

**Activity13****STEM in Action****Solar Vehicles**

Most cars run on gasoline, this contributes to climate change. Some vehicles are running on electricity. Electric vehicles have batteries that must be charged.

**Solar Vehicles**

- Mechanical engineers are designing vehicles that run on nothing but the sun.
- At this time, the amount of energy we can capture from the sun is not as great as the amount of energy we get from gasoline or an electric battery.
- The solar vehicle is so lightweight that most instruments are excluded ,such as the speedometer.
- We can calculate the speed by knowing traveled distance and time taken to calculate the speed of the solar vehicles.



## Concept 2.4 : Energy and Collision

### Activity 1



When 2 objects hit (Collide with) each other, the faster and heavier one that has more energy, causes more damage than the slower and lighter object that has less energy.

### An example of collision :-

#### A wrecking ball :

It is a very heavy steel ball, that swings on a cable, and its used to collide with a building to help construction workers knock down buildings.



## Activity 2

## Collision

### Collision in Cricket

- ❖ It is a popular game, in which a player uses a wooden bat to hit the ball.
- ❖ The player hits the ball which moves at a high speed to collide with the bat.
- ❖ The bat transfers its kinetic energy to the ball, the speed of the ball increases and the ball returns back in a different direction.
- ❖ This collision produces a popping sound and the player feels the bat hitting the ball.



**Activity 3****Watching Object Collide**

**What happens to the driver when a car stops suddenly?**

-The driver's body keeps moving forward where the objects are in motion stay in motion, until something stops them.

**\*The equipment used during collisions of cars:-**

**1.Seatbelts**

They keep the driver and passengers from moving forward when the car stops suddenly.



**2.Airbags**

They are made up of thin, nylon materials folded into the steering wheel, seats, dashboard or doors.

-During a crash, airbags inflate automatically when sensors in the car detect a crash.

-A sensor tells the airbags to inflate and fill with a gas.

-After collision, the airbags deflate almost as fast as they inflate, as they have holes or vents to allow them to deflate.



\*Their importance:-

- Airbags slow the speed of the driver moving forward.
- They absorb the energy car due its collision.

**Collisions between cars and trains :-**

- \*During accidents, trains are much larger than cars, and they travel at higher speed than cars.
- \*It is more dangerous as the force of collision between the cars and the trains increases.



**Activity 4****Energy and Collisions**

When two objects crash with each other, we can say a collision happens between them.

**Collision:** It is the moment where two objects hit or make contact in a forceful way.

**Examples :**

1.What happens if you are running down the street and you hit a traffic sign post?

- 1-You will stop moving forward.
- 2-You may bounce off and get hurt
- 3-The traffic sign will vibrate.



\*The kinetic energy transfers from your body to the traffic sign, this leads to the vibration of the sign.

\*A part of your kinetic energy changes into sound energy.

### Activity 5

### The Effect of Speed on Collisions

**When a speeding object hits another object, the energy is transferred to the other object, where:-**

-By increasing the speed of the object, the transferred energy during collision increases, it may be in the form of heat, light or sound energy.

**Comparison between the fast-moving and the slow-moving objects:-**

#### **Fast-moving object**

More energy

When it hits another object more force is exerted.

This force causes big damage can't be repaired.

#### **Slow-moving object**

Less energy

When it hits another object less force is exerted.

This force causes less damage than the fast-moving object.



If two cars move at different speeds in opposite directions collide with each other.



The forces exerted in the accident depend on the speed so it would be a much more severe damage.

If two cars move at different speeds in same directions collide with each other.



The forces exerted in the accident depend on the speed so it would be a less severe damage.

## Activity 6

### Speed & Collision

- As the force and the speed of a moving object increases, the amount of its kinetic energy increases during **collision**.
- As the kinetic energy of a moving object increases during collision, more damage will happen to this object.



#### ► Tools



Modeling clay



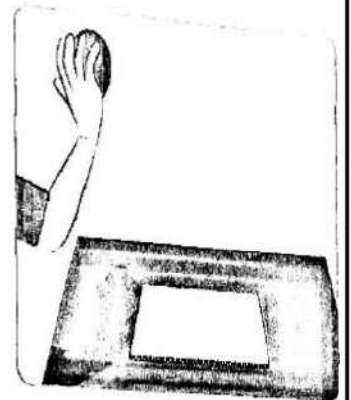
Piece of cardboard



Hard surface  
(wooden table)

## Steps

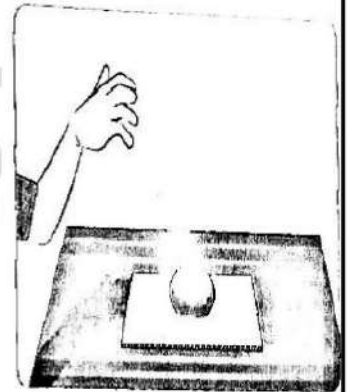
1. Roll a ball of clay in your hands and smoothing its sides.
2. Use the cardboard to make a landing platform, where the clay ball falls on and place this platform on a hard surface like a wooden table.
3. Hold the clay ball at a distance 1 meter above the platform.
4. Lightly open your hands to drop the clay ball onto the platform without throwing it.



### Observation

The shape of the clay ball changes a little and becomes irregular after dropping it.

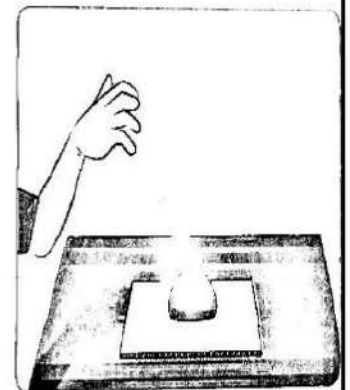
5. Smooth the clay ball over and lift it up to 1 meter above the platform, then repeat the experiment again, but this time throw the clay ball with a gentle force to increase its speed.



### Observation

The shape of the clay ball change more and becomes more irregular after throwing it gently.

6. Repeat the experiment one more time and throw the clay ball with a hard force, so its speed increases much more.



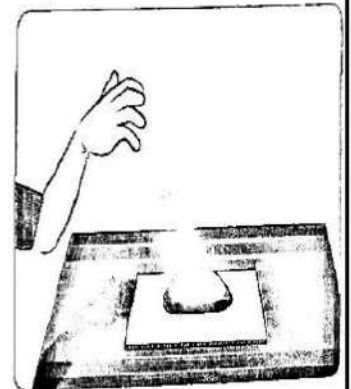
## Observation

The shape of the ball changes much more and becomes completely irregular after throwing it hard.

## Conclusion

As the force and speed of a moving object increase, the amount of its kinetic energy increases during collision.

As the ne the energy of a moving object increases during collision, more damage will happen to this object.



## Activity 7

## Effect of Mass on Collisions

**Different vehicles have different masses, as the large truck has bigger mass than a car.**

\*As the mass of the object increases, its kinetic energy increases.

If both of them is travelling at the same speed, so the truck has more kinetic energy than the car , so the truck needs a bigger engine than the car, so the amount of fuel that burns inside the engine increases providing it with more kinetic energy.



**The Truck**

- \*Big mass.
- \*Big engine
- \*Uses more fuel
- \*More kinetic energy



**The Car**

- \*Small mass.
- \*Small engine
- \*Uses less fuel
- \*Less kinetic energy

### Effect of mass on collisions

A large-mass vehicle (car) causes more damage when it hits something than a small-mass vehicle (bike) travelling at the same speed.



**Activity 8****Mass in collisions**

- The speed of an object increases by increasing its mass.
- By increasing the mass of the object that moves down a ramp, the kinetic energy increases.
- Both **speed** and **kinetic** energy of a moving object can be increased by:-

1-Increasing the angle of a ramp

2-Increasing the mass of the object.

**1. How does mass affect speed?**

We will carry out an experiment to show the relation between mass of objects and their speed.

**Tools**

• 3 toy cars



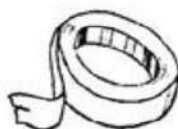
• Balance (scale)



• 2 books



cardboard sheet



masking tape



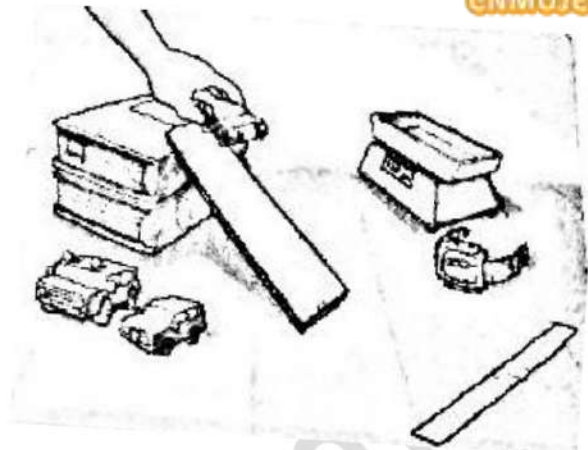
stopwatch



meterstick

### Steps

1. Use the cardboard to make a ramp.
2. Place one end of the cardboard ramp on the top of two books over each other, while the other end resting on the floor.
3. Mark a finish line with a piece of masking tape where the distance between the tape and the end of the ramp is 1 meter.
4. Weigh the red car by using the balance and record its mass in the table below.
5. Release the car from the top of the ramp, while your friend hold a stopwatch to measure the time taken to cross the finish line, then calculate the speed of this car.
6. Repeat the previous steps using the blue car, then the yellow one and record their masses and the time taken by each of them to cover the same distance in the table below, then calculate the speed of each of them.



### Observations :

The results of the three toy cars are

Cars	Mass	Distance	Time	Speed=distance / time
Red	110 gm	1m	4 sec.	$\frac{1}{4}$ m/ sec.
Blue	160 gm	1m	3 sec.	$\frac{1}{3}$ m sec.
Yellow	210 gm	1m	2 sec.	$\frac{1}{2}$ m/ sec

**According to the table above, we can observe that:**

By increasing the mass of the car , the time taken to cross the finish line decreases because the speed of the moving car on a ramp increases.

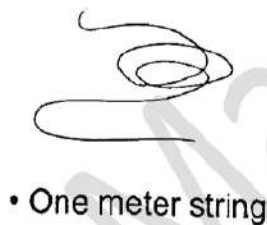
### **Conclusion**

The speed of the moving objects on a ramp increases by increasing its mass.

### **2. How does mass affect kinetic energy ?**

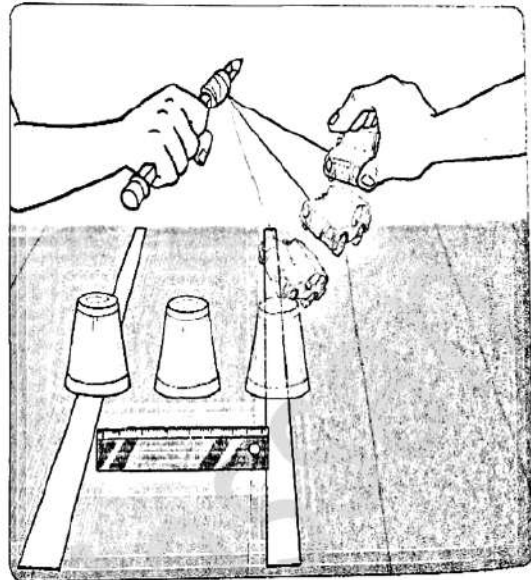
We will carry out an experiment to show the relation between mass of objects and their kinetic energy.

#### **Tools**



### Steps

1. Tie one end of the string to a pencil and the other end to the red toy car.
2. Place the paper cup on the floor, and mark the cup's starting location on the floor with a piece of masking tape.
3. Hold the car straight out, so the cup is in the swinging path of the car when you let it go.
4. Release the toy car to collide with the paper cup.
5. Mark where the cup moved to using a piece of masking tape and then use the ruler to measure how far this is from the starting position.
6. Repeat the previous steps using the blue car, then the yellow one and record the results in another table.



### Observations

The results of the free car toys are :

Cars	Moved distances
Red car	7 cm.
Blue car	12 cm.
Yellow car	15 cm.

**According to the table above, we can observe that:**

By increasing the mass of the car, the distance that the paper cup travels increases.

### **Conclusion**

By increasing the mass of an object that moves a ramp , the kinetic energy of this object increases.

### **Note**

The speed and kinetic energy of a moving object on a ramp can be increased by:

1. Increasing the angle of the ramp.
2. Increasing the mass of the object.

**Activity 9****Energy Conversions during Collisions****Newton cradle**

When the pendulum ball is raised up it stores potential energy



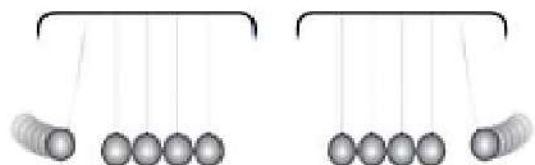
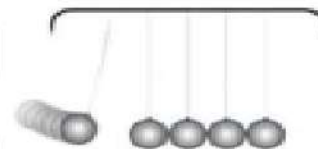
When the ball is left to move in the direction of the rest balls the potential energy decreases gradually and changes into kinetic energy



When the ball collides the amount of kinetic energy of first ball transfers to the second ball during collision and successively reaches to last ball



When the energy reaches the last ball it moves with kinetic energy equals to the kinetic energy of first ball



➤ **Notes:**

- ❖ If you leave the moving balls of Newton's cradle long enough, their kinetic energy decreases gradually until they stop after lots of collisions.
- ❖ Energy is conserved during collision, so it cannot be destroyed, but the amount energy before the collision is equal to the amount of energy after the collision.

**Some energy is lost into different forms in a newton's cradle:**

1. Some kinetic energy changes into sound energy
2. Some energy lost in form of friction between string and other moving parts.
3. Some energy are lost when the balls pass through the air,

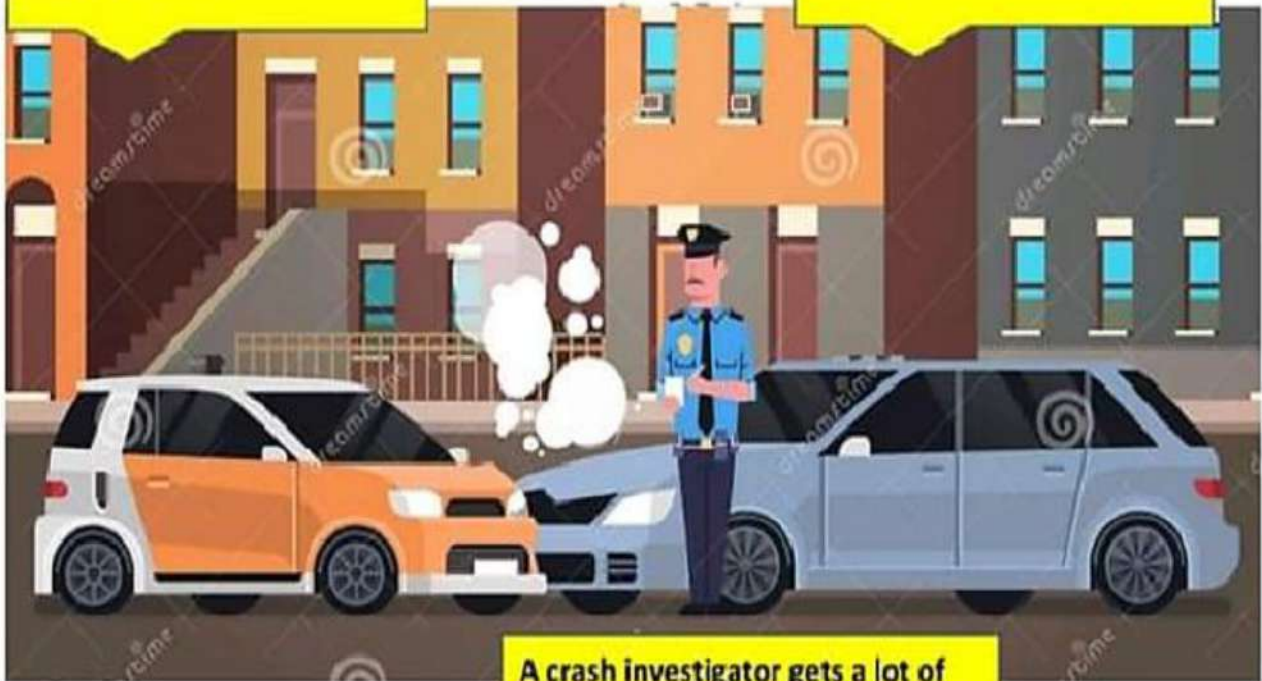
## Activity 11

### STEM in Action

### Crash investigator

A crash investigator sees a car crash as a puzzle, to solve this puzzle, he uses scientific laws of motion

A crash investigator must ask the drivers of the two cars to determine who caused the accident.



A crash investigator gets a lot of information as a result of examining the two cars and he also finds out more information using what he knows about force, energy and motion.

### Crash Site Scenario

<u>Front collision</u>	<u>Side collision</u>
<ul style="list-style-type: none"> <li>➤ The red car moves through its right way slowly towards the intersection, while the blue car moves very fast in a wrong direction .</li> <li>➤ The two cars meet each other and collide from the front.</li> <li>➤ The red arrow shows the direction of the red car after collision.</li> </ul>	<ul style="list-style-type: none"> <li>➤ The red car moves in a straight line across the intersection from the stop position, while the blue car moves also in a straight line, so the blue car hits the red car at its side.</li> <li>➤ The red arrow shows the direction of the red car after collision.</li> </ul>



## Glossary

Vehicles	مركبات
Speedometer	عداد السرعة
Collision	تصادم
Deconstruction	هدم مبنى
Seatbelts	حزام امان
Airbags	كيس هواء
Inflate	يتملى
Deflate	يفرغ
Passengers	ركاب
Vents	فتحات

## Theme 3

### Concept 3.1 : Devices and Energy

#### Scientific facts you have studied



#### 1.How Do Humans Use Fuel to Produce Energy ?

We use fuel to cook food, operate appliances, heat and provide lighting.

#### 2 .Types of Fuel

We use wood or natural gas as fuel.

#### 3.How to Use the Energy output?

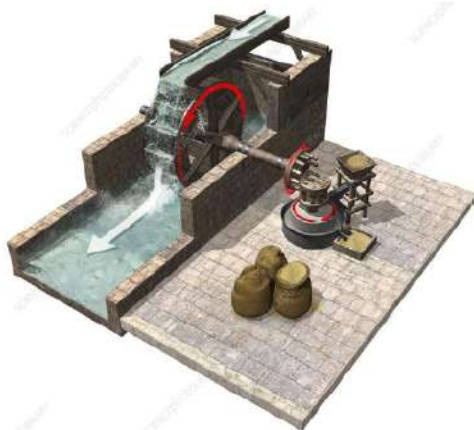
Electricity is a form of energy that comes originally from fuel and we use it to cook food, drive cars and operate appliances.

## Resources of Energy

Renewable Resources	Non Renewable Resources
Ex. Sun – wind - water	Ex. coal - petroleum - natural gas

### Water as a source of energy

1. The water flowing from the waves in the sea and the ocean creating movement to generate energy by falling or flowing water to move things such as water mills .



2. The water moves through the slides in the turbines and it rotates and produces energy to move the machines.



3. Scientists and engineers have developed using the power of water (hydropower), so they built dams on the rivers to generate electricity.



4. Dams generate a lot of clean energy but they affect the surrounding ecosystems when they change water path.

### Activity 1

- Objects move around us and there is a relationship between energy, work and force.
- Energy transfers from one form to another.
- Technology helps us convert light energy from the sun into different forms of energy that can help us operate our mobile phones.



## Activity 2

### Energy in remote controlled toy cars

1. Many games can be played remotely, such as cars and trucks remote-controlled toy planes and boats



2. Devices need energy to make them move and perform their functions such as turning in corners, moving arms or operating cameras from a distance.



3. The devices use electricity and internal batteries as power sources.

4. When the batteries run out, they must be recharged or replaced with new batteries.

5. The device must be connected to the nearest charger to power the device.

**Note :**

- In our daily life, we use some devices, and each device has a type of energy needed to be operated, for example :

Device	Used energy
fridge→	electric
electric cooker → or gas cooker→	electric or chemical

- Some devices work by solar energy, such as calculators.
- The electricity that comes out of the charger recharges the battery by recharging the chemical reactions inside.

### Activity 3

#### Mars exploration vehicle

- An interplanetary exploration vehicle needs energy to operate it while it is on the surface of Mars to explore it.
- By looking at the pictures, we notice :
  1. Mars is **54 million km** far from the Earth, which is a very large distance, and a spacecraft takes six months or more to get there .
  2. Missions to Mars have relied on **remotely operated** vehicles or robots and humans have not been sent for the last few decades .
  3. The most famous exploration vehicle is Mars exploration vehicle "**Curiosity**", which travels to the surface of Mars.
  4. These robots need energy to be operated to be controlled remotely like toys .
  5. There are other ways in which Mars exploration vehicle can get its energy , such as:
    - a) the sun
    - b) long life batteries
    - c) solar panels
    - d) radioactive isotopesbatteries for electrical power supply





### Activity 4

**Input energy = energy used/ consumed**  
**Output energy = energy produced/ resulted**

Device	Hair dryer	Soap dispenser	Washing machines
			
Input energy	Electric	potential	electric
Output energy	heat, kinetic, sound	kinetic	kinetic

Think about rubbing your hands together ( complete)

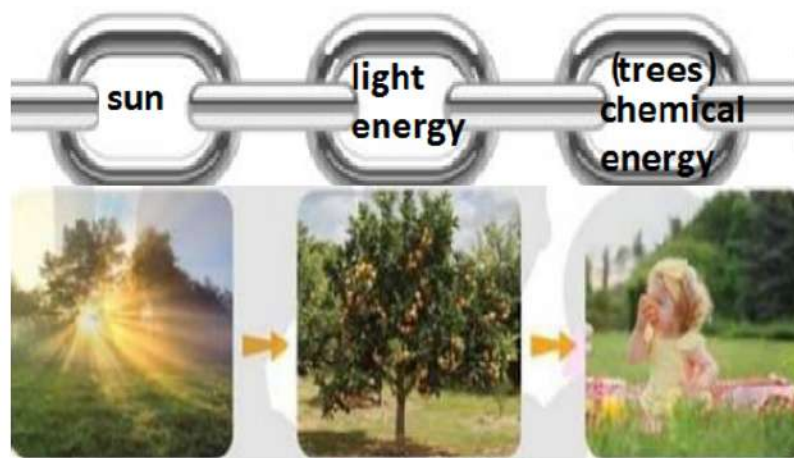
Input energy: \_\_\_\_\_

Output energy: \_\_\_\_\_

**Activity 5****Energy Chains**

**Where does the energy we use come from and what is it transformed ?**

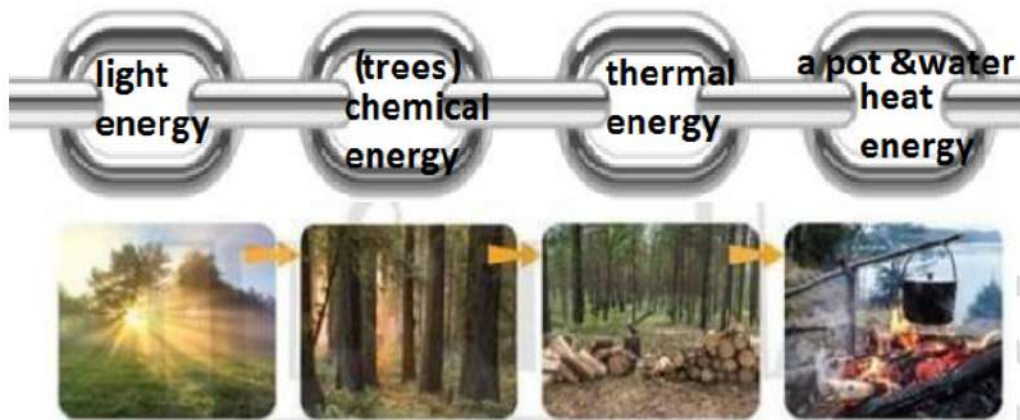
**a. Food chain when we eat food**



According to the diagram of **energy chains**, we conclude that :

- a) the source of most energy we use is **solar** energy.
- b) the chain of energy from the sun that reaches the Earth begins as **light energy**.
- c) the plants convert **light** energy into **chemical** energy in the form of sugary substances, as an orange tree does, when we eat an orange fruit ,the body uses **chemical** energy to move .

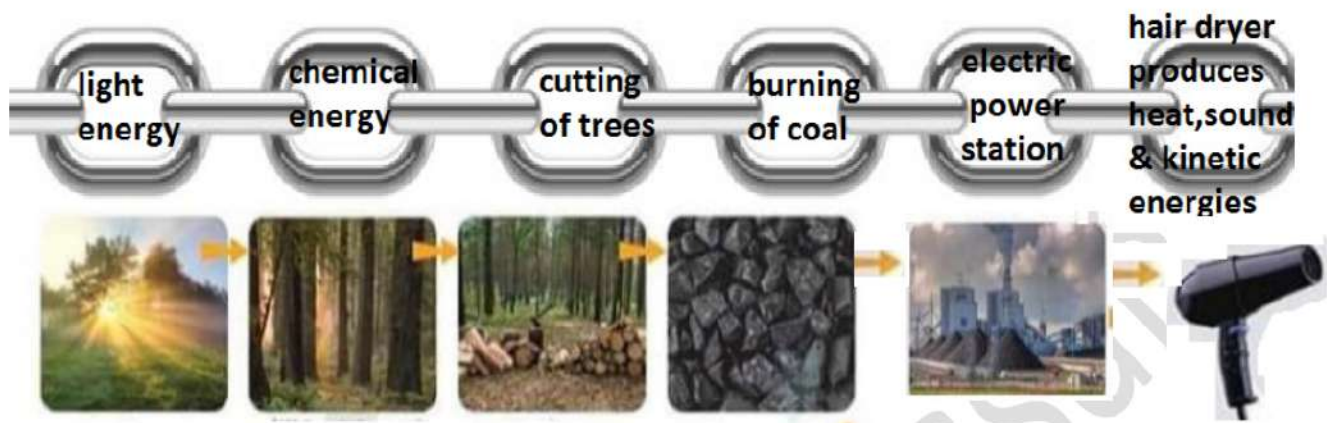
### b. Food chain when we heat water



According to the diagram of **energy chains**, we conclude that :

- a) **light** energy from the sun changes into **chemical** energy in plants.
- b) When trees are cut and wood is burned from the tree producing **thermal** energy that heats water up.

### c. Food chain in the hair dryer



According to the diagram of **energy chains**, we conclude that :

- sun provides **light** energy which changes into **chemical** energy in plants.
- when trees are cut , we get wood to make coal.
- burning coal to generate electric energy in the electric power stations.
- the electric power stations provide the required energy to operate the hair dryer through an electric wire made of copper.

**Notes :**

- Electric energy comes from the **electric power stations**.
- Electricity also can be generated by burning **coal** or **natural gas**.
- Coal is one of the forms of **chemical** energy, coal was formed millions of years ago from **the remains of dead trees** .
- Not all of the energy that enters the energy chain reaches the device ,as some of it leaks and turns into energy that the device doesn't use.
- Most of the lost energy escapes in a form of heat energy.

### Activity 6

#### Energy and devices that we use in our daily life

Device	Importance	Energy input	Energy output
<b>Electric lamp</b>	Lighting	Electric	Light- sound
<b>Electric heater</b>	Heating water or air	Electric	Thermal
<b>Electric fan</b>	Cooling air	Electric	Kinetic- sound
<b>Cooker</b>	Cook food	Electric - chemical	Thermal
<b>T . V.</b>	watching news- entertainment	Electric	Light- sound
<b>Dynamo</b>	Obtaining electricity	Kinetic- magnetic	Electric
<b>Watch</b>	Knowing time	Electric	Kinetic
<b>A toy with a spring</b>	Playing	Elastic potential	Kinetic
<b>Bell</b>	Alerting	Kinetic	Sound

#### **Note:**

Some input energy is wasted in other forms.

Example: Some of the kinetic energy used to operate a pencil sharpener comes out in a form of heat due to friction.

**Activity7****Conservation of Energy**

- ✦ Energy can change.
- ✦ There are many types of energy that are constantly transfer from one form to another.
- ✦ When you eat breakfast, food provides you with **chemical** energy.
- ✦ When you push the bike pedals, the bike moves and the stored **chemical** energy inside the human body converts into **kinetic** energy.
- ✦ The **kinetic energy** of the bike converts into **thermal energy** as the tires rub on the road.
- ✦ When you turn on a light bulb, the **electrical** energy converts into **light** energy and sometimes into **thermal** energy, so the room becomes **brighter** and when you bring the hand closer, we feel **hot**.

**Law of Conservation of Energy**

**Energy is neither created nor created out of nothing, but transforms from one form to another continuously.**

**Activity 8****Energy Flow Tracking**

1. Energy is conserved and it is neither destroyed nor created from nothing.
2. The energy that enters any device must eventually come out of it, whether in the same form or another form.
3. All devices have energy entering it and another energy coming out.



### According to the energy chains, we conclude:

1. Each energy must have a space in which it is located.
2. The energy is transformed from one form to another.
3. The transformed energy sometimes does not help in performing the function it is designed for.

#### Example

##### a. In the hair dryer:

\* Input energy is the **electrical** energy.

\* Output energy is **thermal, sound** and **kinetic** energy.

Sound and kinetic (moving air) can be considered as a loss of "energy" as they do not contribute to the function of the device, which is drying.



##### b. In the mobile phone:

\* Input energy

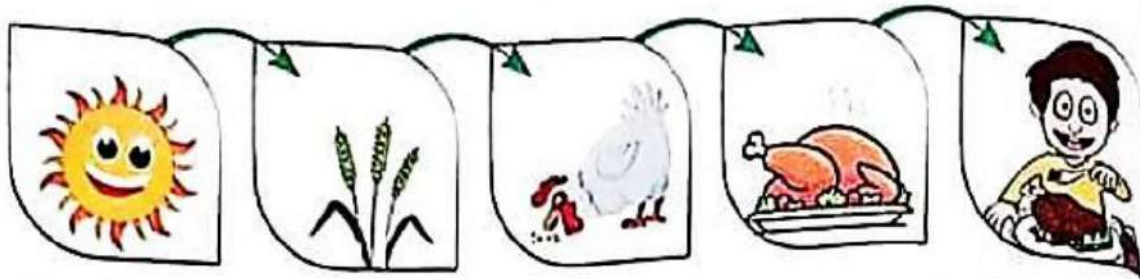
The **electrical** energy enters and is stored inside the battery in the form of **chemical** energy during charging.

\* Output energy

-The phone converts some of the stored energy, so the chemical energy inside the battery is converted into other forms of energy.

-The phone uses energy to **light** up and ring (**sound**), and its **stored energy** used to process information.



**Activity 9****Building an Energy Chain**

The previous diagram shows:

1. Paths of energy transfer from input to output.
2. Possible energy transformations that help the device perform its functions.
3. Energy is transformed from one form to another.

**Note**

- ☒ Plants get light energy from the sun.
- ☒ The light energy in the plant transforms into stored energy, so the chicken feeds on the grains and obtains the stored energy.

**Build your own energy chain  
using photos in magazines as  
the previous example**

**Activity 10****Energy in remote controlled toy cars**

They are cars that run on electric power and a set of remote control devices.

\* It is possible to transform the energy inside the toy car into electrical energy, and its engine is responsible for saving energy.

**Hypothesis**

Energy forms can transform into other forms of energy (most of the energy you use comes from the sun can transform into any form of energy by technology).

**Evidence**

- ☐ We find that there are many devices that need some types of energy to be operated.
- ☐ These devices can convert this energy into other forms of energy, such as :
  - The electric lamp obtains electrical energy and converts it into light energy and thermal energy.
  - The chemical energy in the battery is converted into electrical energy to operate the remote control cars.

**Notes:**

- 1) Almost all of the energies we use originally come from the sun.
- 2) Energy is transformed from one form into various other forms.
- 3) Some of the devices we use in our daily life need energy to operate.
- 4) Energy from the sun is converted into chemical energy in sources such as coal, which is used to produce electricity in power stations.

**Activity 11****STEM****Functions and energy in systems**

There are many scientists have jobs that require knowledge of energy in systems, such as :

- a. Environmental scientists check how energy flows through food webs in the system that affect living organisms.
- b. Some environmental scientists study the movement of energy in hard ecosystems (the ocean floor or the Arctic).
- c. Engineers use energy to design technology to solve problems. Where the parts of the system are designed to convert energy from one form to another, such as a mobile phone or computer, get the screen to light up or make a sound .

**Power problems:**

- There is a power-related problem in the mobile phone system, so engineers use a solution to this problem.
- The engineers find that the mobile phone is not energy saving as it consumes battery power significantly in a short time after charging.
- The engineers test the mobile phone, modify the battery and re-select it to verify that the battery lasts longer charge.

## Activity 12



- The energy from the sun can be transformed into any form of energy that can be used to operate devices in daily life.
- The different forms of energy that are mentioned in this concept are solar, electrical and chemical, and sound energies.
- Solar energy is transformed into chemical energy that is stored in the plant, and trees can turn after their growth into coal, which is converted into electrical energy in electric power stations.

## Glossary

Devices/ appliances	اجهزة
Renewable	متجددة
Non Renewable	غير متجددة
Water mills	طواحين الماء
Turbines	توربينات
Hydropower	كهرومائية
Dams	سدود
Ecosystem	نظام بيئي
Exploration vehicle	عرب استكشاف
Radioactive isotopes batteries	بطاريات بالنظائر المشعة
Input	مدخلات
Output	مخرجات
Energy chains	سلاسل طاقة
Conservation of energy	قانون حفظ الطاقة
Energy flow tracking	تتبع تدفق الطاقة