This document can be downloaded at: blogs.sd41.bc.ca/science

 (select the DLRC tab)

ZeeBeez

If you have never used a ZeeBeez, brief video demonstrations of the ZeeBeez toy can be found at:

<https://www.youtube.com/watch?v=pTkqoip3PBk>

<https://www.youtube.com/watch?v=PLa0bzBK2r0>

note:

* some people like to spin the ZeeBeez as they are dropped and some prefer not to spin them
* the spinning might help the ZeeBeez ‘land flat’ more regularly but it depends on how well you are able to spin it (in theory, the angular momentum from the spin helps ‘steady the fall’)

Class Inquiry (for Intermediate Grades)

* Predict, plan/design investigation, analyze and communicate findings

1) Drop the ZeeBeez once and have the class generate questions they are wondering about. They will most likely ask ‘How does it work?’ This can be discussed briefly or very deeply if you want to get into a ‘full physics discussion’. (see section at end for more information)

The main focus for this activity is to have students plan and perform an experiment and then analyze the results. ***With this in mind, try to have students generate questions they can investigate with an experiment***. It may or may not require much assistance on your part to generate questions such as:

* Does the drop height for the ZeeBeez change the rebound height?
* Does dropping the ZeeBeez onto different surfaces change the rebound height?

Some other potential questions:

* Is it helpful to spin the ZeeBeez as you drop it?
* When you drop the ZeeBeez, does it usually rebound vertically?

2) Have students predict an answer to their question(s).

3) On the board write the following:

Purpose of activity - To plan an experiment, analyze the results, and justify our conclusions

4) Have students work in groups of 2 or 3 and decide how they will measure and record the information. Have measurement tools available (ex. metre sticks, tape measure, . . . )

Suggestions:

Students can organize some of their thoughts using a PEOE sheet

( one sheet for each question being investigated )

P – predict

E – briefly explain reason(s) for prediction

O – briefly state summary of observations (due to space limitations, organize your data elsewhere)

E – explain your findings – justify the reasoning behind your analysis ( suggestion: write ‘See Attached’ on the PEOE form for this section and then encourage students to elaborate fully on how they planned their experiment, the decisions they made on making measurements, the interpretation they made from the data, . . . )

Students can record information in tables such as:

|  |  |  |
| --- | --- | --- |
| Drop Height (cm) | Rebound Height (cm)* 5 trials in this example but students need to decide upon how many they will use
 | Average Rebound Height (cm) |
| 40 | 60, 50, 0 , 65, 70 |  |
| 50 | 50, 55, 30, 60, 65 |  |
| etc | etc |  |

|  |  |
| --- | --- |
| Drop Height = \_\_\_\_\_ cmSurface | Rebound Height (cm)* 3 trials in this example but students need to decide upon how many they will use
 |
| wood | 40, 0, 40 |
| carpet | 30, 25, 35 |
| etc | etc |

|  |  |
| --- | --- |
| Drop Height = \_\_\_\_\_\_ cmTrial # | Rebound Angle ( degrees ) |
| 1 | 0 |
| 2 | 10 |
| 3 | -15 |
| etc | etc |

Note:

* Height and angle measurements will be approximate - students may want to round to whole numbers, multiples of 2 or 5 - the ZeeBeez travels very fast so measurements will have a large uncertainty – ask students to determine strategies for making their measurements and then discuss their choices
* For calculating the average, did students use median, mode, mean? Or perhaps they calculated the mean after some outliers were removed from their list of measurements?
* If students measure angles:

0° 🡪 rebounded vertically

-5° vs 5° 🡪 perhaps use negative and positive signs to discuss direction ( for example, left versus right of vertical could be distinguished by negative and positive angles )

 students may want to consider ‘forwards and backwards’ as well which would require 3d versus 2d thinking – this will be much harder to measure and record)

* Having students capture parts of their investigation by video may be helpful

How does the ZeeBeez work?

First of all, let’s discuss how rubber balls bounce and then compare this to a falling ZeeBeez.

Imagine a falling rubber ball hitting the floor. For a material like a rubber ball, it deforms when it hits the floor.  During this deformation, the ‘kinetic energy’ (energy due to motion), is changed to ‘elastic energy’ (stored energy due to compression or stretching). The ball then snaps back like a stretched elastic band, and the stored elastic energy converts back into ‘kinetic energy’ launching the ball upwards.

As an example, see the tennis ball deform in the following video:

<https://www.youtube.com/watch?v=aGsntCznhcY&feature=youtu.be>

In reality, when falling materials collide with the ground, some kinetic energy is lost in the collision to heat and/or deforming the ground. The further a material bounces back up, the more kinetic energy was transferred to elastic energy during the bounce (if no kinetic energy was lost, the material would bounce back to the height from which it was dropped).

So, for bouncing objects, there are two things to consider:

1. Is the object ‘very elastic’? *( Elasticity*is the property of solid materials to return to their original shape and size after the forces deforming them have been removed )
2. How difficult is it to deform the object?

note: some materials like hardened metals can bounce very well if dropped onto a hard enough surface – they just require a lot of energy to deform - if you dropped a metal ball onto a soft surface, then energy would be absorbed by the soft surface and lost as either heat or deformation (i.e. denting the surface).

Do glass and steel balls bounce better than rubber balls?

<http://sciencenotes.org/why-a-glass-ball-bounces-higher-than-a-rubber-ball/>

Now consider the ZeeBeez. If you drop the ZeeBeez from a low enough height, the ZeeBeez doesn’t return upwards at all. From some heights, the ZeeBeez actually returns upwards to a higher point than it started. The motion of ZeeBeez is not the same as a bouncing rubber ball. The elastic energy being released at the point of contact is different than that of a bouncing ball.

For the ZeeBeez, the elastic energy that causes it to propel upwards is stored when you ‘bend it back’ (think of a spring being compressed and then later released). Unlike a bouncing ball, the ZeeBeez elastic energy is not due to the kinetic energy of the fall.

When you bend the ZeeBeez backwards, the stored elastic energy is always the same, so dropping it from greater heights does not increase the energy it has to return upwards.

Here are some links you might also find interesting

slow motion - golf ball deformation when hit:

<http://ftw.usatoday.com/2015/12/this-video-of-a-high-speed-golf-ball-hitting-steel-is-mesmerizing>

<https://www.youtube.com/watch?v=6TA1s1oNpbk>

What is happening at the atomic level when objects bounce?

<https://www.reddit.com/r/askscience/comments/1pa92v/why_do_things_bounce/>

Kinematics analysis of a bouncing ball:

<http://www.real-world-physics-problems.com/bouncing-ball-physics.html>