# *Egg bungee jump* Teaching and learning plan

## Learning intentions

Students will be able to:

* understand that one or more different forms (or types) of energy can be present at the same time
* explain that one form of energy can be transformed into other forms and vice versa
* identify that the total amount of energy remains constant (total energy is conserved)
* design a fair test investigation
* 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 *Egg bungee jump* CLE will depend on the depth of the prior knowledge of students and the time taken to:

* perform the 1–4 rubber bands investigation
* complete the Excel analysis
* determine the number of rubber bands for the test drop
* perform the test drop
* follow up with any further student worksheets designed by the teacher and
* follow up with any further extension activities.

Allow 2–4 hours.

[**Planning ahead and equipment list**](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Planning%20and%20equipment%20list_Yr10_Egg%20Bungee%20Jump.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.

* Safety glasses should be used since rubber bands are involved and they could snap and flick into the eye.
* Consider any egg allergies.
* The retort stand bases can be clamped to the lab bench with a C-clamp if desired to prevent them toppling over during the investigation.

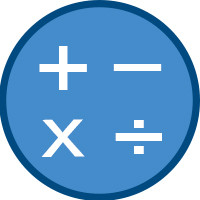
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## Introduction

This CLE focuses on energy and energy conservation and links to year 10 Australian Curriculum: Science.

### What to do

1. Introduce students to the concept of energy conservation during the motion of an object by showing the video of Wile E. Coyote trying to catch the Road Runner using a bungee cord. ‘Wile E. Coyote and Road Runner – Coyote Falls’, YouTube (3:00 min) <https://youtu.be/IleZWq45jDg> This is an excellent demonstration of the transformation of gravitational potential energy into other forms and one most students would enjoy watching and discussing.
2. Show the whole video through once, then rewind and stop the video when Wile E. is about to jump off the bridge.



Ask the students the following questions.

* What type of energy does Wile E. have at the top?
* What type of energy is this transformed into at the bottom?
* Were there any other energy transformations occurring during the fall?
* What happens to the amount of energy in the whole system?

1. Stop the video again when Wile E. is halfway down the fall just before the bungee cord has started to stretch. Explore the energy transformations that are taking place. (See ‘Expected results and explanations’ below).
2. Ask the students to draw an energy transformation diagram for the Wile E. jump and use this to explain the concept of energy conservation.

### Expected results and explanations

When Wile E. is about to jump off the bridge, he has a set quantity of GPE only given by his mass × gravity × his height. He is still, so his KE is zero and the bungee cord is not stretched so EPE = 0. At the bottom, as he hovers over the Road Runner, he is again momentarily still so his KE = 0, he is almost at ground level so his height is insignificant and GPE = 0, but EPE has a high value as the bungee cord is fully stretched. At this stage in the class discussion when comparing the top position to the bottom, students could express knowledge of the Law of Conservation of Energy by stating that almost all the GPE at the top is converted into EPE at the bottom. A small amount of energy is ‘lost’ to other forms such as heat in the stretching bungee cord. The total amount of energy in the whole ‘system’ is constant throughout the transformations that occur.

The energy analysis can then be expanded to include halfway down the fall (or any other intermediate point) where the GPE has reduced from its maximum on the bridge to a smaller amount, the KE is increasing and the EPE may or may not have started to increase depending on whether or not the bungee cord is starting to stretch. Teachers may choose to explore these ideas with students or restrict the analysis to only the top and bottom points.

## Core

### Equipment needed

Per group:

* 1 egg (plus some in reserve to account for breakages)
* 1 plastic sandwich bag or ziplock bag
* 1 wire length (or large paper clip)
* 1 or 2 boxes of rubber bands (a longish size will work as long as they are not so weak that they break with the force exerted by the falling egg or so strong that they hardly stretch from the force of the falling egg)
* 1 metre ruler
* 1 retort stand
* 1 boss head and clamp
* 1 pair of pliers (can be shared between groups)

**Notes**

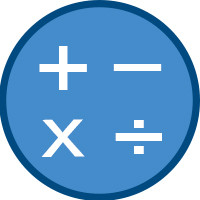
1. Ziplock plastic sandwich bags work well to hold the egg.
2. The wire or paper clip should be tightly wound around the top of the plastic bag (maybe using pliers) to avoid the bag slipping and the egg breaking.
3. Make the length of the wire shorter than the length of the unstretched rubber band so that the bottom of the egg can be lifted level with the clamp shaft on the first drop.

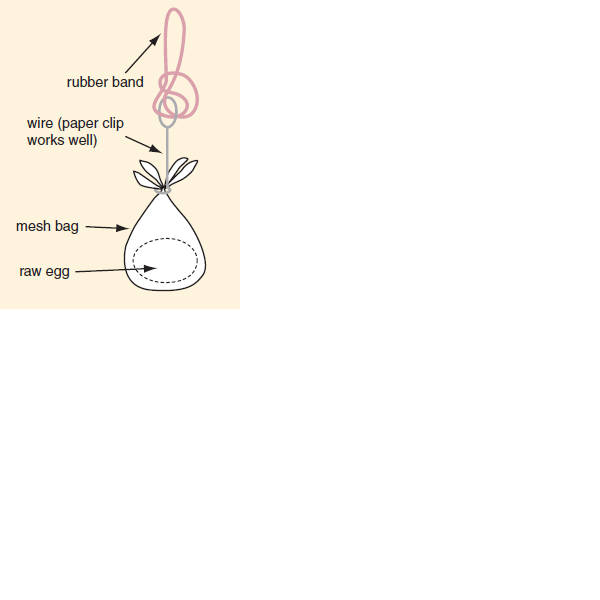
### What to do

1. Hand out the [student investigation sheet](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Student%20investigation%20sheet_Yr10_Egg%20Bungee%20Jump.docx).
2. Demonstrate the equipment to be used and explain the task to students.

*Teacher notes:* The equipment as demonstrated is a simple example only and just a starting point for the students. It does not replicate what they will be setting up themselves. The egg in the bag is raised to a point where the bottom of the egg is level with the clamp shaft. The egg is dropped and the bungee motion demonstrated.)

There are three main phases to the investigation. The first is the testing of 1–4 rubber bands to obtain some raw data. The second is the analysis of this data to form an x–y scatter graph. The number of rubber bands used to reach a drop distance of close to 150 cm is determined from one of two ways as outlined in the ‘Expected results and explanations’ below. Teachers will need to decide how much assistance to give to students during this phase. The third phase is carrying out the 150 cm ‘test’ bungee drops, as outlined on the student investigation sheet.

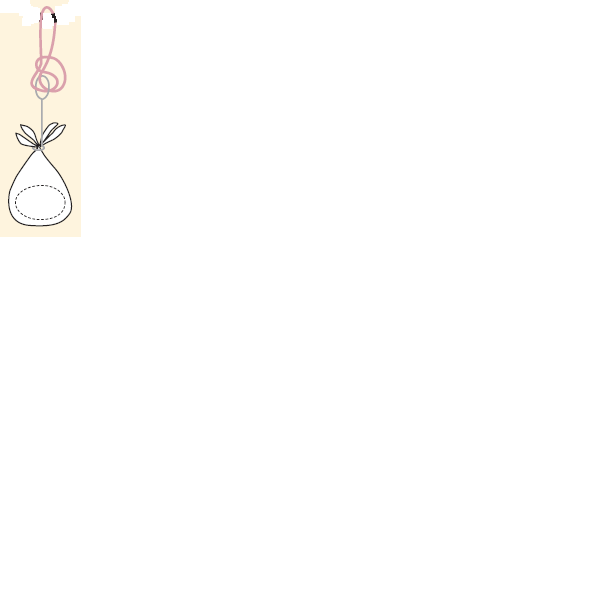




lab bench

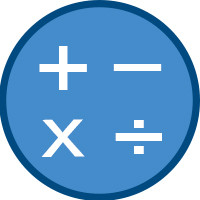
retort stand

boss head and clamp



plastic sandwich bag

1. Inform students that they will be gathering data on an ‘egg bungee jump’ using a rubber band bungee cord. Discuss the safe use of rubber bands with students. (It is advisable that students to wear eye protection when stretching the rubber bands even though no projectiles are involved.)
2. Inform the students they will measure how far an egg will drop, measured from the clamp shaft, first with a bungee cord consisting of only one rubber band, then with two rubber bands joined end to end, then with three bands, then with four. From this data, students are to determine how many rubber bands will be needed for a ‘safe’ drop from 1.5 metres in height (but they are not to test this yet).



1. Inform students that each group is to get their egg as close to the floor as possible, without the egg hitting the floor, from a 1.5 metre bungee fall. They will get three trials. No rehearsals from this height are allowed. They are only allowed to ‘test’ a drop with 1, 2, 3 and 4 rubber bands, then determine their ideal bungee length for the 1.5 metre drop and perform the test trials.

*Teacher notes:* Students can be allowed three trials so that they have a chance to correct any problems, without penalty, on the first or second trial if needed.

1. Instruct students to work in groups of four. One student will keep the retort stand steady and hold the metre ruler steady with the bottom edge of the clamp shaft (one metre ruler is usually sufficient for the students who are testing up to 4 rubber bands), a second student will line up the egg with the clamp shaft and drop the egg, the third student is the ‘egg protector’ and will keep the egg safe during its motion and the fourth student will crouch down to measure the distance travelled by the egg by reading off the metre ruler.

*Teacher notes:* The teacher can either instruct students how to determine the number of rubber bands needed for the 1.5 metre jump, or the teacher can allow the students to devise their own methods of using their data. The amount of data analysis guidance given to students should be based on their abilities and the teacher’s pedagogical goals.

### Expected results and explanations

(Note: data for distance fallen will vary depending on the type of rubber bands chosen for the activity)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of rubber bands | Distance fallen (cm) | | | |
| Trial 1 | Trial 2 | Trial 3 | Average |
| 1 | 20 | 20 | 21 | 20.7 |
| 2 | 33 | 34 | 35 | 34.0 |
| 3 | 48 | 49 | 50 | 49.0 |
| 4 | 64 | 65 | 67 | 65.3 |

To graph the data, enter the number of rubber bands and the average distance fallen into an Excel spreadsheet. Choose to display an x–y scatter graph without the line. Once displayed, right click on one of the data points and choose ‘add trendline’. Right click on the trendline and choose ‘format trendline’ then click in the box ‘display equation on chart’. With axes labels, a title and suitable gridlines, the following graph should be achievable.

From these results the equation of the trendline found to be: *y* = 14.9*x* + 5

So, for a drop length of 150 cm, *y* = 150 and solve for *x*:

150 = 14.9*x* + 5

145 = 14.9*x*

*x* = 145 ÷ 14.9

*x* = 9.73

So, 9 rubber bands would be the prediction, as 10 would produce a longer drop than 150 cm and make the egg break.

This can be determined graphically as well by extrapolating the graph past 150 cm on the y-axis. To do this, right click on the trendline in excel and choose ‘format trendline’. Choose ‘forecast forward’ and insert 8 periods (which will take it from 4 rubber bands to 12). Note this matches the sample data here, but might need altering to suit your rubber bands. The y-axis needs to pass 150 cm.

The following graph can be achieved:

### Rubber band determination

Go up to 150 cm on the y-axis and along to meet the line, and then down to approx. 9.8 (see arrows on graph above). So 9.8 rubber bands would produce a drop of 150 cm, meaning 9 rubber bands would produce a safe drop and 10 would be too many. This group would then set up their equipment for a 9-rubber-band drop and take the ‘test’ in front of their teacher to see if it works and whether they pass or not. Recall that 3 trials are allowed at this test stage.

## Conclusion

Post investigation follow up can be done via class discussion or more formally through a teacher designed student worksheet or assignment.

The open-ended nature of the activity encourages students to think about their experimental procedures and techniques. There are many possible variables that may affect the accuracy of the data students will collect, so this activity provides a rich source of post-experiment discussion on the sources of error that students encountered. The teacher may wish to create a post-experiment worksheet with questions about this aspect of the activity or any other questions about the energy transformations involved in the motion of the egg, as well as energy calculations if desired.

The data students will gather provides a practical context for solving equations and for graph plotting with real meaning for the gradient and y-intercept values. The y-intercept represents the combined length of the wire and the egg in its bag hanging with no rubber bands attached. The gradient of the line represents the additional falling distance per added rubber band.

Some questions to consider after the investigation, perhaps for inclusion on a teacher-designed student worksheet might include:

* Was your egg bungee jump successful?
* What would you change to make it better?
* How do you think bungee jump creators test the length of a bungee cord for a human bungee jump?
* How would this need to altered for jumpers of different mass?
* What were the sources of error in this activity?
* How did your group control the source of error to minimise their impact on your results?

Additional questions could be included that analyse the different energy forms during the bungee jump and transformations between these energy types.

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### Assessment opportunities

This investigation provides an opportunity to assess student understanding of the concepts related to energy and energy conservation.

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

To assess the success of the activity (i.e., the 1.5 metre test drop), the simplest method is to award a mark out of 100 that is calculated by 100 minus the number of centimetres off the ground the group’s egg is at the test. Students can be allowed three trials so that they have a chance to correct any problems, without penalty, on the first and second trial if needed. They must also provide the accompanying data tables and graphs in order to receive their mark.