



Key Stage 4 – Explosive energy

Notes for teachers

At a glance

This activity is based on work being carried out at The University of Oxford. A team is using laser-light to create tabletop supernovas to understand the origins of magnetic fields in our universe.

Students will carry out the double ball drop experiment, being careful to gather accurate and repeatable data. They apply their knowledge of energy transfer to explain their results and find out how this is analogous to a supernova.



Learning Outcomes

- Students can collect accurate and repeatable data.
- Students can use ideas about energy transfer and momentum to explain the behaviour of dropping balls.
- Students can explain how the double ball drop is analogous to a supernova.

Each student will need

- 1 copy of the pupil worksheet

Each pair of students will also need

- A tennis ball
- A ping pong ball
- Metre ruler
- Clamp stand and clamp

<http://www.oxfordsparks.ox.ac.uk/sheddinglight>



- Eye protection
- Mobile device (optional)

Possible Lesson Activities

1. Starter activity

- Show the animation 'Shedding Light on the Situation' to the class that outlines a range of research projects being carried out at The University of Oxford using light. Discuss the work being done creating table-top supernovas. Ask students to suggest why scientists would want to do this (it is much easier than studying real ones!).
- Ask students to read through page 1 of the pupil worksheet which gives some background information on supernovas. They also answer the questions.

2. Main activity: Carrying out the double ball drop experiment

- Discuss with the students that the research using table-top supernovas is using a model to collect data in order to study something that is very large and far away. Tell them that they are going to carry out an experiment that is a model for what happens during a supernova.
- Students work in pairs and carry out the experiment as outlined on page 2 of the pupil worksheet. They will drop a tennis ball and a ping-pong ball from 20 cm and measure the rebound height. Using a mobile device to record the bounce will make it much easier to measure the height as they can replay the bounce (in slow motion if possible).
- They will repeat their measurements a total of four times to increase repeatability. They should record their results in a suitable results table which you can supply if necessary.
- They then collect data for a double ball drop. This time the ping-pong ball is placed on top of the tennis ball and they are dropped together. The students are aiming for four bounces where the ping-pong ball travels straight up so its final height (and that of the tennis ball) can be measured. This is not easy and students may need several attempts. This allows for good discussion on why accuracy is important.
- Students will see that during the double ball drop the ping-pong ball bounces much higher than expected.

3. Main activity: Drawing conclusions

- Students then answer questions 1-7 on page 3 of the pupil worksheet to explain the science behind their results. When they have finished, go through the answers with them.

Answers:

1 a) Gravitational potential energy

b) Kinetic energy

2 a) Energy is transferred from the gravitational potential store into a kinetic store in the ball and a thermal energy store in the air through friction between the ball and the air.

b) Energy is transferred from the kinetic store in the ball to an elastic energy store in the ball and thermal energy store in the desk.

3. Some of the kinetic energy stored in the ball is transferred to energy stores in the air and



desk. This is dissipated away from the ball so the ball has less energy.

4. The bounciest ball is whichever one had the highest rebound height. It is the bounciest because more energy is transferred into a kinetic energy store during the rebound; it is more efficient.

5. The data should show that the rebound height of the tennis ball when dropped alone is greater than the rebound height when it is dropped with the ping-pong ball. Also, the rebound of the ping-pong ball is much higher during the double ball drop compared to when it was dropped alone. Therefore, you can conclude that some of the energy store in the tennis ball has been transferred to the ping-pong ball during the collision.

6. During the rebound some of the kinetic energy store is transferred from the tennis ball to the ping-pong ball. Because the mass of the ping-pong ball is smaller, the increase in its velocity will be greater.

- You could also use the data to calculate potential and kinetic energy of the balls using the equations $P.E. = mgh$ and $K.E = \frac{1}{2}mv^2$. Show the students how to combine the equations to give $v = \sqrt{2gh}$ and calculate the velocity of the balls.

4. Plenary

- Ask students to discuss in pairs the question about supernova on page 3 of the pupil worksheet. They will find it useful to look back at the information from page 1.
- Listen to their ideas to check understanding.

Weblinks

https://www.youtube.com/watch?v=2UHS883_P60

Physics Girl demonstrates a spectacular stacked ball drop and explains why this is analogous to what happens during a supernova.