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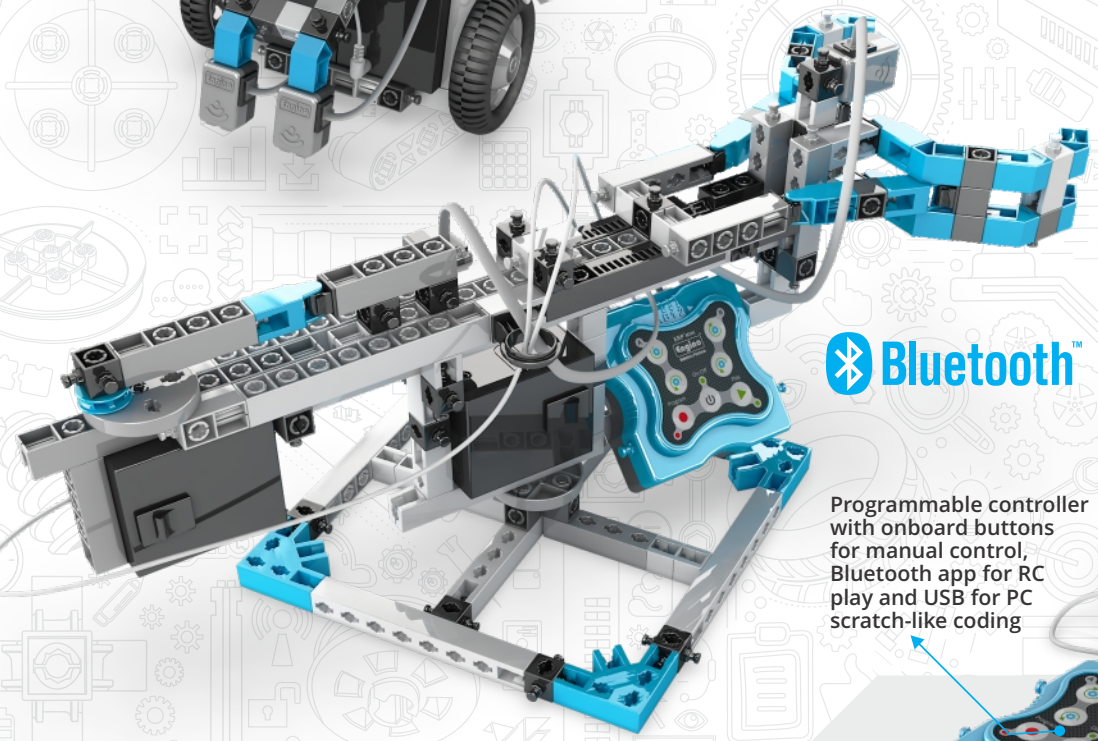

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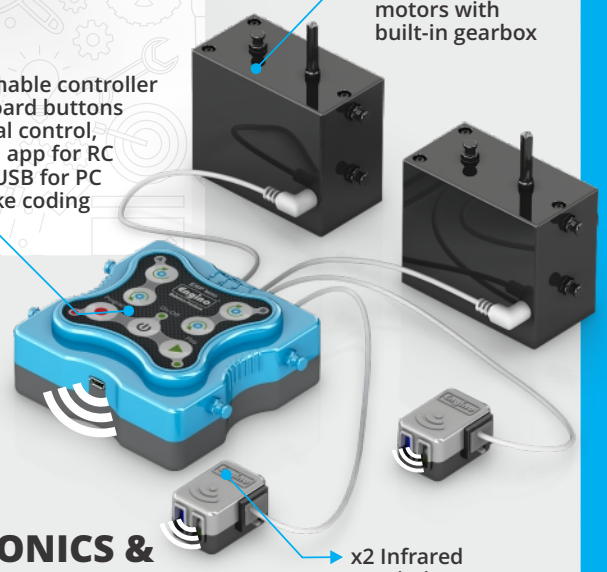

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Online theory & activities

Theory

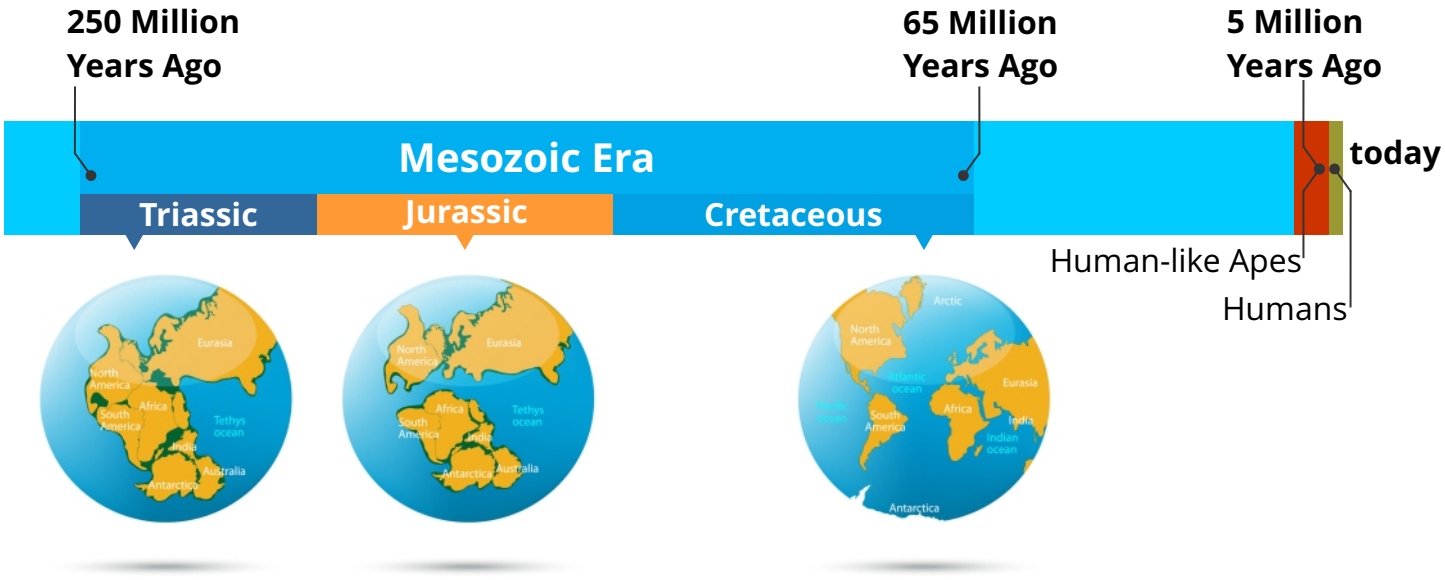
Dinosaurs were the biggest and probably the scariest animals that have ever lived on planet Earth. Some were small, but others were gigantic. Some were fed by plants and had long necks, and others had sharp teeth to eat meat. This extraordinary group of animals, dominated our planet for almost 200 million years and came to a mysterious sudden vanish. Have you ever wondered what types of dinosaurs existed? How was Earth during their era? What are fossils and what is the job of a paleontologist?

Dinosaurs dominated the Jurassic Earth

This booklet of **JURASSIC EARTH** contains a great deal of useful information and amazing facts, so that you will learn about dinosaurs and the science of palaeontology. Follow the **building instructions**, contained in this booklet and also online, to build exciting dinosaurs models such as **a stegosaurus, a triceratops, a brontosaurus, an ankylosaurus, and a pterodactylus**. Get on board in this journey to the prehistoric Earth.

The Era of Reptiles

Any event or fact that happened before humans appear on Earth is called **prehistoric**. In fact, our planet has a very long history of about 4 billion years. Dinosaurs lived a long time ago, during a period named as **Mesozoic Era.** It is also called the "age of reptiles", and lasted about 250-65 million years ago. Earth characteristics such as climate, landmass and animals have undergone drastic changes during this time.



Dinosaurs lived very long time ago. During their era Earth's continents changed to the current shape.

Triassic Period

The first of the Mesozoic period was the **Triassic** period, in which the whole landmass of Earth was contained in one single continent, called the **Pangea.** The continent was mostly dry like a desert with water sources to the coasts. The first dinosaurs appeared in this epoch and began to challenge primitive reptilians and amphibians.

Jurassic Period

The second period was the **Jurassic** period. It was the most active epoch in terms of dinosaur's growth. During the Jurassic period, dinosaurs diversified greatly and spread out to occupy land, sea and air, dominating the whole animal kingdom. Some of the most famous and gigantic species lived during this epoch such as the Brachiosaurus, the Stegosaurs and the Ankylosaurs.

Due to the geological activity of tectonic plates, Pangea split in two main lands: Laurasia and Gondwana. The climate in that period was tropical, with moisture-laden winds from the ocean. Dense forests were covering wide areas.

Cretaceous Period

The third and last period of the Mesozoic era was the **Cretaceous** period. During this time, Earth began to look alike the planet we know today. The movement of tectonic plates formed some of the mountain ranges of today, such as the Appalachians in North America and the Alps in Europe.

Did you know?

The word Dinosaur means a terrible lizard. It comes from two Greek words. The word "dino" which means terrible or causing suffer and the word "saura" which means lizard. Hence, dinosaur means a terrible lizard or a lizard that causes the other to suffer. This word is coined to Sir Richard Owen, when he assigned uncategorized bones to a totally new species called "dinosauria" in 1841.

A gigantic dinosaur could spread terror

Become a paleontologist

No one has ever seen a true, living dinosaur so all information and characteristics are based on fossils and bones and not on direct observation. A **palaeontologist** is the scientist who works on collecting and analysing fossils.

Fossils

The only direct way we have of learning about dinosaurs is by studying **fossils**. Fossils are the remains of ancient animals and plants. They have been found on every continent on Earth, maybe even near where you live! Fossils are excavated from sedimentary rock layers.

How are fossils formed?

The process of forming a fossil is called **fossilization,** and is done under specific and special conditions. The following steps must happen for the creation of a fossil.

1. Once a living animal or a tree dies, it must be covered by sand and soil pretty quickly.
2. Since bones and teeth will not rot soon like its organic parts, they will be encased in deep layers of land.
3. Over long time and gradually these body parts will begin to decay, and create holes and cavities.
4. This cavities shall be replaced with minerals from water, forming a replica of the bone or teeth but made by materials within the rock.

Therefore, a fossil of a bone doesn't have any bone in it! A fossilized object has the same shape as the original object, but it is more like a rock.

This process is not so favourable, so most animals simply decayed instead of fossilize. Paleontologists estimate that only a small percentage of the dinosaur genera that ever lived has been turned to fossils. That's why finding a dinosaur fossil is precious.

Extreme dinosaurs

The most fearsome

In 1997 the most fearsome predator was made known to the scientific community, called **Giganotosaurus.** It had the sharp teeth abound 25cm long and a skull of 2m. Lived 95 million years ago, this 8 metres tall monster was spreading fear and terror to its nearby preys.

The biggest in water

Dinosaurs dominated the ocean too! The largest marine dinosaur that lived during the Jurassic period was the **Liopleurodon.** This marine reptile measured more than 6m in length. It was one of the top predators around. Its jaws alone are believed to have been over 3 metres long – roughly the distance from the floor to the ceiling!

Did you know?

Dinosaur reproduction is achieved through eggs. Fossils of their eggs have been found at over 200 different sites around the world. The largest egg was up to 60 cm, while the oldest known dinosaur eggs and embryos are from a dinosaur which lived during the Jurassic period, about 190 million years ago. Some scientists suspect that the extinction of dinosaurs can be explained if other animals could attack their nests and eat the eggs, reducing their reproduction rate.

Fossilized dinosaurs eggs

The biggest on air

Among the avian dinosaurs, **Quetzalcoatlus** was the largest. With wings wide open it could have wingspan up to 10m ! It shares a similar genealogic tree just like Pterodactylus.

The biggest on land

The largest dinosaur ever known is the **Argentinosaurus**, who could be as long as 35 meters from head to tail. This gigantic creature could weigh up to 100 tons! This is like 20 elephants.

Extinction of dinos

Dinosaurs disappeared suddenly from Earth by the end of the Mesozoic period. Along with the dinosaurs more than 50% of the species who lived on Earth were also vanished. When such large numbers of species undergo global extinction in a short period of time, scientists call it as a **mass extinction** event. Some drastic and catastrophic events should happen to cause such dramatic changes of earth's fauna. The dinosaur extinction is named as the **K–T extinction** event, however the exact reasons are still unknown to scientists. This mysterious event is challenging paleontologists and geologists to seek for facts in old rocks and fossils.

Impact theory

One explanation is the theory of a large **asteroid** hitting the Earth. Such an impact could have created dramatic changes to the atmosphere and global climate. Huge dust clouds could cover the Sun for months, blocking sunlight and disturbing the vital function of photosynthesis. Temperature could drop significantly while terrible infernos could last for years.

Volcanic eruptions

Another explanation can be the intensive volcanic activities that occurred on Earth during those times. One of the largest volcanic features on Earth are the **Deccan Traps,** located in India. Geologists estimate that those gigantic "mountains of lava" were formed at the same time when the K–T extinction occurred. Such enormous eruptions could have created deadly conditions on Earth. Toxic gases should have made the atmosphere poisonous, and causing a significant blocking of sunlight.

Did you know?

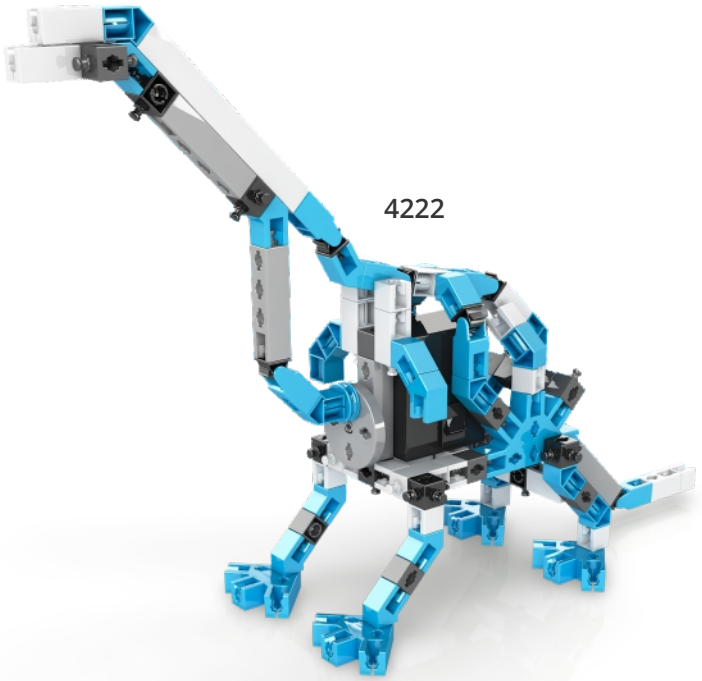
A total of five mass extinctions have been recorded by studying fossils. Each one vanished more than 50% of the living species and plants on Earth. The Tardigrade, is a tiny animal which survived from all extinction events! It is so small that it can only be seen through a microscope. It can sustain extreme temperatures and pressures, and can live without food or water for more than 30 years!

The tardigrade has survived all 5 mass extinctions

Models

Brontosaurus

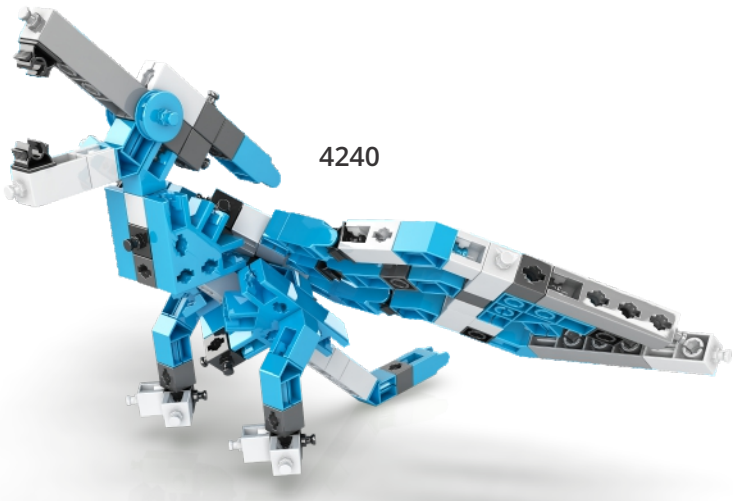
One of the most iconic dinosaurs who lived during the Jurassic period is the brontosaurus. It was a gigantic dino, weighing up to 17 tons and measuring up to 22 metres long from head to tail. It had a long neck which was used to knock down trees in search for its food.



It also had a very long tail, used for balance and to whip its predators. To support its heavy weight, Brontosaurus had four very thick legs. For years, paleontologists confused this kind with another dinosaur, called Apatosaurus, because they both share similar characteristics.

Pterodactylus

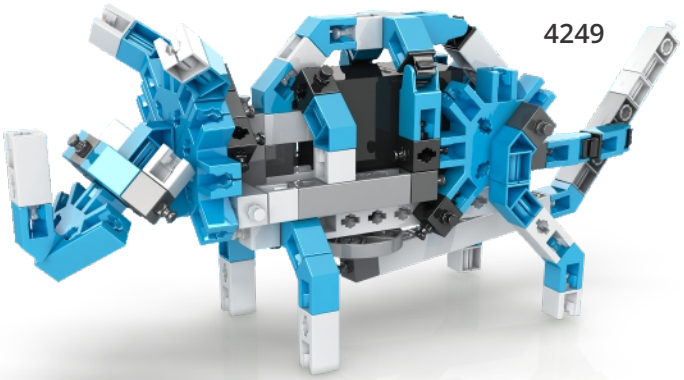
Pterodactylus was a member of the pterosaurs family, while its name means “winged finger”. It lived in the later Jurassic period and is one of the most studied flying dinosaurs. More than 30 different fossils have been found belonging to this creature. Pterodactylus may lived on small islands, in lagoons or on the coasts.



It had wings formed by a skin and muscle membrane stretching from its elongated fourth finger to its hind limbs. It was not as huge as other dinosaurs as its wingspan was about 1 meter. It was a carnivore animal and probably preyed upon fish and other small animals.

Triceratops

Triceratops is one of the most easily recognizable dinosaurs due to its large body, unique frill and the three horns. Its name comes from the Greek words, '*tri*' meaning three '*keras*' meaning horn and *'opsi'* meaning face. So, a triceratops literally means a three horned face.



Triceratops is well distinguished by its very large skull, being longer than 2 metres sometimes. It also had between 400 and 800 teeth, however despite its large number of teeth triceratops was a plant eater.

Stegosaurus

Another legendary dinosaur who lived during the Jurassic period was the Stegosaurus. Large and heavy, Stegosaurus is one of the most easily identifiable dinosaurs, due to its double row of kite-shaped plates. The plates were rising vertically along the rounded back and a pair of spikes extended at the end of its tail. The largest plates were found over its hips and could measure up to 60 cm.

Stegosaurus is also known for having the smallest head in respect to its total size. Its brain is estimated to be no more than 80 grams! The fact that such a huge animal, weighing around 5 tons, had such a tiny brain contributed to the popular old idea that this was probably the dumbest dinosaur that walked on Earth!

Ankylosaurus

Ankylosaurus was one of the last dinosaurs remaining before the large extinction event that occurred at the end of the Mesozoic Era. The prominent feature of Ankylosaurus was its armour. It consisted of knobs, plates and spikes of a bone embedded in its skin.

Those extended bones could vary in size and shape, estimating to be up to 35 cm long. Similar body armour is found on crocodiles and armadillos today. Ankylosaurus was fed from low-lying plants while its small teeth were not designed to completely grind large amounts of leaves. However, it had a sort of fermentation digestive system to break down the un-chewed plants.

Did you know?

Not all dinosaurs died! Birds are considered to be the closest relatives to dinosaurs. There are many bones of present birds which look alike the old pterosaur and their skeleton structure shares similar characteristic. Some avian dinosaurs were able to survive the K-T extinction event and after a long evolution they became much smaller. Hence, birds can be considered as modern dinosaurs!

Birds are descendants of dinosaurs

Quiz

Can you discover the following words inside the box? Search horizontal, vertical and diagonal to find them!

REPTILES, JURASSIC, DINOSAUR, PANGEA, EXTINCTION, FOSSIL

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

Experiment with the dinosaur's neck

As you have already learned by reading the booklet, one of the most iconic dinosaurs who lived during the Jurassic period is the brontosaurus. It was a gigantic dino with very long tail and neck which were merely used for balance.

Due to its huge and massive size, Brontosaurus could not hide anywhere or run fast from its predators. In order to protect itself against predators, Brontosaurus used its long neck to keep its head away from shorter predators. It also used its tail as a whip to make a huge sound to scare off its predators.

On many occasions though, its long neck and tail were used to attack and whip its predators. For instance, its large neck was filled with a system of air sacs that helped in fighting its enemies. All of its strength was concentrated on these body parts.

Are you ready to find out the reason why brontosaurus had very long and massive neck and tail?
Lets perform the next page's experiment to get answers for the above questions!
Get ready to discover what momentum is and which factors affect it.

- Why do you think brontosaurus' long neck was helpful to whip predators? What would happen if its neck was shorter?

- Do you think that the mass of the neck affected the impact? What would happen if its neck was lightweight?

Learning about: **Momentum**

Dinosaur's neck

Some dinosaurs used their sharp teeth to fight their enemies or their predators! Brontosaurus was not one of them! Perform the following experiment to discover which of its strengths it used to fight its predators.

Discover:

- What is momentum?
- Which factors affect momentum?

Level Of Difficulty ★★★☆☆

Materials Needed:

- Engino® (ce101mp-a).
- Measure tape.

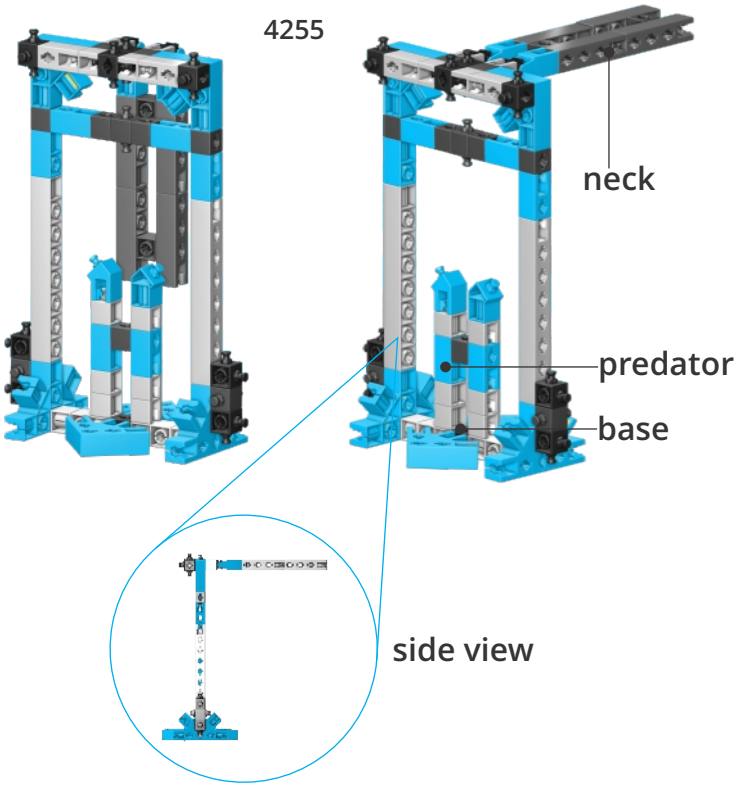
Procedure:

1. Find the instructions and build the **Dinosaur's neck** model.

2. For safety reasons it is better you conduct the experiment at a spacious place and make sure no one is standing in front of the model.

3. For each case you need to hold the model from the top with one hand and elevate the neck **horizontally** with the other one. For each trail the **predator** should be placed on the center of the **base** (see the picture on the right)**.**

4. For **case 1** lift the neck up and let it hit the predator. The gained velocity is due to the gravitational pull of the Earth. Use the measure tape to find the distance that the predator travelled. The distance should be measured from the center of the base until the closest point of the predator. Write your observations on **exercise 1** and try to explain them.



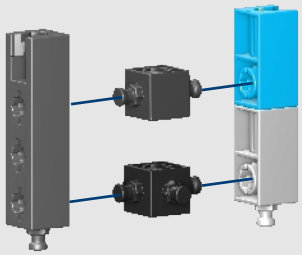
1. a) How much distance did the predator travel?
b) Complete the gaps in the sentences in order to explain your observations using the words: **stops, lost, moves, predator**.

a) Predator's travelled distance = ...cm

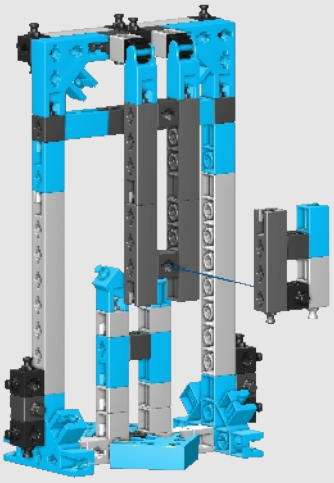
b) The neck loses velocity and ..... while the predator gains velocity and ..... . This is what we call momentum. Momentum is transfered from the neck to the ..... . The momentum ..... by the neck is gained by the predator.

Procedure:

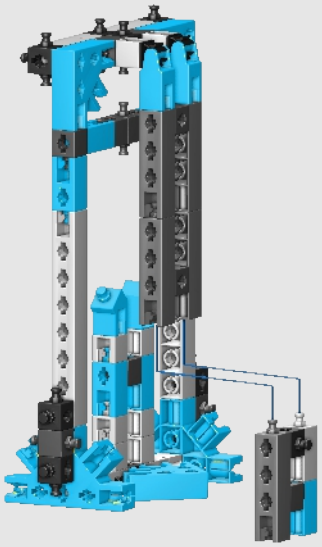
5. Build an additional mass as it is shown below.



6. For **case 2** place the additional part to the neck (see the picture below). Then repeat the procedure to whip the predator and do **exercise 2**.



7. For **case 3** switch the additional mass from the neck to the position shown below. In that way you are actually increasing the length of the neck, so that greater velocity is gained just before the collision. Let the neck hit the predator and write your findings on **exercise 3** and **4**.



2. a) Note the predator's travelled distance.
b) Fill in the gaps in the sentences using the words from the box to compare the two cases.
You may use a word more than once.

momentum, distance, increased, mass

a) Predator's travelled distance = ...cm

b) Comparing the two cases we can conclude that,

when the mass of the neck is ....., the

predator's travelled ..... is also increased. So,

the greater the ..... of an object is, the greater

the ..... can transfer.

3. a) Measure and note how much distance the predator travelled.
b) Compare the results for the three cases.
Note that the mass for case 2 and 3 is the same.

a) Predator's travelled distance = ...cm

b)

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4. Which is the relationship between momentum and velocity (increased length)?

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Theory

Mass

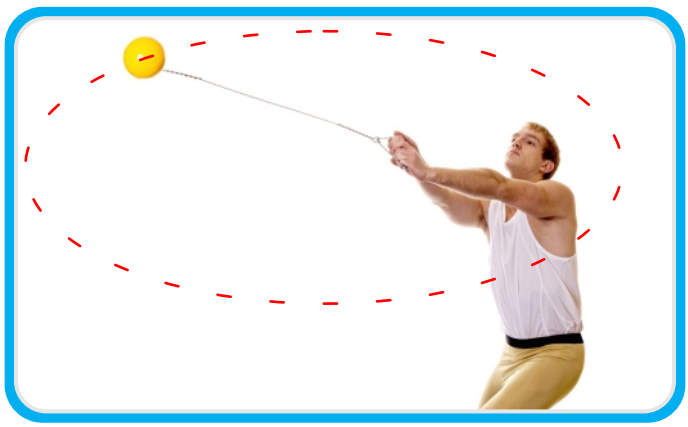
Mass is the quantity that tells the amount of matter in an object. It is measured in kilograms in the International System of units (SI). You may often come across different units, such as grams, which are commonly used for small objects i.e an apple. Also, tones is a unit used for huge objects like a ship for example. To measure the mass of an object we use the instrument called balance. A body's mass is considered to be constant no matter its location. For instance, a 2kg object on Earth, will have the same mass on the Moon!

Velocity

Any moving object has velocity. Velocity is the change in distance over time. In simple terms, if you are able to cover more distance in less time then you have a higher velocity. Many times velocity is referred to as speed. In reality velocity and speed have different meanings in physics. Actually, speed is defined as the travelled distance per unit of time. Velocity and speed are equal when the object is moving in one direction, otherwise they differ.

Velocity in Circular motion

Circular motion is defined as the rotation about a point following a circular path or a circular orbit. If an object moves in a circular path, there is some force acting on it causing it to change from its straight-line path. An object moving in a circular path has two different velocities, the linear velocity and the angular velocity (rotational velocity). The linear velocity of the object moving in a circular path is directly proportional to the angular velocity and the radius of the circular path. In other words, if the angular velocity is constant and the **radius is increased** the **linear velocity will be increased** too!



Momentum

When an object is in motion, thus it has velocity, it generates **Momentum**. The idea of momentum was introduced by the French scientist and philosopher Descartes. He was experimenting on objects moving after collisions. Momentum is commonly denoted by the letter **p,** and is calculated by multiplying the **mass (m)** and the **velocity (v)** that an object has. Hence, the bigger the mass of an object the bigger the momentum. Likewise, the greater the velocity it has the greater the momentum. In case that the object is not in motion, hence its velocity is zero, it will not carry any momentum since the product between mass and velocity is zero!

Advanced information:

From the formula (see on the right) it is obvious that momentum, mass and velocity are interrelated! As a matter of fact, momentum is directly proportional to mass and velocity. In other words, the bigger the mass of an object the bigger the momentum. Likewise, the greater the velocity it has the greater the momentum.

$$p = m \times v$$

p = momentum
m = mass
v = velocity

Formula for calculating Momentum

Conservation of Momentum

One of the most important physics laws is the **conservation of momentum**. This means that in a closed system, when objects collide with each other the total momentum remains unchanged! The only thing that happens is a transfer of momentum from one object to the other and the momentum lost by one object is gained by the other one. A game of billiard is a fine example. When the cue ball (white colour) hits another ball, we observe that the second ball moves, while the cue loses velocity.

Quiz

Exercise 1

Can you briefly describe the following pictures in relation to the notion of momentum and the law of conservation of momentum?

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Exercise 2

A car has a **mass** of **1500 kg** and is moving at a constant **velocity** of **20 m/s**. Using the formula: **momentum = mass x velocity** calculate its momentum**.**

momentum = mass x velocity .....

momentum = x .....

momentum = kgm/s .....

Knowledge check: check what you have learned.

- [ ] What is **momentum**?
- [ ] Which are the two **factors** that affect **momentum**?
- [ ] How does **mass** affect **momentum**?
- [ ] How does **velocity** affect **momentum**?
- [ ] What is the **conservation of momentum**?