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| A Study of Packing Peanuts – Eco-Friendly vs. Less Eco-Friendly |
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Introduction

 Packing peanuts are used to protect items that are being moved from one location to another location. Because they resemble the outer shell of a peanut, they are called peanuts. They are considered “loose-fill”, a term that means they are loose in the box. Due to their smaller size, they can envelope the object being shipped and fill the box more evenly. Peanuts can be interlocking, which helps protect the object even more by limiting the shifting the object will do during shipping.

There are now two different materials used for the manufacturing of peanuts – polystyrene polymers and starch-based polymers. Extrusion is the method used with either type of material to manufacture the peanuts. Extrusion is the process where a polymer is placed in an extruder and mixed with a blowing agent like water. The mixture is then pushed through a small opening. The mixture then puffs up as it leaves the machine. The puffing is caused by the rapid expansion and vaporization of the blowing agent.

Polystyrene peanuts were introduced by Dow Chemical in the mid-1960’s. Today’s peanuts can be made with either a “virgin” polystyrene or a recycled polystyrene polymer. This type of peanut can be used multiple times without any effect in its ability to protect fragile items. Manufactures have added a special kind of anti-static material to the process so that it safer to ship fragile electrical components. However, when you want to dispose of them, they can only be broken down through potentially environmentally harmful chemical processes. If you add polystyrene peanuts to acetone (nail polish remover), they will dissolve.

More environmentally friendly peanuts were introduced in the early 1990’s. These are made with plant-based polymers such as corn and have several benefits:

* They are made of renewable resources
* They are naturally low static.
* They are easily disposable by either composting or dissolving in water.

This experiment also acts as an introduction to gravity, force and speed. Because the target audience for this experiment is third graders, the third grade GLCE’s will be utilized for age appropriate explanations. The definitions found in ScienceSaurus will be utilized:

* “Gravity is the force of attraction between objects that have mass. Since all objects have mass, gravity acts on all objects…”
* “Force is a push or pull on an object. Objects exert forces on each other.”
* “Speed is the distance travel by an object in a given amount of time.”

The purpose this research project was to test the hypothesis that eco-friendly packing peanuts are as effective as less eco-friendly packing peanuts in protecting a breakable item.

**GLEC(s)**

**S.IP.E.1 Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.**

**S.IP.03.12** Generate questions based on observations.

**S.IP.03.13** Plan and conduct simple and fair investigations.

**S.IP.03.14** Manipulate simple tools that aid observation and data collection (for example: hand lens, balance, ruler, meter stick, measuring cup, thermometer, spring scale, stop watch/timer).

**S.IP.03.15** Make accurate measurements with appropriate units (centimeters, meters, Celsius, grams, seconds, minutes) for the measurement tool.

**S.IP.03.16** Construct simple charts and graphs from data and observations.

**S.IA.E.1 Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations.**

**S.IA.03.11** Summarize information from charts and graphs to answer scientific questions.

**S.IA.03.12** Share ideas about science through purposeful conversation in collaborative groups.

**S.IA.03.13** Communicate and present findings of observations and investigations.

**S.IA.03.14** Develop research strategies and skills for information gathering and problem solving.

**S.IA.03.15** Compare and contrast sets of data from multiple trials of a science investigation to explain reasons for differences.

**S.RS.E.1 Reflecting on knowledge is the application of scientific knowledge to new and different situations. Reflecting on knowledge requires careful analysis of evidence that guides decision-making and the application of science throughout history and within society.**

**S.RS.03.17** Identify current problems that may be solved through the use of technology.

**S.RS.03.18** Describe the effect humans and other organisms have on the balance of the natural world.

**P.FM.E.2 – Gravity – Earth pulls down all objects with a force called gravity. With few exceptions, objects fall to the ground no matter where the object is on the Earth**

**P.FM.03.22 –** Identify the force that pulls objects towards the Earth.

**P.FM.E.3 Force- A force is either a push or a pull. The motion of objects can be changed by forces. The size of the change is related to the size of the force. The change is also related to the weight (mass) of the object on which the force is being exerted. When an object does not move in response to a force, it is because another force is being applied by the environment.**

**P.FM.03.35** Describe how a push or a pull is a force.

**P.FM.03.36** Relate a change in motion of an object to the force that caused the change of motion.

**P.FM.03.37** Demonstrate how the change in motion of an object is related to the strength of the force acting upon the object and to the mass of the object.

**P.FM.03.38** Demonstrate when an object does not move in response to a force, it is because another force is acting on it.

**P.FM.E.4 Speed- An object is in motion when its position is changing. The speed of an object is defined by how far it travels in a standard amount of time. \***

**P.FM.03.41** Describe the motion of objects in terms of direction. \*

**P.FM.03.42** Identify changes in motion (change direction, speeding up, slowing down).

**P.FM.03.43** Relate the speed of an object to the distance it travels in a standard amount of time.

**E.ES.E.4 – Natural Resources – The supply of many natural resources is limited. Humans have devised methods for extending their use of natural resources through recycling, reuse and renewal.**

**E.ES.03.43 –** Describe ways humans are protecting, extending and restoring resources (recycle, reuse, reduce, renewal)

**E.ES.03.44 –** Recognize that paper, metal, glass and some plastics can be recycled.

Discussion

 By looking at the data (and the glasses) you can see that both types of packing peanuts protect a fragile item when dropped from a variety of heights. The trends that I found with my data could not be substantiated with any other similar research. However, common sense tells us that if bio-degradable peanuts were not as effective in preventing damage that they would not be available on such a wide level. It was interesting to see that stores like Staples did not offer any other type of peanut but the biodegradable which was $7.00 per cubic foot, while FedEx Kinko’s only offered a recycled polystyrene peanut which cost $5.00 per cubic foot.

One article did mention that the biodegradable peanuts weighed more than the polystyrene peanuts. This could be seen a potential negative, because it could add to the cost of shipping. While the actual weight per peanut is not significantly different (.1333 grams from biodegradable vs. .1111 grams for non-biodegradable), by the time you filled the box the weight difference became more noticeable (415 grams for non-biodegradable vs. 455 grams for biodegradable.) It becomes an issue of a higher up-front cost for the biodegradable peanuts due to a higher cost per cubic foot and higher mailing costs vs. long –term societal costs when using the less eco-friendly peanuts.

The only source of possible experimental errors would come from the potential variation of effort put into the dropping of the boxes. Because the boxes were pushed by a person there is always some difference in the amount of effort exerted by the individual. This is a wonderful lead into a discussion regarding gravity, force and speed.

Conclusion

The results of the experiment provide evidence to support my hypothesis that eco-friendly packing peanuts are as effective as less eco-friendly packing peanuts in protecting a breakable item. We tested the peanuts at a variety of heights multiple times with the same result – the glass was not broken.

 This experiment does two things: it looks at different types of packing peanuts and serves as in introduction to the concepts of gravity, force and speed. Gravity, force and speed do not appear to have been factors in whether the glasses broke or not. The glasses did not break even when dropped from a fairly high (10+ feet). We know that the amount of force varied from trial to trail, thus affecting the speed.

While the packing peanuts seem to have many differences, they have some very important similarities. The first is that both polystyrene and starch-based peanuts are made out of polymers. Polymers are long-chained molecules that have a unit that repeats. The starch-based peanuts are polar and have a hydroxy group that interacts with water and is dissolvable. The polystyrene peanuts are nonpolar and do not hydroxy group. Without the hydroxy group, the polystyrene peanuts do not dissolve.

 As mentioned before, the gravity portion of the experiment was the least constrained. If I were to do this again, I would have a better way of making sure that this variable was handled in a more consistent manner.

It would be interesting to see what kind of change in variables would result in a failure to protect the glass. Would you need to drop it from a higher height? Drop with more effort? Utilize fewer peanuts? Use a thinner box? Employ a more fragile glass object? These questions could be used to extend the experiments.

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