

Four different experiments to analyze

CER Practice A

Your mom is in the process of building a new restaurant. She needs to buy equipment to cook the food. She looked at different frying pans made out of other materials. A good frying pan will transfer heat quickly from the stove burner to the food allowing the chef to control the cooking process.

You decide to do a test to investigate heat flow through different materials. You connect to beakers using the same material. One beaker contains hot water, and the other has cold water. You are looking to see how quickly the heat from the hot water container gets transferred to the cool water container.

Material	Beaker A temp. at 0 seconds	Beaker B temp. at 0 seconds	Beaker A temp. at 120 seconds	Beaker B temp. at 120 seconds	Beaker A temp. at 300 seconds	Beaker B temp. at 300 seconds
Aluminum	95	5	74.7			
Copper	95	5	64.6			
Steel	95	5	89.3			
Glass	95	5	94.9			

Which material should the pan be made out of?

CER Practice B

Students are investigating different ways to increase the temperature of substance different tests, changing the volume, pressure, or heat source to see how it affects of a substance. The data they gathered is below?

Experiment 1: Keep the volume of the gas the same and increase the pressure.

	Time 0 seconds	Time 15 seconds	Time 30 seconds	Time 45 seconds
Pressure (atm)	1	1.5	2	2.5
Temperature (°K)	298	447	596	745

Experiment 2: Keep the pressure of the gas in the container the same and increase

	Time 0 seconds	Time 15 seconds	Time 30 seconds	Time 45 seconds
volume (L)	3	3.5	4	4.5
Temperature (°K)	298	348	397	447

Experiment 3: Keep the volume of the gas the same and increase the heat on the gas burner on high.

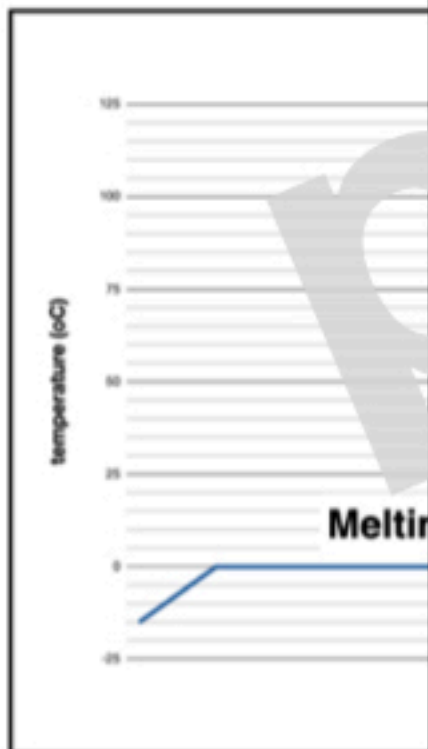
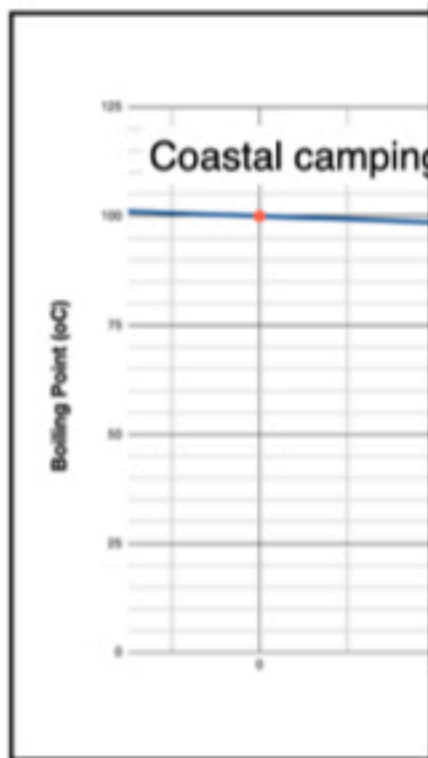
	Time 0 seconds	Time 15 seconds	Time 30 seconds	Time 45 seconds
temperature of flame burner (°K)	425	425	425	425
Temperature (°K)	100	185	245	300

Is adding heat the only way to increase the temperature of a substance?

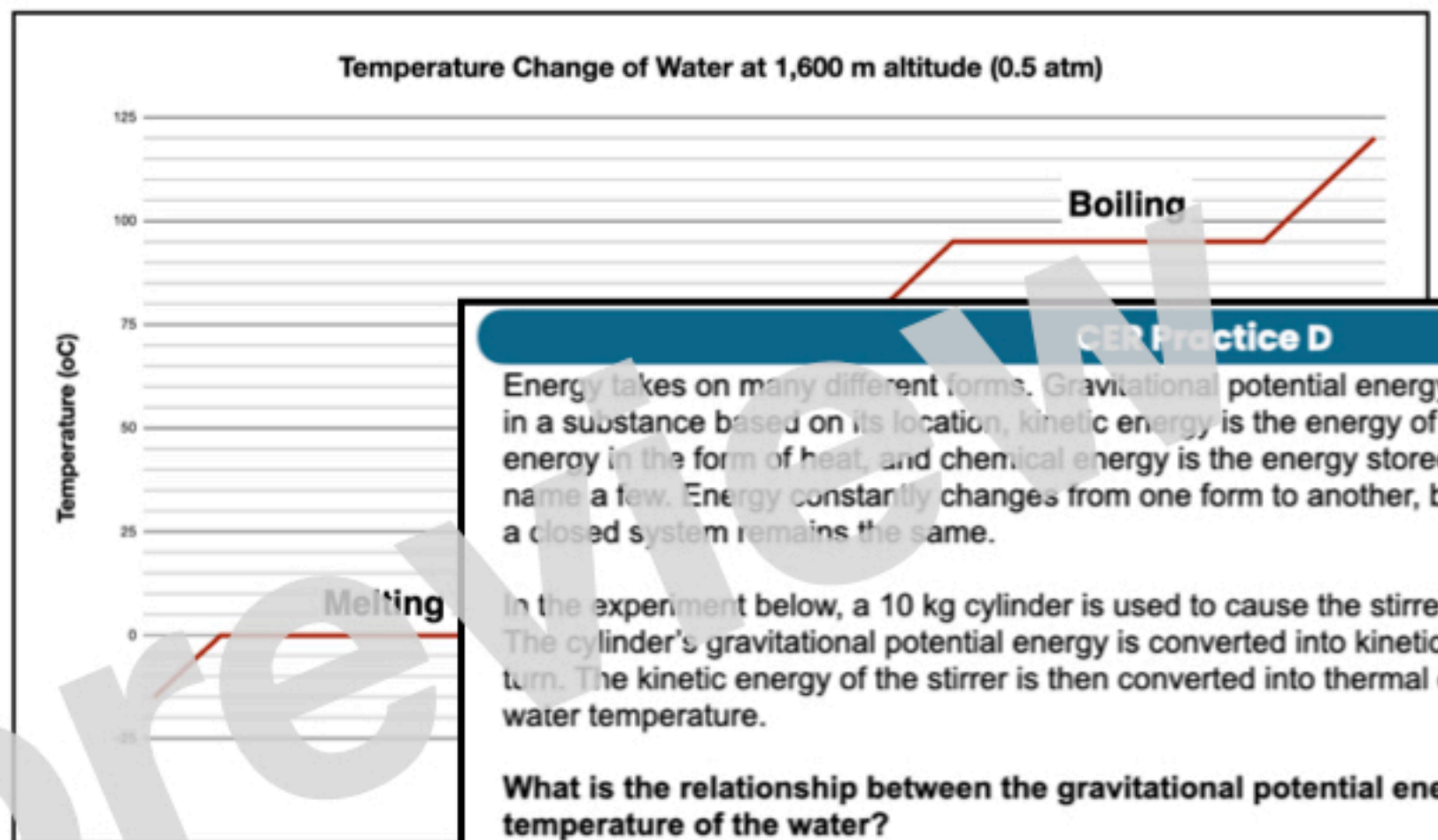
Four different experiments to analyze

CER Practice C

Parker is an avid backpacker. They have done many hikes along the California and Oregon coast. A friend invites them to go camping with them in the Eagles nest wilderness outside of Denver. On the first night of the trip, Parker is in charge of making pasta for dinner. The goal is to eat dinner, clean up, and put things away before it gets dark. The sun sets at 8:00 pm, and from their previous camping experience, they know it takes 30 minutes to cook pasta when camping on the coast. They start making dinner at 7:00, leaving 30 minutes to eat and clean up before the sun sets. At 7:45, they notice that the pasta is still not done. They are confused as to why it is taking so much longer, especially since the water started boiling sooner than it did on their coastal trips.



CER Practice C



What is the effect of altitude on

CER Practice D

Energy takes on many different forms. Gravitational potential energy is in a substance based on its location, kinetic energy is the energy of motion, energy in the form of heat, and chemical energy is the energy stored in a substance. Energy constantly changes from one form to another, but in a closed system remains the same.

In the experiment below, a 10 kg cylinder is used to cause the stirrer to turn. The cylinder's gravitational potential energy is converted into kinetic energy. The kinetic energy of the stirrer is then converted into thermal energy, which increases the water temperature.

What is the relationship between the gravitational potential energy and the temperature of the water?

10 kg Cylinder Height (m)	Gravitational potential energy of the cylinder (J)	Starting temperature (°C)	Final temperature (°C)
100 m	9,800	25	27
300 m	29,400	25	31
500 m	49,000	25	34
700 m	68,600	25	37
900 m	88,200	25	40

One-page background information sheet about the topic

Thermal Energy Background Information

Phase Changes

When heat is added to a substance, the particles inside are energized, and their kinetic energy increases. As their kinetic energy increases, the substance changes from one state to another. For example, water in a solid state is called ice. The particles in an ice cube strongly attract each other, which keeps them packed tightly together. As heat is added, the particles gain more kinetic energy. This helps weaken their attraction, and they start to separate from each other. They will continue to separate until they can slide past each other. When this happens, the ice becomes liquid water. This process is called melting. If more heat is added, the particles will continue to gain energy. This weakens the attraction and causes the particles to pick up speed. Eventually, they move so fast that they collide with each other. The liquid water turns into steam. This process is called vaporization. (When vaporization happens at the surface of the liquid, it's called evaporation. When vaporization occurs throughout the liquid, it's called boiling). Sometimes, the particles increase their energy so fast that they go directly from a solid state to a gas state. When this happens, it's called sublimation. Frozen carbon dioxide, otherwise known as dry ice, does this.

The opposite happens when heat is removed. Their kinetic energy decreases. For example, the particles in steam are moving super fast and collide with each other. The particles have very little attraction to each other. The particles slow down as heat is removed and the substance cools down. This increases their attraction. Eventually, they get close together and start sliding past each other. When this happens, the steam becomes liquid water. This process is called condensation. If the particles continue to slow down, their energy decreases even more. The attraction between them becomes greater. At some point, they become so attracted to each other that they huddle together and become packed in. The liquid water turns into ice. This process is called freezing.

Gas Laws

All gases, no matter the substance, obey specific laws. These laws help explain how gases will behave when pressure, volume, temperature, and amount of particles change. Charles' law is known as the temperature-volume law. This law explains the relationship between temperature and volume when pressure and the number of particles of the substance are kept the same. Temperature and volume are directly proportional, so if one goes up, so does the other. If the temperature increases, the volume will also increase. This law can be experienced with balloons on a hot day. Boyle's law is known as the pressure-volume law. This law explains the relationship between pressure and volume when temperature and the number of particles of the substance are kept the same. Pressure and volume have an inverse relationship, so if one goes up, the other goes down. If the pressure increases, the volume will decrease. Gay-Lussac's law is known as the pressure-temperature law. This law explains the relationship between temperature and pressure when volume and the number of particles of the substance are kept the same. Temperature and pressure are directly proportional, so if one goes up, so does the other. If the temperature increases, the pressure will also increase.

Thermal energy

Thermal energy is also known as heat energy. It is the energy in a system that is dependent on temperature. It results from the kinetic energy of all the particles in a system, including the distance between the particles and their attraction. Substances in a liquid state have more thermal energy than those in a solid state because they have less attraction and higher kinetic energy. Heat transfers thermal energy from a substance of higher temperature to a substance of lower temperature. Heat always transfers from greater thermal energy to lower thermal energy.

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Grading Rubric and Student Self-Assessment Check List

CER: SCIENTIFIC EXPLANATION

Grading Rubric

	4	3	2	1	0
Claim	Claim is accurate and complete	Claim is accurate but not complete	Claim is partially accurate or complete	Claim is inaccurate	No claim is stated
Evidence	Provides appropriate and sufficient evidence that includes measurements or observations that have been analyzed and interpreted to support the claim	Provides appropriate and sufficient evidence to support the claim	Provides appropriate but insufficient evidence to support the claim or also includes inappropriate evidence	Provides inappropriate evidence that does not support the claim	No evidence is given to support the claim
Reasoning	Explains correctly, using scientific principles, why the evidence is included and how it supports the claim.	Explains correctly why the evidence is included or how it supports the claim but not both.	Explains why the evidence is included and how it supports the claim, however some of the reasoning is incorrect.	Explains why the evidence is included or how it supports the claim, but not both and some of the reasoning is incorrect.	No reasoning is given to link the evidence to the claim
Mechanics	The writing is easy to follow with lots of academic language and details. Contains no grammar or spelling errors.	The writing is easy to follow with lots of details and a few grammar or spelling errors.	The writing is hard to follow with only some details. Contains some grammar or spelling errors.	The writing is hard to follow with few details. Contains a lot of grammar or spelling errors.	The writing is hard to follow with no details. Contains a lot of grammar and spelling errors.

Comments:

Total Points

Grade

CER self-assessment

the question

question

comes from (according to the d

d in the data table or graph

when appropriate

supports the claim

important

ence

Mechanics

- ☐ No spelling errors
- ☐ No grammar errors
- ☐ Easy to read

Digital or Print

Evidence: Found in the data table (example: the actual color or given temperature)

Reasoning: How it identifies if a chemical change occurred (example: color change, color change)

Evidence Add text	→	Reasoning Add text
Evidence Add text	→	Reasoning Add text
Evidence Add text	→	Reasoning Add text
Evidence Add text	→	Reasoning Add text

1

Claim, Evidence, and Reasoning

Claim

The claim answers the question. It states what you think. It is written in a scientific sentence using academic language. There should be no "I" in the statement.

Some sentence frames to help you write your claim statement:

- When you mix _____ and _____, a chemical change _____.
- Mixing _____ and _____ creates. I does not create _____.
- Combining _____ and _____ results in _____.

Evidence

The evidence is the actual observations, measurements, or quotes from the experiment or articles. Information should come from the data collection when using a lab.

Some sentence frames to help you write your evidence statements:

- According to the data, _____.
- During the experiment, _____.
- During the investigation, _____.
- It was discovered that _____.

Reasoning

The reasoning explains why the evidence supports the claim. It uses knowledge that is already known from science class and real world knowledge to link the evidence to the claim.

Some sentence frames to help you write your reasoning statement:

- This indicates _____.
- This supports the claim because _____.
- This is important because _____.
- This suggests that _____.
- I know _____.
- Therefore, I can conclude _____.

2

Question:
Add text

Claim:
Add text

Evidence:
Add text

Reasoning:
Add text

3

Question:
Add text

Claim:
Add text

Evidence 1:
Add text

Evidence 2:
Add text

Evidence 3:
Add text

Reasoning:
Add text

4

Question:
Add text

Claim:
Add text

Evidence 1:
Add text

Reasoning 1:
Add text

Evidence 2:
Add text

Reasoning 2:
Add text

Concluding sentence:
Add text

5

Re-write your CER so that it is all together in one paragraph

Question:
Add text

Claim:
Add text

Evidence:
Add text

Reasoning:
Add text

Concluding sentence:
Add text

6

Student CER self-assessment

Claim

- ☐ Includes the names of the chemicals in the experiment
- ☐ States if a chemical reaction occurred or not
- ☐ States the answer to the question

Evidence

- ☐ States where the information comes from (according to the data, during the experiment.)
- ☐ Includes observations found in the data table
- ☐ Includes actual numbers when appropriate

Reasoning

- ☐ Explains how the evidence supports the claim
- ☐ States why the evidence is important
- ☐ Includes a concluding sentence

Mechanics

- ☐ No spelling errors
- ☐ No grammar errors
- ☐ Easy to read
- ☐ Includes transition words or sentences

7

Example Write-Ups for All Four Experiments

Possible answer for CER Practice A

Question: What is the relationship between plant diversity and an ecosystems resilience to drought?

Claim:
The relationship between plant diversity and the res ecosystem to drought is directly proportional.

Evidence:

According to the graph, as the plant species became increased from 1 to 20, the resistance to drought increased from 1 to almost 4.

Possible answer for CER Practice B

Question: What is the impact of the crown-of-thorns starfish on the ecosystem?

Claim:
The crown-of-thorns has a negative impact on the ecosystem, especially on the invertebrates.

Evidence:

Possible answer for CER Practice C

Question: What is the impact of human development on an ecosystem?

Claim:
Human development can have a negative impact on an ecosystem.

Evidence:

According to the graph, rabbits saw an increase in population around 50 to 375 during the first five years. When humans cleared the area and started developing it, the population decreased from 375 to 250 in the next five years. During the last five years, when the human population doubled, the rabbit population declined. The diagram shows that rabbits eat grass and foxes are predators.

Reasoning:

I know that organisms in an ecosystem interact, and a diagram can show a model of that interaction. When one organism is affected by an outside source, the other organisms can be affected. In this case, a decrease in the rabbit population could impact the fox and hawk population. Therefore, I know that human development can have a negative impact on an ecosystem.

the first ten years, the population of crown-of-thorns starfish increased from 20 to 1,000. During that same period, the population of sea urchins went from 30 to 5 while the population of sea stars held steady. From 10 to 50 years, the population of crown-of-thorns starfish decreased from 1,000 to 300. The sea urchin population decreased and was pretty much gone by year 50. The sea star population also decreased, with the algae population increasing the most. The sponges went from a little over 100 to about 50. The sea urchins went from around 30 to about five as well.

Possible answer for CER Practice D

Question: Which human interaction, hunting or logging, creates a more significant impact on the forest ecosystem?

Claim:
Logging creates a more significant impact on the forest ecosystem than hunting.

Evidence:

According to the data tables, when there is no hunting or logging, the number of organisms holds steady, with trees maintaining a population of 1,100, mushrooms 12,000, deer 900, and bears 200. When hunting is allowed, the deer population drops to around 200, the rest of the organisms increase with the bears increasing to 300, the trees to 1,000, and the mushrooms to 13,000 after 20 years. When logging is allowed, all of the organisms decrease. The mushrooms drop to 100, the deer to 1, and the bear to 50 by year 20. The trees disappear by the end of the 20 years.



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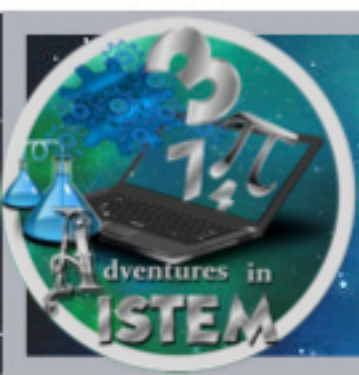
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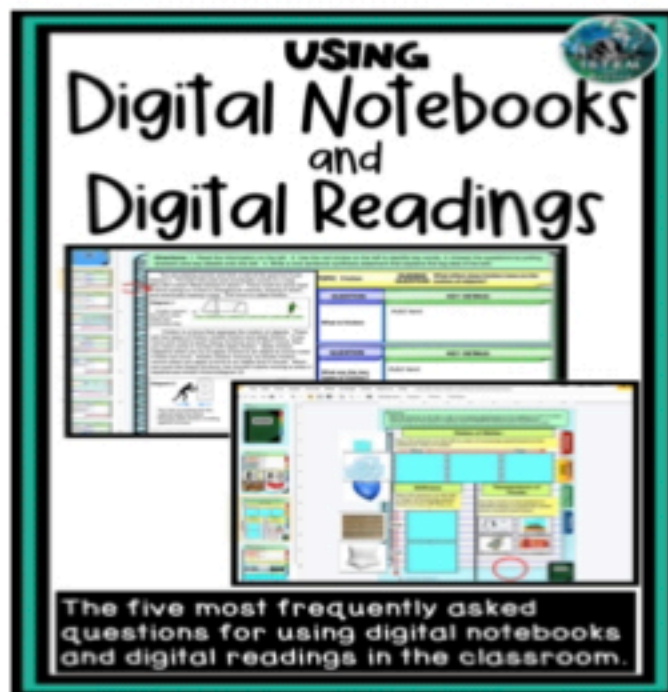




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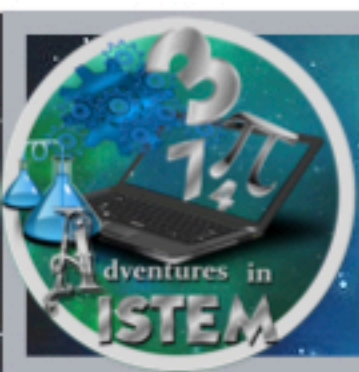
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I would also recommend checking out my Google Slide videos that demonstrate how to drag and drop pieces, write in the text boxes, add objects, and more. These are short videos that can easily be shared with students and parents. Click the picture for the link





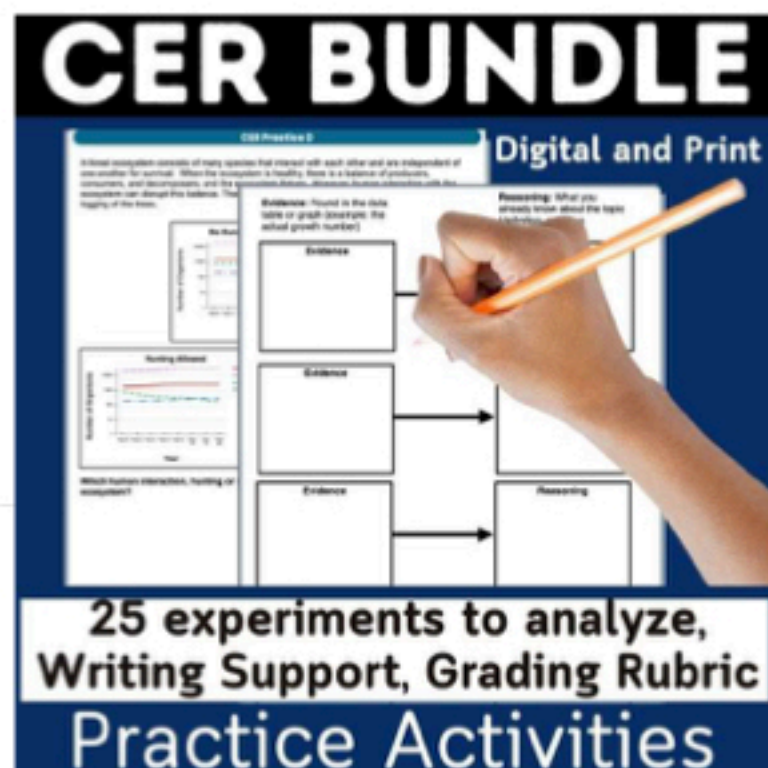
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