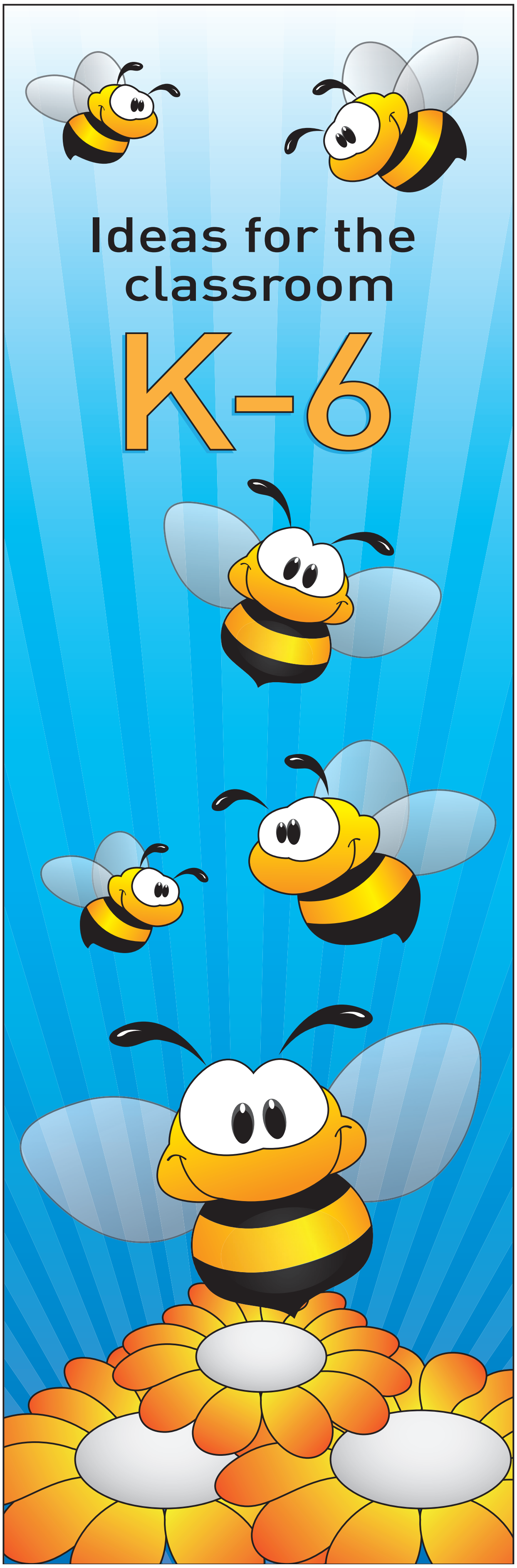

What if Science was a Game that everyone could Win? Part III

By Marti Ellen

When we begin to learn Maths, we count and learn 1+1. When we learn to read, we start with the ABC's and put them together into words. But where does learning science begin?

The game of science.

In Parts I and II, we focused on the basic keystones of the game: energy, mass and forces, and built our foundation of science as a game that every one could win. No one would think it was 'hard' and no one would be left behind. We began with the most basic everyday concepts. Taking tiny steps and only changing one thing at a time, students constructed things and developed answers for themselves.

Now that we have a foundation, we want to build upon it and take our understanding of energy, mass and forces further. We will again validate that we can win at the game, and that the game is fun.

Part of the objective of playing a game is learning how to move the pieces skilfully. It takes practice. It takes time. It takes repetition. If you play the game often it will become part of your everyday life.

So how do we set this strategy in motion in our teaching? What system do we use?

Here is a process to follow to relate energy, mass and forces to the real physical world through simple, hands-on activities:

1) Pick a machine that will excite the imagination of your students, for example a battering ram, catapult, roller coaster or other.
2) Have students build a model of it. You can use a kit, paddle pop sticks, Lego, or other readily available construction material.
3) Help students analyse the machine by breaking it down into its purpose, component parts and the principles each one uses.
4) Have an activity ready to demonstrate the answer to each one.

What if Science was a Game that everyone could Win? Part III (continued)

Our example:

1) Build a model battering ram. (ST1-16P, ST2-16P, critical and creative thinking, literacy)

2) Use a kit or design your own model. Here is one suggestion: build a battering ram out of paddle pop sticks. Make a plan in advance so the glued-together sections are ready to assemble as needed. You can attach the sections to each other with rubber bands. Put some plasticine on the four legs to attach it to the surface it is standing on. Use a piece of string to attach the ram to the top of the frame. The ram should be able to swing freely through the frame. To stabilise it horizontally a second paddle pop stick could be attached to the top, with another piece of string tied to the pole of the ram.

Figure 1. diagram of a battering ram made of paddle pop sticks and rubber bands.

3) Next, analyse the battering ram based on its purpose, component parts and the principles it uses (ACSIS231, ACSIS232, critical and creative thinking):

- Understand that a battering ram is an example of a machine that was used in ancient times to knock down enemy walls and doors. The walls were often made of heavy stone and doors of thick timber reinforced with heavy cross beams.
- Understand that a great amount of energy was necessary to knock down the walls and doors.
- Realise that to create such a force, a machine (battering ram) was developed that consisted of a large mass suspended by a rope hanging from a frame that could be moved into a particular position.
- Understand that the machine needed to use a heavy mass to be effective. The mass could be attached to the end of a heavy wooden pole so several men could hold on to the pole and push it. The pole also added to the mass.
- Understand that by fixing the pole on a rope and swinging the “ram” back and forth, it gained a large amount of kinetic energy that could be used to knock down the wall or door.
- The principles to understand are:
  - The greater the mass the greater the kinetic energy (activity 1)
  - Pendulum motion (activity 2)

4) Here are examples of activities you can use to demonstrate these topics:

Activity 1: energy (ST1-7PW, ACSSU033, ST1-12MW, ACSSU018, ST2-7PW, ACSSU076, ST2-13MW, ACSSU074, critical and creative thinking)

Materials:

Plastic shopping bag with handles

lots of mass e.g. golf balls, blocks, or tins of food

Hold an empty bag by the handles with one hand. Use the other hand to twist the empty bag 10 full turns. Keeping hold of its handles, let go with the second hand. What happens?

Not very much. The bag untwists very slowly and with little kinetic energy.

What if Science was a Game that everyone could Win? Part III (continued)

Put some mass into the bag.

Figure 2.

Twist the bag 10 full turns once again.

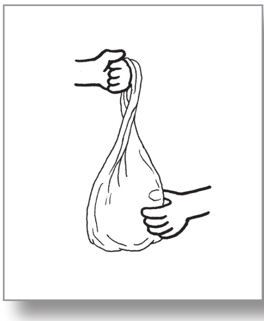

Figure 3.

While still holding the bag handles, let go the second hand once again.

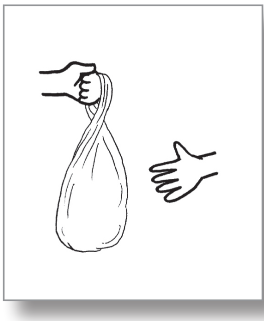

Figure 4.

Now what happens when you let go of the bag?

It took more of your energy to twist the loaded bag, which means that the potential energy of the twisted bag increases with the greater mass put into the bag. This is then observed as the greater kinetic energy of the spinning bag when released. The relationship of ***more mass-> more energy*** *is the point we wish to make.*

Activity 2: storing and releasing energy (ST2-4WS, ACSIS053, ACSIS064, ACSIS054, ACSIS065, ACSIS055, AACSIS066, ACSIS057, ACSIS068, ACSIS058, ACSIS069, ACSHE050, ACSHE061, ACSIS215, ACSIS216, ACSIS060, ACSIS071, ST2-7PW, ACSSU076, ST2-13MW, ACSSU074, ST2-16P, ACSIS086, ACSIS103, ACSHE081, ACSHE098, ACSIS087, ACSIS104, ACSIS091, ACSIS108, ACSIS218, ACSIS221, ST3-5WT, ST3-13MW, critical and creative thinking, literacy, work and enterprise, personal and social capability, numeracy, ethical understanding)

Materials:

2 chairs

metre stick or broom stick

cotton thread

5 washers

timer

ruler

How can you store energy and release it when you choose?

Make a pendulum as shown in Figure 5.

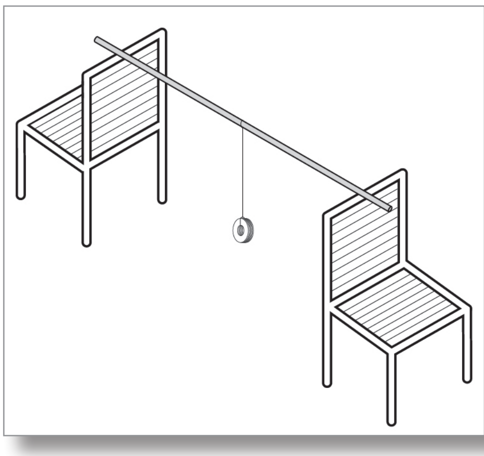

Figure 5.

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Pull back the pendulum. (Figure 6.) As you do this you are storing energy.

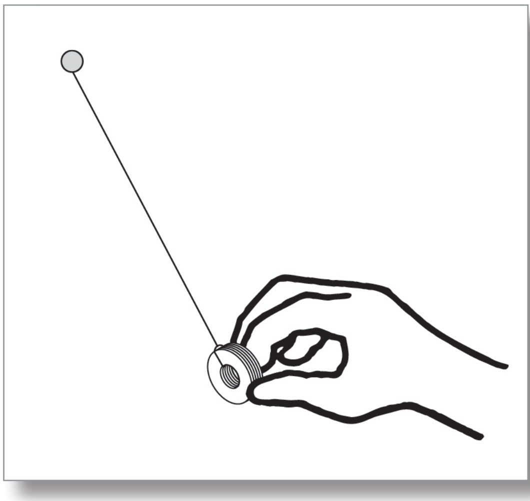

Figure 6.

Let it go. (Figure 7.) When you do this the energy you stored is released, turning into kinetic energy.

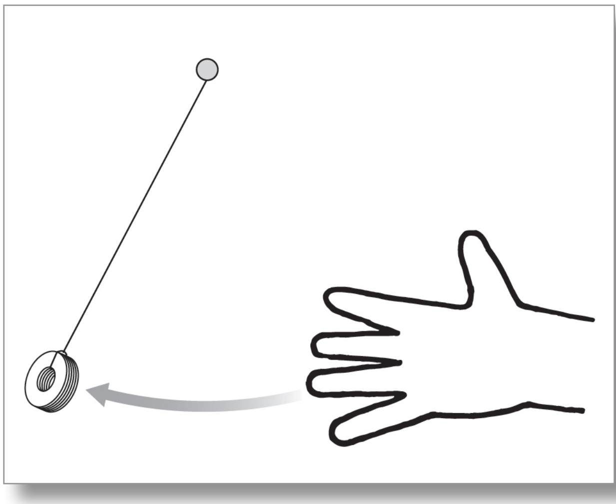

Figure 7.

Repeat several times. At what point is the kinetic energy greatest (this would be helpful to know when using a battering ram)?

Repeat the activity, but change the length of the string. What effect does that cause? How would that principle be put to best use in your battering ram?

As you hold the pendulum up before letting go (potential energy), it has no movement. Once you let go, it travels as the potential energy is converted into kinetic energy. To use a battering ram most effectively, the wall should be as close as possible to the part of the swing where the kinetic energy is greatest. The kinetic energy is greatest at the bottom of the swing i.e. when the thread is vertical, since beyond that point the mass swings upwards, so its kinetic energy starts turning back into potential energy.

Observe the arc of the swing of your model battering ram from the side. Even though it seems that the ram moves horizontally, you can observe that the path is a small arc. For the greatest effect you would position your battering ram up as close as possible to the wall so the wall is struck with the greatest amount of energy, and therefore the greatest force, since the motion of the pendulum (battering ram) follows through up and into and beyond the wall. This knocks it down.

The length of the string or rope of a pendulum is what determines the period, or speed of the swing. It also relates to how much energy the pendulum has. The greater the length of the rope, the greater is the force which can be exerted.

To create the most effective battering ram: 1) use a high, strong frame to be able to use the longest rope possible from which to swing the ram and 2) have as heavy a mass as possible to heave at the wall.

In this investigation, we have related the simple, underlying principles of energy, mass and forces to the real world. We have created a series of steps that leads students to build and experience answers for themselves. That is the key to winning the game. It becomes easy when we break down a big question and focus on demonstrating and experiencing the little questions that make it up.

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