

## High-Adventure Science: Systems Thinking Questions

Do not put your name on this assessment!

Teacher: \_\_\_\_\_ Class Period: \_\_\_\_\_

Gender: \_\_\_\_ Male \_\_\_\_ Female

Do you speak English as your first language? \_\_\_\_ yes \_\_\_\_ no

Do you often use computers for science learning? \_\_\_\_ yes \_\_\_\_ no

## Climate Systems 1

The image shows a portion of Earth. Some is covered by water (dark grey on left). Some is covered by land (light grey in center). Some is covered by ice (white).



1. Energy comes from the Sun and interacts with Earth and gases in the atmosphere.
  - a. Identify individual parts of the Earth system.
  - b. Draw arrows to show how energy flows throughout the system.
2. Using your diagram, explain the flow of energy throughout parts of the Earth system.
- 3a. Predict what might happen to the temperature in this region if the ice melted completely.

The temperature would

- ☐ increase.
- ☐ decrease.
- ☐ stay about the same.

- 3b. Explain your prediction based on changes that might occur to the flow of energy in the Earth system as the ice melts.

## Climate Systems 2



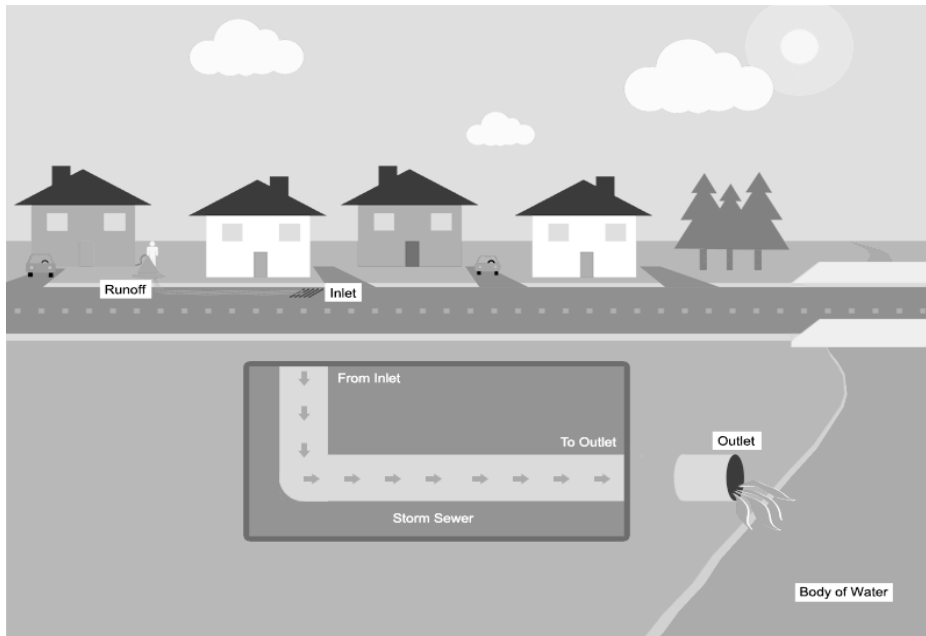
1. The image above shows a portion of the Earth system with water and clouds.
  - a. Circle and label the parts of Earth's climate system.
  - b. Draw arrows to show how water moves around the system and affects the temperature.
2. Using your diagram, explain how water vapor and cloud cover can be both a cause **and** an effect of global warming.
- 3a. Predict what would happen if there is an increase in the amount of clouds.

The temperature will show

  - ☐ a warming trend.
  - ☐ a cooling trend.
  - ☐ both a warming and a cooling trend.
  - ☐ no warming or cooling trend.
- 3b. Explain your prediction based on how an increase in the amount of clouds can change energy distribution throughout Earth's system shown on your diagram.

## Water Systems 1

In urban and suburban areas, the impervious surfaces created by buildings and pavement change the flow of rainwater and snowmelt in the landscape.



1. Draw arrows on this picture to show all the possible ways that water from a heavy rainstorm can flow.

2. Using your diagram, describe the flow of water in this environment.

3a. Land cover can change the stream flow.

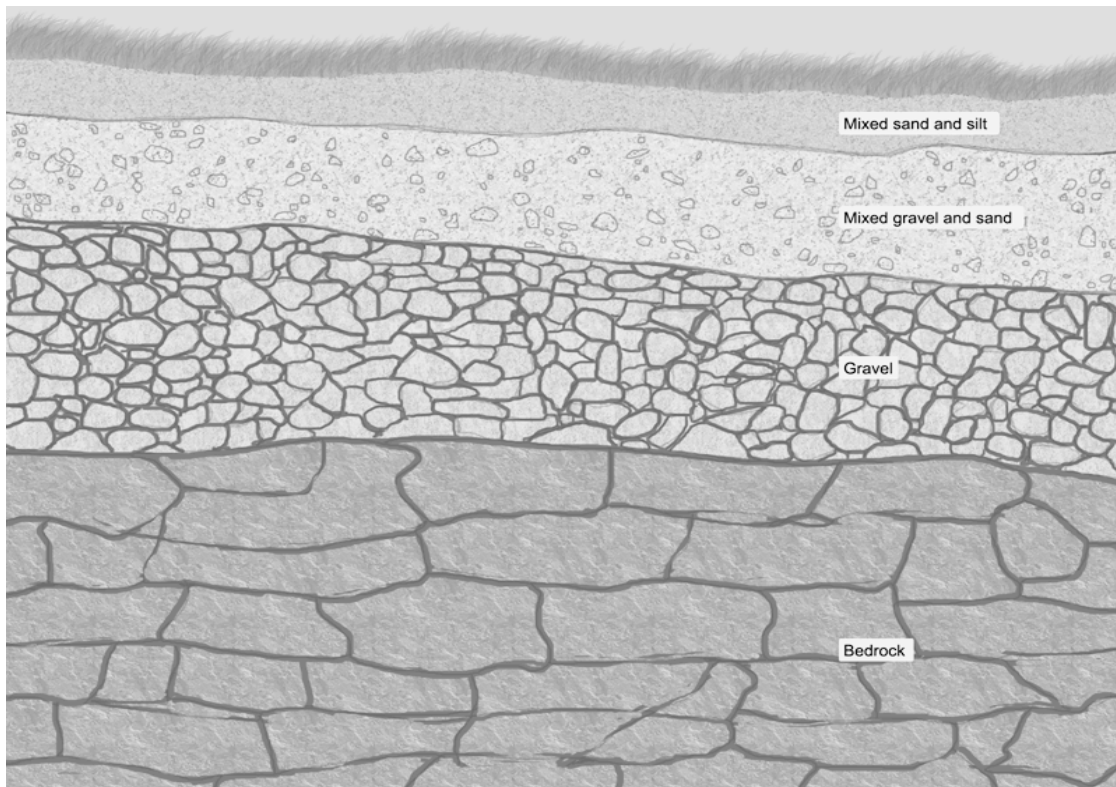
Predict what might happen to the amount of water in the stream and groundwater if a larger portion of the landscape was covered by pavement.

- \_\_\_ stream level decrease; groundwater level decrease
- \_\_\_ stream level decrease; groundwater level increase
- \_\_\_ stream level increase; groundwater level decrease
- \_\_\_ stream level increase; groundwater level increase

3b. Explain your prediction based on changes that might occur to the flow of water with increased amounts of pavement.

## Water Systems 2

Whether water flows into the ground or across the surface is affected by the amount of rain, as well as the types, thicknesses, and water contents of soil and sediment layers under the ground. The picture shows a cross-section of a plot of land. A light rain falls on the area shown in the picture.



1. Draw arrows to show the flow of water through the layers. Use arrow thickness to indicate the amount of water that can penetrate each layer (thicker for more infiltration, thinner for less infiltration).

2. Using your diagram, describe how the flow of water would change in a heavy rainstorm.

3a. Predict how the flow of water would change if the top layer was clay.

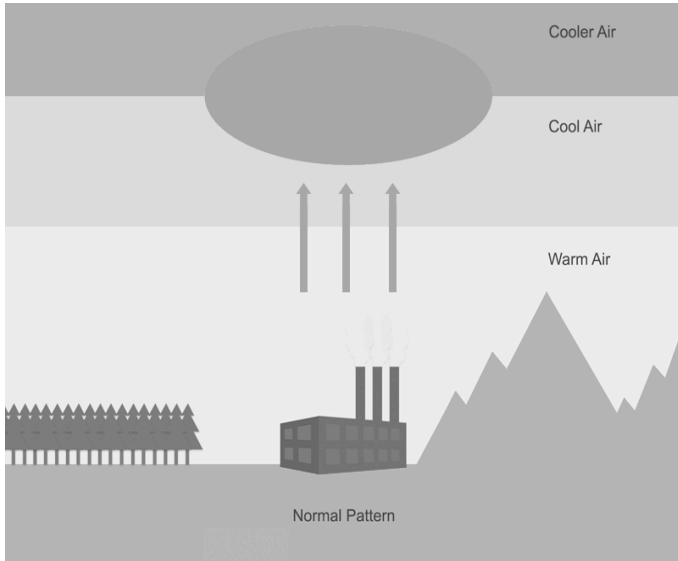
Water would

- ☐ not flow into the ground.
- ☐ flow into the ground at a much slower rate.
- ☐ flow into the ground at a much faster rate.
- ☐ flow into the ground at about the same rate.

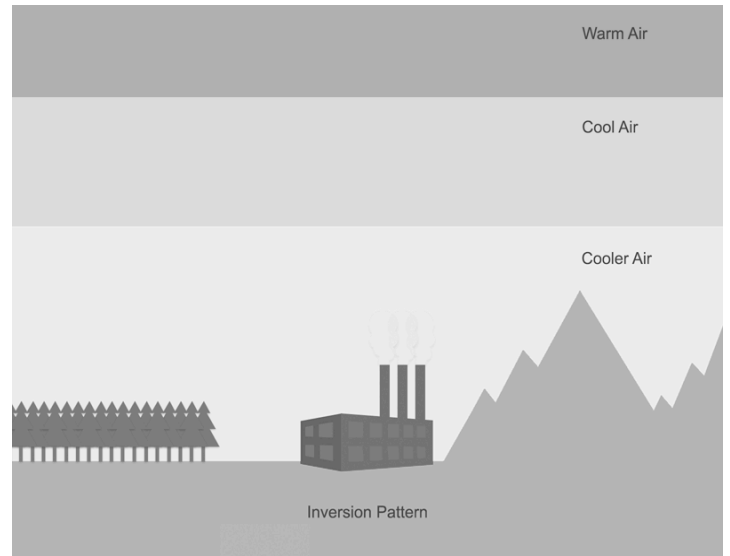
3b. Explain your prediction based on the porosity and permeability of different layers.

## Atmosphere Systems 1

Figure A shows that air typically cools with elevation. The arrows indicate how pollutants from the smokestacks on the ground move through the air. Figure B shows a reversed temperature pattern.



**Figure A.**



**Figure B.**

1. Draw arrows to show how pollutants would move in the inverted air layers in Figure B.
  2. Using your diagram, describe how pollutants would move in Figure B. Include how the mountains (on the right) might play a role in how pollutants flow in this area.
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- 3a. The city decides to build a wall on its left side (the side without the mountains) to quiet noise from a nearby highway. Predict what might happen to air quality in the city if the wall is built.

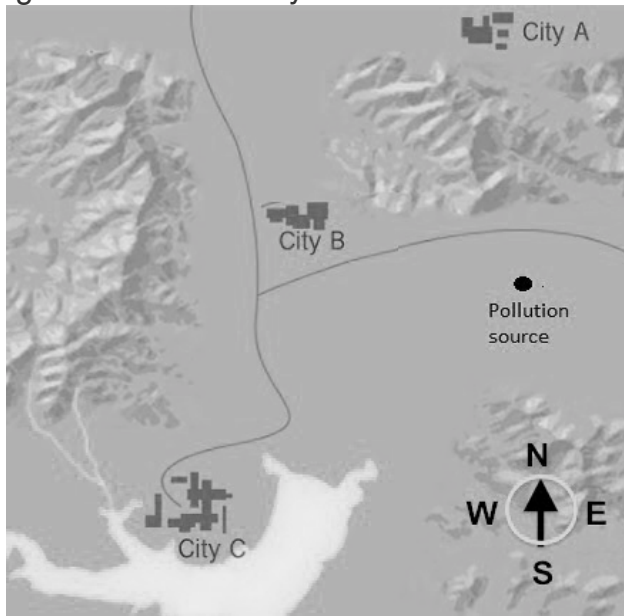
Air quality will

- ☐ get worse.
- ☐ get better.
- ☐ stay about the same.

- 3b. Explain your prediction based on changes that might occur to the flow of pollutants as a result of building the wall.

## Atmosphere Systems 2

The image shows a bird's eye view of three cities and a pollution source.



1. Draw arrows to show the flow of pollutants from the pollution source when winds are blowing from the southeast.

2. City A asserts that the smokestack near City B is the biggest source of pollution in City A. Do you agree?

\_\_\_yes  
\_\_\_no

Using your diagram, explain your choice.

3a. Temperature inversions occur when the air at lower altitudes is cooler than the air at higher altitudes.

Predict which city is most likely to experience temperature inversions.

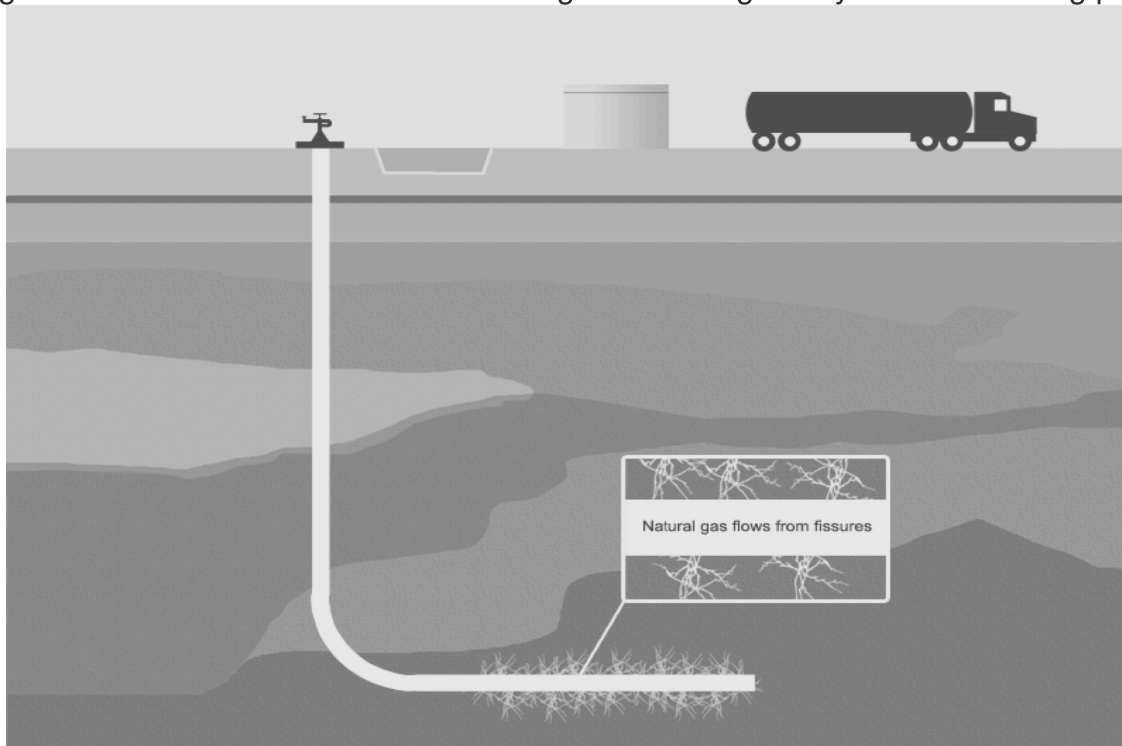
\_\_\_City A  
\_\_\_City B  
\_\_\_City C

3b. Explain your prediction based on the topography, geography, and airflow in the diagram.

## Energy Systems 1

The image shows a horizontal drilling and hydraulic fracturing operation.

Millions of gallons of water move in and out of the ground during the hydraulic fracturing process.



1. Draw arrows to show the flow of water in the hydraulic fracturing process and what happens to the water after the fracturing is completed.

2. Using your diagram, describe how the water flows throughout the system.

3a. There is concern that fluids, chemically-contaminated from the drilling process, might have moved up from the fracturing zone to contaminate the drinking water. The water table is shown as a blue layer just below the ground.

Based on your diagram, what is the likelihood that contaminants would move from the horizontal wells and hydraulic fractures to the water table?

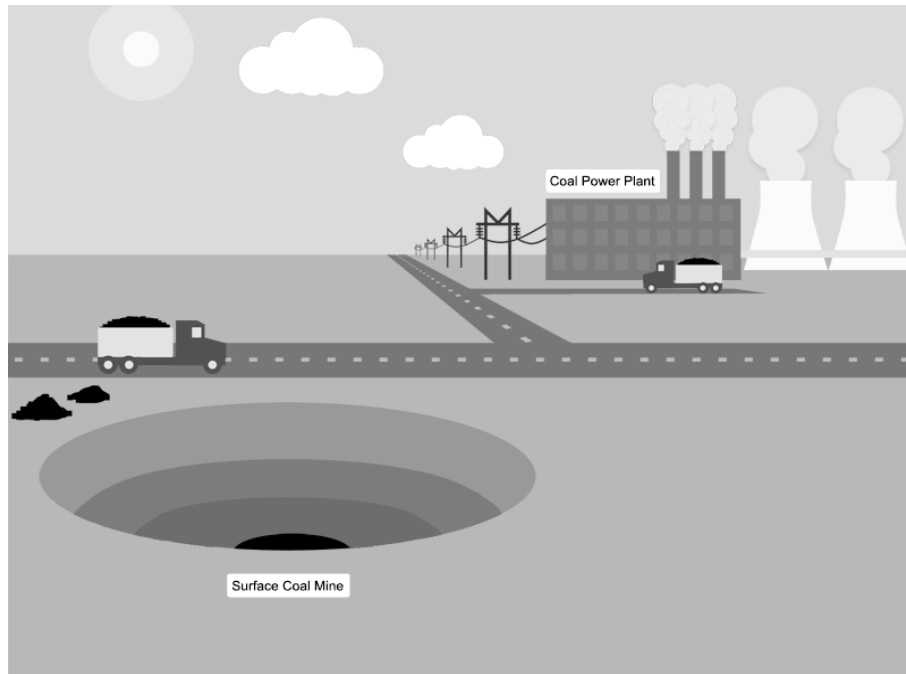
- ☐ very likely
- ☐ likely
- ☐ not likely

3b. Explain your prediction using your diagram.



## Energy Systems 2

The image shows a coal-based energy system, from collecting coal from the source (the mine) to generating electricity at the power plant.



1. Circle and label several different locations in the diagram to identify places where the coal-based energy system interacts with the environment.

2. Describe how each location you circled in the diagram interacts with the environment.

3a. Improving the efficiency of coal-fired power plants has been a focus for the coal industry. Energy-efficiency changes allow more electricity to be generated from less coal.

From the diagram, predict how efficient power plants might affect the environment. (Select all that apply.)

Energy-efficient power plants will

- ☐ improve air quality.
- ☐ reduce habitat destruction.
- ☐ improve water quality.
- ☐ lower greenhouse gas emissions.

3b. Explain your reason(s) for your prediction(s) using your diagram.