Thrill Ride:
Expansion on a Theme

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Contents of Curriculum Unit

Overview

While Thrill Ride is a fun, action-packed unit for seventh-graders, it presents experiments that are difficult for seventh-graders to follow. The book calls for the students to do a lot of data organization themselves.

In addition, most of the readings are portrayed as optional. The students are expected to do a lot of reading and research on their own as a result of their investigations. The middle school students that I taught need to have the readings that I want them to read and think about assigned or read in class. By reading these together in class, I could provide a forum to discuss what each reading meant, to point out - with the students' help - important parts of each reading.

Many of the middle school students are not yet ready for the amount of freedom and lack of guidance this book requires of them. Many of the important concepts, while integral to the experiments, are not given enough emphasis. I feel that having more examples might help students to attain a firmer grasp of the different concepts. A more structured format for experiments would guide the learning experience for the students and hopefully give them a firm foundation for future experiments. Students are not yet ready to design their own experiments and too ready to think that they are doing the same experiment when they are varying different variables on one extended experiment. Careful guidance and more explicit instructions on how to systematically vary different variables can be given to help students learn more and make this unit more user friendly.

Rationale

Thrill Ride endeavors to persuade inquisitive students to experiment, read further to define problems, redefine experiments, and experiment further in order to learn about the laws of force and motion. This is a laudable goal for middle school students to achieve. Any student with a firm foundation in science and experimentation, who possesses the confidence to try and do many activities on his or her own, who does not get discouraged with false starts and blind alleys, and who has the drive to achieve will do very well with this module.

However, many middle school students have little patience for what they consider the tedious work that this involves. Many will need more repetition of the meaning behind what they are discovering. Some students are reluctant to read information that is not assigned and required. Many of the students in my class were reluctant to take advantage of the opportunities that this module affords. I think that most middle school students I have taught need much guidance in doing experiments that require investigating several variables. They need to have the variables talked about, discussed and listed. They need guidance in realizing that testing out each variable must be done with each individual variable. Varying only one variable at a time goes against their rather free-wheeling style and they want to do many different variables without paying attention to each one individually and then their possible interactions.

Middle school students I have taught also need more opportunities to see the consequences of the motion and force with more demonstrations and experiments that illustrate the three laws of motion than are given in this module. More demonstrations and experiments can make the three laws of motion familiar enough to them to let them talk, write, and refer to them easily and with good understanding.

By having demonstrations and hands-on activities that are easier for the students to follow, I hope to make scientific experiments and the scientific method more concrete for students, and hopefully more memorable as well. All students, even students who may have trouble in reading or math, can participate in predicting what will happen in an experiment and making a chart or other record of their results. Some students need to have data sheets to fill out so that the onus of all of the data's organization is not on them. Or, the students can be given the task of setting up the data sheets, perhaps with recognition of the best in the class that everyone will then use. Recognizing that setting up a data sheet is a complicated step that requires thought and preparations is important to having students carry out experiments and record results in a systematic way. Without this systematic collection of information, the student cannot draw useful conclusions from the experiment he or she has carried out.

Many of our students have trouble going from the printed page of what to do to the concrete steps of an experiment. By breaking down some of the larger experimental projects into smaller units, I hope that the students can follow and gather their experimental data better. Some students with whom I have used this book complained about having to 'do the same experiment again.' This showed a lack of understanding of the differences between what they had done and what they were being asked to do. The difficulty of following instructions that require them to go back and forth across several numbered instructions several times made them feel that they were doing the same experiment several times. Perhaps with the larger organizational picture discussed and presented to them, along with the smaller experiments that are part of the larger one, the students will see that these smaller experiments are different, although they are variations on a theme. The importance of keeping notes and paying special attention to details (in a way that many of our students are not inclined to do but is necessary for scientific thinking) is illustrated in these activities.

With more direction, students can understand the need for systematic variation of the variables to be able to reach a conclusion. Also, students will be better able to separate out the different effects the variables have. With previous experience with the laws of motion, the students will more easily see how the laws of force and motion apply to each variable they are investigating.

Objectives

Students will gain more familiarity with the scientific method, designing and developing experiments. Students will learn about carrying out an investigation, listing and gathering materials, setting up and carrying out procedures with controls and variables, and constructing data sheets, graphs, and charts. Students will understand through demonstrations and experiments how scientific principles of mechanical phenomena work.

The unit, Thrill Ride, is enclosed in real world applications so that students will gain an understanding of how mechanical phenomena are relevant to everyday life. Students will learn the three laws of motion and be able to tell which one or ones apply under various circumstances. The three laws are: the first law of motion states that every object in motion will continue along in motion unless acted on by a force and that every object that is at rest will remain at rest unless acted upon by a force; the second law of motion states that force equals mass times acceleration; and the third law of motion states that for every action there is an equal and opposite reaction.

Strategies

To begin with, I think that there needs to be an introduction to some of the important concepts in this unit. First, the law of conservation of energy should be introduced and related to examples in the students' lives. Next, I would want to have some demonstrations and experiments that introduce Newton's three laws of motion. I think that it is important to introduce these concepts and allow students to feel more confidence in their ability to identify Newton's three laws of motion and understand the law of conservation of energy.

Many of the activities in Thrill Ride just seem too complicated for seventh grade students to follow easily. For example, the first activity in Thrill Ride, 'Brake It, But Don't Break It!' allows students to investigate a cart's distance rolled when started at various positions on ramps of varying heights with varying loads. This calls for a lot of planning both before they begin and as they go along. Students will benefit from having this broken down into separate but related experiments.

I would introduce this as a project that involves several related experiments, together forming a larger experiment. This might take the form of a large chart so that students can see how each of their experiments are part of a larger experiment. This unit can also benefit from some additional short demonstrations and experiments that illustrate force, motion, and their interaction. By having these illustrations of the three laws of motion at the beginning, students are able to begin to incorporate them into their framework of how objects move. Then when the laws of motion are explored in the experiments in this unit, students are able to relate what they know to these new experiments.

Classroom Activities

Energy Conservation

One idea that I don't see emphasized in Thrill Ride is that all energy is conserved, that energy changes forms, but is not created nor destroyed. This is a very important concept for students to learn along with what is presented in Thrill Ride. I think that some time should be devoted to teaching and discussing this concept with the students.

The concept is introduced in a discovery file, 'Indestructible Energy', on p., 17 of the student book, Thrill Ride. I think that this discovery file should be read with the students. The teacher then may ask the students to name some forms of energy. These should be listed on the board, an overhead, or a chart. I would next see if students could give me some examples of energy changing from one form to another. I would again list the ways one energy form changes into another on the board or an overhead. Then students may be able to think of counterexamples where they think energy is not conserved (my students came up with many examples). These counterexamples can then be used to see if other students can figure out what form the energy turns into. If the students can not be led to think of what form of energy has emerged when one form of energy is being depleted, I would try to explain it. If there are examples that the I can not explain, then the students and I would need to research what happens to that energy. Rosen's Physics Workshop 1: Understanding Energy and Forces gives many examples of energy changing forms.

Many examples of energy show energy gradually changing into heat or light or mechanical energy. Some examples the teacher may want to bring up are: a car, its energy from the gas is turned into mechanical energy to move the car and also into heat energy - which must be dissipated so as not to overheat the car; toasters turn electrical energy into heat energy; and radios turn electrical energy into sound energy and heat energy. Students can usually think up many more examples and keeping a list of the examples would help students and me to keep track of which ones we have already gone over and might help us think up more examples. This could be written on a chalk board, but I think that I would prefer to write it on a chart or paper so that we could keep on referring to it in the classroom during this unit.

At this point, it would be helpful to make a KWL chart to show what the students know about energy, motion, and force, what they want to learn about these, and what they have learned. Students would then be able to add to this chart as we learned more. At first, they might still be adding questions to the chart. As we did more in the unit, more and more answers would be added. Adding to the chart could serve as a good sponge activity for the end of the class period.

Introduction to Force and Motion

At this point, students should read and learn about Newton's Three Laws of Motion.. As the students read about the Three Laws of Motion in Thrill Ride, I would emphasize that they will be doing experiments that will illustrate these laws and that the students will need to decide what law is being illustrated. In each of the following illustrations of motion and energy, the students should be encouraged to make predictions of what will happen and why and then be asked to explain what happened and why it happened if their results differ from their prediction. I would select from the following short activities to illustrate Newton's Laws.

Inertia

The first law refers to the inertia of an object: an object in motion will tend to stay in motion and an object at rest will tend to stay at rest unless acted upon by a force. Inertia can be illustrated with a ramp, a toy car, a Lego person, and a block of wood or other stopping material. The students then see what happens to the Lego person in the toy car when the car is accelerating down a ramp and hits the block. The students then fashion a seat belt to keep the Lego person attached to the toy car. This 'seat belt' can be made from a rubber band or twisty or some string. While the person flying from the car when the car is suddenly stopped shows the law of inertia very well, the value of 'seat belt' is also shown very vividly.

Another simple illustration of inertia, uses a beaker or cup, an index card, and a penny. If the penny is put on the index card over the beaker, the index card can be flicked away and the penny drops into the beaker.

Inertia can also be shown with the use of 10 identical washers and an index card. The student uses the index card to hit the bottom washer, this results in the bottom washer being knocked away, but the other washers just fall straight down so you still have a pile of washers, just one that is one washer shorter. Some of my students found this very fascinating and continued to knock out the bottom washer for quite some time. I always especially like it when the students find an experiment so compelling.

Inertia can be memorably demonstrated with a small bucket, a 2-foot length of string and a cup of water. This is probably best if done outdoors. The cup of water is placed in the bucket, which is tied to the string. The teacher then swings the bucket in a circle gradually going higher, until the container swings completely upside down. The water will stay in the bucket because of its inertia, which forces the water to try to continue its trajectory.

Mass and Weight

There is a short discovery file on p. 24. about mass and weight. This needs to be assigned, read and discussed by the class. How does the mass of an object affect its inertia? I would bring up the idea of moving an object that is virtually weightless because you are out in space. How difficult would it be to stop it? I would look for some movie footage on the astronauts moving objects in space to illustrate this to students.

Conservation of Energy

Relating to the law of conservation of energy, this investigation looks at reducing friction, and thus enhancing the amount of energy that pulls forward without turning into friction. Investigating friction is important since friction turns energy into heat and gradually uses up enough energy to stop moving objects; if students don't realize that the mechanical energy has changed into heat energy, they may think the energy disappeared. Students can compare the force needed to pull a box across a table compared to the force needed to pull that same box with dowels underneath it. The dowels roll and greatly decrease the amount of energy that is turned into heat as a result of friction. Pulling the box with a spring scale allows students to measure the force necessary to start the box moving and then the force necessary to keep it moving. It would be best on this experiment to have students do it at least 3 times so they can take an average of their measurement of force. Emphasis should be placed on doing it enough times so that your results are as reliable as possible.

Potential Energy versus Kinetic Energy

Another very important concept is potential energy versus kinetic energy. Potential energy is energy that is not energy of movement but rather energy of position. Kinetic energy is energy of motion. In this investigation of potential and kinetic energy, students can roll marbles of different sizes and weights down an inclined plane into an empty milk carton. After each marble roll, students should write down the results in a table. The table needs to have room for different sizes and weights of marbles as well as a place to record how far the marble made the milk carton move from its original position. An inclined plane that might be easy to find is the rulers with ridges on each side. Students need to keep track of the height of the beginning of the ramp, the different sizes and weight of the marbles, and how far the marbles push the empty milk carton at the end of the ramp. Students then make conclusions about what affects the force the marble has on the milk carton. Here again, I think that one might want to talk about this investigation with the students and see if the students can list the variables that they will want to change.

Action - Reaction

Newton's third law, that for every action there is a reaction is especially difficult to get a handle on for many middle school students (I think this because it seemed that way for me.)   If a student sits on a chair and pushes against a wall, frequently there is no movement of the chair; at most, there is a small movement. Since the student is pushing against the wall, the wall exerts an equal and opposite force back. This does not seem intuitive, though, given that we see no movement. A wheeled chair allows students to see the equal and opposite force that the wall exerts.

Direction of Force

Here is another simple demonstration that might help students think about force and how it affects objects. One must have several empty milk cartons, a nail, some string, and a sink or large basin for water to pour into. You use the nail to make holes in each side of the milk cartons. One milk carton should have the holes on each side of the carton on the left bottom of each side. When water is put in the carton, the water flows out of these holes, making the carton spin to the left. You can see if students can predict what will happen when you have a carton with holes on the bottom right of each side. Discussion should focus on Newton's third law that for every action there is an equal and opposite reaction. Then, see if students can predict what will happen if the holes are placed in the center of each side. No spinning would occur, since the forces setting the above cartons in motion would cancel each other out. This demonstration shows that for every force, there is an equal and opposite reaction.

Brake It But don't Break It

'In Brake It But Don't Break It' there are several different aspects of the larger experiment that need to be pointed out to the students. To help the students to understand the many varied parts, I would try to set out what we were going to do for the students. First we would set up the experiment, then do a preliminary informal experiment to figure out what variables we need to study. After this students would need to stop, make sure they are taking down all the information they will need to write their experiment, and make a data sheet or sheets to take down all the information in a systematic way.   I would then have a hand out or poster that lists all the different parts or smaller experiments that make up the whole, ideally, this is something the class and I would work on together.

Setting up the experiment

After the students got their carts or made them, the next step is fitting the cart with a piece of paper cut to fit snuggly in the cart. The experiment calls for marking the paper that is in the bottom of the cart with lines around the block that will be put in the middle of the cart, marking this paper with lines 0.5 cm. apart going around the block, so the students can easily record how much the block moves on each trial. This is most easily accomplished with the use of a piece of 0.5 cm. graphing paper cut to fit snuggly in the cart. With the graphing paper, students just need to draw around their block and trace the lines that are .5 cm apart and label them.

Next the students will be trying to lessen or get rid of the bump that would naturally come at the bottom of the ramp where the ramp meets the floor. This can be done in groups, or the teacher could lead a discussion that would result in a solution or a number of different solutions that the students may then try out to see which on each group feels works best.

At this point the students would do their informal experiment to familiarize themselves with the experiment and check to see what variables they think might influence how far the cart travels before stopping.

Designing Data Sheets

As they talk about the preliminary results, it may become apparent that the students need to write down enough information to specify exactly what was done and what happened on each trial. The necessity of good notes that anyone could follow and use to duplicate the experiment should be brought up. Creating a table to record such data as track height, start and stop distance, number of blocks, and block movement should become an obvious necessity to the students.

I think students in their groups might be able to develop a chart for this. I would like to assign each group of two students to try to develop the best chart for recording all this information. This would be a graded assignment, with an interim grade and a final grade. Emphasis would be put on designing a way to record all the information and I would suggest that we might not be able to put all the information on one piece of paper. We would also need to discuss how many trials should be done to be sure that the results could be replicated, since they would need places in their charts for this. They might want a place on the charts to put three to five observations of the same variables effect as well as a place to average these observations.

Then I would let each student pair try to come up with a system that they thought would work well. Afterwards, I would review and discuss with the students the benefits and drawbacks of their recording system. Lastly, I would encourage students to share ideas with other groups and perhaps even change their system in accordance with what they see as an improvement. Emphasis would be put on copying only the best ideas of other students. While this might seem like too much emphasis on organizing data, I have found that students do not allow themselves enough space for all their observations and frequently are not playful enough. I would also let students know that they can continually change the way they record their data if they can improve on it. The only caveat would be that data must be well labeled and clear, so that when they go back to look at it, they would be sure of what exactly they had recorded.

The Experiment

Next, the students need to do procedure 5, which calls for the students starting the cart at various positions on the ramp. The teacher needs to ask the students to first choose which positions they are going to try to start the car at on the ramp. These positions should then be marked on the ramp and measured from the starting place on the ramp to the bottom of the ramp. Students can then begin their experiment and record the starting positions and how far the cart traveled from the ramp. They also need to remember to keep track of the block's position in the cart and to put the block back in the middle before beginning the next trial. Students also need to be reminded to release the cart from the starting position, rather than pushing it. After each experimental segment, students are asked to graph the data they have collected.

I would remind the students that they need to have their informal data, their more formally collected data, and then formal charts and graphs that they would summarize their results with a formal write up. I think that this end is difficult to keep in mind sometimes as the students get caught up in the experiment.

Students would be able to follow their data charts to do the different parts of the experiments. I think that I would also develop a check list for them of the different activities in this experiment. The check list would give different days for different parts of the experiments and allow the students to understand the time length of this project.

Lastly, students need to design a way to have the cart start at the highest position on the ramp, stopping the cart in the shortest distance with having the block in the cart move the least. Students could compare and compete on the success of having their cart stop most quickly and safely for the block. However, I would emphasize that the students need to write up their data and present it to the company in a professional manner if they hope to 'win the contract.' Explanations and presentation of data is what will matter as much as a good design.

Roller Derby

This task contains fewer parts than the previous one. However, to do this activity, vector arrows must be drawn along the side of the final sketch of their apparatus that shows directional forces with a label telling what those forces are.

It might be best to either before or during the construction to go over forces and their directions with the students to ensure that they are familiar with them and can use them. The teacher can give an example of a bicycle, where the pedals are pushed down (vector force downward), the energy is transferred to the gears that turn the energy into a vector force that pushes forward. Emphasis should be place on energy always having a direction.

Students can be reminded of the introductory demonstration of the spinning milk carton. The holes along the bottom where the water could escape gave the milk carton directional force or counterbalanced directional force.

Data Collection

Tables to record data are extremely important to running this experiment well. From the start, the teacher needs to emphasize that the groups should be keeping track of their different trials, such as exactly how they have their materials set up for the ride, where they are letting the ball go, and if the ball successfully lands in the cup, or if not in the cup, whether it goes past it or falls short. As they use different balls, that is another factor that must be taken into account.

To help students to realize all the data they will need to write up their experiment, it might help to have students individually read over the questions they will be answering to analyze the changes in the ball's energy. As the students read, they should be making a list of what data they will need to write this up.

I would then lead the students in a discussion of what they found they needed to record so that they would be prepared to take down all the necessary data.

Students must always bear in mind that they should be able to take their ride apart into several sections for travel or storage. I would want to have boxes for the groups of students to store their track in. Because this experiment involves taking apart and putting their model back together, I would try to make sure that the groups had all the equipment and were ready to record data each time they were doing the experiment.

Give It a Whirl

In this experiment, students check out how a whirling object is affected by gravity forces and the radius of the circle whirled around. I think that reading (again as an assignment) 'Ferris Wheels, Figure Eights, and Moon Trips' to begin this investigation is essential. With roller coasters and any ride where people travel in a circle, thought must be given to why the rider is not going in a straight line. In this experiment, the students will see that the string pulls them to the middle and does not allow the passenger) or in this case, the washer) to travel in the straight line that inertia alone would dictate. This is probably a good time to address the case of the roller coaster going in a loop. Discussion with the students of what keeps the carts from going in a straight line is essential. People do not usually think of a track, by its very existence as exerting a force. However, the track of the roller coaster actually acts the part of the string in 'Give It a Whirl', as the force that acts on the object and keeps it from going in a straight line.

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Materials

wood or other material to use as a ramp
toy car
lego person
string
washers
index card
beaker
coin
bucket
box
wooden dowels
spring scale
marbles of different sizes and weights
rulers
small empty milk cartons
wheeled chair
carts
small blocks for in carts
1/4 inch graph paper
a variety of materials to help slow a cart down:
- foam
- material
- sandpaper
- cardboard
- whatever else students might bring in

cardboard to make a track
boxes
straws
paperclips

Content standards addressed by this unit:

1. All students explain how scientific principles of chemical, physical and biological phenomena have developed and relate them to real-world situations.

2. All students demonstrate knowledge of basic concepts and principles of physical, chemical, biological and earth sciences.

6. All students develop and apply skills of observation, data collection, analysis, pattern recognition, prediction and scientific reasoning in designing and conducting experiments and solving technological problems.