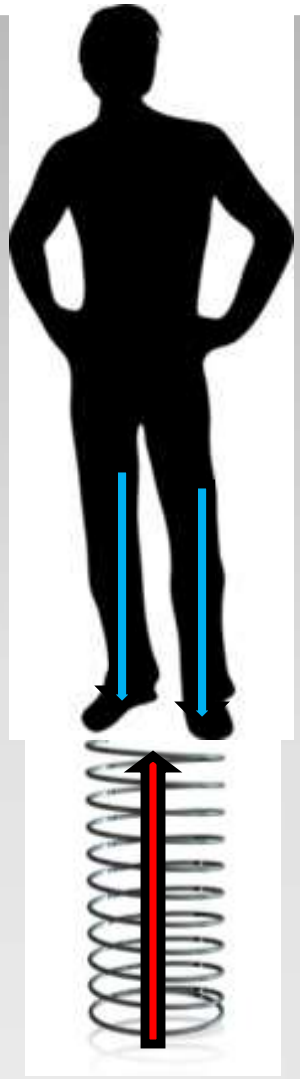
Get physical...

Is steel elastic?

Get physical...

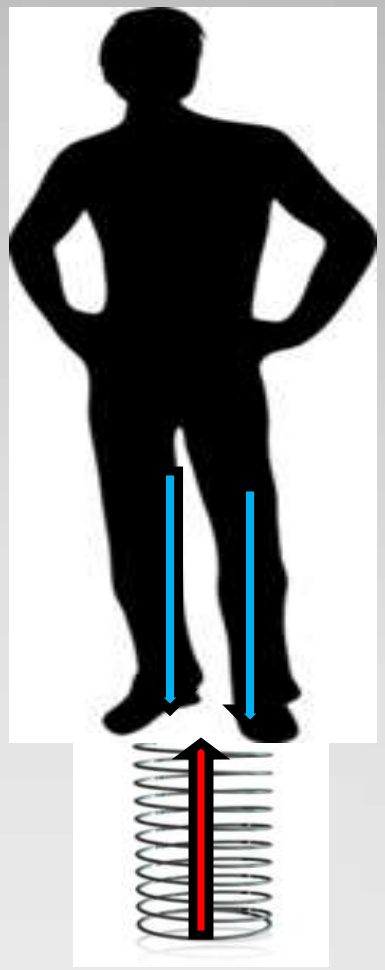
Is a SPRING elastic?

Get physical...



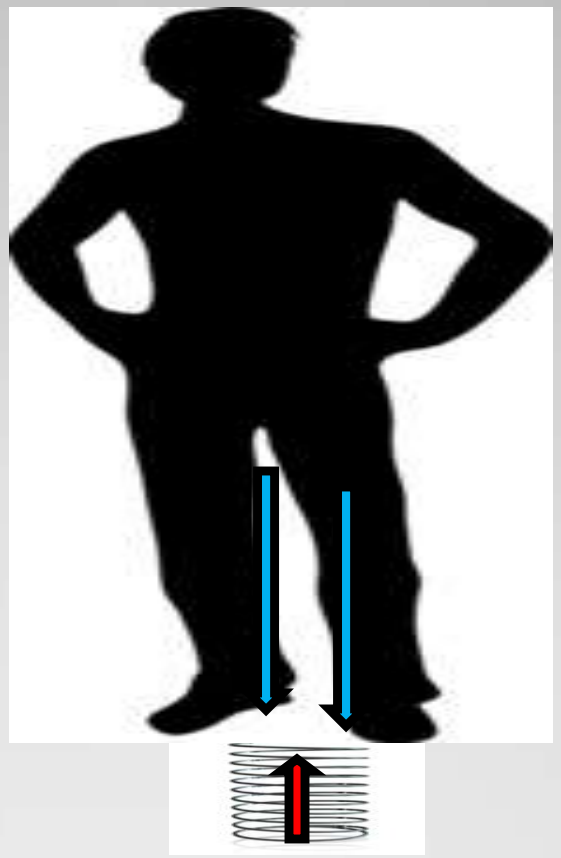
NMMESA

Get physical...



NMMESA

Get physical...



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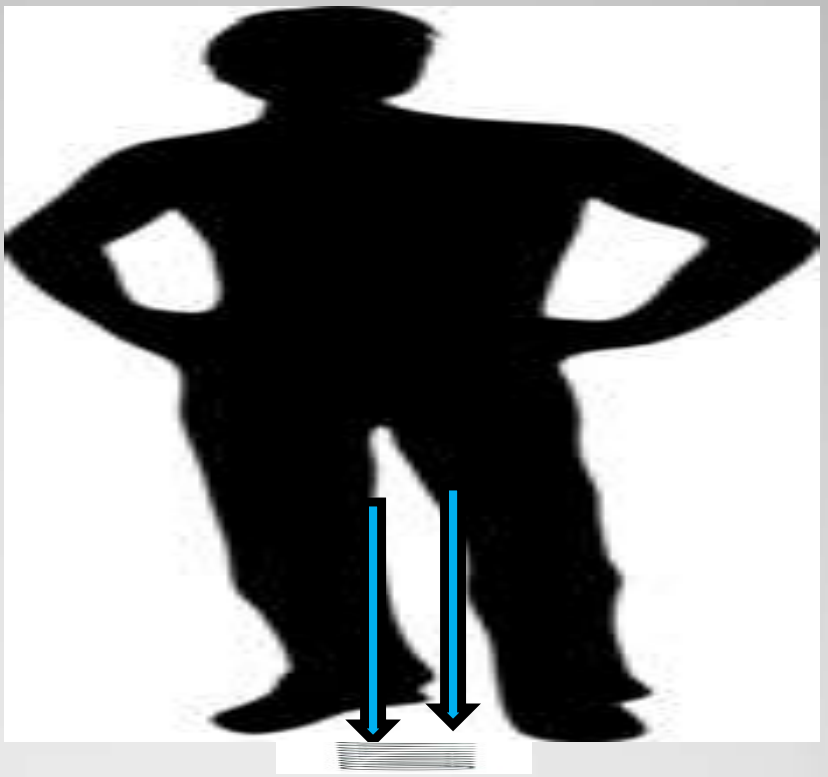
Get physical...



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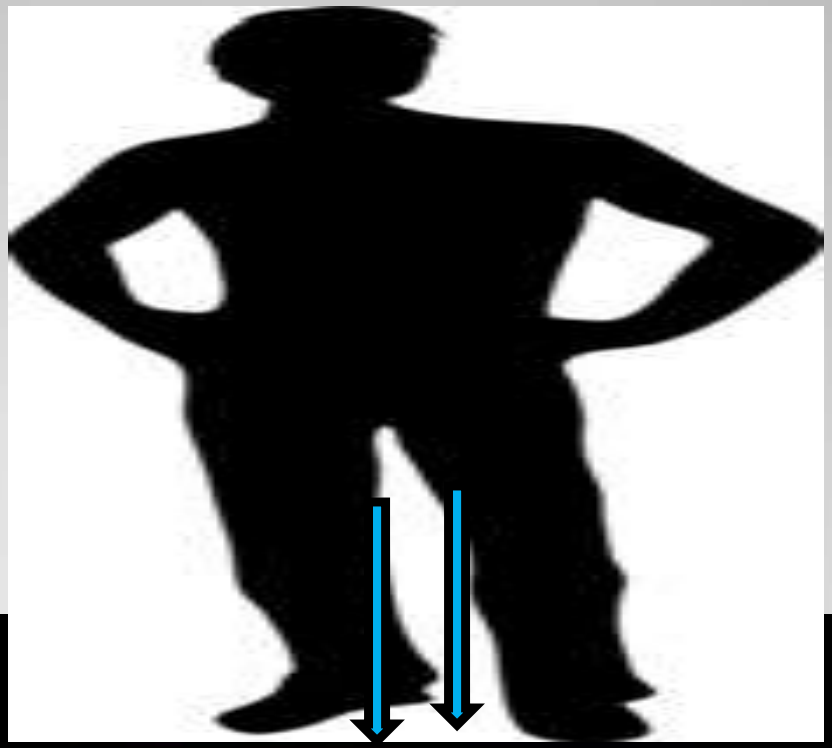
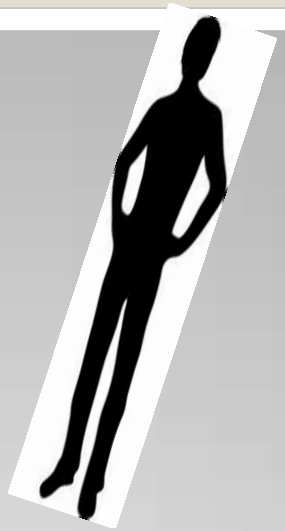


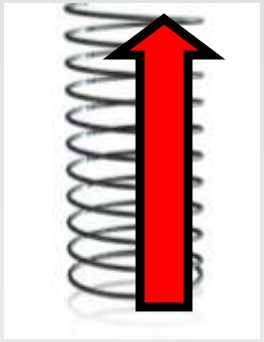
NMMESA

Get physical...

NMMESA

Get physical...





NMMESA

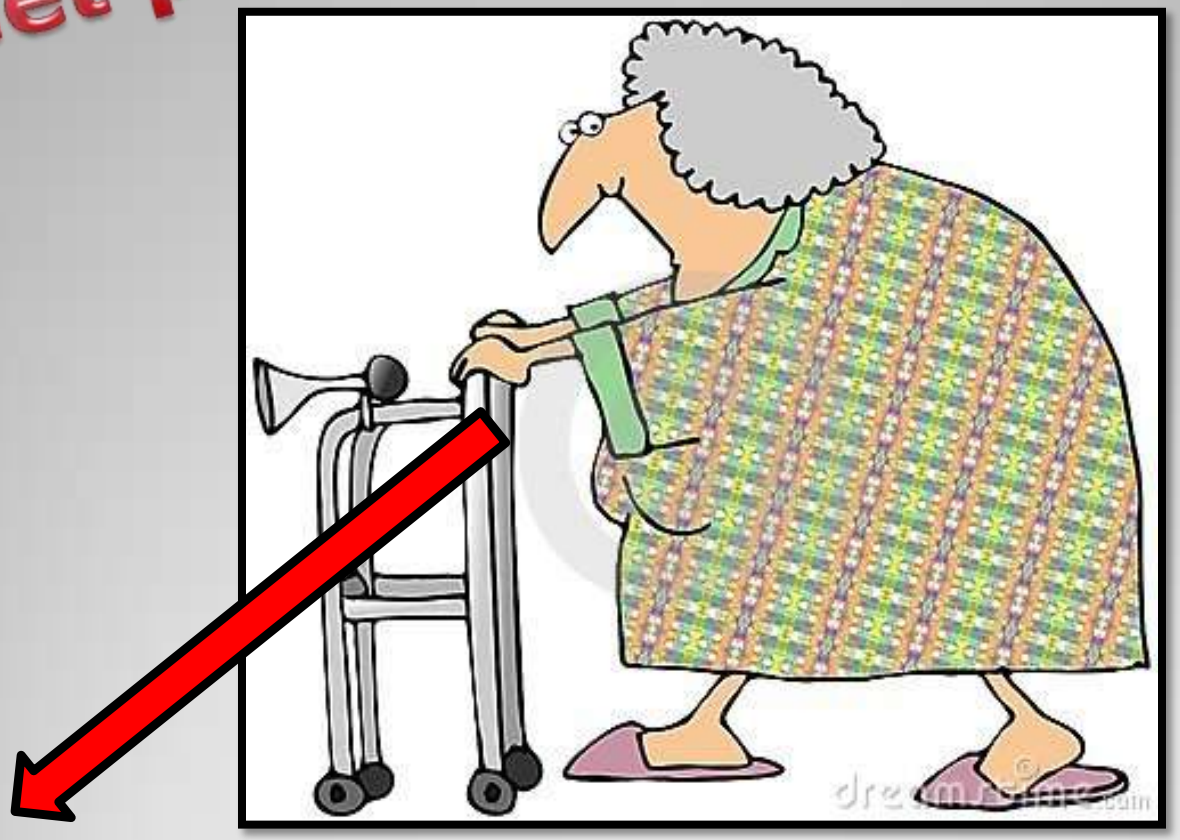
Get physical...

Stand up!

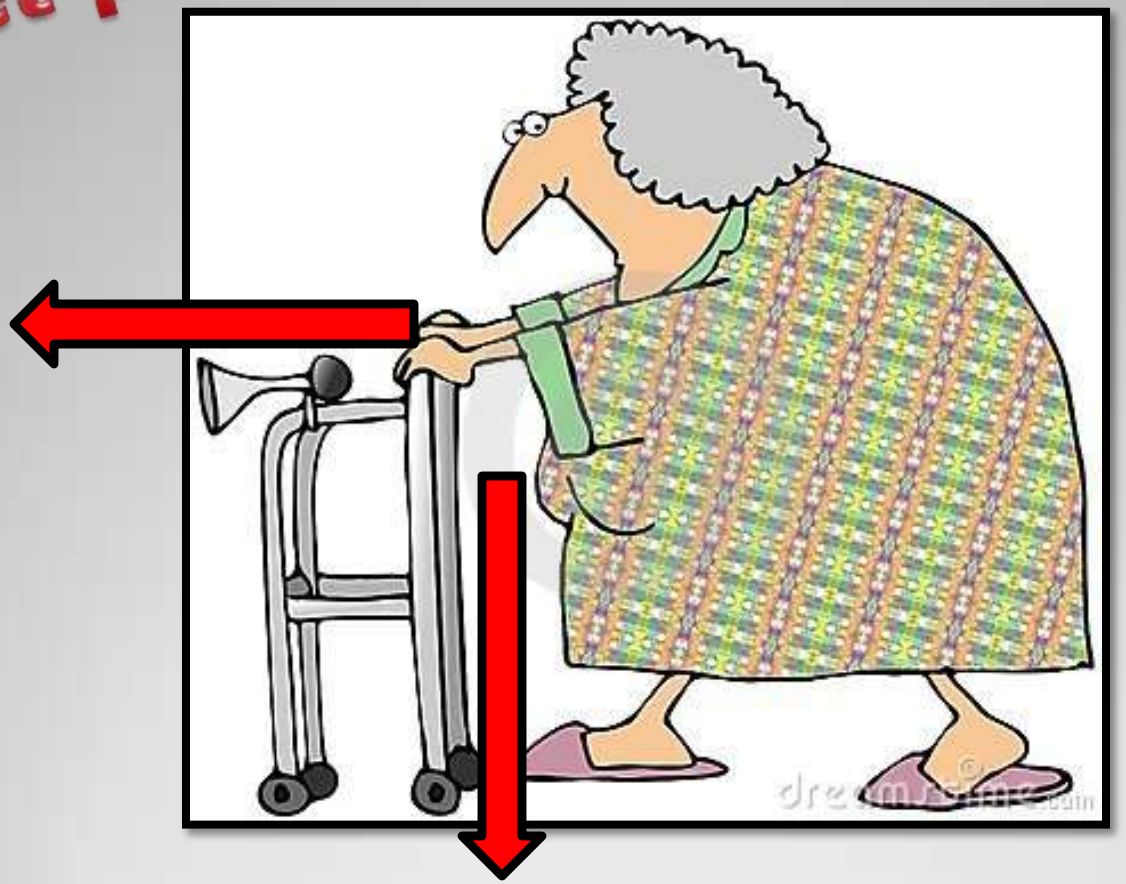
Lean on your chair.

What direction is the force going?

Get physical...



Get physical...



NMMESA

Get physical…

Lean into a partner and see how far out you can go. Feel the force getting greater.

Get physical...

Put a scale under each of the two people making the bridge.

Note your weight.

Now lean in to one another. What happens to the weight shown on the scales?

Get physical…

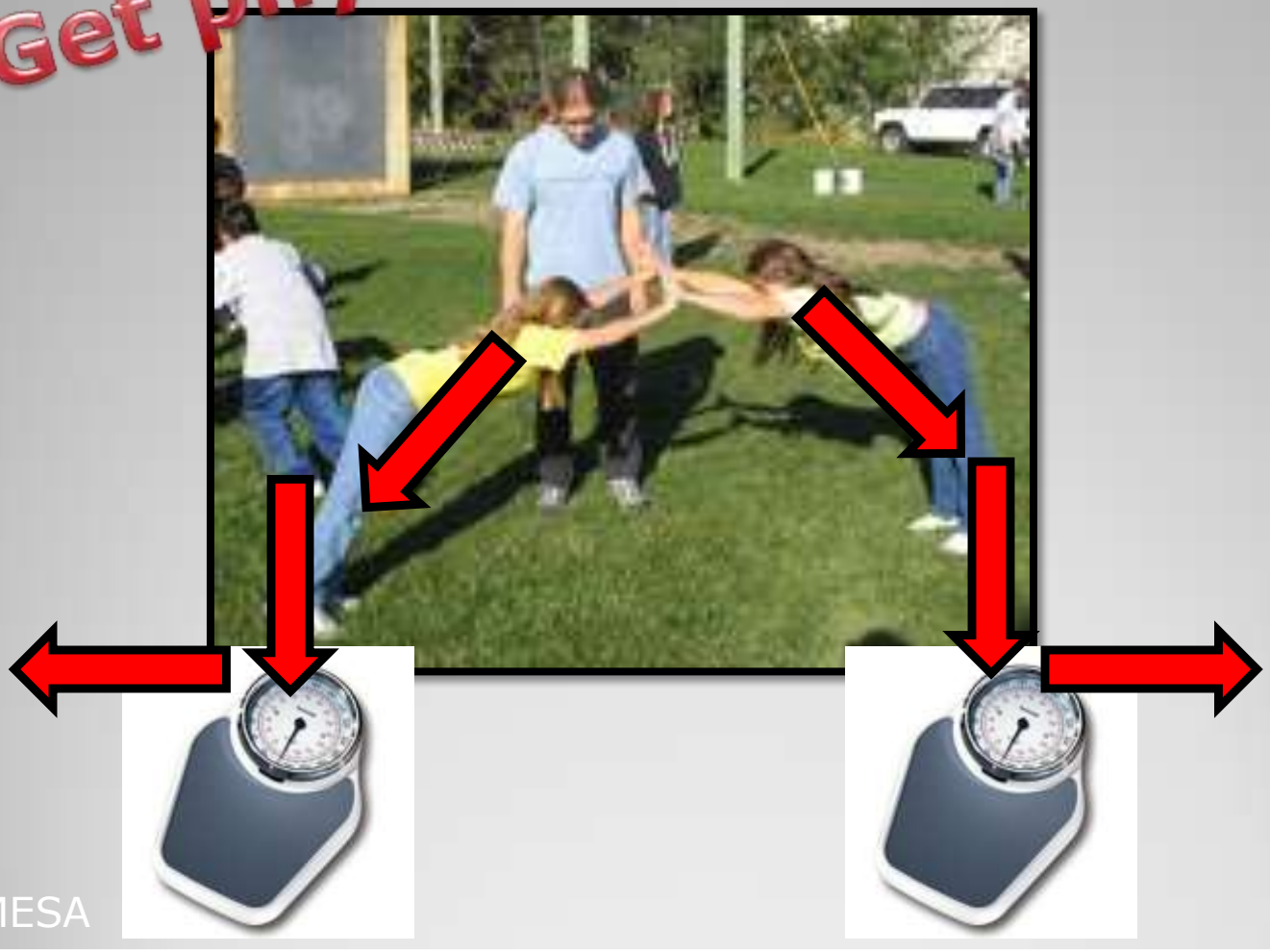
NMMESA

Get physical…

NMMESA

Get physical...

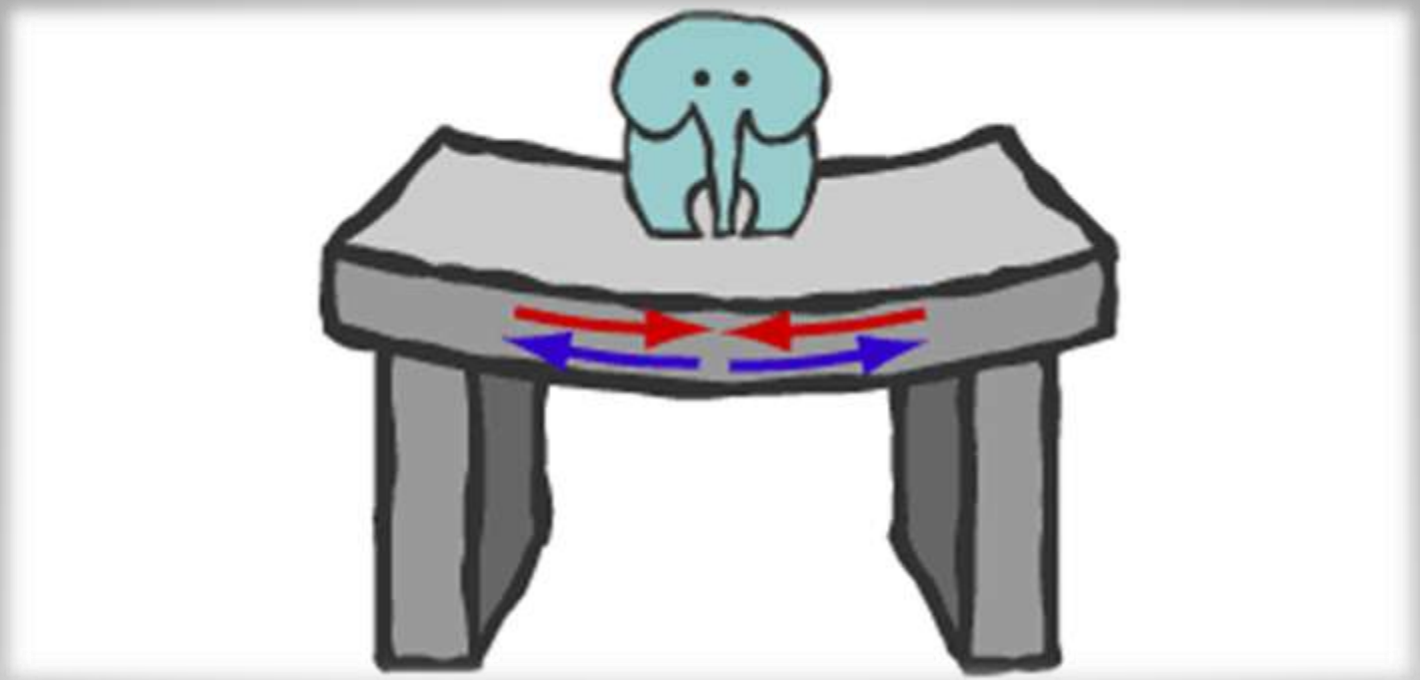
Get physical...



NMMESA

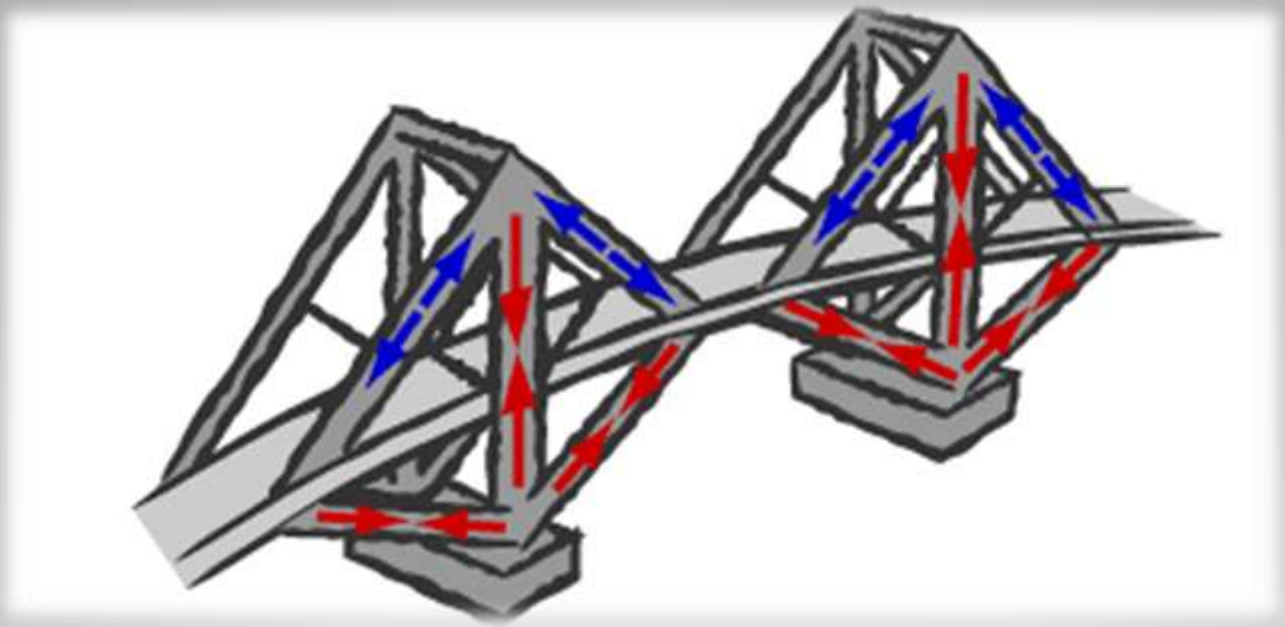
Get physical…

Different bridges look different…



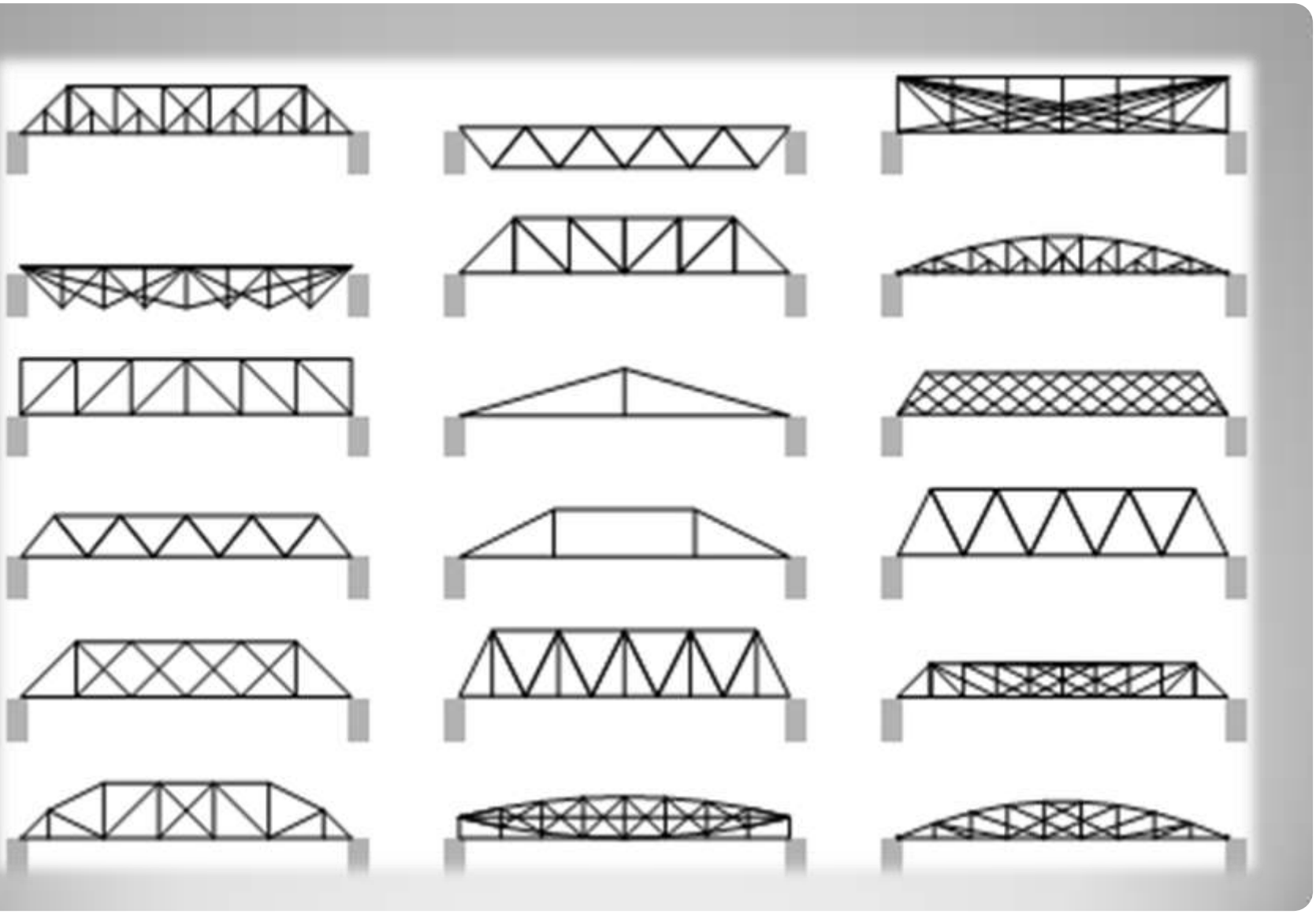
Beam Bridge

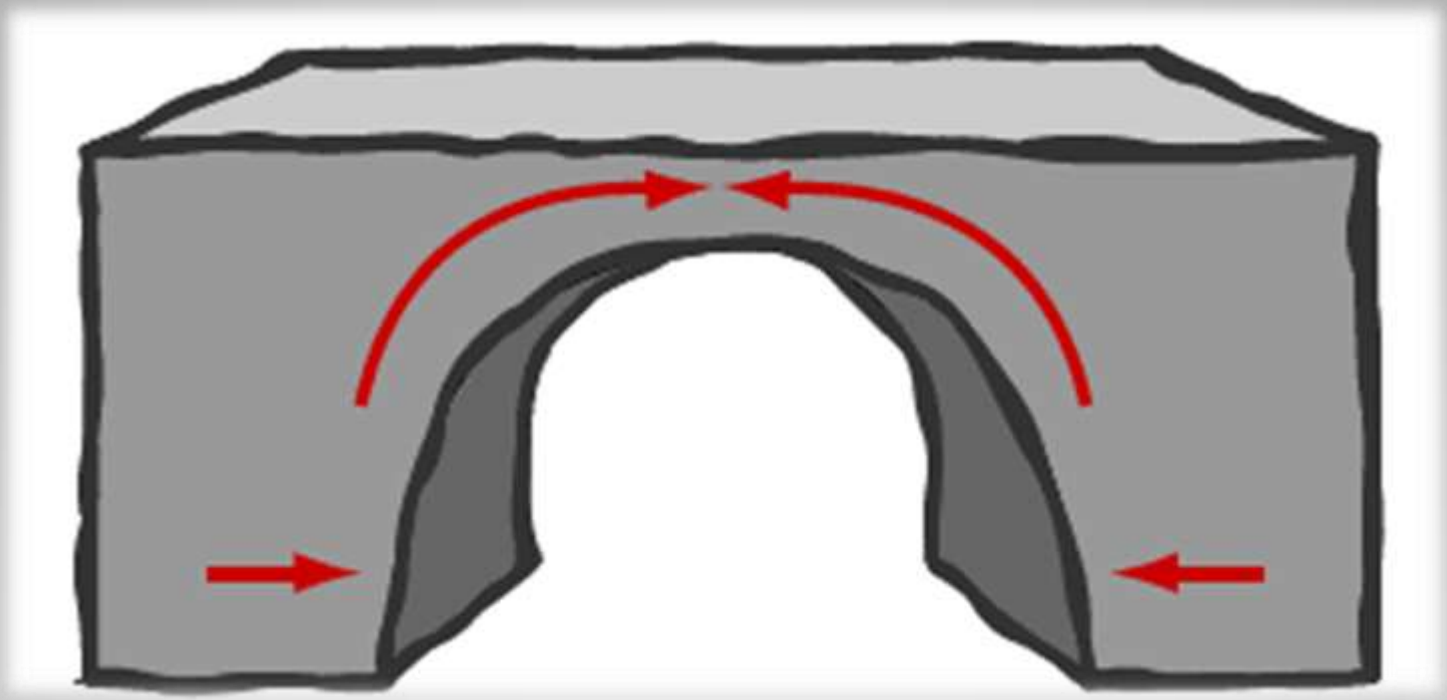
NMMESA



Truss Bridge

NMMESA





Arch Bridge

NMMESA

Suspension Bridge

NMMESA

Bridge Basics

Bridges distribute

Forces

Bridge Basics

The three basic forces involved are

TENSION,

Bridge Basics

The three basic forces involved are

TENSION, COMPRESSION

Bridge Basics

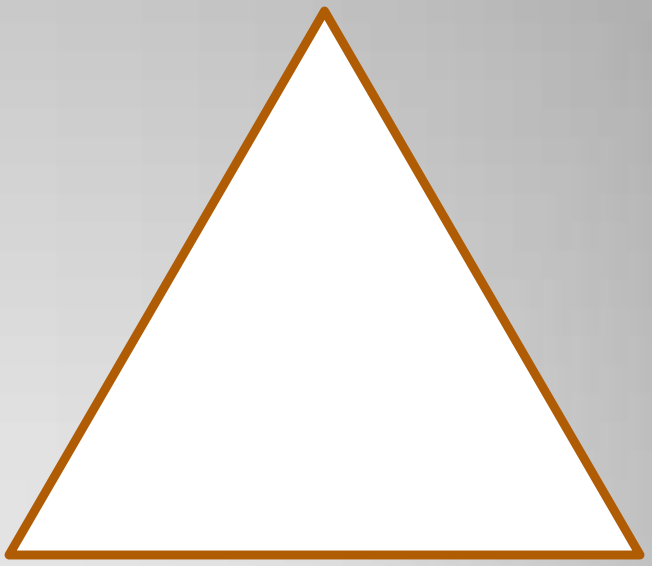
The three basic forces involved are

TENSION, COMPRESSION and TORSION

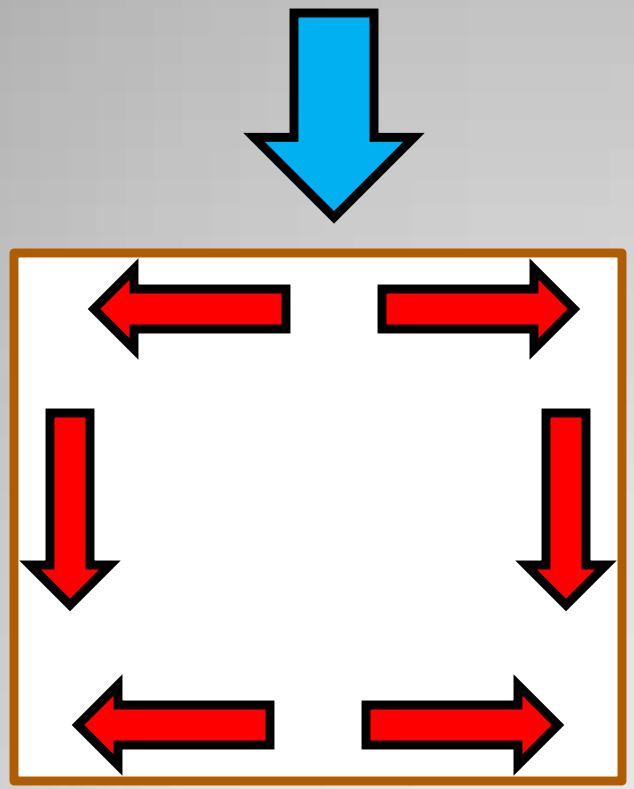
Let’s do something…

Bridge Basics

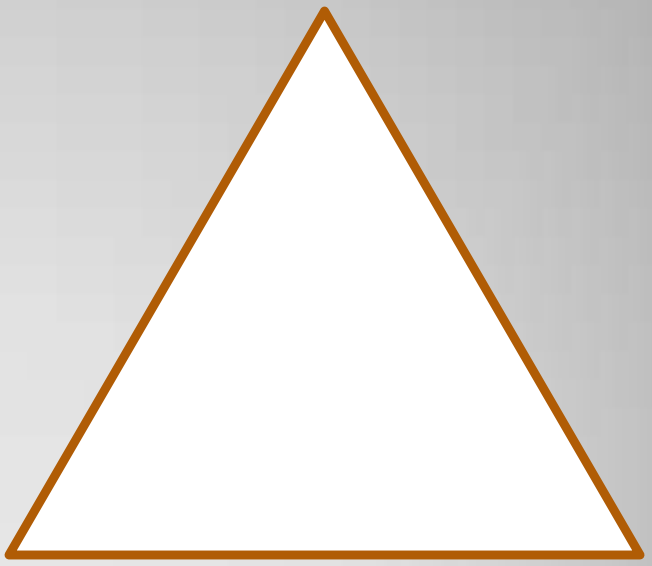
vs.



Bridge Basics

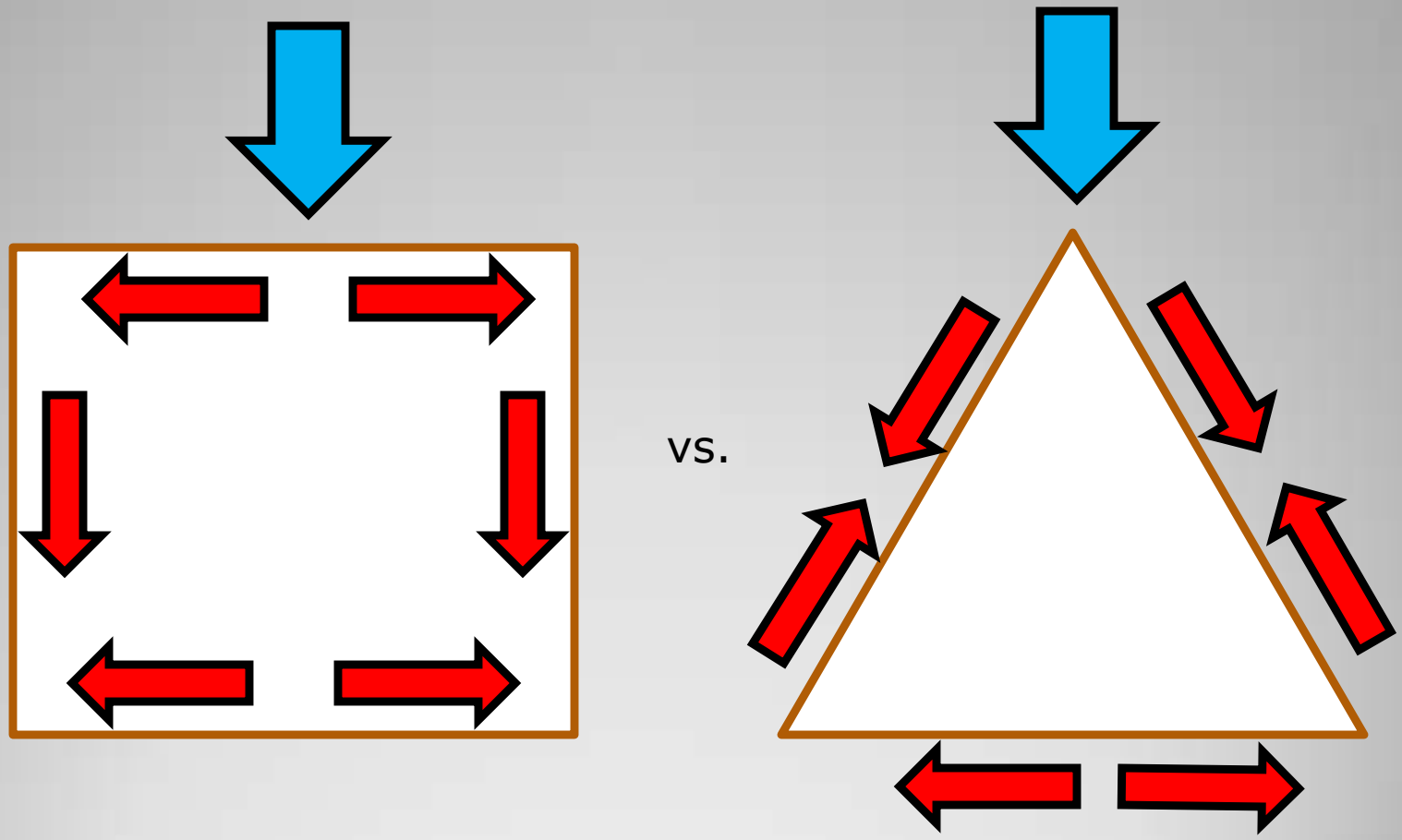


vs.



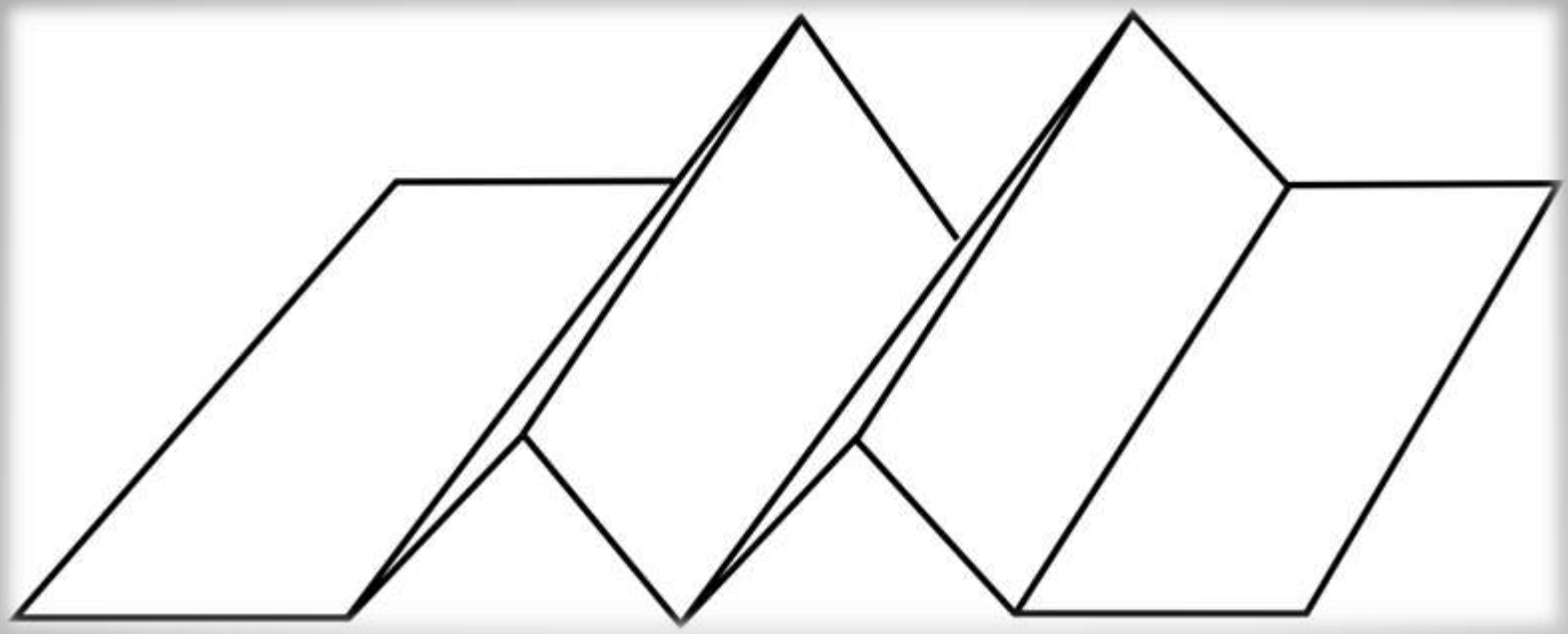
NMMESA

Bridge Basics



NMMESA

Let’s make a simple beam bridge…



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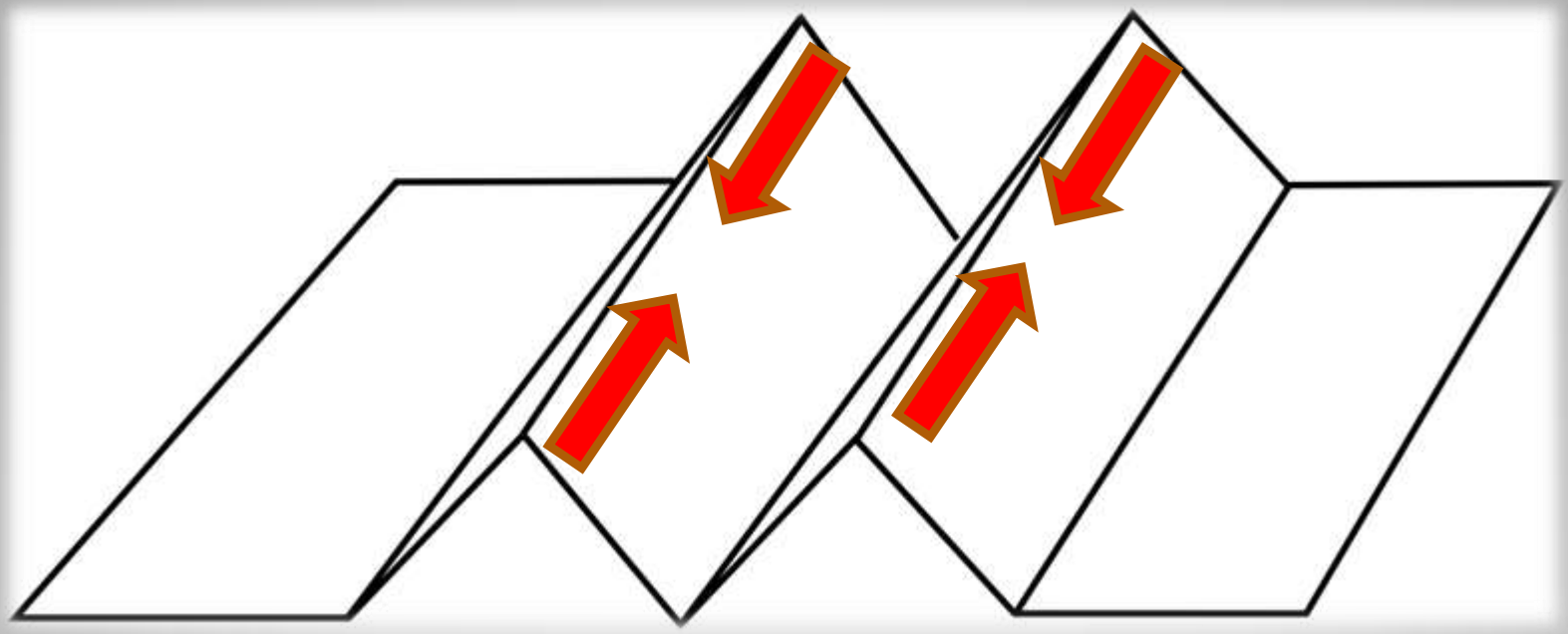
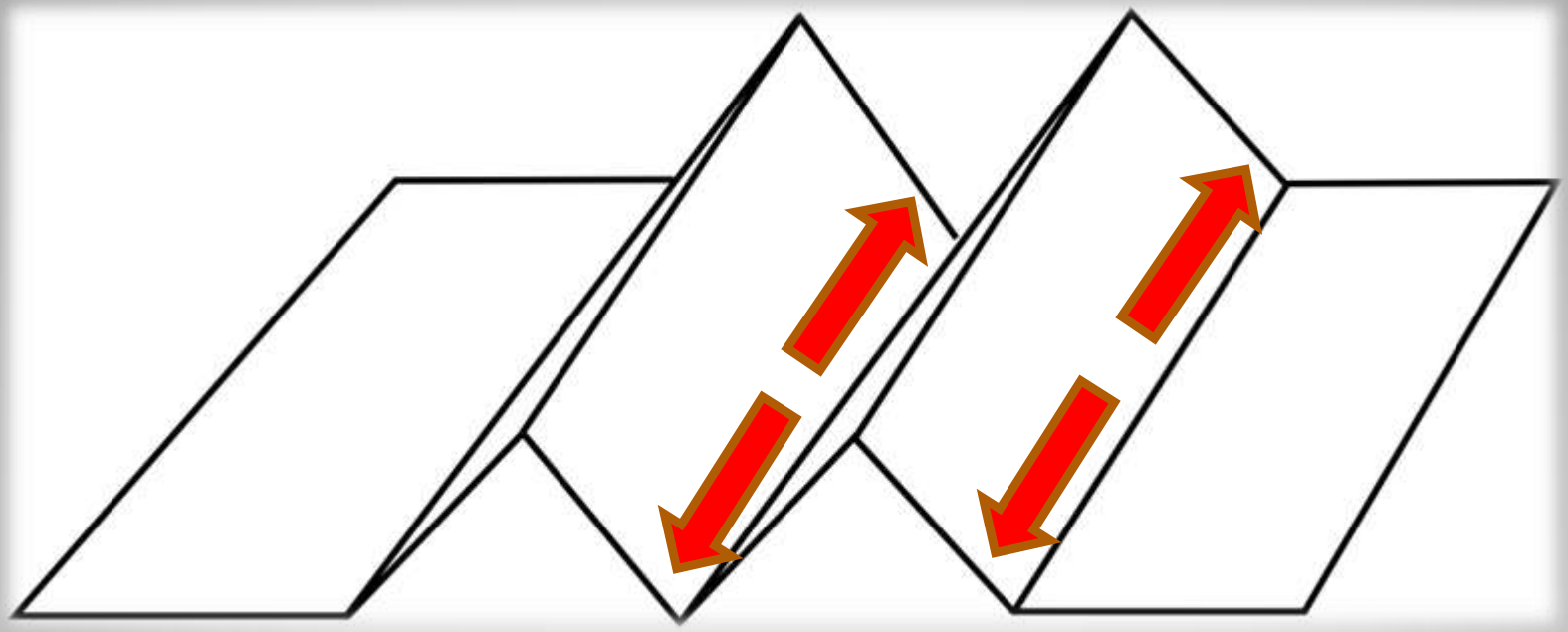
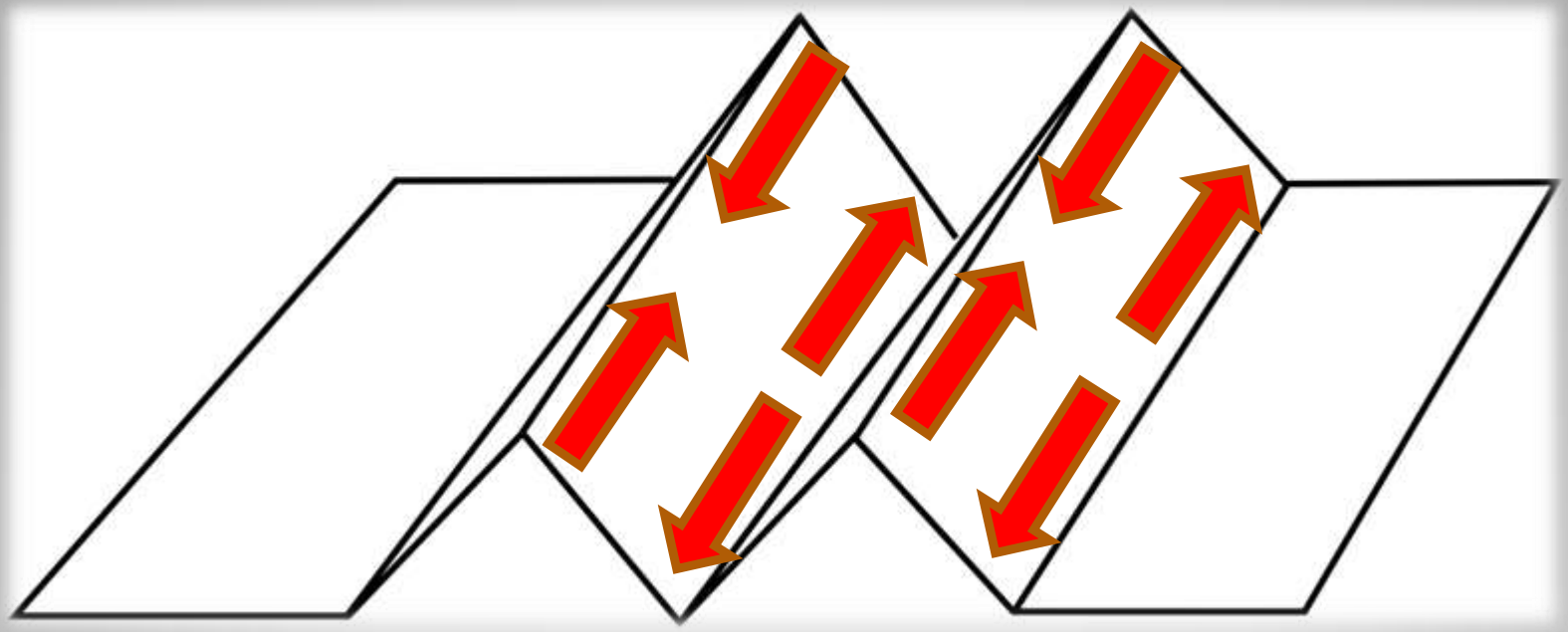


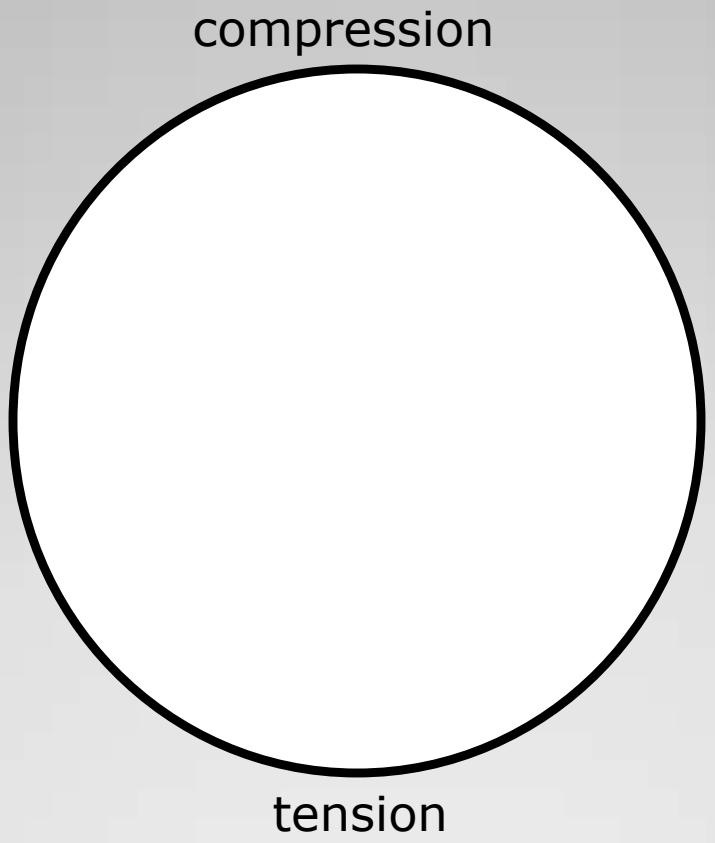




The forces are “distributed”

Paper tube beams

Paper tube beams



So if bridges distribute Forces...

Bridge Basics

So if bridges distribute Forces…

What are forces exactly?

Bridge Basics

When we talk about “forces” we are talking about the

MASS

something has when it is affected by

GRAVITY.

Bridge Basics

An elephant on the moon has the same mass as an elephant on the earth. The difference is, on the moon, the elephant weighs less.

Bridge Basics

Gravity is not a force.

It is an acceleration.

To calculate force you multiply the mass something has (in kg.) by the acceleration of gravity (9.8 meters per second squared on the Earth).

To calculate force you multiply the mass something has (in kg.) by the acceleration of gravity (9.8 meters per second squared on the Earth).

This gives you the force in a unit called NEWTONS.

Drop and object on Earth and after one second it will be speeding along at 9.8 meters per second…

For every second after that, it will accelerate an additional 9.8 meters/second.

End of second 1 = 9.8m/s

End of second 2 = 19.6m/s

End of second 3 = 29.4m/s

and so on…

End of second 1 = 9.8m/s

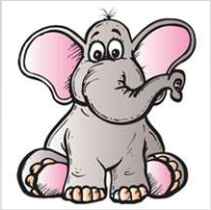
End of second 2 = 19.6m/s

End of second 3 = 29.4m/s

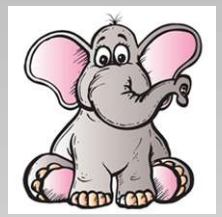
and so on…

…until the force of drag on the falling object equals the weight of the object.

So to find out the force this elephant's weight exerts, we convert its mass to Newtons.

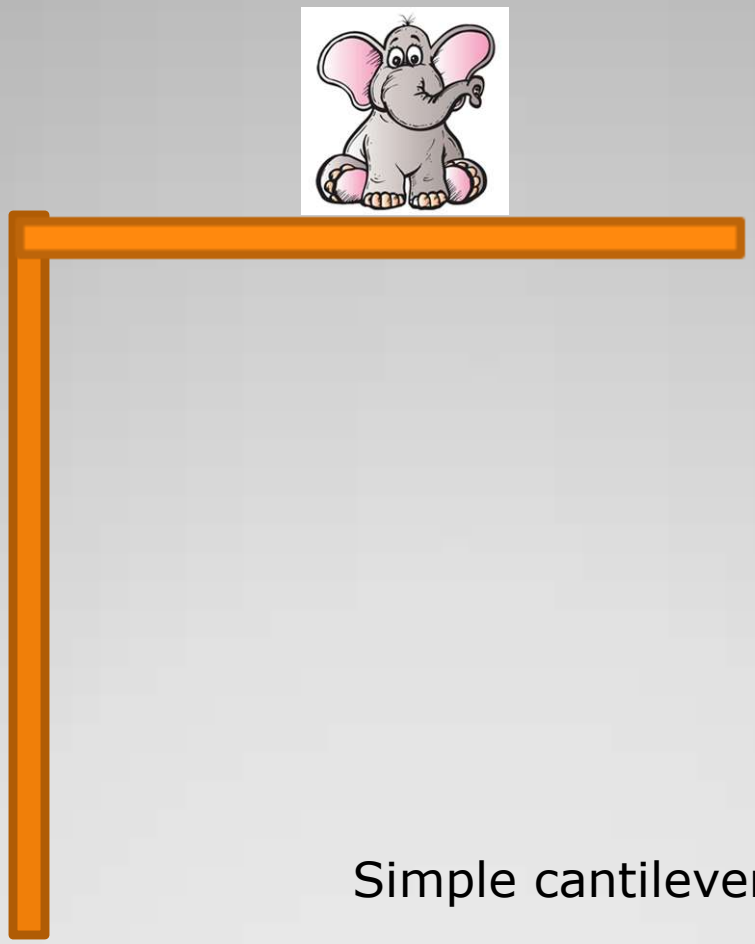


100kg



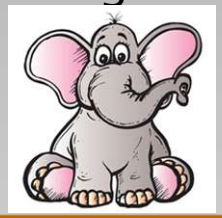
Mass=100kg

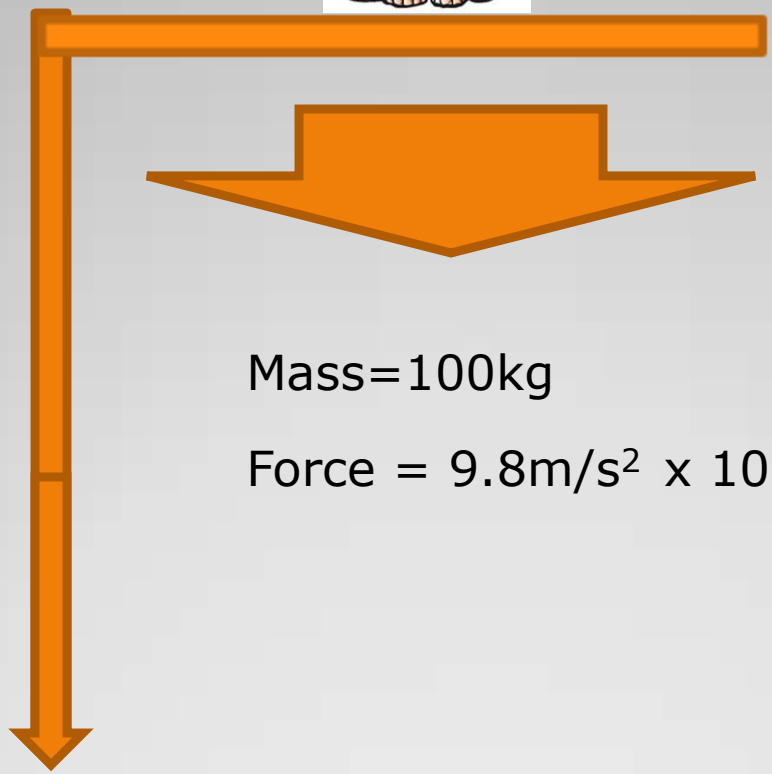
Force = 9.8m/s^2 x 100kg = 980newtons



Simple cantilever

100kg



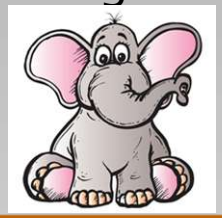


Mass=100kg

Force = 9.8m/s^2 x 100kg = 980newtons

980n

100kg

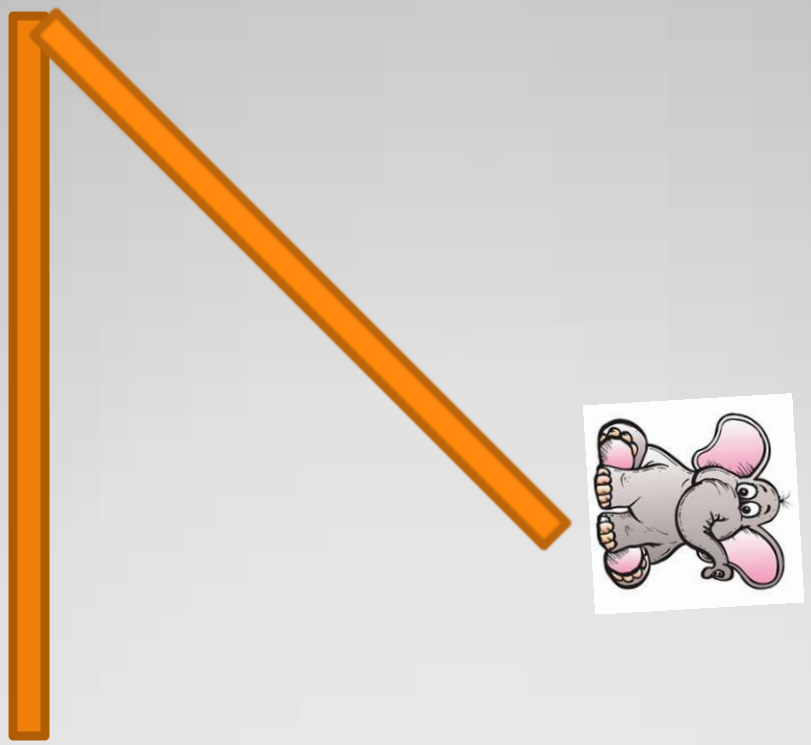


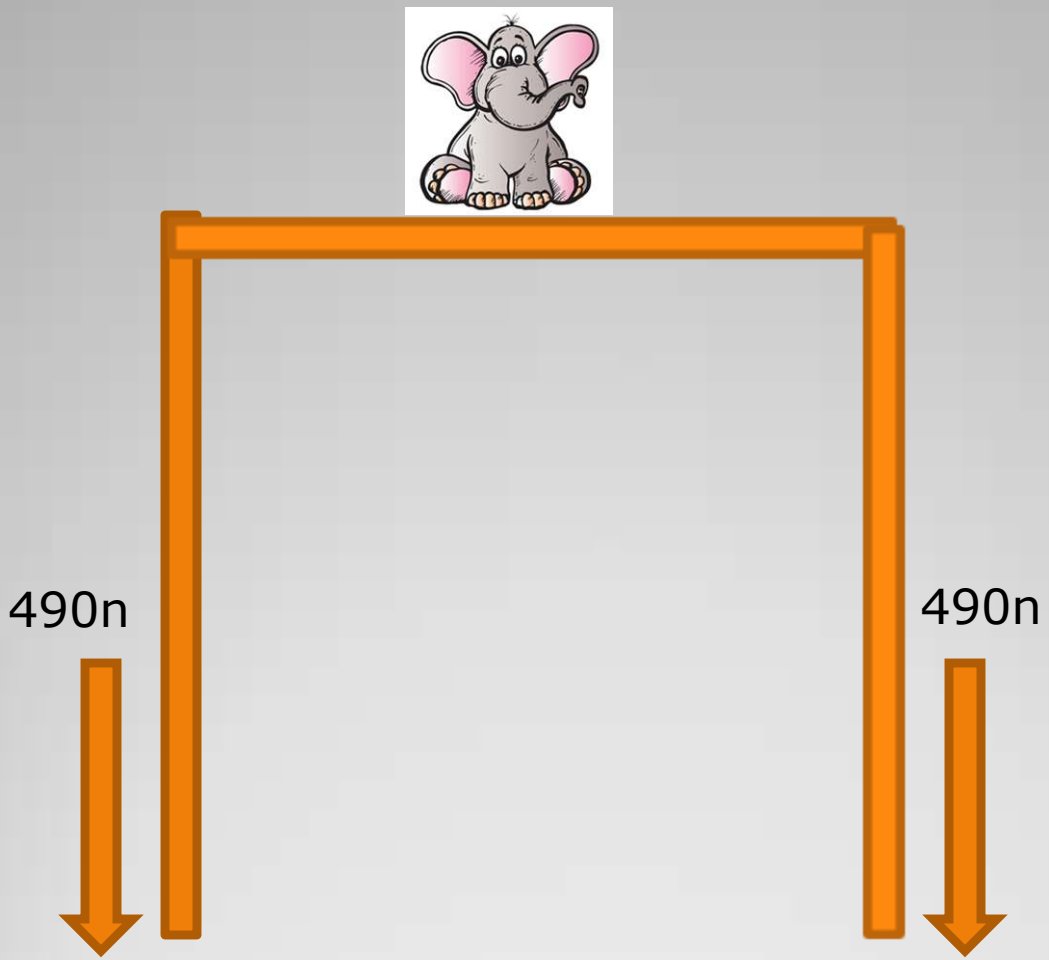
Mass=100kg

Force = 9.8m/s^2 x 100kg = 980newtons

980n

980n





NMMESA

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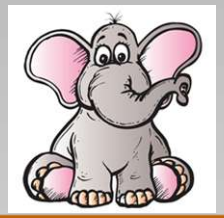
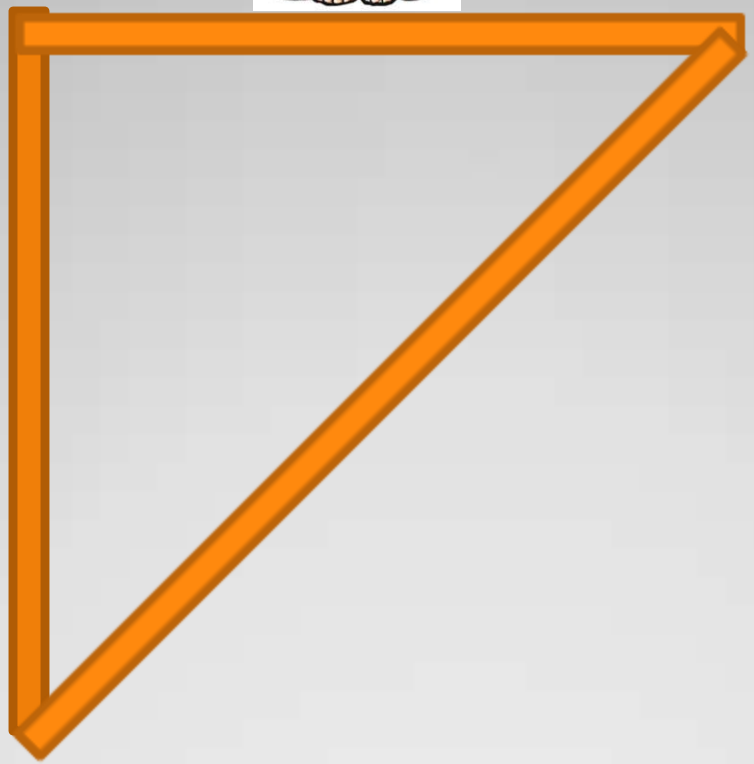
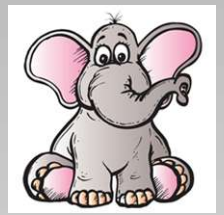
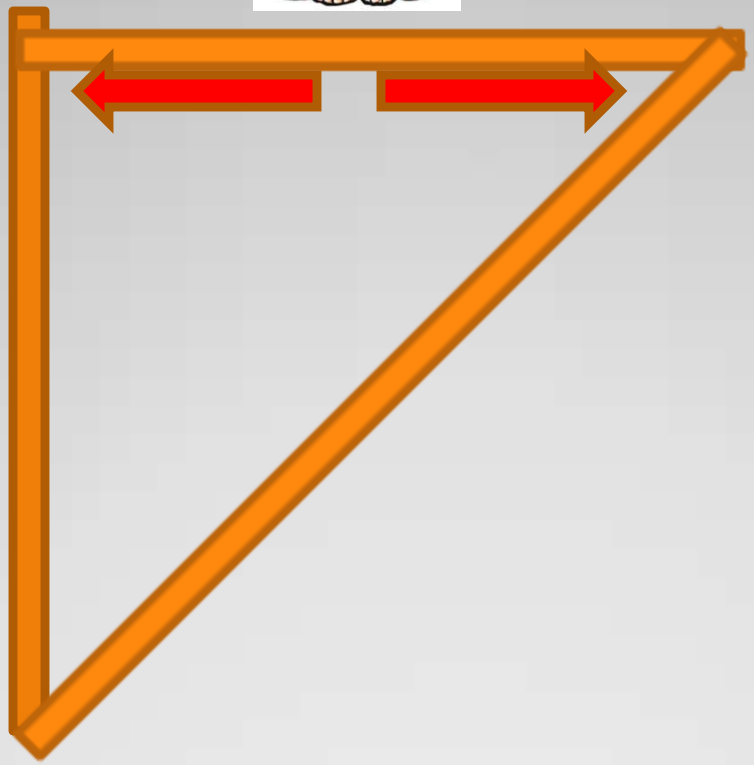




NMMESA

?

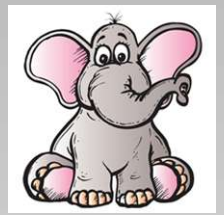


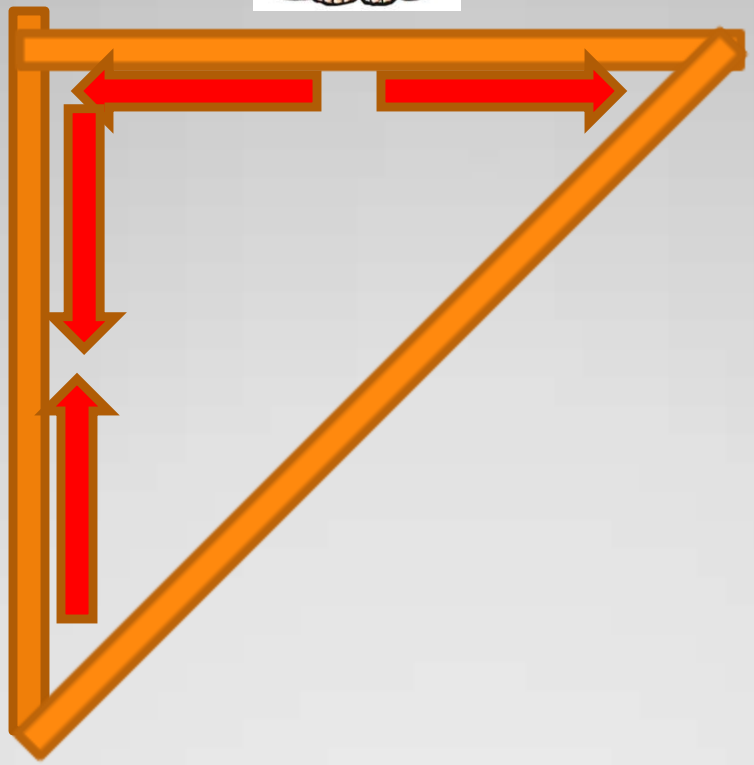


NMMESA

Force Analysis

?

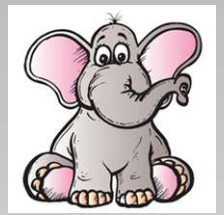


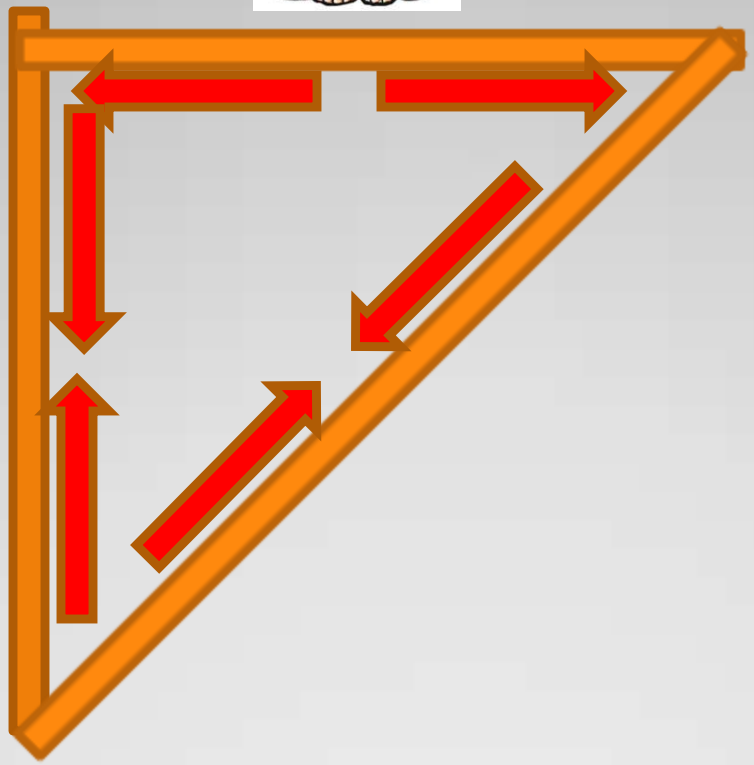


NMMESA

Force Analysis

?



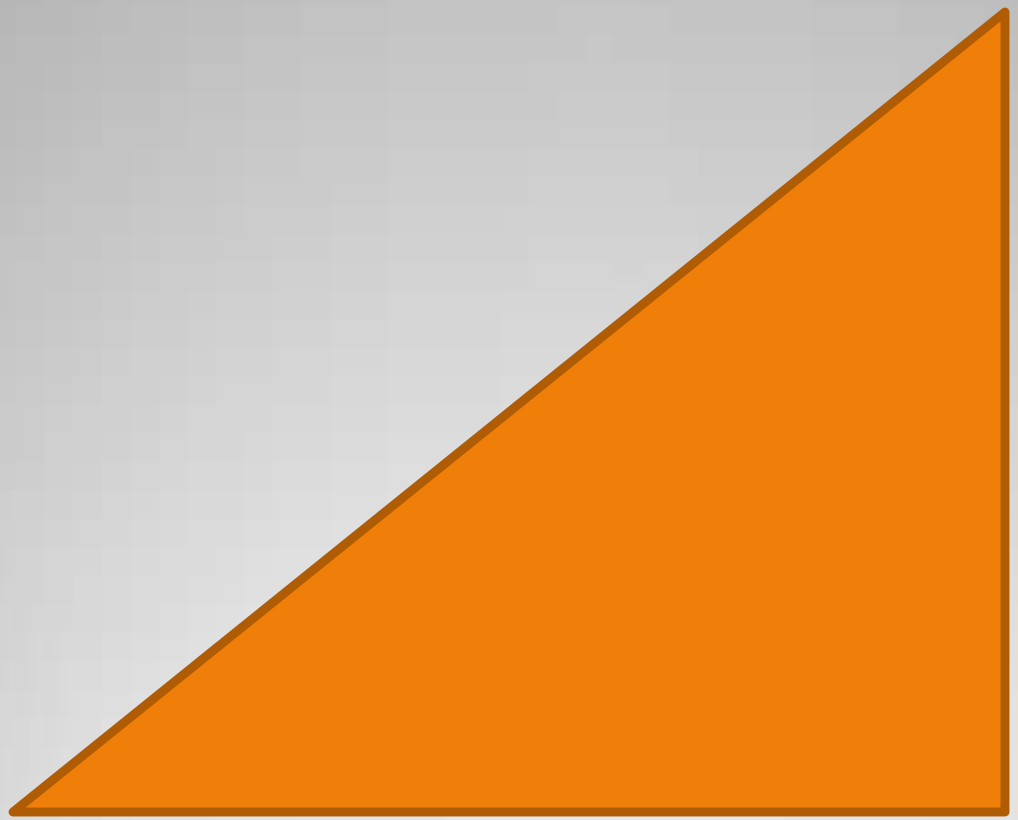


NMMESA

Force Analysis

Now let’s figure out how much force is pushing on the angled support.

Let’s ask Pythagoras.



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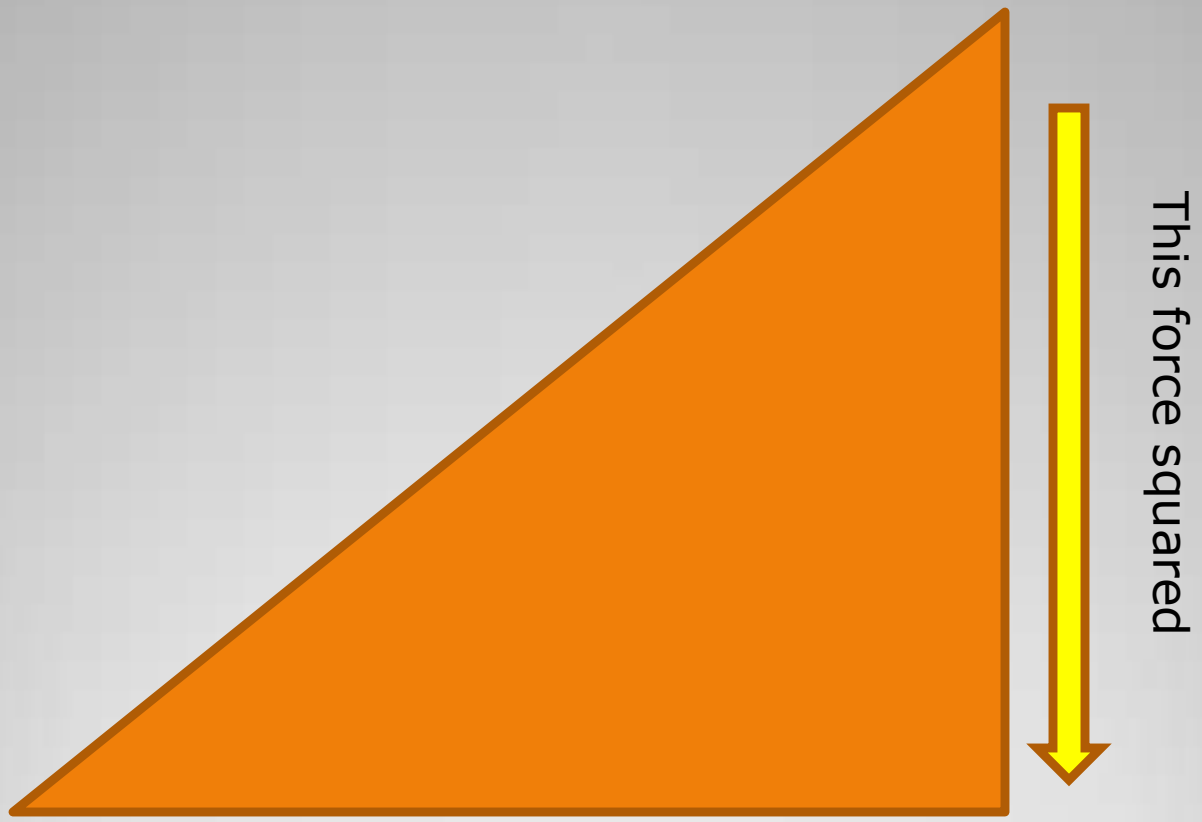

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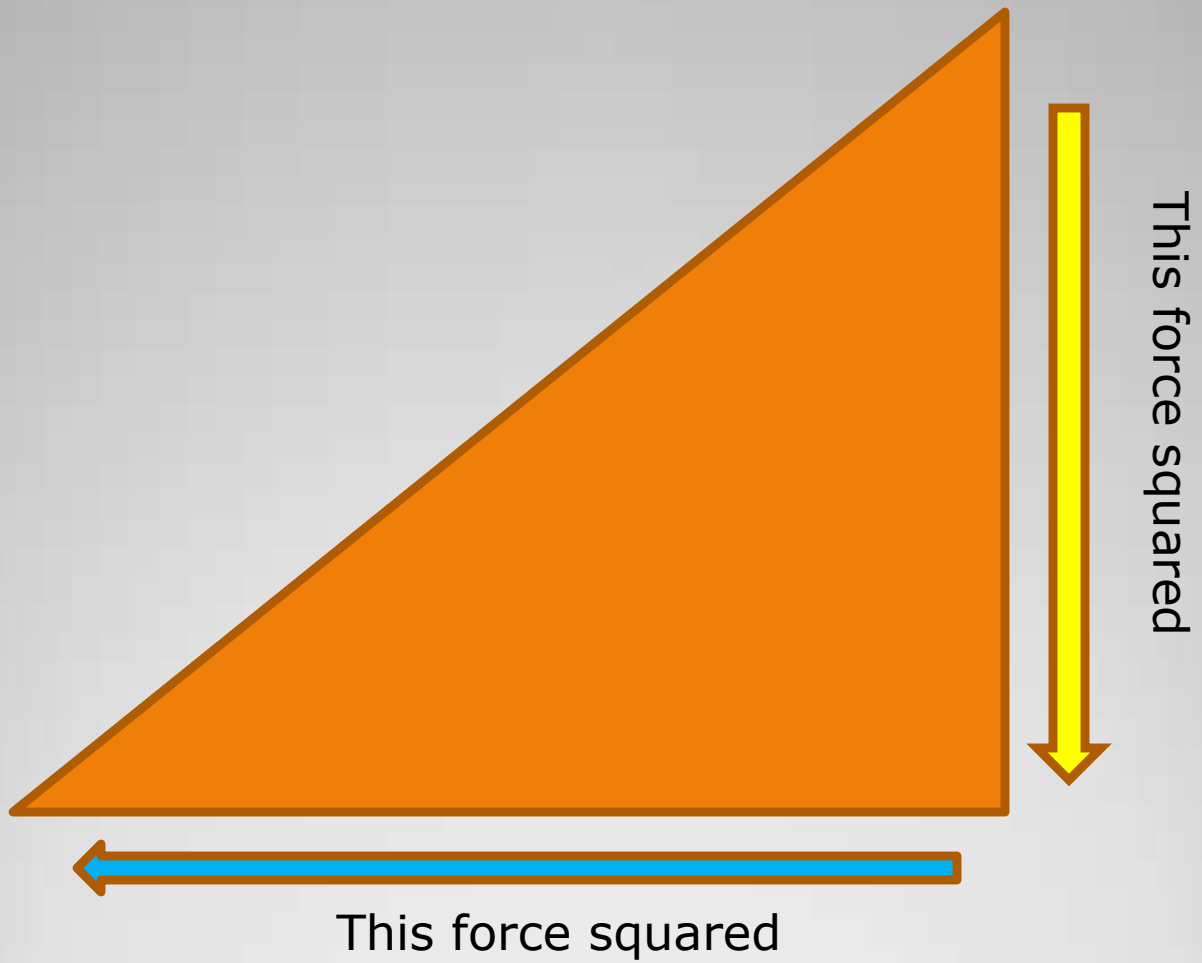
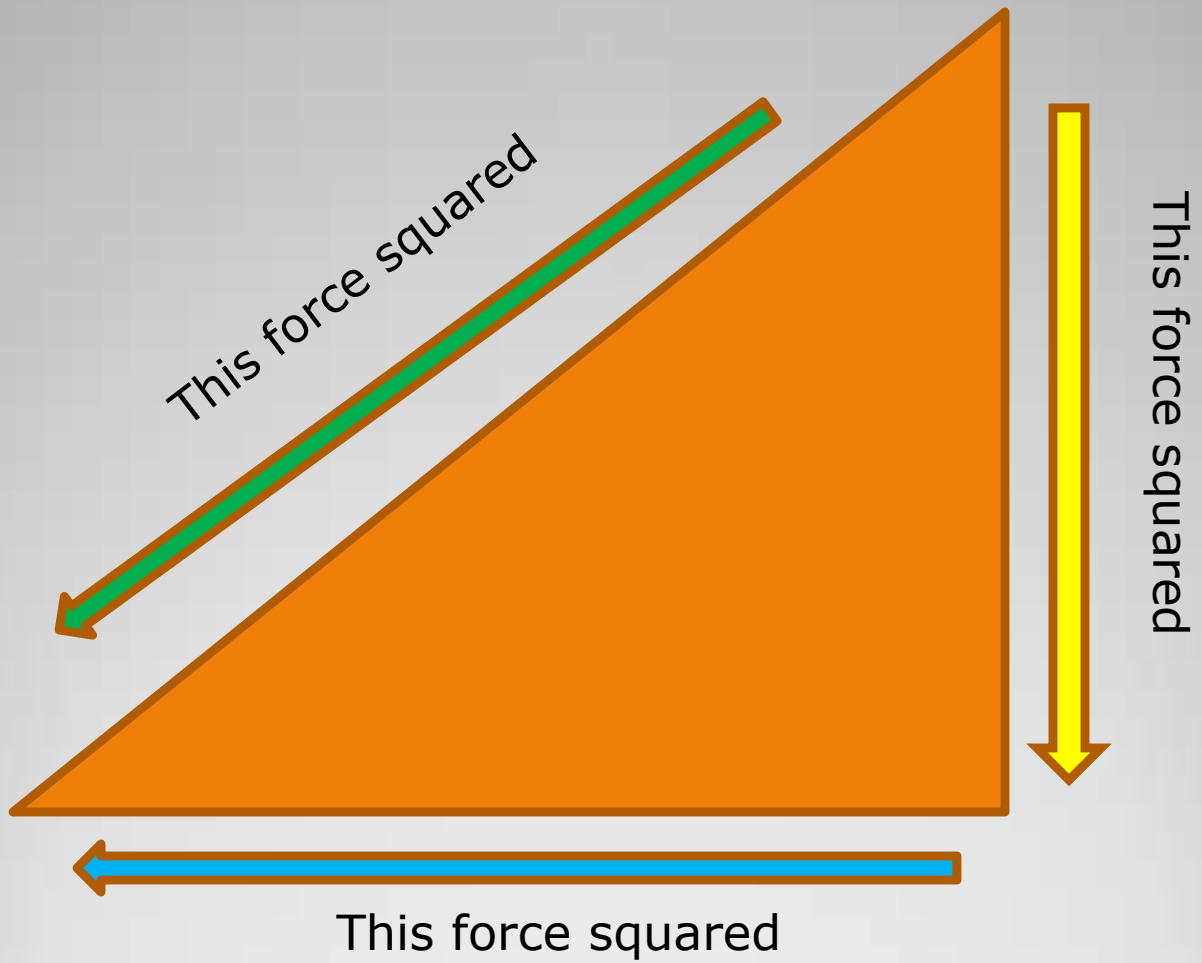
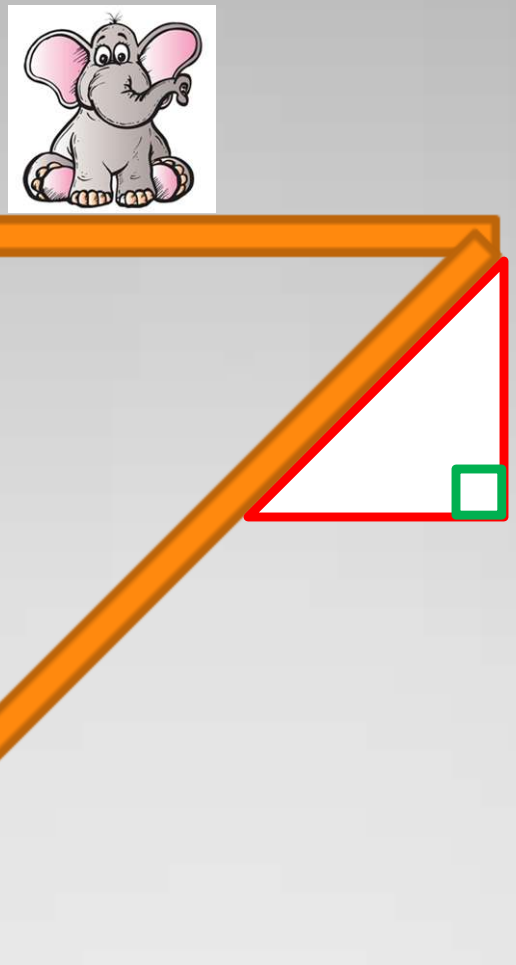
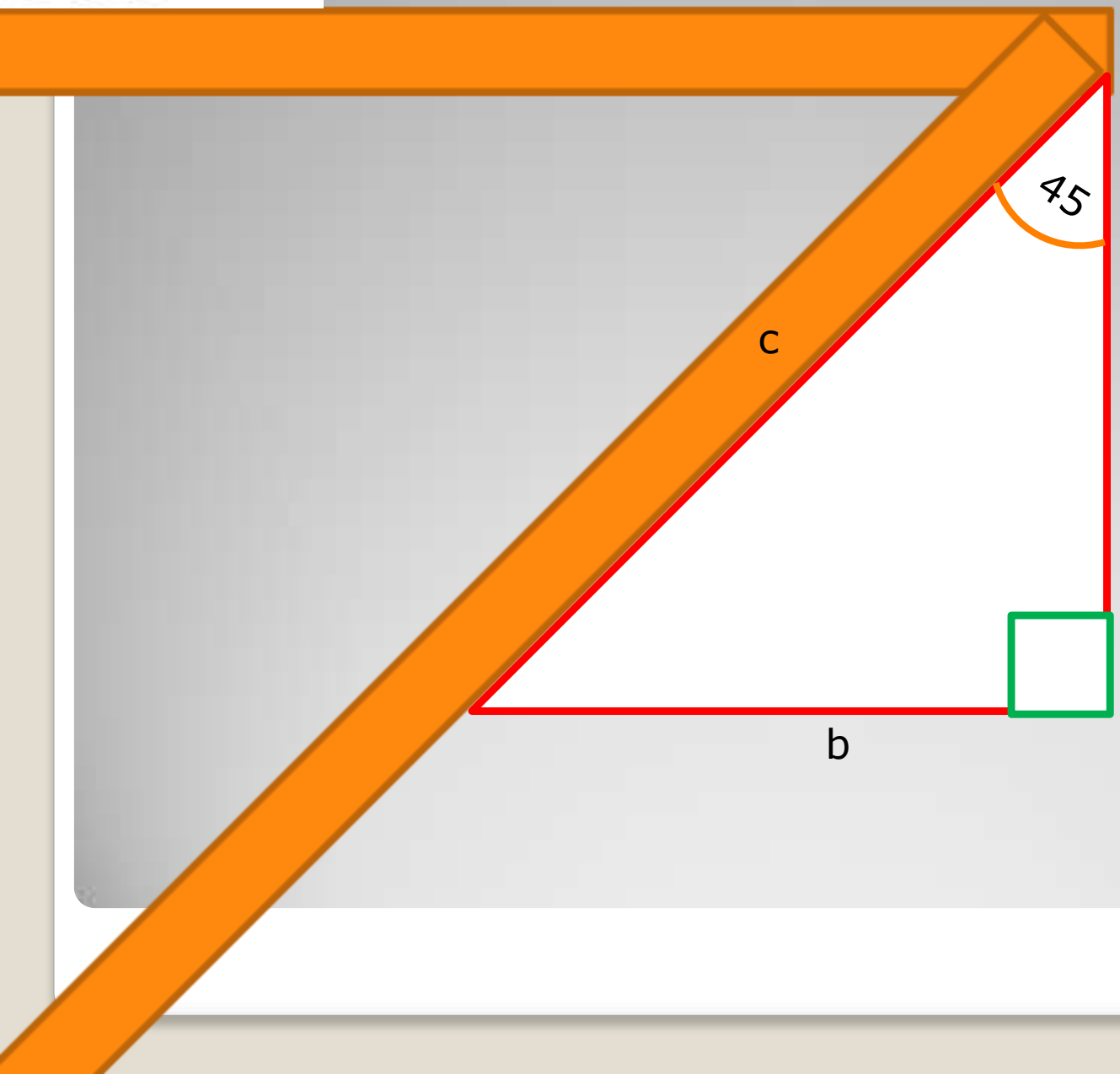
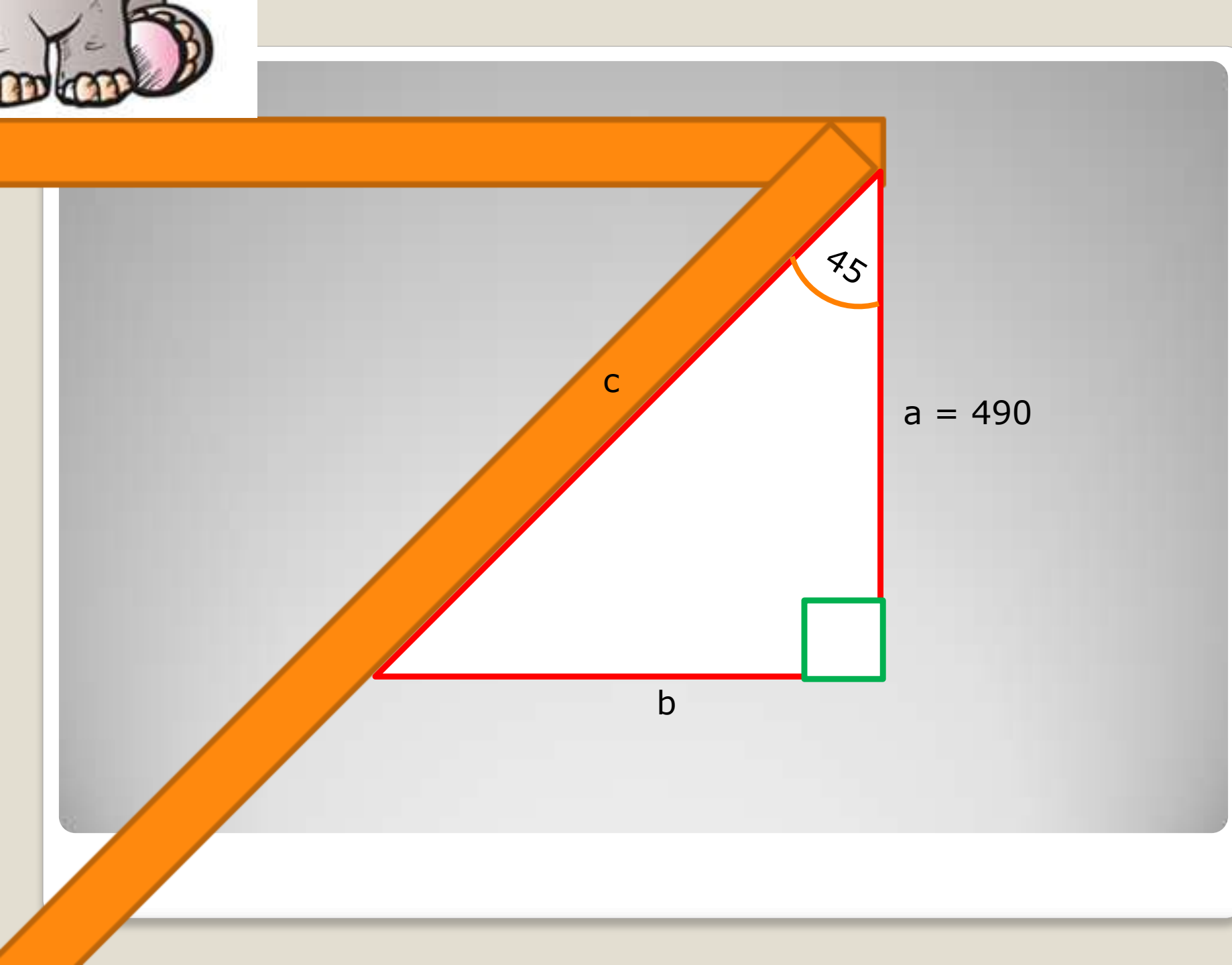


Let's ask Pythagoras.






490n
45
c
a
b


45
c
a = 490
b

We know what “a” is.

We know what “a” is.

Now let’s find out what “b” is.

We know what “a” is.

Now let’s find out what “b” is.

Using the…

Pythagorean

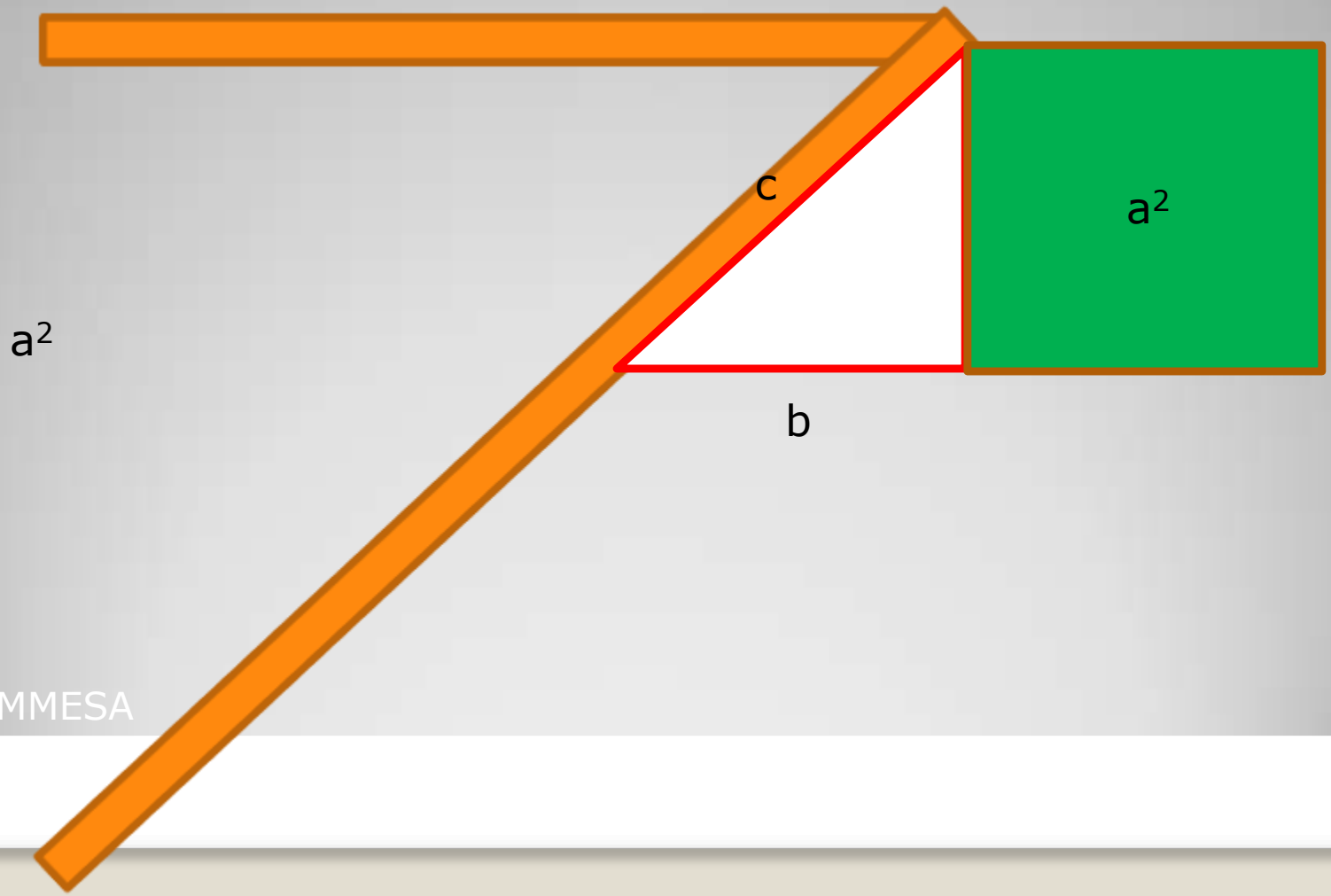
NMMESA

Pythagorean Theorem!

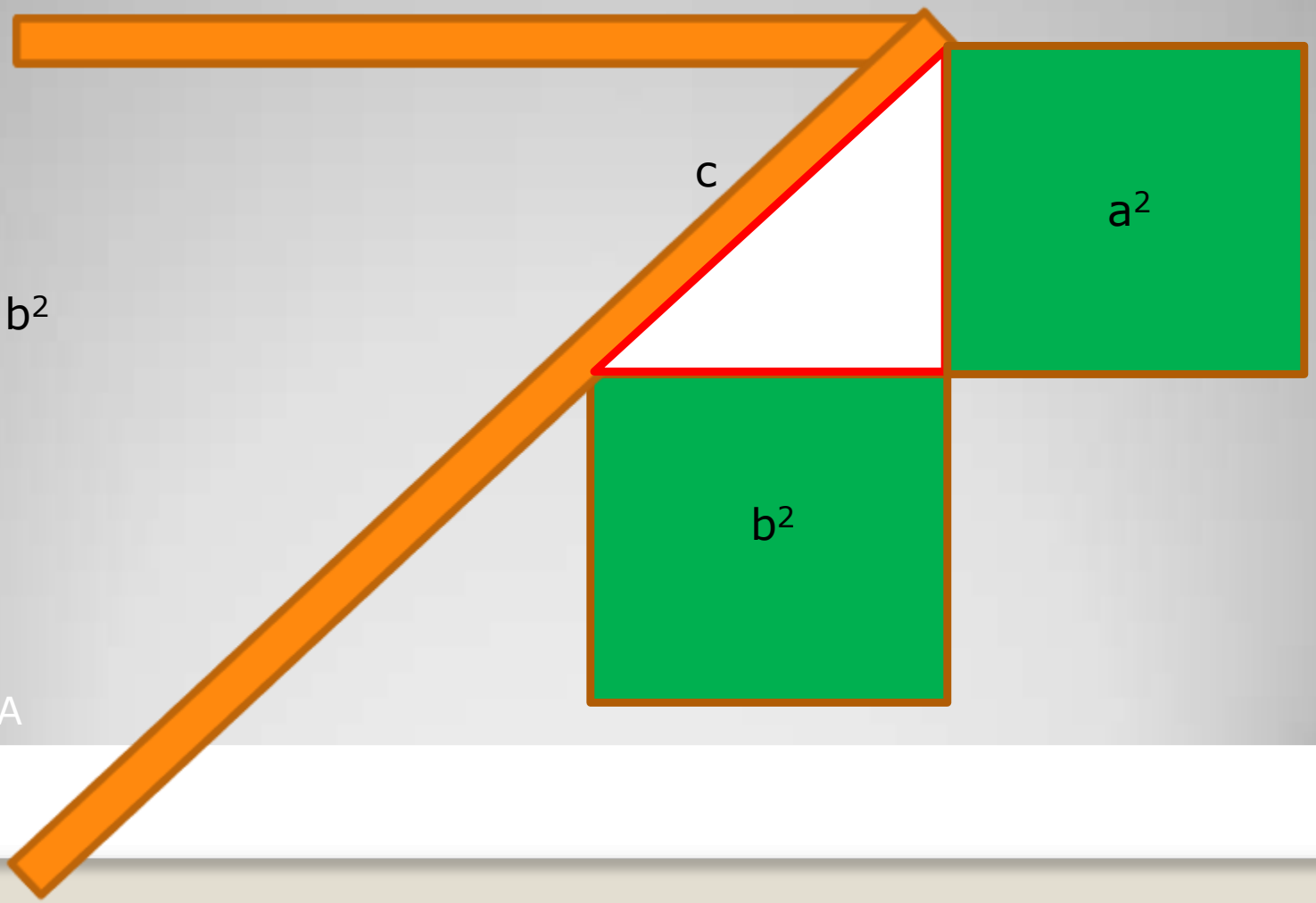
NMMESA

$$a^2 + b^2 = c^2$$

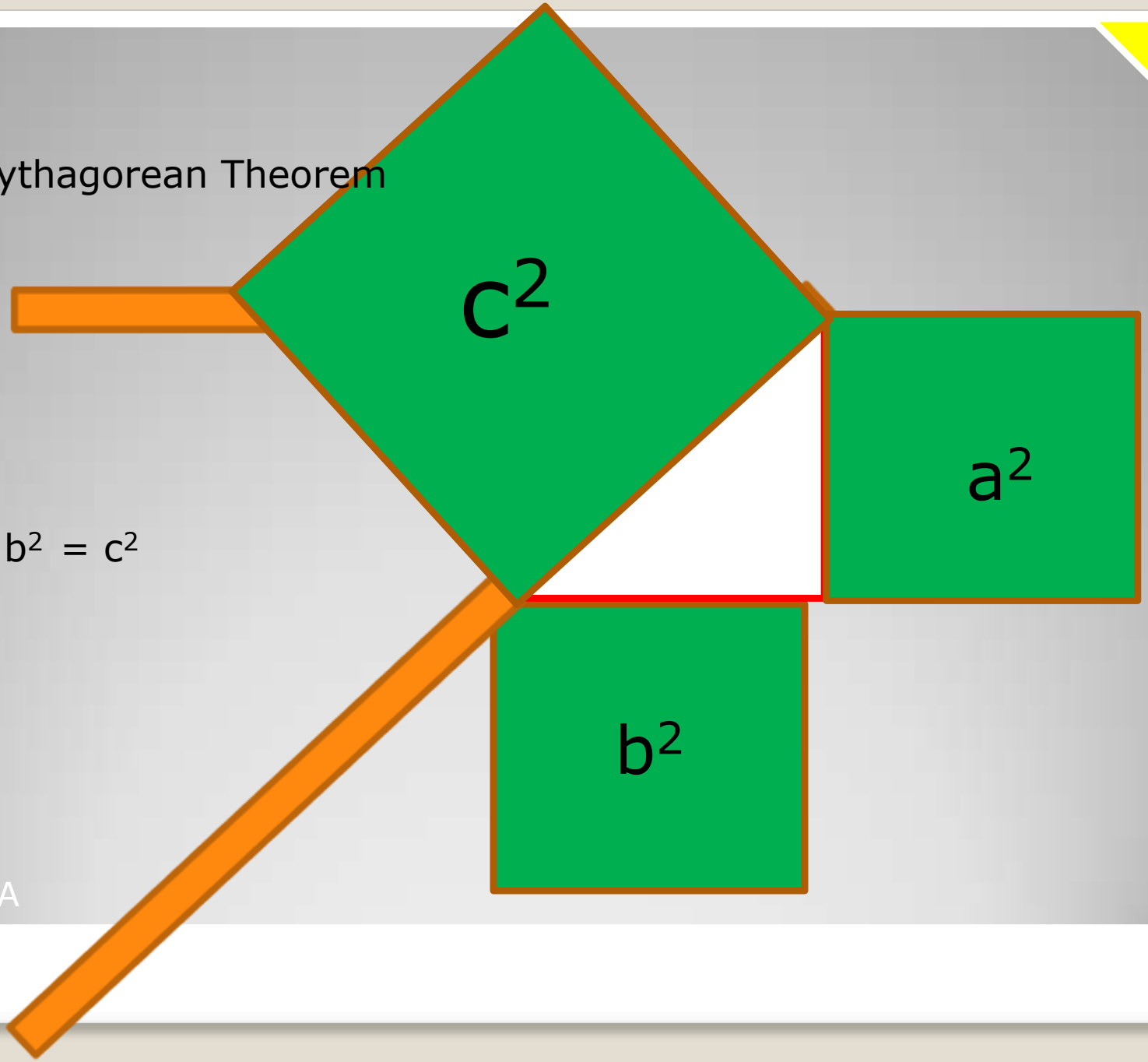
Pythagorean Theorem



Pythagorean Theorem



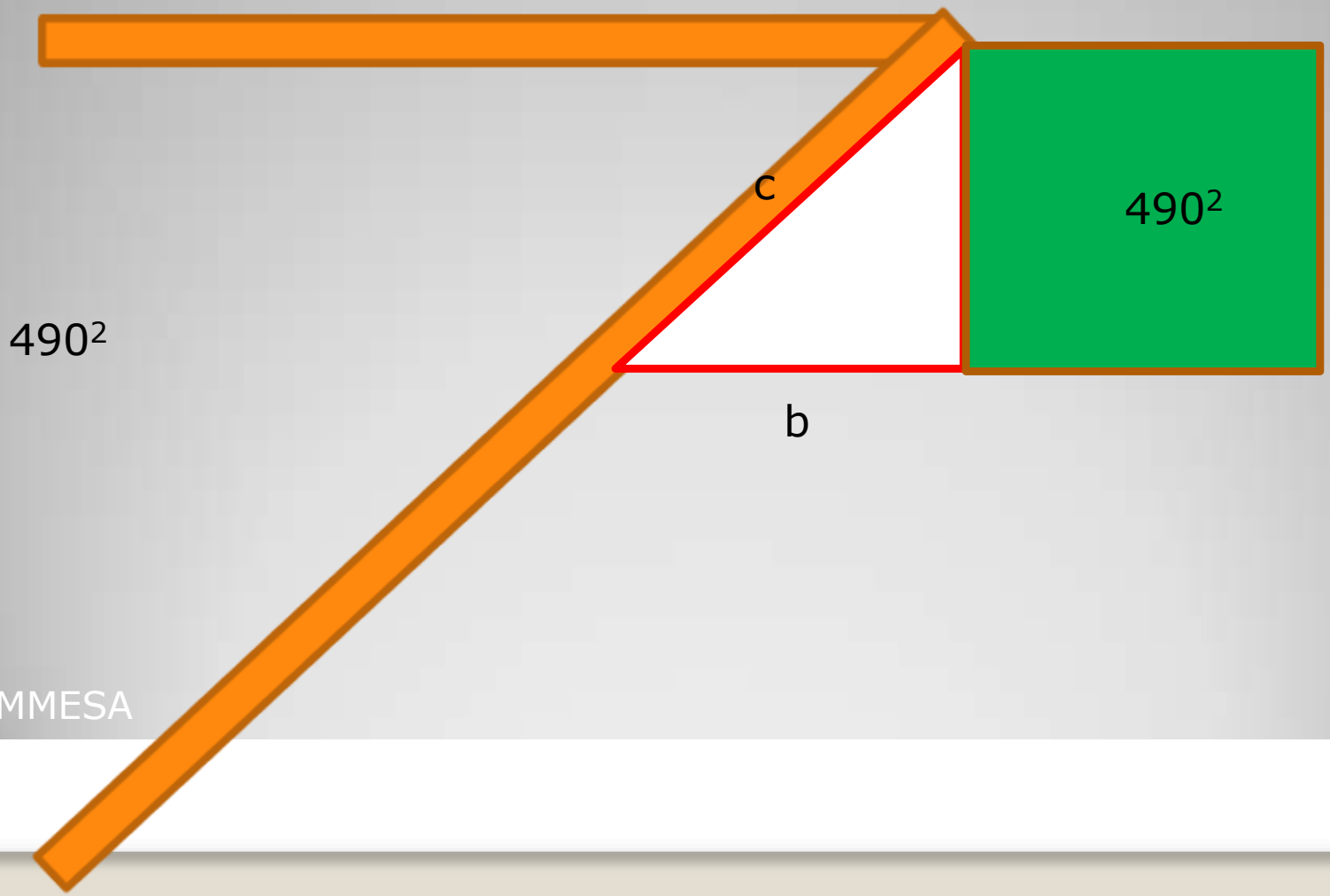
Pythagorean Theorem



$a^2 + b^2 = c^2$

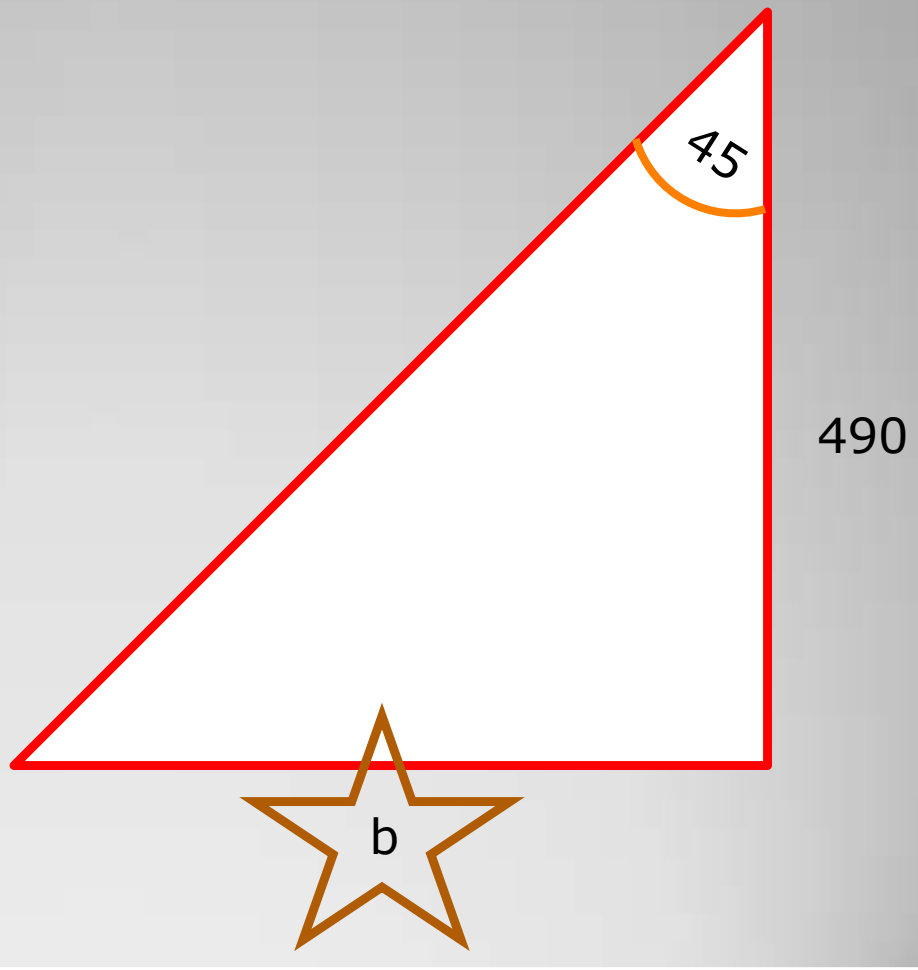
NMMESA

Pythagorean Theorem



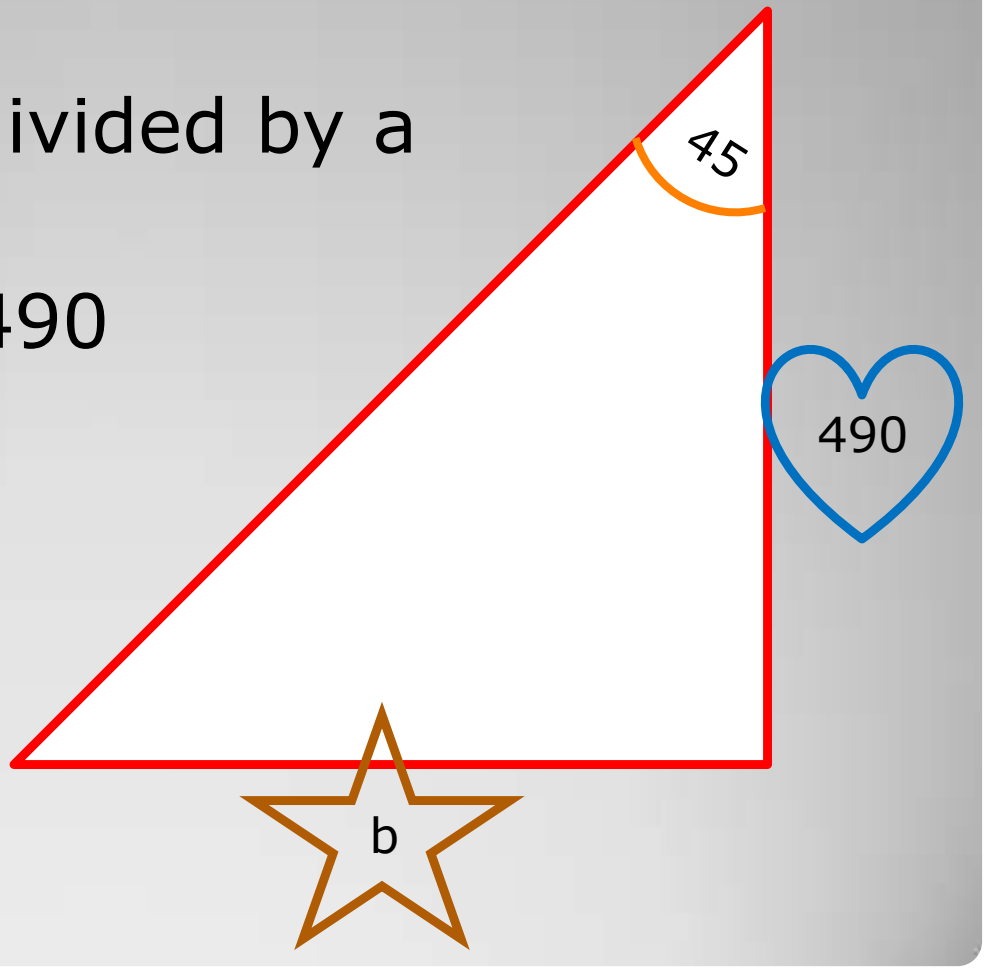
Using the trigonometric function, tangent we can solve for “b”.

Tangent = b

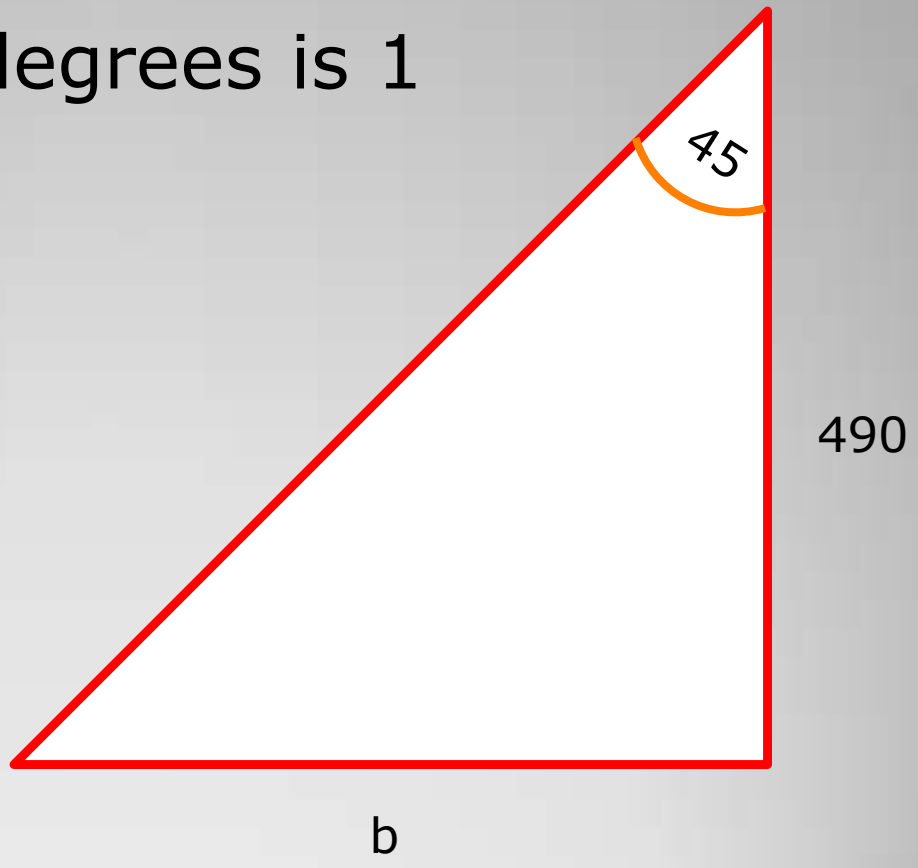


Tangent = b divided by a

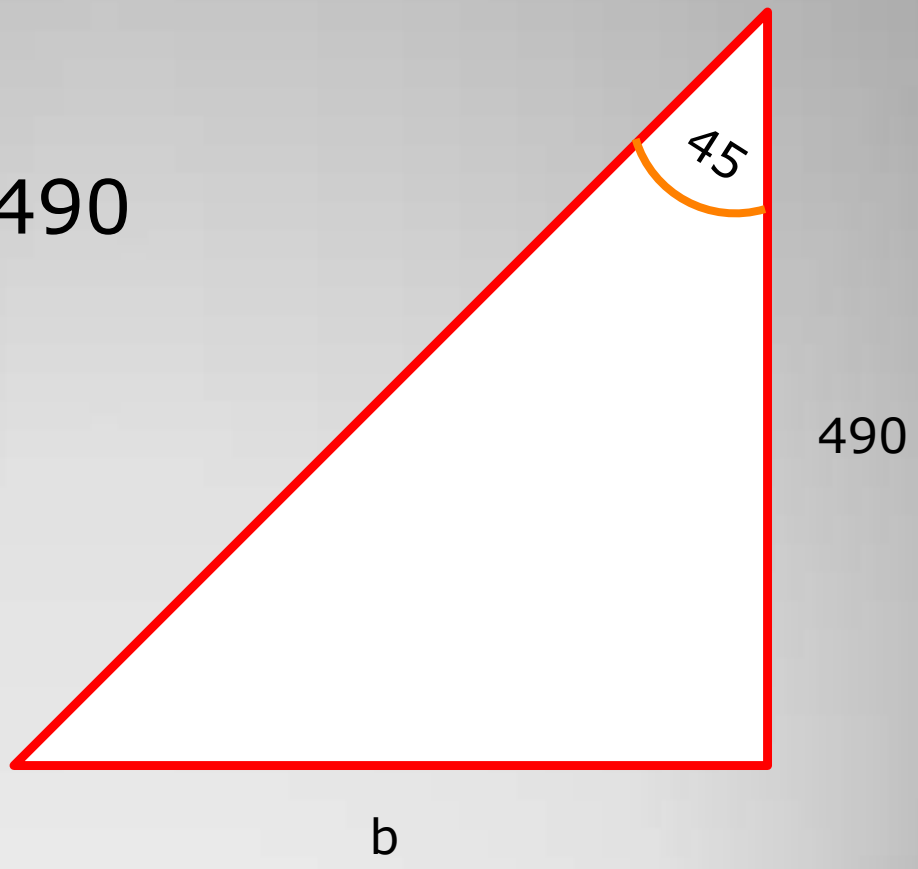
Tangent = b/490



The tangent of 45 degrees is 1

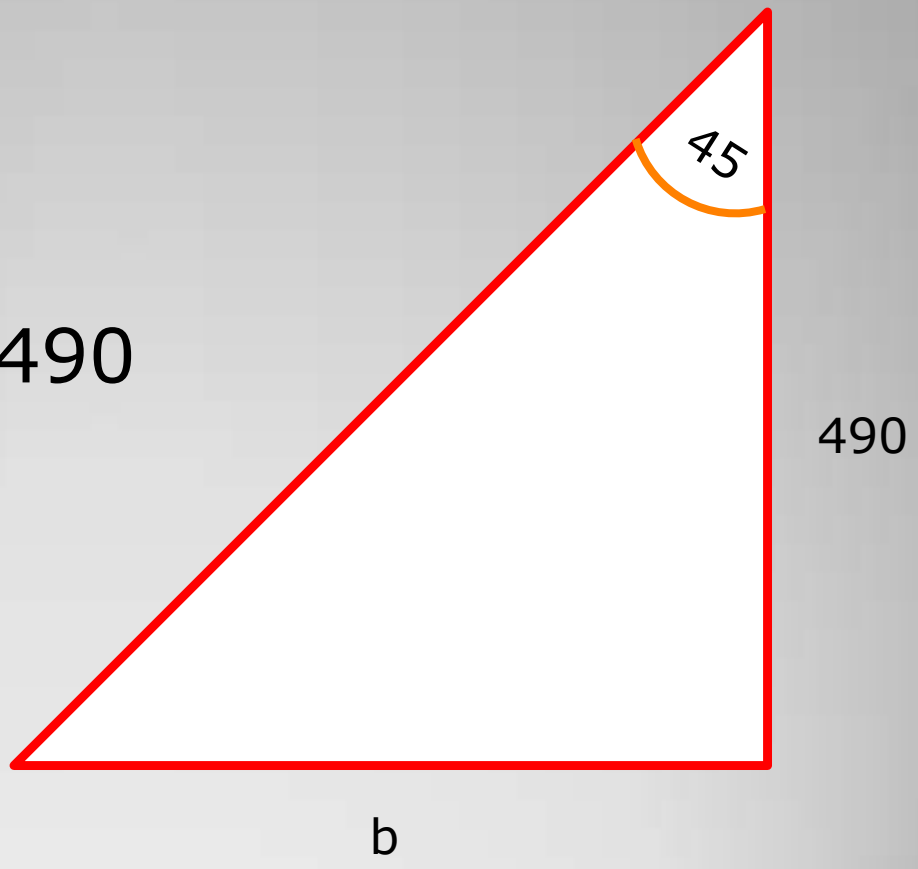


$$1 = b/490$$

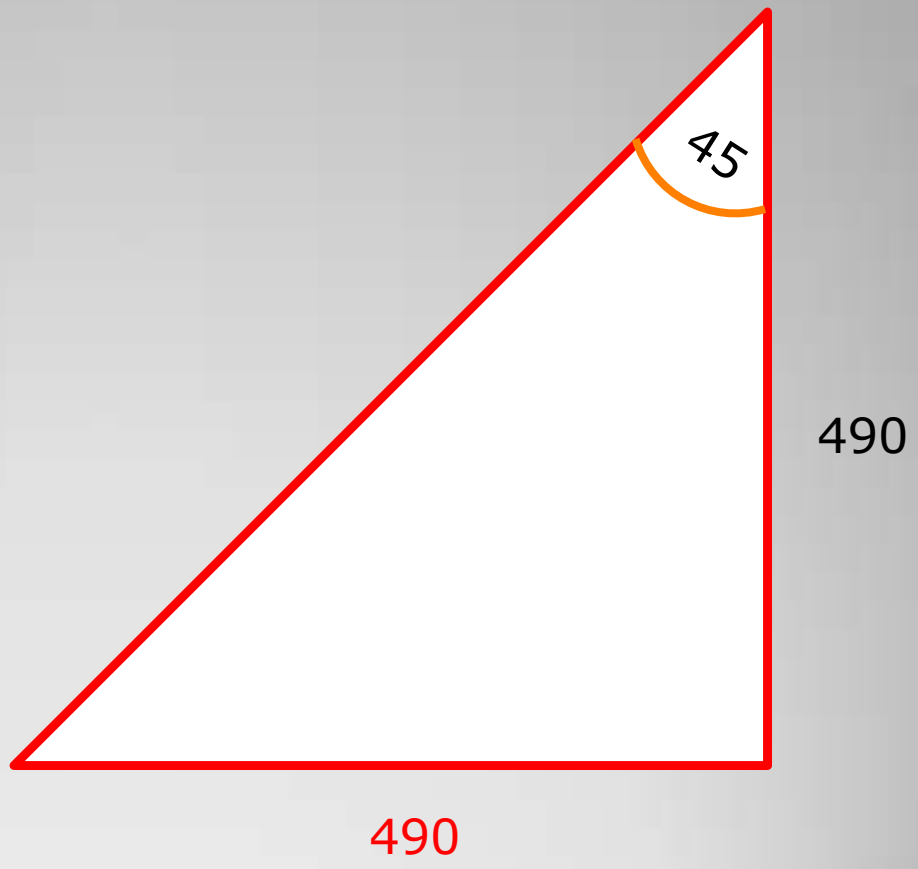


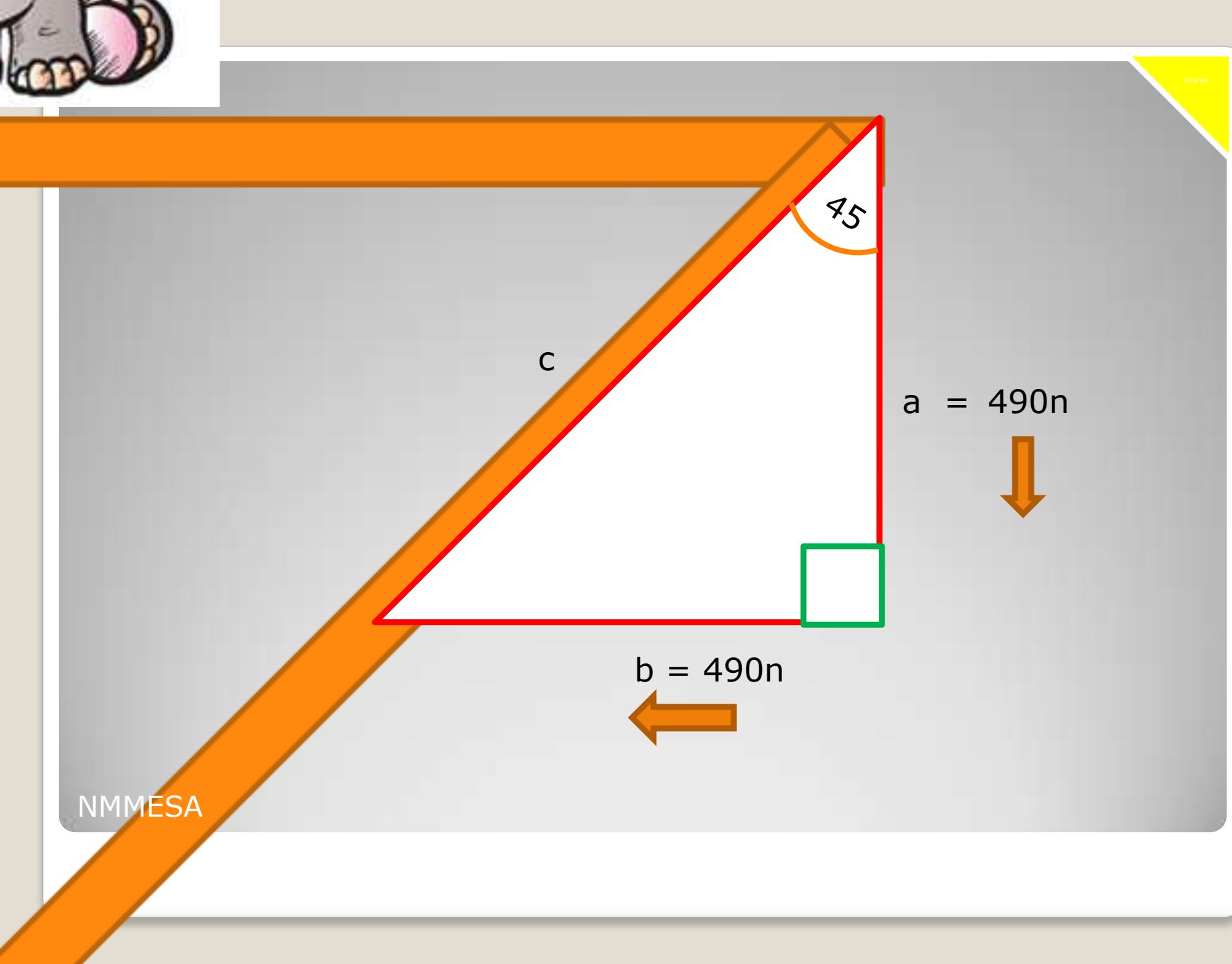
$$1 = b/490$$

$$490 * 1 = b/490 * 490$$



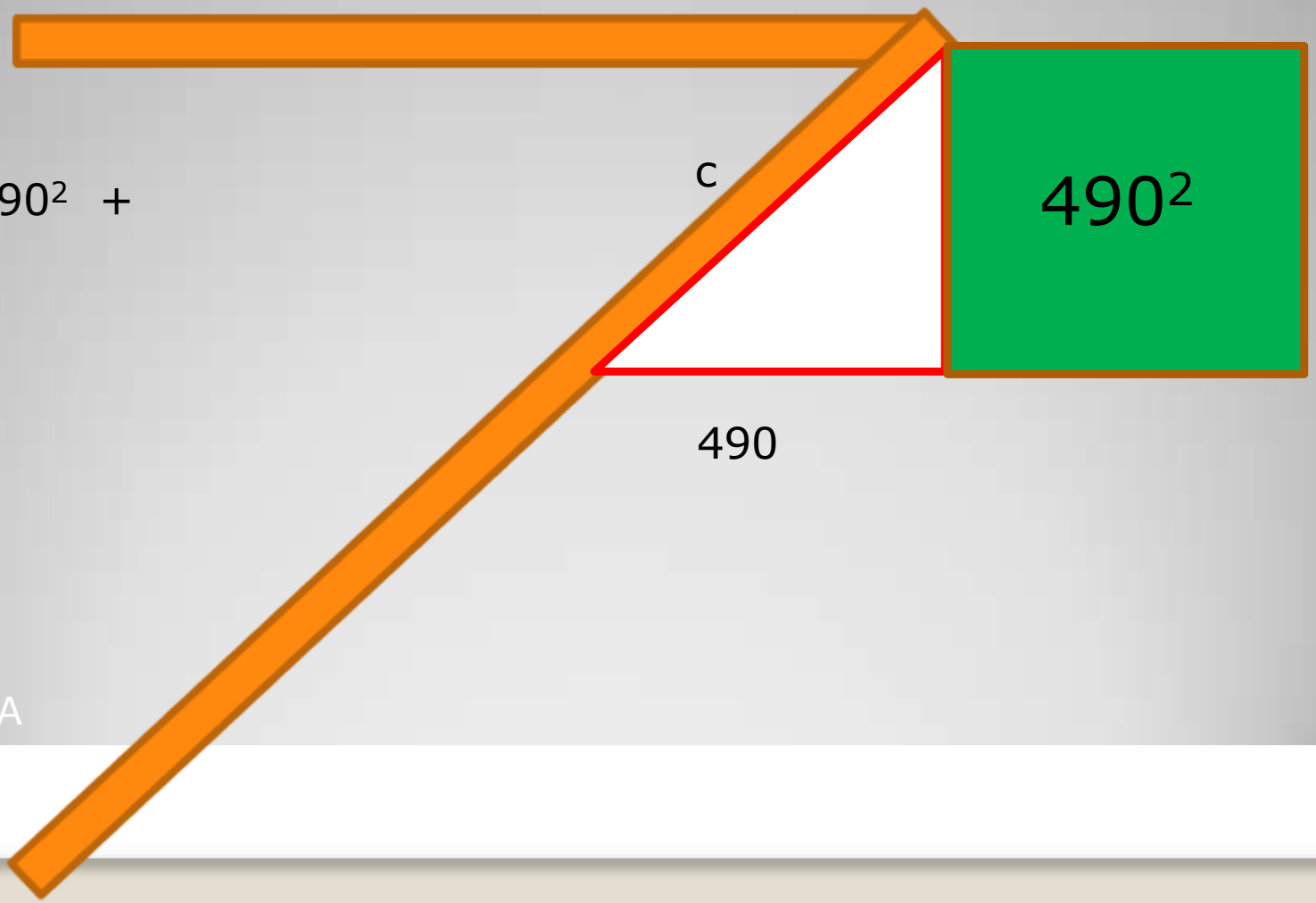
490 = b





NMMESA

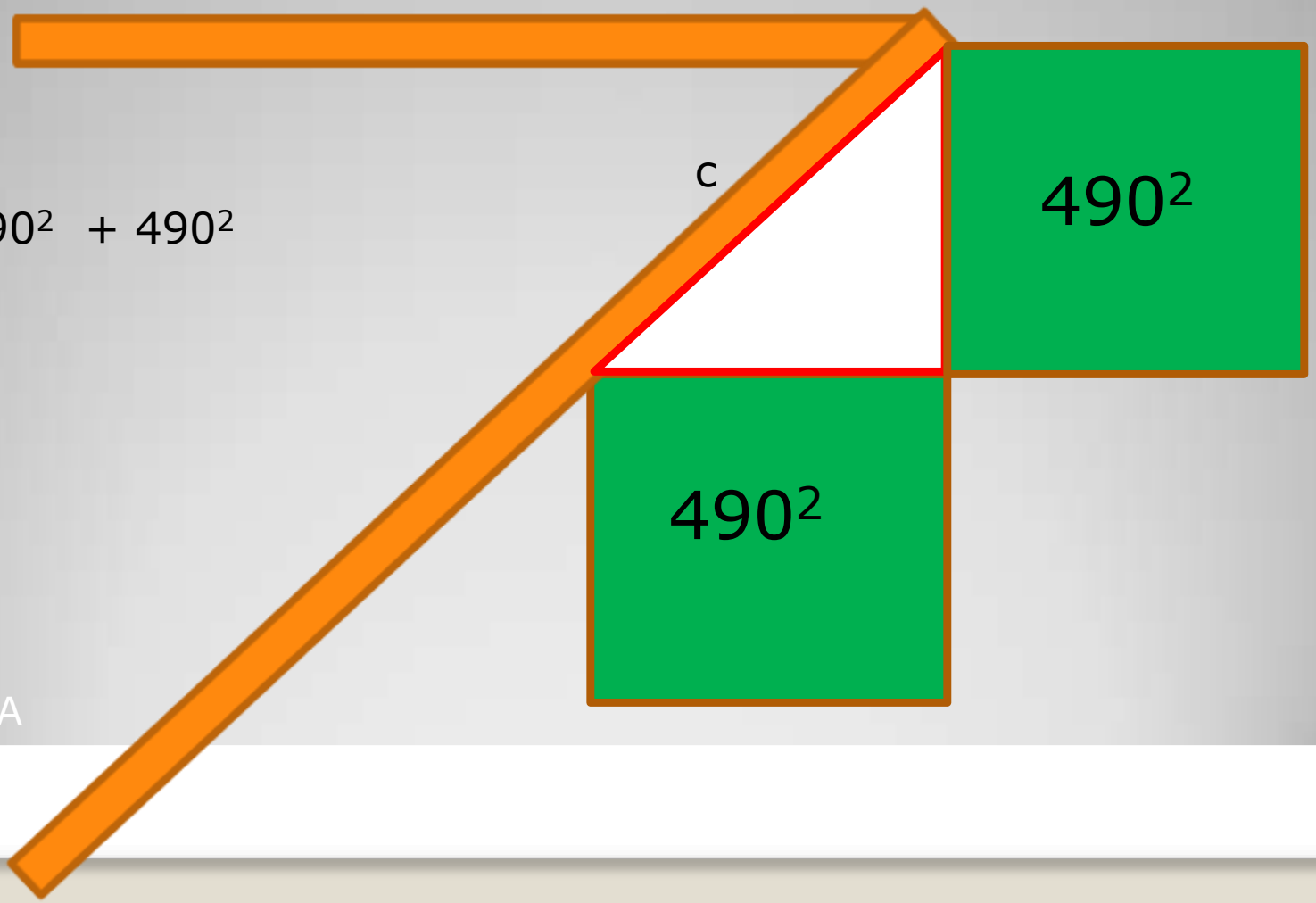
Pythagorean Theorem

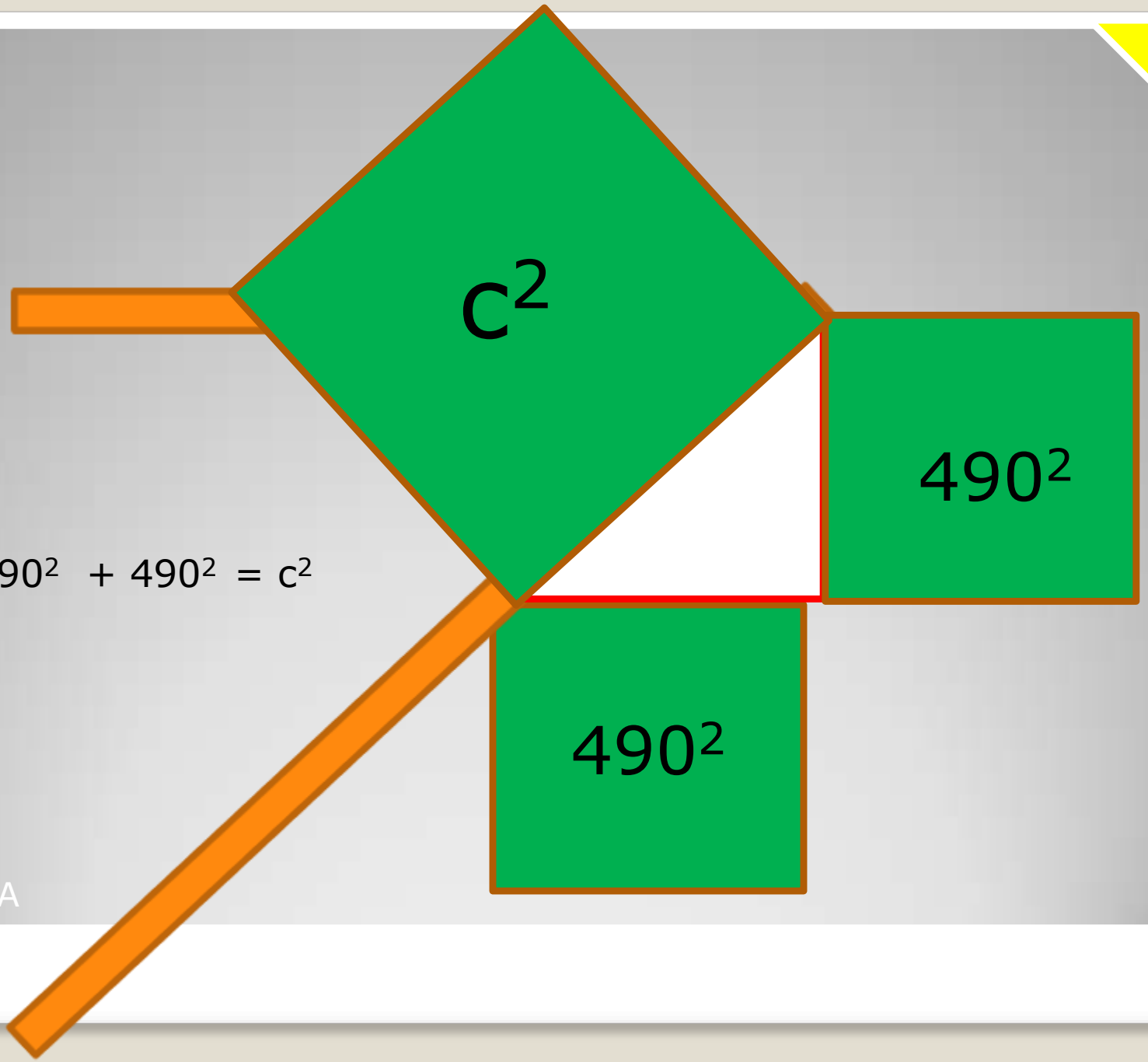


NMMESA

Pythagorean Theorem

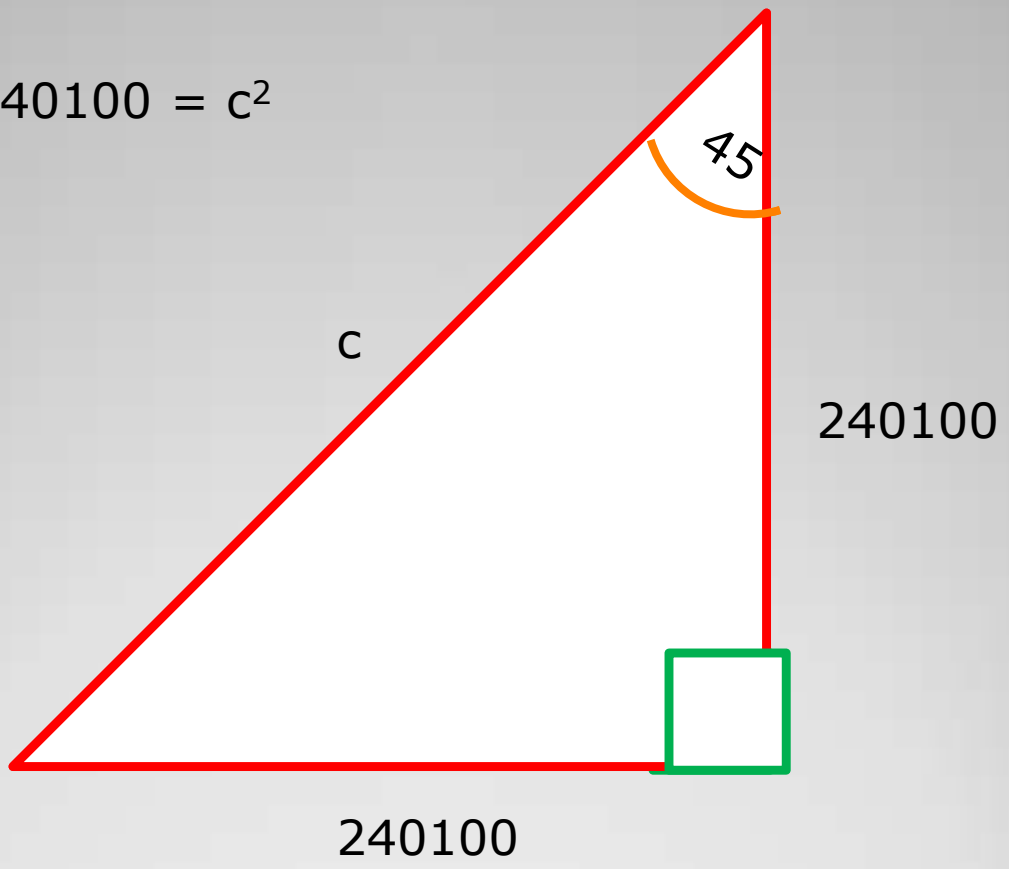
$490^2 + 490^2$





$490^2 + 490^2 = c^2$

$240100 + 240100 = c^2$



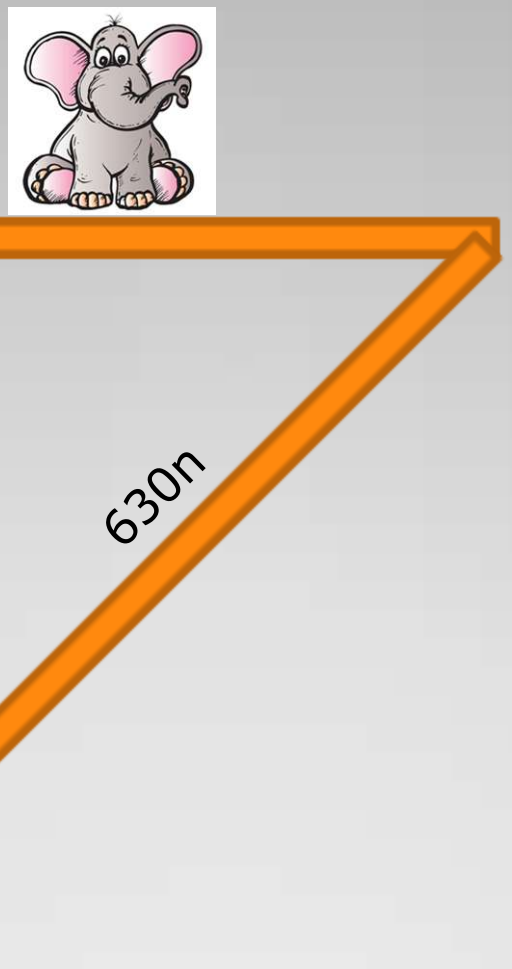
$$240100 + 240100 = c^2$$

$$480200 = c^2$$

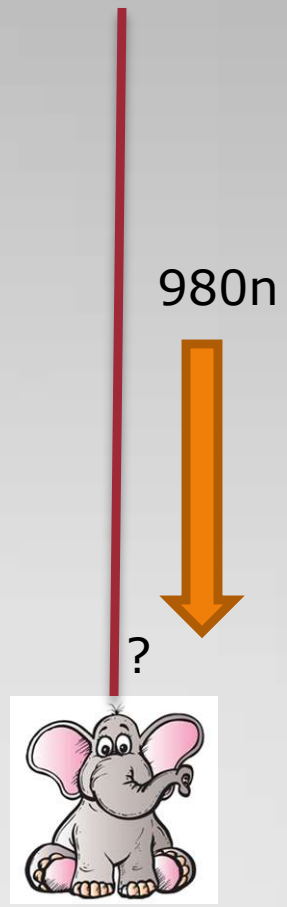
$$\sqrt{480200} = \sqrt{c^2}$$

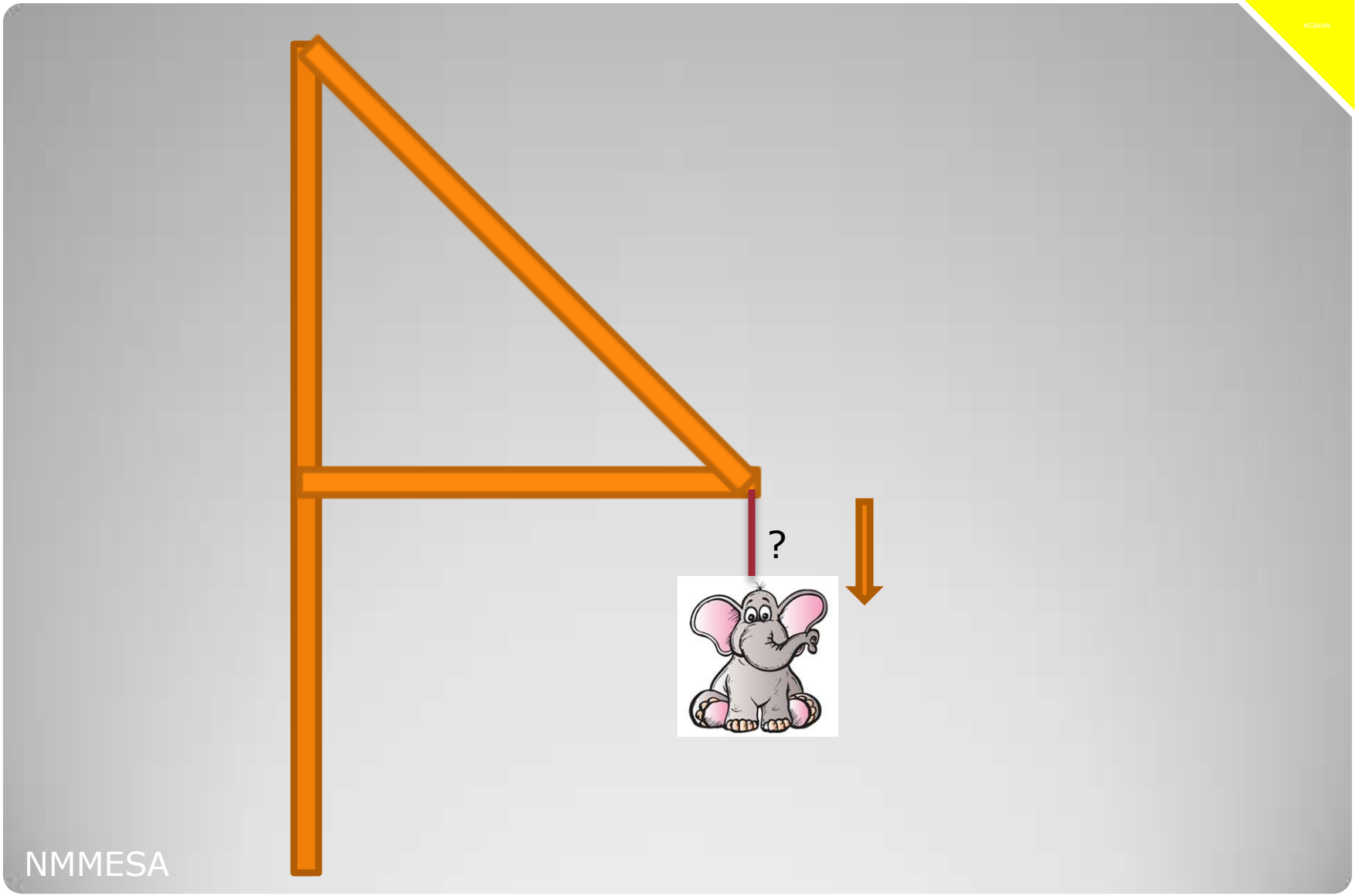
$$693 = c$$

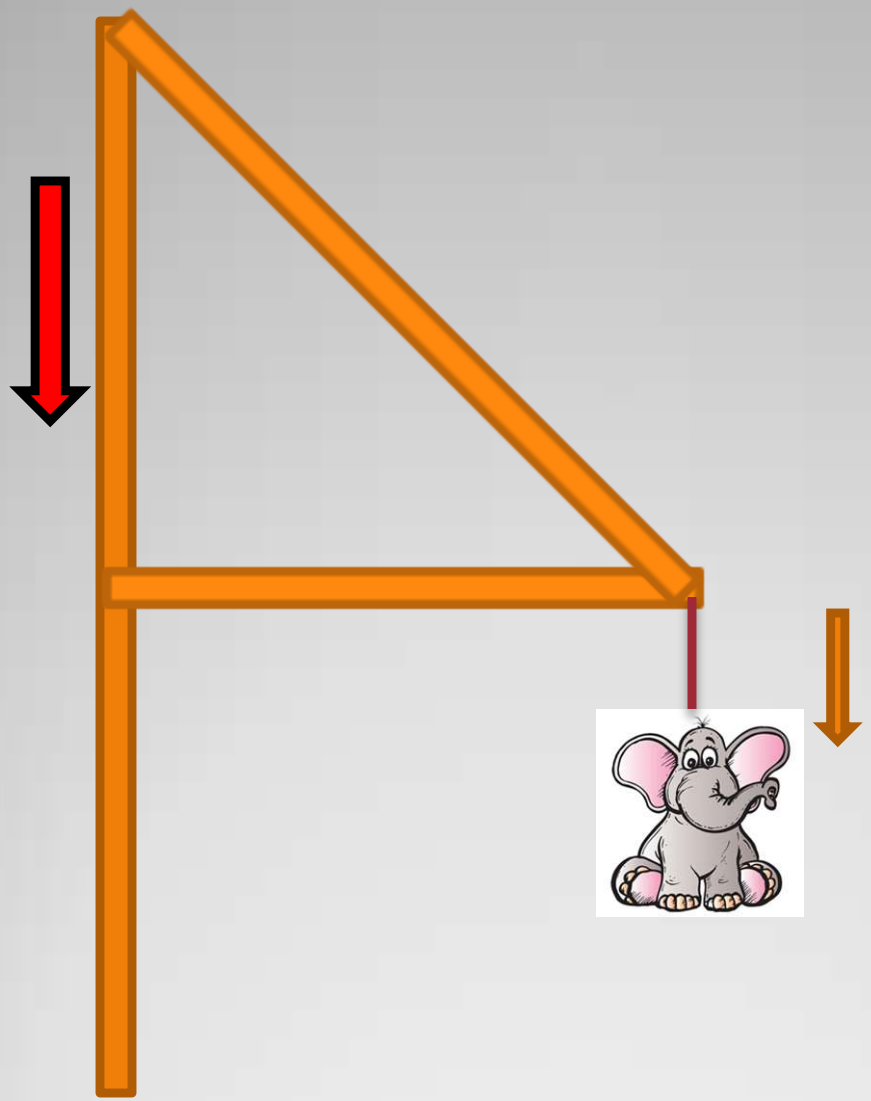
NMMESA

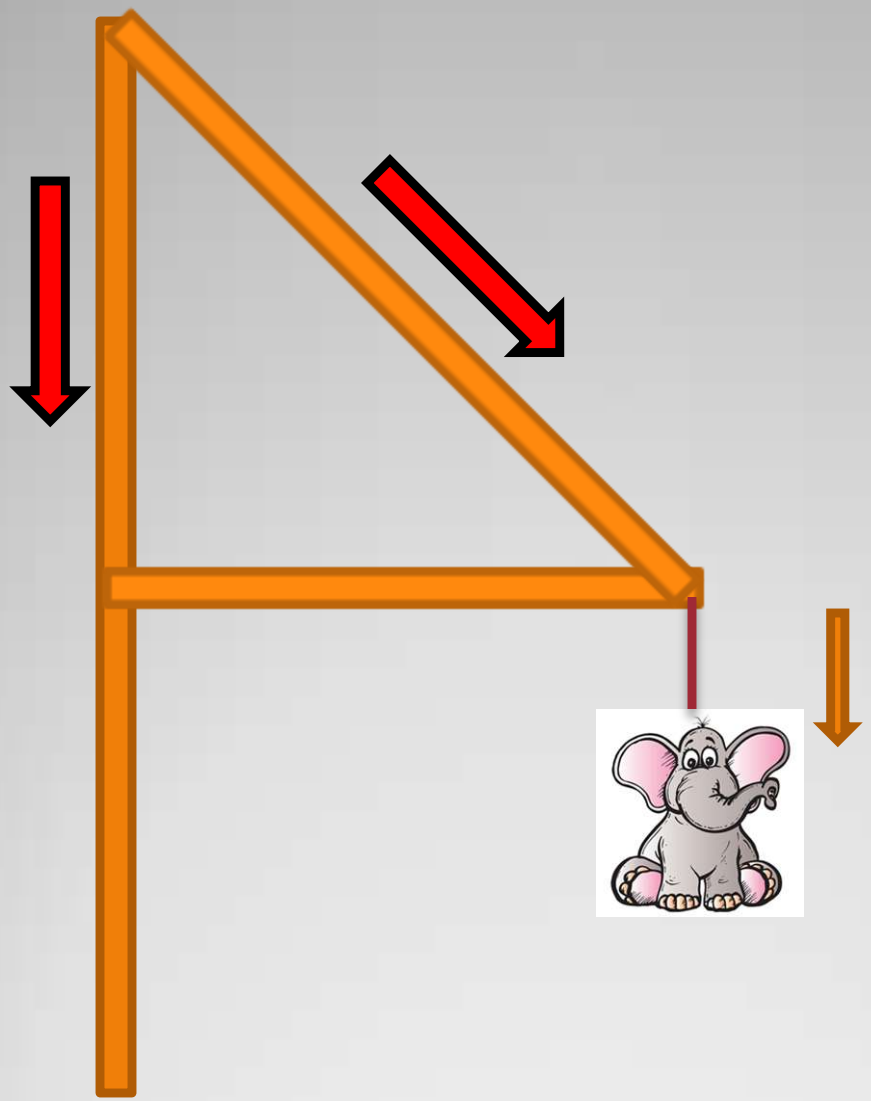


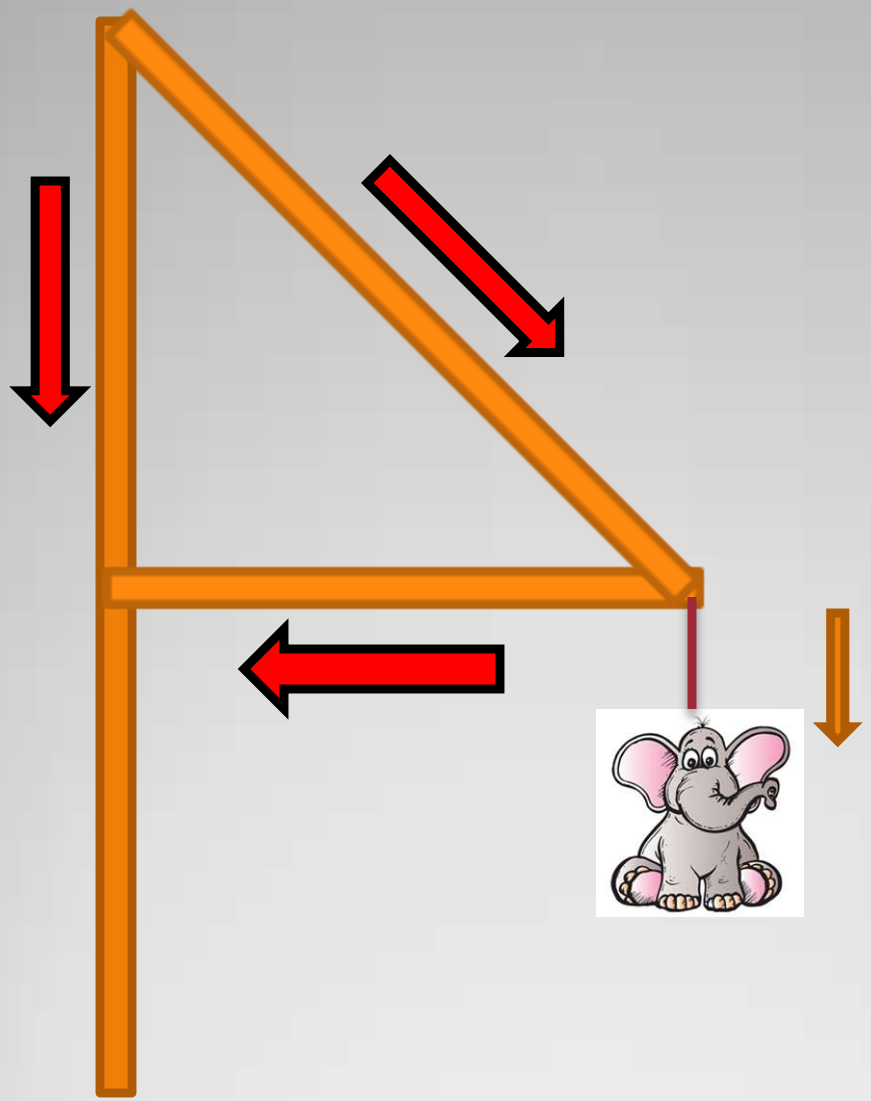
NMMESA

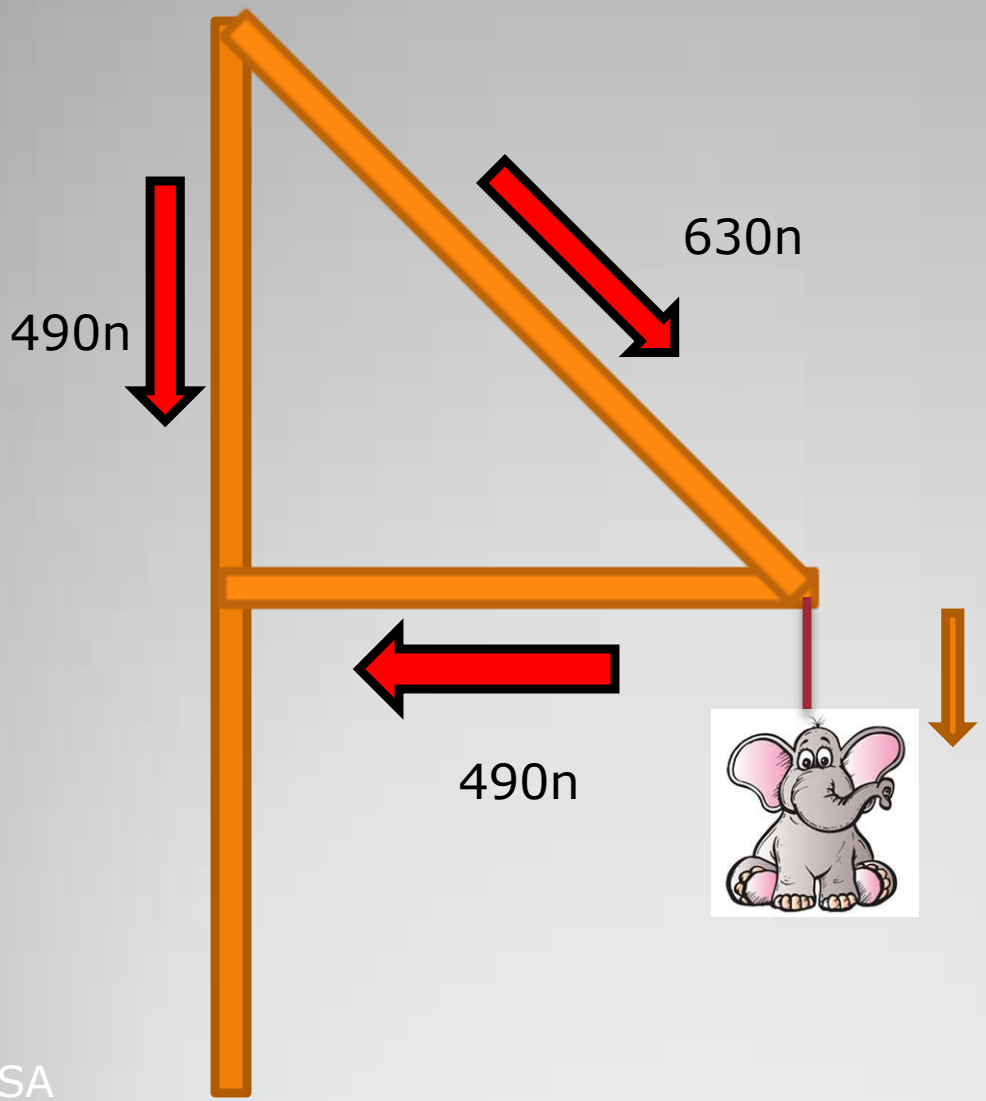

980n
?


?
NMMESA









NMMESA

Reflect

How do bridges distribute forces?

The Competition

Provided by NM MESA

- Final Parameters
- 2 pairs-child scissors
- Single Hole Punch
- 1 ruler
- 4 pencils
- Any additional materials necessary to complete surprise task

The Competition

Provided by Student Teams

- Total of 4 feet of yarn or string
- 25 Metal Brads:
- 2 additional pairs of child scissors-Not to used as part of the design, for construction only
- 4 Standard Size (letter size) Manila Folders:
- 4 Sheets of Newspaper
- 10 Standard Size Playing Cards (2.5” x 3.5” maximum size)
- 1 Roll of Scotch Type Tape: transparent adhesive tape 3/4” x 1300” (about 36 yards). If on dispenser, dispenser cannot be used as part of the design.
- 10 Popsicle Sticks: no greater than 1” x 6”8/25/2011

Boats

You may wonder…

Why do some things float and other don't?

You may wonder...

How can I win this boat competition?

You may wonder...

Why are we grateful for a naked Greek?

Get physical...

Make a small boat from paper and see how many pennies it can hold before sinking. It is OK to get a little competitive!

Let’s think about

WEIGHT

Let’s think about

WEIGHT

MASS

Let’s think about

WEIGHT

MASS

VOLUME

Let’s think about

WEIGHT

MASS

VOLUME

DENSITY

Let’s think about

WEIGHT

MASS

VOLUME

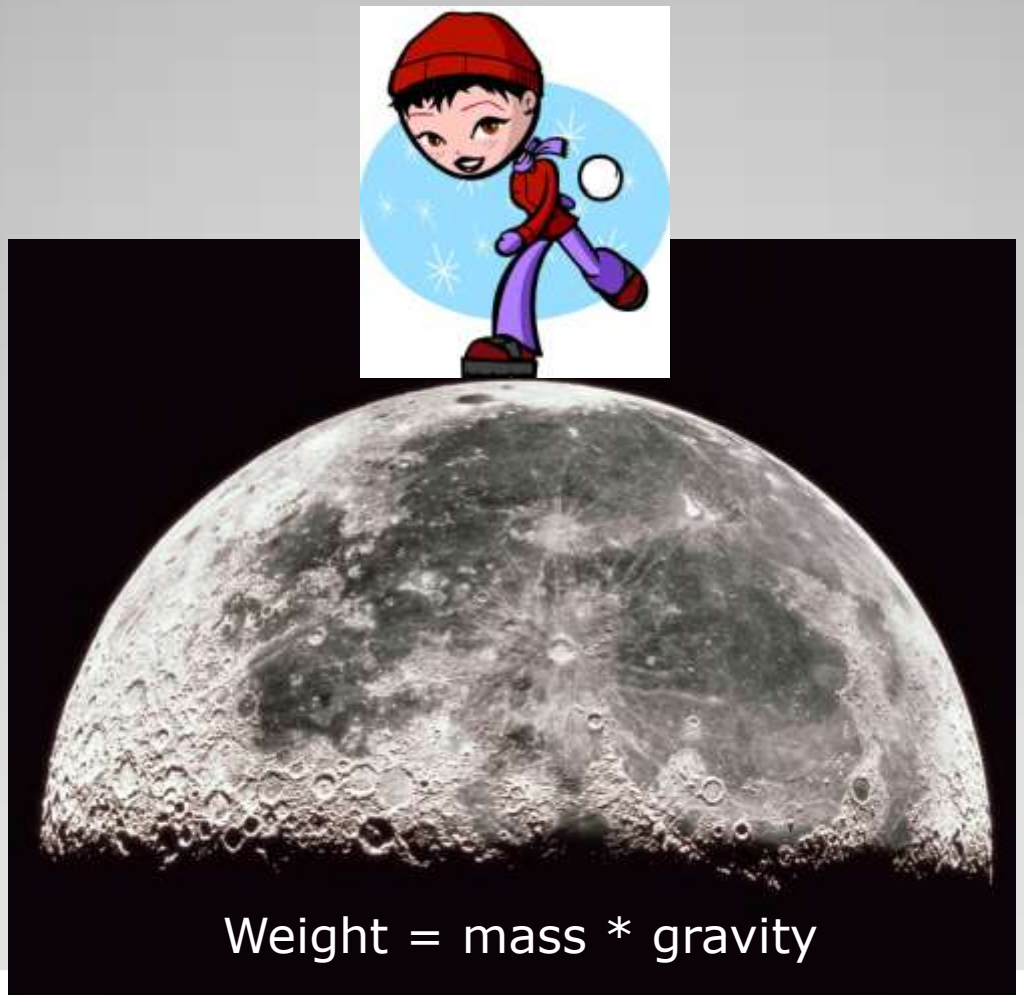
DENSITY

GRAVITY

A snowball's **WEIGHT** is the its **MASS** (the amount of atoms it is made from) falling in the gravity of Earth.

WEIGHT

On the moon, the snowball has the same mass but it doesn't weigh as much.



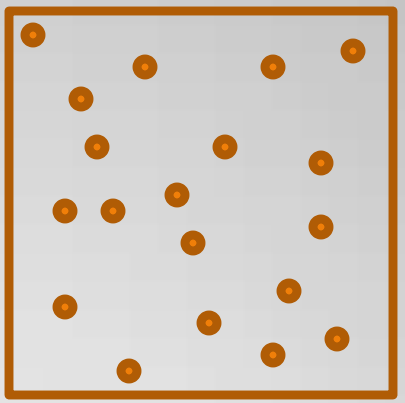
A snowball has a particular size. Call it…

VOLUME

A snowball can be packed together a little or a lot. We can call that its…

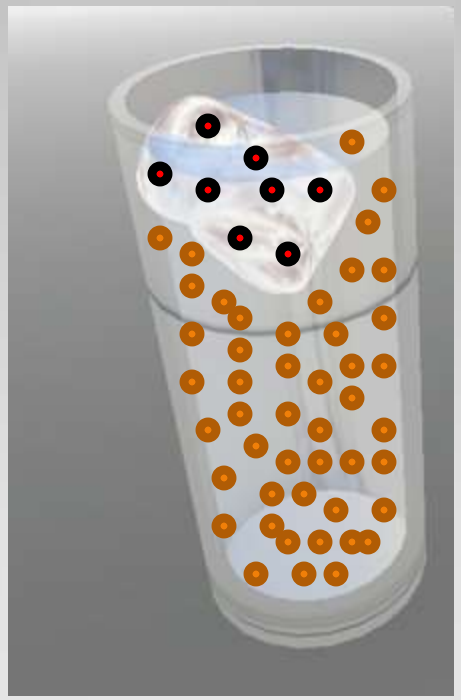
DENSITY

DENSITY = matter is in each cubic area



DENSITY = MASS/VOLUME

Less dense objects float



on more dense fluids.

Get physical...

Make a paper ball that can float.

Make a paper ball that will sink.

- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
- Iron 7900 kg/m

so this 

- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
- Iron 7900 kg/m

so this

floats on this

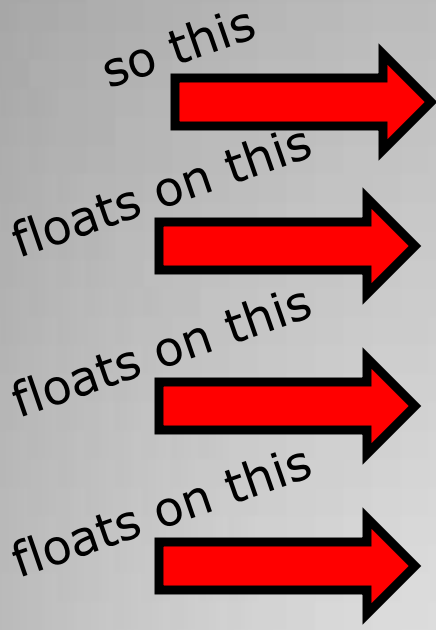
- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
- Iron 7900 kg/m

so this

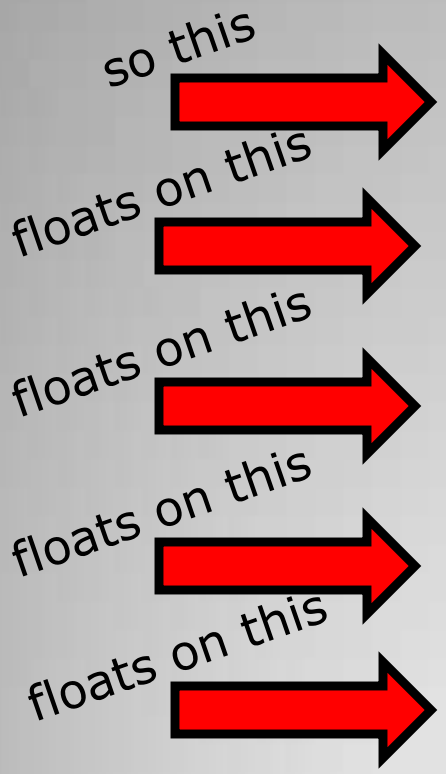
floats on this

floats on this

- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
- Iron 7900 kg/m



- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
- Iron 7900 kg/m

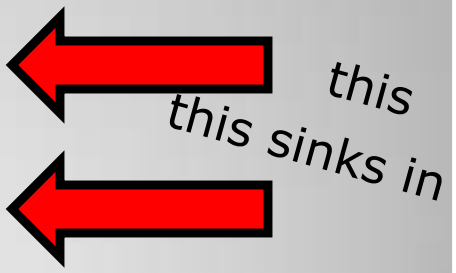


- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
- Iron 7900 kg/m

And…

- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
- Iron 7900 kg/m

- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
- Iron 7900 kg/m



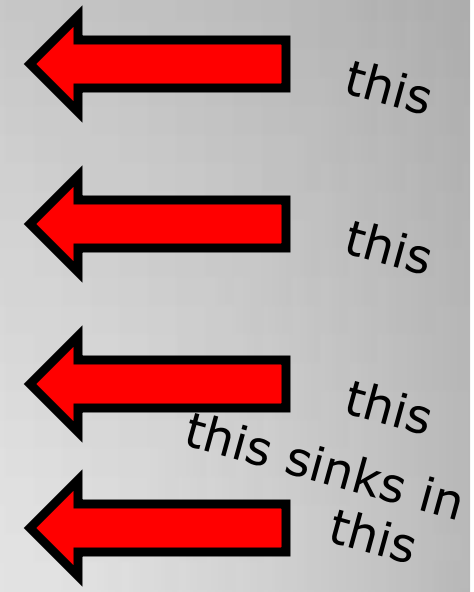
- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
- Iron 7900 kg/m

this

this

this sinks in

- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
- Iron 7900 kg/m



- Air 1.21 kg/m3
- Ice 917 kg/m3
- Pure water 1000 kg/m3
- Sea water 1024 kg/m3
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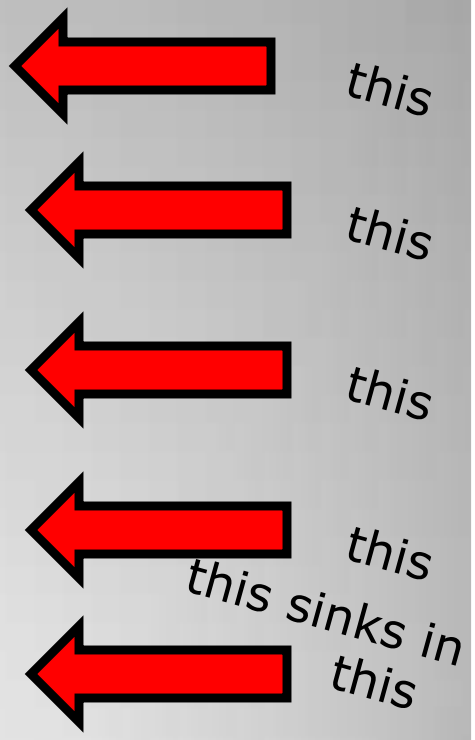
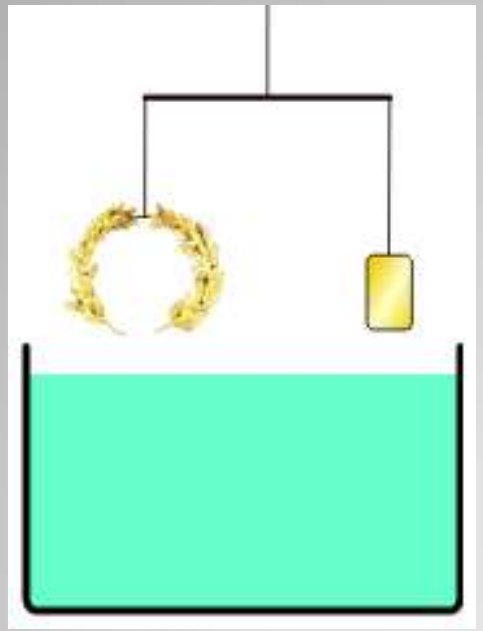


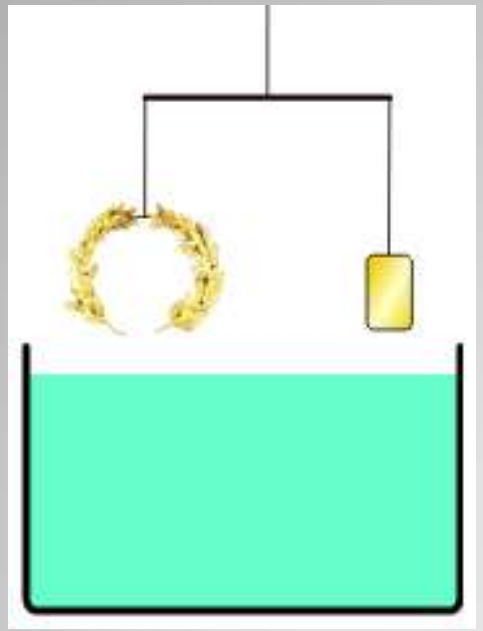
Archimedes Principle

When an object is immersed in a fluid, there is an upward buoyant force *equal to the weight of the* ***volume of fluid*** *displaced by the object.*

- Movie time…
- The Crown of Syracuse

- http://www.youtube.com/watch?v=wEvtahSn_ms

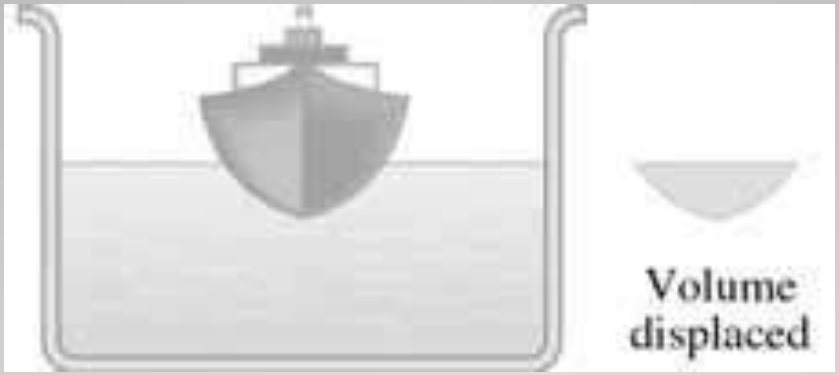




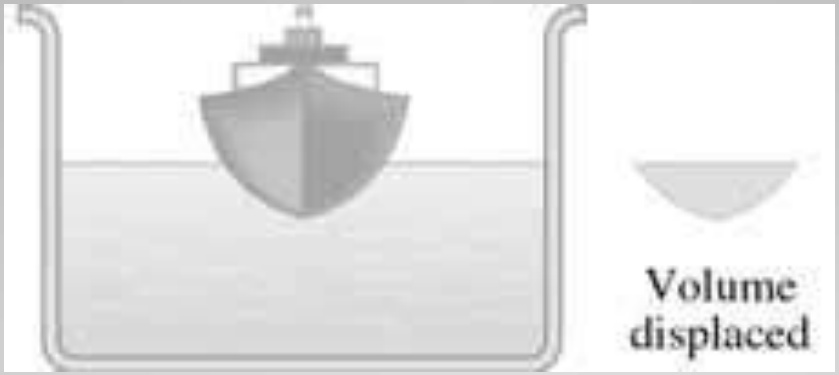
Must be bigger
More buoyant force

An object will float if the buoyant force (the weight of the water displaced) equals the weight of the object

The more weight you put inside…



The more weight you put inside…



The more water it displaces and the more buoyant it becomes.

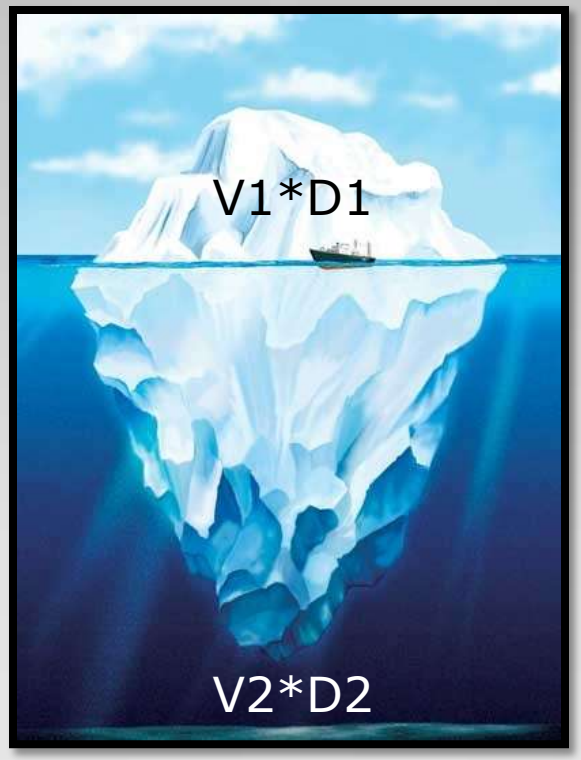
When an object is immersed in a fluid, there is an upward buoyant force *equal to the weight of the volume of water displaced*

Iceberg calculations…

Let’s compare the weight of the ice to the weight of the water.

The lighter one will float.

Iceberg calculations…



(volume of ice x density of ice) = (volume of water x density of water)

Iceberg calculations…

(volume of ice x density of ice) = (volume of water x density of water)

Or…

$$\frac{\text{Volume of ice}}{\text{Volume of water}} = \frac{\text{Density of water}}{\text{Density of ice}}$$

(volume of ice x 917 kg/m3) = (volume of water x 1024 kg/m3)

Or…

$$\frac{\text{Volume of ice}}{\text{Volume of water}} = \frac{1024 kg/m^3}{917 kg/m^3}$$

The ratio is greater than 1 so…

The iceberg floats!

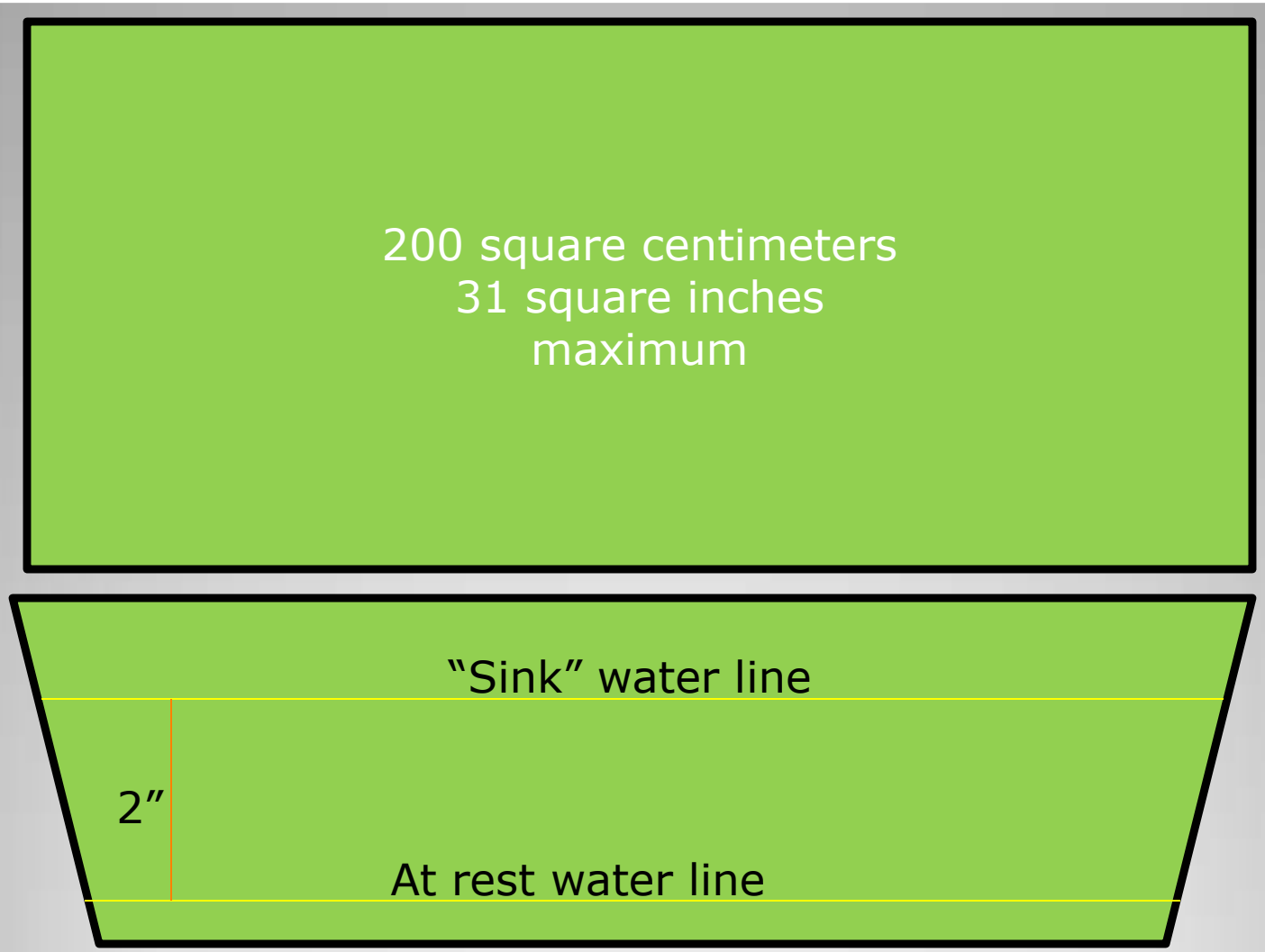
If the weight of the fluid displaced is greater than the weight of the object, the object FLOATS.

- Movie Time
- The Archimedes Principle

For your boat to gain the highest points available in this contest it must displace 1000g of water.

400 pennies = 1000g

For your boat to gain the highest points available in this contest it must displace 1000g of water.


200 square centimeters
31 square inches
maximum
“Sink” water line
2”
At rest water line

The Competition

Parameters

Materials:

- One piece of paper
- Glue
- Waterproofing spray

The Competition

Parameters

Task:

To build a boat, no bigger than 6” x 6” that can float for up to 10 minutes as weights are added every 30 seconds.

How much weight can a paper boat hold.

After all, its only paper…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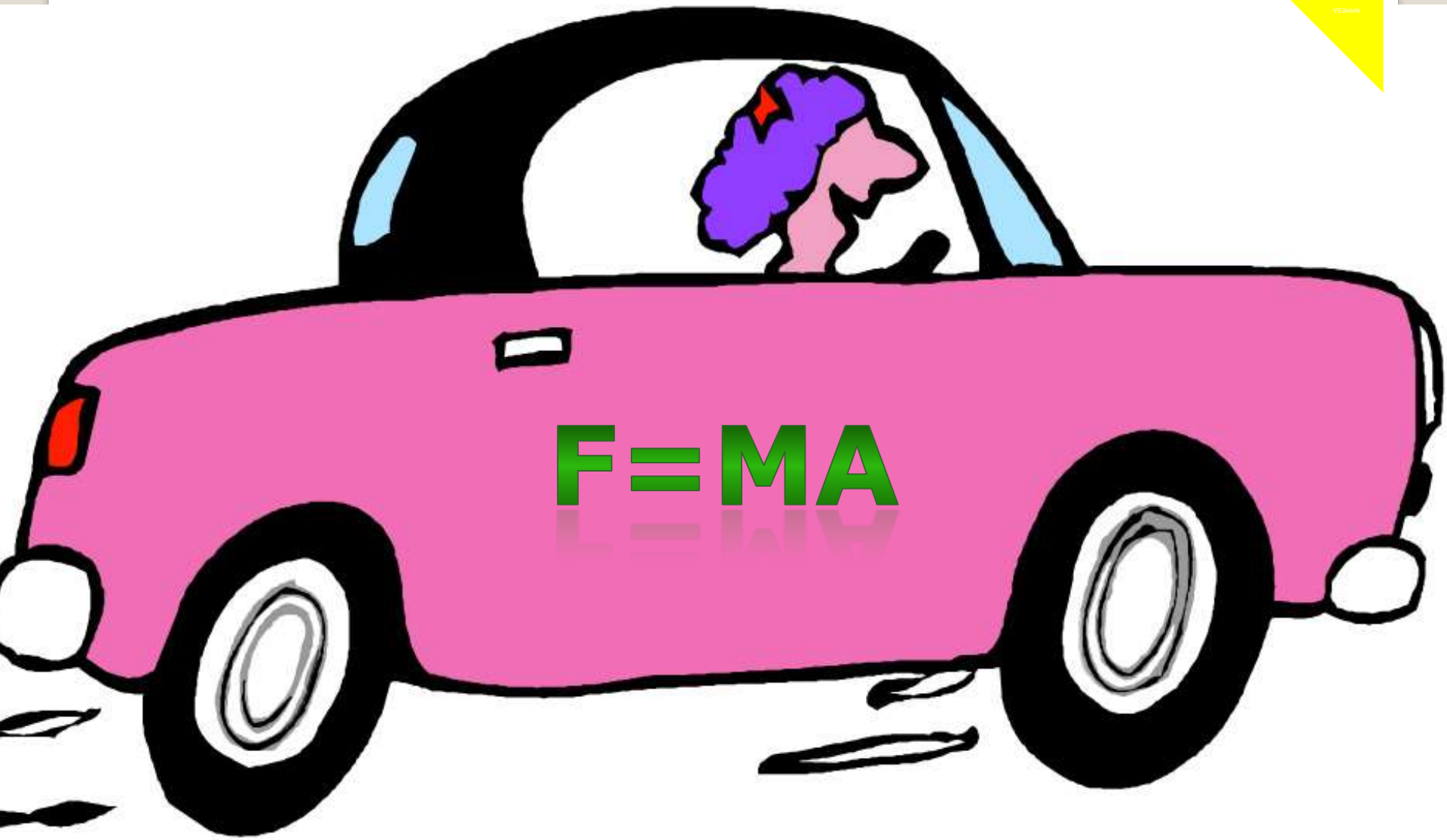


You may wonder...

Why are dragsters fast?

You may wonder...

Why are tanks slow?

You may wonder...

What math do I need in order to win the car competition?

Get physical...

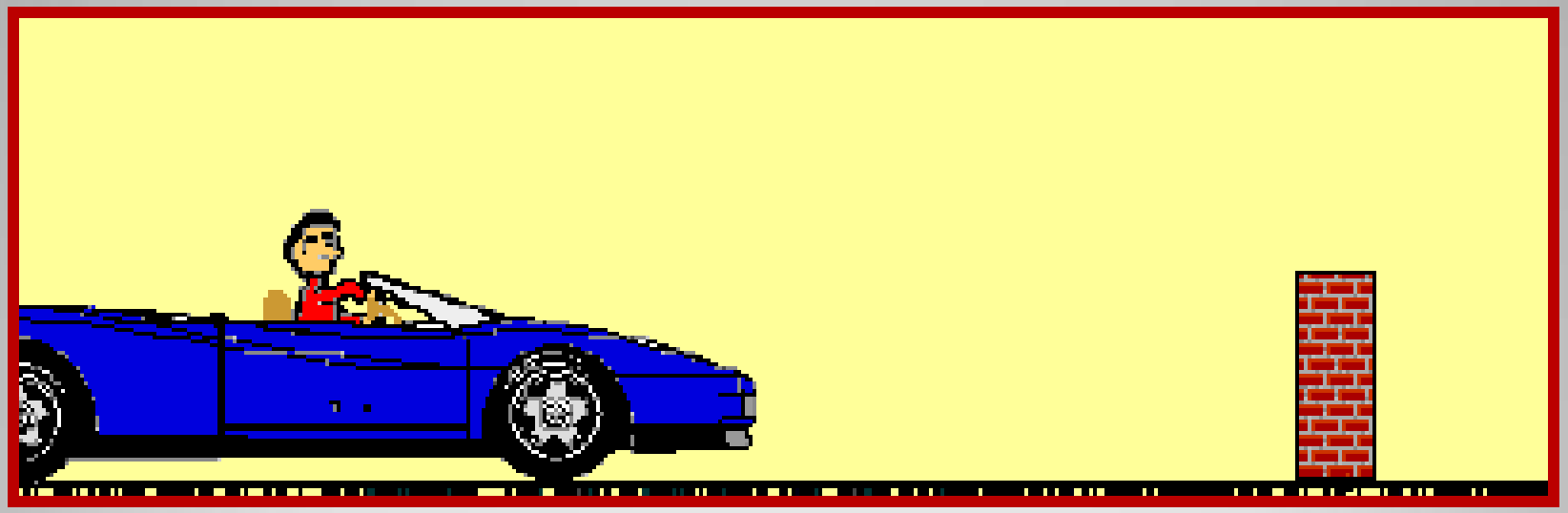
With one mighty finger, move something across the surface of your desk.

Newton’s first law…

An object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

This law is often called "the law of inertia".

Newton’s first law…



Newton’s second law…

The change of momentum of a body is proportional to the impulse impressed on the body, and happens along the straight line on which that impulse is impressed.

Newton’s second law…

The change of momentum of a body is proportional to the impulse impressed on the body, and happens along the straight line on which that impulse is impressed.

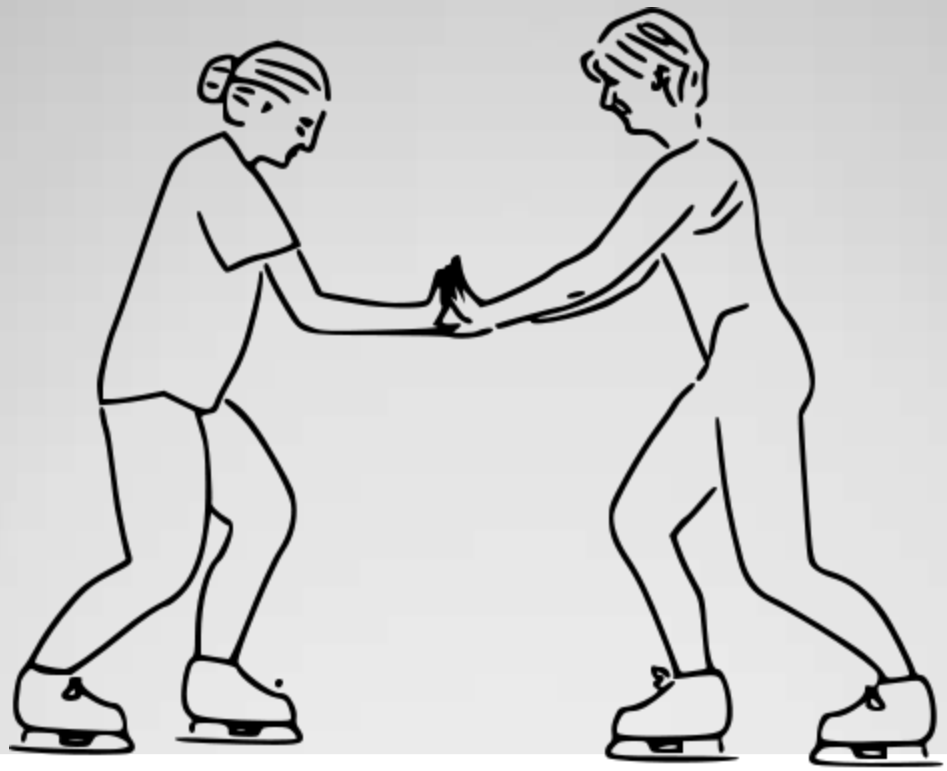
Force = Mass * Acceleration

Newton’s second law…

The force required to push a big truck is greater than the Force required to push a bicycle.

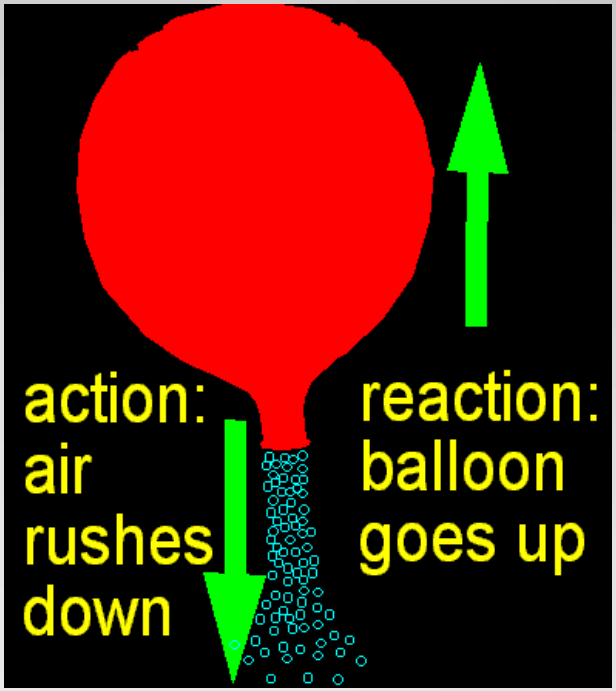
Newton’s third law…

For every action there is an opposite and equal reaction.



Newton’s third law…

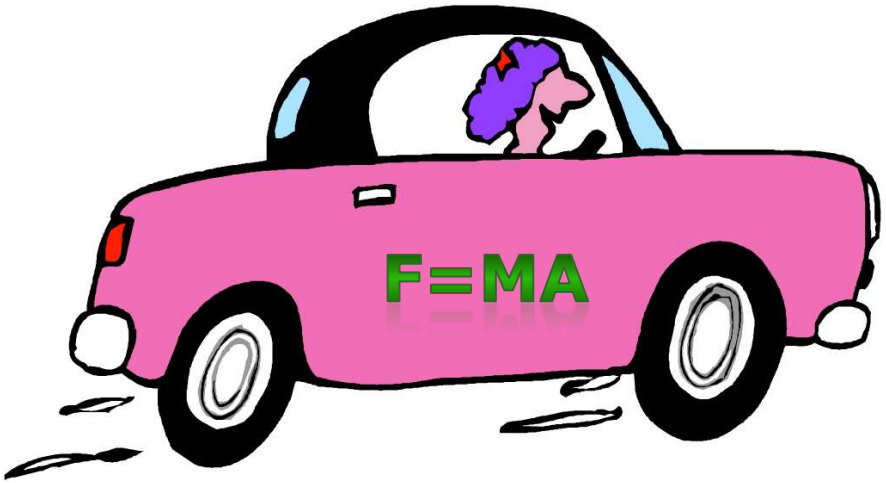
For every action there is an opposite and equal reaction.



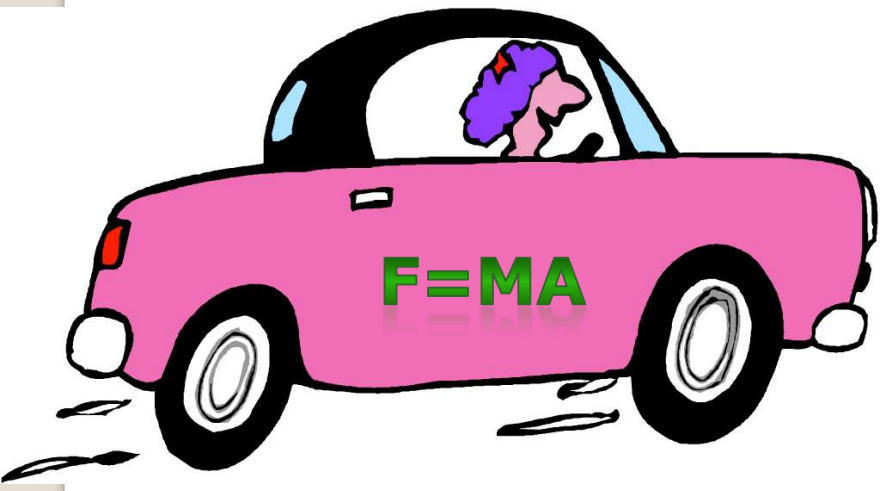
Newton's third law…

Push on a something with more mass than yourself. You exert a force on the truck. The truck exerts an equal but opposite force on you. But, because of the second law, the trucks greater mass makes you accelerate more.

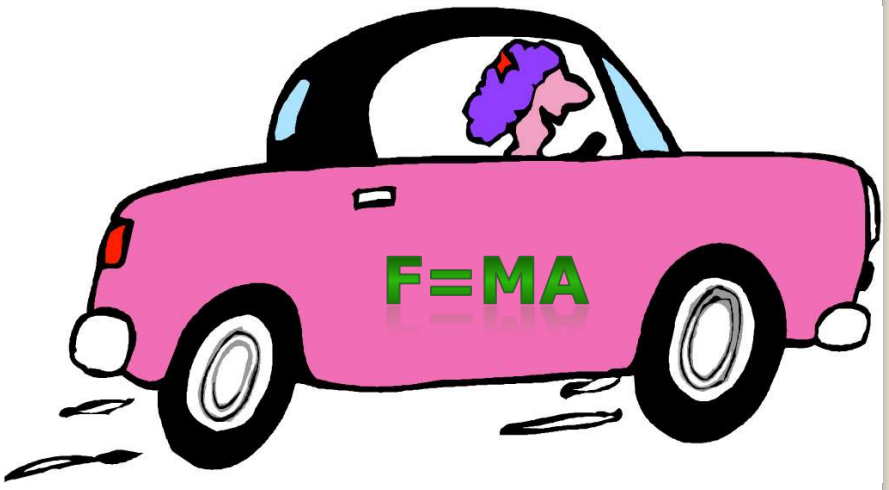
Motion – Moving from one place to



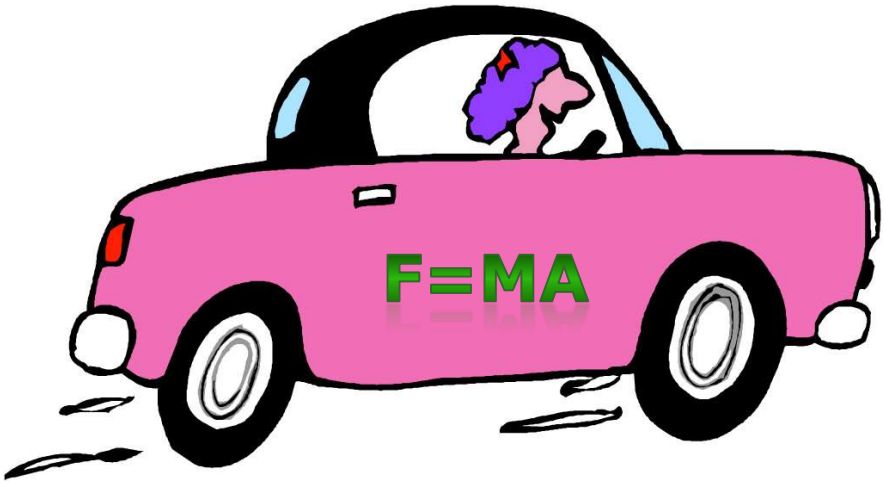
Motion – Moving from one place



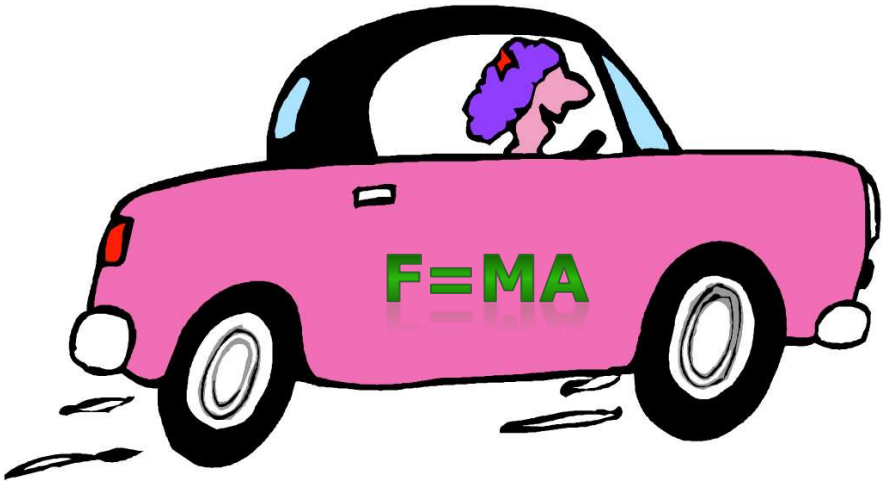
Motion – Moving from one place to another.



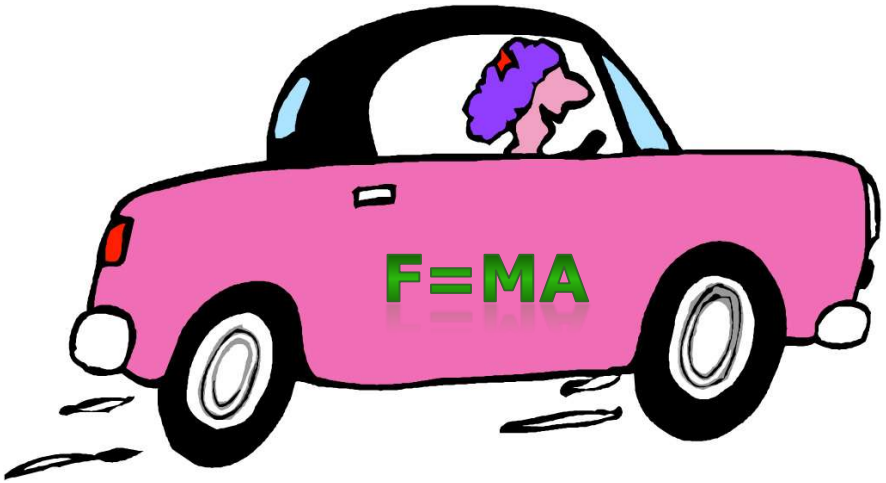
Force – A push or pull on an object.



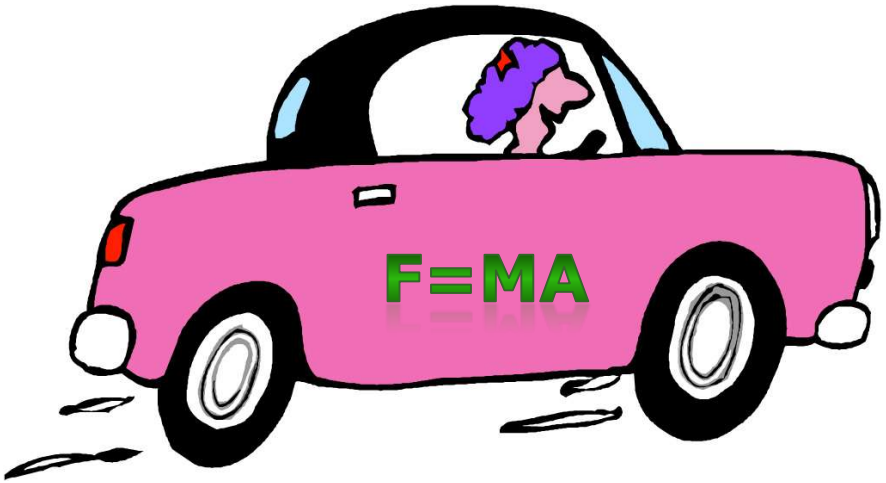
Velocity – How fast and in what direction.



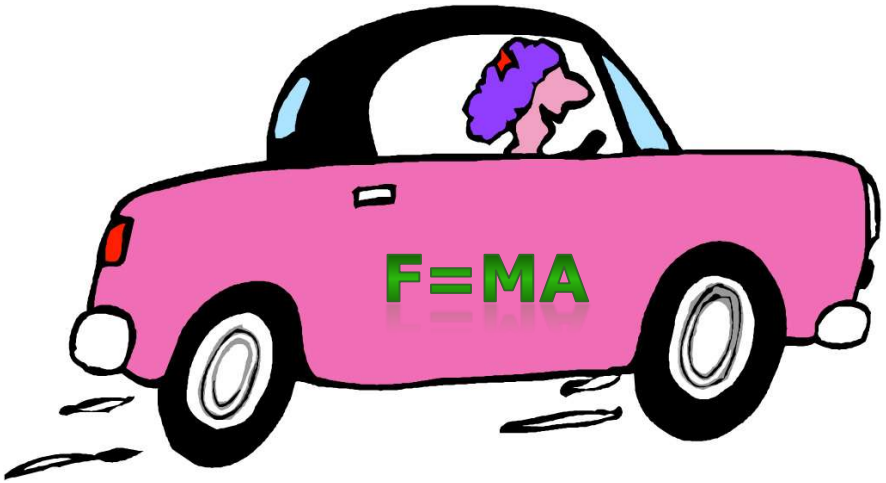
Acceleration – Velocity changing over time.



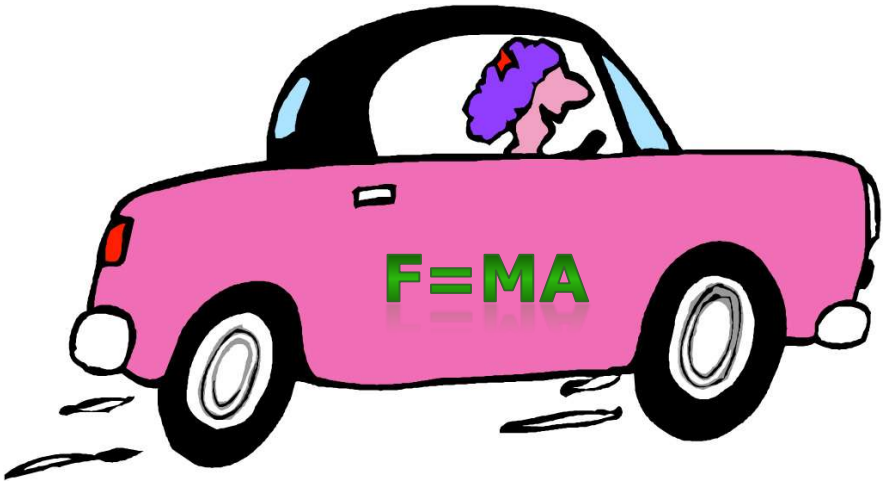
Mass – Amount of matter in an object.



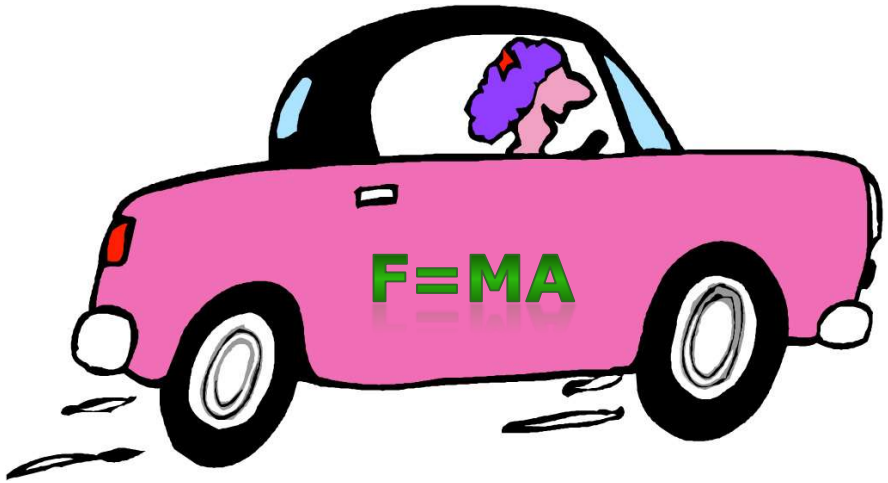
Inertia – Objects at a stand still resist moving. Objects moving resist stopping.



Torque – How much force is turning the wheels.

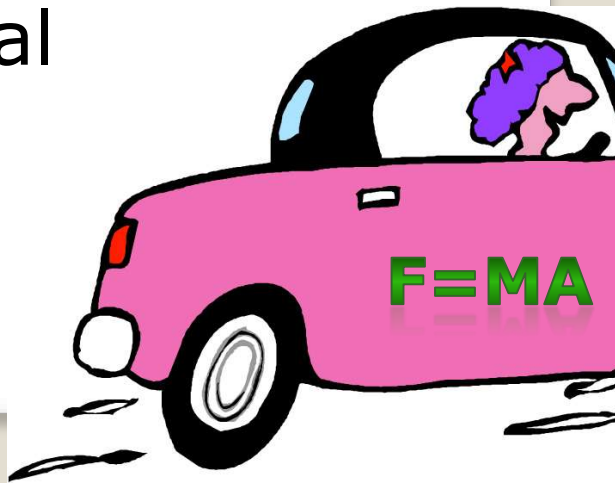


Friction– The force resisting the motion of two objects that are sliding against one another.



Kinematic Equations

Vf= Velocity final
Vi= Velocity Initial
Tf= Time final
Ti= Time Initial
a= Acceleration
Df= Distance Final
Di= Distance initial



Kinematic Equations

To find out how *fast* the car went…

$$V_f = V_i + a*(T_f-T_i)$$

To find out how *far* the car went…

$$D_f = D_i + V_i*(T_f-T_i) + 0.5*a*(T_f-T_i)^2$$

Kinematic Equations

To find out how *fast* the car went…

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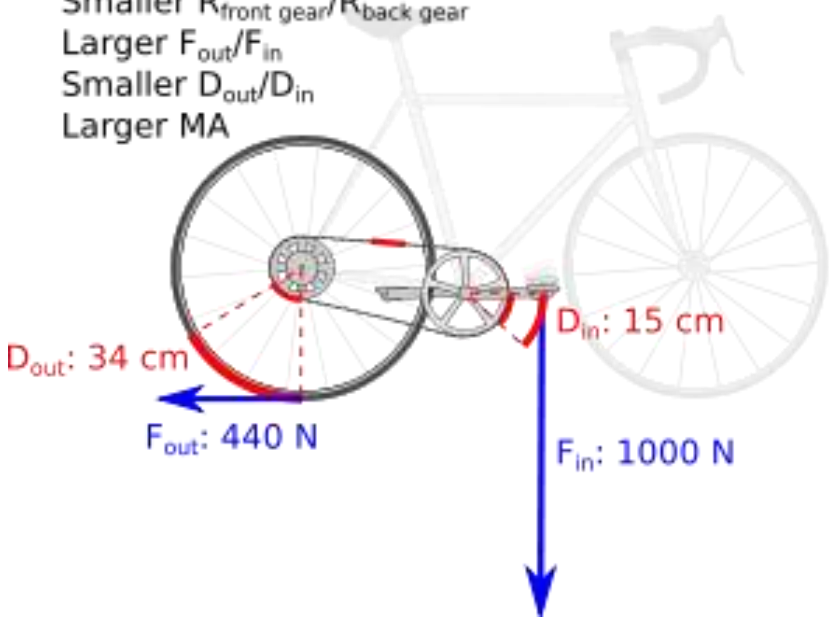
Torque vs. Speed

Vs.

Torque vs. Speed

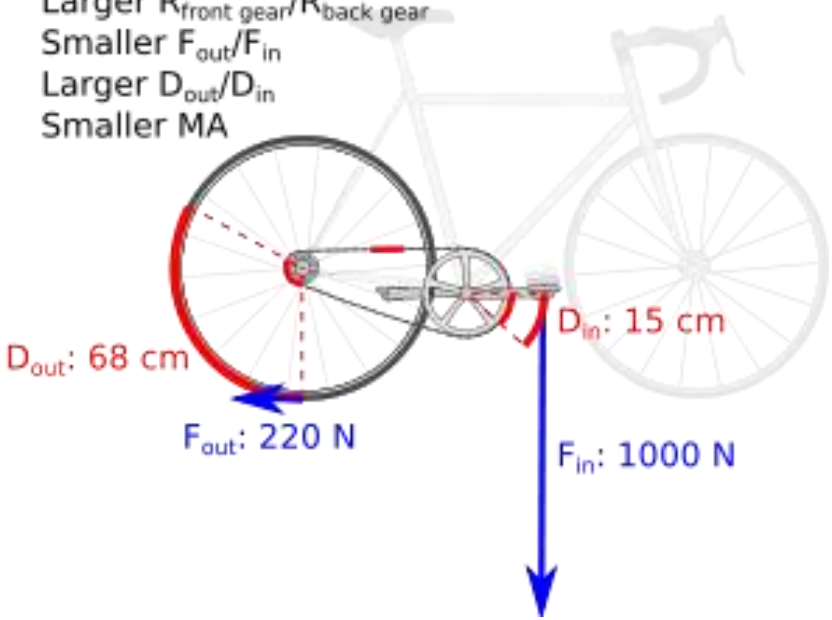
Low gear

Smaller $R_{front\ gear}/R_{back\ gear}$
Larger F_{out}/F_{in}
Smaller D_{out}/D_{in}
Larger MA

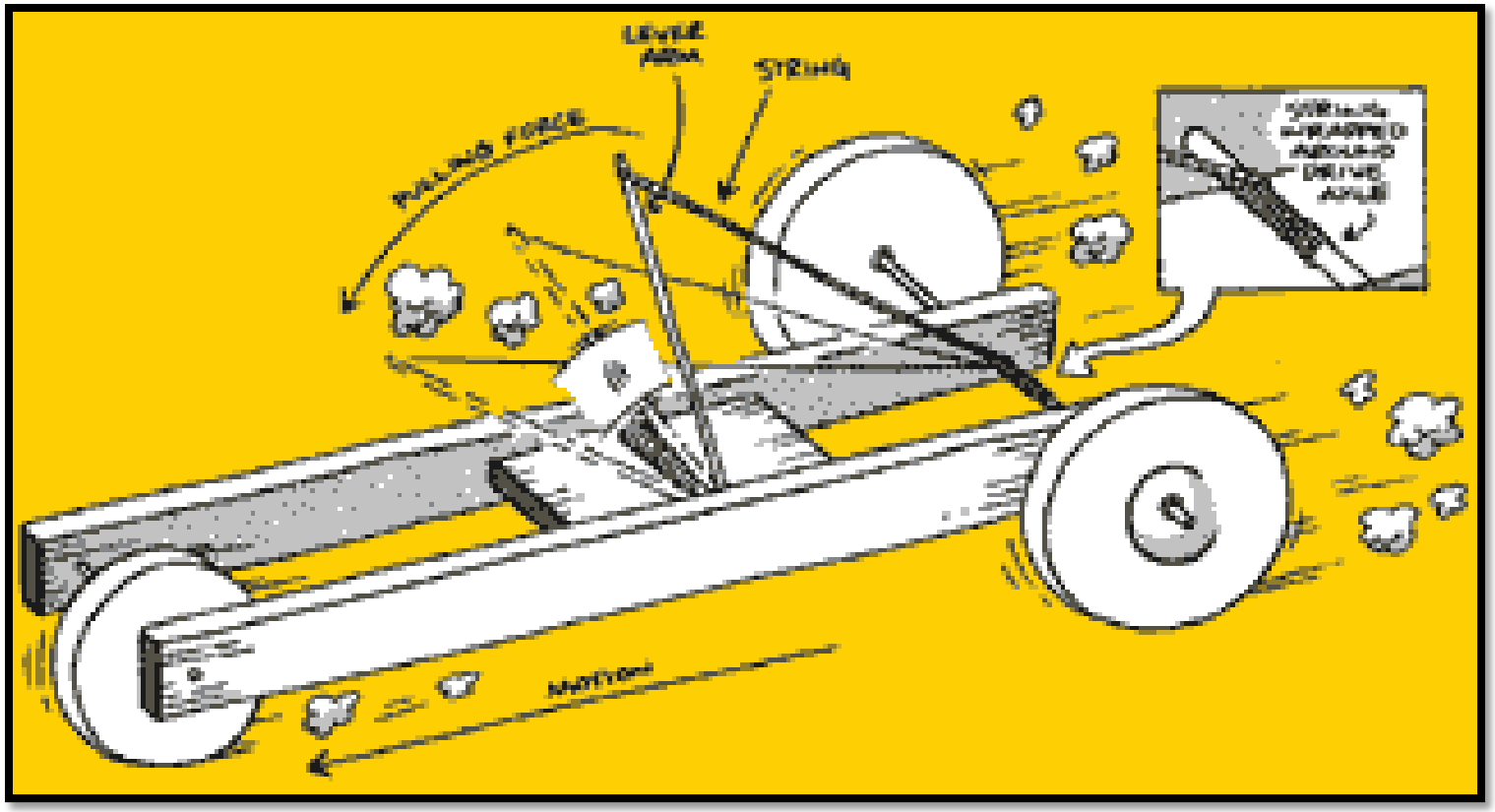


High gear

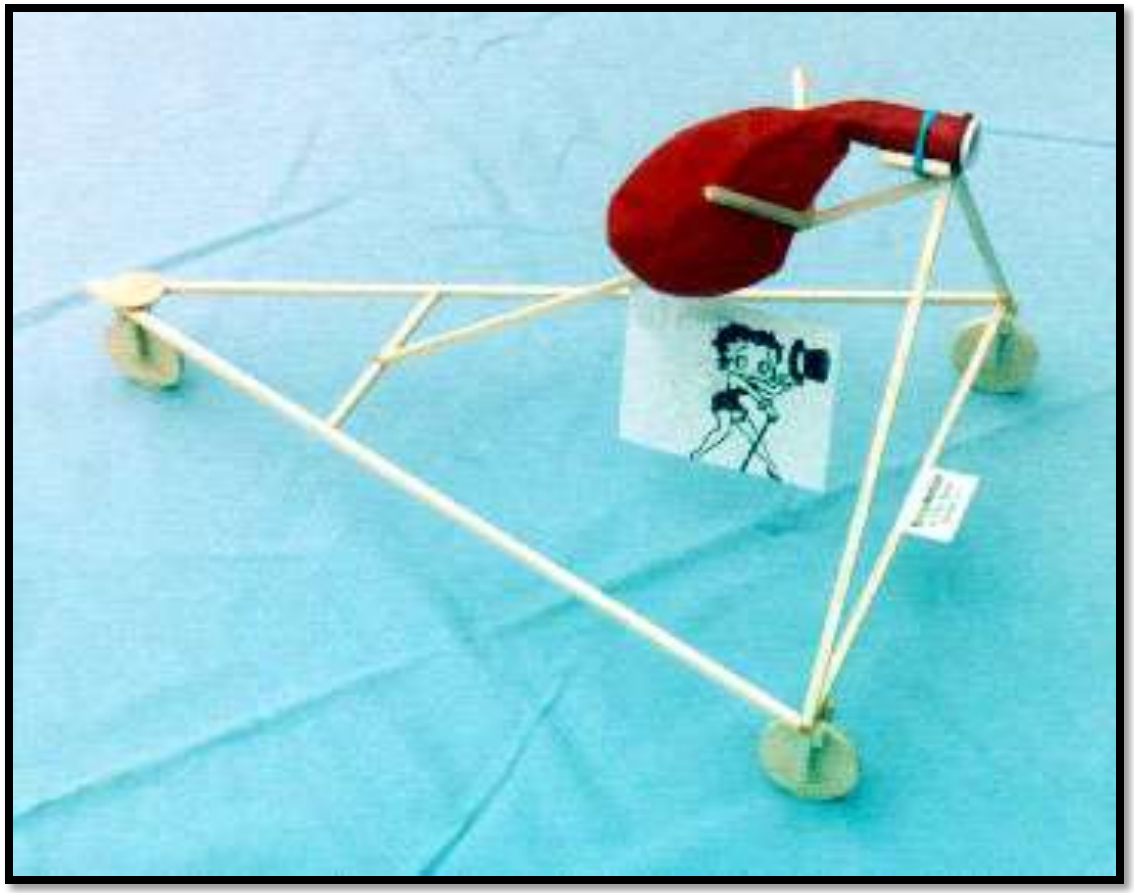
Larger $R_{front\ gear}/R_{back\ gear}$
Smaller F_{out}/F_{in}
Larger D_{out}/D_{in}
Smaller MA



Mousetrap powered cars



Balloon powered cars



To win this competition you will need to…

Make a car that can carry a total of 6lbs of weight from point a to point b (in a total of 5 minutes). You can take as many trips as you need and divide the 6lbs into as many small loads as required. The vehicle must be able to carry a 1 pound weight.