Looks like a rock!

# Metadata

## *General Info*

Title

Looks like a rock!

Short description

Meteorites pose a great danger to space travel. Not only for various satellites, but also for the lives of astronauts in space stations. To learn more about meteorites, you don't necessarily have to run a lab in space. Some meteorites come dangerously close to Earth, and many hit the ground with varying energy.

Keywords

Meteorites, energy, impact, crater, astrophysics, atmosphere, regmaglypts, elements, meteorite hunting.

# *Educational Context*

## Context

Student centered problem-based learning, interdisciplinary extension to geology possible.

## Age

Secondary level, but the appropriate age level depends on the task and intent - meteorite impacts could also be a topic in elementary school (see notes at the end of this description: Background Information for the Teacher).

## Prerequisites

None.

## Lv. Of difficulty

Varies depending on the effect of an impact, which should be studied, and the math available.

## Duration

3 hrs max

# *Educational Objective*

Create an educational framework with the goal to challenge our students and start the process of inquiry-based learning. The focus of the investigations is the connection between cause and effect.

## Cognitive Objectives

The focus lies on problem-based learning.

## Affective

Promoting group work.

## Psychomotor

Depends on task at hand.

# *Subject Domain*

Mostly localized in the field of physics, but could be extended to geology and even humanitarian sciences (how do people deal with hazards and threats?).

## Big Ideas of Science

Scientific problems often pose a great challenge to human ingenuity. Getting unnecessary complications out of the way is at the heart of scientific inquiry. Working together on a problem, acquiring the necessary background knowledge, critically examining the answers obtained, and presenting the results in an appealing manner are the cornerstones of scientific work.

## Subject Domain

It is in the nature of man that he tries to decipher the inexplicable. In principle, there are two contrary approaches here: On the one hand the retreat to superstition and irrational conspiracy theories and on the other hand the objective approach to

experiment and model building. In this activity the clear link between effect and cause shall be worked out.

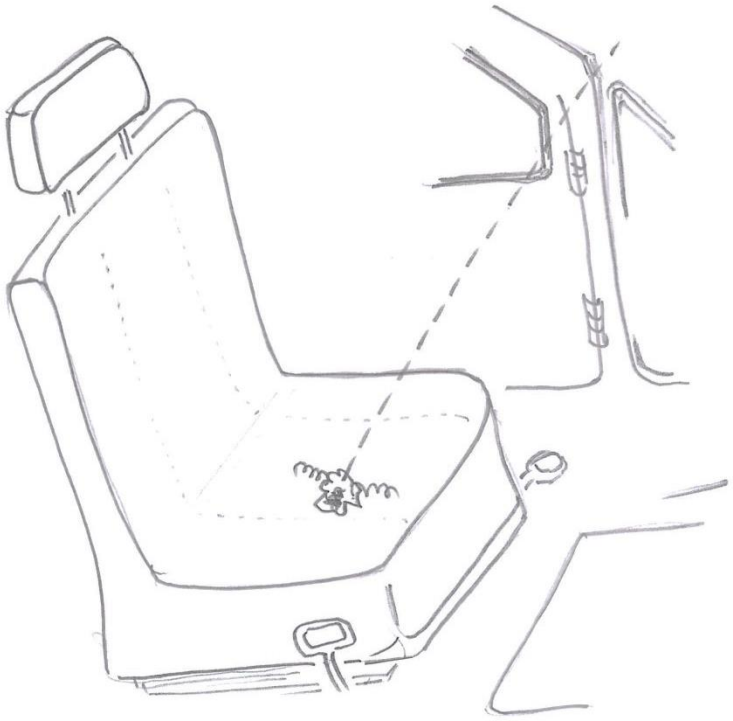
# Orienting & Asking Questions

Imagine your mother wants to drive you to school. You both go to the car, which is parked in the garage, and your mother opens the car door and screams, "Oh God, there's a hole in the car seat!" Only after you inspect the hole in the driver's seat do you also find a hole in the roof of the car. And there's even a hole in the roof of the garage.

That's exactly what happened to Mr. McCain and his Pontiac. This time, it certainly wasn't the neighbor who plays tennis and whose mis-hit tennis ball then lands on your property. Even if you threw a ball, such as those used in shot put, the heavy iron ball would not go through the roof of your garage. The thing that entered your car must have had quite a bit of energy - kinetic energy, that is!

It would be interesting to know the kinetic energy of a Pontiac at full speed, wouldn't it? I'd like to compare that value with the kinetic energy of an object that punctures the garage roof, the roof of the car and finally the driver's seat.

You think I made the story up? Go to the Website and see for yourself:
https://www.youtube.com/watch?v=BM7cD5EKQes&ab_channel=AtlasObscura

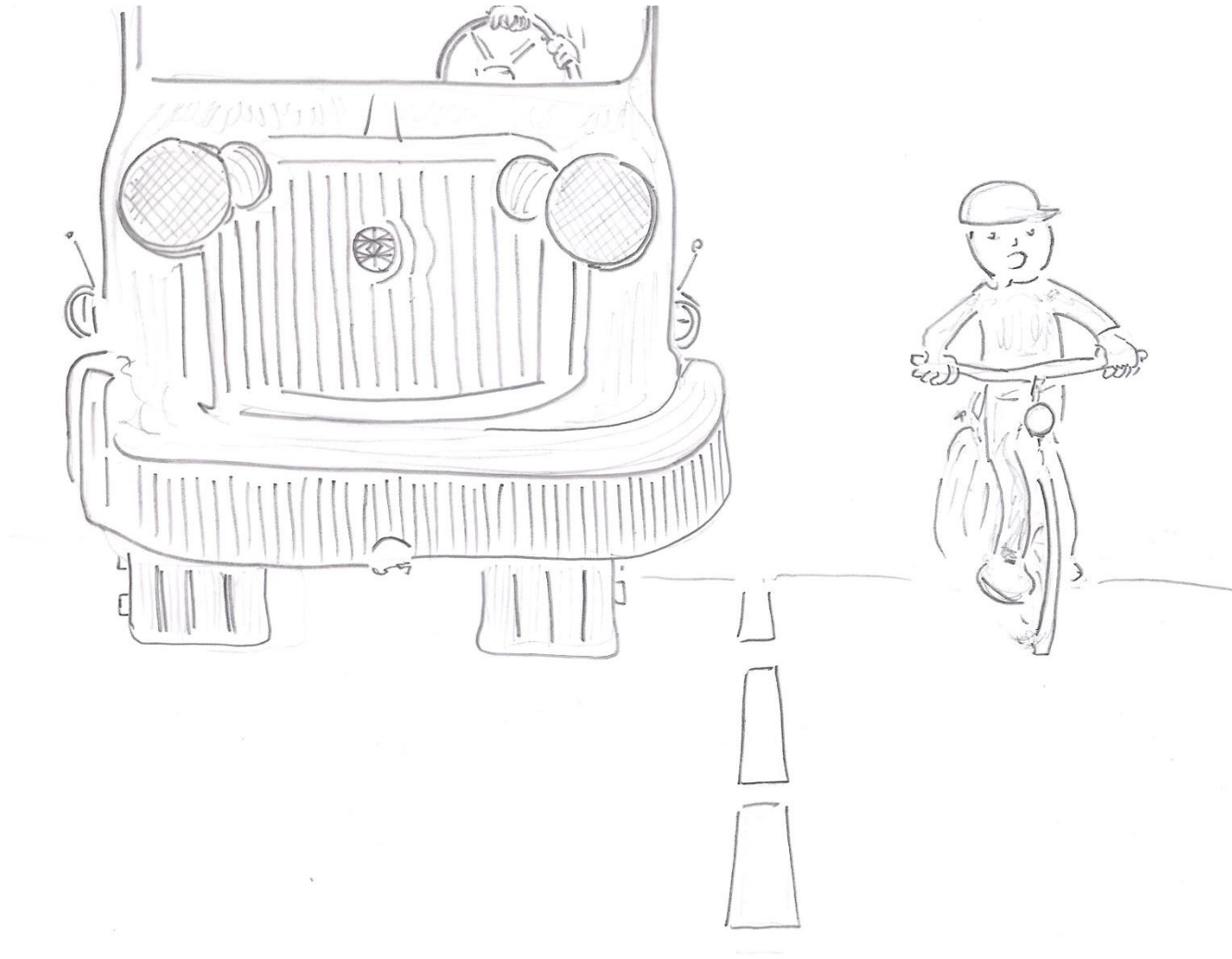


# Hypothesis Generation and Design

Wow, that hit me with tremendous energy! Think of the following situation: You are standing in the middle of a street and have to make a quick decision. One step to the right and you would be hit by a bicycle. One step to the right and you would be hit by a truck. Don't worry about the speed of the two vehicles: they are both heading towards you at the same speed. Would you agree that in this case it makes no difference whether you step to the right or to the left? If not - why not?

You probably got the idea that speed is not the only thing that makes a difference. So check your HYPOTHESIS.

In a good experimental setup, you could control the speed and mass of an object hitting an obstacle. What about falling objects? Does the height from which an object falls determine the velocity just before it hits the ground? What do you think about this? Believe it or not, you can certainly find the answer on the Internet - but make sure you use trustworthy sites!



# Planning and Investigation

Now plan your own investigation.

For this experiment you will need some stones or marbles. First, measure the weight of the different stones you have collected. Make sure you have a nice assortment of different weights.

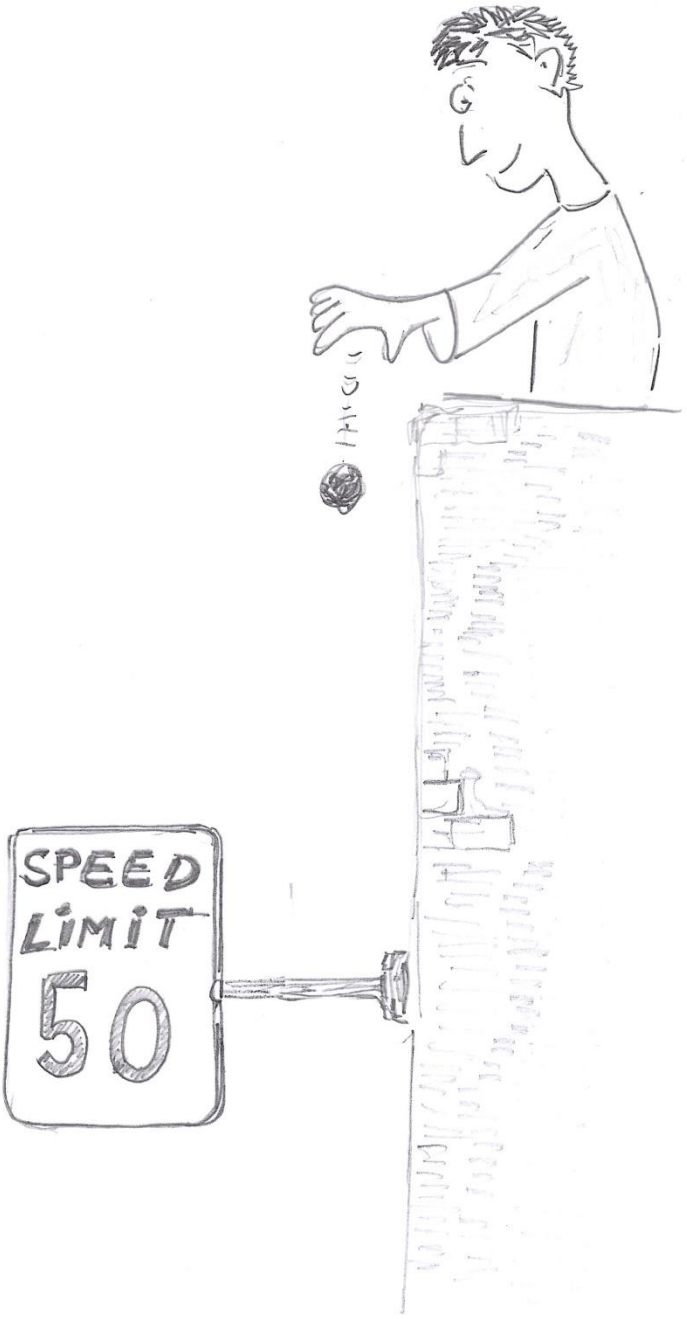
If you drop the stones from different heights, they will reach different velocities just before impact.

To have a measure of impact energy, you could make a batch of crackers and check how many of them break when the rock hits the crackers. Then you can collect the broken crackers and bake a delicious cake. (Yes, it is possible to make a cake with crackers. Believe me and look on the Internet).

While you are eating, you should fill in the table:

| **Mass of the object:** | **Height of free fall:** | **Number of smashed crakers:** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

Hopefully you have enough mental energy to work out some interesting ANALYSIS from your set of data!


SPEED
LIMIT
50

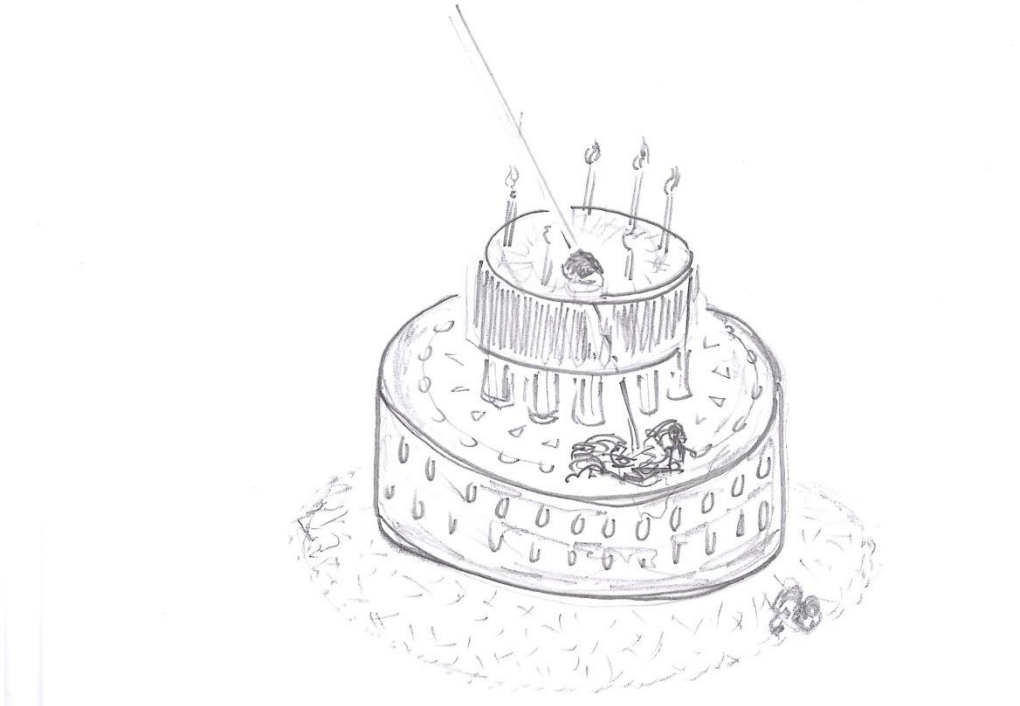
# Analysis & Interpretation

How many data points should you collect? More than you can eat!

To make sense of your data you must go back and check, what your hypothesis was. Do you have all the data you need to check your hypothesis? What data are missing? What should you keep track of? Maybe it is not the best idea to change everything at every run of the experiment. What should stay the same for some runs of the experiments? Would it make sense to let everything the same for a couple of runs? If so, why?

You must take another piece of the cake to answer such a whole heap of questions!

You probably need even time to bring some order into my set of questions.



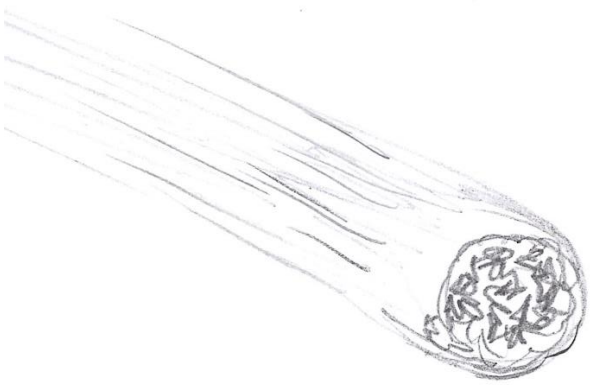
# Conclusion & Evaluation

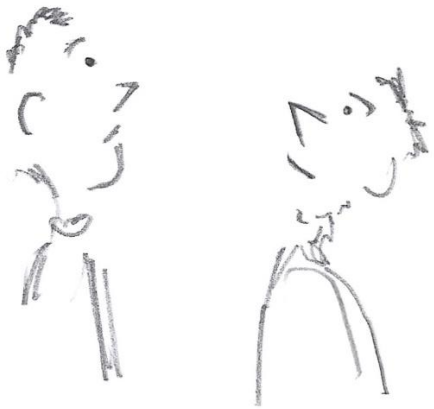
Now it's time to return to our original topic: the hole in the roof caused by a special stone. A stone from far away!

Speaking of objects that fall to Earth from outer space, what formed the interesting surface features that can be found on their surface? I wonder what elements these rocks from space are made of.

You guessed it: there will always be a new question lurking behind the one you just answered. Answering questions - that is the business of science!

I look forward to your report and to reading what answers you can give!





# Background Information for the Teacher:

It can be beneficial to include the beginning of the activity in a story and arouse the curiosity of the students.

This could be the Chelyabinsk asteroid in 2013. How was it that so many people (more than 1500) were injured by the event? Were they directly hit by the debris left in the upper atmosphere after the small asteroid exploded? (The asteroid exploded before it reached the ground at an altitude of about 30 km.)

It might be beneficial to have students formulate a whole series of questions covering a wide range of topics. After that, however, it would be necessary to scaffold the process of breaking down the initial questions so that students are able to answer them successfully.