# *Forms of energy* Teaching and learning plan

## Learning intentions

Students will be able to:

* identify different forms (or types) of energy;
* explain that one form of energy can be transformed into other forms;
* represent an energy transformation with a flow diagram;
* understand that any energy transformation involves some ‘*waste’* or non-useful energy;
* make accurate measurements;
* construct appropriate representations that allow them to interpret and analyse the data;
* identify patterns and relationships in data;
* draw conclusions based on evidence.

## Suggested time for this CLE

The time needed to complete the *Forms of energy* CLE will depend on the depth of the prior knowledge of students, the time to perform the three investigations—‘Water drop’, ‘Dismantle a device’ and ‘Energy efficiency’—and follow up with any further extension activities. Allow 2–3 hours.

[**Planning ahead and equipment list**](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Planning%20and%20equipment%20list_yr8_Forms%20of%20energy.docx)

## Safety considerations

When you and your class are completing your Risk Assessment, consider the following safety points and add any other relevant ones to the list.

* Remind students that some floor surfaces can become slippery when wet.
* When dismantling devices, take care NOT to dismantle the battery (These should be removed prior to, or at the beginning of, the process).
* Take care when working with boiling water in investigation 3.
* Ensure that the electric kettles have been tested and have a current tag.

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## Introduction

This CLE focuses on energy and energy transformations and links to Year 8 Australian Curriculum: Science.

### Equipment needed

* sticky notes
* chart with heading ‘What we think’

### What to do

1. Ask students what they think energy is and to write their ideas on sticky notes and stick these up on the chart under the heading ‘What we think.’ Ask them to name as many forms (types) of energy that they can think of.

Students may have identified kinetic energy and potential energy, however it is important to describe and give an example of kinetic energy and then the three different forms (gravitational, elastic and chemical) of potential energy. (Kinetic is the energy of movement, gravitational potential energy is simply stored energy when an object has height above a surface, elastic potential energy is energy stored in an object or material under stress e.g. a stretched spring, chemical energy is energy stored in chemicals e.g. food.)

1. Ask students the following questions.

* Where do we find both kinetic energy and gravitational potential occurring at the same time? (Answers will vary: in a swinging pendulum, on a child’s swing, on a slide at the playground, i.e. any situation where an object falls down from a height or rolls down an incline, its gravitational potential energy is converted into kinetic energy. When are these two forms involved in the context of water? (In a waterfall, on a waterslide, in a fountain, etc.)
* How can we represent the energy transformations happening in each of these situations? (Introduce flow diagrams at this point.)

1. Show students the video ‘Amazing Hydro-Electric Power Collector’, *YouTube* (3:59 min) <https://youtu.be/x1fXAdODGvA>
2. Explain how a hydroelectric power station generates electricity. (Water stored in a dam is allowed to fall and in the process its gravitational potential energy is transformed into kinetic energy. The kinetic energy of the falling water spins a turbine, which in turn spins a generator and generates electricity.) Engineers must understand how the height of the water in the dam affects its gravitational potential energy and hence how much kinetic energy the water gains as it falls. They design a hydroelectric power station based on this information so that it produces a significant amount of electricity.
3. Ask students how they could represent the energy transformations in a hydroelectric plant with a flow diagram? (gravitational potential energy 🡪 kinetic energy 🡪 electrical energy.)

## Core

### Investigation 1: Water drop

In this investigation, students will drop water from different heights to demonstrate how the gravitational potential energy of the water is transformed into kinetic energy as it falls and hits a piece of spread out newspaper. Since falling water travels too fast to measure its speed and hence its kinetic energy, the size of the splash produced will be measured instead. The drop height will be the independent variable and the maximum diameter of the splash pattern will be the dependent variable.

### Equipment needed

Per group:

* clear plastic straw
* paper cup (recyclable)
* metre ruler
* marker pen
* newspaper or butcher’s paper (minimum of 20–30 sheets per group)
* weights to hold the newspaper flat

### What to do

1. Demonstrate to students how to use the straw as a dipper.

Dip the straw into a cup of water and while the straw is in the water, place a finger over the open top end of the straw. Lift the straw from the water with the finger still over the end and the water should remain inside the straw. Gently shake off any loose drops on the end of the straw. With the metre ruler vertical over two sheets of newspaper, line up the bottom end of the straw at the correct height. Remove the ruler and remove the finger and the water should fall out of the straw. Small splash patterns are reasonably straightforward to measure. Larger patterns will be less distinct with some water drops going quite some distance. The approximate diameter of the splash pattern should be measured as shown below.

Small splash pattern showing where to measure

Larger splash pattern

showing where to measure

1. Allow the students to design their own procedure. They should be able to make decisions about: how much water will need to be dropped to achieve a decent splash, how the volume of water in the straw will be controlled for each drop, how the newspaper will be kept flat, which part of the straw will need to be lined up with the drop height, how the size of the splash pattern will be measured, how many different drop heights will be tested, the number of trials needed for each drop height, and how any other variables will be controlled to ensure a fair test.
2. Let the students begin investigation 1.

If a 5 cm mark on the straw is used, they are only using small amounts of water each time and the investigation can easily be done inside, where wind won’t blow their newspaper around. It is important that the newspaper is flat so that ‘hills’ don’t block any drops and prevent them from travelling as far as they might have otherwise.

1. Conclude the investigation with a comparison of each team's results table and graphs.
2. Some discussion questions could include the following.

* What makes a good investigation? Why is this?
* What pattern do the results show?
* What conclusion can be drawn?
* How would engineers use this to design hydroelectric power plants?
* In what other contexts would engineers use this understanding to design devices?

### Expected results and explanations

In designing the fair test procedure, typical responses might be the following.

* Mark a line on the straw about 5 cm from one end.
* Use weights to hold the newspaper flat.
* Line up the bottom end of the straw with the correct drop height on the ruler.
* Look for the furthest wet spots on the newspaper and measure across to the furthest on the other side.
* Use 4–5 different drop heights with at least 3 trials for each drop (drop heights in the range of 10 to 50 cm seem to work well).
* Ensure the same people perform the same tasks each time.
* Ensure the metre ruler is vertical when measuring the drop height.
* Ensure 2 layers of dry newspaper are used each time to make the next drop detectable.
* Dry off the bench with the used newspaper in between trials so the newspaper doesn’t become contaminated etc.

Students should predict that when water is dropped from greater heights the size of the splash increases. In fact, the splash pattern becomes less cohesive past about the 20 cm drop height as stray drops spread much further out than the central ‘pool’.

Sample results table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| drop height (cm) | splash diameter (cm) | | | |
| trial 1 | trial 2 | trial 3 | average |
| 10 | 5 | 6 | 6 | 5.3 |
| 20 | 16 | 9 | 16 | 14 |
| 30 | 26 | 33 | 21 | 27 |
| 40 | 26 | 40 | 33 | 33 |
| 50 | 33 | 45 | 36 | 38 |

### Explanation

The data shows that a larger drop height produces a larger splash diameter. At greater heights the water in the straw has more gravitational potential energy. As the water falls, this potential energy is transformed into kinetic energy. The greater the height, the more kinetic energy the water has when it hits the paper. This energy propels the water into a larger splash pattern. (It is similar to explosions. Larger explosions produced bigger craters due to greater amounts of energy.)

*Note:* Although a linear trendline has been added to the graph, it is probably not necessarily the best fit for the data or the best explanation of the relationship between the variables.

For a drop height right next to the surface of the newspaper (i.e., practically zero) the water will still spread out and form a pool on the newspaper meaning that the graph should have a non-zero y-intercept. As the drop height gets higher and higher (above about 40 cm in this sample data), the graph should start to flatten out as this one tends to show indicating that increased height has less of an effect on the splash diameter.

### Investigation 2: Dismantle a device

In this investigation, students will examine some common everyday devices to determine which parts might be responsible for the energy transformation they perform.

Some weeks prior to starting this investigation, ask your students if they have any old devices at home that are no longer needed such as old mobile phones, old iPods, old TV remote controls, fans, calculators, power tools, etc.

### Equipment needed

Per group:

* [student investigation sheet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20investigation%20sheet_yr8_Forms%20of%20energy.docx)
* screwdrivers
* magnifying glass
* other tools as required

Shared amongst the class:

* several devices partly dismantled to show their interior components

### What to do

1. Hand out the [student investigation sheet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20investigation%20sheet_yr8_Forms%20of%20energy.docx) and allocate student groups.
2. Instruct each group to examine each device and determine what it is.
3. Students should locate the parts of the device that are responsible for the energy transformation and describe them. (Teacher input or questioning might be needed to provide hints here.)
4. Students should write an energy flow diagram that shows the energy transformation that the device performs.
5. Conclude with a comparison of each team's findings.
6. Some discussion questions:

* What are the energy transformations in each device?
* What part/s of the device is responsible for the energy transformation?

### Expected results and explanations

Students might write something like this:



**Mobile phone:** (The energy source is the battery and the phone does not work if this is flat, so all processes must start with chemical potential energy)

* receiving a phone call: chemical potential energy 🡪 electrical 🡪 light, sound, kinetic (vibration)
* sending a phone call: chemical potential energy 🡪 electrical 🡪sound 🡪 electrical 🡪 electromagnetic (radio / microwave)

Photo by jppi at Morguefile.com

A mobile phone is very similar to an ordinary CB radio or walkie-talkie. As you speak, the microphone converts sound energy into electrical energy, which is then transmitted via radio waves. When you receive a call, the receiver converts the radio waves into electrical energy, which is converted into sound by the speaker. (Student research might enable them to identify which parts are which in the phone they dismantle.)

### Investigation 3: Energy efficiency

In this investigation, students will determine the energy efficiency of a range of electric kettles and identify what form(s) the wasted or non-useful energy has when using an electric kettle.

### Equipment needed

Per group:

* three different electric kettles
* thermometer
* 500 mL measuring cylinder
* stopwatch
* tap water

### What to do

Instruct students to:

1. Identify from the bottom or side of the kettle what its power rating is in watts and record this in the results table on the [student investigation sheet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20investigation%20sheet_yr8_Forms%20of%20energy.docx).
2. Measure out 500 mL of water and pour it into the empty kettle. Allow it to sit for a few minutes to allow the temperature of the water to stabilise (in case the kettle is still hot from its last boil).
3. Measure the temperature of the water.
4. Switch the kettle on, and at the same moment, start the stopwatch.
5. Stop the stopwatch when the water boils and the kettle turns off.
6. To avoid injury from boiling water, assume the temperature of the boiling water is 100 °C (or for more accuracy record the actual temperature of the water inside the kettle).
7. Complete the results table on the [student investigation sheet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20investigation%20sheet_yr8_Forms%20of%20energy.docx).
8. Repeat these steps for the other kettles.
9. Compare results with the rest of the class.
10. Conclude with a comparison of each team's results table, efficiency value and research work

### Expected results and explanations

Sample results

|  |  |  |  |
| --- | --- | --- | --- |
| kettle letter | starting temperature of water (°C) | final temperature of water (°C) | time taken to boil  500 mL (0.5 L) of water (seconds) |
| A | 20 | 100 | 82 |

Sample analysis

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| kettle letter | power rating (W) | time (s) | input energy (J)  =  power × time | output energy (J)  =  0.5 × 4200 × ΔT | efficiency  =  output energy input energy  × 100 % |
| A | 2400 | 82 | 2400 × 82  = 196 800 J | 0.5 × 4200 × 80  = 168 000 J | 168 000  196 800  = 85 % |

The waste or non-useful energy (in this sample 196,800 − 168,000 = 28,800 Joules) is the sound of the boiling water, the heat that is transferred to the kettle body and then into the air rather than into the water and the energy carried away with any escaping steam.

Another variable to investigate could be the volume of water in the kettle. Usually, higher efficiency will be achieved with higher water volumes as the surface area of the top of the water remains fairly constant.

*Note:* With a cost of electricity of about 20c per kilowatthour, this amount of input energy costs about 1 cent! (196,800 J ÷ 3,600,000 J/kWh × 20 c/kWh = 1.089 c)

Also, some people always fill a kettle right up and boil the whole contents (perhaps 2 L of water) just to make 1 cup of tea or coffee, which, if repeatedly done, is a big waste of electricity.

## Conclusion

1. Watch the video: ‘OK Go - This Too Shall Pass - Rube Goldberg Machine - Official Video’, *YouTube* (3:53 min) <https://youtu.be/qybUFnY7Y8w>
2. Ask the students to work in groups to present a representation of the energy transformations shown in the video. Have them write a small explanation of how efficient they thought these transformations were.

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### Assessment opportunities

Investigation 1 provides an opportunity to assess student understanding of the concepts related to the transformation of gravitational potential energy into kinetic energy.

In addition, the level of student achievement of the science inquiry skills, *Processing and analysing data and information* could be assessed.