Forward Motion

A Science Curriculum for 4th Grade

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Designed for Roses in Concrete, Oakland, CA
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Overview: Roses In Concrete (for EDUC 208B Assignment)

Site: Roses in Concrete

Roses In Concrete, founded in 2014, is a growing charter school located in East Oakland, CA, a community that historically has struggled with poverty and crime. The school was founded by Jeff Duncan-Andrade, who has written and spoken extensively about the effects that such an environment has on children as they develop. Duncan-Andrade has taught in East Oakland for over 20 years, holds a Ph.D from the University of California, Berkeley, and is an Associate Professor of Raza Studies and Education Administration at San Francisco State University (Wilson, 2014).

Roses In Concrete enrolls students from the surrounding neighborhood in East Oakland and currently serves grades K-6. The majority of students receive free and reduced lunch and a third are English learners (Education Data Partnership, 2017). Many of the students and their families face extraordinary levels of stress outside of school because of neighborhood violence. The San Francisco Chronicle began mapping homicide rates in 2002 to call attention to the violence, and maps today still reveal extremely high levels of violent crime (although these rates have declined substantially since 2002, they are still among the highest in California). It is likely that a child growing up in East Oakland has personally witnessed a murder or violent crime by the time she enters high school. Exposure to this kind of violence can result in PTSD - a psychological disorder usually associated with soldiers at war. Duncan-Andrade claims that urban youth are twice as likely as soldiers returning from Iraq to display the symptoms of mild to severe PTSD, and one in three children growing up in East Oakland experience this kind of trauma (TEDx Talks, 2011).

To counteract these negative environmental effects, Roses In Concrete strives to be a center of health for the neighborhood and create a community of support for students and parents. Teachers use innovative teaching methods to engage learners as individuals and encourage self-esteem and self-worth while at school. Learners are encouraged to express themselves and discover how topics relate to their lives and society at-large (Tagawa, 2014).

A school steeped in social justice, Roses In Concrete is determined to break the cycle of crime and poverty in Oakland by focusing on the community's youth. The name Roses In Concrete was inspired by the following poem by Tupac Shakur (more commonly known as 2Pac the rapper):

> *Did you hear about the rose that grew*
> *from a crack in the concrete?*
> *Proving nature's law is wrong it*
> *learned to walk without having feet.*
> *Funny it seems, but by keeping its dreams,*
> *it learned to breathe fresh air.*
> *Long live the rose that grew from concrete*
> *when no one else ever cared. (Shakur)*

In his TED Talk, Duncan-Andrade says, "When you see a rose growing in the concrete, you don't question its damaged petals. Of course it has damaged petals - it's growing in the concrete" (TEDx Talks, 2011). As the school's mission statement articulates, we should "celebrate the tenacity and will of the rose that against all odds finds a way to grow in the inhospitable and toxic environment of the concrete, that it might transform the concrete into a rose garden" (Roses In Concrete, 2016).

Roses In Concrete pursues its mission in three ways: nurturing the rose, removing the concrete, and growing a garden.

Nurturing the Rose

What does a rose need to grow and thrive? Soil, water, sunlight, nutrients. What does a child need to grow and thrive? According to Maslow's hierarchy of needs, a classic theory in developmental psychology, the basic needs of human development are physical well-being, safety, love and belonging. These are what a child needs first and foremost (Maslow, 1943, pp. 430-437). "And yet," says Duncan-Andrade, "when you look at this list of things that lead to self-actualization, not a single public school teacher in this country is evaluated on their ability to do those things" (TEDx Talks, 2011).

Beyond the core elements of health and safety, Maslow describes belonging and esteem as key ingredients to a child's success. One of the forms this can take has been described as "self efficacy," or "people's belief that they have what it takes to accomplish a goal" (Schwartz et al, p. 317). Believing in oneself is often associated with having a "growth mindset," as opposed to a "fixed mindset." A growth mindset holds that abilities can grow with effort, whereas people with a fixed mindset believe abilities are innate and unchangeable (Dweck 2006). To fulfill a student's needs for

esteem and belonging, then, we must guide learning experiences, which promote a growth mindset.

Self-efficacy and a growth mindset are especially important for school science, which is often perceived as difficult or inaccessible to students, compared to other subjects (Lyons 2005). To the extent that this perception is real, and science actually is more difficult than other subjects in school, the cause is likely the way science is taught, rather than the nature of science itself.

Removing the Concrete

When social and structural forces—like the cycle of poverty, crime, and systematic exclusion of minorities from myriad resources—act to hinder a child's development, they must be addressed directly. Removing the concrete requires first exposing it for what it is. In physics, students must learn that for every action there is a reaction; in social justice, students must also learn social *in*justice. In guiding its curricula, Roses In Concrete utilizes Bree Picower's *Six Elements of Social Justice Curriculum Design for the Elementary Classroom* (Picower 2012). Picower's elements include:

1) Self-love and knowledge
2) Respect for Others
3) Issues of Social Injustice
4) Social Movements and Social Change
5) Awareness Raising
6) Social Action

Picower's element #1 harkens to the lower levels of Maslow's needs and self-efficacy, but #3—exposing the concrete—is a key piece of Roses in Concrete's mission. Of course, reflecting on injustice should naturally lead to action and a desire for change, which is where our curriculum merges with a Freirean take on critical theory in education. Freire, too, is concerned with self-efficacy and the empowerment of students. For Freire, a revolutionary educator's "efforts must be imbued with a profound trust in people and their creative power" (Freire 2005, p. 75). But Freire also insists that those creative powers be used to change the status quo—a view that aligns with Picower's elements #4-6. It is apparent how these three aspects of Roses in Concrete's mission flow together: self-efficacy empowers student's belief in themselves, studying social injustice inspires action, and action seeks to change the status quo. The rose grows in the concrete, sees the concrete for what it is, and acts to destroy it.

Growing a Garden

A single rose cannot destroy all the concrete on its own—at least, not without a jackhammer. It is not enough to cultivate roses, have them bloom, and then leave. Roses In Concrete aims to convert the pavement into a garden right in Oakland. This is a multifarious goal, and no one can tell a youth who becomes successful where to go once she graduates from college. But by fostering connections with the local community at an early age, and emphasizing hope, change, and empathy through the curriculum, a school may instill a sense of belonging and responsibility in its students to become future citizens (TEDx Talks, 2011).

Applying Ideology in Our Curriculum

Our *Forward Motion* curriculum improves self-efficacy by making science fun, accessible, and relevant to students. Our activities challenge students to observe the things—from windup toys to pendulums to bungee cords—and question how they work and why. An additional "build" activity allows students to design and construct their own toy vehicle. Our assessment tools will not simply measure student learning; they will allow students to reflect on what they have learned, which encourages a growth mindset. Our Scientist of the Day lessons will expose social injustice by explicitly addressing the underrepresentation of women and minorities in science, and discussing them with the class. Celebrating certain women and minorities of science will inspire students who are minorities (which is most of the students at Roses in Concrete) towards positive role models.

Site Constraints and Usability

Our curriculum is likely to be used by the 4th-grade teacher who teaches in Spanish, Marina. In the long run, 4th-grade students at Roses In Concrete will have some fluency in Spanish, since dual language learning will begin in Kindergarten. But since the school is only 2 years old, many 4^{th}-graders are beginning Spanish learners, while others are fluent. Marina faces an extra challenge in her classroom with such a wide range of Spanish proficiency.

Marina develops her curriculum from scratch, doing research on "non-colonialist" topics, translating topics to Spanish, and scaffolding the lessons so that students who speak/read at a Kindergarten Spanish level to a 4th-grade Spanish level can participate. This requires a lot of hands-on activities and very simple vocabulary to get concepts across.

The teachers at Roses in Concrete are generally focused on language arts, social studies and math, and science is often an afterthought. When taught, science is generally integrated into other subject and skill lessons (eg. Water wars in Bolivia, Afro-Latin culture in Cuba, Writing, Music, etc.).

Accessibility to STEM is just as important for teachers as it is for students. FOSS-kits overwhelm teachers with too much information and preparation. It would be helpful for Marina to have a day-by-day kit of materials, activities, assessments, and reference information, with the possibility for extension when they get more comfortable.

Curriculum Overview (for Roses in Concrete)

Site, Learners, and Ideology

Roses In Concrete is committed to the future of the community. It is not enough to cultivate roses, have them bloom, and then leave. Roses In Concrete aims to create a garden right in Oakland. This is a multifarious goal, and no one can tell a youth who becomes successful where to go once she graduates from college. But by fostering connections with the local community at an early age, and emphasizing hope, change, and empathy through the curriculum, a school may instill a sense of belonging and responsibility in its students to become future citizens (TEDx Talks, 2011).

Roses In Concrete Ideology

A social justice mission extends beyond the nurturing of little roses. In physics, students must learn that for every action there is a reaction; in social justice, students must also learn social *in*justice. In guiding its curricula, Roses In Concrete utilizes Bree Picower's *Six Elements of Social Justice Curriculum Design for the Elementary Classroom* (Picower 2012). Picower's elements include:

1) Self-love and knowledge
2) Respect for Others
3) Issues of Social Injustice
4) Social Movements and Social Change
5) Awareness Raising
6) Social Action

Picower's elements align with multiple theories of education. Elements 2 and 5 overlap with Progressivism emphasizing students' awareness of environment and surroundings, using that awareness to arrange their environment into an experience that is conducive to learning and curiosity (Dewey, 1938). Critical Theory focuses on student liberation, which can be found throughout Picower's curriculum. Students are given the information they need to question the way the world works, and educators empower their students to effect change (Freire, 1972).

Building on Critical Theory, this curriculum also aims to foster responsibility in students to make their community and the world a better place. This leads into

Nodding' Ideology of Care, which posits that being cared for (as with Maslow's needs) is interlinked with caring (as for one's community). Nodding writes, "in supportive environments where children learn how to respond to dependable caring, they can begin to develop the capacity to care" (Nodding 1992, p. 52).

Bilingual Classrooms

Roses In Concrete has implemented Spanish-English dual immersion instruction. In the long run, 4th-grade students at Roses In Concrete will have some fluency in Spanish, since dual language learning will begin in Kindergarten. But since the school is only 2 years old, many students are beginning Spanish learners, while others are fluent. Spanish teachers face an extra challenge with such a wide range of Spanish proficiency in their classroom.

These teachers develop their curriculum from scratch, doing research on "non-colonialist" topics, translating topics to Spanish, and scaffolding the lessons so that students who speak/read at a Kindergarten Spanish level to a 5th-grade Spanish level can participate. This requires a lot of hands-on activities and very simple vocabulary to get concepts across.

The Importance of STEM

The teachers at Roses in Concrete are generally focused on language arts, social studies and math, and science is often an afterthought. When taught, science is generally integrated into other subject and skill lessons (eg. Water wars in Bolivia, Afro-Latin culture in Cuba, Writing, Music, etc.).

Accessibility to STEM is just as important for teachers as it is for students. FOSS-kits overwhelm teachers with too much information and preparation. It would be helpful for the teachers at Roses In Concrete to have a day-by-day kit of materials, activities, assessments, and reference information, with the possibility for extension when they get more comfortable.

Aligned with the school's mission and philosophy, this curriculum leverages the ideologies present in Roses In Concrete today to teach bilingual physical science to 4th grade students.

Overarching Learning Goals

- ***Agency:*** Science is accessible, understandable, inclusive, and fun. Science is not intimidating; it is not exclusively the purview of the privileged and powerful.

- ***Scientific Method:*** You can solve problems and understand the world by using the scientific methods of asking questions and making observations.

- ***Understanding:*** Motion comes from various energy sources and many factors affect how something moves.

- ***Concern:*** Women and minority ethnic voices have been historically, and still are, undervalued in science.

Lesson Structure, Objectives and Assessment

Structure of the lessons

Each lesson will follow a similar structure:

I. Scientist of the Day (5 mins)
II. Activity (35 mins)
III. Science Journal (5 mins)

The Science Journal

The science journal is meant to focus on three key elements: writing everything down, and the individuality and personalized aspects of being a scientist. Scientists everywhere are encouraged (or required) to write every little detail down in their science notebooks, such that anyone wanting to repeat an experiment can simply look at the journal and recreate the experiment. Building this skill early will help students feel more confident in future science classrooms. Therefore, encourage students to write anything and everything in their journals; no matter how big or small they think the detail.

Regarding the individuality, everyone keeps a science notebook differently. Some teachers have particular ways in which students are encouraged to organize their notebook, but as a scientist in a laboratory, no two people keep a notebook in the same way. In this ilk, the questions are meant to be guidelines of what to include in the journal, without providing a required way to organize it. The questions are both specific to the lessons, and broad to encourage big picture thinking. After each activity, students will be asked to answer the "Debrief Questions." These questions, and their scaffolds, are below:

Debrief Questions:

1) What did you learn? I learned_____ because I saw_____.
2) How do you know? I know because______.
3) Why do we care? We care because______.
4) What else would you like to investigate? I would like to investigate ______ because_____.
5) How can you relate it to something else outside the classroom? It is similar to_____ because_____.
6) Draw a picture explaining what you think is happening.

Encourage students to answer as many as they feel comfortable, and not to necessarily do them in order. Some may choose to draw one picture and label it; others might choose to stick with words. This is where students can choose the medium in which they feel most confident, capable, and comfortable.

On a practical level, the science journals can be composition notebooks, blank paper stapled together, or blank pages that will go into a folder.

Groups

For all activities involving groups, it's recommended that each group have a strong Spanish speaker to help make sense of and capture discussion.

Activity Overview, Objectives and Vocabulary Needed

Day 1: Unit Introduction

Vocabulary: Scientist, Engineer, Mathematician, Job, Diversity, Build, Rocket

Objectives:

- Students will understand what diversity in science means and why it is valuable
- Students will understand that there are hidden figures throughout history and in science today

Day 2: Inertia Tricks

Vocabulary: Astronaut, Space, Inertia, Weight

Objectives:

- Students will understand the property of inertia and the impact of weight on the movement of an object

- Students will express agency in capturing observations through journal and debrief

Day 3: Things That Move Stations

Vocabulary: Nobel Prize, Energy, Source Gravity, Movement, Walk, Jump, Inside

Objectives:

- Different objects store energy in various ways
- Energy can be used to *do* different things

Day 4: Pendulum Activity

Vocabulary: Author, Clock, Period, Pendulum, Mass, Length, Time, Variable

Objectives:

- Students will be able to follow the scientific method of experimentation.
- Students will understand collaboration with other scientists is important.
- Students will understand that in an experiment, scientists can only change one variable at a time.

Day 5: Build Day

Vocabulary: Entrepreneur, Space station, Design, Brainstorm, Air, Wheels

Objectives:

- Students will design and build a car that will go furthest on one breath of air
- Students will see their own ability to design and build something that moves

Day 6: Demo Day

Vocabulary needed: Test, Distance, Stability, Team Work

Objectives:

- Students will understand the various factors that impact motion
- Students will use their learned methods of experimentation and collaboration on a product they built themselves

Assessment

Assessing this unit is threefold: the science journal, individual participation, and class participation.

The science journal should be graded based on quality of answers, depth of notes, and growth over time. The quality of answers and depth of notes will depend on the method through which students have answered the questions. If a student uses words, do they answer the questions at a level appropriate to their knowledge? Does the student write as much as possible down? Do they include all of the information necessary to answer the questions? Is there growth over time? The growth over time is the most important aspect: do the notes become more detailed by the end of the unit? Does the quality of answers improve? Additionally, in between lessons, if possible, write two or three questions for the students in their notebooks (i.e. if a student doesn't include enough detail in their observations in order to answer the questions, asking "what indicates that this is the case?"). Then, during the next lesson, give students an opportunity to answer the questions in their notebooks in a different colored pen.

Individual participation is observed during each activity: does the student actively participate in the activities, are they contributing to the work?

Class participation is observed during the debrief. Ideally, over the course of the unit, all students will participate with the debrief. Encouraging this at the beginning will set expectations, and help the more shy students speak up in class.

The curriculum is structured such that students who learn best in different ways can all succeed. This is why the journal includes drawing as well as words. So grading should work accordingly.

Lesson Plans

Day 1: Unit Introduction

Handout and Introduce Science Journal

Discussion/Activity I: Scientist of the Day

Pose the following questions to students:
Can you name any scientists?
Any women scientists or scientists of color?
What is diversity?

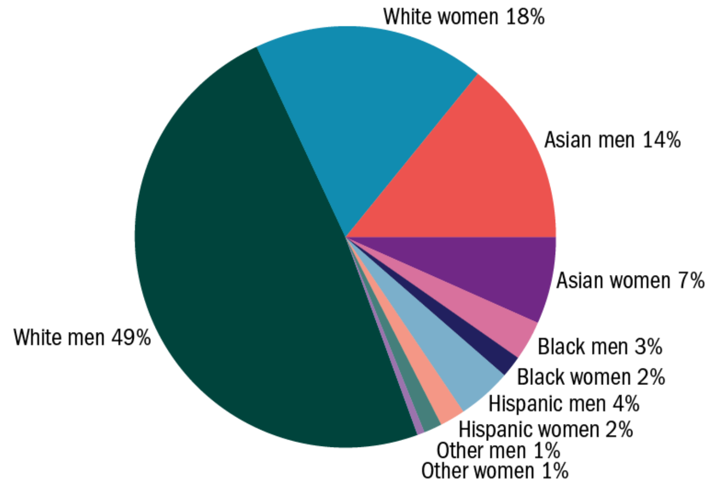
Tell the students some statistics on diversity in science and engineering—
White men make up about half of all of the people in America working as scientists and engineers.

In every racial and ethnic group, there are more men than women in these jobs.

Non-white women make up about 1 in 10 scientist and engineers in the workplace.

Graph is included for teacher's reference below.
You can project this graph for the students to see, write up the numbers on the board or talk through the numbers with your students.

Scientists and engineers working in science and engineering occupations: 2015



NOTES: Hispanic may be any race. Other includes American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, and multiple race.
Women, Minorities, and Persons with Disabilities in Science and Engineering: 2017

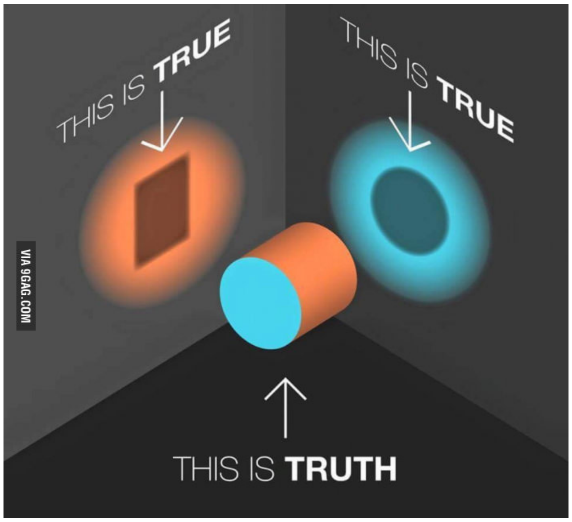
https://www.nsf.gov/statistics/2017/nsf17310/digest/occupation/overall.cfm
For more information, see this link to census data. This study also compares diversity numbers to total representation in the workforce.
https://www.census.gov/prod/2013pubs/acs-24.pdf

Watch the Hidden Figures Trailer: https://www.youtube.com/watch?v=RK8xHq6dfAo

Ask the students what is the value of diversity in science?
Diversity in science is _____ because _____.

Picture included for teacher's reference below.
Project this image if possible to show how looking at the same object from two different perspectives can give different answers that are both the truth.

Diversity in science is important because we need new perspectives and creative ways to look at problems. We also need people with the passion to help their local community and the skills to do it.



Explain how scientist of the day will work for this unit.
Each day of this unit we'll highlight a new scientist who has contributed work and discoveries that affect our everyday lives. Once we uncover the scientist of the day, you will spend 5 minutes writing in your journal:

- Scientist's Name
- What questions would you want to ask them?
  I would want to ask this (scientist/engineer) about ______ because ______.
- How does their work/discovery affect your daily life?
  This scientist's work about _____ affects my life because ______.

List of Scientists of the Day:
In the back of the unit you can find a list of each scientist of the day included in a given lesson, as well as additional female scientists and scientists of color that can be used for extension of this unit. You can project these pages for students to see or print a copy of the page to put up on the wall or hand out to each student.

Activity II: Observing Cartoons

Before the Lesson:
Set up only requires projecting this video and the debrief questions on a screen for students.

Part 1: Watching the Video https://www.youtube.com/watch?v=_9ieb1Y1VCY
Have students watch the video one time through, and ask them to look for anything "weird". Ask them in their science journals to write down or draw the parts they find

"weird" and why they think those parts are "weird". Provide them with the sentence structure if necessary:

I think ________ part was weird because _______.

Part 2: Pair & Share

In pairs, have students share what they found weird, and discuss why they thought it was weird.

After, have students share what their partner thought was weird.

Debrief:

Have students answer as many or as few of the debrief questions as they feel can.

Day 2: Inertia

Activity I: Scientist of the Day [Mae Carol Jemison]

Activity II: Inertia Tricks

Before the Lesson:

Collect the following materials for each group (create groups of 3 students):

- 2 sheets of newspaper
- 1 plastic cup
- 20 pennies
- 1 table or hard surface

Set up stations before class to ensure that students get started quickly.

Trial 1: Without Weight (10 mins)

Students will try to pull newspaper out from under an empty cup (and fail because the cup doesn't have enough mass to stay in place).

Trials 2-5: With Weight (15 mins)

Students will add pennies to their cups until they can pull the newspaper out without knocking over the cup. *Students can choose how many pennies to add to the cup, and should run a few trials experimenting with different weights.*

Science Journal: (10 min)

After completing all of the trials, students are encouraged to answer the debrief questions in their science journals.

Debrief: (10 min)

After students are given a chance to document observations in their science journals, bring the class together to debrief and discuss a definition of inertia.

1) Ask students what happened when the cup was empty and when different weights were added.
2) Building on this conversation, explain that inertia is a fundamental component of motion. The following notes are meant to help create a definition:
    a) Newton's First Law of Motion (often called the Law of Inertia) states: "An object at rest stays at rest and an object in motion stays in motion with

the same speed and in the same direction unless acted upon by an unbalanced force."[1]

b) More simply, inertia can be described as "the resistance an object has to a change in its state of motion."[2]
c) **Teacher Note:** If students have not yet learned about Newton, it may be helpful to describe the basic definition of inertia without referencing "Newton's First Law of Motion."

3) Use the following prompts to connect the relationship between the weight of an object and inertia:
   a) As the weight of an object increases, the inertia ____. [*Answer: increases*]
   b) Relate this concept to real objects:
      i) **For instance:** Changing the motion of a really heavy object (like a car) requires a much_______ [*answer: larger*] force than the force needed to change the motion of a really light object (like a plastic cup).

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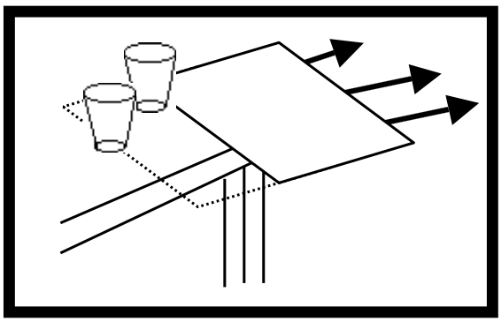
[1] The Physics Classroom. "Newton's First Law." 2016. <http://www.physicsclassroom.com/class/newtlaws/Lesson-1/Newton-s-First-Law>
[2] Ibid

MAGIC TRICK INSTRUCTIONS

Trial 1: Without Weight

In groups of 3:

1) Lay both sheets of newspaper on the corner of the table.
2) Set an empty plastic cup on top of the newspaper.
3) Pull the edge of the newspaper away from the table with a sharp pull.
4) Note observations in the science journal*:
    a) What happened to the cup when the newspaper was pulled? When we pulled the newspaper, the cup______.



Trials 2-5: With Weight

In your same groups:

1) Lay both sheets of newspaper on the corner of the table.
2) Add weight (pennies) to the plastic cup and place the cup on top of the newspaper. [Each group can choose the number of pennies to add]
3) Write down the number of pennies added in the science journal.
4) Pull the edge of the newspaper away from the table with a sharp pull.
5) Note observations in the science journal:
    a) What happened to the cup when _____ (# of) pennies were added? When we pulled the newspaper, the cup with _____ (# of) pennies ______.
6) Repeat this activity by adding different amounts of pennies each time.

* Note: You may use this table if needed to document observations in the science journal, but try to create your own version.

Trial #	# Of Pennies Used	Observations
1	0	When we pulled the newspaper, the empty cup______.
2		When we pulled the newspaper, the cup with _____ (# of) pennies ______.
3		When we pulled the newspaper, the cup with _____ (# of) pennies ______.
4		When we pulled the newspaper, the cup with _____ (# of) pennies ______.
5		When we pulled the newspaper, the cup with _____ (# of) pennies ______.

This activity was modeled off the following Inertia Tricks worksheet forwarded by Stephanie Rafaela from the Stanford Graduate School of Education:

Inertia Tricks

Name_______________

Inertia is a property that governs all matter. Inertia is defined as

____

____

____

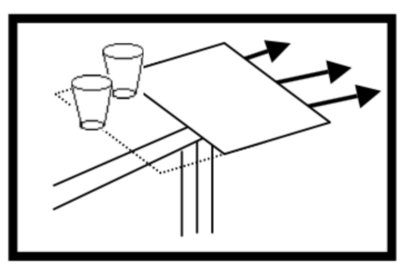
____

Inertia is related to the mass of an object in that, as the mass of an object increases, the inertia___________. This makes sense because to change the motion of a really massive thing requires a much __________ force than the force needed to change the motion of a really light object. Inertia is also related to the weight of an object. Weight is defined as _______________________________________

____________________, and so the more mass, the more weight, the ____________________inertia.

The Tablecloth Trick

1. Open a newspaper and lay two sheets on the corner of your table.
2. First set up one PLASTIC cup, later you can try two.
3. Practice giving the newspaper a sharp pull.
4. What happens and why? (note: there are several possibilities here! Document what really happens and think about why!)



Day 3: Things That Move Stations

Activity I: Scientist of the Day [Gerty Cori]

Activity II: Wind-Up Toys

In this lesson, students investigate what it takes for different objects to move on their own, and how it happens.

Structure:

This activity utilizes the "jigsaw" technique. During Part 1, students will be divided into 3 stations (windup toys, popper toys, and slinkies), where they will become experts at describing and understanding the toy at their station. During Part 2, students will be rearranged to form groups of one expert of each toy, and teach the others about how their toy works.

Before the Lesson:

Set up 3 stations at different tables. Make sure there are enough items to have one for each student. You may either assign students to tables or allow them to choose which table/toy they want to investigate.

Windup toys:

Note: this station needs 2 flat surfaces: a high friction surface and a smooth surface (the high friction surface can be a placemat, tablecloth, mouse pad).

Popper toys

Note: this station needs 2 surfaces: a hard surface and a soft surface (a towel, pillow, or piece of clothing will do for the soft surface).

Slinkies

Note: this station needs a ramp, or a staircase, so the slinky can "walk" downhill.

Part 1: 20 min
Spanish learners may use the fill-in-the-blank sentence frames for writing in their science journals. Spanish speakers can write responses to the question prompts in their science journals. Allow students to take their time exploring their toy and answer the questions.

Part 2: 10 min
Students rearrange to form groups of 3, with one expert of each toy in each group. Each student will then spend a few minutes showing their toy to the others in the group and explaining some important features. In their science journals, students should be writing or drawing what they hear from the other students.

Debrief: 5 mins
Ask students to share what they learned from another student in their group. Give them a few minutes to make sure they answered the debrief questions in their science journals.

Wind Up Toys

Spanish learner:

1) The toy _____ (how does it move?) when _____ (what did you do?) the knob.
2) The energy that makes the toy move came from _______ (twisting the knob, my hands, etc)
3) Twisting the knob once makes the toy move for ______ (more time/less time) than twisting the knob three times.
4) The toy moves ______ (faster/slower) on the ________ (whatever the "grippy" surface is) compared to the table.
5) Draw a picture of the "guts" of the toy.
6) Design your own wind-up toy that does something different.

Spanish speaker

1) Investigate the toys at your table. What do they do?
2) Where does the energy that allows the toy to move come from?
3) What are the 3 things that you want the rest of class to know about this toy?
   a) Does it move faster on one kind of surface than another?
   b) How long does the movement last? Can you make it last longer or shorter? How?
4) What do you think the "guts" of the toy look like? After discussing with the other students at your table, draw a picture of what you think it looks like in your notebook.
5) Design your own wind-up toy that does something different.

Poppers

Spanish learners:

1) The toy ______ (what does it do?) when I _____ (what did you do?).
2) The energy that makes the toy move came from _____ (my thumb / pushing it down)
3) The toy bounces ______ (higher/lower) on the hard surface compared to the soft surface.
4) When I set it on a flat surface, the toy pops ______, but when I set it on an angled surface, it pops _____.
5) The toy stays still for about _____ seconds before popping.
6) Draw a picture of what is happening that makes it "pop."
7) Design your own toy that could pop up on its own.

Spanish speakers:

1) Investigate the toys at your table. What do they do?
2) Where does the energy that makes the toy move come from?
3) What exactly is happening, that makes it "pop"? What is pushing off of what?
4) Draw a picture to illustrate this in your notebook.
5) What are the 3 things you want the rest of your class to know about this toy?
   a) What direction does it go when it pops? Can you make it pop in different directions?
   b) How long does it stay still for before popping? Is it always the same amount of time?
6) Design your own toy that could pop up on its own.

Slinky

Spanish learners:

1) The slinky looks like it _____ down the ramp/stairs.
2) The slinky ______ when it reaches the bottom of the ramp/stairs.
3) The energy, which causes the slinky to move, comes from ______.
4) Draw a picture of how the slinky moves.

Spanish speakers:

1) Investigate the toy at your table. What can it do?
2) Can you get the slinky to move down the ramp/stairs on its own? When does the slinky stop moving on its own?
3) Where does the energy that causes the slinky to move come from?
4) What are the 3 things you want the rest of your class to know about this toy?
5) Draw a picture of how the slinky that moves.

Day 4: Pendulum Activity

Activity I: Scientist of the Day Benjamin Banneker

Activity II: Pendulums

Before the Lesson:

There are four different kinds of groups that are matched into pairs. Groups A & B will work together, and groups C & D will work together. If you have more than 4 groups, pair them similarly, and repeat the procedures (i.e. Groups E & F will be identical to A & B, groups G & H will be identical to C & D etc). You will need:

- String
- Rulers (1 foot; 2 per group)[3]
- Weights[4]
- Stop Watch
- Instructions Card

Groups 1 & 2 will work together to determine how the length of the string affects the swing of the pendulum. Groups 3 & 4 will work together to determine how the mass of the pendulum affects the swing of the pendulum. Below is a table of the setup for each group:

Group	String Length	Mass
A	2.5 feet	A
B	0.5 feet	A
C	2.5 feet	A
D	2.5 feet	B

[3] A NOTE ON RULERS: each group will need one ruler to measure the length of their string, but they also need something to tie/tape the pendulum to – either another ruler or a popsicle stick etc.

[4] A NOTE ON WEIGHTS: these can be anything, so long as the masses are very different and won't affect the string length. They could be blocks that have been prepared ahead of time with string tied around them so the only assembly is tying the pendulum string to the string around the block. Just ensure that the masses on three of the weights are close and one is very different.

There are four parts to this activity: making the pendulum, collecting data/answering questions, working with the partner group to determine whether or not the variable affects the pendulum, and sharing with the class.

Part 1: Each group will get a card that includes instructions; they will create the pendulum according to the instructions and write in the science journals the length of the string and the mass of the object.

Part 2: In each group, they will swing the pendulum 6 times [such that every person does each job twice], writing in their science journals how long it takes to do one full swing (back to the starting position). They will write/draw in the science journal what they observed.

Part 3: The partner groups will get together and discuss their data, what was the same, what was different, and what they can tell from the data.

Part 4: EITHER: the whole class comes together and discusses what they have learned, OR each group pair works with another group pair to learn what happened in the other experiments.
This should function as a dialogue. Give them the sentence structures:

The ***period*** of the pendulum IS/IS NOT affected by the ______. I know this because our data showed _______.

It is important here to also talk about how many variables you could change between experiments. Asking students what would happen if Groups B&D were working together. The goal is to show them that with both variables different, you can't know which one changed the period of the pendulum.

Debrief: Give the students a few minutes to answer the debrief questions in their notebooks.

PENDULUM INSTRUCTIONS

Today we are going to learn about **pendulums**. Pendulums are like swings, and are used to tell time, and were used in clocks.

Part 1: **Building your pendulum**
On your desk, you will see everything you need to make your pendulum.
Tie the end of the string to your mass.
Tie the other end of the string to a ruler.

The amount of time it takes for the pendulum to swing one direction, and back to its original side is called the ***period***.

In your science notebook, answer the following questions:

1) What is the *length* of the string?

   The pendulum is __________ inches long.

2) How heavy is your pendulum? What is its' ***mass***?

   The pendulum weighs __________.

3) What ***variable*** do you think could change the ***period*** of the pendulum?

   The __________ could change the ***period*** of the pendulum. I think this because __________.

4) Draw a picture/diagram that shows how a pendulum works.

Part 2: **Collecting data**

Each person has a job, and everyone will do each job. Person A will hold the ruler on the desk, so the pendulum is hanging off the desk. Person B is going to hold the end of the pendulum and let it go. Person C is going to hold the stopwatch and time how long it takes the pendulum to swing one way and back again. At the end of each turn, everyone will switch jobs (use the table below to help).

Trial	Ruler	Pendulum	Stopwatch
1&2	A	B	C
3&4	C	A	B
5&6	B	C	A

In your lab notebook, be sure to include (through diagrams or words):

1) You answers to the questions from Part 1.
2) The trial number and how long the ***period*** is for each trial.
3) Calculate the *Average* time of the ***period*** for your pendulum.

Part 3: **Pairing up with another group**

With another group, answer the following questions in your science journal.

1) What about your data is the same?
2) What about your data is different? (Which ***variable*** are you comparing?)
3) Based on your data, what do you know?
4) Are there any other questions you'd like to investigate?
5) What else works like a pendulum? Draw a picture of something that works in a similar way.

Part 4: **Sharing with the class**

As a class we will talk about what the other groups did, make sure you take notes in your science journal!

Debrief:

In your science journal, answer as few or as many of the debrief questions as you can.

Day 5: Build Day

Activity I: Scientist of the Day [Noramay Cadena]

***Activity II: Plan and Build Lifesaver Cars*[5]**

Before the Lesson:

Hand out instructions to each student and group them in teams of 3.

You can frame this either as a challenge (moderately competitive) or a group-based exploration activity. In the latter, students can be encouraged to compare notes between teams during the design process (this expectation should be shared right away). Be prepared for the students to take it as a competition regardless of how it is introduced.

For an example on how to build a Lifesaver Car, see this YouTube video:
https://www.youtube.com/watch?v=YE9NqiUTSuE

Materials per team (goal is to use only the materials provided):

- 4 wheels (alt. 4 lifesavers)
- 3 plastic rods (alt. 3 straws)
- 1 long piece of tape (equal for each team)
- 1 cardstock or 4 index cards (for making the car body)
- Pair of scissors
- Ruler

Part 1: Plan

Students take 5 minutes individually to plan and brainstorm in their journals what their car might look like.

Students take 5 minutes with their team to compare notes and agree on the final design. Make sure each student captures the new design in their own journal.

Part 2: Build

Students spend 20 minutes building their Lifesaver Cars. Make sure they write down key decisions they make.

[5] http://afterschoolscienceclubs.pbworks.com/w/file/fetch/35819462/Lifesaver-car-handout.pdf

Day 6: Demo Day

***Activity: Test & Demo Lifesaver Cars*[6]**

Before the Lesson:
Students will test their cars with one group member setting up the car and providing the breath of air, one using the stopwatch and one measuring how far the car travels.

Activity:
Students will test their car 3 times with no added mass and twice with the added mass of two pennies. During the first three runs, they are allowed to make changes to their car, but for the next two runs they cannot make any changes. Make sure students track their trials in their journals. See the instruction page for a detailed description of the trials.

Debrief:
On the board, have each group record their initial distance and distance with added pennies.

As a class, review the collection of results on the board. Conclude with a class discussion. During this discussion, address any misconceptions the students identified during their predictions.

1) Has increased mass impacted the distance traveled by your car and the design process? How do you know?
    a) Possible answer: Increased mass increase requires more force to move the car the same distance, similar to the inertia challenge.
2) What decisions affect the distance traveled by the Lifesaver Cars?
    a) Possible answers: The type of materials used to build the cart, the number of wheels, the stability of the cart, the mass added.
3) What else could we have tested in this activity?
    a) Possible answers: The dimensions of the cart, the length, height, the number of wheels.
4) What could be affected by these changes?
    a) Possible answers: Speed, distance traveled, and stability.

Potential Additional concepts to discuss:

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[6] https://www.teachengineering.org/activities/view/cub_measurement_lesson01_activity2
http://stem4all.edc.org/sites/stem4all.edc.org/files/Activity%20Center%20-%20Puff%20Cars.pdf

- Friction: Different materials affect the way the car moves and stops.
- Balance: Car stability affects the way the car moves.
- Design process: How did teams decide what to build? How many times did they change the design?
- Teamwork: How did the team work together?
- Compare and contrast of cars that went furthest/shortest!

LIFESAVER CAR INSTRUCTIONS

Design & build a car using that will go the furthest on one breath of air.

Part 1: Design & Build

Materials per team (goal is to use only the materials provided):
- 4 wheels (alt. 4 lifesavers)
- 1 plastic rod (alt. 1 straw)
- 1 long piece of tape (equal for each team)
- 1 piece of paper (for making the car body) (alt. index cards)
- Pair of scissors

Individually to plan and brainstorm in your journal what your car might look like. Then compare notes with your team and agree on the final design. Make sure you put the new team design in your own journal.

Build your Lifesaver Car using the given materials!

Make sure you write down any key decisions or changes in your journal.

Part 2: **Test & Demo**
Each person has a job, and everyone will do each job. Person A will set up the car and blow one breath into the sail. Person B will hold the stopwatch and count 10 seconds. Person C will measure with the ruler how far the car traveled in that amount of time. At the end of each turn, everyone will switch jobs (use the table below to help). This is a good time for students to make modifications to their designs to ensure quality results. What can be improved? Does it roll smoothly? Does it roll straight? Can it carry some added weight?

Trial	Breath	Stopwatch	Ruler
1	A	B	C
2	C	A	B
3	B	C	A

In your lab notebook, be sure to include (through diagrams or words):

1) The trial number, the ***distance*** that the car travels and the time for each trial.
2) Calculate the *Average* time of the ***distance*** for your car.

Part 3: Adding Mass
Before they test their cars with the additional pennies, ask each group to predict how far it will travel with additional ***mass***. Have groups write their predictions and reasoning in their journals.

Have each group add two pennies to their Lifesaver Cars, representing the mass of a driver and a passenger. Secure the pennies with tape. Have each group test their design with added ***mass*** twice.

Make sure they track number of pennies and ***distance*** traveled in their journals.

Part 4: **Sharing with the Class**
As a class we will talk about what the other groups did, make sure you take notes!

Debrief:
Answer as many or as few of the debrief questions as you can

Scientist of the Day

Mae Carol Jemison

Born October 17, 1956
American
Engineer, physician and NASA astronaut

Jemison became the first African-American woman to travel in space when she went into orbit aboard the Space Shuttle Endeavour on September 12, 1992. She's won numerous awards and honors for her work supporting scientific education and discovery.

Gerty Cori

Born August 15, 1896 – October 26, 1957
American, Austrian, Hungarian
Biochemist

She, in collaboration with her husband Carl Cori, received a Nobel Prize in 1947 for their discovery of how glycogen (animal starch) is broken down in the body for use as a store and source of energy.
http://encyclopedia.kids.net.au/page/ge/Gerty_Cori

Benjamin Banneker

Born November 9, 1731 - October 9, 1806
American
Author, scientist, mathematician, farmer, astronomer, publisher and urban planner

Even before his successful work in astronomy and urban planning, at the age of 22, having seen only two timepieces in his lifetime -- a sundial and a pocket watching -- Banneker constructed a striking clock almost entirely out of wood, based on his own drawings and calculations. The clock continued to run until it was destroyed in a fire forty years later.
http://www.pbs.org/wgbh/aia/part2/2p84.html

Noramay Cadena

Born 1982
Mexican, American
Engineer, entrepreneur

Noramay Cadena built systems for the international space station, and was team leader of the satellite assembly, integration and testing of products at Boeing. She also started a company called Latinas in STEM Foundation, to introduce young Latinas to careers in STEM.

Activity Extensions - Additional Female Scientists and Scientists of Color

Admiral Grace Brewster Murray Hopper. Hopper was an early computer programmer and the developer of the first compiler for a computer programming language.
Vocabulary needed: Computer, programmer, and language

Marie M. Daly. Daly was the first Black woman to earn a Ph.D. in Chemistry.
Vocabulary needed: Chemistry, cell

Sameera Moussa. Moussa held a PhD in atomic radiation and set up the international Atomic Energy for Peace Conference.
Vocabulary needed: Radiation, peace

Elizabeth Blackburn. Blackburn won the Nobel Prize in Physiology or Medicine in 2009 for work on chromosomes.
Vocabulary needed: Medicine, Nobel Prize

Dr. Daniel Hale Williams. Dr. Williams was a black physician who performed the world's first successful open heart surgery.

Garrett Morgan. Morgan was a Black inventor, who made both the first traffic signal and the first patented gas mask.

James West. West was a Black inventor who developed the mic in the 1960s, holds 47 US patents and more than 200 foreign patents.
Vocabulary needed: Inventor, microphone, patent

https://www.famousscientists.org/15-famous-black-scientists-in-history/
http://femaleentrepreneurs.institute/15-amazing-female-scientists/
http://www.sciencealert.com/10-inspiring-women-in-science