Theatre of Science IGCSE Physics: Energy 1: Conservation of Energy

Today's lesson will cover the following speci points (Pearson and Cambridge):

Know the principle of the conservation of energy and apply this principle to simple examples

State that energy may be stored as kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic and internal (thermal) (Pearson's spec adds 'magnetic').

Describe how energy is transferred between stores during events and processes, including examples of transfer by forces (mechanical work done), electrical currents (electrical work done), heating, and by electromagnetic, sound and other waves

Starter Question!

What have Energy and Happiness got in common? List your ideas.

Principal of Conservation of Energy

Energy cannot be created or destroyed, it can only be transferred from one store to another

Energy Store	Example (To complete in future lessons too, or independently)
Kinetic	
Gravitational-potential	
Chemical	
Elastic (strain)	
Nuclear	
Electrostatic	
Internal (thermal)	
Magnetic	

For each example say…
What store is filled?
What store is emptied?

Example: Walking uphill

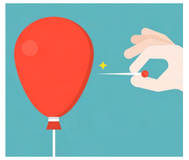
Store filled: *Gravitational*
Store emptied: *Chemical*
(chemical energy stored by my body is being shifted)

Catapult being pulled back

Store filled:

Store emptied:

Balloon bursting



Store filled:

Store emptied:

Lifting a cat onto a shelf

Store filled:

Store emptied:

Hot chocolate cooling down

Store filled:

Store emptied:

Meteorite falling to Earth

Store filled:

Store emptied:

Heating water on a gas stove

Store filled:

Store emptied:

Energy can be transferred by: Forces (mechanically), Electric currents, heating, waves

These are all clips from real websites. Can you spot all the mistakes that have been made when talking about energy? (Some are fine!)

Energy from trees. People can get energy by burning the scrap wood

Project

Plants create energy

over 100,000 lorry trips per year. Taking rubbish to the EfW also means that most black bag rubbish is converted into energy. The

leaves. Plants use the energy of the sun to change water and carbon dioxide into a sugar called **glucose**. Gl

Plants make their energy by combining the water with carbon dioxide from

Biomass energy production explained

Biomass feedstocks can be used to create 3 types of energy:

1. Heat
2. Electricity
3. Biofuels, such as biodiesel

Green energy

Types of Waste That Can Be Turned Into Energy

September 26, 2017

as trees capture energy from the sun in chemical reactions. This is the energy that is released when they burn.

GCSE Questions!

1) A tennis ball is hit with a racket. While the ball and the racket are touching, the ball gets squashed and changes shape. State the type of energy stored in the ball.

2) A person jogs along a path. Complete the sentence.

As the person jogs, the energy in their

_____ store decreases.

3) Energy can be stored. Give examples of two ways that energy can be stored.

_____

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Theatre of Science IGCSE Physics: Energy 2: Energy Stores

An IGCSE question says "give an example of a _____ energy store". Complete the sentence giving the best example for each store.

Store	Example
Kinetic	
Gravitational-potential	
Chemical	
Elastic (strain)	
Nuclear	
Electrostatic	
Internal (thermal)	
Magnetic	

Choices! Choose one for each box!

1) Football falling
2) Ball being kicked
3) Tree falling over
4) Book on a shelf
5) A banana
6) An ice cream
7) Elastic band
8) Ball being squashed
9) Nuclear fusion in the Sun
10) Negative and positive things being attracted to each other
11) Comb attracting tiny pieces of paper
12) Kettle heating water
13) Magnets that have stuck together
14) Magnets being attracted to each other

Energy is shifted from store to store in 4 different ways.

What's the pathway? Put M, E, P or R in the box.

Done? List the energy stores too!

M: Mechanical - by a force

E: Electrical - a current flowing

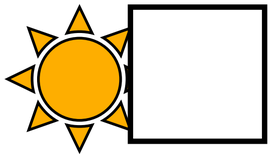
P: Heating by particles

R: Heating by radiation

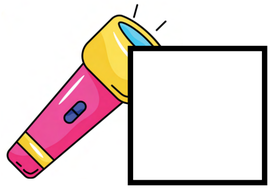
Chemical store of power station

→

Bulb lighting up



The Sun heating Earth



Torch being turned on

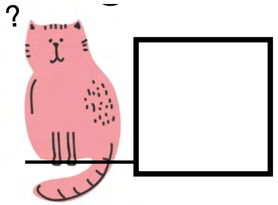
→

Torch lighting up

Picking up an electric guitar

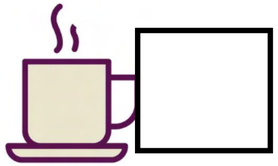
→

Holding an electric guitar



Lifting a cat down from a shelf

Book falling off a shelf



Hot chocolate making the mug it's in hot.

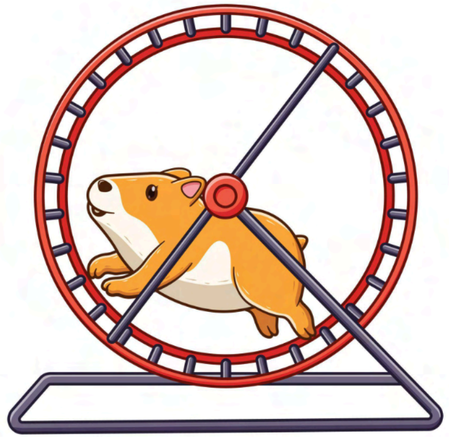
Bulb lighting up

→

Air around bulb getting hot

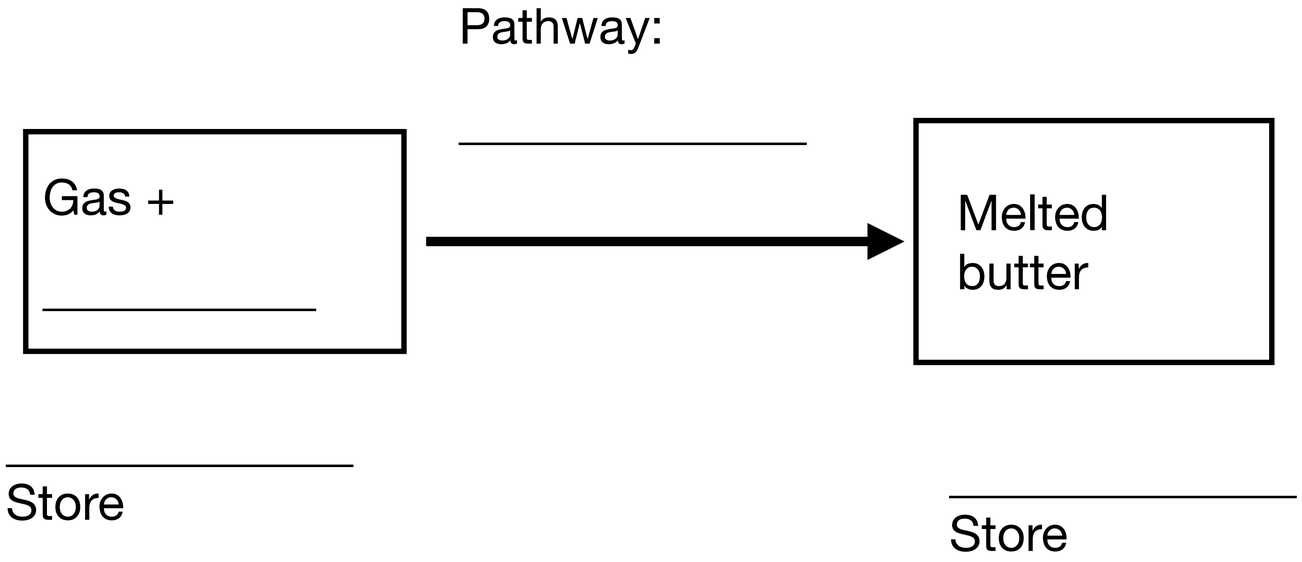
GCSE Questions!

1) A hamster runs in a wheel. Explain why the hamster's decrease in chemical energy is not equal to the wheel's increase in kinetic energy.



2) A car travelling along a road decreases its chemical store and increases its kinetic store. Describe the motion of the car.

3) A gas stove is used to melt butter in a pan. Fill in the four gaps to complete the simple flow diagram.



Theatre of Science IGCSE Physics: Energy 3: Work Done

Today's lesson will cover the following speci points (Pearson and Cambridge):

Understand that mechanical or electrical work done is equal to the energy transferred

Recall and use the equation for mechanical working W = Fd = ΔE

Define power as work done per unit time and also as energy transferred per unit time; recall and use the equations (a) P = W t (b) P = ΔE t

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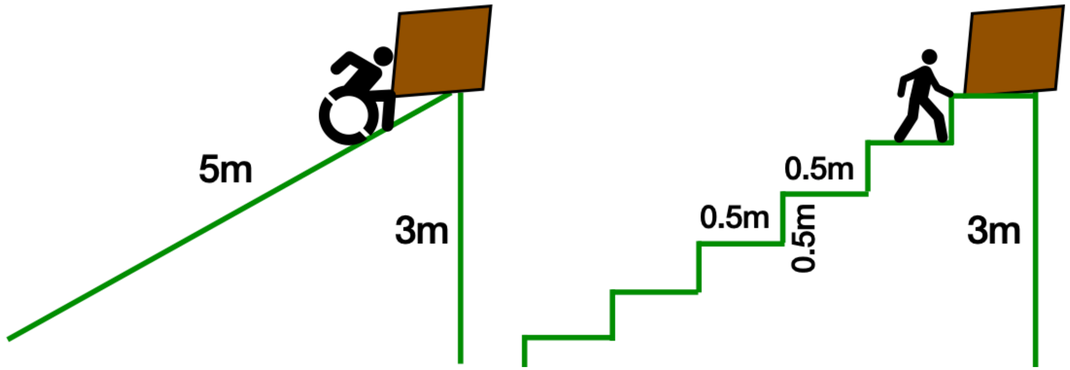
These people have got this 4N box to the top of the hill. How much work has each done against gravity?

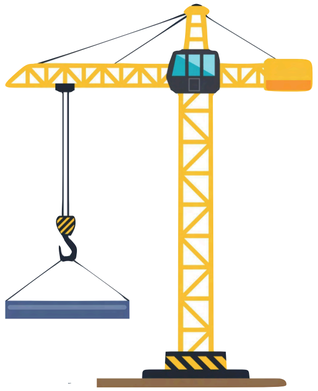


work done = force x distance moved in the direction of the force

A cat weighing 20N fall off a 4m high shelf. How much work is done by gravity?

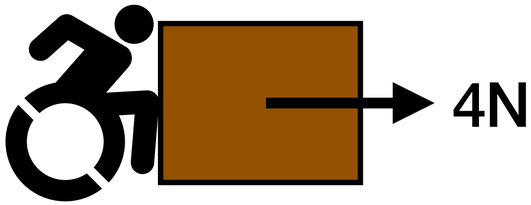
Raphael lifts a 300N weight and shifts 300J of energy from his chemical store. How high does he lift the weight?

A crane lifts 8000N onto a 20m high scaffold. How much work does it do against gravity?



An acrobat weighing 900N sits on a hoop and is lifted 18m into the air. How much work does she do?

A box weighs 5N. A woman pushes it with a force of 4N. It goes 2m. How much work is done against gravity?



A T. rex drags a 40000N Triceratops 100m to its nest. How much work does it do?

If you did Forces! Is “distance moved in the direction of the force” a scalar or a vector?!

Theatre of Science IGCSE Physics. Energy 4: Gravitational Potential and Kinetic Energy

Today's lesson will cover the following speci points (Pearson and Cambridge):

Recall and use the equation for kinetic energy Ek = 1/2mv2

Recall and use the equation for the change in gravitational potential energy ΔE p = mgΔh

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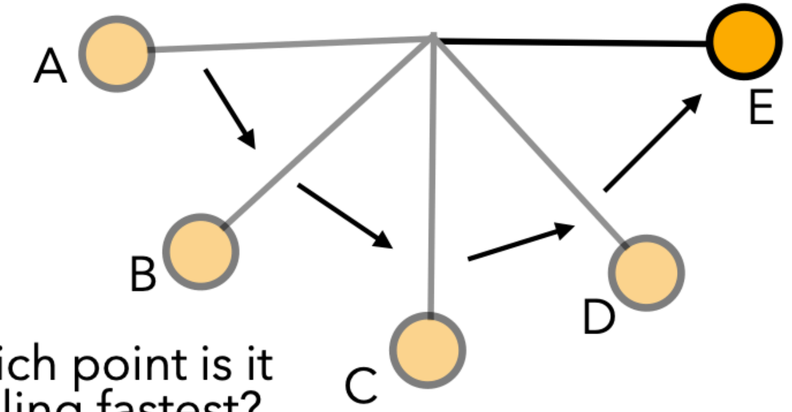
At which point in its swing does the pendulum have the most gravitational potential energy?

At which point does it have the most kinetic energy?



At which point is it travelling fastest?

Are there any points at which is stays still?

Change in gravitational Potential Energy = mass x g x change in height

g = 9.8N/kg

A cannonball of mass 8kg is fired directly upwards and reaches a height of 15m. How much gravitational potential energy does it have at its highest point?

Wormy parachutes to the ground from a height of 100m. If her mass is 0.2kg, calculate the change in her gravitational potential energy.

It has lost 392J of gravitational potential energy by the time the owner of the cannon realises he's going to get bonked on the head. How high is the cannon ball at this point?

A cyclist with a mass of 90kg rides a 10kg bike at 11m/s. How much kinetic energy does she have?

Kinetic Energy = 1/2 mv^2

A 40g tennis ball travels at 30m/s. How much kinetic energy does it have?

A 120kg skateboarder has 2940J of kinetic energy. How fast are they going?

Change in gravitational Potential Energy = mass x g x change in height

Kinetic Energy = 1/2 mv^2

A 70kg man sledges down a 6m high hill. If the snow is frictionless, how fast is he going at the bottom?

A 200kg rollercoaster car has 21560J of kinetic energy as it starts to move up a hill. If the rollercoaster is frictionless, what is the maximum height the hill can be for the car to make it to the top?

Theatre of Science IGCSE Physics. Energy Lesson 5: Efficiency

Today's lesson will cover the following specification points (Pearson and Cambridge):

Understand, qualitatively, the concept of efficiency of energy transfer

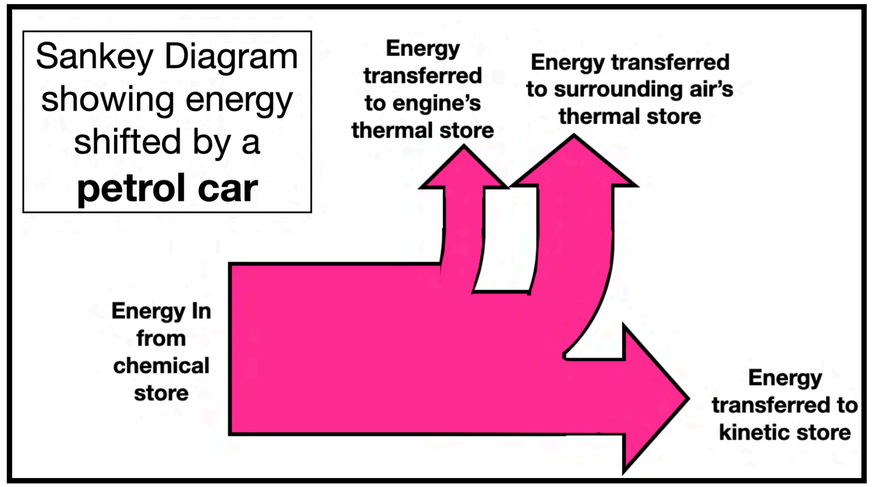
Define efficiency as:

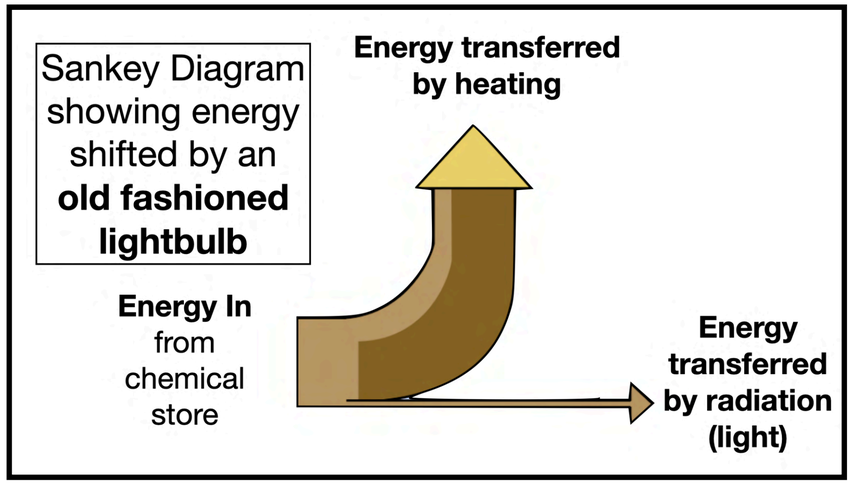
(a) (%) efficiency = (useful energy output) (total energy input) (× 100%)

(b) (%) efficiency = (useful power output) (total power input) (× 100%) recall and use these equations

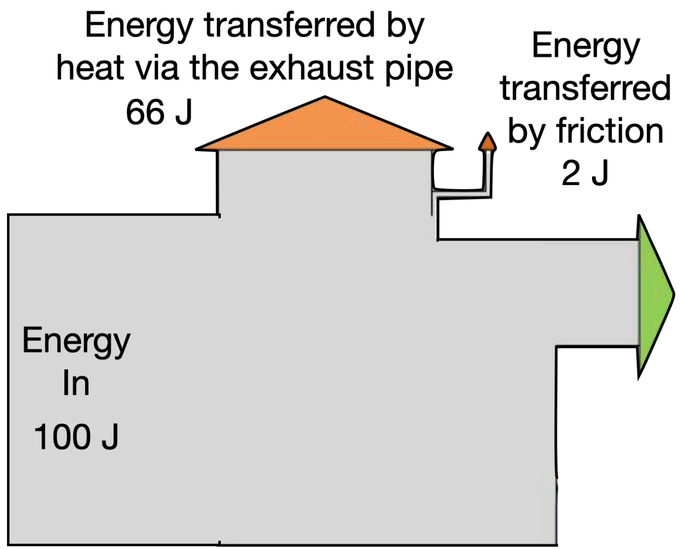
Know the principle of the conservation of energy and apply it to complex examples involving multiple stages, including the interpretation of Sankey diagrams (Pearson says 'describe a variety of everyday and scientific devices and situations').

Why do you think the arrows on these diagrams go off to the side?





Your friend has to draw a Sankey diagram for work*



Energy transferred by mechanical force to movement of turbine

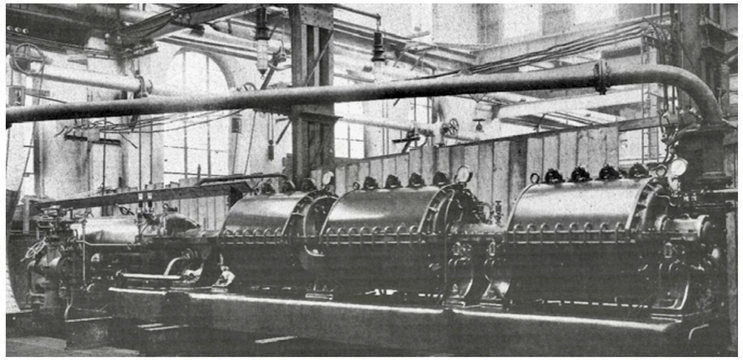
32 J

They ask for your help. Any other ‘rules’ for drawing Sankey diagrams you can spot?

*Perfectly believable scenario.

The Armengaud-Lemale: a gas turbine invented in Paris in 1906

Wikipedia says it “was too inefficient to produce useful work”.



Imagine you’re talking to someone who hasn’t studied any physics. Explain what this means!

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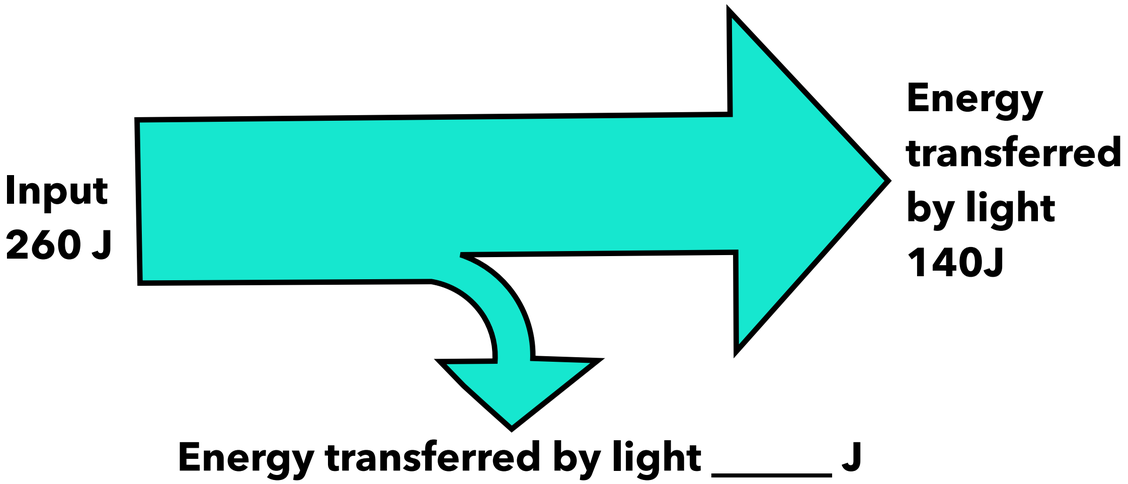
$$(\%)\ \text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$$

1) A motor uses 600J of energy to do 150J of useful work. What is its efficiency?

2) A Sankey diagram for a light bulb is shown below. Fill in the missing value, and calculate how efficient the bulb is.



3) A plug-in phone charger uses 20J of energy. 12J is shifted to the phone's battery, and 8J heats up the air around the charger. How efficient is the charger?

4) A wireless phone charger uses 7J of energy. 6.3J heats up the air around the charger and the rest charges the battery.

How much energy does the charger shift to the battery?

Which is more efficient, the wireless or plug-in charger?

5) The glowing red filament in a toaster receives energy electrically. 100% of this energy is shifted to the filament's thermal energy store. Is the toaster 100% efficient? Explain your answer.

Theatre of Science IGCSE Physics.
Energy Lesson 6: Fossil Fuels and Alternatives!

Today's lesson will cover the following spec points (Pearson and Cambridge):

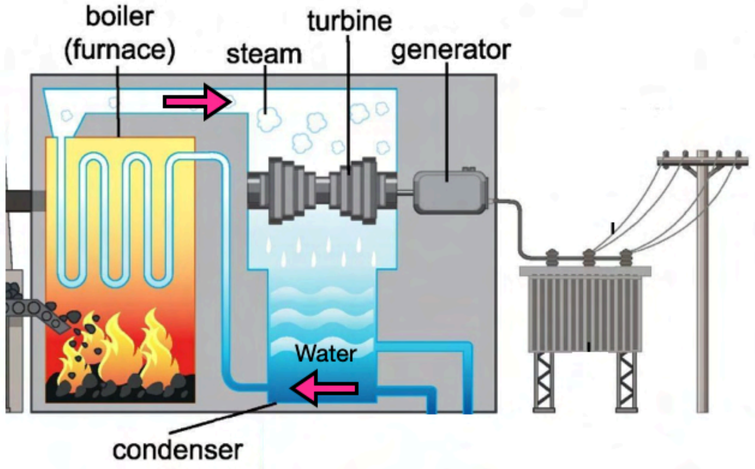
Describe how useful energy may be obtained, or electrical power generated, from:

Chemical energy stored in **fossil fuels**
Chemical energy stored in **biofuels** (Cambridge only)
Geothermal resources
Wind energy

Describe **advantages and disadvantage**s of each method in terms of renewability, availability, reliability, scale and environmental impact

GCSE questions!

This power station burns fossil fuel



1) Which part transfers energy from a *chemical* store to a *thermal* store? (1)

a) Boiler/Furnace
b) Turbine
c) Generator
d) Condenser

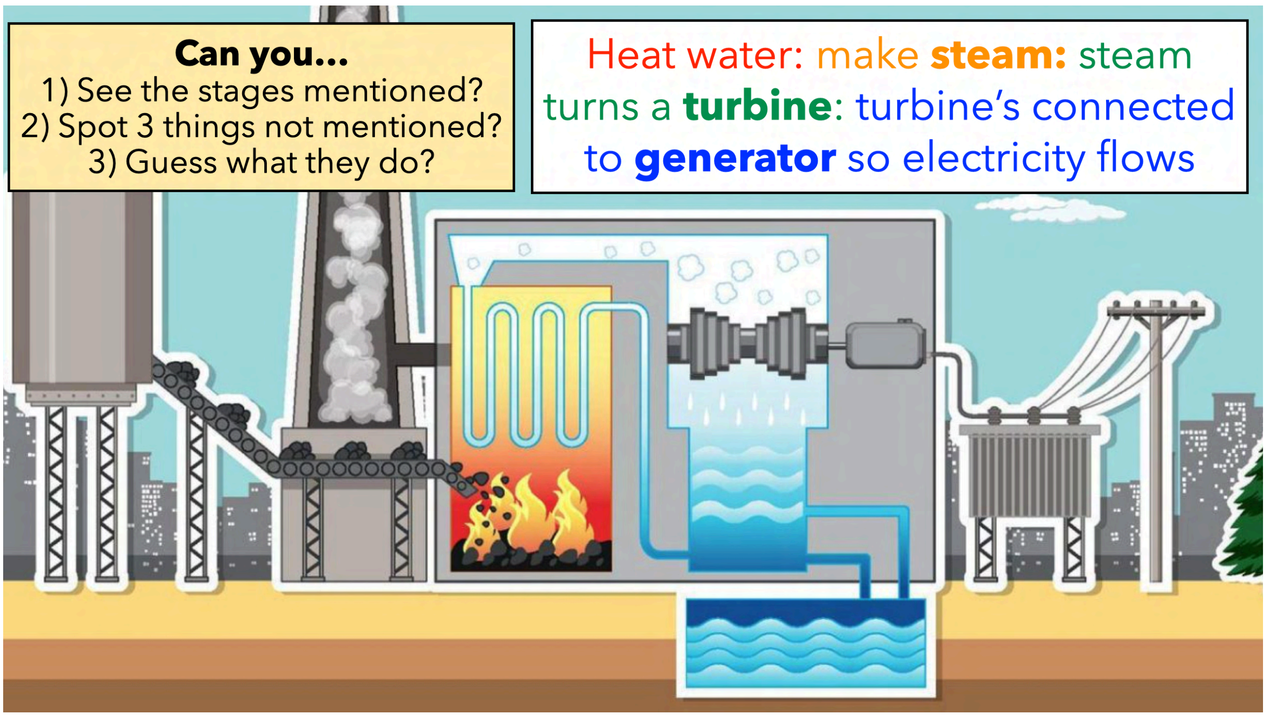
2) Which part transfers energy electrically from a kinetic energy store? (1)

a) Boiler/Furnace
b) Turbine
c) Generator
d) Condenser

3) Name one fossil fuel (1) _____

4) Give two advantages of using wind turbines for generating electricity, compared to using fossil fuels.

5) Give one disadvantage of wind turbines, compared to fossil fuels.



Land can still be used for farming

You can't have it on demand

Can be noisy for people living nearby

Unreliable

It can be reused again and again

Which of these are disadvantages and which are advantages of using **fossil fuel** **biofuels** **wind** **geothermal** to produce electricity.

Carbon-neutral

Difficult to find suitable places for it

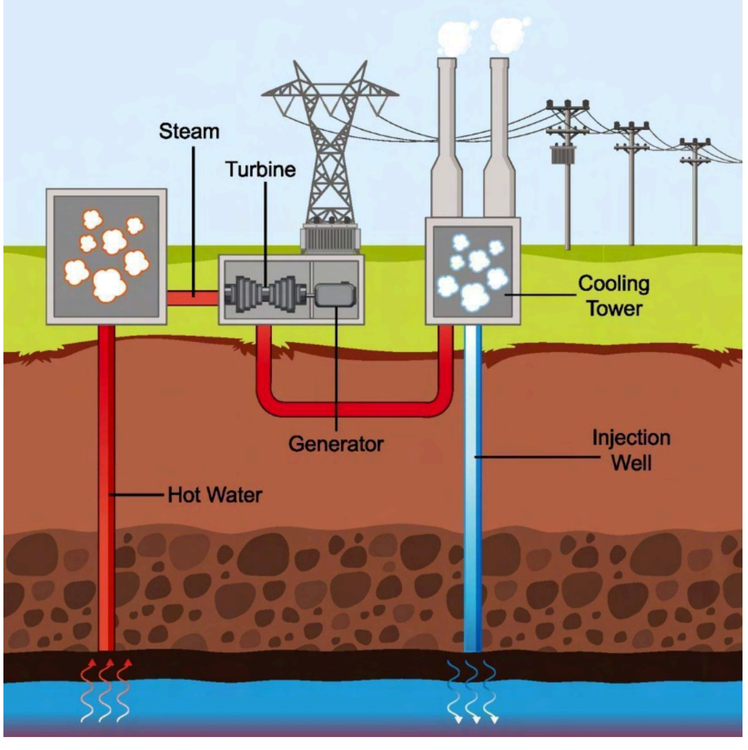
Doesn't give off pollution / carbon dioxide

Can be used on demand

Makes more nutritious flour

Takes up a lot of farm land

Reliable



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Theatre of Science IGCSE Physics.
Energy Lesson 7: Energy from Water!

Today's lesson will cover the following spec points (Pearson and Cambridge):

Describe how useful energy may be obtained, or electrical power generated, from:

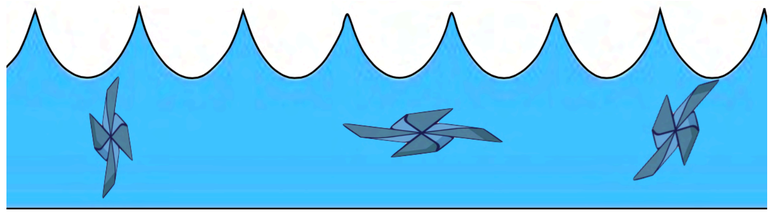
Water, including the energy stored in waves, in tides, and in water behind hydroelectric dams

Describe **advantages and disadvantages** of each method in terms of renewability, availability, reliability, scale and environmental impact

What causes waves?

_____

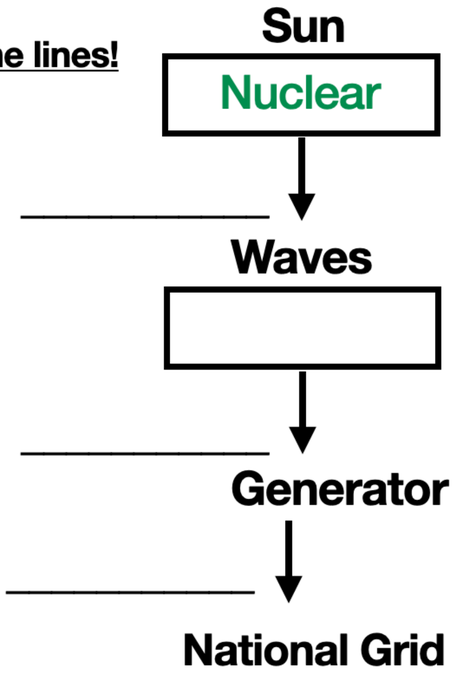
Which turbine is going to harness the most energy from these waves?



_____

Write a store in the box and pathways on the lines!

Energy Stores	Pathways
Kinetic	Mechanically (by force)
Gravitational potential	Electrically
Chemical	By radiation
Elastic (strain)	By heating (Because of temperature difference)
Nuclear	
Electrostatic	
Internal (thermal)	
Magnetic	



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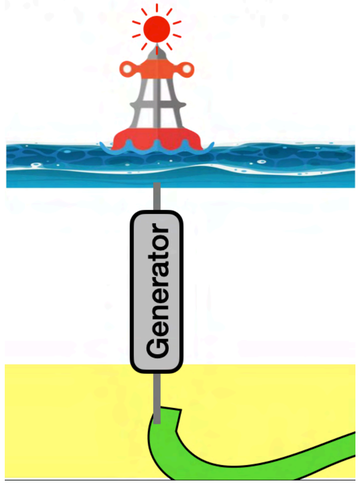
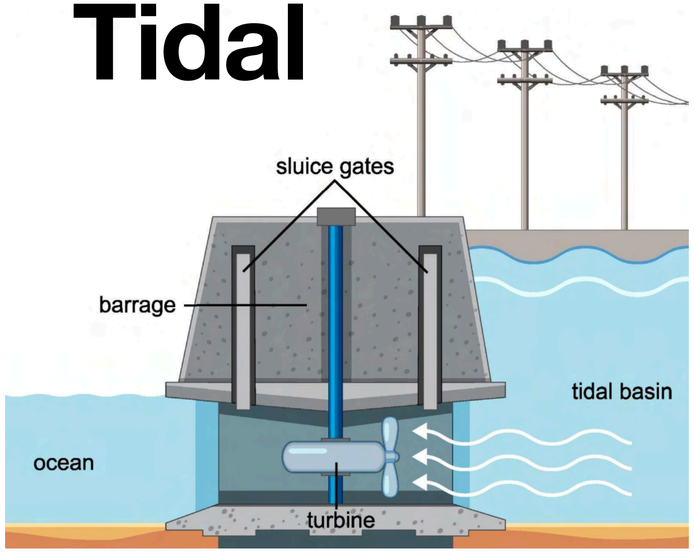
Optional Notes Page!

Waves eg

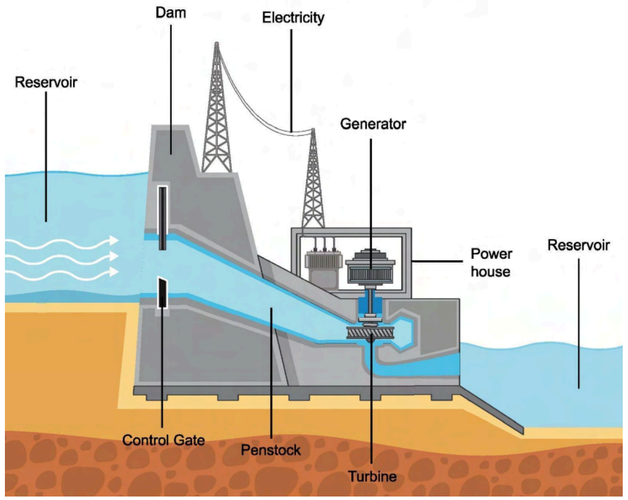
Point Absorber!

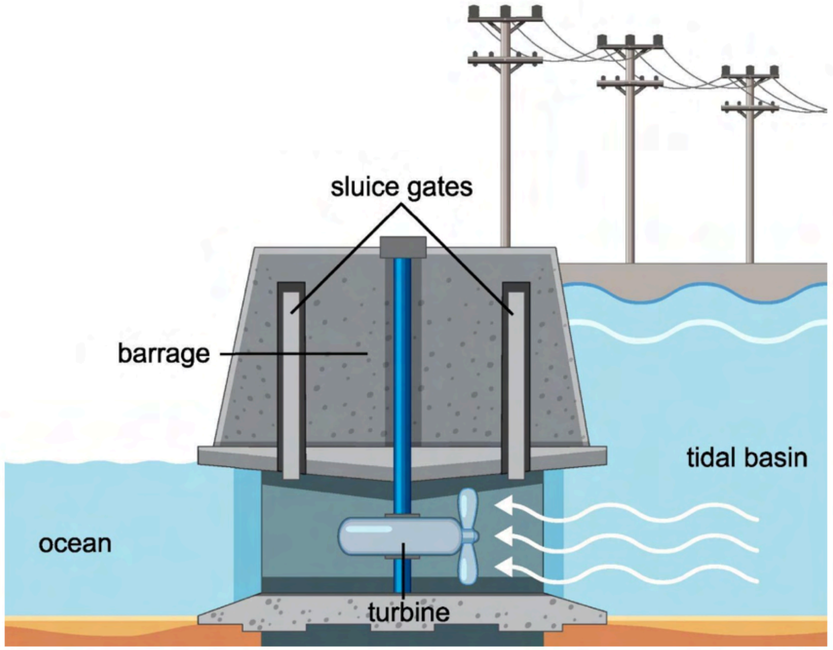


Tidal



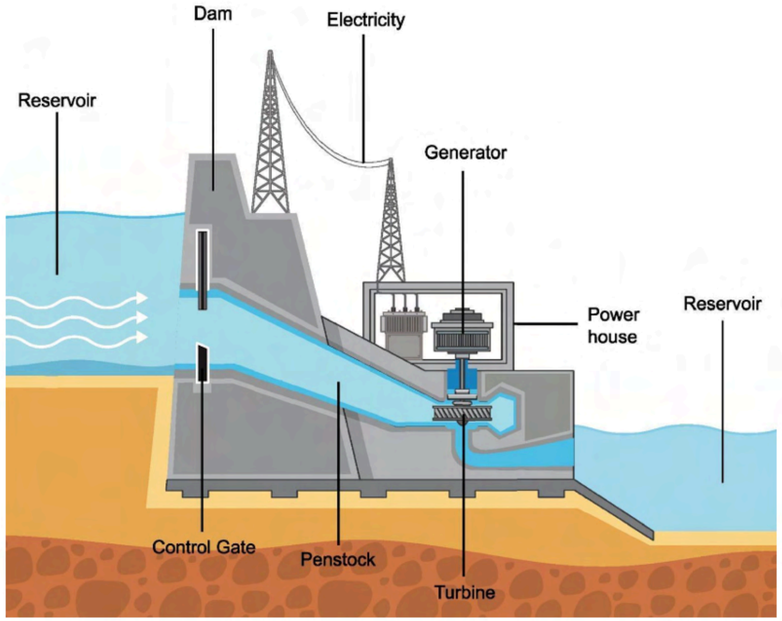
Hydroelectric Dam





Tidal power
(the tide flowing through a turbine)

Hydro-power
(river water flowing through a turbine)



What do they have in common?

They don't release pollution while running

Their energy comes from the Sun

They harm migrating animals

What's different about them?

Reliable

Renewable

No need to transport fuel

Large area might need to be flooded

Expensive to build

Hard to find places to put them

Theatre of Science IGCSE Physics. Energy Lesson 8: Solar Energy

Today's lesson will cover the following spec points (Pearson and Cambridge):

Describe how useful energy may be obtained, or electrical power generated, from:

nuclear fuel

light from the Sun to generate electrical power (solar cells)

infrared and other electromagnetic waves from the Sun to heat water (solar panels)

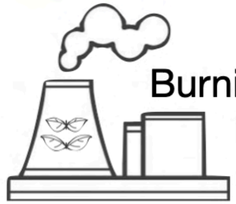
Describe **advantages and disadvantages** of each method in terms of renewability, availability, reliability, scale and environmental impact

Which of these renewable ways of generating electricity have I made up?

Using the energy of smoke from active volcanoes

Capturing sunlight

Using energy of water being released from a dam

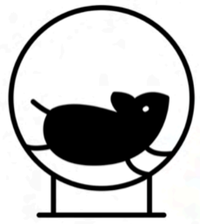


Burning wood instead of coal

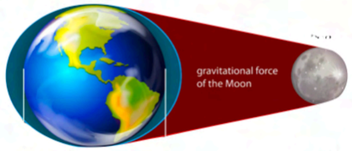
Using the energy of waves

Drilling a hole and using Earth's heat

Using the energy of hamsters in wheels



Burning gas that comes off rubbish dumps



Using the energy of the tides going in and out

2. Say WHY the made-up methods wouldn't work:

3. Say WHERE the energy first came from in each case!

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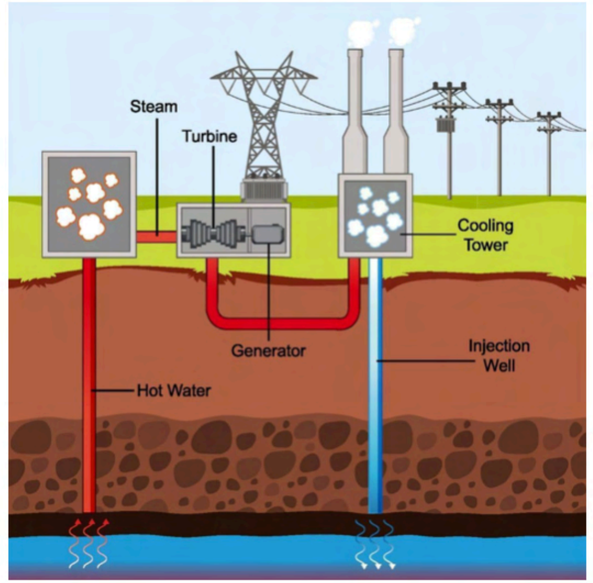
Match the description to the renewable energy source

Solar Cells: Use sunlight to produce electricity

Geothermal: Use Earth's heat to make steam, to generate electricity



Reliable: energy is always available

Releases some harmful gases trapped inside Earth

Very hard to find places to put it

Cheap to run

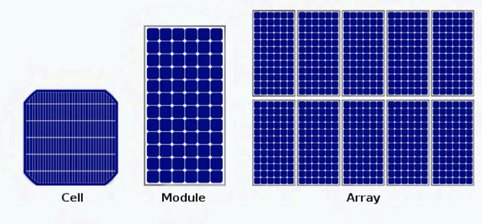
Easy to look after

Takes up farm land

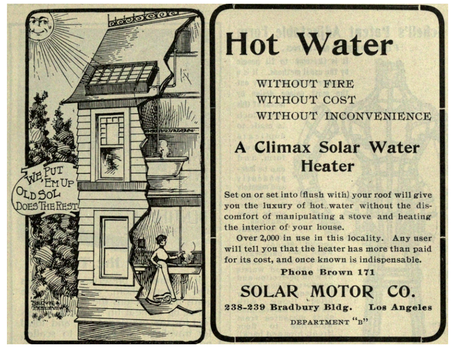
No pollution released while working

Where they are (ie, in the shade?) makes a big difference to how well they work

(Photovoltaic) Solar Cell



Solar ‘Panel’ / Heating



Advantages of _____ over _____

Advantages of _____ over _____

Advantages of _____ over _____

Advantages of _____ over _____

Theatre of Science IGCSE Physics. Energy 9: Conduction and Convection!

Today's lesson will cover the following spec points (Pearson and Cambridge):

Describe the particle structure of solids, liquids and gases in terms of the arrangement, separation and motion of the particles, and represent these states using simple particle diagrams

Explain convection in liquids and gases in terms of density changes and describe experiments to illustrate convection

Know that convection is an important method of thermal energy transfer in liquids and gases

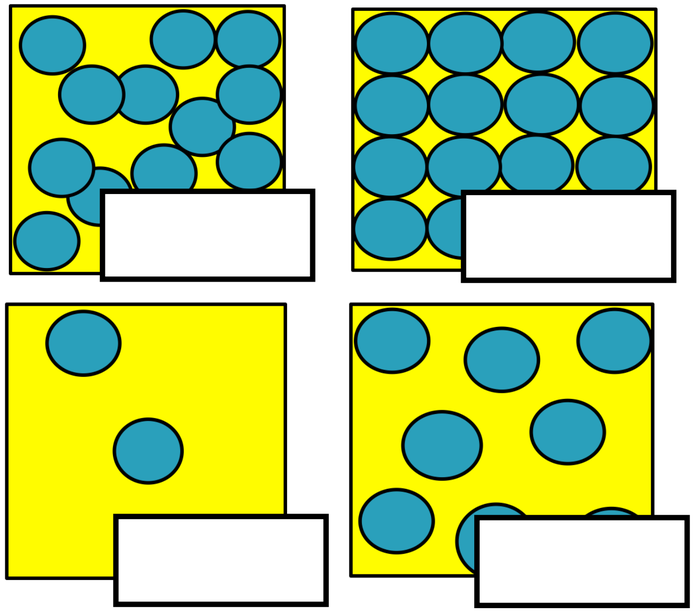
Describe thermal conduction in all solids in terms of atomic or molecular lattice vibrations and also in terms of the movement of free (delocalised) electrons in metallic conductors

Describe, in terms of particles, why thermal conduction is bad in gases and most liquids
Know that there are many solids that conduct thermal energy better than thermal insulators but do so less well than good thermal conductors

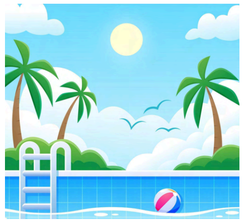
Explain some of the basic everyday applications and consequences of conduction, convection (and radiation), including: (a) heating objects such as kitchen pans (b) heating a room by convection

Starter: As a kid, I used to run outside and leave the kitchen door open. My Mum would always say "Shut the door, you're letting all the cold air in!" Why was she wrong?!

Which of these diagrams best represents how the particles are arranged in a solid, and liquid and a gas? Label them. One isn't a good model of any of them!



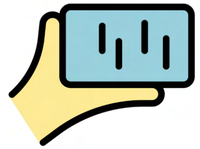
Is it Conduction?! Write mostly, a bit, or no!



The Sun heating the surface of a swimming pool

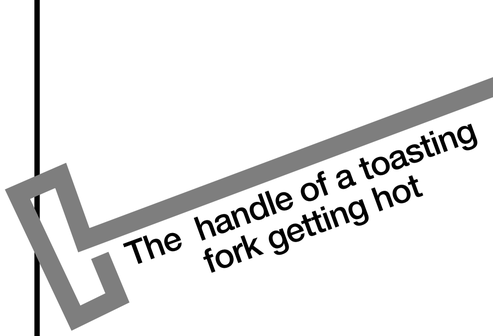
Soup heating on a stove

A radiator heating a room



An ice cube making your hand cold

Fire toasting a marshmallow



The handle of a toasting fork getting hot

1) The kitten is cold! Put the stages in the correct order to heat her up before her eyes get frostbite!

a) Air particles gain energy

b) The radiator heats the air

d) Then is heated by the radiator

f) So spread out

c) Cold air is pushed out of the way

h) and rise

e) And the cycle continues

g) And sinks

2) Add more stages to question one. Include the words “more dense” & “less dense”.

3) How many examples of convection can you see below? Name and explain them!

4) Explain why the little freezers inside fridges are always at the top.

GCSE Questions!

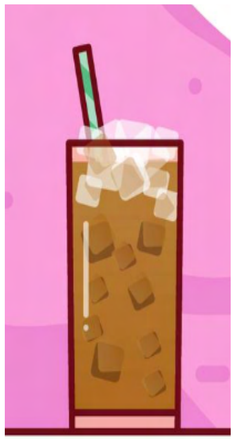
1) Energy is transferred from this hot mug of tea to the surroundings. Complete the sentences below using the words “Conduction” or “Convection”.

Energy is transferred through the sides of the mug by _____

In the air around the mug, energy is transferred by _____

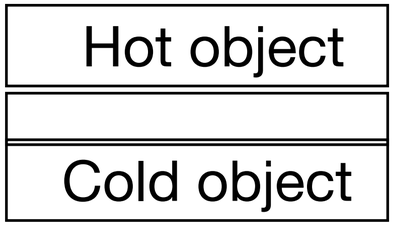
2) The picture shows ice being used to cool some hot coffee. How is the coffee at the bottom of the glass being cooled?

a. Conduction
b. Convection
c. Condensation



3) The gap between these hot and cold objects can be filled with air, iron, a vacuum or water. Which will allow thermal energy to pass between the surfaces the fastest?

a. Air
b. Iron
c. Vacuum
d. Water



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(If you're too old for magazines and stickers you're wrong, but you can opt out).

Theatre of Science IGCSE Physics. Energy 10: Radiation!

Today's lesson will cover the following spec points (Pearson and Cambridge):

Know that thermal radiation is infrared radiation and that all objects emit this radiation

Know that thermal energy transfer by thermal radiation does not require a medium

Describe the effect of surface colour (black or white) and texture (dull or shiny) on the emission, absorption and reflection of infrared radiation

Know that for an object to be at a constant temperature it needs to transfer energy away from the object at the same rate that it receives energy

Know what happens to an object if the rate at which it receives energy is less or more than the rate at which it transfers energy away from the object

Know how the temperature of the Earth is affected by factors controlling the balance between incoming radiation and radiation emitted from the Earth's surface

Describe experiments to distinguish between good and bad emitters of infrared radiation

Describe experiments to distinguish between good and bad absorbers of infrared radiation

Describe how the rate of emission of radiation depends on the surface temperature and surface area of an object

Electromagnetic Waves

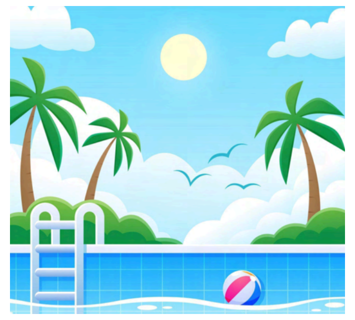
(Least energy) (Most energy)

Radio Microwave Infrared Light Ultra-violet X-ray Gamma

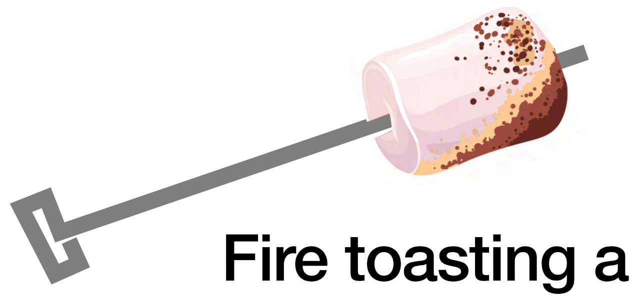
White and shiny materials are good at **reflecting infrared** radiation. Black and matt materials are good at absorbing and emitting radiation.

Write / sketch two examples of each:

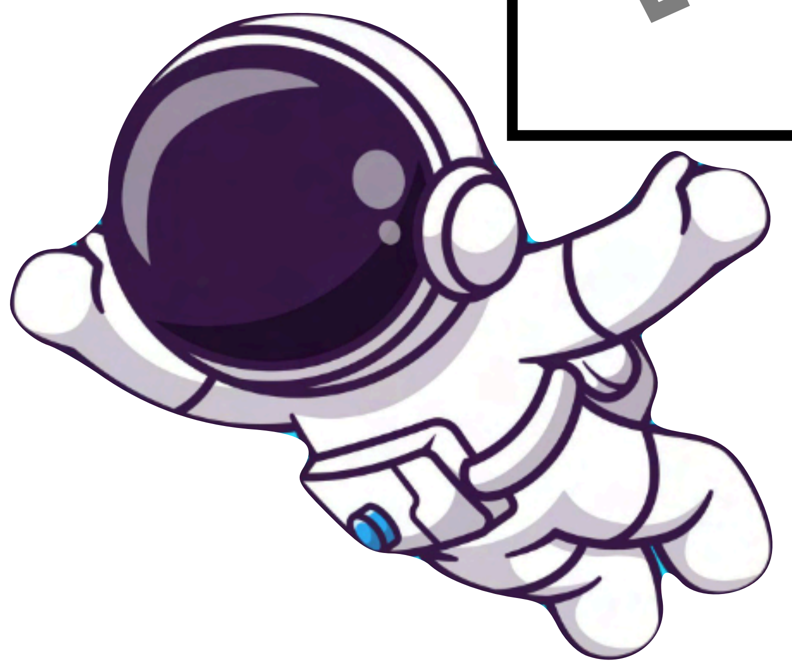
Examples of heating by radiation from last week.



The Sun heating the surface of a swimming pool



Fire toasting a marshmallow



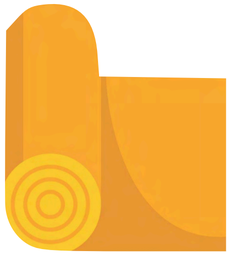
Eg: Astronauts wear white suits on space walks to reflect radiation given off by the Sun.

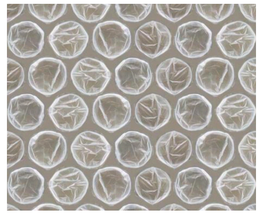
Why are radiators white? Shouldn't they be emitting radiation?!

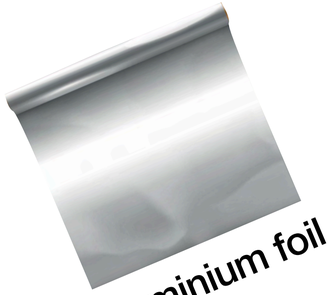
I’m going out for an hour. You’re in charge of keeping my coffee hot. You look around the room for equipment to help you complete this vitally important task and find:

Newspaper


Shiny black fabric


Thick wool


Bubble wrap


Aluminium foil


Scissors

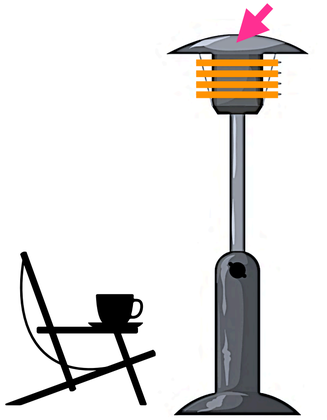

Tape


String

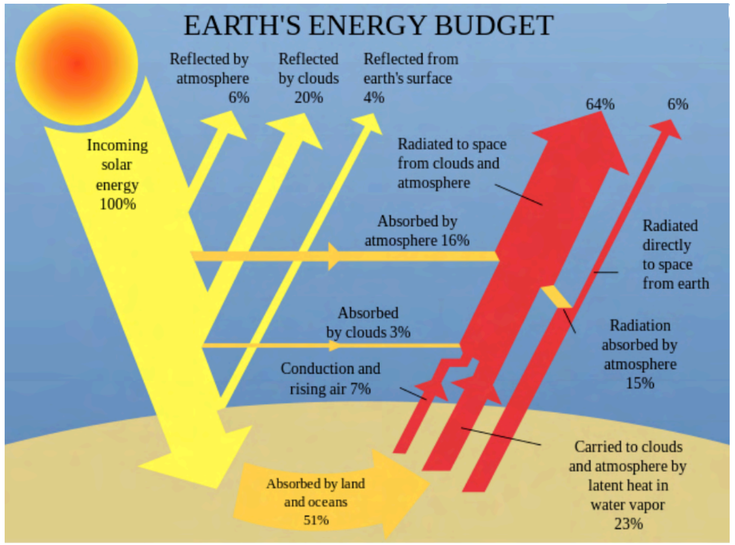
Try a few designs! What’s the absolute best you can do?

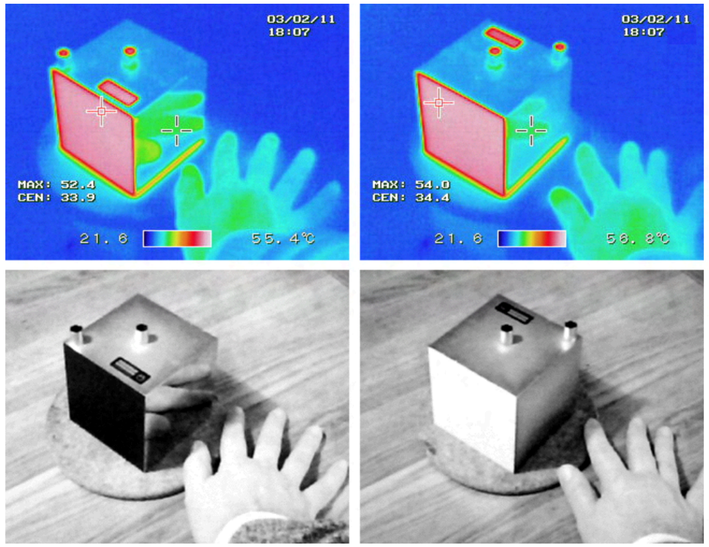
How does snow behave when radiation shines on it?

Why does a patio heater have a shiny metal *top*?



Far more complicated than you need!





A Leslie cube

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