Working with Diagrams

Much of what you learn in school is presented as written text. However, information can also be presented in other ways. *Visuals*, such as diagrams, photographs, and maps, are also important ways to communicate scientific information or data.

**Reading Diagrams**

A diagram is a labeled illustration. Diagrams use pictures to show information such as the parts of an object or stages of a process. A diagram may show information that is described in writing. It may be used in place of words to provide you with information about a subject.

**Diagrams That Show an Object**

The first step in reading a diagram is to identify the subject or topic of the diagram. Often this information is presented in a title. Sometimes knowing the title is all you need to answer a question correctly.

**Example** Look at the title of the diagram shown below. What is the subject or topic of the diagram?

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The Human Skeleton

- **Skull**
- **Collarbone**
- **Upper arm bone**
- **Shoulder blade**
- **Rib**
- **Backbone**
- **Hip bone**
- **Wrist bones**
- **Thigh bone**
- **Ankle bones**

*About 206 bones make up the human skeleton.*

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**Content Clues**

The skeleton supports the human body, gives it shape, and protects the internal organs.

The ribs form a "cage" that protects the lungs and other internal organs.

Bones are connected at the joints. This gives the skeleton flexibility and allows it to move.
The labels on diagrams are words or phrases that provide details about the subject of the diagram, such as the names of different parts of the object being shown. In most cases lines connect the labels to the parts they are identifying.

Look at the labels on the diagram of the skeleton. What kinds of information or details do they give you about the skeleton?

Many diagrams also have a third part, called a caption. The caption usually appears below the diagram. A caption is a sentence or a phrase that gives you more information about the diagram shown. Captions often sum up what the diagram shows. What does the caption for the illustration on page 42 tell you?

Diagrams That Compare and Contrast
Sometimes you might be given a diagram that compares and contrasts.

Example The following diagram compares the Fahrenheit temperature scale with the Celsius temperature scale.

<table>
<thead>
<tr>
<th>TEMPERATURE SCALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fahrenheit</td>
</tr>
<tr>
<td>40°F</td>
</tr>
<tr>
<td>32°F</td>
</tr>
<tr>
<td>0°F</td>
</tr>
<tr>
<td>-20°F</td>
</tr>
<tr>
<td>-40°F</td>
</tr>
</tbody>
</table>

To tell someone how to convert from Fahrenheit to Celsius, you would need to write a procedure such as this one:

1. Subtract 32 from the Fahrenheit number.
2. Divide your answer by 9.
3. Multiply your answer by 5.

This procedure may be useful, but it does not give you a clear picture of how the two scales are related. By showing them together on a diagram, you can more easily see, for example, that 0 degrees Celsius and 32 degrees Fahrenheit are both the freezing point of water. What is the boiling point of water on each scale? ________
This diagram shows the relationship between the two temperature scales. It could also be used as a tool for converting from one scale to the other. How do you think using the diagram to convert would compare in terms of accuracy to actually doing the calculations?

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**Diagrams That Show a Process**

Some diagrams show information about a process.

**Example** The following diagram shows the life cycle of a butterfly. What part of the diagram tells you the subject of the diagram?

This diagram has arrows in addition to labels. Symbols such as arrows are often used in diagrams to indicate processes or change. Look at the labels and the symbols. What do these labels tell you must occur before the caterpillar becomes a butterfly?

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**LIFE CYCLE OF A BUTTERFLY**

![Diagram of the life cycle of a butterfly]

During the process called metamorphosis, an egg hatches into a caterpillar. The caterpillar will eventually become a butterfly and lay its own eggs.

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**Test Tip**

In a cycle or flowchart diagram, the direction of the arrows is very important. Arrows point from one step to the next. Between steps a change occurs.

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Some process diagrams are used to show how to make or do something. Often it is easier to demonstrate a task using a picture than it is to write step-by-step instructions. More often a picture or diagram is needed to make step-by-step instructions easier to understand.
Example  The diagram below shows how to make a worm habitat, or wormery, from a shoebox. Wormeries can be used to study food chains.

This type of diagram usually has a list of materials needed for the task. The sizes of the parts are usually shown in true proportion to one another. For example, the layers of potting soil are much thicker than the layers of sand. Another way of saying this is that the diagram is "drawn to scale."

A WORMERY

Materials Needed:
Shoebox with lid
Adhesive tape
Pen
Scissors
Empty plastic bottle
1 cup of sand
Dry leaves
3 cups of damp potting soil
4 small cubes of potato and apple
2 or 3 earthworms

Holes
Lid taped to box

Apple and potato cubes
Dry leaves
Damp soil 5 cm
Sand between each layer 1 cm

Bottle

Do you think you could make a wormery by just using the materials list and diagram? __________________________

Based on the diagram, how do you think you would use a wormery? __________________________

A well-planned instruction diagram can replace most written instructions. This type of diagram is usually included with products that need to be assembled by the buyer.

Very often there will be no written instructions. Even the list of materials and the tools needed for assembly will be shown as pictures. A diagram like this one eliminates the need to include instructions in several different languages.

Content Clue
Earthworms live in warm, moist soil. They churn up the ground and make it more fertile as they eat decaying plant matter and soil.

Test Tip
Assembly-instruction diagrams often use arrows to show the sequence of assembly.
Practice
Living and Nonliving Things

Base your answers to questions 1–4 on the diagram below, which compares an animal cell with a plant cell.

**Test Tip**
 Sometimes the drawings in a diagram share labels. A line may point to one or both illustrations. If it points to both, the two drawings have that same part in common.

**Content Clue**
 Remember that plants are producers. They use water, carbon dioxide, chlorophyll, and the energy in sunlight to make their own food.

There are more similarities between plant and animal cells than there are differences.

1 Which cell part is present in the plant cell but not in the animal cell?
   1 vacuole
   2 cell membrane
   3 chloroplast
   4 nucleus

2 Which activity do plant cells perform that animal cells do not perform?
   1 respiration
   2 photosynthesis
   3 reproduction
   4 locomotion

3 Which cell part is larger in plant cells than in animal cells?
   1 cell membrane
   2 vacuole
   3 cytoplasm
   4 nucleus

4 What is the substance that surrounds the nucleus of the cell?
Practice

Genetic Information

The chart below shows sickle-cell anemia being passed through several generations of a family. Base your answers to questions 1–5 on this chart.

<table>
<thead>
<tr>
<th>Sickle-Cell Anemia Pedigree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
</tr>
<tr>
<td>II</td>
</tr>
<tr>
<td>III</td>
</tr>
<tr>
<td>IV</td>
</tr>
</tbody>
</table>

1 How many generations are represented in this chart?

2 How many carriers of the sickle-cell trait are in each generation?

3 How many people in the family were born with the disease of sickle-cell anemia?

4 From which parent did the second-generation children inherit the sickle-cell gene?

5 In which generation did sickle-cell anemia first actually appear?

Content Clue

A pedigree chart is used to study inherited diseases or disorders. It is similar to a "family tree." Other inherited disorders include color blindness and hemophilia.

Key:

- Normal Male
- Normal Female
- Parents
- Has the disease
- Carries gene for disease
- Offspring
- Generation
1, 2, 3 . . . Offspring
Practice
Change Over Time

The diagram below shows two undisturbed deposits of sedimentary rock that contain fossils. It also shows a fossil that might be found in a layer of this rock. Base your answers to questions 1–4 on this diagram.

1 In rock formation (1), which layer was deposited first? How do you know?

2 Read each statement below. Based on the diagram, which one is accurate?
   1 Fossils in Layer C are the same age as those in Layer L.
   2 Fossils in Layer B are the same age as those in Layer J.
   3 Fossils in Layer A were formed first.
   4 Fossils in Layer L are the same age as those in Layer E.

3 Which layers in rock formation (1) match the layers in rock formation (2)?
   1 A, B, and C
   2 B, C, and D
   3 C, D, and E
   4 A, C, and D

4 On a separate sheet of paper, explain how the trilobite fossil (3) could be used to determine the age of the rock layers. Keep in mind that scientists know when trilobites lived.
Reproduction and Development

The diagram below shows the parts of a flower. Study the flower parts; then answer questions 1–6.

1 Which flower part is the male reproductive organ?
   1 pistil  2 seed  3 stamen  4 ovary

2 How many stamens does this flower have?

3 Which flower part is the female reproductive organ?
   1 pistil  2 pollen  3 stamen  4 ovary

4 Many flowers are pollinated by insects. What role do the flower's petals have in that process?

5 How many ovules does this flower have?

6 Name the parts of the stamen.

Content Clue
Pollen contains the male reproductive cell. It is produced in the anther.

Content Clue
The ovule in seed-bearing plants is the container for the egg.
Practice

Meeting Daily Needs

The diagram below shows the skulls of several different animals. Study the teeth of these animals to answer questions 1–4 below.

**Mammal Adaptations**

- Horse
- Cat
- Squirrel
- Chimpanzee
- Human

1 Which of the mammals shown have large canine teeth for tearing?

2 How are the teeth in the diagram appropriate for each mammal’s diet? Use two specific examples from the diagram as part of your explanation.

3 Based on your answer to question 1 and what you already know, how would you classify humans?
   1 producers
   2 herbivores
   3 omnivores
   4 decomposers

4 All the mammals in the diagram are
   1 producers
   2 consumers
   3 omnivores
   4 decomposers

**Test Tip**

Read all of the questions before studying the diagram. Knowing the questions helps you focus on the parts of the diagram where you will find the answers.

**Content Clues**

- **Herbivores** eat only plants.
- **Carnivores** eat only meat.
- **Omnivores** eat both plants and meat.
Practice
Energy in Ecosystems

A food web shows feeding relationships among the species in a community. Study the food web diagram below, then answer questions 1–3.

1 Which of the following is a food chain within this food web?
   1 grasshopper → grass → rabbit
   2 snake → rabbit → hawk
   3 grass → mouse → owl
   4 mouse → hawk → snake

2 In which direction is energy flowing through this food web? Give an example that uses four of the organisms shown.

3 Explain what would happen in this food web if the grass became polluted. Assume that the pollutant does not kill the grass immediately. Which organisms will accumulate the most pollutant in their bodies?
Practice

Humans and the Environment

Study the map and table to answer questions 1–4.

<table>
<thead>
<tr>
<th>Biome</th>
<th>Average Yearly Rainfall</th>
<th>Average Yearly Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tundra</td>
<td>less than 25 cm</td>
<td>-25°C–4°C</td>
</tr>
<tr>
<td>Coniferous Forest</td>
<td>25–75 cm</td>
<td>-10°C–14°C</td>
</tr>
<tr>
<td>Deciduous Forest</td>
<td>75–125 cm</td>
<td>6°C–28°C</td>
</tr>
<tr>
<td>Tropical Rain Forest</td>
<td>200–450 cm</td>
<td>25°C–28°C</td>
</tr>
<tr>
<td>Grassland</td>
<td>25–75 cm</td>
<td>0°C–25°C</td>
</tr>
<tr>
<td>Desert</td>
<td>less than 25 cm</td>
<td>24°C–40°C</td>
</tr>
</tbody>
</table>

1 Which type of biome is found in the northeastern United States?

2 Which type of biome is found in northern Africa? How much rain would you expect to fall yearly in this biome?

3 Which biome receives the most yearly rainfall?

4 Which biome has the highest average temperatures?
Practice

The Earth and Space

Base your answers to questions 1–6 on the diagram below, which shows the solar system.

**THE SOLAR SYSTEM**

<table>
<thead>
<tr>
<th>A</th>
<th>Mercury</th>
<th>D</th>
<th>Mars</th>
<th>G</th>
<th>Uranus</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Venus</td>
<td>E</td>
<td>Jupiter</td>
<td>H</td>
<td>Neptune</td>
</tr>
<tr>
<td>C</td>
<td>Earth</td>
<td>F</td>
<td>Saturn</td>
<td>I</td>
<td>Pluto</td>
</tr>
</tbody>
</table>

**Test Tip**

Some diagrams have a key, or legend. The key is a list of labels set to one side or below the diagram.

1. Which is the largest planet?
   1. Pluto
   2. Earth
   3. Jupiter
   4. Sun

2. What is the star in this solar system called?
   1. Venus
   2. the Sun
   3. a comet
   4. Earth

3. Which is the sixth planet from the Sun?

4. Which letter in the legend indicates the planet Earth?

5. Between which two planets is the asteroid belt found?

6. Which object contains most of the matter in the solar system?
   1. Jupiter
   2. Mars
   3. Earth
   4. the Sun

**Content Clues**

Use this to remember the order of the planets: "My Very Enchanting Mother Just Served Us Nine Pizzas." The first letter of each word stands for a planet. For example, the M in My stands for Mercury.

The asteroid belt contains many thousands of rocklike objects that vary in size.
Practice

The Interaction of Air, Land, and Water

Base your answers to questions 1–4 on the diagram below, which shows the water cycle.

**THE WATER CYCLE**

Precipitation → Condensation → Evaporation → Runoff → Ocean

Water moves continuously between the atmosphere and the surface of the Earth.

1. As ocean water evaporates, it
   1. falls as rain
   2. rises
   3. forms a river
   4. moves toward the mountains

2. Clouds form by the process of
   1. evaporation
   2. the ocean
   3. condensation
   4. rain

3. What happens in the water cycle after water vapor rises?

   ______________________________________________________________________________________

4. Explain the movement of water in the water cycle.

   ______________________________________________________________________________________

**Test Tip**

Follow the arrows in a diagram to understand the order of the steps in the process being shown.

**Content Clue**

Evaporation is caused by heat energy from the Sun.

**Test Tip**

For a "short answer" question, if you are not sure how much to write, write at least one full sentence. Start your sentence by using part of the question in your answer. This is called "echoing the question."
Base your answers to questions 1–5 on the diagram of the carbon atom shown below.

1. How many electrons does this atom have?

2. What is carbon's atomic number? How can you tell?

3. How many other elements have the same atomic number as carbon? Explain your answer.

4. What is the mass number of carbon?

5. Compare the number of protons to the number of electrons in this atom. Is this atom neutral? Explain your answer.
Practice

Forms of Energy

The diagram below shows an electrical circuit, which is made up of a battery, a switch, two bulbs, and the wire connecting them. Study the diagram. Then answer questions 1–5 below.

**A N E L E C T R I C A L C I R C U I T**

1. Is this a series circuit or a parallel circuit?

2. If bulb (1) were to go out, bulb (2) would
   1. be brighter
   2. be dimmer
   3. remain the same
   4. go out

3. What would happen if you added a third bulb to this circuit?
   1. All the bulbs would give off less light.
   2. The circuit would overload and burn out.
   3. The battery would die.
   4. The circuit would be one-third brighter.

4. In which direction is the current flowing in this circuit?

5. What would happen to the bulbs if the switch were opened?

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**Content Clue**

In a **series circuit**, the current flows through the components one after the other. In a **parallel circuit**, the current passes through all the parts at once.

In a simple circuit such as this one, electrical energy is converted to heat and **light energy**.
The diagram below shows a magnet and the magnet's magnetic field. Study the diagram. Then answer questions 1–5.

1 What do the iron filings around this magnet show?

2 A compass needle is a magnet that points to the Earth’s North and South poles. How could you use a compass to find what direction you are facing?

3 Where near the magnet would you find the most lines of force?

4 Where is the magnetic field the strongest?

5 How could a wire and this magnet be used to produce an electric current?
Improving Reading and Writing Skills

Reading Strategies
Tests sometimes contain words that are unfamiliar or reading passages that are difficult to understand. During most tests you won’t have a dictionary at hand. You have to figure out what the words mean on your own. Here are some things you can do:

- use context clues
- find key words in a passage
- state the main idea

Use Context Clues
The way a word is used in a sentence and the words surrounding it make up the word’s context. The word context comes from an old English word that means “the weaving together of words.” You can use a sentence’s context to help you determine the meaning of unfamiliar words.

Example Sometimes a word is defined directly, as in the following passage.

Xylem is a type of plant tissue. It transports water and minerals from the roots of the plant to the rest of the plant. It also supports the plant.

The first sentence defines the word xylem, and the next two sentences give more details that make the meaning clearer.

Some passages contain only general, or indirect, clues about the meaning of a word.

Example Read the following passage and see if you can guess at the meanings of the words unicellular and multicellular.

One way organisms change is by growing, or becoming larger. In a unicellular organism, growth occurs as new materials are added to the cell. The cells of a multicellular organism also grow, as new material is added to each cell. However, most growth in multicellular organisms is caused by the formation of new cells.

Note that the sentence about the unicellular organism uses the singular form of the word cell. The text referring to the growth of a multicellular organism uses the plural form, cells. These are indirect clues that unicellular refers to one cell while multicellular refers to many cells.