

Transformation 2013 Design Challenge Planning Form Guide

Design Challenge Title: It's All Relative

Teacher(s): Pamela Miller

School: Harlandale High School

Subject: Special Relativity

Abstract: In this design challenge students will create a photography project that demonstrates an application of the concept of special relativity.

MEETING THE NEEDS
OF STEM EDUCATION
THROUGH DESIGN CHALLENGES

Begin with the End in Mind

The theme or “big ideas” for this design challenge:

Students will be able to explain the concepts behind special relativity and apply that knowledge to situations involving two frames of reference.

TEKS/SEs that students will learn in the design challenge:

(4) Science concepts. The student knows the laws governing motion. The student is expected to:

(E) identify and describe motion relative to different frames of reference

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(D) communicate valid conclusions;

Key performance indicators students will develop in this design challenge:

Students will describe motion relative to different frames of reference. Students will be able to describe the frames of reference in a given situation and relate overall observations to special relativity.

21st century skills that students will practice in this design challenge:

www.21stcenturyskills.org

Critical thinking, written and oral communication, collaboration, use of technology, creativity

STEM career connections and real world applications of content learned in this design challenge:

Careers: Astronaut, physicist

Applications: Daily observations are different depending on your frame of reference

The Design Challenge

You have just gotten a part-time job at an art gallery that has recently opened to the public. A convention of physicists is coming into town for the National Physics Convention, and your employer wants to take advantage of this. The focus of the conference is special relativity, and your boss has offered you 30 days of paid vacation if you create a piece of art work based on the theory of special relativity. Your art work must be complete with an explanation of how it relates to special relativity by the time of the conference's opening ceremonies, one week from today. You may choose to work with a partner to complete this project.

Map the Design Challenge

Performance Indicators	Already Learned	Taught before the project	Taught during the project
1. <i>Student description of motion relative to frames of reference</i>		X	X
2. <i>Student relates daily observations to special relativity</i>		X	X
3. <i>Student generates art work related to special relativity</i>		X	X
4. <i>Student explains art work as it relates to special relativity (both orally and written)</i>		X	X

Team-Building Activity

It is important that teachers provide team-building activities for students to help build the 21st Century Skills that are necessary for success in the workforce. Team-building helps establish and develop a greater sense of cooperation and trust among team members, helps students adapt to new group requirements so that they can get along well in a new group, serves to bring out the strengths of the individuals, helps identify roles when working together, and leads to effective collaboration and communication among team members so that they function as an efficient, productive group. Our students are often not taught how to work in groups, yet we assume that they automatically know how. Use team-building activities with your students so that you can see the benefits which include improvement in planning skills, problem solving skills, decision making skills, time management skills, personal confidence, and motivation and morale.

Zoom

- This engaging group activity helps develop communication skills, perspective taking, and problem solving skills.
- Based on the intriguing, wordless, picture books "Zoom" by Istvan Banyai which consist of 30 sequential "pictures within pictures". The Zoom narrative moves from a rooster to a ship to a city street to a desert island and outer space. Zoom has been published in 18 countries.
- Hand out one picture per person (make sure a continuous sequence is used).
- Explain that participants may only look at their own pictures and must keep their pictures hidden from others.
- Encourage participants to study their picture, since it contains important information to help solve a problem.
- The challenge is for the group to sequence the pictures in the correct order without looking at one another's pictures.
- Participants will generally mill around talking to others to see whether their pictures have anything in common. Sometimes leadership efforts will emerge to try to understand the overall story.
- When the group believes they have all the pictures in order (usually after ~15 minutes), the pictures can be turned over for everyone to see.
- Once the challenge is finished, allow everyone to see the pictures and encourage participants to sort out any mistakes in the order (can be done on a table or the floor), then let everyone walk around view the pictures in sequence so they understand the full story.

Processing Ideas

- Why was it hard to get the story together?
(everyone had a piece, but no-one had the big picture)
- What type of communication was used in attempting to solve the problem?
- What communication methods might have worked better? e.g., Imagine if, at the outset, the group had taken the time to let each person describe his/her picture to the rest of the group. What would

have happened then? Would the solution have been found faster? What prevented such strategies from being considered?

- Did you try to "second position" (i.e., see one's communications from the perspective of others)?
- If you were to tackle a similar activity again, what do you think this group could do differently?
- What real life activities are similar to this activity?

Describe to students that the story in this activity was all about perspective. Special relativity is similar in that motion is described in terms of a certain perspective or "frame of reference".

5E Lesson Plan

Design Challenge Title: *It's All Relative*

TEKS/TAKS objectives: *Physics 2D, 4E*

Engage Activity

Use the Zoom team-building activity as part of the Engage Activity. Upon completion, introduce the students to the design challenge.

You have just gotten a part-time job at an art gallery that has recently opened to the public. A convention of physicists is coming into town for the National Physics Convention, and your employer wants to take advantage of this. The focus of the conference is special relativity, and your boss has offered you 30 days of paid vacation if you create a piece of art work based on the theory of special relativity. Your art work must be complete with an explanation of how it relates to special relativity by the time of the conference's opening ceremonies, one week from today. You may choose to work with a partner to complete this project.

Engage Activity Products and Artifacts

Students generate a journal entry reflecting on the process of the Zoom activity and their current understanding of special relativity.

Engage Activity Materials/Equipment

Zoom PowerPoint (print pictures), plastic sheet covers to protect pictures

Engage Activity Resources

Banyai, I. (1995). *Zoom New York: Viking / Penguin.*

Banyai, I. (1998). *Re-Zoom New York: Viking / Penguin.*

Explore Activity

Arrange students in groups of 3-4. Groups should be heterogeneous in ability level. Write the following information on the board:

Einstein began his theory of special relativity with two assumptions:

1. The Principle of Relativity: One cannot tell by any experiment whether one is at rest or moving uniformly (that is, moving in a straight line with constant velocity). In other

words, **there is no such thing as absolute rest**. All motion or rest is only in relation to other observed objects (i.e. I can consider myself not to be moving with respect to the earth while at the same time I am moving very rapidly with respect to the sun).

2. The Constancy of the Velocity of Light: The speed of light has the same value c with respect to any observer either at rest or moving uniformly.

Present each group with one of the thought experiments below. Additional thought experiments, illustrations, and answers can be found at the website listed in the resource section for the explore activity.

Have each student in the group read the experiment individually, and draw a diagram of what the experiment describes. Have students share their diagrams with their group members. Diagrams will be modified as peers clarify understanding for each other. Once all group members understand the situation described, give the students approximately 15 minutes to come up with their answer. Then have each group present their thought experiment, diagram, and solution to the class. This can be recorded on chart paper and hung around the room.

Experiment 1: Mrs. Einstein is standing in a field and Mr. Einstein is riding on a railroad car that is moving with velocity v . Mr. Einstein shines a flashlight in the direction in which he is moving. For which observer is the speed of light faster?

Experiment 2: Mrs. Einstein is standing in a field. Next to her is a light clock. That is, two mirrors that are reflecting a beam of light back and forth, and the journey from one mirror to the other and back again counts as one tick of the clock. Also, Mrs. Einstein is wearing a watch that is synchronized with her light clock.

Standing on a railroad car is Mr. Einstein. He also has a light clock, and his clock is synchronized with Mrs. Einstein's and his own wristwatch. The railroad car is not moving.

What affect does this situation have on the observers' clocks?

Experiment 3: We now have the same set up except that the railroad car is now moving to the left with a velocity v .

What affect does this new situation have on the observers' clocks?

Experiment 4: Mrs. Einstein is standing in a field and she sees two simultaneous flashes of lightning. Mr. Einstein is on a railroad car moving to the left with velocity v . What will Mr. Einstein see?

Experiment 5: Super Einstein is flying through space with his twin brother, Murray, who is 186,000 miles behind him. Every time he wants to make an acceleration of 10 mph, he uses a flashlight to signal his brother so that they will accelerate together and stay the same distance apart. From Einstein's perspective, he and his brother are 186,000 miles apart, and by letting 1 second pass on his clock before accelerating, he allows the light to reach his brother right at the moment of acceleration. As a result, from Einstein's point of view he and his brother accelerate together and remain a constant 186,000 miles apart.

This is what Einstein sees, but if we are standing still with respect to Einstein and his brother, then what will we see?

It is acceptable to give more than one group the same thought experiment, as this may increase quality of discussion during presentations.

Explore Activity Products and Artifacts

Group record of thought experiment on chart paper

Explore Activity Materials/Equipment

Thought experiments printed on individual sheets, chart paper, markers

Explore Activity Resources

This activity is based on the following website:

<http://aether.lbl.gov/www/classes/p139/exp/gedanken.html>

Explain Activity

Have student products from Explore available for reference.

Have students take Cornell notes as you link thought experiments to important concepts in special relativity using the PowerPoint presentation.

Give students time to process after each concept, either by discussing their understanding with a partner or generating the question to go in the left column of the Cornell notes. At the end of class or for homework, have students review their notes and write a summary. See resource section for a website explaining how to take Cornell notes.

Have students begin brainstorming section of “It’s All Relative”.

Explain Activity Products and Artifacts

Cornell notes

Brainstorming section of “It’s All Relative”

Explain Activity Materials/Equipment

Student Product from explore, Special Relativity PowerPoint, Computer with PowerPoint, Projector

Explain Activity Resources

PowerPoint Resource: <http://aether.lbl.gov/www/classes/p139/exp/gedanken.html>

Instructions for Cornell notes <http://coe.jmu.edu/learningtoolbox/cornellnotes.html>

Elaborate Activity

Students were introduced to the design challenge at the end of the engage activity and instructed to brainstorm through out the week.

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After brainstorming and receiving additional instruction on special relativity (through explore and explain pieces), the student will choose his/her topic and begin explanation of how their art work will connect the topic to special relativity. The majority of the project itself should be completed outside of class.

For photography projects, give students the option of loading their photograph(s) on the computer directly from storage devices. If available, you can use student computers to display these projects during evaluation.

Elaborate Activity Products and Artifacts

Special Relativity Art Work, Explanation

Elaborate Activity Materials/Equipment

“It’s All Relative” handout, student collected supplies, additional supplies you may want to have available to supplement student budget: photo paper, digital cameras, paints, paint brushes, butcher paper, markers, shoeboxes (for dioramas), modeling clay, construction paper, magazines (collages), popsicle sticks, etc.

Elaborate Activity Resources

“It’s All Relative-Scoring Rubric”

Evaluate Activity

Place pieces of student art work with explanations throughout the room. Working in groups of three, have students rotate around the room and score each project using a sticky note and the project rubric. On the front of the sticky note have the group write one thing done well on the project and one thing that needs work. On the back of the sticky note, the group will write a rubric-based grade for the project and attach it to the project explanation sheet.

It is not important that every student scores every piece of art work. This is meant to reinforce the concept of special relativity and evaluate student understanding.

Evaluate Activity Products and Artifacts

Student evaluations of special relativity art work.

Evaluate Activity Materials/Equipment

Student work, sticky notes, “It’s All Relative-Scoring Rubric”

Evaluate Activity Resources

“It’s All Relative-Scoring Rubric”

It's All Relative

The Challenge:

You have just gotten a part-time job at an art gallery that has recently opened to the public. A convention of physicists is coming into town for the National Physics Convention, and your employer wants to take advantage of this. The focus of the conference is special relativity, and your boss has offered you 1 month of paid vacation if you create a piece of art work based on the theory of special relativity. Your art work must be complete with an explanation of how it relates to special relativity by the time of the conference's opening ceremonies, one week from today. You may choose to work with a partner to complete this project.

Medium for your art work (drawing, photography, sculpture, diorama, etc.):

Brainstorming:

Use this section to brainstorm possible topics for your art work that can be connected to the concept of special relativity.

Topic Chosen: _____

Explanation:

Write a 5-7 sentence paragraph explaining how your art work is connected to the theory of special relativity. Refer to the project rubric as you work (see back of this sheet). Attach this sheet to your work of art.

Plan the Assessment

Engage Artifact(s)/Product(s): <i>Reflection on Engage Activity</i>
Explore Artifact(s)/Product(s): <i>Group poster on thought experiment</i>
Explain Artifact(s)/Product(s): <i>Cornell notes, Brainstorming for “It’s All Relative”</i>
Elaborate Artifact(s)/Product(s): <i>“It’s All Relative” explanation and art work</i>
Evaluate Artifact(s)/Product(s): <i>Student evaluations of “It’s All Relative” art work and explanations</i>

Rubrics

It's All Relative: Scoring Rubric

Vocabulary to use in explanation: Special relativity, time dilation, frame of reference, simultaneity, length contraction, speed of light

	0	1	2	3	4
Art Work	Not present	Not original work AND messy/poorly constructed	Not original work OR messy/poorly constructed	Original work, neat, sturdy construction	Goes above and beyond requirements, elicits a WOW! response
Explanation	Not present or not original work	Illegible, insufficient length OR no vocabulary used	Explanation is legible, sufficient length, and uses at least half of vocabulary terms	Explanation is legible, sufficient length, and uses more than half of vocabulary	Explanation is typed, sufficient length, and uses ALL vocabulary

Total points earned: _____/8 points

Story Board

	Day 1	Day 2	Day 3	Day 4	Day 5
<p>Week 1 Activities (based on 50 minute class periods)</p>	<ul style="list-style-type: none"> ▪ Engage and Team Building: Zoom ▪ Debrief/Reflect ▪ Introduce design challenge, direct students to brainstorm ideas throughout week 	<ul style="list-style-type: none"> ▪ Explore: Thought experiments in groups 	<ul style="list-style-type: none"> ▪ Explain: link work on thought experiments to special relativity vocabulary/ concepts ▪ Have students decide on medium and topic ▪ Instruct students to bring supplies to work on art project/ explanation on the following day 	<ul style="list-style-type: none"> ▪ Elaborate: Students work on project and/or explanation in class ▪ Students will finish project for homework 	<ul style="list-style-type: none"> ▪ Evaluate: Students display art work and grade peer work in groups using rubric