A2: CHANGING ENERGY

Overview

The aim of the following activities is to help the students to understand visually how the different forms of energy are interrelated. They are useful both as teacher-led as well as student-led activities.

As the activity proceeds, the teacher poses probing questions for the students – What if…?, What do you think might happen if…? – leading them to an understanding of the different energies involved and how they are interlinked.

A2 ACTIVITY 1: THROWING PEBBLES introduces **gravitational potential energy** and kinetic energy. **A2 ACTIVITY 2: THE OBEDIENT BOTTLE** looks at **elastic potential** and **kinetic energies**. In **A2 ACTIVITY 3: THE POWER OF THE WIND — MAKING YOUR OWN GENERATOR** students construct a wind generator and use it to light an LED. **A2 ACTIVITY 4: EXPLORING THE WIND TURBINE** examines an alternative for generating electricity using a renewable source. **A2 ACTIVITY 5: THE ENERGY OF BOUNCE** examines the energies involved when balls bounce. How **gravitational potential energy** and **kinetic energy** change as a pendulum oscillates is examined in **A2 ACTIVITY 6: THE ENERGY OF SWING**.

A2 ACTIVITY 7: HEATING AND COOLING examines the simulation Energy Forms and Changes, which allows students to explore the energies involved in **heating and cooling** solids as well as examining some energy systems. **A2 ACTIVITY 8: THE ENERGY OF SKATING** examines another simulation Energy Skate Park: Basics, in which the students explore the **conservation of energy** by observing the results of changing both the shape and surface of a skater's track.

Suggested approaches:

- Before using any of these activities, a brainstorming session should take place to gather ideas that students have about different forms of energy – What is **kinetic energy**? Why is it so called? What is the origin of the word **kinetic**? Sometimes knowing the etymology of unfamiliar scientific words can make the understanding of them easier for students.
- A discussion should be facilitated to gather ideas and questions that students have about different forms of energy. Some useful questions to pose before the activity session might be, for example: What is **kinetic energy**? What is **friction**? The aim of both the brainstorming session and the discussion should be to enable the students to draw up a bank of questions to which they could find the answers as they carry out the various activities.
- There are a number of ways to use these simulations. They can be conducted in small groups or with the whole class together. Students could direct you as to what to do, and so present you with opportunities to ask questions of the class as a whole. As well as the simulations, the PhET website provides resource material for teachers to adapt to suit their own class situations.

A2 ACTIVITY 1: THROWING PEBBLES

Background

An effective introduction to **gravitational potential** and **kinetic energies** can be made through simply lifting and dropping pebbles onto an empty can. Some questions should be posed to the students: Which is easier to lift and to drop? Which pebble might make the greater dent?

The students may come to the conclusion that because a large pebble makes a greater dent than a small pebble when dropped from the same height, the large pebble must have a greater store of energy than the small one.

The activity can be expanded quantitatively by using force meters to calculate the **gravitational potential energy** involved, dropping the pebbles from different heights and comparing the resultant dents.

Equipment required:

- Selection of large and small pebbles
- Empty soft drink cans
- Tongs suitable for holding both large and small pebbles (optional)
- Newton meter with pan attached
- Metre stick/measuring tape

What to do:

1. Gather a variety of stones ranging from small pebbles to rocks (but no bigger than the can). If possible, have two similar collections, enabling one group to drop stones from one height and a second group from a different height.
2. Lift a little pebble and a large stone from the floor and place each on a table.
3. Lay an empty can on the floor near the table.
4. Drop the pebble so that it strikes the can.
5. Observe and record what happens.
6. Replace this can with another empty one.
7. Drop the large stone so that it strikes the can.
8. Observe and record what happens.
9. Compare both observations and comment.

EXTENSION ACTIVITY:

It may be appropriate to show the students that potential energy can be calculated using the following formula:

Potential Energy = mass x acceleration of gravity x height.

1. Lay an empty can on the floor.
2. Using the Newton meter find the weight of the pebble.
3. Holding the pebble in the tongs, measure and record its height above the floor.
4. Release the pebble and observe the result.
5. Calculate the potential energy using the formula above.
6. Using different pebbles repeat steps 1 – 5, measuring and logging the height from which the pebble is dropped and how it relates to the impact on the can.

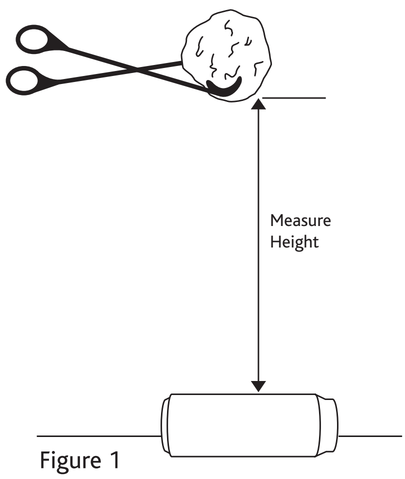


Figure 1

Using both the observation of the impact of the pebble on the can and its corresponding potential energy, what conclusion might you arrive at?

A2 ACTIVITY 2: THE OBEDIENT BOTTLE

Background

The **Obedient Bottle** or **Come Back Can** is a visual, explorative introduction to **elastic potential energy** and its conversion to **kinetic energy**.

When the cylinder is rolled, it acquires **kinetic energy**. As it slows down, this energy is transferred to the twisted elastic band inside in the form of **potential energy**. The twisted band's **potential energy** is then transferred back to the container in **kinetic energy** as it unwinds.

The energy transfer is due to a weight attached to the elastic band. This weight is pulled down by gravity, but it is also subjected to the twisting force from the elastic band. As long as the weight is greater than the twisting force on the band the elastic band will continue to twist. When the **kinetic energy** is mostly transferred to **potential energy** (to the elastic band) the bottle or can will stop rolling allowing the elastic band to untwist. However, because the weight is in the middle of the band only the end loops will unwind, causing the can to roll backwards.

This activity is useful for addressing some misconceptions such as: *Something not moving cannot have energy* (**potential energy** is energy **stored** in an object **due to position**); *An object has potential energy only when it is not moving* (**potential energy** depends on an object's **position**, whether it is moving or not); *The only type of potential energy is gravitational* (there are **other forms** of **potential energy**, such as **elastic potential energy** and **chemical potential energy**).

Suggested approaches:

- The **Obedient Bottle** may be carried out in two parts: before the session prepare the bottle or can. Have the bottle totally covered so that the students just see a cylindrical container. Gently roll it on the table for the students to see what happens – do not let them handle it. Continue rolling it as the students hypothesise as to what is happening. Depending on the class you may now decide to let them make their own Obedient Bottle so that they can test their hypotheses.
- Alternatively you may decide to let the students experiment with the prepared bottle, encouraging them to be observant and explain to you what they see and why the bottle behaves in this way.

Equipment required:

- Plastic bottle (any soft-drink size is suitable) with top, or a cylindrical, Pringles© tube-type container with a lid (again any size is suitable)
- Length of string – slightly longer than the length of whichever container is being used
- Metal nuts or washers (size depends on width of bottle/container)
- Two paper clips/two matchsticks
- Elastic bands
- Hook, such as a crochet needle (one can be fashioned using a large paperclip)
- Scissors or knitting needle, for boring holes in the container lids

What to do:

USING A CYLINDRICAL CONTAINER, E.G. A PRINGLES© TUBE

1. Carefully punch a hole in the centre of both the lid and the base of the container as shown in **A** below.
2. Slip the elastic band into the nut and tie a knot as shown in **B** below.
3. Using a paper clip or matchstick to keep it in place, insert the elastic band through the hole in the base as shown in **C** below.
4. Using the hook, pull the elastic band up to the top of the container and through the lid of the container as shown in **D** below.
5. Put the lid on the container and secure the elastic with the other matchstick or paperclip.
6. Cover the can completely with paper, ensuring that all signs of elastics and matchsticks are concealed. This will be the demonstration can prepared before class.

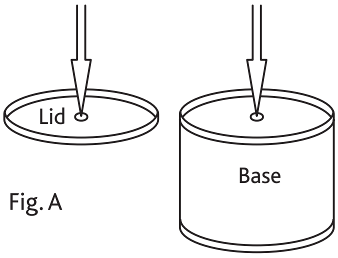


Fig. A

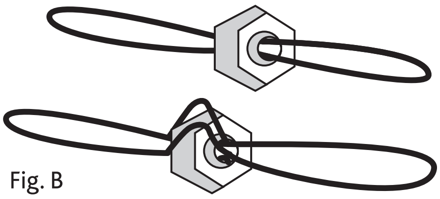


Fig. B

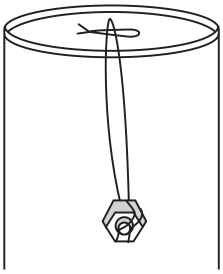


Fig. C

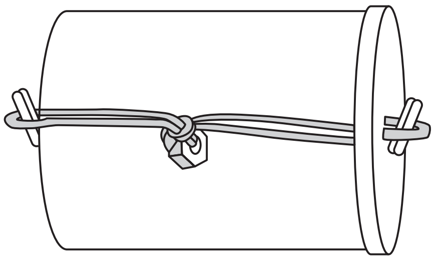


Fig. D

USING A CLEAR PLASTIC BOTTLE

1. Remove all labels from the bottle.
2. Carefully punch a hole in the centre of both the lid and the base of the bottle as shown in **A** above.
3. Slip the elastic band into the nut and tie a knot as shown in **B** above.
4. Make a neat cut in the side of the bottle to insert the elastic band with the nut.
5. Carefully attach one end of the elastic band with a paperclip or matchstick to the lid as in Figure **E**.
6. Pull the other end with the hook through the hole in the base. Secure it using the other paperclip or matchstick and seal with tape as shown in **E** above.
7. Check if the nut/washer is touching the side of the container. If it is then you will need to use a shorter elastic band.
8. If making two bottles, instead of a bottle and a can, conceal what is happening in the demonstration bottle by covering it with paper or painting the outside and covering the lid and base carefully with opaque tape.

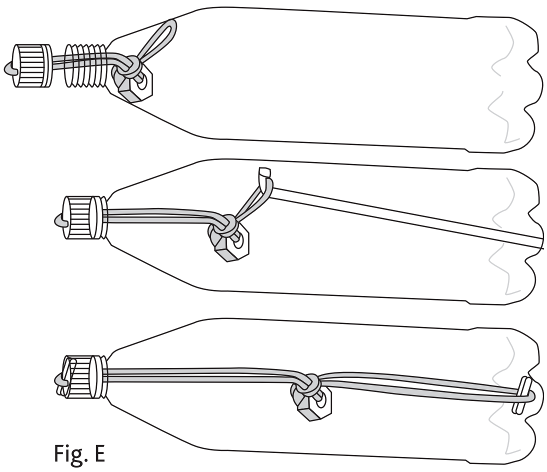


Fig. E

A useful video on the construction of the bottle is available at http://www.stevespanglerscience.com/lab/experiments/magic-rollback-can-sick-science.

Questions to promote discussion:

1. What do you expect to happen within the bottle/can if you roll it on a flat surface?
2. How could you observe and record it in action?
3. What happens when you roll the bottle/can?
4. Can you explain why?
5. How does this compare with your predictions?
6. What energies are involved?
7. What do you think might happen if there was no nut?
8. Does the position of the nut make a difference to the behaviour of the bottle/can?
9. How do you think the bottle would roll if the nut was positioned as shown in Figure 2?

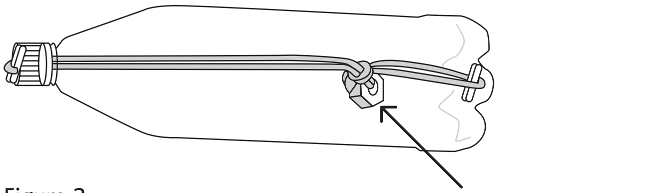


Figure 2

Click here to explore an interesting interactive site for the students in preparation for the remaining questions.

10. What do you expect will happen if you roll the bottle on an inclined surface?
11. Are there any other forces in action if you use an inclined surface?
12. Does the rise of this inclined surface make a difference to the outcome?

A2 ACTIVITY 3: THE POWER OF THE WIND — MAKING YOUR OWN GENERATOR

Background

In this activity, students investigate how the power of the wind can be harnessed to generate electricity.

Students build their own wind generator. The propeller is connected to a Lego motor with an LED. When the blades of the propeller move, energy is fed to the connected motor. The motor converts **rotational energy** into **electrical energy** to make the light go on.

By going through these steps themselves, students experience first-hand the process of feeding one kind of energy (**motion**) into a generator, and getting another (**electricity**) out. The experience helps them to visualise the concepts of **energy conversion** and the **conservation of energy**, and to appreciate the power of the wind. When the propeller moves, they can see what a simple rotation can achieve. A little propulsion will cause the LED to light up, indicating that sufficient energy has been harnessed.

Students then use their acquired skills and knowledge to investigate the questions posed in **A2.3 WORKSHEET C: THE POWER OF THE WIND — WHAT DO YOU THINK?**

Suggested approaches:

- The following link contains a wealth of information on wind energy:
  EPA Wind Energy – Powering the Future.
- As a lead-in, students could be set a short research project on wind energy before constructing their own windmill. The following links may be useful:
  Wind Energy Activities
  SEAI's Wind Energy information.
- Before construction the students could watch the video on the following links:
  https://vimeo.com/20705049 – English version
  http://vimeo.com/28864041 – Irish version

Equipment required:

- 9V Lego motor or similar, with matching cable
- LED with connecting leads
- Aluminium can
- Ruler
- Permanent marker or CD pen (to write on can)
- Scissors
- Glue gun
- Sandpaper
- Protective gloves (for cutting the can)
- Support rod for windmill
- Hand fan or hairdryer (low watt preferable)

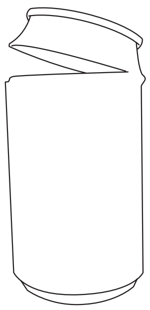


Figure 3: Cutting the top from the can

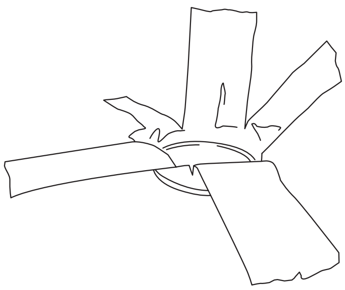


Figure 4: Cutting the blades

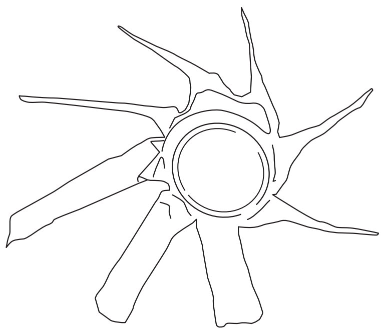


Figure 5: Angling the blades

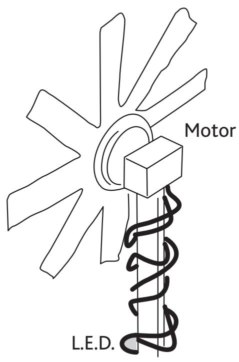


Figure 6: Assembled windmill

What to do:

1. Measure and note the circumference of the can.
2. Wearing the protective gloves, cut the top off the can.
3. Use the marker to make three evenly spaced lines in the side of the can – these will be the blades for the propeller.
4. Cut along the lines.
5. Fold down and carefully angle the blades.
6. Using the glue gun attach an 'axle' for the motor onto to the top of the can and attach the motor to it.
7. Set up a support rod for the motor-windmill structure and connect the LED as shown in the Figure 6.
8. Gently fan the blades. As they move, the LED should light, indicating that electricity is being generated. Investigate using the hairdryer or fan and vary the distance of the blades accordingly.

Having constructed and used the windmill the students are now presented with various questions. Using **A2.3 WORKSHEET C: THE POWER OF THE WIND — WHAT DO YOU THINK?** the class can be divided into groups with each group assigned some questions from the worksheet that they could be asked to investigate. They can then be asked to present their findings to the class. In **A2 ACTIVITY 4: EXPLORING THE WIND TURBINE** students examine the commercial aspect of investing in wind farms.

There is also a version of this activity on page 66 of Science on Stage 1 & 2, available at Science on Stage resources web page.

A2.3 Worksheet C: The Power of the Wind — What do you think?

1. Does it matter how many blades there are on the generator?
2. How many blades are on wind turbines in Ireland?
3. To make the generator spin faster, would we increase or decrease the number of blades on it?
4. Would the speed of the wind turbine change if the blades were at different angles?
5. How could you generate more electricity using this generator?
6. Describe what types of energy are involved in this system.
7. Does the type of material from which the blades are made affect the system?
8. There are many people who object to the installation of wind turbines as generators of electricity. Give three reasons for objection.
9. Are there many wind farms in Ireland? How are they used and who mainly uses them?
10. What is the benefit of using wind to generate electricity rather than burning fuels such as coal, peat or oil?
11. How much electricity is generated by wind in Ireland compared to the quantity of electricity generated by fossil fuels?

A2 ACTIVITY 4: EXPLORING THE WIND TURBINE

Background

The aim of this investigation is to examine one alternative for generating electricity using a renewable source. Students may be familiar with the **dynamo** used on a bike or the decorative LEDs which are often attached to the spokes or the valves. However, they may not make a conscious connection between movement and the generation of electrical energy. The previous investigation – **A2 ACTIVITY 3: THE POWER OF THE WIND — MAKING YOUR OWN GENERATOR** – is a good lead-in to this activity.

What to do:

1. If appropriate, recap on the investigation **A2.3 WORKSHEET C: THE POWER OF THE WIND — WHAT DO YOU THINK?** using it as a lead-in to research into wind turbines, their uses, advantages, etc.
2. Use a roleplay approach as this contentious issue lends itself well to this method.
3. Divide the class into three groups – **A**, **B** and **C**,

   Group A is to present the case for the erection of a wind turbine/wind farm,

   Group B is to oppose such an idea, whilst

   Group C represents the general public who, having listened to both cases, then votes on whether to accept, reject or request more information indicating what might need clarification, etc. If appropriate, two or three students from this group could be assigned the role of reporters who would then write up an article/write a radio script/present a TV clip for general presentation to the class, or even the school community.
4. The two groups presenting their cases should be given a timeline for that presentation plus time for questions from the audience.

Resources:

- The SEAI website has a section on wind energy which includes some case studies.
- Visit the Irish Wind Energy Associations website for a list of FAQs, videos and an interactive map.
- Tippeary Energy Agency have information on a community-owned wind farm.
- SEAI have a report on the significance of noise in relation to onshore wind farms.
- Try out a virtual laboratory on wind power, it includes a teacher's guide.
- The howstuffworks website has a series of articles on wind power.

A2 ACTIVITY 5: THE ENERGY OF BOUNCE

Background

This activity is a great way to open a discussion about the energies involved in **bouncing**, and to demonstrate the principle of the **Conservation of Energy**.

Before the ball is dropped, it has **potential gravitational energy**, which will cause it to rebound when it hits the ground. Some of this energy is **converted** to **heat energy** and **sound energy**, so it loses **momentum** and will not rebound to the original height.

Students can film the action and then replay it in slow motion to observe bounce patterns. Following that, students could consider why in tennis, squash, rugby and basketball, the ball is often repeatedly bounced before the player uses it.

After the activity students can consolidate and further their learning by answering **A2.5 WORKSHEET D: THE ENERGY OF BOUNCE**.

Equipment required:

- Two basketballs – one fully inflated and the other partially inflated
- A selection of smaller balls – table tennis ball, squash ball, tennis ball
- Measuring tape or supported screen marked at intervals, or a data logger and motion sensor
- Worksheet – **A2.5 WORKSHEET D: THE ENERGY OF BOUNCE**

Suggested approaches:

- If the class has internet and viewing access, show this short SEAI video to inspire a class discussion before carrying out the activity. Alternatively, you could watch this video and replicate the presentation for your class.
- You might discuss with the class whether some balls bounce better than others, or what it is like to ride a bike with a flat tyre. Click here to view a useful webpage with information and ideas on teaching a class about air pressure and force.

What to do:

1. Give the fully inflated ball to one student, and the partially inflated ball to another, and ask them both to drop the balls from the same height.
2. Compare the bounce of both balls by observing return bounce heights.
3. Bounce the balls and let them continue for a number of rebounds. By having a marked screen behind the balls, it should be possible to measure the successive rebounds. The activity could also be videoed and reviewed frame by frame.
4. Now move on to **A2.5 WORKSHEET D: THE ENERGY OF BOUNCE** – the class could complete the worksheet together or individually.

ALTERNATIVE

You might wish to use the worksheet during the activity, rather than after it. It could be used to guide the lesson, with actions carried out to find the answer to each question. In this way students can focus on the activity without needing as much teacher input.

FURTHER LEARNING

For teachers wishing to elaborate further on this theme, there is an appropriate activity on page 13 of *Physics on Stage 3: Demonstrations and teaching ideas*.

In this more advanced lesson, a student is asked to demonstrate what happens when one small ball is placed on top of the basketball and both are dropped together. The class is asked to observe and consider the following questions:

- What happens on the rebound?
- Is there a difference depending on which of the small balls is placed on top of the basketball?

A2.5 Worksheet D: The Energy of Bounce

1. What happens to both balls when they are dropped from a height?

   ____

2. Which ball bounces higher, the partially inflated ball or the fully inflated ball?

   ____

   ____

3. Which ball applies more pressure on the ground? Explain!

   ____

   ____

4. The law of the Conservation of Energy says that

   ____

   ____

5. Fill in the blank and circle the correct answer:

   Before the ball is dropped, it has ________________ energy. We know this because the ball is/isn't moving but is about to fall.

6. When the ball is falling, it has ________________ energy. While the ball is falling it has its maximum ________________ energy.

7. Circle the correct answer!
   After the ball hits the ground, does it:
   (a) return to the original height?
   (b) not bounce at all?
   (c) return to half the original height?

8. Explain your answer to question 7.

   ____

   ____

9. Fill in the blanks:

   After the ball hits the ground, its ________________ energy is converted to other forms of ________________. When the ball hits the ground it makes a ________________. Sound is a form of ________________. Therefore we can say that some of the ________________ energy is converted to ________________ energy. After continuous bouncing the ball begins to heat up. This is caused by ________________ between the ball and the ground. Heat is a form of ________________. Therefore, we can say that some of the kinetic energy is converted to ________________ energy. Finally, when the ball is bounced close to your feet you feel ________________ from the floor. This is caused by some of the ball's ________________ energy being converted to ________________ energy.

A2 ACTIVITY 6: THE ENERGY OF SWING

Background

The pendulum is a simple machine for transferring **gravitational potential energy** to **kinetic energy** and back again. This activity centres on the conversions between **kinetic potential energy** and **gravitational potential energy** as a pendulum swings back and forth.

When the pendulum is at the highest point of its **swing** it has no **kinetic energy** but at that moment its **gravitational potential energy** is at its maximum.

As the pendulum swings downwards, the **gravitational potential energy is transferred to kinetic energy**, causing the pendulum to **accelerate**.

At the lowest point of the swing the **kinetic energy** is at a maximum and **gravitational potential energy** is at a minimum.

The pendulum **swings** upwards until it reaches the top of its **swing**. At this stage the **kinetic energy** is at a minimum whilst the **gravitational potential energy** is at a maximum.

This cycle continues, **but the energy does not remain the same**. Each swing becomes lower as some energy is used as the pendulum overcomes air resistance – **friction**.

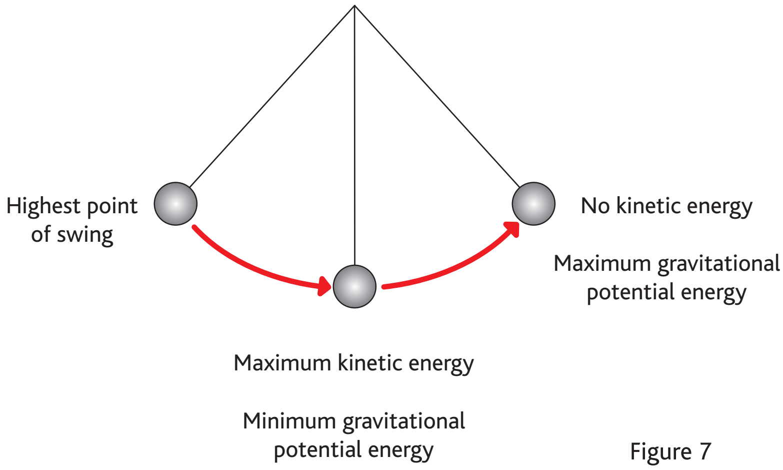


Figure 7

Equipment required:

- Retort stand
- Squash ball or similar
- Small cup-hook or a thumb-tack attached to a piece of string
- Sellotape
- Newton's cradle (optional)

What to do:

1. Set up the Newton's cradle. Ask the class if anyone can tell you what will happen if you pull back one of the balls and then release it. After collecting predictions, pull back a ball at one end of the Newton's cradle, and release it. Compare observations with predictions. Ask the class to predict what would happen if you pulled back two balls and released them. If a Newton's cradle is not available a video of this activity is available here.
2. After watching the video the following activity can be carried out. Fix the cup-hook or attach the thumb-tack to the squash ball using Sellotape. Using the string, suspend the ball from the retort stand.

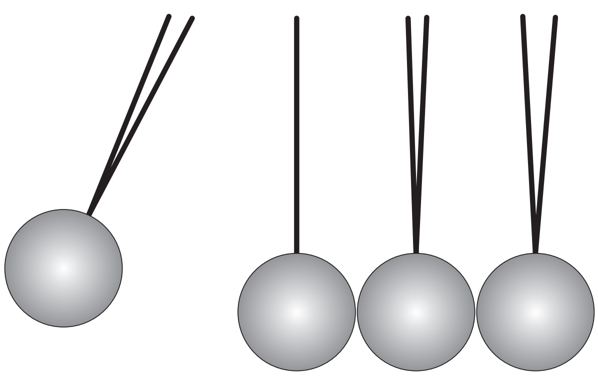


Figure 8

3. Pull the ball back a distance and ask a student to hold their palm at that point, as shown in Figure 9.

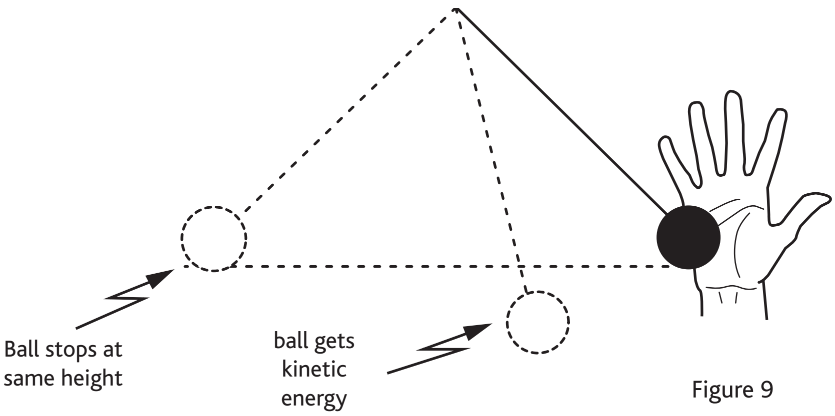


Figure 9

4. Release the ball and observe it as it oscillates. Remind the student not to move their hand.
5. As the ball swings back and forth it is behaving like a pendulum. Prompt discussion by asking questions such as – Can you think of where you may have seen a pendulum in action? How about if you are on a swing? What about a trapeze artist?

What next:

- It may have been a while since students sat on a swing. Ask them to think back on what it was like to swing. Ask them to consider the following questions:
  - ? ***How would someone on a swing reach a good height without anyone pushing them?***
  - ? ***What would they do to make themselves swing faster and higher?***
  - ? ***What energies are involved in this process?***
- Click here for a short video on swings – it might be useful to show after the students have offered some explanations on the swing questions above.

A2 ACTIVITY 7: HEATING AND COOLING

Background

This activity allows students to explore the **heating** and **cooling** of a brick, a lump of iron and water. It is a lead-in to an exploration of various **energy systems** – **mechanical**, **electrical**, **thermal** and **chemical** – and creates an opportunity for students to observe **energy flows**.

This activity relies on access to the PhET simulations from the University of Colorado, Boulder, USA. The simulations are interactive and have the added bonus of being available in different languages. The simulation Energy Forms and Changes contains a comprehensive teacher's guide and a list of suggested ideas. It can be used with a projector to share the screen with the class; either the students may direct the action while the teacher makes suggestions, or vice versa.

What you need:

There are three ways to run PhET simulations:

a) Run them online in class, or;

b) Install all the simulations onto a drive thus eliminating the need for an internet connection to run the simulations, or;

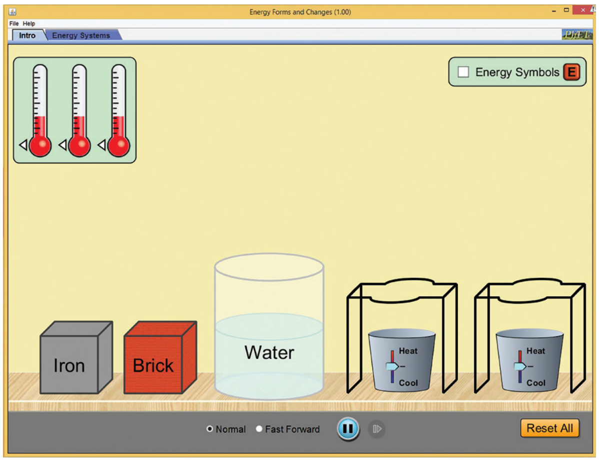
c) Download the simulations needed, again eliminating the need for an internet connection to run the simulations.

Suggested approaches:

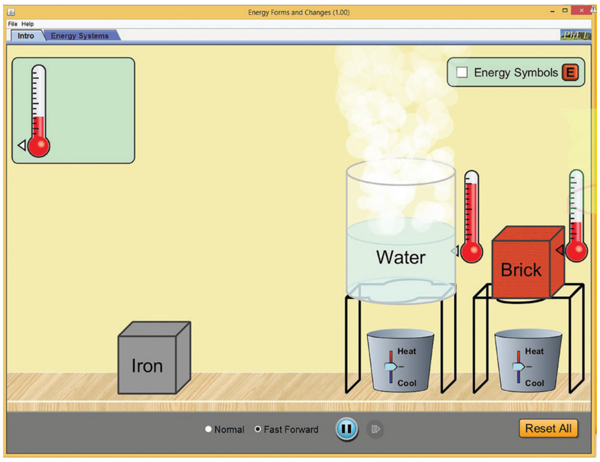
- This link: https://phet.colorado.edu/en/simulation/energy-forms-and-changes will take you directly to the simulation.
- Showing simulations on the whiteboard makes it possible for all the students to participate. Students can guide either the teacher or other students in the actions taken. Using the simulations this way helps to ensure that the whole class are seeing the same thing and allows the teacher to address any possible misconceptions as they come up.

Preview

i. The first simulation is **an introduction to energy**. It shows how energy is **added** or **removed** through **heating** and **cooling**.

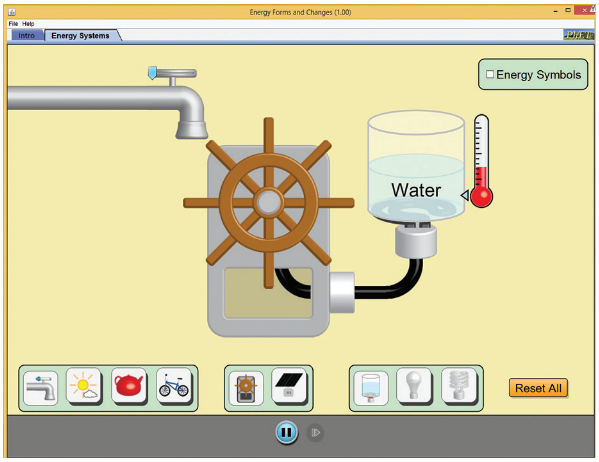


PhET Interactive Simulations
University of Colorado
http://phet.colorado.edu

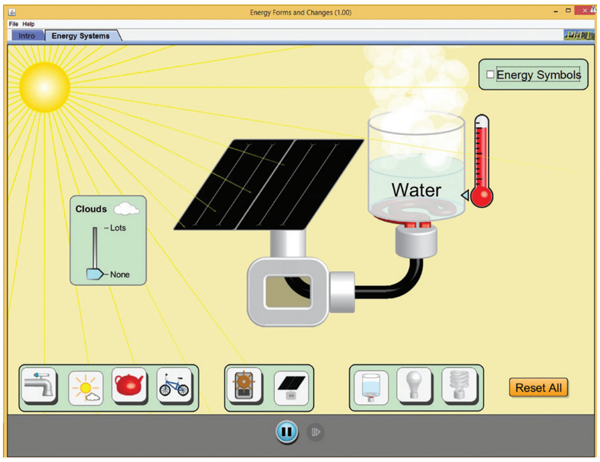


PhET Interactive Simulations
University of Colorado
http://phet.colorado.edu

ii. The second exercise simulates an investigation into **energy flow** and **energy changes** in various **energy systems**.



PhET Interactive Simulations
University of Colorado
http://phet.colorado.edu



PhET Interactive Simulations
University of Colorado
http://phet.colorado.edu

A2 ACTIVITY 8: THE ENERGY OF SKATING

Background

This activity also makes use of PhET simulations from the University of Colorado, Boulder, USA. The simulations are interactive and have the added bonus of being available in different languages. The simulation Energy Skate Park contains a comprehensive teacher's guide and helpful suggestions, and can be used as a whole-class activity led by either the students or the teacher, or as an activity where the class is divided into groups.

The simulation uses a skateboarder to explore the **conservation of energy** and different types of energy. As well as using different types of tracks there is a graphic representation of the **energy changes**.

What you need:

There are three ways to run PhET simulations:

a) Run them online in class, or;
b) Install all the simulations onto a drive thus eliminating the need for an internet connection to run the simulations, or;
c) Download the simulations needed, again eliminating the need for an internet connection to run the simulations.

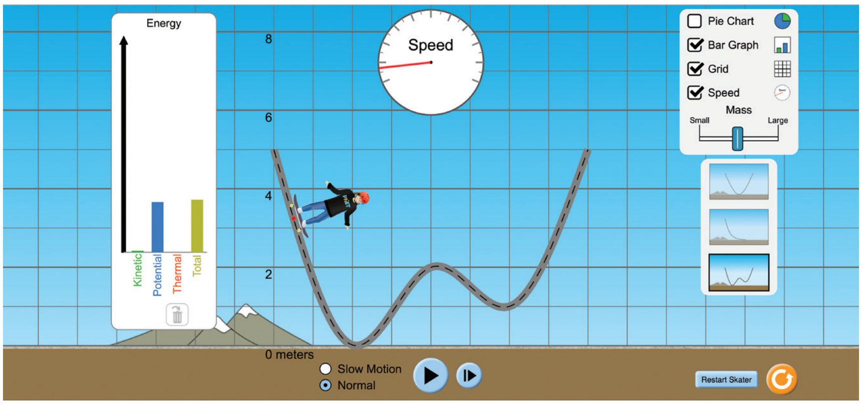
Suggested approaches:

- This link: https://phet.colorado.edu/en/simulation/skate-park-basics leads directly to the simulation.
- Showing the simulation on the whiteboard makes it possible for all the students to participate. Students can guide either the teacher or other students in the actions taken. Using the simulation this way helps to ensure that the whole class are seeing the same thing and allows the teacher to address any possible misconceptions as they come up.

Preview

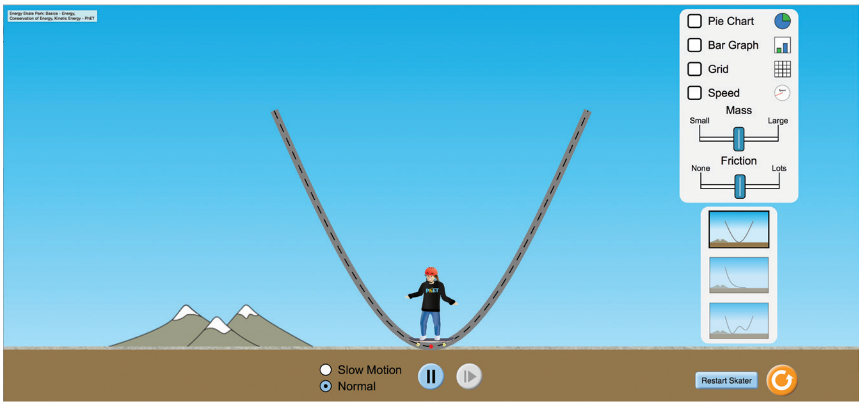
There are three activities in this simulation:

1. The first exercise in an **introduction to the energies involved in skating**. Students can examine the skate path on the three different tracks either in slow motion or at normal speed while at the same time viewing the various energies involved on a graph that displays **height**, **mass** and **speed**. The students can use this simulation to discover how **changing the mass of the skater alters the energies involved**.



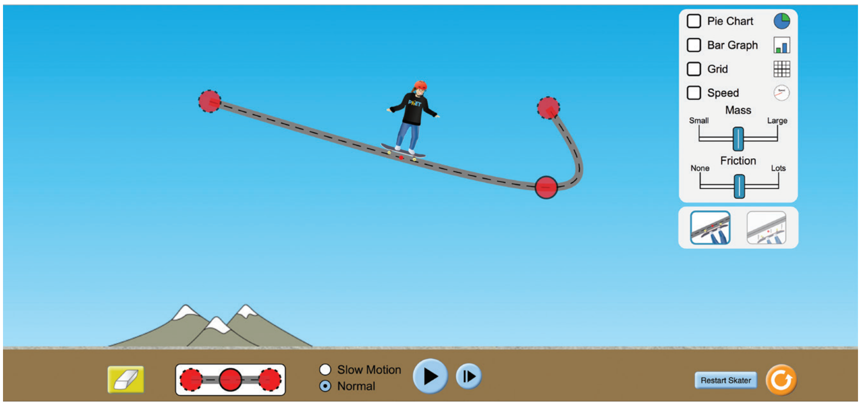
PhET Interactive Simulations
University of Colorado
http://phet.colorado.edu

2. The second simulation shows the effect of **friction** on the skater. There are **two variables** – the **track shape** and **friction**. The action is viewed within a graph that displays these variables.



PhET Interactive Simulations
University of Colorado
http://phet.colorado.edu

3. The third simulation allows students to design and virtually build their own tracks. They then use these to explain the **conservation of energy**.



PhET Interactive Simulations
University of Colorado
http://phet.colorado.edu