Lesson Plans & Guide:

Doktor Kaboom! It's *Just* Rocket Science™

Things to Know

- Videos and Lessons are suitable for grades 3-8.
- Activities can be differentiated to make challenge level appropriate to grade level.
- This interactive video includes some "call and response" that may seem loud for those with sensory sensitivities. Set expectations for acceptable noise level with students in advance.
- The results of some science experiences may happen quickly and surprise some students.

Work of Art

Through highly interactive comic performances Doktor Kaboom encourages students to express their awe of scientific demonstrations, to creatively explore the world around them, and to realize that science and mathematics are meant for everyone.

Overview

This Arts Engagement Experience consists of 3 videos for grades 3-8 that total 30+ minutes. Each one demonstrates one of Isaac Newton's Three Laws of Motion.

- First Law, Inertia (15:28 min)
- Second Law, The Law of Acceleration F = ma (8:30 min)
- Third Law, Action/Reaction (8:05 min)

The lesson plans that go with each video engage learners in math, science, and arts activities that exercise and develop Social-Emotional competencies and 21st-Century Skills.

Learning Connections

- **Math**: Make sense of problems and persevere in solving them.
- **Fine Arts Standards - Theatre**
  - Observe how a character's choices impact an audience's perspective in a theatrical work.
  - Recognize how a character's circumstances impact an audience's perspective in a theatrical work.
  - Use audience reaction to assess the impact of a theatrical work on that specific audience.
  - Explain how the actions and motivations of characters in a theatrical work may impact a community or culture's understanding.
  - Identify and evaluate issues and situations in a theatrical work from an audience member's perspective.
  - Identify how the intended or supposed purpose of a theatrical work appeals to a specific audience.
- **Social-Emotional Learning** (Respect. Understanding. Cooperation. Making good choices.)
- **21st Century skills** (Critical thinking. Creativity. Collaboration. Communication.)

Recommended Advance Preparation for this Arts Engagement

- Preview each Video

- Review Resources
  - *It's Just Rocket Science* Study Guide, by Doktor Kaboom (note list of print and online resources on last pages)
  - Applause Series CURRICULUM GUIDE, Civic Center of Greater Des Moines pp. 9-14

- Review Lesson Plans – notice lesson components
  - Things to Know
  - Learning Connections
  - Glossary
  - Learning Outcomes
  - Warm-up – to get minds and bodies ready for lesson content
  - Main Activity- the video
  - Post-Video Activity
  - Reflection – to help students retain the learning
  - Closure – to bring the lesson to satisfying completion

- Decide how you want to structure this Arts Engagement Experience.
  - Which videos will you use?
  - Will you show any video more than once?
  - Which lesson plans will you use?
  - What is your time frame for the entire Experience?

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Lesson Plan 1 – Inertia

Things to Know

- Prepare Inertia Project materials in advance.
- Activities can be differentiated to make challenge level appropriate to grade level.
- This interactive video includes some "call and response" that may seem loud for those with sensory sensitivities. Set expectations for acceptable noise level with students in advance.
- The results of some science experiences may happen quickly and surprise some students.

Learning Connections

- Science (Sir Isaac Newton's first Law of Motion: Inertia)
- Theatre (Actor's Tools; Costume and Set design)
- Social-Emotional Learning (Respect. Making good choices)
- 21st Century skills (Critical thinking. Communication.)

Learning Outcomes

Students will **KNOW:**

- Science Safety Rules;
- Sir Isaac Newton's 1st Law of Motion.

Students will **UNDERSTAND:**

- Intellectually: Sir Isaac Newton's time in history.
- Experientially: science safety rules; hypothesis; Inertia.

Students **WILL BE ABLE TO:**

- form a hypothesis about a project;
- test the hypothesis;
- report the outcome of the test and what is learned by it.

Glossary (write these two terms on the whiteboard)

- **Hypothesis**: a guess about what the outcome of an experiment will be.
- **Inertia**: property in which an object at rest stays at rest, or an object in motion stays in motion, *until acted upon by an outside force*.

Warm-Up (5 min) – to get minds and bodies ready for lesson content

- Brainstorm and capture on whiteboard: what we know about Inertia.

Set – for the video:

- practice appropriate volume for "call and response" interaction;
- Doktor Kaboom will explain and demonstrate *Inertia* – Newton's 1st Law of Motion;
- pay attention to the three Science Safety Rules;
- Doktor Kaboom will give us a project to do.

Main Activity – play the video (15+ minutes)

Post-Video Reflection – group discussion

- Who wants for us to do the assignment Doktor Kaboom gave us?
- Do you think Rocket Science is hard or easy? Why?
  Doktor Kaboom says: Science is for *everybody*, not just students who win the Science fair!
- What do you know about Inertia now that you didn't know before the video?
- How might you explain Inertia to a friend?
- Can we recall the three rules for Science "Safetyness"?

Post-Video activity – Inertia Project

- This activity can be done the same day that you present lesson and video, or a day or so after.
- For young learners, the teacher or adult partner will actually perform the experiment while students closely observe. Older students can perform the experiment themselves, with appropriate adult supervision.
- Remind students that this experiment is similar to what Doktor Kaboom did with the tablecloth and dishes in the video, we will just use plastic bottles and paper instead.
- Safety reminder: wear goggles.

Post-Activity Reflection - Have students complete the Lab Report found on the next page.

Post Lab Report Reflection:

1. Students share their Lab Reports with a partner or small group. Encourage observations and questions.
2. Large group discussion: What did you learn by looking at other Lab Reports?

Closure: How do you feel about doing Rocket Science?

Lab Report 1– Inertia Project

Your name:

Adult partner's name:

Experiment materials and set-up:

- 3 plastic water bottles (tops cut off, optional);
- 3 pieces of paper;
- food coloring (3 colors);
- water.

Procedure:

- Form a Hypothesis – What do you ***think will happen*** for each bottle? Write your hypothesis for each below.
  - Blue
  - Red
  - Yellow

- Test your hypothesis by performing the experiment.

- Describe what actually happened with each bottle.
  - Blue
  - Red
  - Yellow

  Was your hypothesis right or wrong? Does it matter? Why or why not?

- Write down – "What I learned by doing this experiment."

Lesson Plan 2 – Newton's 2nd Law of Motion

The Law of Acceleration (F=ma)

The ACCELERATION of an object as produced by a net FORCE on the object is directly proportional to the MAGNITUDE of the net force, in the same DIRECTION as the net FORCE and inversely proportional to the MASS of the object.

Things to Know

- The Law of Acceleration seems complicated but can be broken down for understanding.
- Prepare the materials for the experiment in advance.
- This interactive video includes some "call and response" that may be loud for those with sensory sensitivities. Set expectations for acceptable noise level with students in advance.
- The results of some science experiences could happen quickly and surprise some students.

Learning Connections

- Science (Sir Isaac Newton's 2nd Law of Motion (F=ma) is the Law of Acceleration.)
- Theatre (Actor's Tools: body; voice; facial expression.)
- Social-Emotional Learning (Respect. Making good choices.)
- 21st Century skills (Critical thinking. Communication.)

Learning Outcomes

Students will **KNOW:**

- **Balanced force** – a moving or stationary object that ***doesn't change*** force or mass has no acceleration. Inertia means force, mass, and acceleration balance each other out ***until something changes!***
- **Net force** – is the result when the force, mass, and acceleration of an object are unbalanced. This changes the way force affects acceleration of an object.
- **Force is directly proportional to mass** – the greater the force, the greater it accelerates an object's velocity in the same direction.
- **Mass is inversely proportional to acceleration** – the greater an object's mass, the less the same magnitude of force will accelerate its velocity.

Students will **UNDERSTAND:**

- **The Law of Acceleration** (F=ma) tells us what makes an object change acceleration. "F" stands for Force, and "ma" stands for mass times acceleration. Since the formula shows the relationship of force, mass, and acceleration, if we know the amount of any two of these, we can calculate the third.
- An example of "meters per second per second" is an object moving one meter per second for 3 seconds. It moves 1 meter in the first second, 2 meters in the next second, and 3 meters in the last second, for a total of 6 meters in 3 seconds.

Students **WILL BE ABLE TO** define or give an example of:

- **Acceleration** – any change in speed or direction in response to an outside force. It is measured in meters per second per second (meters per second squared).
- **Force** – a push or pull against an object that causes a change in the object's speed and/or direction. It is measured in Newtons.
- **Mass** – the amount of matter in an object. It is measured in kilograms.

Warm-Up (5 min) – to get minds and bodies ready for lesson content

- Read aloud the definitions of the three vocabulary words above.
- Imagine this scenario and tell me what happens:
  - You are on a playground merry-go-round, and a bigger person is pushing it while running on the ground next to it. What happens?
  - Four other kids get on the merry-go-round and ask the bigger person to keep pushing. What happens
- Analyze
  - What is the FORCE in this scenario?
  - What MASS is this force acting on?
  - How does force ACCELERATE the speed of the merry-go-round?
  - How does mass affect the power of force to ACCELERATE merry-go-round speed?

Set – As we watch this video, notice:

- how Doktor Kaboom demonstrates Force; Mass; Acceleration;
- how he demonstrates direct and inverse proportionality;
- how he uses actor tools in the lesson.

Main Activity – play the video (8+ minutes)

Post-Video Reflection – group discussion

- Talk about ways Doktor Kaboom demonstrated Force; Mass; and Acceleration.
- Describe how he uses actor tools.
- How does the use of actor tools affect audience response to the video?
- Do we want to try the experiment in the video?

Post-Video activity – The Law of Acceleration

- This activity can be done the same day that you present lesson and video, or a day or so after.
- For young learners, the teacher or adult partner will actually perform the experiment while students closely observe. Older students can perform the experiment themselves, with appropriate adult supervision.
- Safety reminder: wear goggles

Post-Activity Reflection - Have students complete the Lab Report found on the page after this lesson.

Post Lab Report Reflection:

1. Students share their Lab Reports with a partner or small group. Encourage observations and questions.
2. Large group discussion: What did you learn by looking at other Lab Reports?

Closure: What are you learning by doing Rocket Science?

Lab Report 2 – The Law of Acceleration

My name:

Adult partner's name:

Experiment materials and set-up:

- Table
- 2 equal-sized bowls containing equal amounts of flour
- 2 rubber balls of different sizes (different mass)
- Cleanup supplies

Procedure:

- Form a Hypothesis - What do you ***think will happen*** when you drop the two balls into the flour? Write your hypothesis for each ball below.
  - Larger
  - Smaller

- Test your hypothesis by performing the experiment. Observe closely. What actually happens with each ball? How does the difference in mass affect how the flour reacts?

- Describe what actually happened
  - Larger
  - Smaller

  Was your hypothesis (for each ball) right or wrong?
  Does it matter whether it was right or wrong? Why or why not?

- Write down – "What I learned by doing this experiment."

Lesson Plan 3 – Action/Reaction

Things to Know

- Preset materials for Action/Reaction activity.
- This interactive video includes some "call and response" that may seem loud for those with sensory sensitivities. Set expectations for acceptable noise level with students in advance.
- The results of some science experiences may happen quickly and surprise some students.

Learning Connections

- Science (Sir Isaac Newton's third Law of Motion: Action/Reaction)
- Theatre (Character. Improvisation.)
- Social-Emotional Learning (Respect. Making good choices.)
- 21st Century skills (Critical thinking. Communication.)

Learning Outcomes

Students will **KNOW**:

- Sir Isaac Newton's 3rd Law of Motion: Action / Reaction.

Students will **UNDERSTAND**:

- that the thrust that launches a rocket is an action/reaction;
- that action/reaction is affected by changes in mass;
- the importance of Science Safety Rules.

Student **WILL BE ABLE TO**:

- write a lab report on a chemical reaction.

Glossary (write these terms on the whiteboard)

- **Chemical Reaction**: occurs when two different elements or compounds come together and at least one of them changes its composition or identity.
- **Force**: anything that acts on a body to change its rate of acceleration or alter its momentum.
- **Trajectory**: the path described by a projectile flying or an object moving under the action of given forces.
- **Thrust**: the propulsive force of a jet or rocket engine.

Warm-Up (5 min) – to get minds and bodies ready for lesson content

- What happens if you blow up a balloon and then let it go? (Or, for more fun, have students actually blow up a balloon and let it go!) Now let's think about what just happened:
- What action propels the balloon? How does the balloon react?
- In which direction does the balloon go? Use your finger to illustrate the balloon's trajectory in the air.
- What about the direction of the air?
- This is an example of Force – simultaneous and equal action and reaction.

We have just demonstrated Rocket Science!

Set – for the video:

- pay attention to the importance of using goggles for safety;
- notice two ways that Doktor Kaboom demonstrates *Action/Reaction*.

Main Activity – play the video (8+ minutes)

Post-Video Reflection – group discussion

- What chemical reaction does Doktor Kaboom show?
- How did his goggles and gloves keep him safe?
- In the video, how does Doktor Kaboom explain Force?
- How does he use his hands to demonstrate Action/Reaction?

Post-Video activity – Action/Reaction Project

- This activity can be done the same day that you present the lesson and video, or a day or so after.
- For young learners, the teacher or adult partner will actually perform the experiment while students closely observe. Older students can perform the experiment themselves, with appropriate adult supervision.
- Safety reminder: wear goggles

Post-Activity Reflection - Have students complete the Lab Report found on the next page.

Post Lab Report Reflection:

- Students share their Lab Reports with a partner or small group. Encourage observations and questions.
- Large group discussion: What did you learn by looking at other Lab Reports?

Closure: Would you like to keep studying Rocket Science? Why or why not?

Lab Report 3 – Action/Reaction

My name:

Adult partner's name:

Experiment materials and set-up:

- Several short lengths of straw, threaded onto a really long string
- Attach the string/straw high up on one end of the room. Pull it taut and attach the other end low on the opposite end of the room to form a diagonal line across the space.
- Elongated balloons
- Pennies for changing mass of balloons
- Tape for attaching prepared balloon to the string

Procedure:

- Form a Hypothesis - What do you ***think will happen*** when you test each balloon on the string? Write your hypothesis for each below.
  - Empty balloon
  - Balloon with added mass (2 pennies insider)
  - Balloon with added mass (6 pennies inside)

- Test your hypothesis by performing the experiment.
  - Blow up the empty balloon. Without releasing any air, tape it to the first straw on the string. Release the air. Observe closely. What actually happened?
  - Repeat the experiment with a balloon containing 2 pennies.
  - Repeat the experiment with a balloon containing 6 pennies.
  - (Optional) Repeat the experiment using three helpers to test all three balloons at once. Tape each prepared balloon to one straw on the string, in order by mass (lightest to heaviest.)

- Describe what actually happened with each balloon.
  - Empty balloon
  - Balloon with added mass (2 pennies inside)
  - Balloon with added mass (6 pennies inside)
  - (Optional) All three balloons at once.

  Was your hypothesis (for each balloon) right or wrong?
  Does it matter whether it was right or wrong? Why or why not?

- Write down – "What I learned by doing this experiment."