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EDEL 643P
Prof. Cannon
2/14/11

The Balloon Powered Car
Adapted from Stéphane Correas, © Sonnentaler/La main à la pâte
Dagmar Wabel and Audrey Bergmann
Third Grade Lesson

Content Standards:
P.5.B.1 – Students know that, when an unbalanced force is applied to an object, the object either speeds up, slows down, or goes in a different direction.
P.5.B.2 – Students know how the strength of a force and mass of an object influence the amount of change in an object's motion.

Process Skills:
N.5.B.3. – Students know the benefits of working with a team and sharing findings.
N.5.A.1 – Students know scientific progress is made by conducting careful investigations, recording data, and communicating the results in an accurate method.

Objective:
The pupil learns that the strength of a force and mass of an object influence the amount of change in an object's motion. The pupil learns how to construct something using given materials, to reflect on the construction process, to improve the design or to correct design flaws. The pupil also learns how to work with a group.

Materials Needed:
IMPORTANT – This is a list of materials for ONE car.
Multiply the parts with the number of teams you have in your class!

- One box of light cartoon material, ca. 10X10x10 cm
- optionally a smaller box, made from paper, ca. 10X3x2cm
- 4 styrofoam balls, ø 38mm
- 2 skewers, cm 15cm
- 2 straws, ca. 20Cm
- one balloon
- duct tape
- glue
- body of a ball-pen (BIC) and its cap
- container or bag for all materials
- pre-made hovercraft

Safety Measures Required:
Pupils must be careful when they handle the skewers because they may have sharp ends! 'We keep the skewers beneath shoulder height.'
The hovercraft needs to be made with super-glue. Because I do feel little for letting 3rd graders handling super-glue I chose a demonstration instead of letting them assemble their own hovercraft.

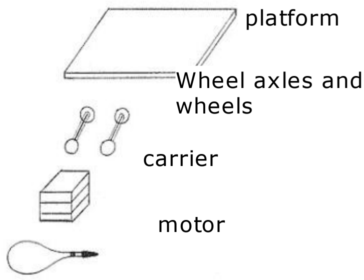
Accommodations/adapations for ELL's:

To accommodate ELL students, symbols have been added to the instructions and the verbal instructions are printed in the student's notebook.

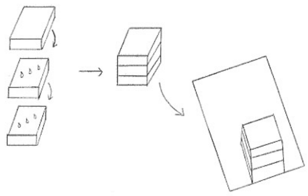
Background Knowledge of Teacher:

Prior to the lesson the teacher must become familiar with the design of the "balloon car". The car consists of a platform, a carrier, two wheel axles with wheels and an air-powered motor. The motor is constructed from an empty ball-pen body, its cap and a balloon. The vehicle powered by air which effuses from a balloon.

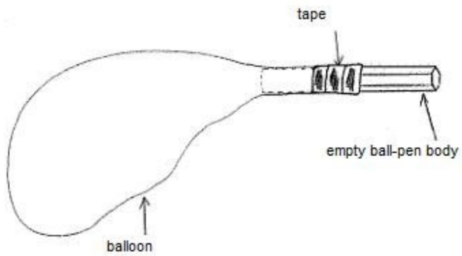
The skewers and ball-pen bodies have to be cut to size by the teacher prior to the lesson. This has to be done with a cutter and for safety reasons should not be done by the students. The carrier is glued to the platform. The position of the carrier does not influence how the car is going to move. However it is important, that the carrier is not too low because that would result in the balloon inhibiting the car's movement when it effuses the air. The balloon should touch neither the ground nor the wheels of the car.

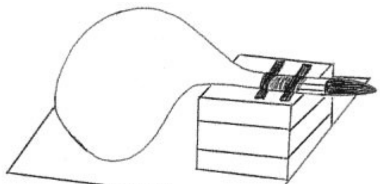


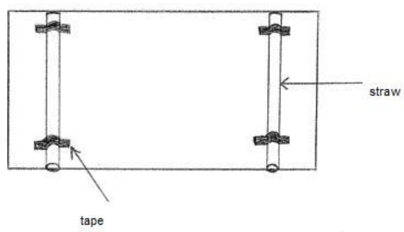
The ball-point body is inserted 2-3cm into the opening of the balloon and is sealed with tape. It must be checked that junction is not leaking air.



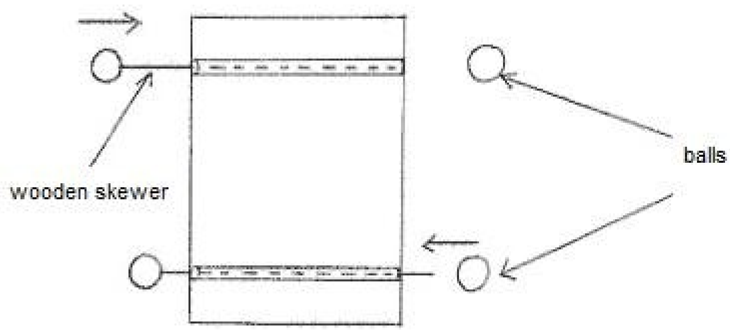
The 'motor' is attached onto the carrier. The balloon must rest on the platform and the ball-point body should protrude ca. 4cm over the kerb. It is important that the balloon is positioned parallel to the centre line. Now the cap of the ball-pan is put back on. Should the cap be lose it can be attached with a little bit of tape.

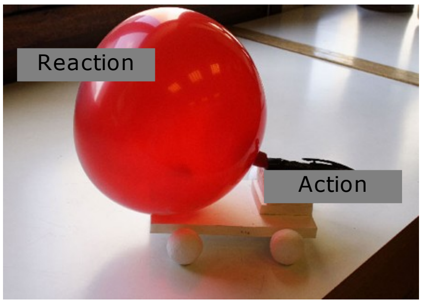






Two 10cm pieces of straw are attached to the bottom of the platform, each about 3cm from the front/rear kerb. The pupils may not realize that the axles must be parallel to each other and also not that they must be perpendicular with the centre line so that the car can move forward properly. These are problems the pupils should explore. The wheels are put on the each ends of the wooden skewer ca. 1cm deep. They can be glued to the skewer which will not allow them to rotate freely but be firmly connected the axle. The skewers must be long enough, so that the wheels will not rub against the platform. Have some spare skewers and wheels ready because some pupils may not realize that they need to put the skewer through the straw before attaching the wheels!





Besides learning how to construct something out of given materials, the pupils should also become aware that the effusion of air from the balloon is an action that causes a reaction, which is the movement of the car.
The balloon acts as an engine and the effusing air creates a thrust which pushes the car forward. The most important part will be that pupils learn that the thrust motion is opposite of the direction in which the air effuses. The pupils will also learn that thrust has a magnitude and a direction. They will learn this from attaching different sized balloons and the direction their car moves.
Newton's Second Law of Motion: Newton's Second Law of Motion tells us that the acceleration of an object is indirectly proportional to its mass and directly proportional to the "net force" applied to it. Here, the mass of an object is calculated by dividing its weight with the gravitational constant.
The relationship is given as $\mathbf{F} = m\mathbf{a}$ where m is the mass of the object (which is not a vector), **F** represents the net force applied to the object (which is a vector and denoted as bold) and **a** represents the acceleration (which is also a vector and denoted by bold.)
The net force implies the difference between the force applied in the direction of the motion and the friction that resists the applied force in the opposite direction.
There are two **forms of energy**; potential and kinetic. **Potential energy** is classified as the type of an energy that is possessed by the object due to its position or its structure. Sometimes potential energy is defined as the stored energy. A reservoir of a hydroelectric dam is a good example of potential energy.
Kinetic energy is classified as the energy of an object in motion. A waterfall initiated by opening the valves of a dam reservoir is a good example of kinetic energy.
Here the potential energy is provided by the compressed air in the balloon. The amount of the potential energy is directly proportional to the size of the balloon. More potential energy can be achieved by attaching multiple balloons to the system. The kinetic energy that will be used to move the car is attained by releasing air captured in the balloon system. The release of the air creates sufficient force move the car.

Background Knowledge of Students:

The pupils should have worked in teams before and they should know that the position of an object can be changed if a force is applied to it. Pupils should have knowledge that things can move in different ways and different speeds. In my experience the prior life experience children have differs greatly according to their background. In an ideal case I would expect children to know that they can only go fast on a bicycle if they use a lot of energy, that cars need fuel in order to drive, they may have built their own soap box and have played with match box cars of different sizes. The pupils would also have some construction experience playing with Lego, Knacks or similar toys.

Engagement:

The teacher prepares the hovercraft before class starts. At the beginning of the class the hovercraft is presented to the students and the teacher holds a brainstorm on how the hovercraft may work. Is there fuel inside? If yes, what kind of fuel? How does it work? How will it move? The pupils discuss in their group and draft a simplified sketch about the workings of the hovercraft in their notebooks. The results are discussed briefly in class.
→ The desired outcome should be that students notice that the hovercraft is powered by the effused air. They should also be able to predict the erratic movement the hovercraft will make.

Now open up the soda bottle top to release the air of the balloon and let the students watch. Briefly discuss the movements of the hovercraft, it's direction and the workings of it.

How do you rate your Engagement? 1 2 **3** 4 5

Transition to next phase:
Give instructions what the students will do in the next phase, form the groups, then hand out the bags with the materials.

Exploration:

The pupils examine the content of their bag and brainstorm in their group what they can construct with it and how. They draft a sketch of their design.
→ weak or inexperienced classes may need a classroom discussion or a model of what they are supposed to build can be shown to them. To guide inexperienced classes a step-by-step guide can be included in the material box or be written on the whiteboard.

Step 1: Look at the materials
Step 2: Draw a sketch
Step 3: Construct
Step 4: Write a building instruction
Step 5: Test run
Step 6: Correct design & test run again
Step 7: Draw a sketch
Step 8: Perform experiments and fill in chart

The pupils construct their car and correct their sketch if necessary. The pupils also must note down a step-by-step written description or series of sketches of how they built their car. In the class-room a test-track is marked. When the pupils have built their car, they can go over there to do a test-run.
After the first test run they go back to their table and record their findings. Some cars will work perfectly, others will have the balloon mounted the wrong way round or the wheel axles are not parallel. This is the moment to find out and enhance the construction of the car. The groups with a faulty car will correct the flaws and perform a second test run.

How do you rate your Exploration? 1 2 3 **4** 5

Transition to next phase: Gather the students for a group discussion.

Explanation:

In a classroom discussion the model of the car is discussed and on the blackboard the final sketch is compiled together. The parts of the car are labeled appropriately (motor, wheel axles, body, carrier). The working of the car is discussed. This will be done in a class-room discussion led by the teacher. The teacher must make sure that the following questions are discussed. What powers the car? How can it be

compared to the working of the Hovercraft? What is inside the balloon? Is it something/nothing? How can we compare the movement of the hovercraft to the rocket-car? How can we change the speed/direction of the car?
The teacher uses the sketch of on the blackboard to explain the workings of the rocket car, using the terms of action, reaction, and direction. The sketch is labeled appropriately. Students copy these terms into their own notebooks.

How do you rate your Explanation? 1 2 **3** 4 5

Transition to next phase: The students go back to their table to copy the sketch into their notebooks. After that they go back into their groups to perform the experiments.

Elaboration:

The class should have discussed how the direction of the car can be changed by changing the angle of the wheel axles. They will try a different angle position of the front and rear wheel axles, make a prediction about the car's behaviour, perform a test run and then note their findings. After that they will use different sized balloons to power their car, predict what happens, perform a test run and note their findings.

The students have a table in their notebooks to record their findings. This will make the activity more structured and in an inexperienced class avoid confusion. Classes who are used to performing scientific inquiry should be able to conduct their own test and record their findings in a table without structured guidance.

How do you rate your Elaboration? 1 2 3 **4** 5

Transition to next phase: Gather the class for a group discussion.

Evaluation:

Formative: The teacher observes and monitors throughout the lesson. The classroom discussion will be helpful to determine whether the students gained insight about the construction of the vehicle and the explanation phase should make clear if they understand that air is mass and that it powers the vehicle. In specific the teacher should monitor the group work, if and how the pupils are collaborating with each other. During the construction phase the teacher must observe if the pupils are able to use problem solving skills and if they work in a structured way. This means, whether pupils are erratically trying to solve their problems, just trying different things without thinking through and discussing their ideas first. For instance if pupils' car is going in the wrong direction, they should be encouraged to look at their design first and think it through instead of just making random changes. Teachers can also observe how pupils are transferring their constructions to a drawing, make mental notes and keep this in mind during the class-room discussion. It's better to hint at it during that phase than simply pointing out and correcting mistakes pupils make.
Summative: The pupils should have the following entries in their notebooks:

- Sketch of the hovercraft
- sketch #1 before they constructed the car
- sketch #2 after they constructed the car
- step-by-step description of how the car is built
- table of test runs

Closure / Clean-up:
The teacher holds a classroom discussion and asks what the pupils have learned from this project. The concept of "action and reaction" is repeated. The teacher

asks how and where else this concept of powering an object can be used. (Aircrafts, jets, rockets, etc.).
The cars are put up for display and may be used again in later experiments. From each table one student returns the material box to the teacher's desk.

How do you rate your Evaluation? 1 2 3 4 5

Grading Rubric:

Components	Points possible	Full points (100%)	Well done (85-99%)	Average work (70-84%)	Needs work (60-70%)	Incomplete or missing (0-59%)
Sketch of hovercraft	20	Sketch contains all parts and is very detailed	Sketch contains all parts, but with less details	<2 parts missing, few details	<3 parts missing, few details	No single parts indicated, no details
Sketch #1 before construction	20	Sketch contains all parts and is very detailed	Sketch contains all parts, but with less details	<2 parts missing, few details	<3 parts missing, few details	
Sketch #2 after construction	20	Sketch contains all parts, very detailed, contains at least 2 improvements	Sketch contains all parts, but with less details, 1-2 improvements	<2 parts missing, few details, little improvement is visible	<3 parts missing, few details, almost similar to sketch #1	Identical to sketch #1, >3 parts missing, no details
Step-by-step description	20	> 5 sentences, all sentences are complete, clear story line	<5 sentences, most sentences are complete, story line is not clear	<4 sentences, most sentences are incomplete, no clear story line	<3 sentences, almost all sentences re incomplete, no story line	<2 sentences, no description at all, all sentences are incomplete/ only single words, very unclear
Test run table	20	All actions performed, all test runs done	<2 sections missing	>3 sections missing	>4 sections missing	>5 sections missing
Total points	100					

Lesson Plan Outline

Teacher: Dagmar Wabel & Audrey Bergmann
School: Elmcrest Elementary School, Reno - NV

Subject: Science
Date: 02/14 & 02/21/ 2011
Time: 14.00 – 15.00

Students will engage in:

☐ Independent activities	☐ Simulations	☒ whole group instruction
☒ Cooperative learning	☐ pairing	☐ lectures
☐ peer tutoring	☒ hands-on	☒ a project
☐ Visuals	☐ centres	☐ technology integration

Standards/Objectives met: P.5.B.1 – Students know that, when an unbalanced force is applied to an object, the object either speeds up, slows down, or goes in a different direction.
P.5.B.2 – Students know how the strength of a force and mass of an object influence the amount of change in an object's motion.
N.5.B.3. – Students know the benefits of working with a team and sharing findings.
N.5.A.1 – Students know scientific progress is made by conducting careful investigations, recording data, and communicating the results in an accurate method.

Time	Procedures followed	Material
10 Min.	**Engagement:** Present the Hovercraft - "Is there fuel inside? If yes, what kind of fuel? How does it work? How will it move?" – form the groups, have children sit in their group – hand out notebooks & go through them – explain the activity – let children repeat instructions	Hovercraft, Notebooks,
40 Min.	**Exploration:** The students construct their balloon cars. They should be given ample time to complete this task and the teacher should do a formative assessment of the process. It is also important to guide the groups through the structured process and make sure they follow the step-by-step construction process.	Bags with materials, whiteboard, notebooks, test track
15 Min.	**Explanation:** Use group discussion and direct instruction to explain. **action, reaction, and direction** What powers the car? How can it be compared to the working of the Hovercraft? What is inside the balloon? Is it something/nothing? How can we compare the movement of the hovercraft to the rocket-car? How can we change the speed/direction of the car? Make a drawing on the Smartboard, together with the students.	Whiteboard, notebooks, student's cars
30 Min.	**Elaboration:** The students should be given ample time to perform the experiments. The teacher assists the students performing their experiments and encourages them to formulate their own questions.	Notebook, test track
15 Min.	**Evaluation:** Classroom discussion. Ask the students what they learned from this project, ask what air is, if they can think of other applications of this 'motor'. Repeat 'action, reaction, direction' and the names of the parts of the car ' motor, wheel axles, body, carrier'.	Smartboard, student's cars, notebooks

Name:

Class:

Draw the Hovercraft!.

Look at the materials.
How will your car look like?
Make a drawing!

Finished making the car?
How does it REALLY look like?
Make a drawing!

Explain step-by-step what you did.

Write a minimum of 5 sentences!

First I ....

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Then I..

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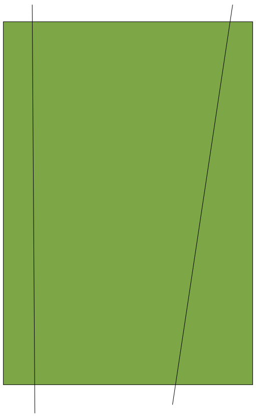
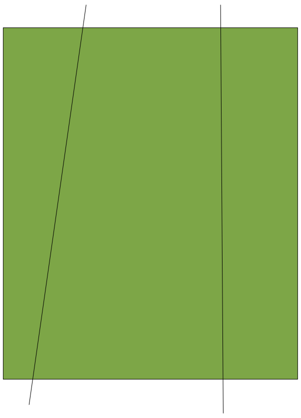
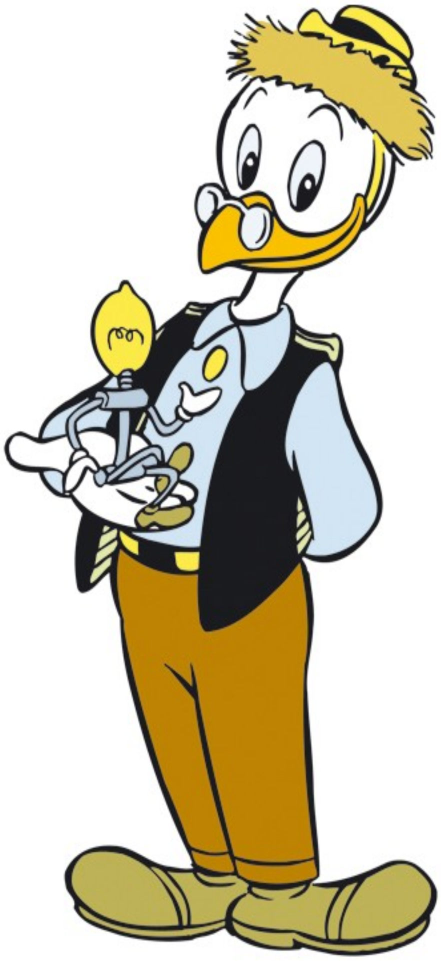
What happens, when you make changes to the car?

	Test Run 1	Test Run 2	Test Run 3
Change the angle of the front wheel axle 			
Change angle of rear wheel axle 			

	Test Run 1	Test Run 2	Test Run 3
Attach a different size balloon			
Put something inside the box!			
?			



STEP – BY – Step

Look at the materials

Draw a sketch

Step 3: Construct

Step 4: Write a building instruction

Step 5: Test run

Step 6: Correct design & test run again

Step 7: Draw a sketch

Step 8: Perform experiments and fill in chart