

Rube Goldberg - Teacher Notes

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Questions:

This experiment is a fun and effective way to teach students about different types of mechanical energy. It provides a hands on experience of energy transfer and transformation, varying types of energy and conservation of energy.

Students will apply their knowledge in designing their own Goldberg machine, which has to include both energy transfers and transformations. This is a particularly engaging investigation as the task really allows students to use their creativity.

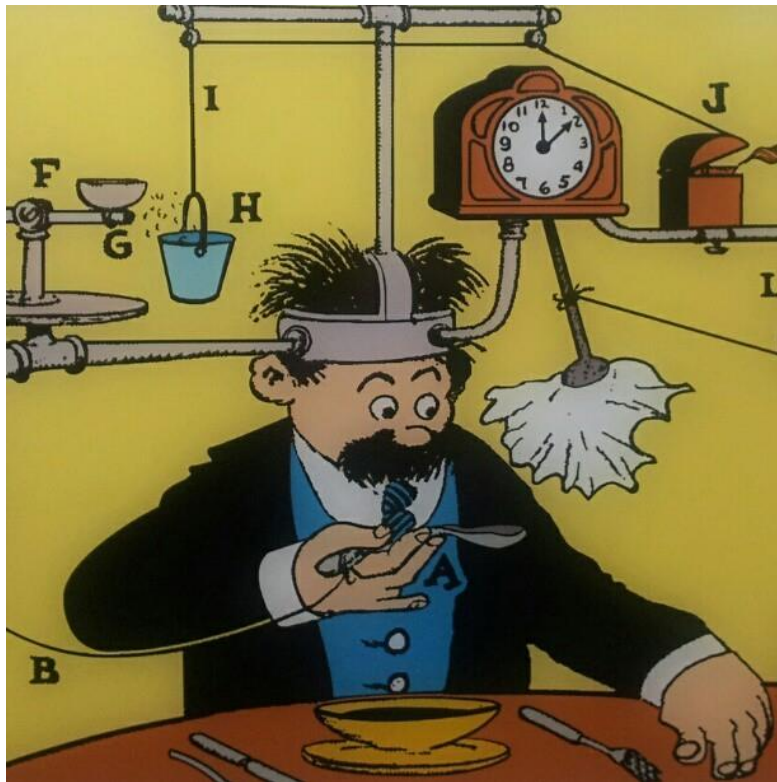


Figure 1

Plan

The experiment has two parts; in the first part, students will watch one of the videos provided which shows Goldberg machines in action. This will further engage students with the experiment and give them insight into what they are expected to do in the second part. These videos will also help them understand the concept of energy transformations and transfers.

In the second part of the experiment, students will form small groups and design their own Goldberg machine.

Conduct

This experiment is open inquiry, in which students will plan, design, conduct, analyse and communicate their findings.

In the first section of the experiment, students have to analyse the video and explain the science behind what they observe.

In the second section, students have to design the whole experiment. Make sure they write a list of all the materials they will use and all the safety precautions they will consider before conducting the experiment.

The machine has to include both energy transfer and transformation. Make sure the space in which they will conduct the experiment is suitable to accommodate their apparatus.

Analyse

For section A, students will describe three energy transformations that occurred in the video they chose. An energy transformation is when one type of energy changes into another type of energy.

Video 1: <https://www.youtube.com/watch?v=j3F8fYeAtro>: Students should notice how the electrical energy in the phone caused a vibration (kinetic energy) in the phone. This in turn was transferred to kinetic energy in the ball which underwent a number of potential energy transformations and again back to kinetic energy, then to electrical energy and finally light energy.

In terms of energy transfers, which mean that the same type of energy is transferred from one object to the other, students should notice how the kinetic energy in the phone vibration was transferred to the ball which started moving. The kinetic energy of the ball was transferred to the dominos pieces as well as to another ball.

Video 2: <https://www.youtube.com/watch?v=GOMIBdM6N7Q>: This video shows a series of energy transformations and transfers. It first started with the stored chemical energy in the man's hand which transformed into kinetic energy as his hand moved, then transferred into kinetic energy of the cup. There is a consecutive series of transformations of gravitational potential energy in the pencils, balls and photo frames which transformed into kinetic energy.

There is also a number of kinetic energy transfers which finally led to the transformation of stored chemical energy into heat energy, which in turn was transformed into kinetic energy of gases and a number of objects.

Finally, the kinetic energy closed a switch which closed a circuit, and then electrical energy was transformed to heat energy in the blower and the kinetic energy of moving air particles. This annoyed the rat, where its chemical stored energy transformed to kinetic energy as it ran, and then a series of gravitational potential energy and kinetic energy transformations occurred until the end, which resulted in the page being turned.

Video 3: <https://www.youtube.com/watch?v=VdSSOAtIrYU>: In this last video there is a number of gravitational potential energy to kinetic energy transformations and a number of kinetic energy transfers which finally cracked a cookie. The whole series started with the transformation of chemical energy in the girl's hand to kinetic energy of the gears, then to the transformation of

kinetic energy in the gears to potential energy in an inner spring. This potential energy transformed to kinetic energy and then a series of kinetic energy transfers and potential energy transformations occurred.

Before starting section B, students can play the online version of the Goldberg machine found here: <http://pbskids.org/zoom/games/goldburgertogo/rubegame.html> ., This may give students insight into what problems they may face when designing their own version and how to solve them.

For section B, where students design their own Goldberg machine, it is important to notice that it is not expected to work on the first attempt. Students are encouraged to make changes and to write down what worked well and what did not work.

Encourage students to measure the angles of any inclined planes and to keep a record of every measurement, such as the distances between objects. They can tabulate their results in a manner such that other students may repeat the same setup and get the same results.

For years 9 and 10, students learn about conservation of energy. It is a good idea to ask them to draw a Sankey diagram to represent the energy transformations and transfers involved in their Goldberg machine.

Problem solving and discussion

Students may inquire about where the 'gravitational potential energy' of an object originates. The answer to this is always another source of energy. For example lifting a book up and putting it on a table has increased the book gravitational potential energy. In this case the energy is transformed from stored chemical energy in somebody's muscles to gravitational potential energy stored in the book.

In all the above videos, the kinetic energy of one object moves another object which already had a gravitational potential energy stored in it and when it falls from its height the potential energy changes to kinetic energy.

For electrical energy, it should be noted that the kinetic energy only allowed the electrical circuit to be closed, therefore the electrical energy is transformed from other sources of energy back in the power generating station.

For section B of the experiment, students should discuss any setup that did not work and the modifications they made to make it work.

Conclusion

This is an open inquiry experiment, students are credited for the design, conduction and discussion of their experiment. Students can make a video of their experiment and publish it on YouTube.

References

Figure 1: Author Todd Van Hoosear. <https://www.flickr.com/photos/vanhoosear/8382403596/in/photolist-dLJ1xW-8x8fHi-8x8f7r-br3yJn-bs8cf2-9n7iDU-9n4f6P-9n7iYN-gDqvPV-Top1Kh-8x8eHa-87LCzc-4GFL4k-wfMsG3-9n4fjD-8xbfmg-4GFKUF-ffSA7-dScHKU-8xbg4U-9n7iwE-8QuC1a-jzHrXT-JWjbm-qCoDG-8x8fN4-dS6VB6-8xbgMu-UqYMv9-9n4fgP-9n7iH1-87LBD6-8xbfNA-9n4fog-87PQQd-87PQW3-87LCWH-87LCqB-8xbgbA-j4xwGH-87PQUd-dS6VbH-dScuDY-74Dgk3-emeHx4-87LCPH-8aVwbz-cXNaNA-8x8epT-87LCUa> Licence: <https://creativecommons.org/licenses/by-sa/2.0/>