Using Toys To Teach The Next Generation Science Standards

For Kindergarten & Grade 3-4

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Description of Content

The content here is suitable for kindergarten and grades 3-4. Grades 1-2 are not included. The content here is categorized according to applicable standard and grade level. The activities presented here revolve around the use of toys which by themselves are already very interesting to kids. This is the motivation behind using toys to teach standards related material.

The toy descriptions will be linked back to the toy pages on my physics website. This allows for easy updating which allows the toy descriptions to stay up-to-date and relevant if product changes ever come about.

Students can be organized into small groups where each group has the same toy and experiments with that toy as described in this ebook. Alternatively, each group has a different toy and once each group is done experimenting with their toy they pass it on to the next group, and this continues until all the groups have experimented with all the toys. Doing it this way means that less toys are needed for the classroom.

Kindergarten

Newton's Cradle - For reference see http://www.real-world-physics-problems.com/newtons-cradle.html

K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

1. Lift up the ball on one end up and drop it. Observe the height that the ball on the other end reaches. Lift the ball higher and observe the height that the ball on the other end reaches. The ball height is higher because the impact force between the balls is higher when the ball is released from a greater height.

2. Lift up the ball on one end and give it a small push towards the balls. Observe the height that the ball on the other end reaches. Lift the ball again and give it a bigger push towards the balls. Observe the height that the ball on the other end reaches. The ball height is higher because the impact force between the balls is higher when the ball is given a bigger push.

3. With the balls hanging straight down tap one end with a pencil. Observe the amount that the balls move. Tap the ball again but harder this time. Observe the amount that the balls move. The balls move a greater amount because the impact force between the balls is higher when the ball is given a bigger tap.

Observe that the balls move in the direction of the forces. For example, if the furthest ball on the right is raised and then dropped, the impact force on the other balls will be pointing left when the balls collide, and the leftmost ball will be pushed leftward after the collision. Similarly, if the ball on the left is raised and then dropped, the impact force on the other balls will be pointing right when the balls collide, and the rightmost ball will be pushed rightward after the collision. The same situation applies if the balls are tapped on the ends. The balls will move in the same direction as the tapping force.

Now, lift away three of the balls so that only two balls are touching each other. Repeat the above experiments 1-3 with the two balls. Is there any difference in the results? There should not be since having more balls touching each other does not change how the forces behave. Having more balls in contact with each other just means that the force has to be transmitted along a greater distance.

K-PS2-2: Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

Put a soft piece of fabric, such as a towel, between any two of the balls. Repeat the above experiments 1-3. Observe the results. With the fabric in between the balls the force is reduced since the fabric acts as a type of "shock absorber" similar to the bumper on a car. This reduces the force that gets transmitted between the balls. This has the effect of slowing down the balls after the impact.

Repeat the above experiment with a piece of paper. Observe the results. The thinner piece of paper has less ability to absorb force than the towel (which is softer and thicker) and the balls will slow down less after impact, as a result. In fact, the amount that the balls slow down, with the piece of paper in place, may be too small to be noticeable.

Stomp Rocket - For reference see http://www.real-world-physics-problems.com/stomp-rocket.html

K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

This is for the outdoors. Punch the bladder of the toy rocket as hard as you can with your fist (being careful not to hurt yourself). Observe how high the rocket goes. Now step on the bladder as hard as you can. Observe how high the rocket goes. The rocket goes higher when the bladder is stepped on because there is more force created during the impact with the foot. This greater force causes the rocket to take off at greater speed which causes it to reach a greater height.

Chaos Tower - For reference see http://www.real-world-physics-problems.com/chaos-tower.html

K-PS2-2: Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

Where desired construct ramps and turns to change the speed and direction of a ball traveling down the tower. Put a ramp sloping upward to decrease the speed of the rolling ball. Put a ramp sloping downward to increase the speed of the rolling ball.

Balsa Glider - For reference see http://www.real-world-physics-problems.com/balsa-glider.html

K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

This is for the outdoors. Wind up the propeller of the glider 10 turns and release it. Observe how fast the glider moves. Now wind up the propeller 20 turns and release it. Observe how fast the glider moves. The glider will move faster the second time because the propeller spins faster since it is wound up more. This means the propeller pushes against the air with greater force which causes the glider to move faster.

K-PS2-2: Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

This is for the outdoors. Wind up the propeller of the glider 20 turns and release it on a flat surface. Observe how fast it moves. Now wind up the propeller 20 turns and release it on a downward sloping ramp. Observe how fast it moves. The glider will move faster

since it is going downhill which enables the force of gravity to "pull" down on it in the same direction as its direction of motion, so it goes faster. Now wind up the propeller 20 turns and release it on an upward sloping ramp. Observe how fast it moves. The glider will move slower since it is going uphill which enables the force of gravity to "pull" down on it in the direction opposite to its direction of motion, so it goes slower.

This exercise tells us that when a force acts on an object in the same direction as its direction of motion it speeds up. When a force acts on an object in the opposite direction to its direction of motion it slows down.

Third Grade

Newton's Cradle - For reference see http://www.real-world-physics-problems.com/newtons-cradle.html

3-PS2-1: Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Observe the Newton's cradle while doing nothing to disturb it. The balls are not moving because there is no unbalanced (or net) force acting on them. Now lift a ball on one end and drop it. The balls then move as a result. This is a result of the unbalanced force introduced when the ball was lifted up and dropped. The force of gravity pulled down on the ball and caused it to hit the ball beside it which then caused the ball on the other end to lift up. When you lifted the ball up initially you exerted an unbalanced force on it which caused it to move upward. And when you released the ball, the unbalanced force of gravity pulled down on the ball.

Now, lift away three of the balls so that only two balls are touching each other. Repeat the above experiment with the two balls. Is there any difference in the results? There should not be since having more balls touching each other does not change how the forces behave. Having more balls in contact with each other just means that the force has to be transmitted along a greater distance.

3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

Lift up a ball on one end and drop it. You will observe that the ball on the other end will lift up in response. Predict what will happen when two balls on one end are lifted up and dropped. The two balls on the other end will lift up in response. Now lift three balls on one end up and release them. Observe what happens.

Tap one end of the balls with a pencil. Observe the amount that the balls move. Tap one end of the balls again, but somewhat harder. The amount that the balls move will be greater. Now tap the end of the balls again, but less hard than you did before, and harder than you did the first time. Observe the amount that the balls move. The amount they

move should be in between the amount on the first and second attempt. This is because the force generated (on the third attempt) is in between the force generated on the first and second attempt.

Stomp Rocket - For reference see http://www.real-world-physics-problems.com/stomp-rocket.html

3-PS2-1: Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

This is for the outdoors. Observe the rocket sitting on its launch platform. It is not moving due to the fact that it is acted on by balanced forces. Now step on the bladder and observe what happens. The rocket will fly into the air because the action of stepping on the bladder forces air underneath the rocket and pushes it upward, causing it to be acted upon by an unbalanced force (which is the force of the air). The force of air pushing from underneath the rocket causes the overall force balance of the rocket to be disrupted which causes the rocket to fly up into the air. The rocket then falls back down to earth because of the force of gravity which is also an unbalanced force acting on the rocket. Once the rocket lands and comes to rest on the ground it is once again acted upon by balanced forces in which the force of gravity pulling down on the rocket is equal to the force of the ground pushing up on the rocket. Therefore the rocket remains stationary.

Balsa Glider - For reference see http://www.real-world-physics-problems.com/balsa-glider.html

3-PS2-1: Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

This is for the outdoors. Wind up the propeller of the glider 20 turns and release it. Hold on to the tail of the glider so that it doesn't move. This is an example of balanced forces acting on an object. The force that you are holding the glider with is equal to the push force of the propeller on the air. Now wind up the propeller of the glider 20 turns and release it. The glider will move. This is an example of unbalanced forces acting on an object. When you release the propeller it spins and pushes on the air with an unbalanced force which causes the glider to move.

Fly Stick - For reference see http://www.real-world-physics-problems.com/fly-stick.html

3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

Play with the flystick to observe the phenomenon of electrostatic attraction and repulsion. The description given on http://www.real-world-physics-problems.com/fly-stick.html

Fourth Grade

Newton's Cradle - For reference see http://www.real-world-physics-problems.com/newtons-cradle.html

4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.

and

4-PS3-3: Ask questions and predict outcomes about the changes in energy that occur when objects collide.

Lift a ball on one end and drop it. The ball on the other end lifts up a certain height. The greater the height reached the more energy the ball has, which means that the colliding ball is moving faster just before impact. During impact the ball that is dropped transfers all its energy to the ball on the other end, and its own energy goes to zero as a result. Similarly, by dropping the ball from a greater height, it reaches a greater speed before impact and has more energy as a result, and this energy is transmitted to the other ball which reaches a height proportional to the energy it gains (from the first ball).

Now, lift away three of the balls so that only two balls are touching each other. Repeat the above experiment with the two balls. Is there any difference in the results? There should not be since having more balls touching each other does not change how the energy behaves. Having more balls in contact with each other just means that the energy has to be transmitted along a greater distance.

Stomp Rocket - For reference see http://www.real-world-physics-problems.com/stomp-rocket.html

4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.

This is for the outdoors. The harder the bladder is stepped on the more energy is given to the rocket and the higher it flies. The height reached is proportional to the energy at takeoff.

Dynamo Torch - For reference see http://www.real-world-physics-problems.com/dynamo-torch.html

4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

and

4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Energy is transferred from the mechanical hand cranking motion to the light bulb, via electricity generated. The electricity is a form of energy which travels from the source (the hand crank which is connected to an electric generator) to the light bulb which causes it to shine.

Radiometer - For reference see http://www.real-world-physics-problems.com/radiometer.html

4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

and

4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Place the radiometer outside when it's sunny. Light energy is transferred from the sun to the vanes which causes them to spin, which is a form of motion energy. You can try shining a flashlight on it to see if it also causes the vanes to spin. If the speed of spinning is less you can conclude that the flashlight is a weaker source of light energy than the sun.

Hand Boiler - For reference see http://www.real-world-physics-problems.com/hand-boiler.html

4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

and

4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

When holding the hand boiler at the bottom, heat energy is transferred from your hand to the liquid inside the boiler. This heat energy causes the special liquid inside to boil. It's similar to how heat from the stove can be used to boil water in a pot. The boiling liquid means it has gained sufficient energy in its atoms to experience boiling.