PRIMARY + STEM

Teaching Resource

ACTIVITY: Barbie Bungee

ACTIVITY OVERVIEW

Forces and materials play a big part in extreme sports and engineering. Combine these into one crazy fun activity, and you get Barbie bungee! Students will be excited to launch toys from heights, with only rubber bands to keep them safe.

Engineers are responsible for the safe movement of human bodies in everyday activities, such as travelling in cars and trains, as well as extreme sports like bungee jumping. Here, we will experiment with the length of bungee cord, with the aim to have an exciting (and safe) jump. Although essentially an engineering activity, this can also be combined with science curriculum, specific to the different year levels.

This activity will focus on the 'produce' and 'evaluate' parts of the design process.

SYNOPSIS

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Engineers are responsible for the safe movement of human bodies in everyday activities, such as travelling in cars and trains, as well as extreme sports like bungee jumping. Here, we will experiment with the length of bungee cord, with the aim to have an exciting (and safe) jump. Although essentially an engineering activity, this can also be combined with science curriculum, specific to the different year levels.

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Foundation – Year 2

- Explore how technologies use forces to create movement in designed solutions. (VCDSTC014)
- Use materials, components, tools, equipment and techniques to produce designed solutions safely (VCDSCD020)
- Use personal preferences to evaluate the success of design ideas, processes and solutions including their care for environment (VCDSCD021)
- The way objects move depends on a variety of factors including their size and shape: a push or a pull affects how an object moves or changes shape (VCSSU048)

Year 3 – 4

- Investigate how forces and the properties of materials affect the behaviour of a designed solution (VCDSTC024)
- Select and use materials, components, tools and equipment using safe work practices to produce designed solutions (VCDSCD030)
- Evaluate design ideas, processes and solutions based on criteria for success developed with guidance and including care for the environment and communities (VCDSCD031)
- Forces can be exerted by one object on another through direct contact or from a distance (VCSSU064)

Year 5 - 6

- Investigate how forces or electrical energy can control movement, sound or light in a designed product or system (VCDSTC034)
- Apply safe procedures when using a variety of materials, components, tools, equipment and techniques to produce designed solutions (VCDSCD040)
- Negotiate criteria for success that include consideration of environmental and social sustainability to evaluate design ideas, processes and solutions (VCDSCD041)

ACTIVITY, MATERIALS AND INSTRUCTIONS

Activity - Barbie Bungee

Determine the number of rubber bands needed for Barbie to successfully bungee jump in your classroom. Barbie wants to get as close to the ground as possible (because that makes it the most exciting) but she doesn't want to get hurt!

Materials for 30 students (working in groups of 2 to 3)

Each group needs:

- One Barbie doll (or other figurine, but Barbies are usually easy to find, and it is easy to attach rubber bands to ankles)
- Pile of rubber bands (number needed depends on size of rubber bands and height of bungee jump)
- 1-metre ruler (or tape measure)

Instructions

Barbie is much smaller than a person, so she can bungee jump just using rubber bands. The inside of a real bungee cord is just a whole lot of rubber bands all together. We will be making Barbie's cord by joining together rubber bands to make the right length. What length do we need so that we are dangerously close to the ground (super exciting!) but not get hurt?

1. Decide on a jumping spot for Barbie. This may be a tall table, window ledge or cupboard top. Measure height of Barbie's bungee jump using ruler or tape measure. To jump, Barbie will stand on the jumping spot while you hold the end of her bungee cord with your finger. Barbie gets pushed off the edge of the jump and you hold on tight to the end of her cord, while she bounces up and down.
2. Place one rubber band around Barbie's ankles. Loop rubber band around several times so that it is secure.
3. Practise joining rubber bands together with a slip knot. This means putting one rubber band through the other, then back through itself. This is how we are going to lengthen Barbie's bungee cord.
4. Add one rubber band to the one around Barbie's ankles. JUMP, BARBIE! You may like to do this one at a time (as students will enjoy watching) or allow students open access to the jumping spot for as many test jumps as they need. How far does she drop with one rubber band? Is she safe? Is it exciting for her?
5. Students keep on adding rubber bands to Barbie's bungee cord until she has an exciting bungee jump (is close to the ground) but is not hurt. (Yes, you will probably have a few Barbie injuries trying to get the number just right!)

Safety note – ensure students are not flicking any rubber bands around the classroom.

HOW TO USE THIS ACTIVITY WITH YOUR STUDENTS

Foundation - Year 2

Introduce this activity to your students by explaining the extreme sport of bungee jumping. Consider showing students one of the video clips from the section below.

If any teachers at your school have been bungee jumping, it would be great to have them speak to students about their experience.

Investigate

Who works out how to keep people safe when they are taking part in extreme sports like bungee jumping? Engineers, scientists, and mathematicians! Materials engineers study the materials used in each sport and work out how they can be used to keep people safe. Physicists and mathematicians make calculations based on our knowledge of forces. Barbie is pulled to the ground by the force of gravity. We are going to be Barbie's engineers and help her to have a safe and fun bungee jump.

Produce and Evaluate and Produce and Evaluate!

Add rubber bands to Barbie's bungee cord, then test to evaluate her jump experience. Remember, Barbie wants to get close to the ground, but not get hurt. Add another rubber band and re-evaluate Barbie's jump experience. Keep going until you get it just right! This is part of the design process that all engineers use, testing and redesigning their products until they best meet the needs of the user.

Years 3/4

Gravity is a great introduction to this activity for Year three and four students, studying the topic as part of their Science curriculum. What can students tell you about gravity and different sports? Gravity is the force that pulls everything around us down towards Earth's surface. Think about sports that the children play, as well as extreme sports that they may have seen adults doing.

Investigate

What forces are involved in bungee jumping?

- gravity pulls the jumper down towards the ground
- spring force from the elastic bungee cord pulls the jumper back up
- air resistance (friction from air) slows down movement through the air, both ways

Forces have opposites and, in bungee jumping, we have gravity vs. spring force. What a battle! Let's make Barbie have an exciting bungee jump, getting as close to the ground as possible, without being injured. We will need to find the number of rubber bands that balances gravity and the spring force when Barbie takes her jump.

Produce and Evaluate and Produce and Evaluate!

Add rubber bands to Barbie's bungee cord, then test to evaluate her jump experience. Remember, Barbie wants to get close to the ground, but not get hurt. Add another rubber band and re-evaluate Barbie's jump experience. Keep going until you get it just right! We are aiming to balance the force from gravity and the spring force from the bungee cord. This is part of the design process that all engineers use, testing and redesigning their products until they best meet the needs of the user.

Extend this activity for your students by challenging them with a higher bungee jump. Find a higher place outside (e.g. top of the playground, stairs). Measure the height that Barbie will jump. Students estimate the number of rubber bands needed, based on how many they used for the first jump. Test it out!

Years 5/6

If you are studying energy, as part of the Science curriculum, you could use this activity to extend students' knowledge of energy types by introducing them to kinetic (movement) and potential (stored) energy. Any objects off the ground will have gravitational potential energy stored in them, which can be converted to kinetic (movement) energy.

This activity also fits well with the study of forces used in a designed product, in the engineering part of Design & Technologies. What can students tell you about gravity and different activities in their lives? Gravity is the force that pulls everything around us down towards the surface of Earth.

Investigate, Produce and Evaluate Forces:

See above description used for Year 3/4 students.

Investigate

What types of energy are involved in bungee jumping?

- gravitational potential energy is stored in the jumper, high above the ground
- kinetic (movement) energy is when the jumper is moving (up or down)
- movement energy stops for the moment when the jumper reaches the bottom of their fall
- heat energy is created when the jumper moves through the air, and also in the stretching bungee cord

Think about these different types of energy while you are helping Barbie to get her jump just right.

Produce and Evaluate and Produce and Evaluate!

See above description used for Year 3/4 students. Your Year 5/6 students will enjoy taking these basic skills to a much higher bungee jumping situation.

DISCUSSION SECTION AND KEY THEMES

KEY THEMES

Bungee jumping

Bungee jumping (also spelt bungy) is jumping from a tall structure (usually a bridge, building or crane), while connected to an elastic cord. It is exciting because you free-fall first, before the cord pulls you back up again.

Modern bungee jumping started (illegally) in 1979, from the Clifton Suspension Bridge in Bristol, England. Some university students took a tradition from Vanuatu, land-diving using vines, and made it into a thrilling sport, which has now spread around the world. Commercial bungee jumping (where people pay to do it legally), began in New Zealand in 1986. Millions of people have jumped since then.

Equipment used includes a safety harness and an elastic rope, called the bungee cord. The elastic rope is made of many strands of rubber. It's like lots and lots of long rubber bands all wrapped together in a braided fabric cover. Why elastic rope and not regular? Normal rope will still stop you from hitting the ground but won't transfer the movement energy from the jumper into elastic energy, allowing them to gently bounce up and down until they stop.

YouTube bungee jumping clips that could be used to show bungee jumping:

1. Golden Eye (James Bond) opening
   https://www.youtube.com/watch?v=mSvuHSqqGSw
   Verzasca Dam, Switzerland
   220m drop
   Longest free-fall swinging bungee on single cord
   (Although, at the bottom, James Bond secures himself to the ground and doesn't let the cord pull him back up).

2. Zhangjiajie Glass Bridge, China.
   https://www.youtube.com/watch?v=XmuWIasLaPU&t=59s
   World's highest commercial bungee jump.
   260m drop

3. AJ Hackett International – Cairns
   https://www.youtube.com/watch?v=aoVI23NfXvk
   This is a 50m bungee jump in Cairns. The clip is a bit longer (four mins) but shows many different people jumping. You could stop clip whenever you like.

Gravity (a force)

Gravity is a force pulling towards the centre of an object. All objects have their own gravity (yes, even people!) but the strength of the pull of gravity depends on the mass of the object. (Mass is the amount of matter in something). So, small objects like my dog or my lunchbox have gravity, but the pull is very weak. Therefore, we usually only talk about gravity of huge objects, such as planets and stars.

Gravity on Earth is the force that makes us slide down playgrounds, makes rain fall, makes bungee jumpers fall down and pulls everything around us towards the surface of Earth.

The force of gravity keeps the planets of our solar system in orbit around the Sun. The pull of gravity from Earth keeps the Moon in orbit, and the pull of gravity from the Moon affects water on Earth and gives us tides.

Air resistance (a force)

When materials rub against each other, they experience a stopping force, called friction. Anything that is matter can cause friction. Air is made of matter, so when things move through air they experience friction, called air resistance.

This is why vehicles that we want to move fast are made in a special shape that can move through the air more easily (aerodynamic or streamlined).

Spring force (a force)

This is the force that pulls the bungee jumper up. It is the opposite of gravity. The spring force increases as the bungee cord is stretched further (as the bungee jumper gets closer to the ground). When the bungee cord is stretched almost to the ground, the spring force becomes greater than the force of gravity and the jumper is flung upwards. Using the laws of physics, the exact length of rope required to give the exact amount of spring force needed can be calculated for individual bungee jumpers.

Elasticity

A material with the property of elasticity is one that can return to its original shape after being stretched out. This is one property of materials that can be studied by materials engineers.

This type of engineer tests behaviour of materials under specific conditions or when combined with other materials, develops new materials, or improves existing materials. Materials showing a high degree of elasticity are called ‘elastic’. Elastic materials include rubber bands, activewear (Lycra), elastic used in sewing (check that waistband of your undies!) and springs. Other materials can have some elasticity but not as much as these.

Energy

Energy is about movement.

Energy cannot be created or destroyed. Energy is transformed from one type of energy to another. Because we understand how to transform energy, we can use it for many purposes.

There are two main groups of energy:

- kinetic (moving)
- potential (stored)

You can use a balloon to show the difference between potential and kinetic energy. A blown-up balloon has potential energy, which is transformed to kinetic energy when you let go of the balloon and it whizzes all over the room.

Another way to illustrate the difference between potential and kinetic energy is to hold a ball up high. Because it is not on the ground, the ball has potential energy. When the ball is released, it falls to the ground, as potential energy is transformed into kinetic energy.

All energies are connected to each other. Energy can be transformed from one type into another. When we are looking at bungee jumping, we can think about the potential (stored) energy and the kinetic (movement) energy.

Barbie bungee and energy

During a Barbie bungee jump we have:

1. Gravitational potential (stored) energy (because Barbie is up high)

TRANSFORMED to

2. Kinetic (movement) energy (as Barbie falls down, towards the ground)

TRANSFORMED to

3. Elastic potential (stored) energy (as the bungee cord is stretched out)

TRANSFORMED to

4. Kinetic (movement) energy (as Barbie is pulled back up by the cord)

Barbie can't go back to her starting height because some energy has been lost to the surrounding air (this is due to friction from air, called air resistance, Barbie rubbing past air molecules on her way down towards the ground) and some has been lost as heat energy. You can feel the lost heat energy by stretching a rubber band quickly, then placing on your nose to feel temperature increase.

Note – these energy transformations are part of Year 7/8 Science curriculum but can be introduced successfully as an extension to Year 5/6 students completing this activity.

QUESTIONS AND ANSWERS

Is bungee jumping dangerous?

Yes, there are dangers involved in bungee jumping, and risks of injury, but there are dangers involved in many sports. Staff working at bungee jumping locations are well-trained. Your equipment (harnesses and rope) will be thoroughly checked before your jump. Professionals ensure that your bungee rope is anchored with the correct knots. Some bungee jumping locations also have netting and airbags at the base, to ensure jumper safety. According to the American Council on Science and Health, you are more likely to be killed by hang gliding, canoeing, mountain hiking, skydiving, and bicycling, compared to bungee jumping.

Can kids bungee jump?

Bungee jumping is not recommended for younger kids. At Australia's bungee jumping venue, Skypark (Cairns, QLD) you must be a minimum of 10 years of age and 45kg to jump solo. You can tandem jump at minimum

10 years of age and 30kg. Kids can experience the bouncy effects of bungee rope on a bungee trampoline. You may have seen these at fun fairs, where you are put in a harness, attached to several bungee ropes, and bounce, spin and flip on a trampoline.

Where else do we experience elastic potential energy?

Most kids have experienced elastic potential energy when jumping on a trampoline. When the springs are stretched, as your feet push on the mat, elastic potential energy is formed from your movement energy. When you reach the lowest point of your jump, the elastic potential energy is transformed into movement energy, which pushes you into the air!

Does air slow you down when you are bungee jumping?

Yes, air slows us down all the time, even when we are falling from hundreds of metres up! When things rub against each other, they experience a stopping force, called friction.

Air is made of matter, so when things move through air they experience friction, called air resistance. This is why vehicles that we want to move fast are made in a special shape that can move through the air more easily (aerodynamic or streamlined). When you bungee jump some of the energy is lost when it is transformed into heat, due to friction from the air. That's why you don't bounce back all the way to the platform when you jump.

What other sports do people do where they jump from high things?

There are several other sports that involve brave sportspeople launching themselves off the top of high places. For example, parachuting, sky diving, base jumping, hang gliding and cliff diving.

What else can bungee cord be used for?

There are many uses for bungee cord. We commonly see it used to tie down loads on trailers, or hold luggage in place, sometimes called occy straps. People use bungee cord for storage, hanging, supporting small curtain sections, replacing shoelaces, woven into a seat, baby-proofing drawers/stairs, and organising shoes. So many uses for this elastic material!

How are rubber bands made?

Rubber is first kneaded, to soften it into a doughy texture. Then the rubber dough is fed through what looks like a giant pasta maker (two metal rollers), flattening the rubber into thick sheets. Chemicals are added to the rubber to make it both stronger and more elastic. Then the rubber is rolled into thin sheets that are rolled into a size that fits into the next part of the machine. This part of the machine takes the warm rubber and shapes it into long tubes. The rubber tubes are placed over solid aluminium tubes coated with talcum powder, to prevent them from sticking. The tubes are placed in a hot oven to harden, this process is called vulcanisation. The rubber tubes are removed from the aluminium by shooting air down them, then washed and dried. Tubes are fed through a machine that cuts

them all to the same size. Here's a great video clip of rubber band making you can watch: https://www.youtube.com/watch?v=aEIAYBGRyYY. Some rubber bands are made from natural rubber, using this process. Others are synthetic, made from manufactured rubber.

Are engineers involved in other extreme sports?

Engineers, scientists, and mathematicians are involved in all sports. If we think of another extreme sport – hang gliding – we need materials engineers to find us the best materials to make our glider stay aloft (light, air catching). We need physicists and meteorologists to help us understand the forces affecting the movement of objects in the air. Engineers are also responsible for the design, testing and manufacture of all safety equipment used in sports. You may have seen 'crash test dummies' before – used to replicate a human body in a certain situation. Engineers test safety features on these dummies before anything gets close to being worn by real people! Thank you, engineers - for keeping us safe!

Why do people like bungee jumping?

Bungee jumping is certainly something that not all of us want to do. But, for those who do, it's about the feeling that they get during this extreme sport. When our body senses danger (e.g. standing on top of a bridge, ready to jump) the hormone adrenaline is produced. It prepares our body to react quickly in a stressful situation. After you jump, your body releases endorphins, hormones that make you feel good, to help deal with this stress. The combination of the adrenalin plus endorphins can make people happy and feeling alive. People want to feel this again and again!

OUTSIDE OR SUPPLEMENTARY READING

Bungee jumping and physics (University of Illinois, USA)
https://van.physics.illinois.edu/qa/listing.php?id=350&t=force,-work,-energy-in-bungee-jumping

Bungee jumping records
https://www.theguardian.com/world/2022/jun/01/french-man-sets-new-world-record-for-most-bungee-jumps-in-24-hours
https://www.guinnessworldrecords.com/search?term=bungee

Why try bungee jumping?
https://awe365.com/why-try-bungee-jumping-5-reasons-to-take-the-leap-of-faith

Bungee cord
https://ropeandcord.com/guides-ideas/what-you-need-to-know-about-bungee-cord/

Gravity (NASA Science Space Place)
https://spaceplace.nasa.gov/what-is-gravity/en/

TOPIC WORDS

- Bungee
- Forces
- Gravity
- Spring
- Elastic
- Friction
- Air resistance
- Engineer
- Physics
- Safety
- Height
- Fall

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