Bungee Barbie: Teachers notes

Summary

Bungee jumping requires a lot of pre-planning and testing before the real thing occurs. If it wasn't for this, if somebody just jumped off the edge of something tall with a rope, it might not be safe! In this experiment, students will be tying rubber bands to a Barbie doll to recreate bungee jumping on a miniature scale. They will be making predictions on what will be happening, measuring the distance fallen against the number of rubber bands to make a model for the bungee jump, reflecting on their predictions and investigating what happened during the jump.

Curriculum Outcomes: Victorian Curriculum F-10

Levels 7 and 8

- Change to an object's motion is caused by unbalanced forces acting on the object; Earth's gravity pulls objects towards the centre of Earth (VCSSU103)
- Energy appears in different forms including movement (kinetic energy), heat, light, chemical energy and potential energy; devices can change energy from one form to another (VCSSU104)

Levels 9 and 10

- The description and explanation of the motion of objects involves the interaction of forces and the exchange of energy and can be described and predicted using the laws of physics (VCSSU133)
- Analyse patterns and trends in data, including describing relationships between variables, identifying inconsistencies in data and sources of uncertainty, and drawing conclusions that are consistent with evidence (VCSSU138)

Key Ideas & Background information

Forces

Standing motionless at the top of a cliff, a bungee jumper is subject to equal forces, up and down. Gravity pulls down and the earth pushes up with the same magnitude. This means that the jumper will not move. As soon as the jumper steps off the ledge the only force acting on is gravity. (Air resistance can be ignored because it is minimal.) The force of the elastic band pulling can also be ignored because when it is loose it has little affect.

When falling, the jumper will accelerate because there is an unbalanced force. Since the jumper does not get close to terminal velocity because the falling distance is short, so air resistance can be ignored for entire fall. It is only when the elastic band is at is maximum distance without being stretched that the force of the elastic band comes into play.

The kinetic energy of the jumper will transfer into elastic potential energy as the band starts to stretch, with some energy being lost as heat and sound. As the band reaches it maximum stretch, at the bottom of the fall, all the kinetic energy has been transferred to elastic potential energy.

Afterwards, the jumper will then be accelerated back up, since the elastic energy is converted back into kinetic energy. As the jumper moves up, his kinetic energy is transferred to gravitational potential energy then back to kinetic as he falls again. This cycle repeats of constant transfer between kinetic and gravitational potential energy and elastic potential energy until all the energy is lost as heat and sound until the jumper stops moving.

For a video explanation, see:

https://www.youtube.com/watch?v=NyVHGdrD7Bo

(Noel K., 2013)

Pedagogy

Inquiry

This is an inquiry activity that can be adjusted by the teacher to be as guided or as open-ended as desired. The student notes begin with specific directions, but later questions allow students to conduct more independent investigations. The teacher may, however, decide to provide close guidance and direction throughout the activity.

Extra notes

What could cause outliers?

- The graph should be linear, it would only be exponential if each new rubber band was attached to the Barbie rather than to each other.
- The point of the Barbie used for measurement, if it was changed during the experiment than the results would be different.
- Varying the method of dropping the Barbie could change results, if it was sometimes pushed then the data would change.

Tips:

- Ensure students have enough space at the start of experiment. At least 3 m is recommended and if Barbie is heavier than more space would be required.
- Students should decide on point of measurement before they start so it does not change. Using the feet of the Barbie is recommend, then adding the height each time, as using the top of the hair of the head is harder to read.
- Using a camera with slow-motion features can help with reading data as you change frame by frame until the Barbie reaches the bottom of its drop.

Acknowledgement to Authors

Previous authors & scientists involved	Short bio / Staff link
 Dr John Long	John Long is a senior lecturer in the faculty of Science, Engineering and Built Environment at Deakin University. His research is in the field of material science and focuses on atomic emission spectrometry analysis of thin surfaces such as coatings on metals like steel. Staff page link: http://www.deakin.edu.au/about-deakin/people/john-long
 Dr Kieran Lim	Kieran Lim is an Associate Professor in the Faculty of Science, Engineering and Built Environment at Deakin University. His research focuses on how students learn and primarily on forensic science by supporting police and forensic scientists with new science skills and techniques to solve crimes. Staff page link: http://www.deakin.edu.au/about-deakin/people/kieran-lim

Louise Lopes and Dorothy Yu were the previous authors of the “Bungie Barbie” workshop investigation.

References

Noel K., 2013, *Minute Physics: the physics of bungee jumping*, YouTube, <https://www.youtube.com/watch?v=NyVHGdrD7Bo>.

Harrisburg Bulldogs, 2016, *Bungee Barbie Algebra*, Harrisburg Bulldogs, <http://harrisburg.k12.mo.us/barbie-bungee-algebra/>.

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