**Circus of energy stores**

When something happens, some energy moves from the energy store(s) at the start to other ones.

Can you spot the energy stores that are losing or gaining energy?

**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. Draw an energy transfer diagram to show how you think the energy stores will change
3. Carry out the instructions to see if you were right
4. Improve your energy transfer diagram if you need to

**Energy transfer diagrams**

**Wind-up toy**

Start End

Energy transfer diagram

****

The spring has wound-down

Toy is wound-up ready to go



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



Magnets are pushed close together

Magnets are far apart

**Pushing magnets together**

**Start End**

Energy transfer diagram



Fan is turned on

Fan is turned off

**Battery powered fan**

Start End

Energy transfer diagram



At the top of the slope

At the bottom of the slope

**Pushing a toy car up a slope**

**Start End**

Energy transfer diagram



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. Draw an energy transfer diagram to show the energy stores at the start and the end

****

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. Draw an energy transfer diagram to show the energy stores at the start and the end



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. Draw an energy transfer diagram to show the energy stores at the start and the end



Fan is turned on

Fan is turned off

**Battery powered fan**

Start End

1. Hold the fan and turn it on
2. Draw an energy transfer diagram to show the energy stores at the start and the end



Stopped at the bottom of the slope

Stopped at the top of the slope

**Pushing a toy car up 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. Draw an energy transfer diagram to show the energy stores at the start and the end



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. Draw an energy transfer diagram to show the energy stores at the start and the end

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

|  |
| --- |
| **Response activity** |
| **Circus of energy stores** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | An energy store of some kind is necessary for something to happen, and something happens when energy transfers between energy stores. |
| Observable learning outcome: | * Identify the energy stores that a range of different objects have * Identify the energy stores at the start and the end of an event * Use precise language to describe transfers of energy between energy stores * Represent energy transfers in events using Sankey diagrams |
| Activity type: | Response, application and practice - practical |
| Key words: | Energy store, energy transfer, chemical, elastic, electromagnetic, heat, gravitational, kinetic |

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

* Diagnostic question: Types of energy store
* Diagnostic question: Energy transfers
* Diagnostic question: Moving energy to different stores
* Diagnostic question: Sankey diagrams (Bridges to later stages of learning)

**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).

When talking about energy, language is important and practising using the language in an accurate and consistent way helps develop students’ understanding over time (Rogers, 2018).

This practical activity gives students the opportunity to think carefully about the energy stores at the start and end points of an event. Later in their studies, these are the points at which useful calculations can be made about the amount of energy in each store. Millar (2014) reminds us that in any transfer, some energy almost inevitably ends up in a heat store of energy, even when this is not the aim. Identifying transfers of energy into the heat store will support understanding of the idea of conservation of energy.

Energy transfers can be represented with box and arrow diagrams that clearly show the different energy stores *and* the ways in which the energy is transferred (these energy diagrams are also used in the second progression toolkit for this key concept).

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 transfer circus* in the second 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 produces 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 hot water 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 these 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: elastic store → kinetic store of car + heat store of car + heat store of surroundings
2. Ball rolling down a slope: gravitational store → kinetic store of ball + heat store of ball + heat store of surroundings
3. Pushing magnets together: chemical store of person pushing → electromagnetic store + heat store of person pushing (heat store of surroundings has been left out because this is negligible – although some students will correctly want to add this on)
4. Battery powered fan: chemical energy of the battery → kinetic store of fan + heat store of fan + kinetic store of the air (some students will spot that they can also add in the heat energy of the surroundings, which is to be encouraged)
5. Pushing a toy car up a slope: chemical store of the person pushing → gravitational store of car + heat store of car + heat store of surroundings (the end point is when the car stops, so no kinetic store)
6. Hot water cooling: heat store of the water → heat store of the surroundings + kinetic store of the air (e.g. convection currents)

**Acknowledgments**

Developed by Pete Fairhurst (UYSEG).

Images: UYSEG

**References**

Boohan, R. (2014). Making sense of energy. *School Science Review,* 96(354)**,** 11.

Fairhurst, P. (2018). Teaching Energy. [Online]. Available at: <https://www.stem.org.uk/best-evidence-science-teaching>.

Institute of Physics. *Supporting Physics Teaching (SPT): Energy* [Online]. Available at: <http://supportingphysicsteaching.net/EnHome.html> [Accessed July 2018].

Millar, R. (2011). Energy. In Sang, D. (ed.) *Teaching Secondary Physics.* London: Hodder Education.

Millar, R. (2014). Teaching about energy: from everyday to scientific understandings. *School Science Review,* 96(354)**,** 6.

Rogers, B. (2018). *The big ideas in physics and how to teach them, 1* ednAbingdon and New York: Routledge.

Tracy, C. (2014). Energy in the new curriculum: an opportunity for change. *School Science Review,* 96(354)**,** 11.