Key Stage 4

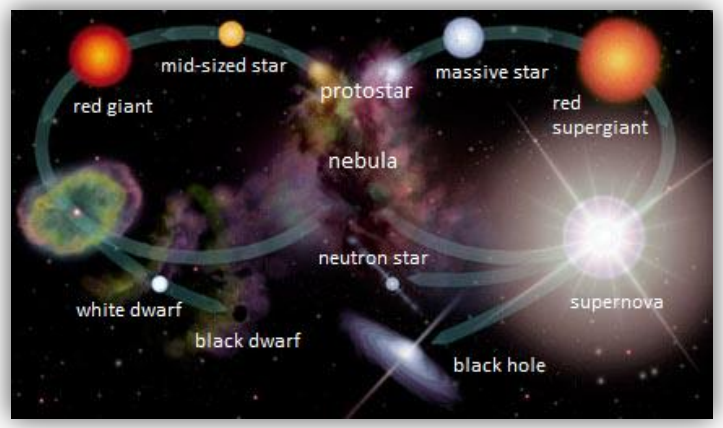
Explosive energy

Pupil worksheet

Scientists at The University of Oxford have recreated supernova explosions in the laboratory small enough to fit into the palm of your hand. To find out why this is so amazing (and amazingly important) read on...

What is a supernova?

Just like us, stars have a life cycle - they are born, they live and then they die. Stars die because they run out of fuel and can no longer carry out nuclear fusion where hydrogen nuclei fuse together to release huge amounts of energy.

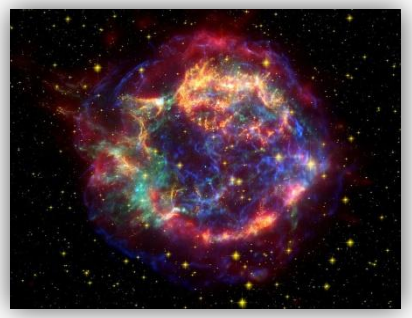


When a large star runs out of hydrogen it will collapse in on itself due to the effects of gravity. With one final spectacular burst the outer parts of the star bounce off of the core and the resulting shockwave explodes the star, leaving only the core of the star behind, as either a neutron star or a black hole. The explosion is called a supernova. The energy released in a typical supernova is on the order of 10^{44} joules - releasing more energy than an entire galaxy in a short amount of time.

What about supernova remnants?

A supernova remnant (SNR) is simply what is left over from a supernova. An example of an SNR in our galaxy, The Milky Way, is Cassiopeia A.

This image is formed using data from three telescopes, each detecting different wavelengths of light.



The blue ring around the outside is the outer edge of the blast wave. The colours on the inside show material that was once contained in the star.

Why study SNRs?

By studying present SNRs, we can understand how space got to be like it is. Heavy elements are formed during supernova explosions. Because the Sun and planets in our solar system contain these elements, it is evidence that it (including you!) formed from the remains of earlier stars that exploded as supernovae.

Your task

1. Answer these questions:
   a) How is a stone falling into a pond an analogy for what happens during a supernova?
   b) Why do scientists use data from several telescopes to study SNRs?
   c) Suggest why the team at Oxford decided to create models of supernova in the lab.
2. Use the instructions on the next page to create your own miniature model of a supernova.

Key Stage 4

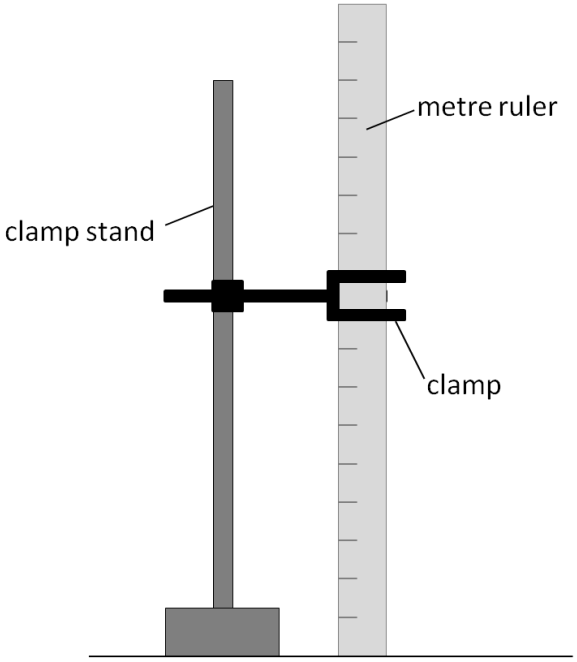
Explosive energy

The double ball drop experiment

How are dropping balls like a supernova? Try this experiment and find out.

You will need:

- A tennis ball
- A ping pong ball
- Metre ruler
- Clamp stand and clamp
- Eye protection
- Mobile device (optional)



Method

1. Set up the clamp stand and metre ruler as shown in the diagram.
2. Line up the bottom of the tennis ball with the 20 cm mark on the metre ruler.
3. Drop the tennis ball from 20 cm. Observe and record the maximum rebound height and record the result. Perform three more trials. It is easier to find the height if you use a mobile device to record the bounce and play it back.
4. Repeat steps 2–3 using the ping-pong ball and record results.
5. Hold the ping pong ball on top of the tennis ball.

6. Line up the bottom of the tennis ball 20 cm above the desk and then release both balls at the same time. Note: The balls may launch at random angles so make sure you are wearing eye protection.
7. Practice steps 5 and 6 until the ping-pong ball launches nearly straight up along the path of the metre ruler. Be patient - this is not easy! Repeat until you have a total of three successful bounces and record the maximum height of both the tennis and the ping-pong ball.

Results

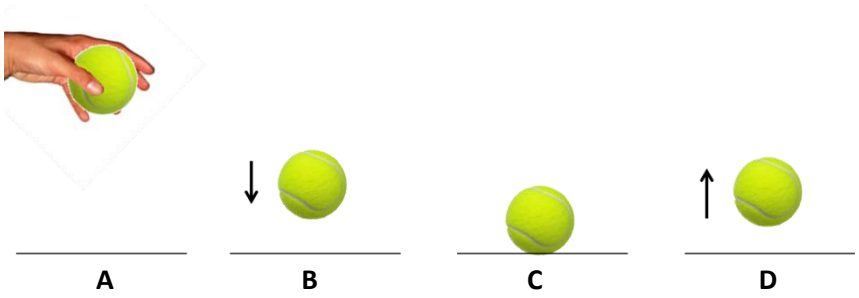
Record your results in suitable results table/s and calculate the means.

Key Stage 4

Explosive energy

Explaining the results

The single ball drop



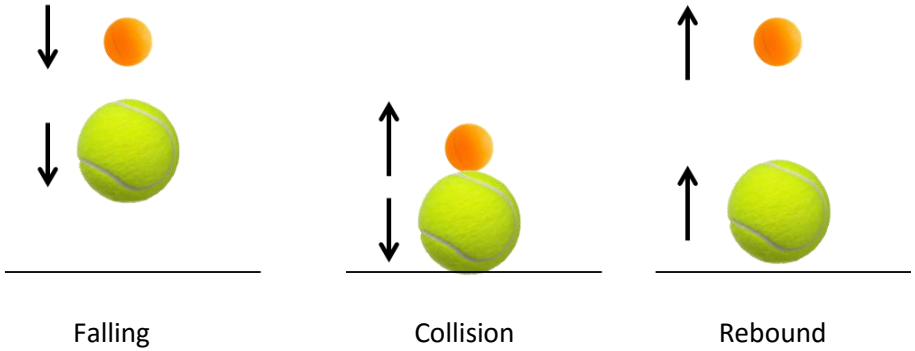
1. What type of energy store is being filled up when the ball is:
   a) being held above the desk? (A)
   b) falling towards the desk? (B)

2. Identify the energy transfers taking place when:
   a) The ball is falling towards the desk (B)
   b) The ball hits the desk (C)

3. Explain why a single ball will never rebound (D) higher than its release height (hint: think about dissipated energy).

4. Use your data to decide which ball is the bounciest. Suggest reasons why, based on energy transfers.

The double ball drop



5. During the collision some energy is passed from the tennis ball to the ping-pong ball. Use data from your experiment to support this hypothesis.

6. Use the equation KE = ½mv^2 to explain how the mass difference between the balls results in a high rebound of the ping-pong ball.

Supernova!

When a supernova happens energy from the dense core is transferred into a shockwave that moves through the less dense outer layers accelerating them to very high velocities (around 6,000 km/s). Explain how the double ball drop experiment is a model for this process.