**Energy transfers circus**

Energy can be transferred from place to place in different ways.

Can you spot *all* of the energy transfers and *describe them clearly*?

**Safety**

* Hot water can burn.
* Spilt water can make the floor slippery.
* Pushing and pulling objects can make people move in unexpected ways.
* Keep beakers in the middle of a clear table.
* Wipe up spilt water straight away.
* Check nobody is too close and move with care.

**Apparatus and materials**

* Different work-stations are set up around the room

**Procedure**

At each work-station:

1. Read the information card
2. Carry out the investigation
3. For each energy transfer describe how the energy is transferred.

*(The best answers are clear and short, but with lots of detail.)*

1. Can you spot any energy transfers that are not shown on the information cards?

**Energy transfer diagrams**

**Wind-up toy**

Start End

Energy transfer diagram

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Surroundings

Heat store

Car

Heat store

Car

Kinetic store

Car

Elastic store

The spring has wound-down

Toy is wound-up ready to go



Surroundings

Heat store

Ball

Heat store

Ball

Kinetic store

Ball

Gravitational store

Ball is rolling along at the bottom of the slope

Ball is not moving at the top of the slope

**Ball rolling down a slope**

Start End

Energy transfer diagram



Arm

Chemical store

Surroundings

Heat store

Magnets

Electromagnetic store

Magnets are pushed close together

Magnets are far apart

**Pushing magnets together**

**Start End**

Energy transfer diagram



Fan

Heat store

Surroundings

Heat store

Fan

Kinetic store

Battery

Chemical store

Fan is turned on

Fan is turned off

**Battery powered fan**

Start End

Energy transfer diagram



Surroundings

Heat store

Car

Heat store

Car

Gravitational store

Arm

Chemical store

At the top of the slope

At the bottom of the slope

**Pushing a toy car to the top of a slope**

**Start End**

Energy transfer diagram



Hot air rising

Kinetic store

Surroundings

Heat store

Water

Heat store

Beaker of hot water

Same beaker, later

**Hot water cooling**

Start End

Energy transfer diagram

**Work-station cards**

**Wind-up toy**

Start End

1. Wind up the toy
2. Let the toy go and see what happens
3. For each energy transfer describe how the energy is transferred.

*(The best answers are clear and short, but with lots of detail.)*

****

Toy is wound-up ready to go

The spring has wound-down

Ball is rolling along at the bottom of the slope

Ball is not moving at the top of the slope

**Ball rolling down a slope**

Start End

1. Hold the ball at the top of the slope
2. Let the ball go and see what happens
3. For each energy transfer describe how the energy is transferred.

*(The best answers are clear and short, but with lots of detail.)*



Magnets are pushed close together

Magnets are far apart

**Pushing magnets together**

Start End

1. Hold the magnets with the north poles pointing at each other
2. Push them together and feel what happens
3. For each energy transfer describe how the energy is transferred.

*(The best answers are clear and short, but with lots of detail.)*



Fan is turned on

Fan is turned off

**Battery powered fan**

Start End

1. Hold the fan and turn it on
2. For each energy transfer describe how the energy is transferred.

*(The best answers are clear and short, but with lots of detail.)*



Stopped at the bottom of the slope

Stopped at the top of the slope

**Pushing a toy car to the top of a slope**

Start End

1. Hold the toy car at the bottom of the slope
2. Give it a push and watch it until it stops near the top of the slope
3. For each energy transfer describe how the energy is transferred.

*(The best answers are clear and short, but with lots of detail.)*



Same beaker, later

Beaker of hot water

**Hot water cooling**

Start End

1. Fill the beaker with hot water
2. Leave the water to cool (you could measure its temperature)
3. For each energy transfer describe how the energy is transferred.

*(The best answers are clear and short, but with lots of detail.)*

*Physics > Big idea PFM: Forces and motion > Topic PFM1: Forces > Key concept PFM1.5: Energy stores and transfers*

|  |
| --- |
| **Response activity** |
| **Energy transfers circus** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | When a force makes things change it mechanically transfers energy between different energy stores.  Friction transfers energy mechanically into a heat store of energy. |
| Observable learning outcome: | * Identify different ways that energy can be transferred * Identify where energy is transferred by rubbing * Describe how energy can be transferred in different ways * Explain how energy is almost always transferred to the heat store of the surroundings |
| Activity type: | Response, application and practice - practical |
| Key words: | Energy store, energy transfer, mechanically, friction, electrically, heating, energy store chemical, elastic, gravitational, heat, kinetic |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: How is energy transferred?
* Diagnostic question: Heating by friction
* Diagnostic question: Slower football
* Diagnostic question: Falling apple
* Diagnostic question: Push up

**What does the research say?**

In teaching energy the BEST resources have adopted a framework based on ‘energy stores’ and ‘energy pathways’ which is advocated by, amongst others, (Boohan, 2014), (Millar, 2014) and (Tracy, 2014). As Millar (2014) says, this approach “is not perfect - but it is adequate and significantly better than [approaches] based on lists of ‘forms of energy’.” A clear guide to this approach can be found on the Institute of Physics’ website (Institute of Physics).

(Rogers, 2018) highlights that the precision in the language we use about energy is important. Because energy is an abstract concept we have to use words to describe it. He advises giving students opportunities to practise using language precisely, to help them develop an accurate model of what is happening. This practical activity gives students the opportunity to observe and describe how energy is transferred in a range of examples.

The Institute of Physics identify four ways that energy can be transferred: mechanically, electrically, heating by [moving] particles and heating by radiation. It is, however, more important to describe the mechanisms or processes that transfer energy, than it is to give each transfer a label. When explaining how energy is transferred, Tracy (2014) recommends that we focus on describing the processes and mechanisms involved. He suggests that trying to identify the ‘energy’ in each step is just a labelling exercise that can get in the way of a clear understanding of what is happening. Describing how friction and drag cause heating introduces students to the dissipation of energy. (Millar, 2005) suggests that to make sense of the *law of conservation of energy*, students need to know that in almost every event there is some heating, whether desired or not, and a consequential increase in the heat store of the surroundings.

A summary of the BEST approach to teaching energy can be found on the Best Evidence Science Teaching home page which is on the STEM Learning website (Fairhurst, 2018).

**Ways to use this activity**

This practical activity gives students the opportunity to practise applying their understanding and to clarify their thinking through discussion. To support this, students should complete the practical circus in pairs or small groups.

Listening to individual groups as they work often highlights any difficulties they might have. These can often be overcome, through a whole class clarification or redirection part way through the activity.

Asking students to report their findings at end of the practical work is a useful check. After a group has fed back, it might be helpful to model an even better answer. You could do this, for example, by asking another group to add to, or clarify, the first observation. Then ask another group to sum up the important part of the observation, and so on.

*Differentiation*

Using the recording sheets can help some students organise their observations so they can more easily focus on the science. If some students are working with a teaching assistant, then a list of prompt questions for the TA could help to make this activity more purposeful.

Some students may benefit from being challenged to draw a Sankey diagram for each energy transfer.

**Equipment**

For the class, one or two sets of:

* Wind-up toy
* Ball
* Toy car
* Ramp (x2)
* Bar magnet (x2)
* Battery powered fan (or similar)
* Kettle
* 250 cm3 plastic beaker
* 0-100 oC thermometer
* Set of work-station instruction cards

**Technician notes**

This is the same practical circus as the one used in the response activity: *Energy stores circus* in the first progression toolkit for this key concept*.* The difference is in how the students engage with each practical station.

There are six practical stations that students move between. For large classes it may be helpful to have two of each one. Similar equipment may be substituted to achieve the same learning outcomes.

1. Wind-up toy: a wind-up toy that moves
2. Ball rolling down a slope: a wooden ramp and a ball to roll down it (helpful if the ramp has sides), possibly with something at the end to catch the ball
3. Pushing magnets together: pair of bar magnets that are fairly strong and with clearly marked north seeking poles
4. Battery powered fan: a battery powered fan – or other battery operated device that produced movement
5. Pushing a toy car up a slope: a toy car and a wooden ramp – with something at the top to stop the car shooting off
6. Hot water cooling: 250 cm3 plastic beaker, thermometer and a kettle. These are best situated near a sink. (Helpful to provide a few spare beakers, so they can be left to cool before pouring away)

**Health and safety**

Because students will be moving between each practical station extra care needs to be taken about relatively low risk activities:

Pushing and pulling objects can make people move in unexpected ways and some students may have a tendency to become boisterous when interacting with equipment in this way.

The practical station with hot water should have a kettle for heating water and a sink. Using a plastic beaker filled half-full means that it is safer to lift and pour out, in comparison to a glass beaker.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

1. Wind-up toy: the spring unwinds and pushes the wheels round (through a series of gears); friction between the car and the ground increases the temperature of both; moving through the air the car bashes into air particles making them move more quickly which increases the temperature of the air and the car.
2. Ball rolling down a slope: as the car in question 1, except that gravity pushes the ball down the slope
3. Pushing magnets together: a person pushes the magnets together, which gets harder the closer they are together; pushing the magnets warms up the person’s muscles, the warm muscles increase the temperature of the air in contact with the person’s skin
4. Battery powered fan: the battery pushes electricity through the wires and through the motor which makes it spin, the fan blades are fixed to the motor so they are pushed round as well; friction in the motor causes heating, and the fan is making the air particles move faster which increases the temperature of the air.
5. Pushing a toy car to the top of a slope: the person pushes the car upwards against the force of gravity; the friction on the car from the turning wheels and the air heats it up a little; the car squashing the slope warms the slope a little, and bashing the air out of the way the car is making the air particles move faster which increases the temperature of the air.
6. Hot water cooling: the hot water is heating the air particles and making them move more quickly which increases the temperature of the air; because it is moving more quickly the warmer air spreads out and rises up

**Acknowledgments**

Developed by Pete Fairhurst (UYSEG).

Images: UYSEG

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