Strand: 7.1.2

Emphasis: Newton's 3rd Law

Anticipated Time Required (assuming 50 minute class periods):

- E. 1 50 min
- E. 2 50 min
- E. 3 120 min
- E 4 50-80 min

Dominant CCC: Systems and System models

Dominant SEP: Engineer a solution to a problem

Management Strategies to support equitable access to content: Ninja Turtle Engineer Teams

Shopping list:

E. 2- per 2 teams

- 2 rolling carts (skateboards, chairs, or boards with wheels)
- 1 rope
- 1 big ball (soccer ball or heavier)
- Smaller balls (tennis ball)

E.3- per team

- 1- 3 oz cup
- Golf Ball
- 2 Plastic grocery Bags
- 1 m String
- 8 straws
- You may decide if they have limits on tape or other materials.
- Provide scissors, rulers, etc.

For : 6- 8 groups per class.

E 4

- String
- Balloons
- Straws
- Clothes pins

7.1.2 Storyline Overview

Anchor Phenomenon: Rockets, bullets, dancers, and drops of water go up or shoot out.		
Student Performance Expectation: Apply Newton's third Law to design solution to a problem involving the motion of two colliding objects in a system. Examples could include collisions between two moving objects or between a moving object and a stationary object.		
Dominant DCI	Dominant CCC	Dominant SEP
Physical Science	Systems and system models	Design and engineer a solution to a problem

Science Experiences					
	CCC/SEP	What are students doing? (This should match your SEP!)	What specific understandings should students get from this experience? (What pieces of the performance expectation does the experience provide?)	New questions students have to propel us to the next science experience	Assessment
1	Patterns, systems/ ask questions, obtain information	Forming into Engineering Teams Finding patterns in the behavior of different objects Listening to direct instruction Observe George Cernan video from first work in space	Students recognize that when forces exerted on an object, that the object exerts a force in the opposite direction. Action/Reaction pairs How to draw a free body diagram	Why couldn't he get any work done? How did they solve his problem.	Journal notes
2	Cause and effect, systems and	Engage in activity on rolling carts	Action/Reaction pairs do occur, but friction is another	How do we solve other problems related to	Complete assignment based on observation

	system models/ design a solution, carry out an investigation	Work as a team to produce ideas to solve the problem of work in space.	action/reaction pair that prevents us from seeing the full effects of the force. Designing a solution is tricky.	Newton's third law?	Design solution assignment.
3	Systems/ system models, design a solution	Teams will construct a device to slow an 'astronaut' down while in his pod and land rightside up.	Engineering requires patience, diligence, teamwork	Are action/reaction pairs always a problem?	APT journal Press Release
4	System models/ construct models, conduct investigation	Video of swimming, flying, walking Rocket Balloon races Assignment: Newton's Laws	Recognize that action/reaction pairs are important	Action/reaction pairs make work possible.	Assignment: Newton's Laws

7.1.2 Learning Episode 1

<table>
<tr><th colspan="2">Student Science Performance</th></tr>
<tr><td>Topic: Newton’s 3rd law</td><td>Title: Getting a reaction from action.</td></tr>
<tr><td colspan="2">Overarching Performance Expectations (Standard) from State Standards or NGSS:
Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects in a system. Examples could include collisions between two moving objects or between a moving object and a stationary object.</td></tr>
<tr><td colspan="2">Lesson Performance Expectations:
Lesson Performance Expectations: Students look for patterns in the behavior of matter when affected by contact forces. Students model forces in systems using free body diagrams. Students construct an understanding of Newton’s 3rd Law and recognize how it applies to systems.
CCC: Patterns, Systems and system models
SEP: Obtain Information, Ask Questions</td></tr>
<tr><td>Students Will. . . To Construct Meaning</td><td>Teacher Will. . . To Support Students</td></tr>
<tr><td>Get organized into groups by moving into 1 of four corners based on personality statements of these Ninja Turtles

Leonardo: I like to get things done and make sure everyone is safe. “ A true Ninja is a master of himself and his environment, so don’t forget: We’re turtles!”
Leader in charge of selecting team: presents choices to the group and helps them come to a final decision, keep track of assignment sheets, keeps track of time and supply budget , helps wherever needed.

Raphael: I don’t give up when things get tough and I like to do things with my hands. “Oh, so that’s the plan from our ‘great leader’, huh? Just sit here on our butts?
Head contractor: in charge of physically building the product and making sure it works.

Donatello: I like to draw plans and figure out how things work. “ Question: Do you like penicillin on your pizza?
Technical Advisor: in charge of writing description of design and drawing iterations of product.

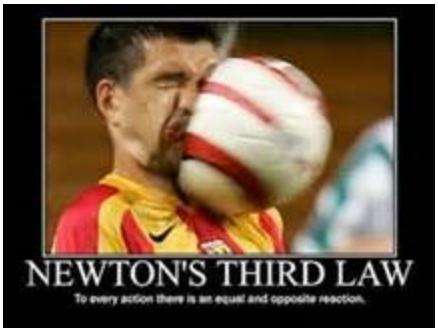
Michelangelo: I like to talk and help others while they work. “I LOVE being a turtle!”
Supply manager: in charge of making sure materials for construction are available including anything brought from home. In charge of maintaining safe, clean work environment,</td><td>Assign students an engineering Team

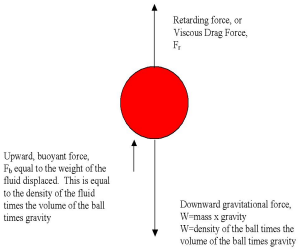
Management Strategy: Ninja Engineering Teams

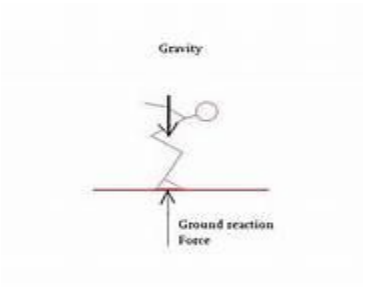
Similar to rainbow lab groups, but different personality traits required. I have some Teenage Mutant Ninja turtle stickers so I thought I’d use the personality types of this famous foursome to help students take on roles for an engineering project which are a little different than lab groups. Most famous groups (power rangers, fantastic 4, fast and furious (kidding-but not)Ron, Hermione, Harry and Seamus, Hogwarts houses) have a typical set of personalities geared towards powerful problem solving. They make good models of how engineering groups might work.
Leonardo: Get it?
Donatello: Got it.
Raphael: Good.
Michaelangelo: I don't get it.
Splinter: “Cowabunga dude. Ha! I made a funny!”

Once students have selected a group, pass out cards with descriptions of responsibilities:
Leonardo: Leader in charge of selecting team: presents choices to the group and helps them come to a final decision, keep track of assignment sheets, keeps track of time and supply budget, helps wherever needed.
Raphael: Head contractor: in charge of physically building the</td></tr>
</table>

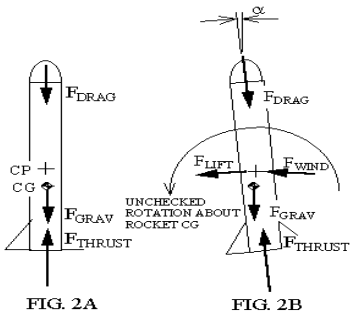
listens carefully and helps with writing, drawing, and building as needed. *Choose your role. Leonardo will choose the rest of his team from each of the groups.* *All members of the team are responsible to make sure the product works and is completed on time and within constraints.* *Your teacher is Master Splinter and is available as advisor, guide and disciplinarian (if necessary)* *Engage with a Phenomenon:* *What do these phenomena have in common?* *Use journal to take notes on patterns you observe* 1. *I observe this* 2. *I observed this, and it reminds me of the last one because of this…* *Get together with team and images of the phenomenon you observed and look for patterns. Do those patterns imply a rule? What is the rule?* *Donatello writes the patterns and rules* *Michelangelo presents them to the class.* *Gather: Use journals to take notes on Newton's 3rd Law.* *Learn the term ACTION/REACTION pair.*	*product and making sure it works.* *Donatello: **Technical Advisor:** in charge of writing description of design and drawing iterations of product.* *Michelangelo: **Supply manager**: in charge of making sure materials for construction are available, including anything brought from home. In charge of maintaining safe, clean work environment, listens carefully and helps with writing, drawing, and building as needed.* ***Teacher:** You are Master Splinter and should make yourself available as advisor, guide and disciplinarian (if necessary) Once students are in teams have them use their journals and observe these videos by looking for patterns in behavior.* **Preparation to view phenomenon:** On the board show them a template that looks like Video #1- I observed…… Video #2- I observed…. And it reminded me of….. Video #3- I observed… And it reminded me of…. Video #4- I observed… And it reminded me of… Video #5- observed...and it reminded me of…. **Phenomenon: There are patterns in the way matter behaves when force is applied.** **Show videos of all of these.** **Ask:**What patterns do you observe in these phenomenon (how are they similar, how are they different) ● Drop of water ● Bouncing ball ● Recoiling gun ● Dancer Leaping ● Space shuttle launching Give students an image sheet to remind them of the phenomena they've observed and let them discuss the patterns and see if they can construct a rule. Donatello will write the patterns and rules and Michaelangelo will present them to the class. **Ask:** Teams send representative to present their findings. **Student Understanding:** The goal is to help students construct Newton's 3rd Law which states that "For every action, there is an equal and opposite reaction." **Direct Instruction:** We have learned that forces are interactions between

Learn that for every action there is an EQUAL and OPPOSITE reaction. *Learn how to model action/reaction pairs using free body diagrams.* *Learn that interactions between matter and forces can be at a distance or contact* *Reason:* *What are examples of the 2 different types of force interactions?* *Use Free Body Diagrams to analyze the images we looked at to start the episode.* *Communicate: Draw the free body diagrams of phenomena observed earlier with their teams. Leonardo should prepare to present to the class.*	matter. These interactions form a SYSTEM. For practical purposes we say that forces can interact with matter in two ways: ● Forces that act at a distance (without touching) ● Forces that act when objects touch **Question:** "Can you give an example of the types of forces or that fit into these categories?" *Students should recognize that gravity and charged particles can act at a distance while friction, Pushing, bouncing and DEFORMING(changing shape) occurs where surfaces touch **Teacher Note:** *of course, the irony here is that even friction or the perceived solidness or two colliding objects is really the interactions that occur between repelling and attractive forces of charged particles (protons, electrons).* Newton Observed as you have observed. That when a force is applied in one direction that there is movement in the opposite direction. Newton was able to quantify the ACTION and REACTION behaviors you have identified and stated his observations and calculations as Newton's Third Law of Motion which states; "For every action there is an EQUAL and OPPOSITE reaction"  **Model:** Use the examples given in phenomenon to demonstrate ACTION/REACTION pairs in these SYSTEMS. Show one or two and have them work in their teams to figure out the rest of them. Have Leonardo come up and share team models. .



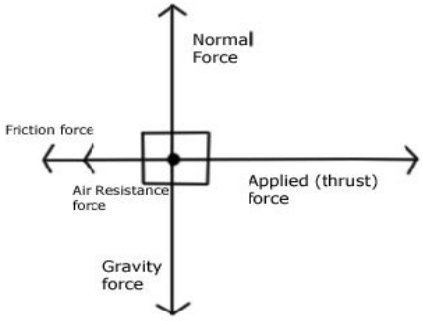


Remember that there is a lot of elastic potential energy (in contracted muscles) being converted into force, that's why we bend our knees and use our muscles. It's not just our weight that the earth pushes us up with. Otherwise..we'd never get off the ground.



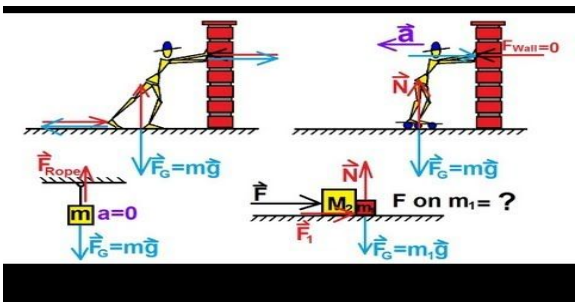
UNSTABLE ROCKET -- CP AHEAD OF CG

Teacher Note: *This is a little hard to grasp because our experience does not always match unless we analyze these contact forces with a tool called a 'FREE BODY DIAGRAM' We have already been using free body diagrams without really talking about it because they are pretty intuitive, but there are some important aspects of free body diagrams we need to understand to construct a CORRECT understanding of contact interactions.*
This video: by bozeman science on Newton's 3rd Law explains the rules very well.
https://www.youtube.com/watch?v=91QYouih4bQ
Recognize that the most important aspect of drawing free body diagrams is that only 1 'body' is considered at a time and the diagram NEVER shows the 'body' acting on the objects around it, just the other objects exerting forces ON THE "BODY".

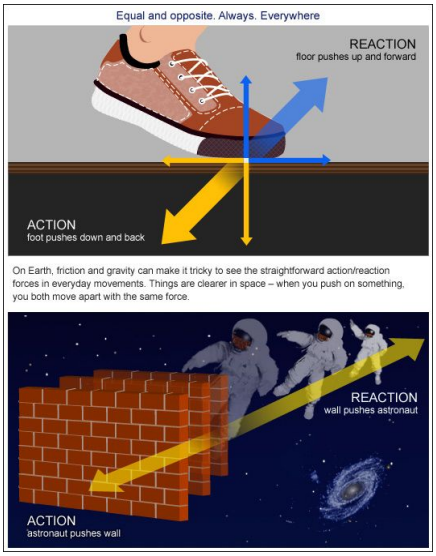
	I think this is important to recognize so that misconceptions about action/reaction pairs don't cause problems. *Example: If I am the object then the earth acts on me by pulling on my mass with a specific acceleration rate. This force that is acting on me is measured as my weight so if I have a mass of 100 kg and gravity is accelerating me at 9.8 m/s² then the force the earth exerts on me is 980 N and THAT is how much force I am exerting BACK on the earth. If I tried to show the force I exerted on the earth by calculating the mass of the earth times my acceleration I would get the mistaken impression that I was exerting a HUGE force on the earth, if the earth exerted that much force BACK on me I'd end up on jupiter!* *If the rule above is followed, then problems like this can be avoided. ONLY DRAW FORCES ACTING ON THE BODY (depending on the object being analyzed) and then recognize that the ' body' is reacting with EQUAL force in the OPPOSITE direction.* *I recommend giving students some guidelines on drawing basic free body diagrams. When the core states that calculations only focus on one-dimensional movement it can be inferred that this is also true of any modeling which means that students should focus on the pushing and pulling that is occurring* *at contact points. It is not necessary to show the 'NORMAL' force and Gravity in the model, but...it could happen. Just don't make it the focus.*  *See picture below:* *(normal force is the red line pointing straight up from the ground and represents the earth's reaction force to his weight (blue line pointing down) not necessary for one dimensional analysis of the reaction pairs of pushing on the wall and pushing against the ground.*

Before watching this video, prepare a OEQ template in your journal.

With your team discuss your observations, explanations, questions.



Below: Blue and yellow vertical line indicating gravity/norma.l focus on the forward motion/friction aspect of the model. This is much easier to observe in space . That's where we go next.



Show students video of Astronauts in space
Prepare: Students prepare to engage in phenomenon by completing OEQ template.
Phenomenon:

- NOVA: Newton's Third Law of Motion

Only play video until 3:00 because we want students to consider the problem.
Students should discuss their observations, explanations and questions with their teams and bring questions to the PARKING LOT for review in next episode.

Assessment: Journal Notes

Assessment of Student Learning

Students journals may be assessed for participation.

7.1.2 Episode 2

<table>
<tr><th colspan="2">Student Science Performance</th></tr>
<tr><td>Topic: Newton's 3rd Law</td><td>Title: Getting a reaction from my action.</td></tr>
<tr><td colspan="2">Overarching Performance Expectations (Standard) from State Standards or NGSS:
Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects in a system. Examples could include collisions between two moving objects or between a moving object and a stationary object.</td></tr>
<tr><td colspan="2">Lesson Performance Expectations:
Students will make observations through investigation of behaviors associated with Newton's 3rd law. Students will work with design team to solve a problems by defining problem, identifying tasks, considering best materials, modeling the solution and communicating to the class.
CCC: Systems, System models, Cause and Effect
SEP: Carry Out an Investigation, Design a solution to a problem</td></tr>
<tr><td>Students Will. . . To Construct Meaning</td><td>Teacher Will. . . To Support Students</td></tr>
<tr><td>Engage with a Phenomenon:
Combine with another team and gather materials. Pick up a copy of the assignment. If you are not engaged in the lab, you should be sitting quietly, writing the assignment. Leonardo is in charge of choosing the participation order. (take turns)
Donatello reads the instructions out loud to the group (s). (take turns kids)

Bring the assignment back to your desk and your team. Discuss each question carefully. Help each other with difficult problems. Fix your answers if necessary. Raphael will present to the class.

Your group will receive a copy of Solving Problems through Engineering worksheet.</td><td>Read and Review
Review questions in the parking lot from the video on George Cernan's problem in space.

Management strategy:
Mass is a variable in today's activities, but body mass for middle school students can be sensitive. Pair students by size well before the lesson, and when you announce pairs, do not call attention to this pairing strategy.

Engage:
Have students combine with another Team for the next activity so that there are eight people per group.
(Four groups)
Materials: Provide groups with
● Two rolling carts (skateboards, chairs, or boards with wheels)
● One rope
● One big ball (soccer ball or heavier)
● Smaller balls (tennis ball)
● Set of instructions for experiments and observation requirements. Assignment- Newton's 3rd Law really? See below
● And a partridge in a pear tree.

Students should meet with teams at their desk and help each other complete their assignments and discuss their answers.
Randomly Generate student names to drive discussion</td></tr>
</table>

Michelangelo reads the instructions out loud. Each member of the team responds to the questions with a specific color of pen or pencil. *Prepare to present solutions to the class. Michelangelo will present.*	from the assignment: Pass out one copy of "Solving Problems through Engineering" Assignment to each team. Raphael reads the instructions out loud to the team. **Challenge:** You have been asked to design a solution to the problems George Cernan was encountering in space. You and your team need to complete the following assignment and be prepared to share your solution with the class. Solving Problems through engineering Assignment. See below. Discuss student questions brought up during presentations. Next episode on why things break when they collide and the effect of equal and opposite forces on different materials and distribution of force. When discussion is over allow students to finish viewing the video and see if they agree with their choices.
Assessment of Student Learning: Assessment on Newton's third Law activity should be graded according to completeness and effort. The assignment should be used to evaluate student understanding of the concept at this point and engagement. Assessment: Designing solutions to problems worksheet should be completed by the team. Each team member should show contribution by responding to one prompt. Assessment should be focused on team compatibility and effectiveness/ Should be used to determine any interventions or helps that are needed before larger engineer project.	

Solving Problems through Engineering. Team # _____

Use your notes from the video and the activity to design a solution to George Cernan's problem on his first space walk.

Constraints: Consider all of the problems of space travel including the problems of adding mass to the rocket, space and the cost of materials.

Each member of the team will write for a specific section. Use different colored pens to show your contribution to the work. All colors should be represented.

Solving Problems through Engineering. Team # _____

1.Given. list the important information given in the problem. - Leonardo- blue

2.Required. summarize the task(s) required to solve the problem. If there is more than one task, then number them in order that they will be accomplished. Donatello - purple

3. Explanation List all materials used throughout the tasks and how they would be used and WHY you choose them. .Raphael- red

4.Solution. Show the solution to the problem in a logical, well-organized, and neat manner. Michelangelo. -orange

Questions:

Newton's 3rd Law...really?

Instructions

1. Teams should pair up according to teacher instruction.

2. Each member should have a copy of this assignment and sit quietly and make observations and take notes while watching the other members of their team. You are not required to take notes during your own turn. You should relate the questions to yourself BY OBSERVING the behavior of your teammates while they do the activities and match that to your own experience. Tricky.

3. Leonardo (s) will take turns choosing who goes first. Donatello will read the instructions out loud.

1. Sit on the rolling platform, push gently against the wall a few times with different force.

- What is the effect of different forces on your acceleration?
- Do the same activity without the rolling cart. How was the reaction to your action different?
- Why do you think it was different?
- Draw a free body diagram of the forces acting on you in this system. Show A/R pairs

2. Sit across from each other and take turns throwing the ball back and forth.

- What happens to your acceleration?
- What happens to the ball's acceleration?
- What happens to your partner's acceleration?
- Do the same thing standing on the ground without the carts. How was the reaction to your action different?
- Draw a free body diagram of the forces acting on you in this system. Show A/R pairs

3. Sit across from each other and hold the rope between you. **Only ONE** of you pull on the rope.

- What happens to your acceleration?
- What happens to your partners acceleration?
- Do the same thing sitting on the ground. How was the reaction to your action different?
- Draw a free body diagram of the forces acting on you in this system. Show A/R pairs

4. Sit across from each other on the rolling platforms. One person pushes against the other person's hands. Make sure only one of you pushes.

- What happens to your acceleration?
- What happens to your partner's acceleration?
- Do the same thing standing on the ground. How was the reaction to your action different?
- Draw a free body diagram of the forces acting on you in this system. Show A/R pairs

5. Invite one person to join ONE of you on the back of your board. (trying to see if different masses are affected by action/reaction pairs differently).

- What is the effect of mass on the acceleration of the more massive cart.
- What is the effect on the less massive cart?
- Which Law describes this behavior?
- Draw a model of this activity indicating the effects of increasing mass on acceleration.

6. Briefly describe the purpose of these activities. Don't tell me they were fun, tell me what you DID in three sentences or more. Prepare to share with your team.

7. Questions: At least three really good questions are required. Prepare to share with your team.

7.1.2 Episode 3

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<tr><td colspan="2">Lesson Performance Expectations:
Students will design and engineer an object that uses Newton’s 3rd law to slow down the speed of a falling object and land the contents upright on the ground.
They will complete a team journal that involves all members and at least 2 iterations of their design and good use of supplies.
CCC: Systems and System models
SEP:Design a solution to a problem</td></tr>
<tr><td>Students Will. . . To Construct Meaning

Watch video of Felix Baumgartner’s famous fall in the Red Bull Stratos. Why do you think they wanted to accomplish this? How can this benefit people to see if people can survive a fall from such a tremendous height? What do you think we could learn from this experience?

Review your roles:</td><td>Teacher Will. . . To Support Students

Phenomenon: Felix Baumgartner's famous fall with Red Bull Stratos Team
https://video.search.yahoo.com/search/video?fr=tightropetb&p=felix+baumgartner+jump+and+flat+spin+scene#id=1&vid=ba77ddc2f917c5fecbb3e1d7fe13247c&action=view

Turn and Talk and discuss.

Ask students to consider why this would be important? What we can learn from them?.

Pass Out journals to the Teams and have them read the first page.

Design a solution to a problem:
When Felix Baumgartner made his famous fall, he didn’t do it alone. Many Engineers and Scientists and Physicians and Trainers helped him to prepare his mind, his body, and his equipment. Their goal was to test methods and equipment that would allow astronauts to survive a fall from earth’s upper atmosphere in case of problems during space travel.
Students are going to create a device that uses Newton’s 3rd law of motion to safely land an astronaut back on earth from a very high altitude using air resistance. The pilot cannot be knocked out of his ‘pod’

Rules:</td></tr>
</table>

Leonardo: ***Leader*** *in charge of* ***selecting team****, presents choices to the group and helps them come to a* ***final decision****,* ***keep track of Assignment sheets****,* ***keeps track of time and supply budget*** *, helps wherever needed.*
Raphael: ***Head contractor****, in charge of* ***physically building the product*** *and making sure it works.*
Donatello: ***Technical Advisor*** *in charge of* ***writing description of design*** *and* ***drawing iterations of product****,*
Michelangelo: ***Supply manager****, in charge of making sure materials for construction are available including anything brought from home. In charge of maintaining safe, clean work environment, listens carefully and helps with writing, drawing, and building as needed.*

Take 4 or 5 sticky notes and write down your thoughts on these 3 BIG IDEAS before you start your project. We call this developing NORMS.

Big Idea 1- What do you think the goals of the assignment are.
Big Idea 2- How do you think people should act when working on a group project?

Write one response per sticky note and put it in the center of your table.

- *Michelangelo will read sticky notes aloud and organize them.*
- *Leonardo will write a rough draft of Team Goals and Team Rules with input from the team.*
- *Donatello writes them in the team journal*
- *Raphael Reads them at the beginning of every day that they are working as a team.*

Work together to Fill out all the entire journal completely. Including the PRESS release which should be written by the whole team. Divided up the content and each person take on a little bit.

- The astronaut must stay in the pod after being dropped from a height of six feet.
- The other materials are used to cushion the landing and keep the astronaut in the pod.
- The pod may not have any type of lid, covering, or roof that intersects the vertical plane of the cup rim.
- Can only put up to four holes in the cup
- Taping or gluing the astronaut into the pod is not allowed
- You may change your design as many times as you like, but no changes can be made once official testing has started.
- The astronaut must still be in the pod and the pod undamaged.
- Designs that survive six foot drop will be tested at greater height to determine best design.

Supplies:

1- 3 oz cup
Golf Ball
2 Plastic grocery Bags
1 m String
8 straws

You may decide if they have limits on tape or other materials.
Provide scissors, rulers, etc.

Students will perform tasks as outline by their character. Students should read through those expectations: Each person reads their card aloud.

	Have students construct Norms. **Management strategy: Norms** *Working in a group can be stressful unless everyone is clear of the expectations and the rules. Setting up norms can be pretty simple. Give sticky notes to everyone in the group (4 o4 5) and have them write down their thoughts on* ● *What they think the goals of the assignment are.* ● *The way they think people should act when working on a group project* *Have Michelangelo organize the notes into categories. Then have the students write down a list TEAM GOALS and TEAM RULES before they engage the project.* *These goals and rules should be written on the first page of their APT journal document.* **Assessment: Astronaut Protection Team (APT): Journal and Press Release**
Assessment of Student Learning *Students journals may be assessed for participation.*	

Team # _____

(Astronaut Protection Team)

When Felix Baumgartner made his famous fall, he didn't do it alone. Many Engineers and Scientists and Physicians and Trainers helped him to prepare his mind, his body, and his equipment. Their goal was to test methods and equipment that would allow astronauts to survive a fall from earth's upper atmosphere in case of problems during space travel.
Students are going to create a device that uses Newton's 3rd law of motion to safely land an astronaut back on earth from a very high altitude using air resistance. The pilot cannot be knocked out of his 'pod'

Rules:

- The astronaut must stay in the pod after being dropped from a height of 6 ft.
- The other materials are used to cushion the landing and keep the astronaut in the pod.
- The pod may not have any type of lid, covering, or roof that intersects the vertical plane of the cup rim.
- Can only put up to 4 holes in the cup
- Taping or gluing the astronaut into the pod is not allowed
- You may change your design as many times as you like, but no changes can be made once official testing has started.
- The astronaut must still be in the pod and the pod undamaged.
- Designs that survive 6 ft drop will be tested at greater height to determine best design.
- Extra supplies will have to be purchased with service to the Team COMMANDER.

Supplies:

1- 3 oz cup
Golf Ball
2 Plastic grocery Bags
1 m String
8 straws
Golf Ball

Time Frame: You have 75 min to test and complete your project before final testing and 20 the next day to complete your APT JOURNAL. Only show your best work in the APT journal. Use your class journals for brainstorming.

TEAM GOALS:

TEAM RULES (norms):

Brainstorm: In your class journals. Define the problem and consider solutions.

Draw a model of what your project will look like.

Draw a Free Body Diagram of how ACTION/REACTION forces will act on this Object (system) using your understanding of Newton's 3rd law.

On this page: Record your test and design another ITERATION of your model (iteration means another version or another try). Try again.

Test 1

- Drop your pod from six feet. Record your observations:
- Did your 'astronaut' and pod survive the six foot drop? _____
- If yes, drop the astronaut from a greater height. How high were you able to go before the system failed? _____

Redesign: How can you make your lander better? Brainstorm in your classroom journals and make some changes.

Changes that need to be made	Draw new design here

Test 2-

- Drop your lander from the higher and higher points until the system fails. Record your observations

- How high was your lander able to fall from without spilling the ‘astronaut’
  _____

Can you make it even better? Brainstorm in your classroom journals and make some changes.

Changes that need to be made	Draw new design here

Communication: Design a Press Release describing your attempts at a successful product to help astronauts land safely from extreme altitudes, maybe even from orbit. Each team member write about 1-2 of these items and then combine them.

Include the following details:

- Names of your team.
- The purpose of your engineering project
- A description of at least two iterations of your product
- The results of at least two tests including the most successful test.
- Successes the team had.
- Problems that still need to be solved.
- Future design ideas.

Title of article:

7.1.2 Episode 4

<table>
<tr><th colspan="2">Student Science Performance</th></tr>
<tr><td>Topic: Newton’s Laws</td><td>Title: Getting a reaction out of action.</td></tr>
<tr><td colspan="2">Overarching Performance Expectations (Standard) from State Standards or NGSS:
Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects in a system. Examples could include collisions between two moving objects or between a moving object and a stationary object.</td></tr>
<tr><td colspan="2">Lesson Performance Expectations:
Students will engage with Newton’s 3rd Law and how it helps us to do work like walk, swim, and fly. Students will construct balloon rockets and complete and assessment showing that they recognize ACTION/REACTION pairs in many different systems.
CCC: Cause and Effect, Systems
SEP: Construct a model, plan and carry out an investigation</td></tr>
<tr><td>Students Will. . . To Construct Meaning

Quick Write in Journals:

What would life be like without action/reaction pairs and friction? Are contact interactions all bad?

How do we <u>use</u> contact interactions like friction and thrust to do work?</td><td>Teacher Will. . . To Support Students

Quick Write in Journals: What would life be like without action/reaction pairs and friction? Are contact interactions all bad?
Phenomenon: Watch rocket Launch (any video will be fine)
People swimming
Airplanes flying

The effects of Newton’s 3rd Law are not all negative. Most of them are extremely positive important. Without action/reaction pairs we couldn’t walk, swim, fly, stand up, sit down, well...really anything.

We tend to focus on friction as a negative, but without friction we would look like this.

https://www.youtube.com/watch?v=nTkM9zFQd4c

Just show the first minute and give the kids some time to laugh at the silly people. :)</td></tr>
</table>

Leonardo's pick a new team

Design and build a balloon rocket .

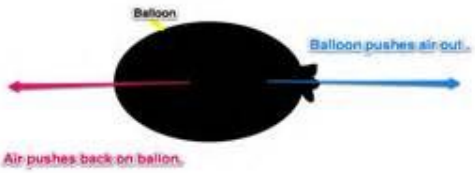
Complete assignment Newton's Third Law

Of course, without ACTION/REACTION pairs , it might not hurt as much!

Rotate Leaders

Activity: Balloon rockets
Materials:

- String
- Balloons
- Straws
- Clothes pins



Assessment: Seedstorylines.org has a great activity and assessment on Newton's 3rd.

https://www.seedstorylines.org/7-1-2
Will take you to the home page. Go to 7th grade-
7.1: 7.1.2: Episode 2
The assignment link: Newton's Third Law
https://docs.google.com/document/d/1H4AuaVpzM0ozMWICvk1rjSIHUGQzIblQ_EAu_V3gy30/edit

Raphael's switch

Assessment of Student Learning
Proficient students can model the action/reaction pairs acting within a system and describe that forces within a system are EQUAL in magnitude and OPPOSITE in direction.