

PEI created performance tasks designed to introduce middle school students to renewable and non-renewable energy resources. To date, these tasks include the following:

#### Renewable and Non-renewable Energy

Renewable Energy: Wind

Renewable Energy: Solar

Renewable Energy: Hydropower

Renewable Energy: Geothermal

Renewable Energy: Biomass

The tasks are designed to provide basic background knowledge about renewable energy including what it is, how it works and the advantages and disadvantages for the environment. Each task focuses on a type of renewable energy, including basic background knowledge, career information, and a variety of print and video resources. Students practice the research skills of locating information, selecting the best information and having enough information to explain or persuade.

The first task, ***Renewable and Non-renewable Energy***, culminates in a speech. Teachers are provided with the SBAC Speech rubric for scoring the student presentations. A template is provided for planning speeches. Teachers may adapt these materials as desired.

The Wind, Solar, Hydropower, Biomass, and Geothermal energy tasks are written to culminate in an argumentative essay. Students present a strong argument for the renewable energy source researched, including providing at least one counter argument with rebuttal. Each task includes an essay organizer to support students in writing an argumentative essay. The SBAC Argumentative rubric is included for scoring student work.

Teachers may want to assign additional research for the students prior to writing their essays. Otherwise, students can draw from the information provided in the performance task.

Each task includes a suggested field experience so that students may learn firsthand about the various renewable energy resources. If you are unable to conduct the field experience, you may want to create a virtual experience for the students where they investigate how the renewable energy resource is affecting their local communities.

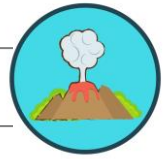
Field Investigations are being developed for each task. These will be posted on the PEI website as they are created. The field investigations will focus on the science behind energy production and align with the NGSS standards.

Teachers should implement the performance tasks in a time frame that works best for them. The original model from SBAC has students completing Part 1 on day 1 and Part 2 on day 2. This may be inadequate for diving deeply into the research materials and ELA skills. Most likely, each performance task will fit into a three to five-day time period.

The main purpose of these tasks is to integrate ELA skills, including reading, writing, listening and speaking, with science content. Think of the tasks as a gateway into a more in-depth study of renewable energy and an opportunity to practice and apply a wide variety of ELA skills. Make the materials work for you and for your students. And do feel free to contact PEI for additional support!



# Performance Task: Renewable Energy - Geothermal



## PART I: Research Student Directions

### Your Assignment:

Your County Council is investigating renewable energy options for the future. The council has asked middle school students to research the pros and cons for different types of renewable energy. **You will focus on geothermal energy.** You will research this type of energy, determine the pros and cons, and share your findings with the county counsel in the form of an argumentative essay.

### Steps you will follow:

To plan and compose your speech, you will do the following:

1. Read an article, an infographic, and a pro-con list and watch two videos.
2. Answer three questions about the sources.
3. Participate in a suggested field experience.
4. Write your essay.



### Directions for beginning:

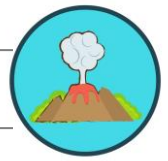
You will now watch two videos, read the article, the pro-con list, and the infographic, taking notes with the template provided. You may refer to the sources and your notes when writing your essay.

### Source Information:

- Source #1: **Article:** *Geothermal Energy* adapted from EPA Climate Change Solutions and the US Energy Information Administration, *Geothermal Energy Explained*. [Source Link](#)
- Source #2: *Geothermal Energy Pros and Cons* adapted from <http://energyinformative.org/geothermal-energy-pros-and-cons/>
- Source #3: Infographic: *Energy that Works Around the Clock* <https://www.proudgreenbuilding.com/news/infographic-geothermal-works-around-the-clock/>
- Source #4: **Video:** Energy 101: Geothermal Energy (3:47) <https://youtu.be/polGsJcFBLQ>  
**Alternative Video:** *Introduction to Geothermal Energy - Borealis GeoPower* (2:32) [https://youtu.be/vmmlYNsL\\_IU](https://youtu.be/vmmlYNsL_IU)
- Source #5: **Career Video:** *Geothermal Energy Association: Careers in Geothermal Energy* [https://youtu.be/wl\\_ICCjhlfk](https://youtu.be/wl_ICCjhlfk) (3:57)



# Performance Task: Renewable Energy - Geothermal

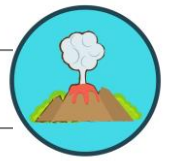


## Note-taking Tool

| Source  | How Geothermal Energy Works | Pros of Geothermal Energy | Cons of Geothermal Energy |
|---|-----------------------------|---------------------------|---------------------------|
| <b>Source #1:</b><br>Article:<br>Geothermal<br>Energy                         |                             |                           |                           |
| <b>Source #2:</b><br>Pro-Con List -<br>Geothermal<br>Energy                   |                             |                           |                           |
| <b>Source #3:</b><br>Infographic:<br>Energy that<br>Works Around<br>the Clock |                             |                           |                           |



# Performance Task: Renewable Energy - Geothermal



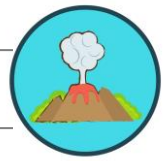
| Source  | How Geothermal Energy Works | Pros of Geothermal Energy | Cons of Geothermal Energy |
|---|-----------------------------|---------------------------|---------------------------|
| <b>Source #4:</b><br>Video – What is Geothermal Energy? |                             |                           |                           |

## Career Video Note-taking Tool

| Source  | Types of Jobs | Key qualifications | Benefits of working in this industry |
|---|---------------|--------------------|--------------------------------------|
| <b>Source #5: Career Video</b> – Geothermal Energy Association Careers in Geothermal Energy |               |                    |                                      |



# Performance Task: Renewable Energy - Geothermal



## Source #1: Article - Geothermal Energy

Sources: [US Energy Information Administration](#) and the [Environmental Protection Agency](#)

If you were to dig a big hole straight down into the Earth, you would notice the temperature getting warmer the deeper you go. That's because the inside of the Earth is full of heat. This heat is called geothermal energy.

The word geothermal comes from the Greek words geo (earth) and thermal (heat). Geothermal energy is heat within the earth. People can use this heat as steam or hot water to heat buildings or to generate electricity.

Geothermal energy is a renewable energy source because heat is continuously produced inside the earth.

### People can capture geothermal energy through:

**Geothermal power plants**, which use heat from deep inside the Earth to generate steam to make electricity.

**Geothermal heat pumps**, which tap into heat close to the Earth's surface to heat water or provide heat for buildings.

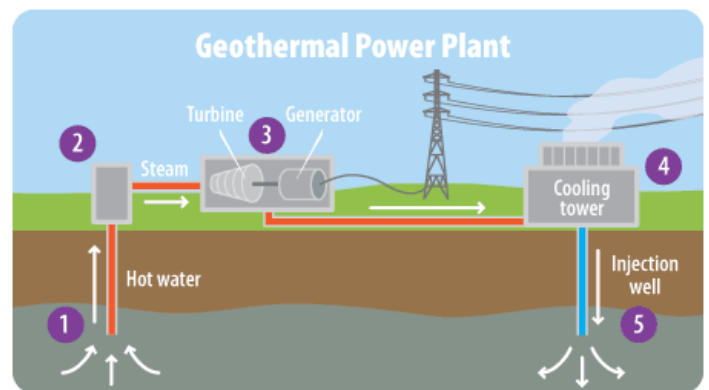


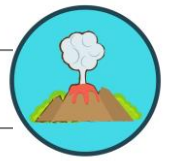
### Geothermal Power Plants

At a geothermal power plant, wells are drilled 1 or 2 miles deep into the Earth to pump steam or hot water to the surface. You're most likely to find one of these power plants in an area that has a lot of hot springs, geysers, or volcanic activity, because these are places where the Earth is particularly hot just below the surface.

### How Geothermal Power Plants Work

1. Hot water is pumped from deep underground through a well under high pressure.
2. When the water reaches the surface, the pressure is dropped, which causes the water to turn into steam.
3. The steam spins a turbine, which is connected to a generator that produces electricity.
4. The steam cools off in a cooling tower and condenses back to water.
5. The cooled water is pumped back into the Earth to begin the process again.





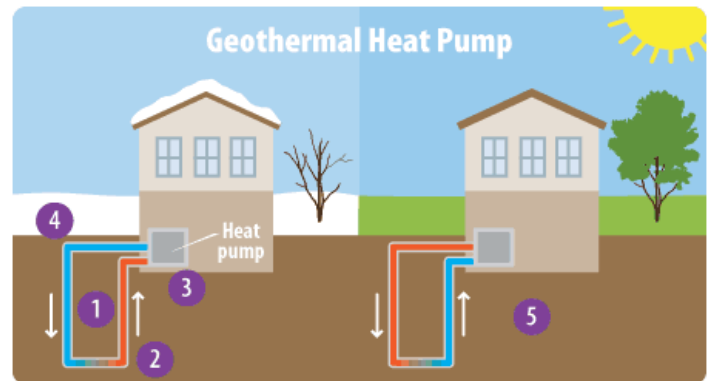
## Geothermal Heat Pumps

Not all geothermal energy comes from power plants. Geothermal heat pumps can do all sorts of things—from heating and cooling homes to warming swimming pools. These systems transfer heat by pumping water or a refrigerant (a special type of fluid) through pipes just below the Earth's surface, where the temperature is a constant 50 to 60°F.

During the winter, the water or refrigerant absorbs warmth from the Earth, and the pump brings this heat to the building above. In the summer, some heat pumps can run in reverse and help cool buildings.

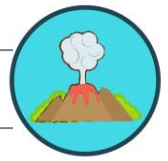
## How Heat Pumps Works

1. Water or a refrigerant move through a loop of pipes.
2. When the weather is cold, the water or refrigerant heats up as it travels through the part of the loop that's buried underground.
3. Once it gets back above ground, the warmed water or refrigerant transfers heat into the building.
4. The water or refrigerant cools down after its heat is transferred. It is pumped back underground where it heats up once more, starting the process again.
5. On a hot day, the system can run in reverse. The water or refrigerant cools the building and then is pumped underground where extra heat is transferred to the ground around the pipes.



## Geothermal heat pumps are energy efficient and cost effective

According to the U.S. Environmental Protection Agency (EPA), geothermal heat pumps are the most energy-efficient, environmentally clean, and cost-effective systems for heating and cooling buildings. All types of buildings, including homes, office buildings, schools, and hospitals, can use geothermal heat pumps.



## Where Geothermal Energy Is Found

Geothermal reservoirs These reservoirs are deep underground and are largely undetectable above ground.

Geothermal energy finds its way to the earth's surface in three ways:

- Volcanoes and fumaroles (holes in the earth where volcanic gases are released)
- Hot springs
- Geysers

## Most geothermal resources are near tectonic plate boundaries

The most active geothermal resources are usually found along major tectonic plate boundaries where most volcanoes are located. One of the most active geothermal areas in the world is called the Ring of Fire, which encircles the Pacific Ocean.



When magma comes near the earth's surface, it heats ground water trapped in porous rock or water running along fractured rock surfaces and faults. Hydrothermal features have two common ingredients, water (hydro) and heat (thermal).

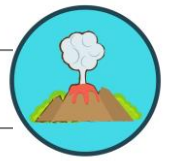
Geologists use various methods to find geothermal reservoirs. Drilling a well and testing the temperature deep underground is the most reliable method for locating a geothermal reservoir.

## Cool Facts

**Looking to the past.** People have used geothermal energy for thousands of years. Ancient Romans, Chinese, and Native American cultures used hot mineral springs for bathing, cooking, and eating.

**Hot stuff!** Most people in Iceland use geothermal energy to heat water and buildings.

**Regional News!** Most of the geothermal power plants in the United States are in western states. California generates the most electricity from geothermal energy. The Geysers dry steam reservoir in Northern California is the largest known dry steam field in the world and has been producing electricity since 1960.



## Source #2: Geothermal Energy Pros and Cons List

### Advantages of Geothermal Energy:

#### 1. Environmentally Friendly

Geothermal energy is generally considered environmentally friendly. There are a few polluting aspects of harnessing geothermal energy, but these are minor compared to the pollution associated with conventional fuel sources (e.g. fossil fuels) The carbon footprint of a geothermal power plant is minimal. Further development of our geothermal resources is considered helpful in the fight against global warming.

#### 2. Renewable and Sustainable

Geothermal reservoirs come from natural resources within the earth and are naturally replenished. Geothermal energy is therefore a renewable energy source. Sustainable is another label used for renewable sources of energy. In other words, geothermal energy is a resource that can sustain its own consumption rate- Unlike conventional energy sources such as coal and fossil fuels. According to scientists, the energy in our geothermal reservoirs will literally last billions of years.

#### 3. Massive Potential

Worldwide energy consumption is about 15 terawatts (TW)- There is a worldwide potential of producing 2 TW through geothermal energy. However, most geothermal reservoirs are not profitable, and we can only utilize a small portion of the total potential. Finding profitable ways to deliver geothermal energy will help to realize its potential.

#### 4. Stable

Geothermal energy is a reliable source of energy. We can predict the power output of a geothermal power plant with remarkable accuracy. This is not the case with solar and wind energy where weather plays a huge part in power production.

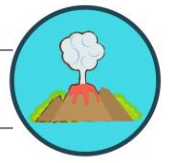
#### 5. Great for Heating and Cooling

There is a tremendous growth in the number of homeowners that utilize geothermal heating and cooling in the last couple of years. Heat pumps are a popular alternative to using coal or natural gas for heating and cooling.

#### 6. Costs are Coming Down

Technology advancements have lowered the cost of geothermal energy.





## Disadvantages of Geothermal Energy

### 1. Environmental Issues

There is a large amount of greenhouse gases below the surface of the earth, some of which travels to the surface and into the atmosphere. These emissions tend to be higher near geothermal power plants. Geothermal power plants are associated with sulfur dioxide and silica emissions, and the reservoirs can contain traces of toxic heavy metals including mercury, arsenic, and boron. However, even with these trace amounts of pollutants, the pollutions associated with geothermal power is nowhere near what we see with coal power and fossil fuels.

### 2. Surface Instability (Earthquakes)

Construction of geothermal power plants can affect the stability of land. In fact, geothermal power plants have led to subsidence or motion of the earth's surface in both Germany and New Zealand. Earthquakes can be triggered due to hydraulic fracturing, which is an intrinsic part of developing enhanced geothermal system power plants. In January 1997, the construction of a geothermal power plant in Switzerland triggered an earthquake with a magnitude of 3.4 on the Richter scale.

### 3. Location Specific

Good geothermal reservoirs are hard to come by. Some countries have been blessed with great resources. For example, Iceland and Philippines meet nearly one third of their electricity demand with geothermal energy.

### 4. Sustainability Issues

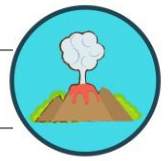
Rainwater seeps through the earth's surface and into the geothermal reservoirs over thousands of years. Studies show that the reservoirs can be depleted if the fluid is removed faster than replaced. Efforts can be made to inject fluid back into the geothermal reservoir after the thermal energy has been utilized (the turbine has generated electricity). Geothermal power is sustainable if reservoirs are properly managed.

### In Summary:

The bottom line is this: Geothermal energy is generally regarded as environmentally friendly, sustainable and reliable. This makes geothermal energy a no-brainer in some places, but heavy upfront costs stop us from realizing the full potential. How much influence geothermal power will have on our energy systems in the future depends on technological advances, energy prices and politics (subsidies).



# Performance Task: Renewable Energy - Geothermal



Source #3: Infographic: Geothermal Energy

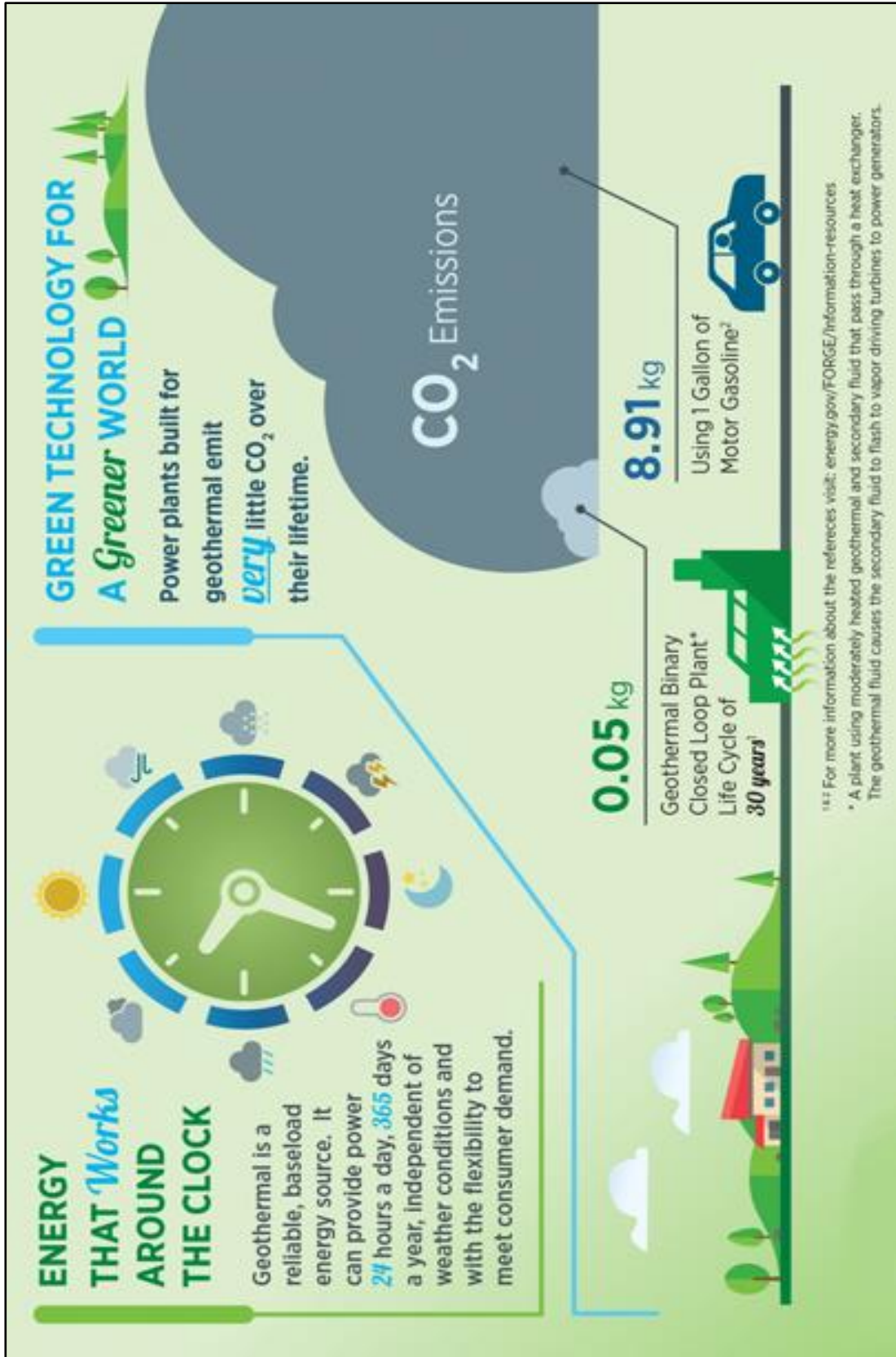
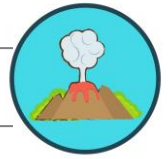


Image Credit: [The National Archives](http://The National Archives)









## **PART 2: Renewable Energy Field Experience**

Arrange to take your students a site where geothermal energy can be observed such as a place where heat pumps are used to generate power. Plan the field experience prior to the students writing their essays. Encourage the students to use information they learn about the benefits of geothermal energy, including employment opportunities, in their essays.

### Field Experience Note-taking Template

Site Visited:

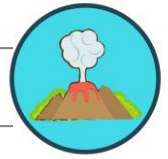
Date and Time:

Benefits of geothermal energy:

Challenges we face using geothermal energy:

How these challenges are being addressed:

Career opportunities in the geothermal energy field:



## PART 3: Essay

### Student Directions:

You will review your notes and plan your argumentative essay. You may use notes from the resources and from the field investigation to write your essay. You may also refer to the sources. Read your assignment and the information about how your essay will be scored. Then begin your work.



### Your assignment:

You have been asked by the County Council to research the pros and cons of geothermal energy and to make a case for continuing to use and expand this type of renewable energy. Your essay should persuade your reader to support geothermal energy production and include the following

- Explain what geothermal energy is and why it is considered renewable.
- Identify a few important pros and one significant con, providing a counter argument to the con.
- Convince the reader why it is important to use geothermal energy as a valuable renewable resource. Consider location, impact on the environment, and potential employment opportunities.

Use the planning template to help you to compose your essay.

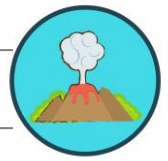
### How your essay will be scored:

1. **Statement of Purpose/Focus** – how well you clearly state and maintain your claim including addressing counter arguments,
2. **Organization** – how well the ideas progress from the introduction to the conclusion using effective transitions and how well you stay on topic throughout the essay.
3. **Elaboration of Evidence** – how well you provide evidence from source about your claim and elaborate with specific information.
4. **Language and Vocabulary** – how well you effectively express ideas using precise language that is appropriate for your audience and purpose.
5. **Conventions** – how well you follow the rules of usage, punctuation, capitalization, and spelling.

### Now begin work on your essay.

- Review your notes
- Plan your essay using the template provided
- Write your essay
- Revise and edit for a final draft





## Planning My Essay

### Essay Components:

Introduction: Capture the reader's interest!

Explain what geothermal energy is and how it is a renewable resource.

State the argument for geothermal energy, including at least three strong pros. Consider access, impact on the environment, and employment opportunities.

1.

2.

3.

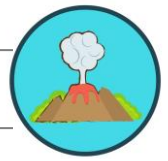
Identify an important con of geothermal energy and provide a counter argument to this con:

Provide a persuasive conclusion:





# Performance Task: Renewable Energy - Geothermal



## Argumentative Writing Rubric (Grades 6–11) Scoring Version

| Score                      | 4  | 3   | 2   | 1  |
|----------------------------|--|---|---|--|
| Statement of Purpose/Focus | <p>The response is fully sustained and consistently and purposefully focused:</p> <ul style="list-style-type: none"> <li>claim is introduced clearly communicated, and the focus is strongly maintained for the purpose, audience, and task</li> <li>alternate or opposing argument(s) are clearly acknowledged or addressed*</li> </ul>   | <p>The response is adequately sustained and generally focused:</p> <ul style="list-style-type: none"> <li>claim is clear and the focus is mostly maintained for the purpose, audience, and task</li> <li>alternate and opposing argument(s) are adequately acknowledged or addressed*</li> </ul>  | <p>The response is somewhat sustained and may have a minor drift in focus:</p> <ul style="list-style-type: none"> <li>claim may be somewhat unclear, or the focus may be insufficiently sustained for the purpose, audience, and task</li> <li>alternate and opposing argument(s) may be confusing or not acknowledged*</li> </ul>  | <p>The response may be related to the purpose but may provide little or no focus:</p> <ul style="list-style-type: none"> <li>claim may be confusing or ambiguous; may be too brief or the focus may drift from the purpose, audience, or task</li> <li>alternate and opposing argument(s) may not be acknowledged*</li> </ul>  |
| Organization               | <p>The response has a clear and effective organizational structure, creating a sense of unity and completeness:</p> <ul style="list-style-type: none"> <li>consistent use of a variety of transitional strategies to clarify the relationships between and among ideas</li> <li>effective introduction and conclusion</li> <li>logical progression of ideas from beginning to end; strong connections between and among ideas with some syntactic variety</li> </ul> | <p>The response has an evident organizational structure and a sense of completeness, though there may be minor flaws and some ideas may be loosely connected:</p> <ul style="list-style-type: none"> <li>adequate use of transitional strategies with some variety to clarify relationships between and among ideas</li> <li>adequate introduction and conclusion</li> <li>adequate progression of ideas from beginning to end; adequate connections between ideas</li> </ul> | <p>The response has an inconsistent organizational structure, and flaws are evident:</p> <ul style="list-style-type: none"> <li>inconsistent use of transitional strategies and/or little variety</li> <li>introduction and conclusion, if present, may be weak</li> <li>uneven progression of ideas from beginning to end; and/or formulaic; inconsistent or unclear connections among ideas</li> </ul>  | <p>The response has little or no discernible organizational structure:</p> <ul style="list-style-type: none"> <li>few or no transitional strategies are evident</li> <li>introduction and conclusion, if present, may be missing</li> <li>frequent extraneous ideas may be evident; ideas may be randomly ordered or have unclear progression</li> </ul>                                       |
| Elaboration of Evidence    | <p>The response provides thorough and convincing support/evidence for the argument(s) and claim that includes the effective use of sources (facts and details).</p> <ul style="list-style-type: none"> <li>comprehensive evidence from sources is integrated; references are relevant, and specific</li> <li>effective use of a variety of elaborative techniques**</li> </ul>   | <p>The response provides adequate support/evidence for the argument(s) and claim that includes partial or uneven use of sources (facts and details).</p> <ul style="list-style-type: none"> <li>adequate evidence from sources is integrated; some references may be general</li> <li>adequate use of some elaborative techniques**</li> </ul>  | <p>The response provides uneven, cursory support/evidence for the argument(s) and claim that includes partial or uneven use of sources (facts and details).</p> <ul style="list-style-type: none"> <li>some evidence from sources may be weakly integrated, imprecise, or repetitive; references may be vague</li> <li>weak or uneven use of elaborative techniques**; development may consist primarily of source summary or may rely on emotional appeal</li> </ul> | <p>The response provides minimal support/evidence for the argument(s) claim that includes little or no use of sources (facts and details).</p> <ul style="list-style-type: none"> <li>evidence from source material is minimal or irrelevant; references may be absent or incorrectly used</li> <li>minimal, if any, use of elaborative techniques**; emotional appeal may dominate</li> </ul> |
| Language                   | <p>The response clearly and effectively expresses ideas, using precise language:</p> <ul style="list-style-type: none"> <li>vocabulary is clearly appropriate for the audience and purpose</li> <li>effective, appropriate style enhances content</li> </ul>   | <p>The response adequately expresses ideas, employing a mix of precise with more general language:</p> <ul style="list-style-type: none"> <li>vocabulary is generally appropriate for the audience and purpose</li> <li>generally appropriate style is evident</li> </ul>   | <p>The response expresses ideas unevenly, using simplistic language:</p> <ul style="list-style-type: none"> <li>vocabulary use is uneven or somewhat ineffective for the audience and purpose</li> <li>inconsistent or weak attempt to create appropriate style</li> </ul>  | <p>The response's expression of ideas is vague, lacks clarity, or is confusing:</p> <ul style="list-style-type: none"> <li>vocabulary is limited or ineffective for the audience and purpose</li> <li>little or no evidence of appropriate style</li> </ul>  |
| Score                      | 2  | 1   | 0   |  |
| Conventions                | <p>The response demonstrates a command of conventions:</p> <ul style="list-style-type: none"> <li>adequate use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling</li> </ul>  | <p>The response demonstrates partial command of conventions:</p> <ul style="list-style-type: none"> <li>limited use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling</li> </ul>  | <p>The response demonstrates little or no command of conventions:</p> <ul style="list-style-type: none"> <li>infrequent use of correct sentence formation, punctuation, capitalization, grammar usage, and spelling</li> </ul>  |  |
| NS                         | <p>Unintelligible, in a language other than English, off-topic, insufficient evidence (incomplete) or copied text. (Off-purpose writing will still receive a score in Conventions).</p>  |   |   |  |

\* Acknowledging and/or addressing the opposing point of view begins at grade 7

\*\* Elaborative techniques may include the use of personal experiences that support the controlling idea