Energy and change

A project funded by the Nuffield Foundation

Theme H

Fuels and food

Theme H - Food and fuels

What is this theme about?

A commonly held (and commonsense) view is that 'fuels contain energy and energy makes things happen'. However this explanation is unhelpful because it fails to take account of the essential role of oxygen, and because it does not address the reason of why things happen.

Why do we need fuels? We need fuels to make things happen that would not just happen by themselves. For example, things do not get hot or start moving on their own for no reason. But burning gas in a cooker can make a saucepan of water not and burning petrol in an engine can make a car move. The essential point is that a change which just happens (e.g. a fuel burning) can drive a change which does not.

Fuels are of no use by themselves. We cannot burn them without oxygen, but we tend to take oxygen for granted because it is all around us and comes 'free'. If we lived on a planet with a methane atmosphere, we would have oxygen piped to our homes to burn in our cookers. What plants do when they make food (and ultimately fossil fuels) is essentially to 'pull apart' fuel from oxygen (a change which does not 'just happen'). This is similar to stretching a spring. The reverse processes (burning fuels and releasing springs) do 'just happen' and can be used to drive other changes.

The activities

H1 Things that 'just happen' and things that don't

H2 Springs and things

H3 Storing and releasing energy

H4 Ways of storing energy

H5 Fuels and food

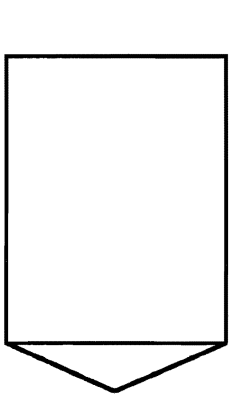
H6 Hydrogen as a fuel

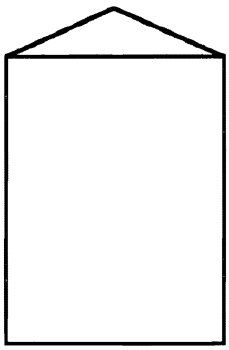
H7 Fuels in Nature

H8 Energy transfers

H9 Impossible changes

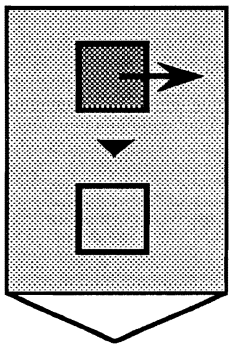
Conventions used in this theme



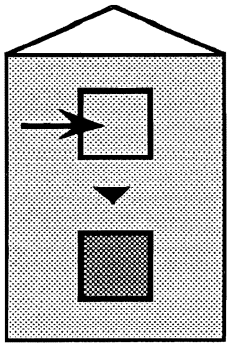


All pictures of change in this booklet show whether the change 'just happens' by itself (down) or does not 'just happen' (up).

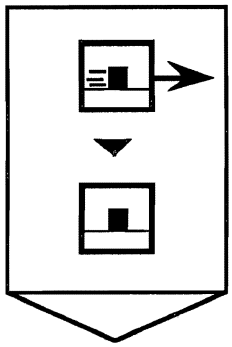
Here are some examples:



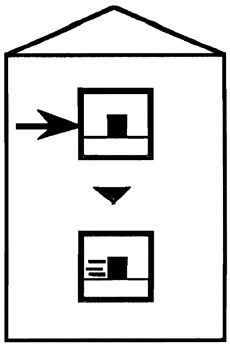
cooling



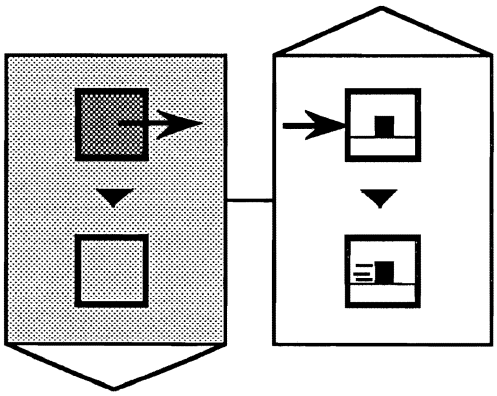
warming



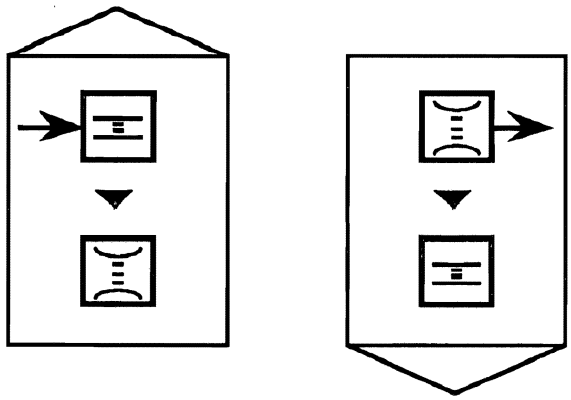
slowing down



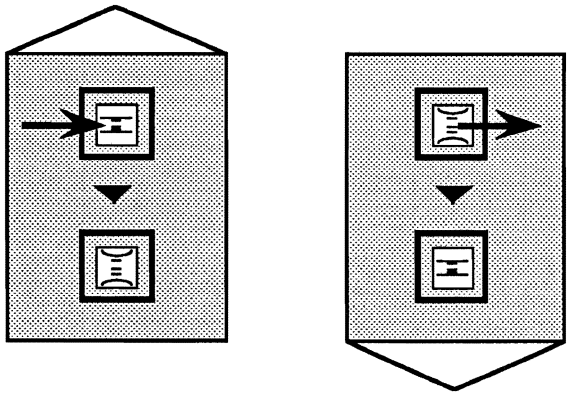
starting to move



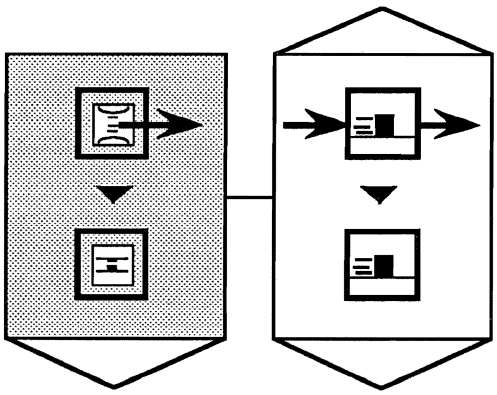
Changes which 'just happen' can drive changes which do not 'just happen' (e.g. a steam engine).



Springs may be stretched (energy is stored) or released (energy escapes and spreads out).



Making a fuel is a bit like stretching a spring. Burning a fuel in oxygen is a bit like releasing a spring.



Changes in which things are kept moving also need a change to drive them. Moving things can transfer energy from one place to another.

Activity H1 - Things that 'just happen' and things that don't

The activity introduces the idea of spontaneous and non-spontaneous changes. Spontaneous changes are those that 'just happen' by themselves and are able to drive other changes which do not 'just happen' by themselves.

Pupils seem to take quite easily to the phrases 'changes that just happen by themselves' and 'changes that do not just happen by themselves', so we have used these terms throughout the activities in this theme. The essential idea which is built on later in this theme is that changes which 'just happen' can drive those which do not. We are often concerned with energy in these changes, but the focus is on spontaneity rather than on the incorrect explanation that 'energy drives changes'.

Sheet 1 is intended to be used as an OHP to introduce the ideas. Sheet 2 is a matching activity for pupils - the changes are about things warming and cooling, and starting to move and stopping. This would be a useful opportunity to give pupils practical experiences of moving things getting warmer, and to discuss what is happening to the energy when moving things slow down. The energy is 'spreading out' and the surroundings warm up. (See also activity B5 'Ways of making things hotter'.)

Answers:
1 C 2 F 3 A 4 B
5 D 6 E

Sheet 3 is a further activity for pupils, in which they need to identify pictures which do not make sense.

Answers:
Pictures 2 and 4 do not make sense, since the two changes (getting hotter and starting to move) do not 'just happen by themselves' as shown. Picture 6 does not make sense, since it shows a change which does not 'just happen' to drive another.

Activity H2 - Springs and things

This activity introduces what happens when springs are pulled and released, and draws the similarity between this and lifting something away from the Earth. It is important in developing the idea of fuels later, since we shall be drawing similarities between fuels and springs.

Sheets 1 and 2 are intended to be used as OHPs to introduce the ideas. Sheet 1 draws the similarity between pulling a spring and lifting something away from the Earth, so the same picture can be used to represent these changes. Other examples of similar changes could be given, e.g. squashing a spring, pulling and releasing a luggage cord or a rubber band, a rocket being fired into space, a falling meteorite. Sheet 2 develops the idea that 'pulling apart' changes

do not 'just happen' but that the opposite change does. However, when we say that these changes 'just happen' we need to add 'once they have been started' because there may be something preventing the change from happening. This is an important idea to be clear about since it causes confusion for pupils when they are thinking about changes to fuels, which often have to be set alight before they burn (see activity H3 'Storing and releasing energy').

Sheet 3 is a matching activity for pupils - note that in this activity there is room for interpretation in the matches which could be made.

Answers:

1 F	2 E	3 B
4 A C H	5 D G	

Activity H3 - Storing and releasing energy

This activity introduces a way of thinking about burning fuels as the coming together of fuel and oxygen that have been 'kept apart'. This is compared to releasing a spring or dropping an object.

An important idea to stress here is that energy is released when a fuel *reacts with oxygen.* A fuel on its own is not a store of energy - a candle would be useless in outer space and a car would not work on the Moon because there is no oxygen. They would be useful as fuels if there was a supply of oxygen as well. (On a planet in which the atmosphere was methane, then oxygen would be a 'fuel'). Fuel burning in oxygen releases energy - this is similar to a spring being released (and in the next activity a picture of a fuel burning will be introduced which looks similar to the equivalent picture for a spring).

Another important idea is that a fuel burning is *a change that 'just happens'.* Children may object to this idea, saying that you need to light it first. They are absolutely right - what we really mean when we say that fuel burning 'just happens' is that it 'just happens once is has been started'.

Answers:

All of the changes which 'just happen' are those in which energy is released (it 'spreads out' and becomes 'less concentrated'). All of the changes which 'do not just happen' are those in which energy is stored.

Activity H4 - Ways of storing energy

This activity looks in detail at one 'case-study' - using water to store energy. Some new 'pictures of changes' are introduced showing energy being stored and released during chemical change.

The pictures introduced here are probably the most difficult so far, since they are not just representing familiar changes in a new way (e.g. a hot object cooling or a moving object slowing down). They require pupils to look at a change in a completely new way. The essential idea is that energy can be stored by *making molecules move faster* or *by splitting molecules apart.* The particular example chosen is water, and this can be accompanied by practical demonstration. Using a power pack to drive the changes, water may be made hotter, or electrolysed to form hydrogen and oxygen. These are both ways of storing energy. Each of the reverse processes 'just happens' and can be used to drive other changes. (*N.B. A mixture of hydrogen and oxygen is explosive and needs to be handled with great caution.* It must never be put into a container. A soap bubble containing the gases may be exploded - it makes a very loud bang - and strongly suggests the idea of energy being released as the 'pulled apart' oxygen and hydrogen join back together.)

Sheets 1, 2 and 3 are OHPs which introduce the ideas. Sheet 1 summarises the changes. Sheet 2 looks at what is happening in terms of particles (see Theme G 'Up and down in complexity' for pictures of 'joining' and 'splitting'). Sheet 3 looks at what is happening in terms of energy. Sheet 4 is a pupil activity - they are asked to write about the changes and the explanations for them that are discussed on the OHPs (Answers: A 1, B 3, C 2, D 4). It would also be worth discussing with pupils in what ways changes A and B are similar and in what way they are different. A summary of the changes follows:

A Storing energy by making something hotter

Immersion heater in water.

- We can store energy in water by making it hotter - making the particles move faster.
- This does not happen 'by itself' - need something to make it happen, to drive the change (in this case - a power pack)

B Storing energy by 'hiding it away'

Electrolysis of water - e.g. Hoffman voltameter

- Making water hot is not the only way can use it to store energy - we can also use store energy by *pulling* the molecules of water apart (the atoms in the molecules are attracted to each other). This is like storing energy in a *spring* by pulling it apart - the energy does not make the water hotter, the energy is 'hidden away' like in a stretched spring. Pulling apart water molecules gives hydrogen and oxygen.
- This does not happen 'by itself' - need something to make it happen, to drive the change (in this case - a power pack)

C Energy escaping (cooling down)

Hot water cools after being heated with immersion heater.

- Energy escapes when the water cools down - the particles slow down.
- This 'just happens by itself' - we can use it to drive other changes, for example:
  making something hot
  making something move (their simple model engine, etc.)

D Energy escaping (releasing energy that was 'hidden away'))

Hydrogen and oxygen react together to form water

- Energy escapes when the hydrogen atoms and oxygen atoms rejoin to form water - like a *spring* being released - the energy 'hidden away' in the hydrogen and oxygen now spreads out.
- This 'just happens by itself' - we can use it to drive other changes, for example:
  making something hot*(burning hydrogen and oxygen together)*
  making electricity (*connecting a voltmeter across the terminals of the Hoffman voltameter after electrolysis will produce a reading of over 1 volt* - this is like a rechargeable battery - using an electric current to change the chemicals, the getting an electric current again as the chemicals change back).

Activity H5 - Fuels and food

This activity develops from the way of thinking about fuels introduced in the previous activity, and extends the range of examples.

Sheet 1 gives a set of changes in which energy is being stored or released. Sheet 2 has a set of pictures to which pupils should match the changes. The pictures show things warming and cooling, starting to move and stopping, and energy being stored or released during chemical change.

Answers:

1 H	2 A C
3 E G	4 B D
5 J	6 F I

Activity H6 - Hydrogen as a fuel

This activity sets the idea of splitting and reforming water molecules into an important social context - the suggestion of a 'hydrogen economy'.

Sheets 1 and 2 are intended to be used as OHPs to introduce the ideas. The information about the use of hydrogen as a fuel is given on the pupil sheet (Sheet 3) which also has questions for pupils to answer. This activity is intended as something which can be done in its own right, but also as a way of thinking about what happens during photosynthesis and respiration (see Activity H7 'Fuels in Nature').

Activity H7 - Fuels in Nature

This activity builds on the ideas of using hydrogen as a fuel, introduced in the previous activity.

Sheets 1 and 2 are intended to be used as OHPs to introduce the ideas - that the use of hydrogen as a fuel is similar to the processes of photosynthesis and respiration. The information about photosynthesis and respiration is given on the pupil sheet (Sheet 3) which also has questions for pupils to answer.

Below is some background information about the similarities between making hydrogen fuel and photosynthesis, and using hydrogen fuel and respiration.

Making hydrogen fuel	Photosynthesis
key step is pulling apart of hydrogen and oxygen (like pulling a spring)	key step is pulling apart of hydrogen and oxygen (like pulling a spring)
this acts as an energy store - energy becomes more concentrated in the system	this acts as an energy store - energy becomes more concentrated in the system
the change does not happen by itself	the change does not happen by itself
energy from Sun to solar cell	energy from Sun to leaf
electricity acts as energy carrier	chlorophyll acts as energy carrier
hydrogen is a gas so it is not very convenient to store - this is a major technical problem in using hydrogen fuel - possible ways of solving the problem are expensive	the plant cannot store hydrogen so it takes in carbon dioxide from the air to make starch - this is an insoluble solid so it is a convenient store of hydrogen
oxygen is readily available in the atmosphere, so this is not stored	oxygen is readily available in the atmosphere, so the plant releases this through the leaves

Using hydrogen fuel	Respiration
energy is not stored in the hydrogen but in the hydrogen/oxygen system	energy is not stored in the fuel but in the fuel/oxygen system (i.e. starch/oxygen)
energy is released when the hydrogen is taken from the store and joins with oxygen (like releasing a spring)	energy is released when the hydrogen is taken from the starch and joins with oxygen (like releasing a spring)
hydrogen joining with oxygen is a change which 'just happens'	starch joining with oxygen is a change which 'just happens'
you could just burn hydrogen in the air - all the stored energy would escape and spread out	you could just burn starch (and other fossil fuels e.g. petrol) in the air - all the stored energy would escape and spread out
you could also use the release of the energy from the store to drive other changes - a fuel cell generates electricity which could be used to drive a motor, etc.	in respiration, the release of the energy from the store can be used to drive other changes - movement, synthesising complex molecules, etc.

Activity H8 - Energy transfers

This activity introduces the idea that energy can be moved from one place to another.

Sheet 1 is intended to be used as an OHP to introduce the ideas. Essentially the point is that in transferring energy from one place to another things need to be kept moving. This could be a physical object, but it could be electricity or radiation. Sheet 2 is an activity sheet for pupils.

Answers:

1 D 2 B
3 A 4 C

Activity H9 - Impossible changes

This activity is intended to consolidate the ideas introduced in this theme.

Pupils need to identify those pictures which show 'impossible changes'.

Answers:

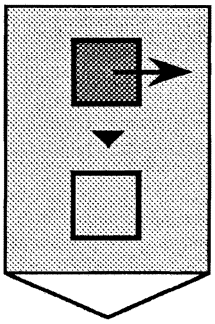
The following are the 'impossible changes':

1 Something does not get hot 'just by itself'.
4 Energy does not get 'hidden away' or stored 'just by itself'.
5 A change that does not 'just happen' cannot drive another change.
7 A change that does not 'just happen' cannot keep another change going.

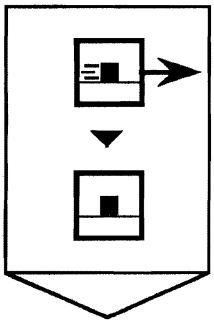
Things that 'just happen' and things that don't

Some changes 'just happen' by themselves:

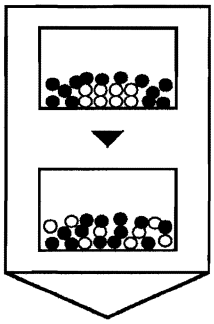
a beaker of hot water cools down



a moving ball slows down and stops



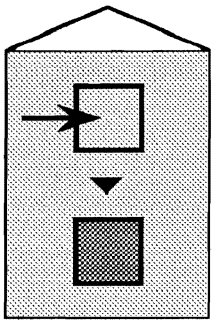
salt dissolves in water

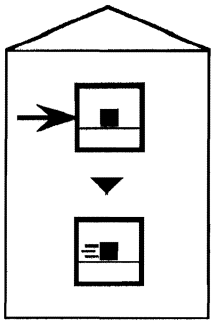


These pictures have been drawn with a box around them pointing down - this is to show that the changes 'just happen'.

Some changes do not 'just happen':

For example, things do not suddenly get hot or start moving for no reason:

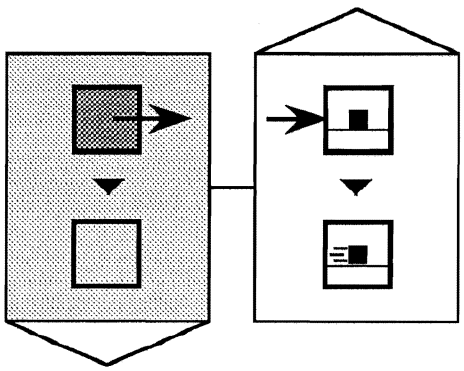




Each of these pictures has a box around it pointing up - this is to show that the change does not 'just happen'.

However, we can use a change that 'just happens' to drive a change that does not.

For example, a steam engine - the engine moves because the hot steam cools.

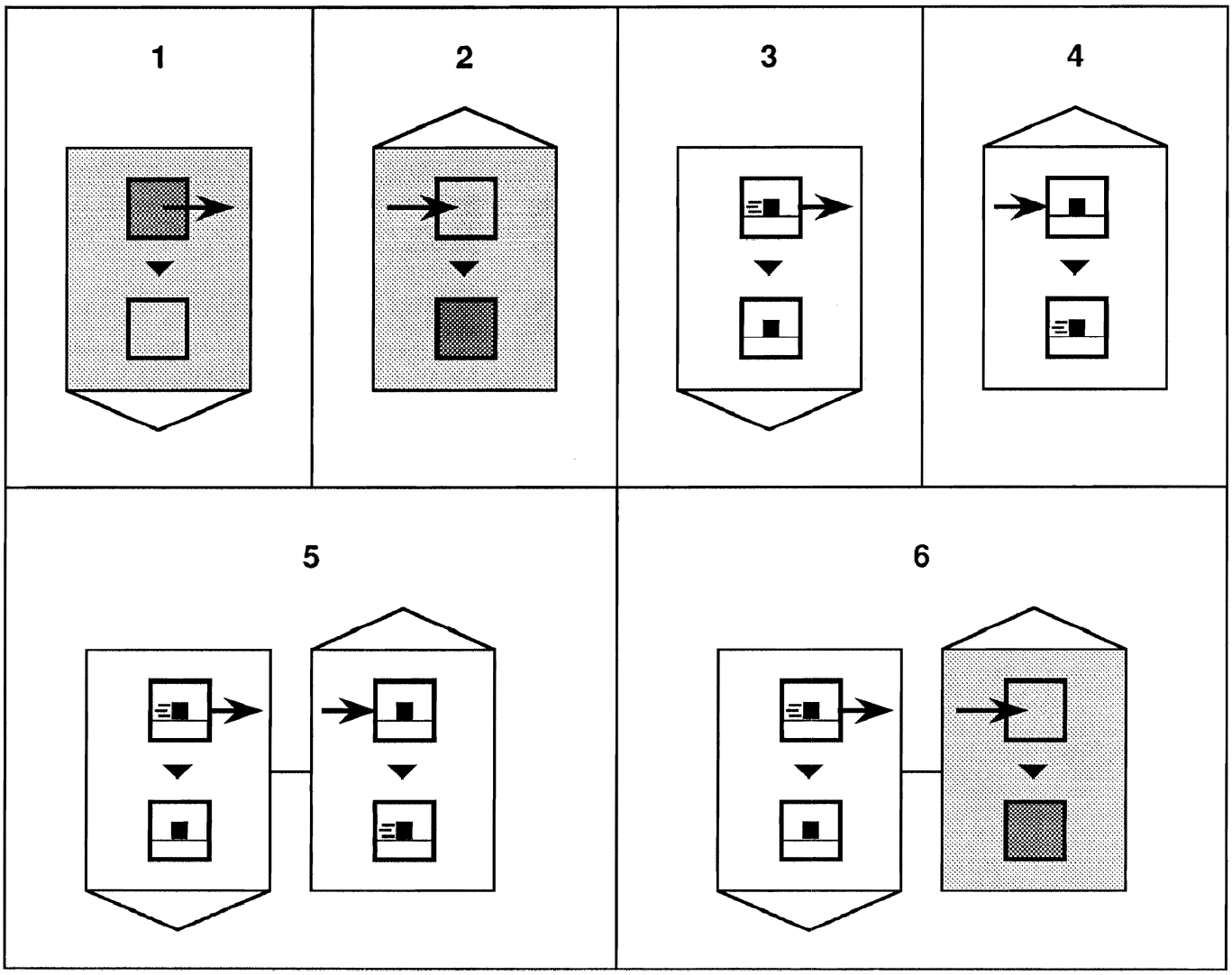


Things that 'just happen' and things that don't

Sheet 2

1 Below are some different changes. Match each one to the picture you think best represents the change. (There is one change for each of the six pictures.)

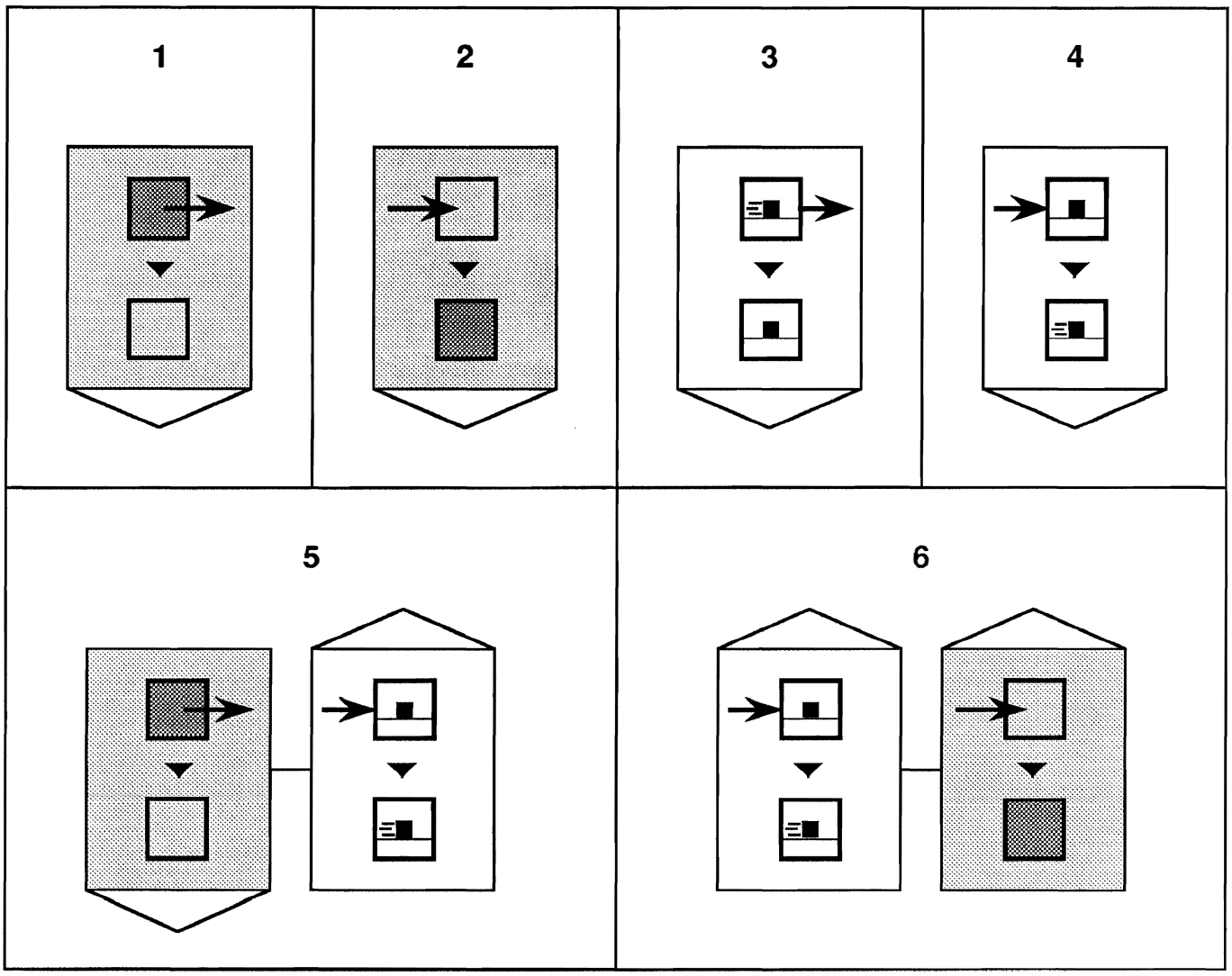
A If you stop pedalling a bicycle it will slow down and stop.	**B** A ball does not start moving just by itself.
C A hot cup of tea cools down.	**D** A tennis racquet hits a ball - the racquet slows down and the ball speeds up.
E When you use the brakes on a car, they get hot as the car slows down.	**F** A saucepan of water does not suddenly become hot for no reason.



2 Below are some pictures representing changes. Some of these pictures do not make sense.

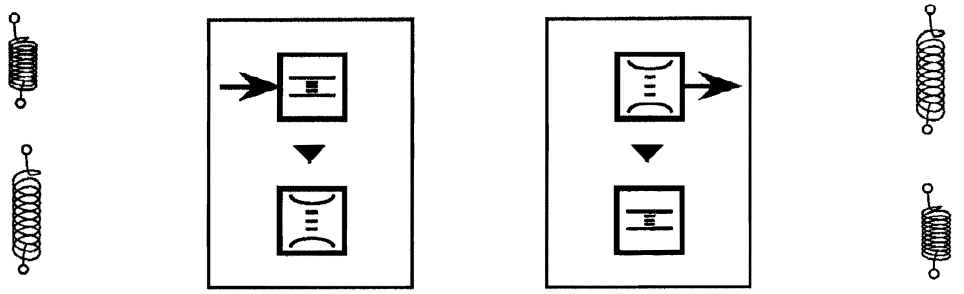
a) Which pictures don't make sense? Why not?

b) Which pictures do make sense? For each one, think of an example of what it could be showing.



Springs and things

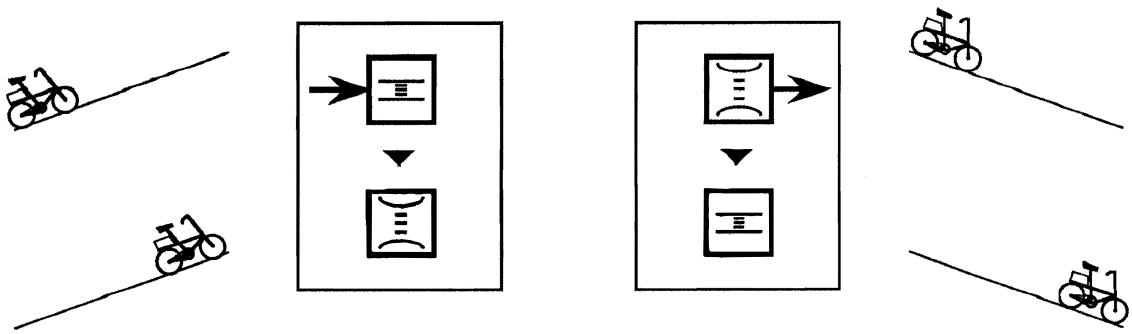
A Pulling a spring



When you pull the two ends of a spring apart, energy is stored.

When you 'let go' of the spring, the energy escapes and spreads out. The spring and the air around it warm up a little.

B Pulling something away from the Earth

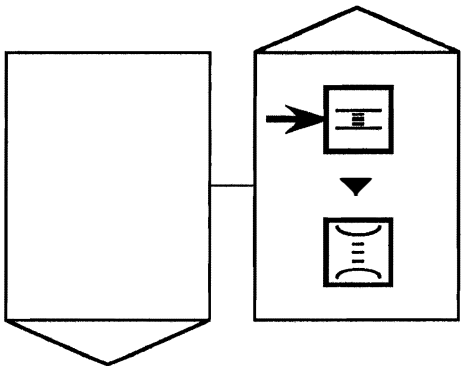


When you push a bicycle up a hill, it is a bit like pulling the two ends of a spring apart - you are 'pulling the bicycle and the Earth apart'.

When the bicycle runs down the hill, the energy escapes and spreads out. The bicycle and the air around it warm up a little.

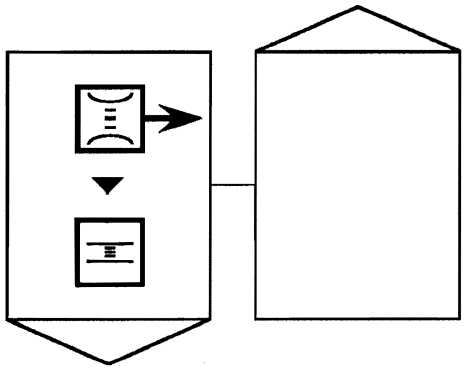
C Things that 'just happen'

These kinds of changes do not 'just happen' by themselves. They need to be driven by other changes.

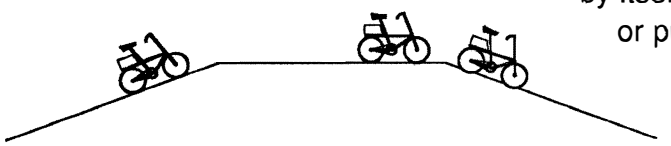


E.g. a bicycle does not go uphill by itself.

These kinds of changes 'just happen' by themselves (... once they have been started). They can drive other changes.

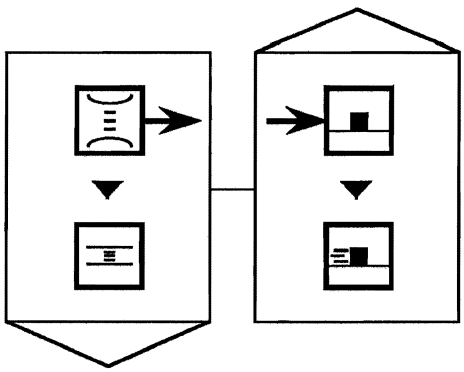


E.g. a bicycle goes downhill 'by itself' (... once you let go or push it over the edge).



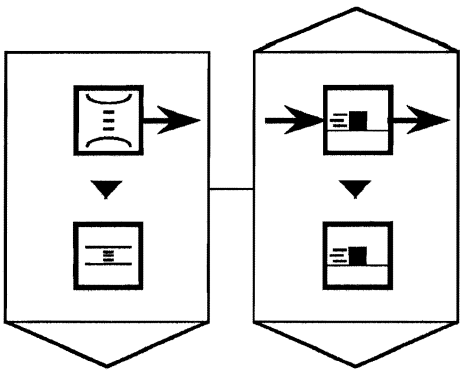
D Getting something moving and keeping it moving

A change which 'just happens' can be used to *get* something moving.



E.g. the spring in a clockwork toy starts to move it along the floor.

A change which 'just happens' can be used to *keep* something moving.



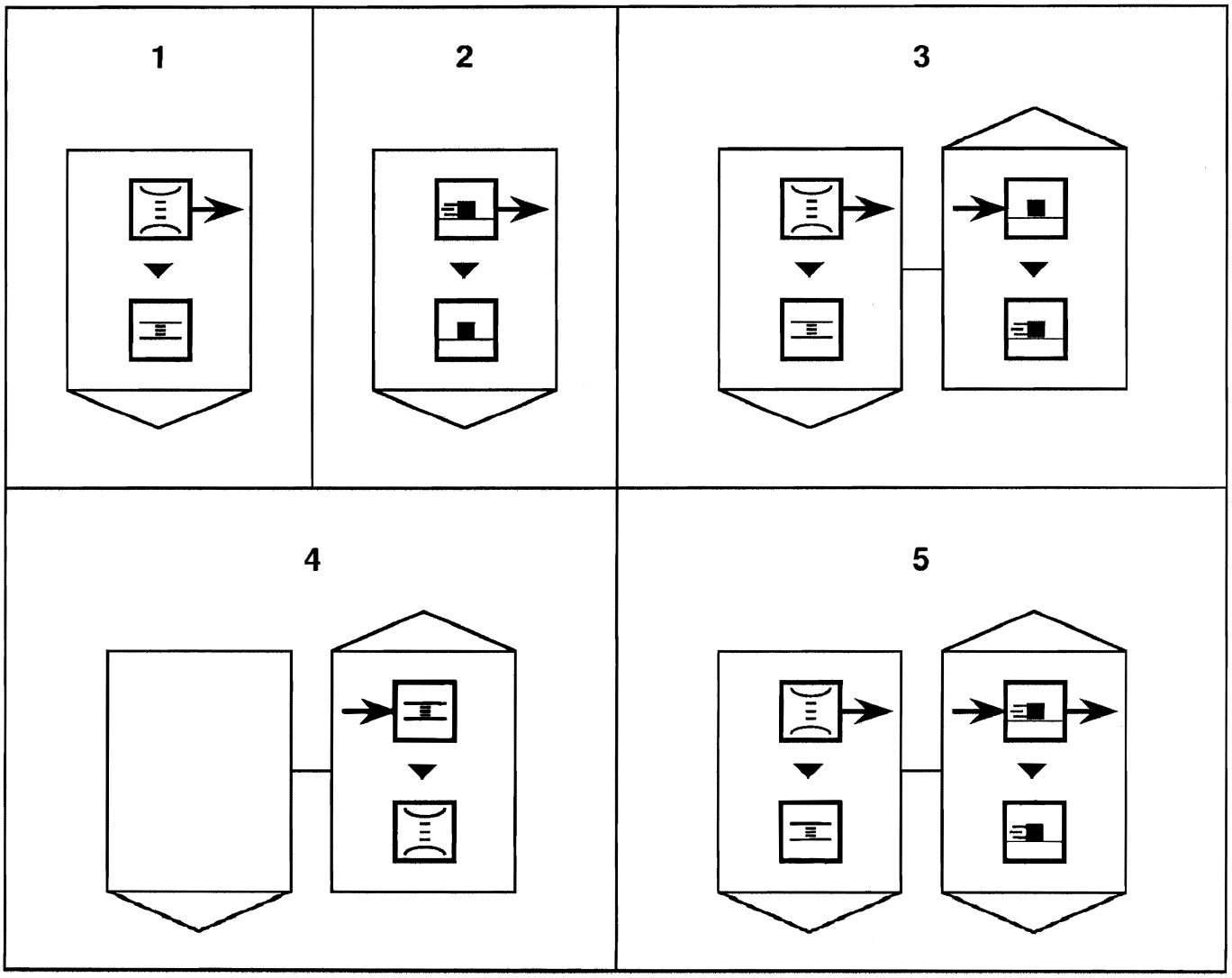
E.g. the spring in a clockwork toy keeps it moving along the floor.

Springs and things

Sheet 3

Below are some different changes. Match each one to the picture you think best represents the change. (You can match more than one change to a picture.)

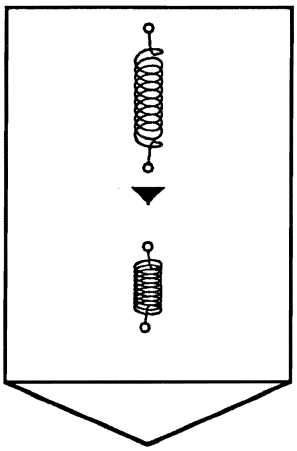
A A clockwork toy is wound up.	**B** A stretched bow is released, firing an arrow.
C Water is pumped to the top of a hill.	**D** A clockwork toy is running along the floor.
E A ball is rolling along the ground and stops.	**F** An old building falls down.
G Water flowing down a river keeps a waterwheel turning.	**H** Someone lifts a bucket to the top of a building.



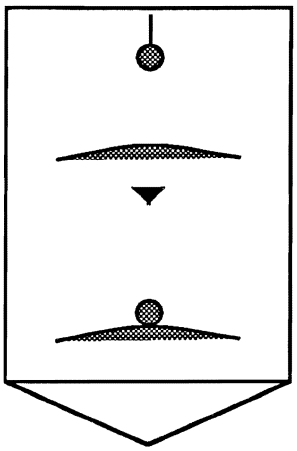
Storing and releasing energy

Energy stores

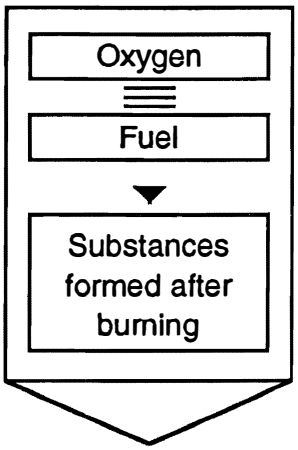
a stretched spring - the two ends are being kept apart



a ball above the ground - the ball and the Earth are being kept apart

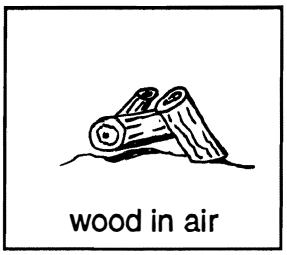


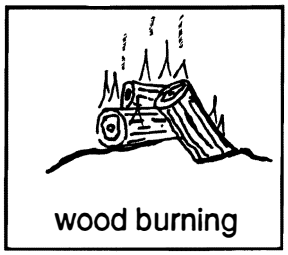
a fuel in air - the fuel and the oxygen are being 'kept apart'

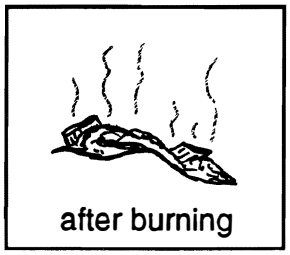


Could you light a candle in outer space? Could you run a car on the Moon? Could you light a match under water?

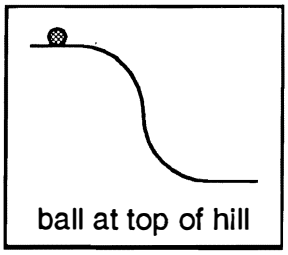
Fuel burning in air 'just happens' by itself ... once it has been started

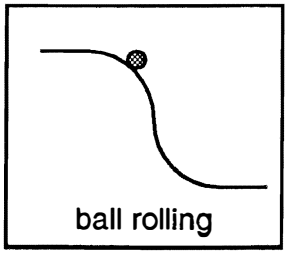


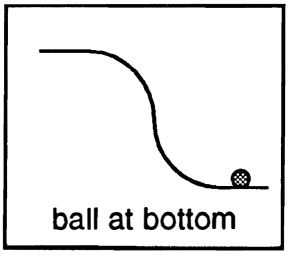




wood burns in air 'just by itself' - though you may need to 'give it a push' (by making it hot) to get it started



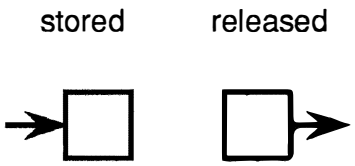
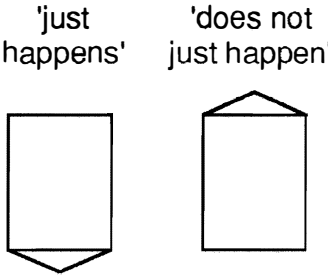




a ball rolls down a hill 'just by itself' - though you may need to 'let it go' or 'give it a push' to get it started

Storing and releasing energy

Sheet 2

Here are some changes. Tick the boxes you think describe what happens in each change.	Is energy being stored? Or is energy being released? 	Is the change something that 'just happens' (once started)? Or is it something that 'does not just happen' by itself? 
A A clockwork toy is running along the floor.	❑ ❑	❑ ❑
B A candle burns with the oxygen in the air.	❑ ❑	❑ ❑
C A stretched bow is released, firing an arrow.	❑ ❑	❑ ❑
D Coal is burnt in a power station.	❑ ❑	❑ ❑
E Petrol is mixed with air in a car engine and burnt.	❑ ❑	❑ ❑
F A clockwork toy is wound up.	❑ ❑	❑ ❑
G A battery is recharged.	❑ ❑	❑ ❑
H Water is pumped up a hill.	❑ ❑	❑ ❑

1 Which are the changes which 'just happen' - energy being stored or released?

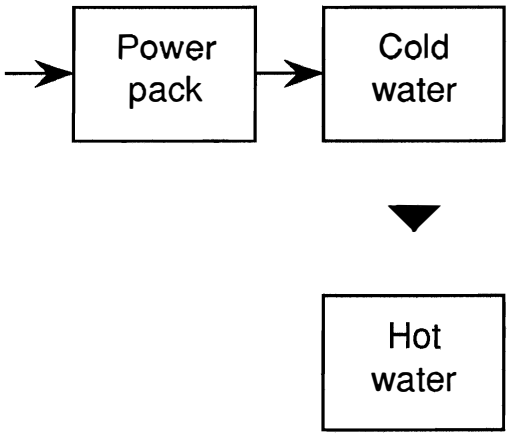
2 Which are the changes which 'do not just happen' - energy being stored or released?

3 Could you light a candle in outer space? Could you run a car on the Moon? Could you light a match under water?

Ways of storing energy

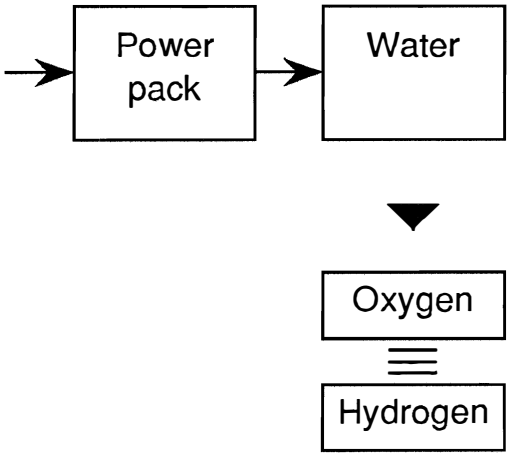
A Storing energy 1

Water is heated with an immersion heater.



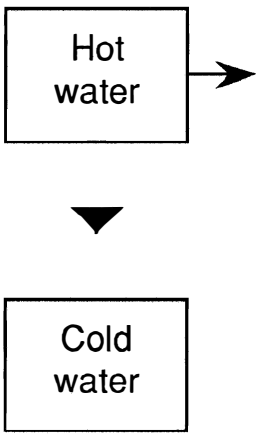
B Storing energy 2

Water is electrolysed to give hydrogen and oxygen.



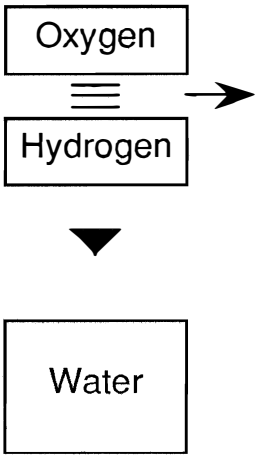
C Energy escaping 1

Hot water is left to cool.



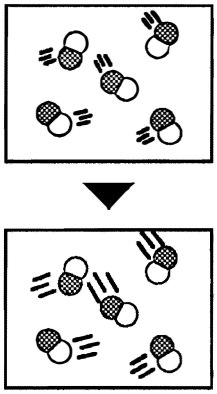
D Energy escaping 2

Hydrogen and oxygen react to form water.



A Storing energy 1

- by making something hotter

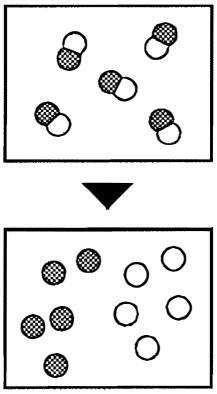


particles move faster

(e.g. water is heated with an immersion heater)

B Storing energy 2

- by splitting particles

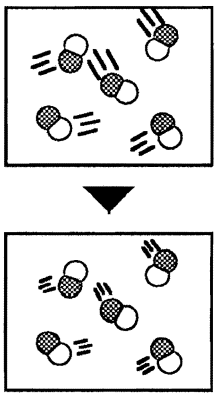


pulling particles apart

(e.g. water is electrolysed to give hydrogen and oxygen)

C Energy escaping 1

- by cooling down

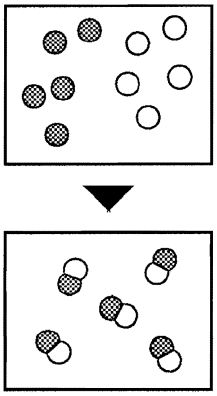


particles move slower

(e.g. hot water is left to cool)

D Energy escaping 2

- by particles joining

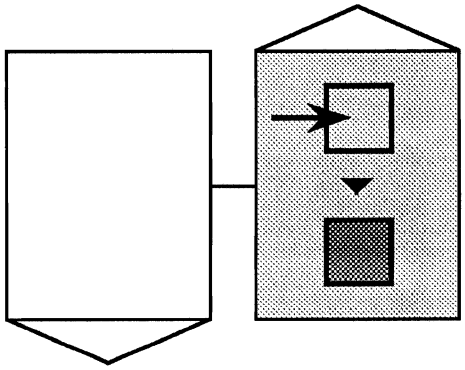


particles forming again

(e.g. hydrogen and oxygen react to form water)

A Storing energy 1

- by making something hotter

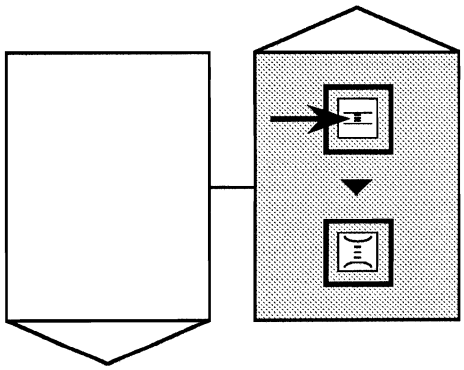


does not 'just happen'
needs to be driven

(e.g. water is heated with an immersion heater)

B Storing energy 2

- by 'hiding it away'

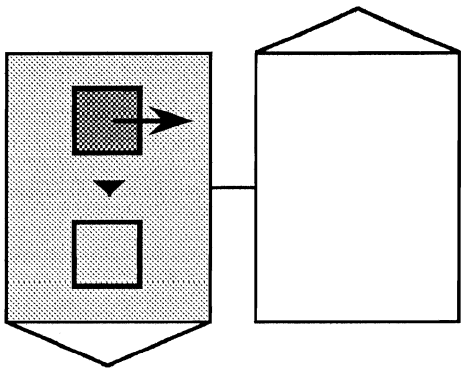


does not 'just happen'
needs to be driven

(e.g. water is electrolysed to give hydrogen and oxygen)

C Energy escaping 1

- by cooling down

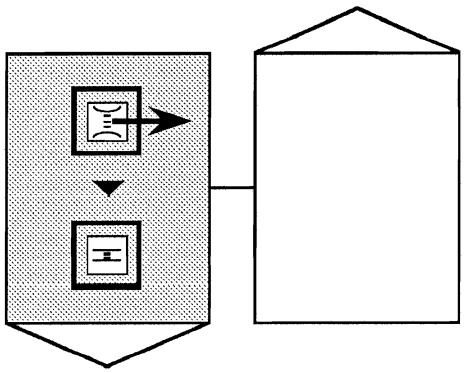


'just happens'
can drive another change

(e.g. hot water is left to cool)

D Energy escaping 2

- by releasing energy that was 'hidden away'



'just happens'
can drive another change

(e.g. hydrogen and oxygen react to form water)

Ways of storing energy

Sheet 4

The pictures below show some ways of storing and releasing energy. Two ways of storing energy are shown:

- by making something hotter (the particles move faster)
- by 'hiding it away' (the particles are pulled apart).

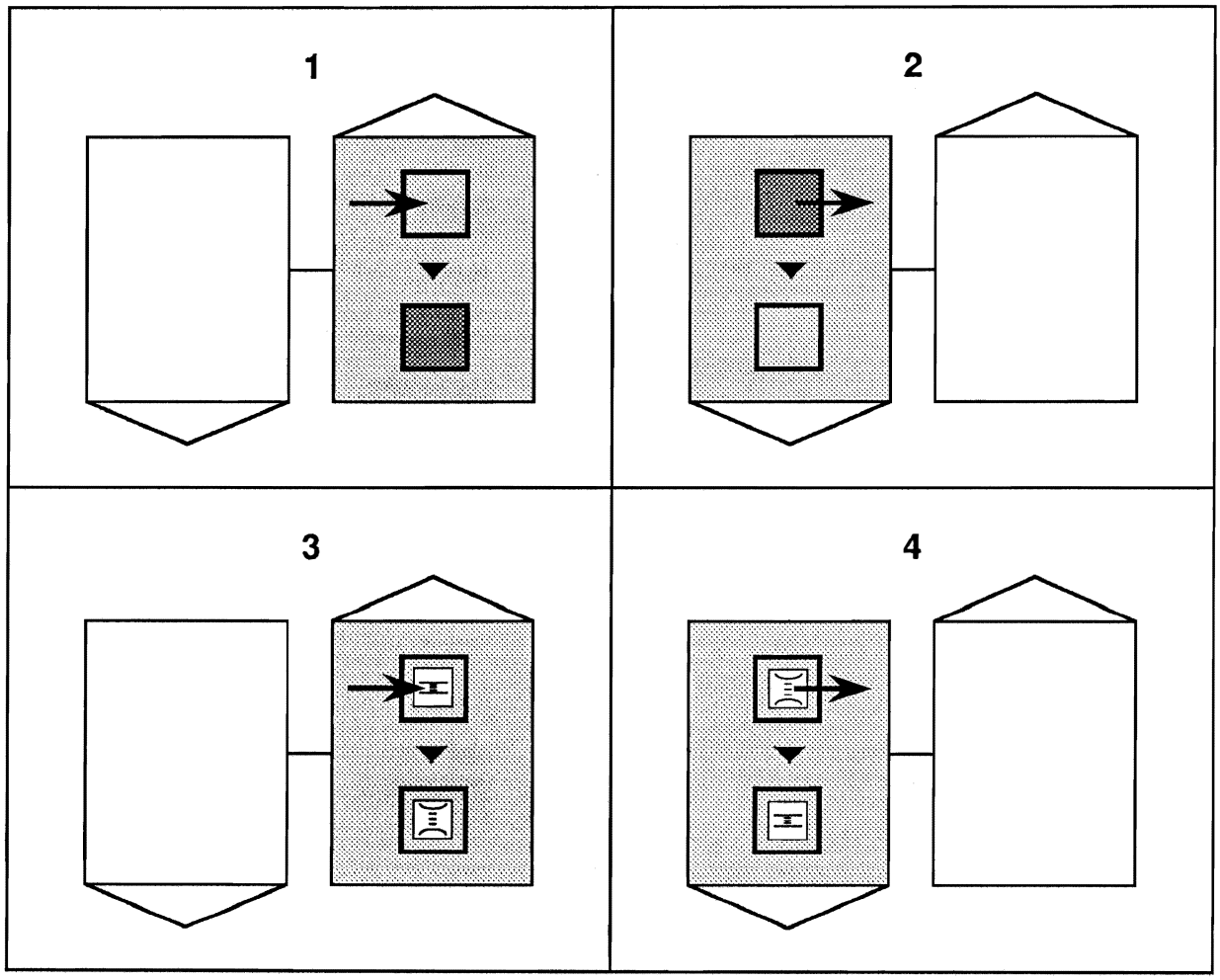
Match each of these changes to the the picture you think is best.

A Water is heated with an immersion heater
B Water is electrolysed to give hydrogen and oxygen
C Hot water is left to cool
D Hydrogen and oxygen react to form water

Questions

For each of the above changes, answer these questions:

1 What happens to the energy?
2 What happens to the particles?
3 Does the change 'just happen' by itself or does it need to be 'driven' by another change?

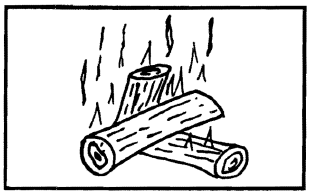


Fuels and food

Sheet 1

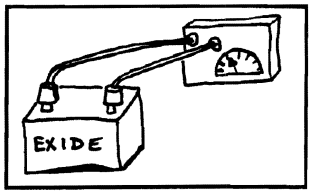
Below are some different changes. Match each one to the picture you think best represents the change. (You can match more than one change to a picture.)

A



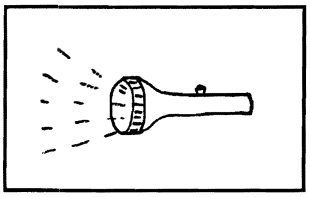
wood burning

B



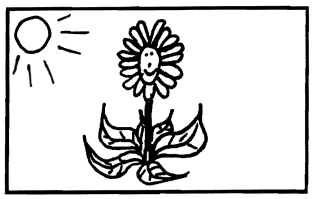
recharging a battery

C



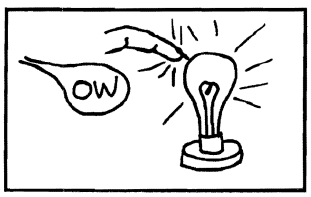
a torch battery runs down

D



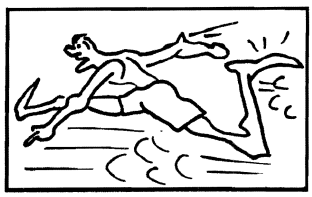
a plant makes starch by photosynthesis

E



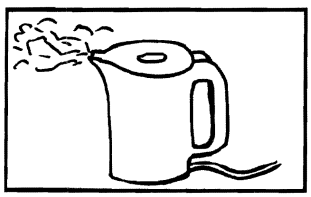
an electric light bulb gets hot

F



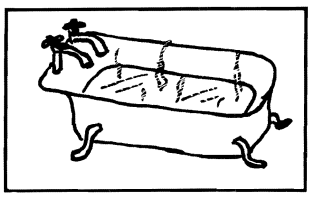
a person uses up food running a race

G



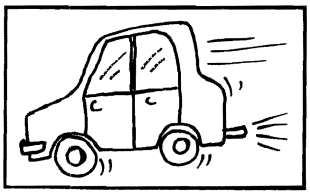
using a kettle to boil some water

H



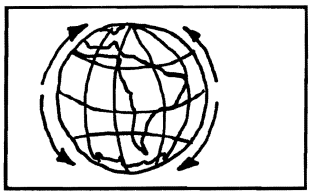
a bath of hot water cools down

I



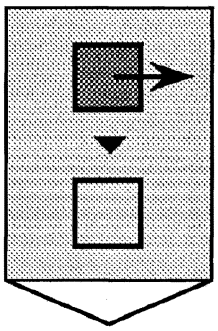
petrol is used in a car engine

J

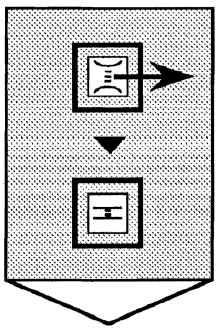


winds blow because energy goes from hot regions of the Earth to cold

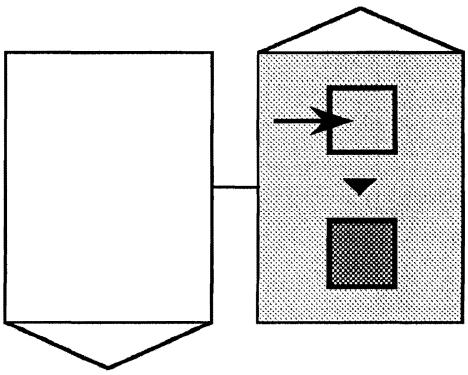
1



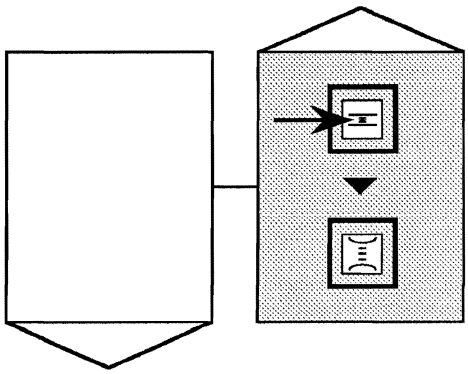
2



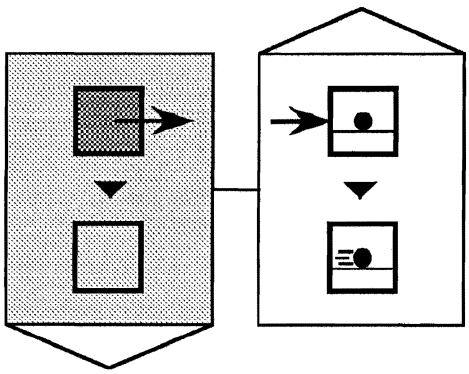
3



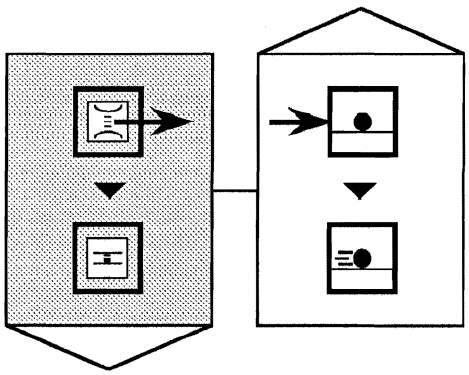
4



5

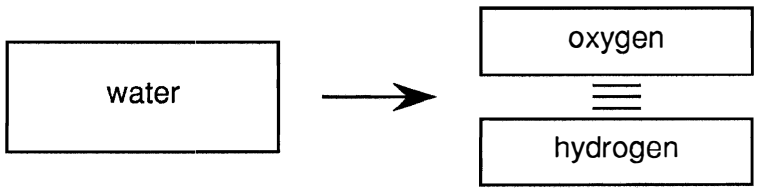


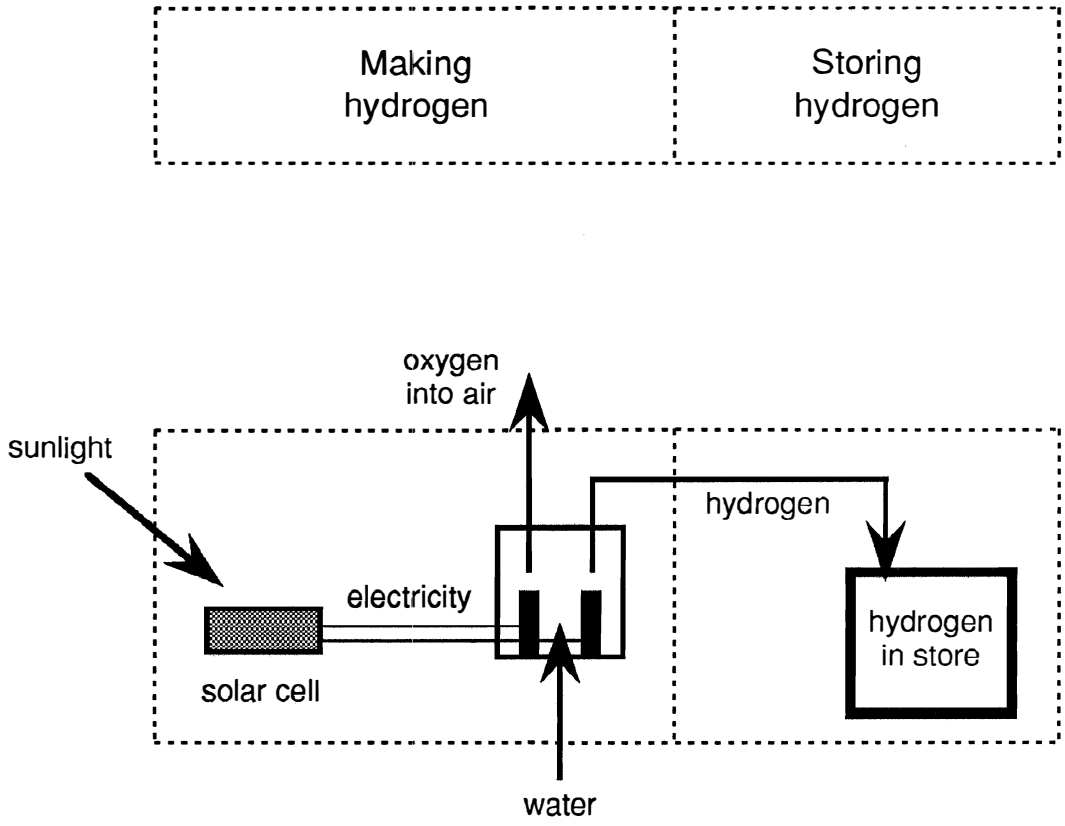
6



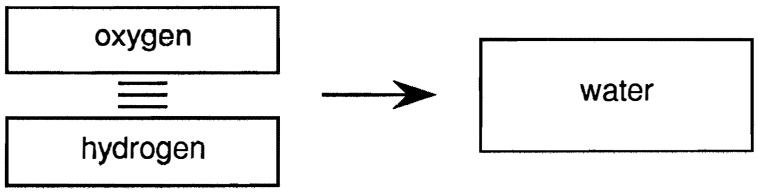
Hydrogen as a fuel

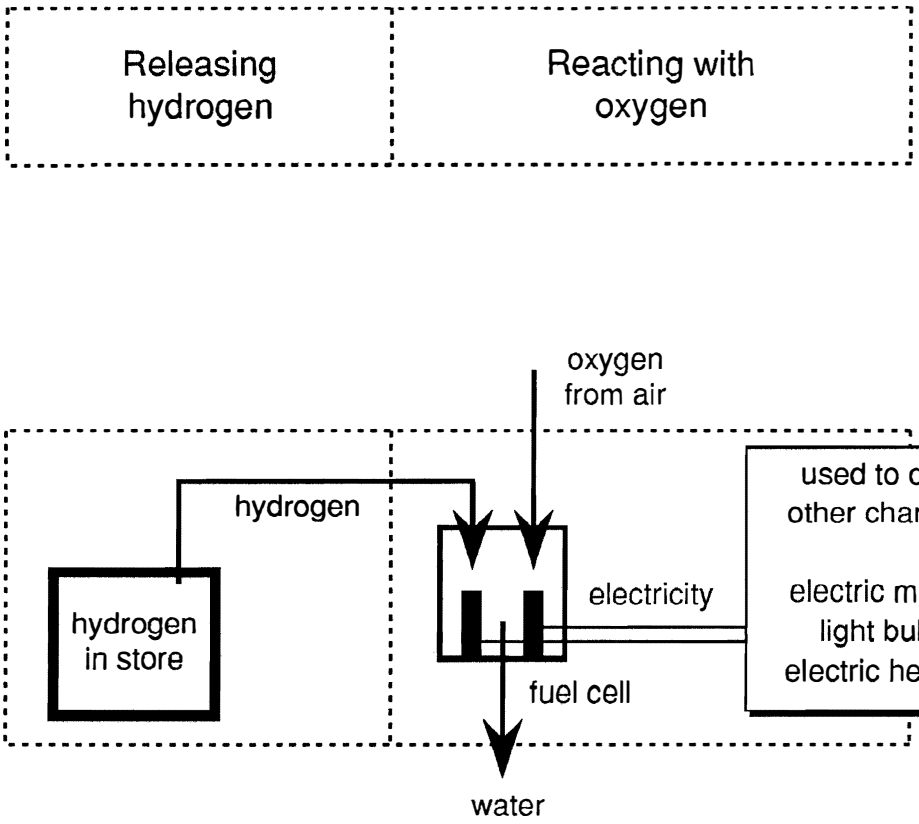
Making hydrogen fuel





Using hydrogen fuel



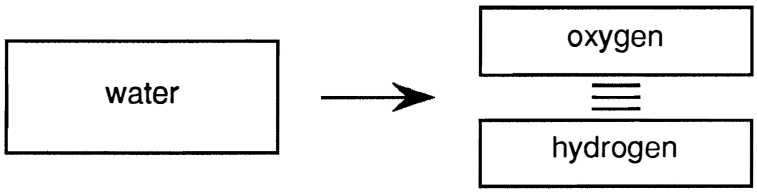


Hydrogen as a fuel

Our lives depend on fossil fuels - coal and oil. But fossil fuels will eventually run out. Some people have suggested that in the future we may have a 'hydrogen economy' - with hydrogen as our main fuel. Other people think that there are too many problems to solve for this to happen.

Making hydrogen fuel

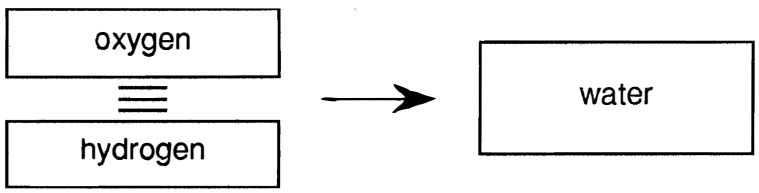
Energy from the Sun could be stored by making hydrogen from water. A solar cell uses sunlight to make electricity which can split the water.



The problem with this is that solar cells are very expensive to make. Some people have suggested that the electricity could be made from nuclear power after fossil fuels run out.

Using hydrogen fuel

A 'fuel cell' can make electricity by combining hydrogen and oxygen (in the air) to make water.



Hydrogen is a very clean fuel, and produces no pollution - when it reacts, only water is produced. It is very light, and much more energy is released when 1kg of hydrogen is burnt compared with 1kg of petrol. The problem is that hydrogen is a gas, so you would need a very big fuel tank to carry it. Researchers are trying to solve the problem. One way is to store the gas under pressure. But this would mean using a heavy container to hold it. More practical solutions are to store it as a very cold liquid, or to absorb it onto metal alloy 'sponges'. But these solutions are very expensive, so the problem remains unsolved.

Questions

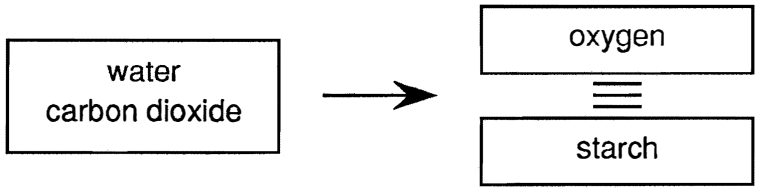
1 Explain what happens to the *particles* and to the *energy* when sunlight is used to make hydrogen fuel.

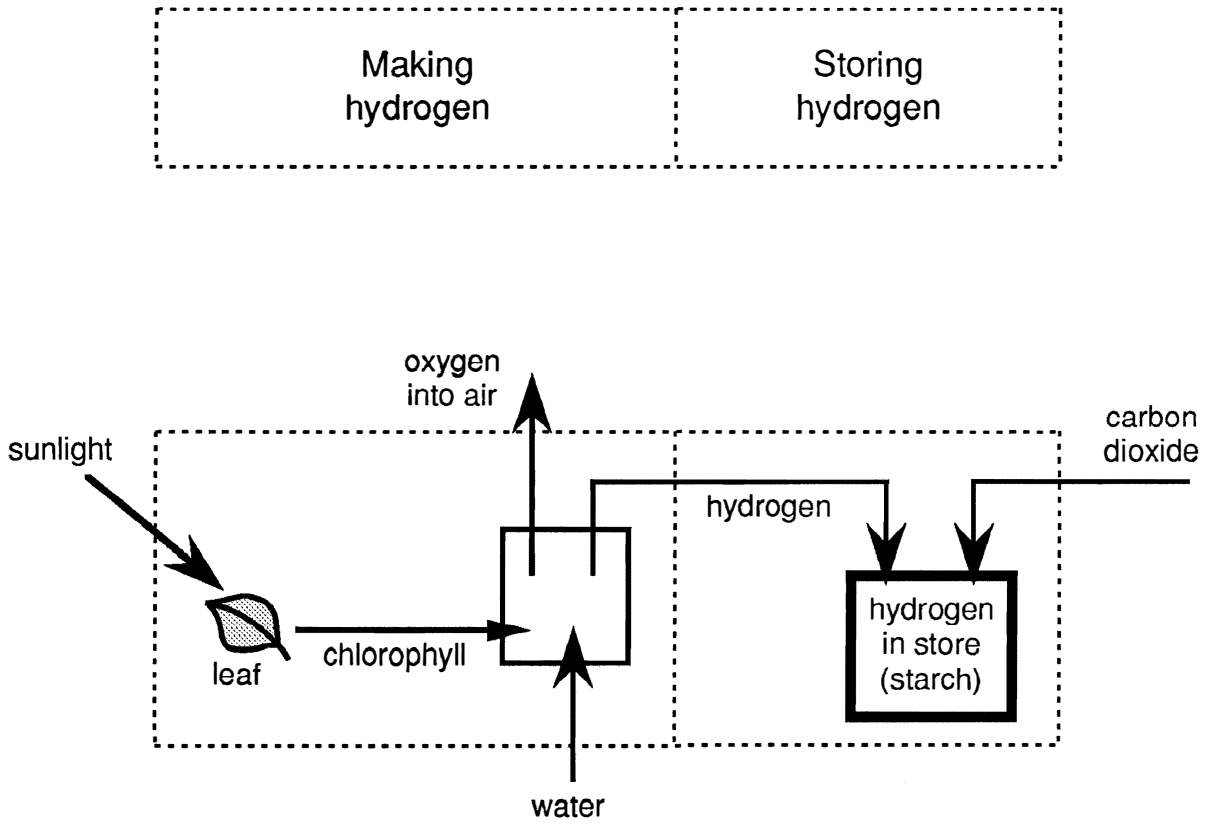
2 Explain what happens to the *particles* and to the *energy* when hydrogen fuel is used to generate electricity.

3 List the advantages of hydrogen as a fuel. List the disadvantages.

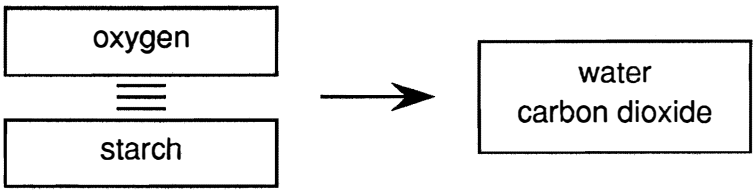
Fuels in Nature

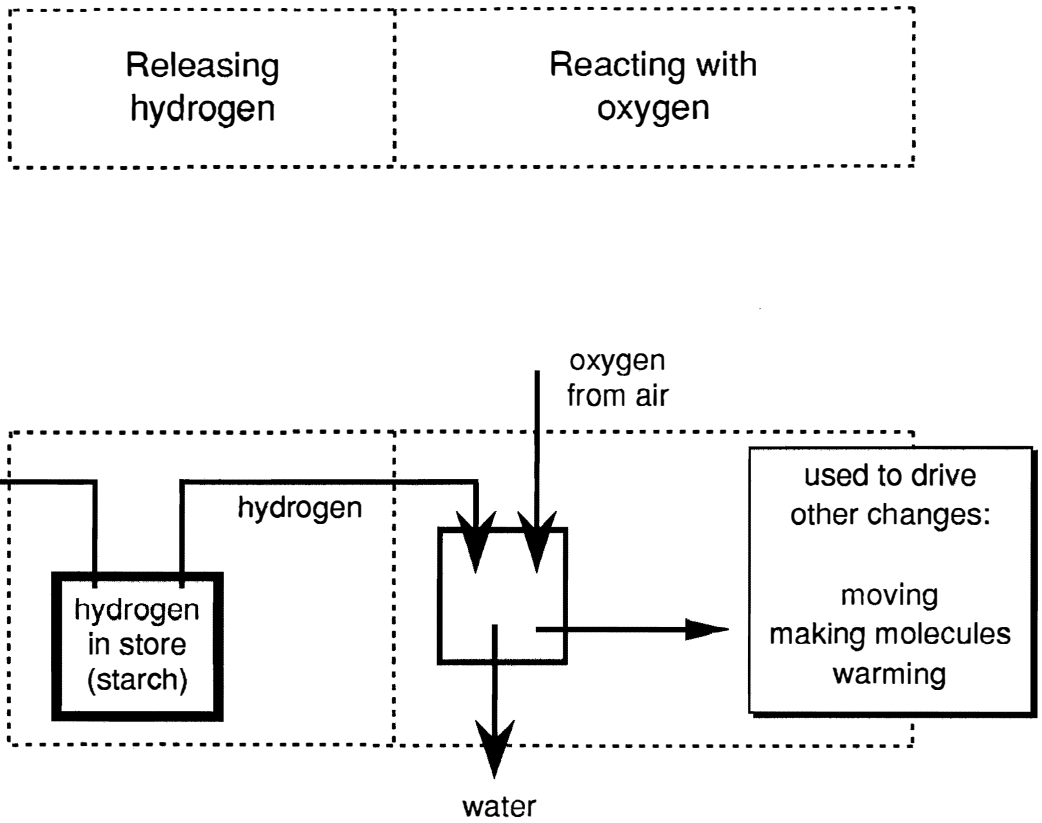
Making fuel - photosynthesis





Using fuel - respiration



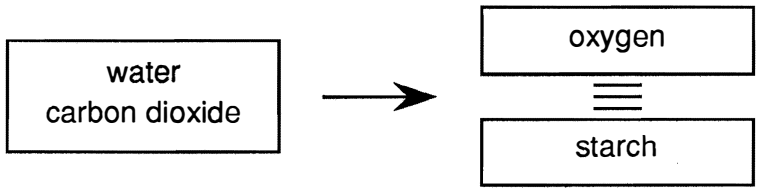


Fuels in Nature

Photosynthesis is a very important reaction for living things since it is the first step in making 'biological fuels' or food. These fuels are used by plants and by the animals that eat the plants. These fuels are also the starting point for fossil fuels, such as coal, oil and gas.

Making fuel - photosynthesis

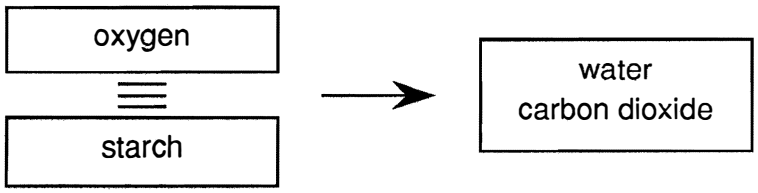
In the first step of photosynthesis, water is split into hydrogen and oxygen. This is very similar to making hydrogen fuel using a solar cell to generate electricity to electrolyse water. The second step is to store the hydrogen. A plant does this by joining the hydrogen to carbon dioxide to form glucose. Glucose molecules are then joined together to form starch. Starch is the fuel that plants store. Overall the process is:



The plant does not need to store oxygen, since there is oxygen in the air. When a plant needs to use the starch as a fuel, it can react it with oxygen from the air.

Using fuel - respiration

When starch is used as a fuel is these steps are reversed. Starch is broken down into glucose, and the hydrogen from the glucose reacts with oxygen forming water. This reaction can drive other changes in the plant, such as building up complex molecules.



Animals which eat plants containing starch can also use the starch as a fuel.

Questions

1 Explain what happens to the *particles* and to the *energy* when sunlight is used to make starch during photosynthesis.

2 Explain what happens to the *particles* and to the *energy* when starch reacts with oxygen during respiration.

3 In what ways is photosynthesis similar to making hydrogen fuel using a solar cell? In what ways is it different?

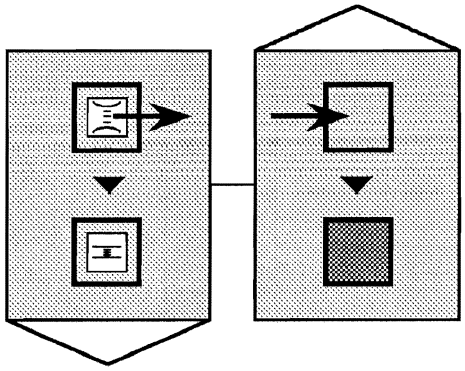
4 In what ways is respiration similar to using hydrogen fuel in a fuel cell? In what ways is it different?

Energy transfers

Things do not get hot 'just by themselves'. We can make things hot by burning a fuel.

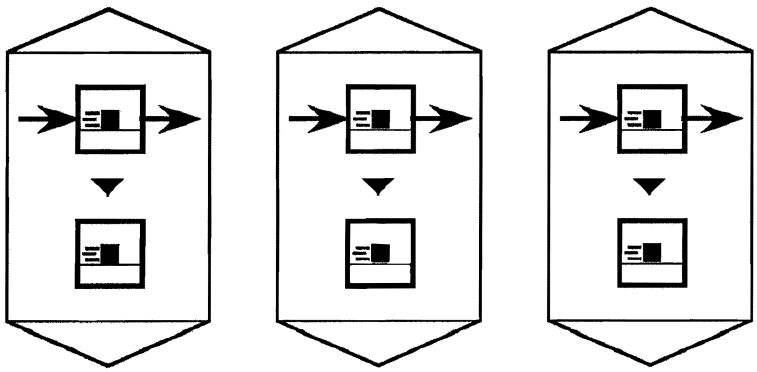
For example, you can boil some water in a saucepan on a gas cooker.

The burning fuel releases energy. The energy goes directly to the water.



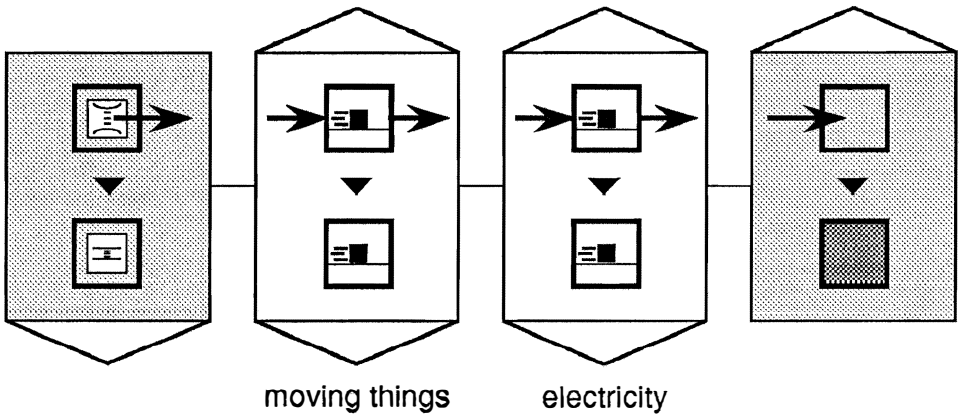
Energy can travel from one place to another.

It can be carried by things that are moving. It can also be carried by electricity and by radiation (e.g. light).



If you boil some water in an electric kettle, you are also using a burning fuel. But the fuel may be burning in a power station many miles away.

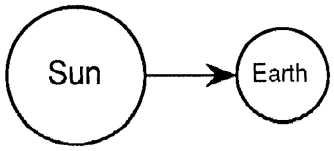
The energy is transferred from the burning fuel to a turbine, next to a generator, and then carried by electricity to your home.



Energy transfers

Sheet 2

1 For each of these changes, draw a simple picture showing how energy moves from one place to another. The first one has been done for you.



A Sun - energy travels from the Sun to the Earth through space

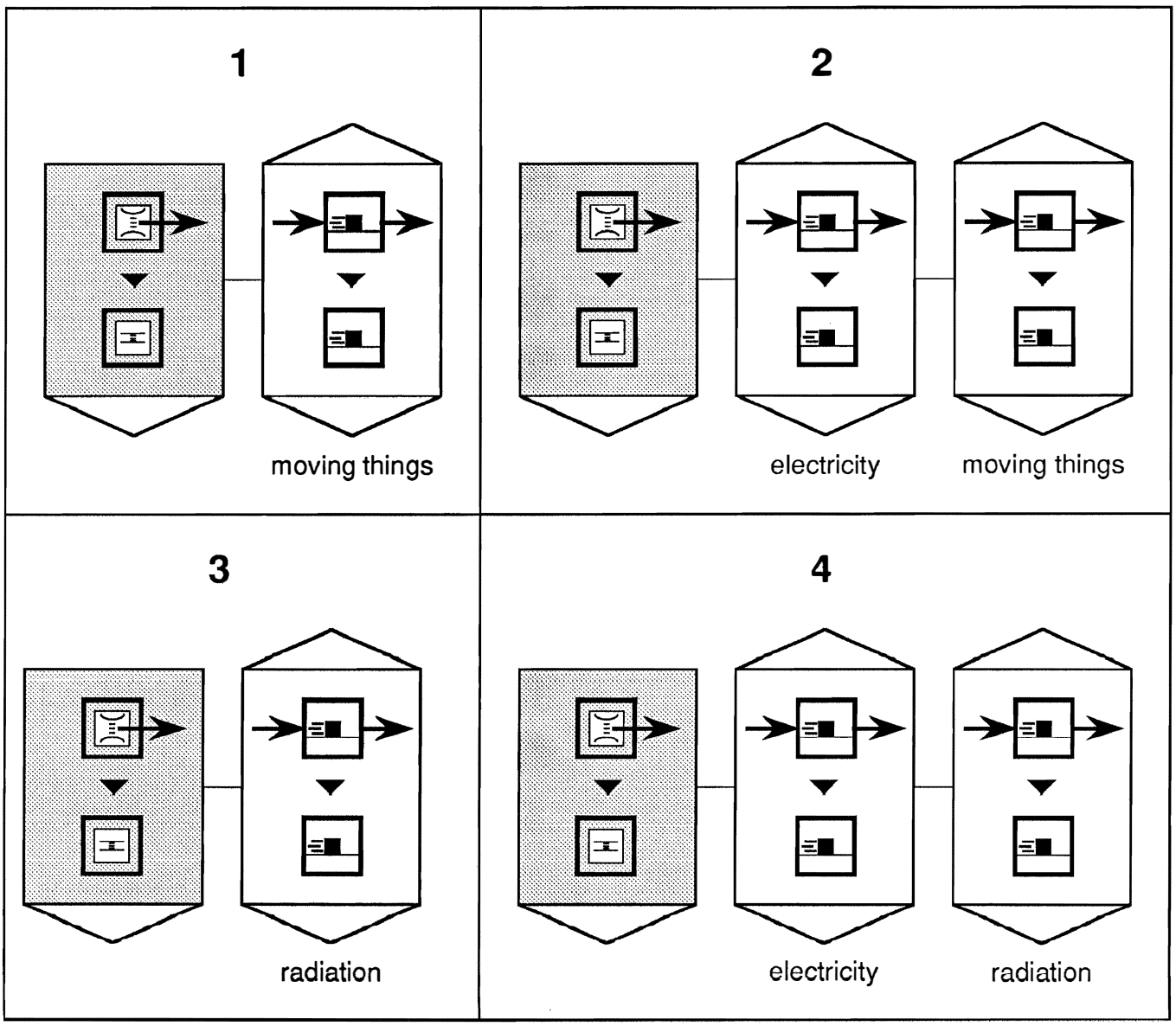
B Electric car - energy is transferred from the battery to the wheels

C Torch - energy goes from the battery to thing you are looking at

D Bus - energy is transferred from the burning fuel in the engine to the wheels

2 Explain how the energy is transferred.

3 Match each situation to the best picture below.

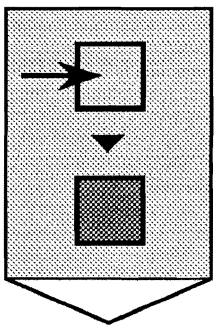


Impossible changes

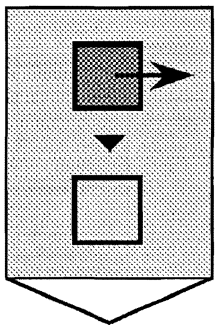
Sheet 1

Which of the following pictures show an impossible change?

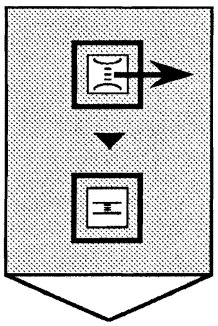
1



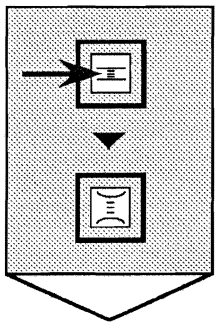
2



3



4



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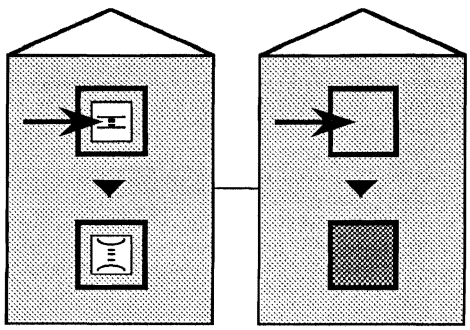

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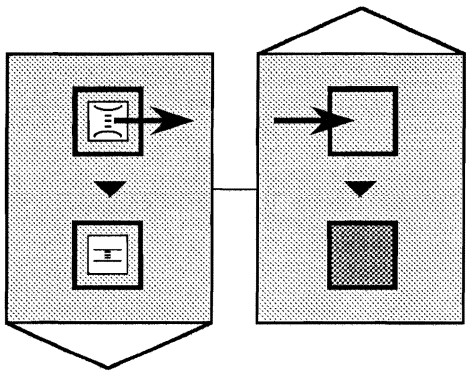

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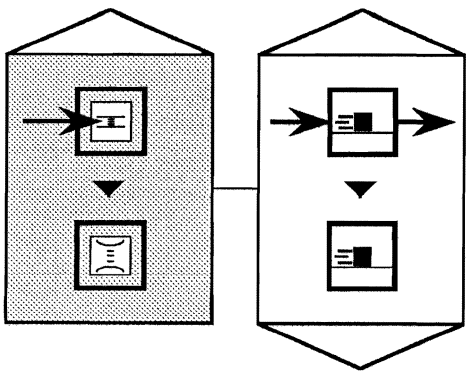

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