# Science Assessment System Through Course Task

## What an Impact!

**Grade Level:**
4

**Phenomena:**
Energy Causes Change

**Science & Engineering Practices:**
Analyzing and Interpreting Data
Engaging in Argument from Evidence

**Crosscutting Concepts:**
Cause and Effect

Designed and revised by Kentucky Department of Education staff
in collaboration with teachers from Kentucky schools and districts.

# Preparing to implement Through Course Tasks in the Classroom

**What is a TCT?**

- TCTs are 3-dimensional tasks specifically designed to get evidence of student competency in two dimensions, Science and Engineering Processes (SEPs) and Crosscutting Concepts (CCC), untethered from Performance Expectations (PEs)/standards. Tasks are sense-making experiences.
- Tasks are to be used formatively. The goal is for both students and teachers to understand areas of strength and improvement for the SEP(s) and CCC assessed within the task.

**How do I facilitate a Through Course Task (TCT)?**

- TCT facilitation is a collaborative process in which teacher teams calibrate understanding of the expectations of the task and refine strategies to be used during task facilitation.

Before the task:

1. Complete the TCT as a learner – compare understanding of task through the lens of success criteria (identified in the task) in order to understand expectations.
   Success criteria include:
   - What is this task designed to get evidence of?
   - What is the task asking the students to do?
   - What might a student response look like?
2. Identify the phenomenon within the task. Consult resources to assure teacher teams have a deep understanding of associated science concepts.
3. Collaborate to generate, review and refine feedback questions during facilitation.
4. Identify potential "trouble spots" and plan for possible misconceptions.

During the task:

5. Collect defensible evidence of each student's competencies in 3-dimensional sense-making for the task.
6. Ask appropriate feedback questions to support student access and engagement with the task in order to elicit accurate evidence of student capacities.

After the task:

7. Reflect on the task as a collaborative team.
8. Review student work samples to identify areas of strength and areas of need.
9. Determine/plan next steps to move 3-D sense making forward through the strengthening of the use of SEPs and CCCs.

Using the materials included in this packet:

- **Task Annotation:**
  - The task annotation is a teacher guide for using the task in the classroom. Additionally, the annotation gives insight into the thinking of developers and the task overall.

    - Each task has science and engineering practices, disciplinary core ideas, and crosscutting concepts designated with both color and text style:
        - **Science and Engineering Practices**
        - *Disciplinary Core Ideas*
        - Crosscutting Concepts
- **Student Task:** The materials to be used by students to complete the TCT.

# What an Impact! Task Annotation

**After analyzing data** of *observable relationships between the relative amounts of energy being transferred during collisions as evidenced by changes in an object's motion or deformation of the object,* **make claims about the** *relative amounts of energy present under varying conditions in each scenario and* the factor causing the differences *in energy using evidence from the data to support your claims.*

**Phenomenon within the task**

Energy causes change. It is possible to compare relative amounts of energy in a situation based on the amount of change caused when other factors are held constant. For example, if a car crashes into a brick wall at 20 mph it will be "changed more" than the same type of car crashing into a brick wall at 5 mph. The car at the higher speed has more energy when it hits the wall and the evidence that the faster car had more energy is that the car is damaged more. Thus, "evidence of change" can be used to identify relative amounts of energy for different situations.

The concept of energy is challenging to understand but laying the foundation with students that "energy causes change" gives them a meaningful way to begin thinking about energy without complex equations, concepts or vocabulary. The intent of this task is to help students understand that energy causes change, appreciate that they can identify relative magnitudes of energy present by noting the amount of change that is caused as evidenced by data, and then reason through what factor in the scenario was likely responsible for that variation in energy based on available data.

The task focuses on the following two ideas related to energy transfer in objects, but students are not expected to explicitly learn this content in the task. Students are expected to begin to develop a conceptual understanding for energy, evidence of energy transfer and factors that affect the amount of energy an object has.

a) Objects dropped from higher points transfer more energy upon collision with surfaces and cause greater change than objects dropped from lower points. This is because an object accelerates to a higher speed before impact when it is dropped from a higher height. Increased speed results in increased energy when all else is held constant.
b) Objects with more mass/weight transfer more energy upon collision with other matter and cause greater change than

objects with less mass/weight if all other variables remain constant.

**NOTE:** This task presents 3 different scenarios to examine energy change: 1) change in potential energy due to difference in height, 2) change in potential energy due to difference in mass/weight and 3) change in kinetic energy due to a change in mass/weight (or perhaps velocity). In the first 2 scenarios, the gravitational potential energy is converted to kinetic energy before there is impact/collision and change happens. Part 3 of the task (completed independently by students) moves beyond changes in potential energy and presents a scenario that only involves kinetic energy transfer. The vocabulary for potential and kinetic energy is not used at the 4$^{th}$ grade level according to our standards, but the concept of **energy, energy of motion, and energy transfer** are part of the grade level standards. **So the task is not about the energy vocabulary**, but about helping students understand that "evidence of change" can be useful as an indicator of relative amounts of energy.

**How the phenomenon relates to DCI**

PS3.C Relationship between Energy and Forces: When objects collide, the contact forces transfer energy so as to change the object's motion.

Students need to understand that more energy results in more change in an object (either in shape or in regards to motion). It is also important that students make a connection that heavier objects traveling at the same speed as lighter objects will have a greater impact, but lighter objects traveling at a higher speed can make a greater impact.

- Students will need to understand that energy is present whenever there are objects moving and that energy can be transferred.
- It is a common misconception for students to use the phrase "produce energy" when they are describing the conversion of potential energy to kinetic energy.
- Students will need some background knowledge about the nature of energy (that it cannot be created/produced, only transferred, moved from matter to matter and transformed or change forms.
- From previous grades, students should have knowledge about force; that forces act on objects and have strength.
- Students will need previous knowledge about objects in contact exert forces on each other.

*Students will use this background knowledge along with logical reasoning to analyze the data in the task and apply the identified cause/effect relationship to make sense of the phenomenon.* It is assumed that most students, by grade 4, have had personal

experiences related to the phenomenon in this task. It is recommended that they be given opportunity to make and share their connections in order to support understanding.

**What information/data will students use within this task?**

- Students will need basic understanding of the concepts and terms involved in this task (force, change, motion, investigate, analyze).
- Students need to have a basic understanding of forces and motion and that forces act upon objects when objects are in contact with each other.
- Students will use qualitative data (*photos of clay ball balls after impact from falling).*
- Students will use a data chart that contains measurements of boys' splashes from a cannonball contest. Measurements are in whole feet. These numbers may be adjusted to show decimals or fractions of whole feet.

Students will need to have prior experiences with:

- manipulating clay ball with hands/various tools.
- making observations from photos.
- understanding of relationship between potential energy and kinetic energy (*to be able to explain how the increase in height causes greater changes to clay ball upon impact with the concrete).*
- Students will need to know what a "cannonball" jump into a swimming pool looks like (link to animation provided in resource page).

**Ideas for setting up the task with students**

1. Allow students to manipulate a ball of clay. They should be familiar with its texture and how it can be shaped and formed with hands/various tools.
2. Discuss that energy can take different forms and can be moved (transferred) from place to place. Energy can change from one form to another.
3. Students should have preliminary experience with the idea of energy and energy transfer by exploring the way objects move. For example, a toy car will have more motion when a greater force is exerted on it. Discussions about potential energy and kinetic energy may lead to lead to exploratory investigations. (Teacher note: Potential energy is in a soccer player's foot until he moves it to kick a soccer ball, then it becomes kinetic energy and it is transferred to the ball causing motion.) A ball that is

dropped from various heights will have different levels of "bounce." A toy car rolled from a high ramp will have more speed than a toy car rolled from a lower ramp.

4. Students may benefit from a brief lesson on force and energy.
5. Discussion techniques can be in the form of "Think, Pair, Share" or begin with discussion starters.
6. Review that investigations can be tests used to collect data. Discuss different types of data (photos, observations, measurements, etc.)

**Intent of the Task for Assessment**

The initial parts of this task elicit evidence of students' ability to analyze qualitative data in the form of photos and quantitative data from tables/charts and relate that processed information as evidence of relative amounts of energy. For example, students are asked to explain the relationship between drop height and energy of the clay ball when it hits the ground, using evidence of change in the clay ball as an indicator of energy. Similarly, students are asked to explain how they know the heavier brother had more energy when he hits the water – what is the evidence of change? And then, what caused one brother to have more energy than the other?

Teachers can support students as needed through these parts of the task to ensure that student understand that evidence of change is an indication of relative amounts of energy. Part 2 concludes with two reflection questions. It is suggested that student respond to these questions independently to provide you with evidence of their understanding of the content in the task. If students do not have a firm understanding of energy causing change, you will need to provide them with more experiences prior to engagement in Part 3. If students don't understand the content in the task, you will not get strong evidence of their ability to engage in the SEPs and CC associated with the last part of the task.

Part 3 of the task should be completed independently. Then connect the data to understand the cause/effect relationships of energy transfer. Then, students will analyze quantitative data about a cannonball contest and use it to make a support an explanation about the effect of an object's weight on the energy that is transferred during a collision. Finally, students will show their understanding of energy transfer and cause/effect relationships when they make connections between the activities in the scenarios with examples from their lives.

**Success Criteria**

*Evidence of Learning Desired based on Progression from Appendices*

Analyze and Interpret Data

- Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics and/or computation.

Constructing Explanations and Designing Solutions

- Construct an explanation of observed relationships.
- Cause and Effect
  Cause and effect relationships are routinely identified, tested and used to explain change.

*Success Criteria*

- Student makes a claim about the evidence of change as an indicator of relative energy for the two bumper car collisions based on data within Part 3 of the task, and supports that claim with evidence embedded in the scenario.
- Student makes a claim about a causative factor (weight of child or speed/velocity of the bumper car) for the differences in energy transferred in the two collisions, and identifies the directional relationship between the factor and change in energy.

*Possible Student Responses*

Bob moved back further when Jose hit him and so Jose must have had more energy than Carla when he hit Bob with his car. Bob moved back 8 feet when Jose hit him and only 5 feet when Carla hit him.

Example: Jose must weigh more than Carla because Bob moved back more when Jose hit him than when Carla hit him. Increased weight results in increased energy for a moving object. Student could also mention speed as a factor that would affect the amount of energy.

**Other information teacher teams might find useful when preparing to use this task in the TCT process**

*It was not feasible for the writers of this TCT to drop a clay ball from the heights shown in the task, therefore the photos of the clay ball balls are not exact representations of the way clay ball changes shape when dropped from the given heights. Therefore, teachers should not attempt to recreate this investigation. Other dough-like substances, like cookie dough, would produce results more similar to the ones used in this TCT. Students should still use logical reasoning to rank the photos by the amount of energy transferred to show the greatest change upon impact.*

**Extensions and/or other uses after the task is implemented**

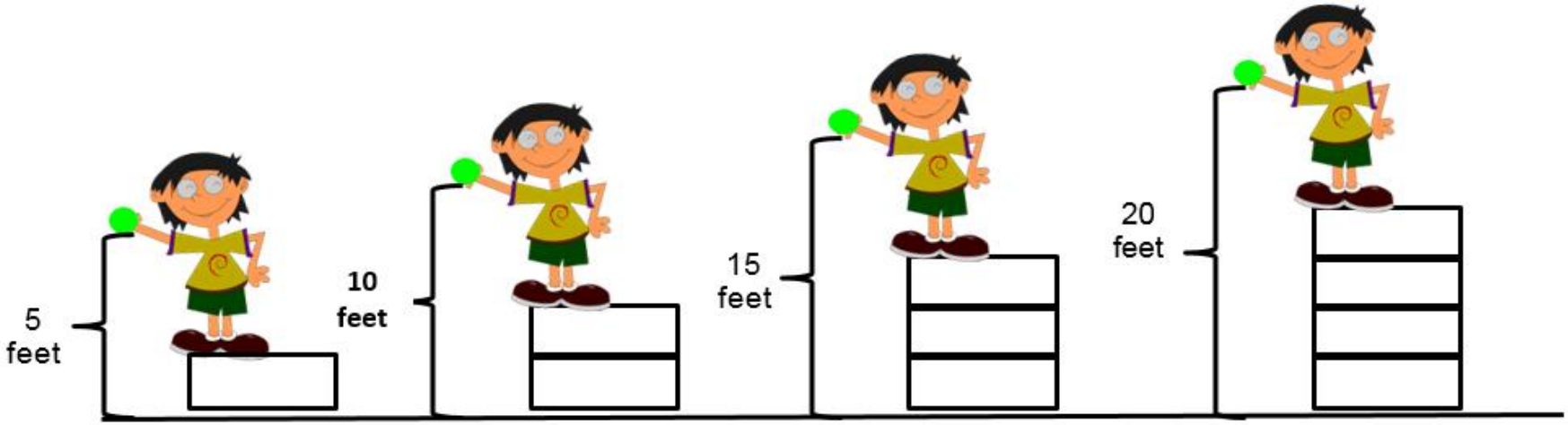
*Since the TCT scenarios provide a pattern of cause/effect relationships between increased potential energy and its effect on the changes made upon collision, students should then be able to predict outcomes in various types of investigations. A next step would be to invite students to create a scenario that does not follow the same pattern of cause and effect. They could try to find an example of an inverse relationship where less potential energy causes greater change. A lesson like this would allow for students to use critical thinking and would provide a good context to discuss controlling variables in order to set up a fair test.*

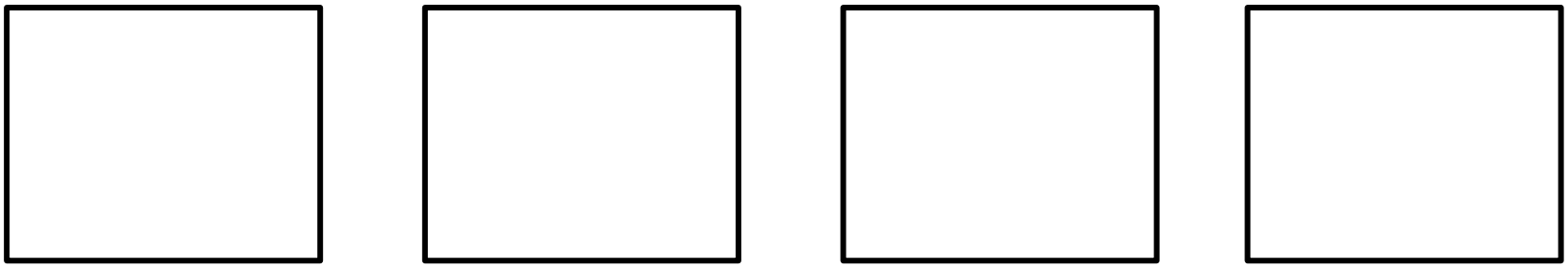
# Through Course Task – What an Impact!

**Part 1: Clay ball Investigation**

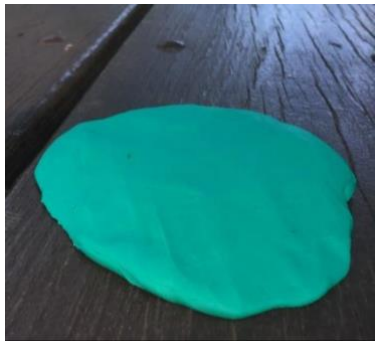
Ellie and Augie were playing with a clay ball. Augie rolled the clay into a ball and dropped it onto the sidewalk. The ball flattened out a bit when it hit the concrete. Ellie said it flattened out because the energy from the impact caused the clay to change shape. Augie rolled the clay back into a ball, climbed up some steps, and dropped it again the same way as before. They noticed a change in the way the ball looked after it was dropped from different heights. Again, they repeated this activity from 2 more different heights.

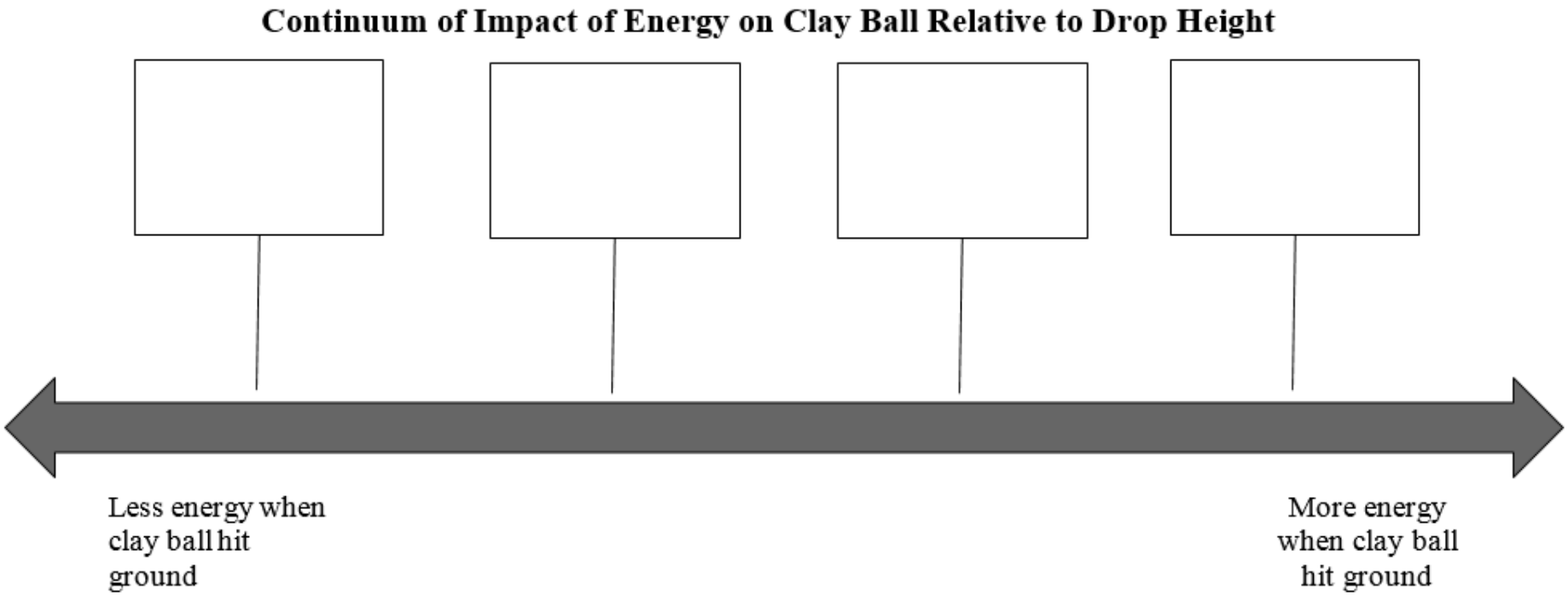
The diagram below shows how Augie dropped the clay from different heights. Cut out the pictures of the clay balls on the next page and glue them onto the boxes in the diagram below to show the heights from which they were dropped.



Cut out the pictures and paste in correct boxes on page 1.






Which clay ball had the most energy when it hit the concrete? Which one had the least? Rank them in order using the heights from least energy to greatest energy. **Write the heights in the boxes on the continuum.**

1. Which drop height caused the clay ball to have the most energy when it the hit the ground?

_____

_____

2. How do the pictures of the clay ball balls help support your answer in the question above?

_____

_____

_____

_____

3. Explain the relationship between drop height and the amount of energy the clay ball has when it hits the ground. Support your explanation with evidence from the pictures of the clay ball.

_____

_____

_____

_____

_____

**Part 2: Cannonball Contest**

The next day, Augie went swimming with his big brother Jake. The boys decide to have a cannonball contest off of the diving board. Augie says, "I bet I can make the biggest splash!" Jake replies, "That's impossible! I will make a bigger splash than you." Both of the brothers agreed to position themselves the same and to simply fall into the water from the same diving board. Below is the data from their contest.

| | Height of Splash for **Augie** (weighs 50 lbs.) | Height of Splash for **Jake** (weighs 100 lbs.) |
|---|---|---|
| Round 1 | 2 feet | 5 feet |
| Round 2 | 3 feet | 6 feet |
| Round 3 | 3 feet | 4 feet |
| Round 4 | 4 feet | 5 feet |

Which brother do you think won the contest? _____ What evidence do you have to support your thinking?

_____

Which brother had more <u>energy</u> when he hit the water? _____ What evidence supports that he had more energy when he hit the water? _____

_____

_____

What is it about Augie and Jake that caused one brother to have more energy when he hit the water? Use the data in the table to support your claim. _____

_____

_____

Let's review. Reflect on the Clay Ball and Cannonball experiences then complete the following items.

1. The factor that caused variation in energy as Augie dropped the clay balls was _____. The evidence for differences in amount of energy was _____

   _____.

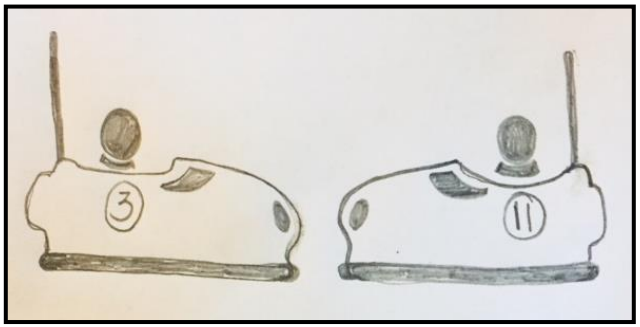
2. The factor that affected variation in energy when the boys had their cannonball contest was _____.

   The evidence for differences in amount of energy was _____

   _____.

Name_____ Date_____

**Part 3: Bumper Cars**




Jose, Bob and Carla all went to ride bumper cars one afternoon. Unfortunately, Bob was not as quick to get going as his friends. Before he had a chance to start up his bumper car, his friends both gave him a bump! First, Carla bumped Bob's bumper car head on. "What's up with you?" yelled Bob. Once Bob's bumper car stopped moving backward, Jose' took aim and smacked Bob's car! "Will you both give me a chance to move on my own?" shouted Bob.

After they finished **Carla** said*, "When I bumped Bob's car, I sent him in the other direction about **2 feet**!"*

**Jose'** exclaimed*, "Well, when I bumped Bob's car, it went sailing father than that. I'd say about **5 feet**!"*

**Bob** responded, *"Man, I felt like didn't stand a chance against you two! You both had more energy than me!"*

Which of the two friends had more energy when they collided with Bob's bumper car? **Carla** or **Jose'** (circle one)

What evidence do you have to support your choice?_____

_____

Identify a factor that would cause one of the friends to have more energy that resulted in Bob's car moving farther?

_____

What is the relationship between the factor you identified and the amount of energy transferred to Bob's car?

_____

_____

**<u>Optional Extension:</u> Time to make your own connections!**

(Note- this does not relate to the provided task success criteria)

Energy causes objects to change all the time in our daily lives. Think about an experience that is different from the examples in this task where energy caused an object to change. It can be something you actually experienced or something you observed. Describe the experience.

_____

_____

_____

_____

Provide evidence that the object in your example had energy.

_____

_____

_____

_____