Texas Essential Knowledge and Skills - Grade Four

(5) Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:
   (A) measure, compare, and contrast physical properties of matter, including size, mass, volume, states (solid, liquid, gas), temperature, magnetism, and the ability to sink or float;
   (B) predict the changes caused by heating and cooling such as ice becoming liquid water and condensation forming on the outside of a glass of ice water; and
   (C) compare and contrast a variety of mixtures and solutions such as rocks in sand, sand in water, or sugar in water.

(6) Force, motion, and energy. The student knows that energy exists in many forms and can be observed in cycles, patterns, and systems. The student is expected to:
   (A) differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal;
   (B) differentiate between conductors and insulators;
   (C) demonstrate that electricity travels in a closed path, creating an electrical circuit, and explore an electromagnetic field; and
   (D) design an experiment to test the effect of force on an object such as a push or a pull, gravity, friction, or magnetism.
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Introduction:

Your group will be designing and building a pinball machine from a lid to a copy paper box or other materials. First you will build the basic machine and then explore some ideas that can make it better. Finally, you will be able to design and build features to make it really fun.

1. Cut a piece of cardboard 16 cm wide and 30 cm long.

2. Fold the cardboard in half lengthwise in a V shape.

3. Tape the V to the bottom of the lid on one end to provide a slope. The point of the V should touch the ground.

4. Cut a hole a little larger than a ping pong ball in the bottom center of the lid and fold it outward so that the ping pong ball can roll out. This hole will eventually be labeled “minus.” You could attach a cup to catch the ball.

5. Cut or break a tongue depressor stick in half.

6. Tape each half to the end of a pencil to make “flippers.”

7. Measure to get the proper location for the flippers. They should be positioned one on each side in front of the bottom hole. They cannot touch each other but have no more than a 2 cm gap.
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8. Poke holes in the lid and insert the pencils.

9. Set the pinball machine on the edge of a table with the pencils sticking out the bottom. You may want to tape it down so it won’t move.

10. Drop a ping pong ball in the lid and try out the flippers, twisting the pencils from underneath.

11. Can you keep the ball in play? If you “mess up” does the ball escape out the bottom hole?

Your basic pinball machine is now finished. Let’s explore some new ideas that you can use to improve your machine.
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(C) compare and contrast a variety of mixtures and solutions such as rocks in sand, sand in water, or sugar in water.

Explore It 1

1. Fold a narrow piece of cardstock lengthwise to form a long V-shape.

2. Hold it at different angles and roll the ping pong ball in the groove.

3. How would this work for getting your ball into play?

4. Tie two rubber bands together.

5. Try different ways to use the rubber band to get the ball into play.
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(D) design an experiment to test the effect of force on an object such as a push or a pull, gravity, friction, or magnetism.

6. Design an experiment to test the effect of force on the ball. Think about pushing or pulling, gravity, friction, and maybe even magnetism.

7. Make a sketch of your experiment here and write notes about what you did and the results.

8. Make several sketches of how you can use what you learned about forces when you build your pinball machine.
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Describe It 1

1. Where did the energy come from to roll the ball down the ramp?

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2. Where did the energy come from to move the ball with the rubber bands?

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3. What did you learn in your experiment?

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4. How can you use what you learned in the design of your pinball machine?

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Explore It 2

1. Cut 1 light bulb from a string of holiday lights. Leave the wires as long as possible.

2. Strip the insulation off about 1 cm on the end of both wires.

3. Touch the bare ends of the wires to a battery.

4. What happens?
5. Attach two long wires to the two terminals on the battery.

6. Connect one of the wires to one of the wires on the light.

7. Connect the other long wire to a paper clip.

8. Touch the paper clip to the end of the other wire on the light.

9. What happens?
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10. Take a long, thin wire and wrap it around a nail.

11. Connect on end of the thin wire to the long wire coming from the battery.

12. Hold the nail close to a paper clip.

13. Touch the other end of the thin wire to the other long wire coming from the battery.

14. What happens?
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(C) compare and contrast a variety of mixtures and solutions such as rocks in sand, sand in water, or sugar in water.

15. Make several sketches of how you can use electricity to make your pinball machine better.
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Describe It 2

1. Why did the light bulb not work when you just attached one wire to the battery, but did work when you attached both?

________________________________________________________________________________________

2. The paper clip was used as a ___________________________

________________________________________________________________________________________

3. What happens when you let electricity flow through a coil of wire?

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4. Give two reasons why you cannot leave a coil of wire connected to a battery for very long.

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5. How can you use what you learned about electricity in your pinball machine?

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Explore It 3

1. Put on safety glasses and gloves and open the window. This is going to be messy and smelly.

2. Your teacher is going to give you a little bit of putty.

3. Squeeze out about 1 cm of hardener from the tube.

4. Use a craft stick to mix them together. It should be one color with no streaks or stripes.

5. You can pick the putty up with your gloves and form it into any shape you want, but you better work fast.
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(D) design an experiment to test the effect of force on an object such as a push or a pull, gravity, friction, or magnetism.

6. What happens?

7. Make several sketches of how you can use this putty in your pinball machine.
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Describe It 3

1. What caused the putty to get hard?

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2. What else happened when the putty was getting hard?

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3. What would happen if the two parts were not mixed together well?

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4. Did the putty freeze? Explain your answer.

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5. Does the putty sink or float? How could you tell without trying it?

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6. Does the putty dissolve in water?

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7. How can you use this putty in your pinball machine?

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Use It

Get the ball into play
1. You have several sketches of how you can use forces to get the ball into play.

2. Pick the best idea and build it.

3. How well does it work?

Electricity
1. You have several sketches of how you can use electricity.
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2. Pick your best ideas and install the wiring.

3. How well does it work?

Shapes
1. You have several sketches of how you can use chemistry in your pinball machine.

2. Design a small object and build it.

3. How well does it work?