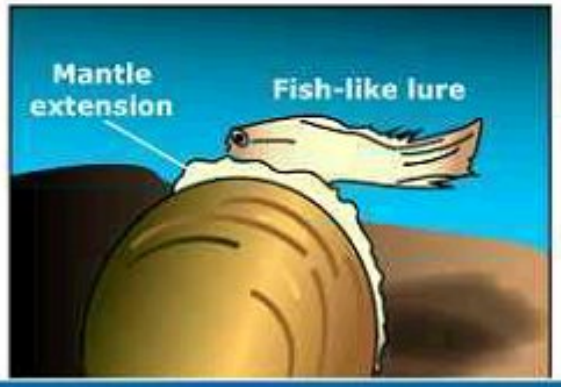
this type of nonmutual relationship, one organism b
expense of the other.

2 One family of freshwater mussel, *Unionidae*, has a life cycle that requires a parasitic larval stage. Each tiny mussel larva attaches to the gills of a fish. The fish immune system encapsulates the larva in a cyst, and the larva develops within that cyst until it is ready for an independent life. The fish is harmed by the parasite infesting the tissues of the gills. When the larva hatches from the gill cyst, it settles into the riverbed to develop into an adult mussel.

3 How do mussel larvae get to the gill of a fish? In most cases, mussels and fish do not interact. However, in *Lampsilis*, one genus of *Unionidae*, there must have been ancestor mussels that, because of random mutation, developed so that part of their extended surface slightly resembled a small fish—the favorite food of big fish. One of the signature elements that fish recognize in their prey is the eyes. Gradually, over generations, these mussels developed a fish-like lure with an eyespot, which is a dark dot that mimics the appearance of a fish eye. When a big fish approaches to eat the lure, the female clam releases her eggs into the big fish's mouth.



Which sentence from the passage demonstrates natural selection in *Lampsilis* mussels?

- (●) "Gradually, over generations, these mussels developed a fish-like lure with an eyespot, which is a dark dot that mimics the appearance of a fish eye." (paragraph 3)
- ( ) "In most cases, mussels and fish do not interact." (paragraph 3)
- ( ) "The fish immune system encapsulates the larva in a cyst, and the larva develops within that cyst until it is ready for an independent life." (paragraph 2)
- ( ) "There are more than 280 species of mussels and clams in North American waterways." (paragraph 1)

Calculator Reference

50681537

Specific heat is a measure of how much heat energy (measured in joules) is needed to change the temperature of 1 gram of substance by 1 degree Celsius (J/g • °C). A high specific heat indicates that a substance will heat and cool slowly. Water has a specific heat considerably higher than most substances: about 4.18 J/g • °C. In comparison, sand has a specific heat of about 0.80 J/g • °C. This difference means that in sandy coastal regions organisms on the sand experience much more dramatic changes in their environmental temperatures than organisms living in the water.

If equal masses of sand and water in a given area experience a 12% increase in heat energy, which prediction can be made about organisms in the area?

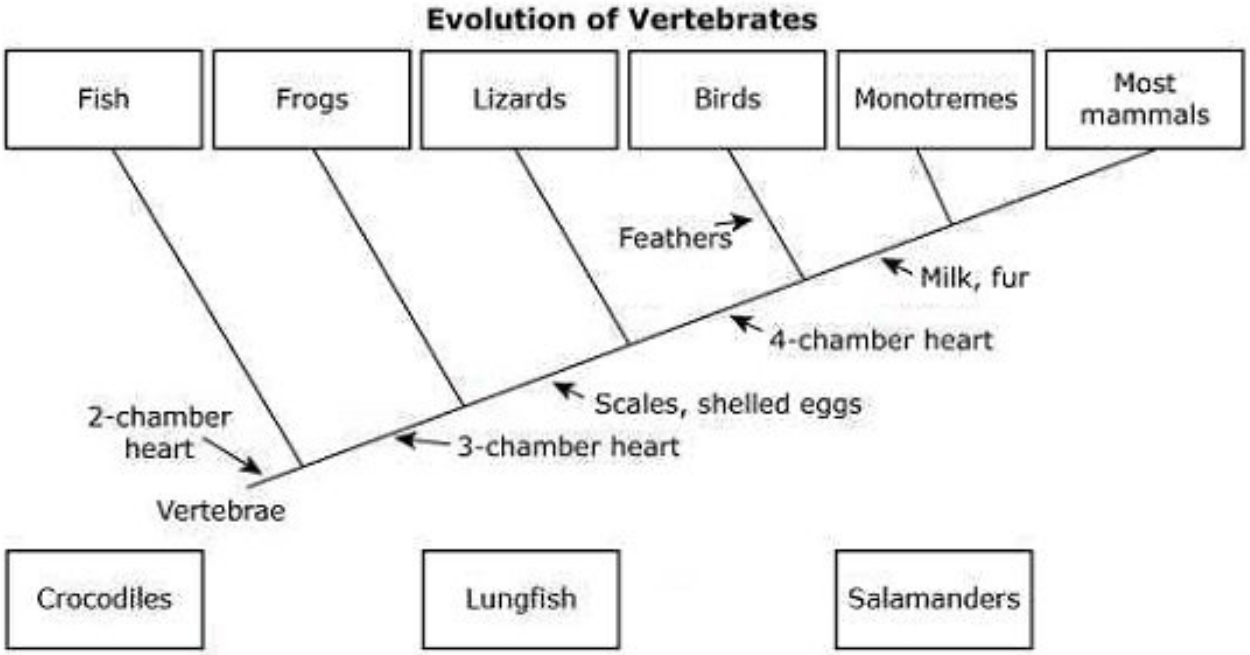
You may use the calculator.

- ○ Organisms living in the ocean will experience an environmental temperature increase of 2.9°C.
- ◉ Organisms living on the sand will experience an environmental temperature increase about 5 times greater than those living in the ocean.
- ○ Organisms living on the sand will experience an environmental temperature increase of 9.6°C.
- ○ Organisms living in the ocean will experience an environmental temperature increase about 5 times greater than those living on the sand.

lungfish			
monotremes	4	fur	produce milk
salamanders	3	skin	soft eggs
lizards	3	scales	shelled eggs

Complete the diagram using the information in the table.

Drag the correct animal groups into the empty boxes in the diagram.



Calculator Reference

The energy density of a fuel is the amount of useful energy stored in a specific amount of that fuel. The energy density, measured in megajoules per kilogram (MJ/kg), is related to the chemical composition of the fuel. The chemical composition and energy density of four fuels are shown in the table.

Fuel	Chemical Composition	Energy Density (MJ/kg)
methane	CH_4	50
propane	C_3H_8	47
butane	C_4H_{10}	46
octane	C_8H_{18}	44

Ethane, which has a chemical composition of C_2H_6, is also a fuel.

What is the predicted energy density of ethane?

You may use the calculator.

- ○ 45 MJ/kg
- ◉ 48 MJ/kg
- ○ 52 MJ/kg
- ○ 42 MJ/kg

Scientists have examined the genetic history of a large group of cheetahs and have found that there was a significant decrease in the genetic diversity of the cheetah species about 10,000 years ago. Scientists found that, even in unrelated groups of cheetahs, individual cheetahs had 99% of the same alleles. By comparison, in a genetically diverse population, even closely related individuals contain only 80% of the same alleles. Genetic diversity is important to the survival of a species, and scientists worry that a disease that cheetahs are not resistant to could decimate the population.

Major histocompatibility complex (MHC) genes are used by the body to identify self from non-self and direct the immune system to attack non-self particles. Invading bacteria and viruses do not contain the same MHC genes and therefore are attacked by the immune system. Within a population, a high diversity of MHC genes protects the population from attack by disease. In a highly diverse population, it is likely that at least some individuals will contain an allele that identifies a new disease as non-self and can direct the immune system to destroy it.

In 1985, research by Stephen O'Brien reported that skin grafts from cheetahs in a zoo in Oregon were accepted by cheetahs in Africa. Skin grafts, like other organ donations, must be between individuals that have the same MHC factors. If any of the genetic factors are different, then the immune system of the individual receiving the organ will identify the organ as non-self and the body will attack the donated organ as if it were a foreign organism such as a virus or bacterium. The conclusion from O'Brien's research was that cheetah MHC genes are as alike as those of identical twins.

More recent research by Simone Sommer took a much more comprehensive approach to examining the genes of a large sample of wild cheetahs. Sommer's research determined how many alleles are present on two different types of MHC genes in approximately 150 cheetahs. Sommer was able to show that the variation in some MHC genes was higher than previously thought. The variation in MHC genes in cheetahs is still smaller than that for other big cat species but appears to be sufficient to allow the populations to identify a wide variety of foreign particles.

According to the passage, what is one of the benefits of genetic diversity?

- ○ A variety of alleles for a gene exist within a population.
- ○ A particular gene has many possible variations.
- ◉ A population has the ability to resist disease.
- ○ An organism has a variety of different types of genes.

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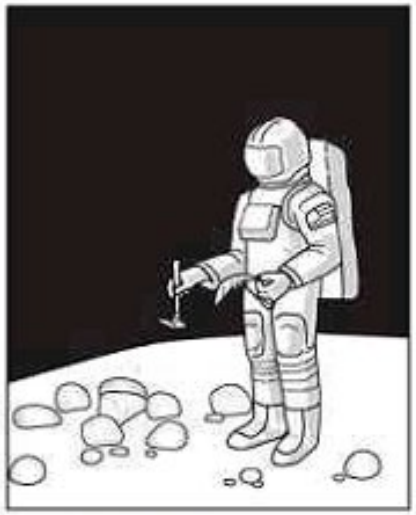
Why is the conclusion about gene variation among cheetahs from Sommer's research more valid than the conclusion from O'Brien's research?

- ○ Sommer's research used a different population of cheetahs than O'Brien's.
- ○ Sommer's conclusion is about disease response, while O'Brien's is about skin grafts.
- ◉ Sommer's conclusion is based on examining the genes, while O'Brien's conclusion is based on acceptance of a skin graft.
- ○ Sommer's research was conducted more recently than O'Brien's.

Recording

$$\text{Kinetic Energy} = \frac{1}{2} \times \text{mass} \times \text{velocity}^2$$

Gravitational Potential Energy = mass × height × gravitational acceleration



What is the relationship between the kinetic energy of the feather and of the hammer just before they hit the surface of the Moon?

You may use the calculator.

- ○ Both objects have the same kinetic energy because they fell with the same velocity.
- ○ The hammer has more kinetic energy than the feather because it will accelerate faster than the feather.
- ◉ The hammer has more kinetic energy than the feather because it has a greater mass.
- ○ Both objects have the same kinetic energy because gravity pulls on both objects equally.

Salt water causes marine ecosystems to be very different from freshwater ecosystems. Organisms in both types of ecosystems are affected by the freezing and melting of ice. An experiment was conducted to test the hypothesis that ice melts faster in salt water than in fresh water. Ice cubes made of fresh water were placed into cups containing either fresh water or salt water. Various data were recorded, and the energy released by each melting ice cube was calculated from the data. The table shows the results for each cup.

Ice-Melting Experiment

Cup	Initial Mass of Water (g)	Final Mass of Water (g)	Change in Mass (g)	Initial Temperature (°C)	Final Temperature (°C)	Change in Temperature (°C)	Time for Ice Cube to Melt (s)	Energy Released (J)
fresh water (not stirred)	50	83	33	45	33	−12	120	11,022
salt water (not stirred)	45	81	36	48	43	−5	480	12,024

What statement describes one or more needed changes to this experiment that would allow the experimenter to draw a valid conclusion?

You may use the calculator.

- ○ Salt water should have been used to make the ice cubes for the cup of salt water.
- ◉ At the beginning, both cups should have contained the same mass of water at the same temperature.
- ○ The time for ice cubes to melt should have been measured in minutes.
- ○ The energy released should have been measured, not calculated.

Recording

Calculator Reference

50681653?

Specific heat is a measure of how much heat energy must be added to one gram of a substance to cause a one degree Celsius increase in temperature. The formula for this relationship is:

$Q=c\times m\times \Delta T$

- Q is the amount of heat added to the substance;
- c is the specific heat of the substance;
- m is the mass of the substance; and
- ΔT is the change in temperature of the substance.

A substance has a mass of 10 grams. This substance has 45 joules of heat added to it, and the change in temperature is 5 degrees.

What is the specific heat of the substance? 0.9 J/gK

You may use the calculator.

Microbial fuel cells could someday transform landfills and wastewater treatment facilities into power sources. Bacteria (microbes) break down simple sugars, producing electrons as a waste product. Fuel cells create anaerobic conditions, allowing the electrons to be transferred out of the bacteria to an anode instead of to environmental oxygen.

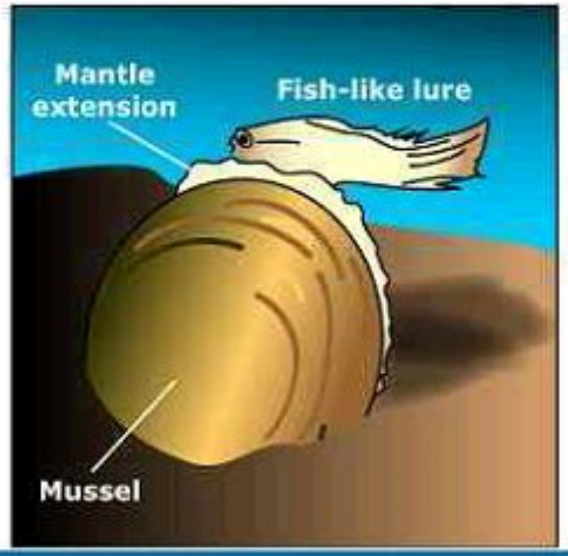
This technology originally worked only when bacteria were provided simple sugars. However, in a 2006 study, certain bacteria metabolized more complex material, such as starches, to make electricity within fuel cells. Special anodes made the process work, allowing bacteria to generate electric current when fed starch.

Which statement best explains the central idea of the paragraphs above?

- ○ Bacteria can be ground up to release electrons and generate electricity.
- ○ Researchers showed that sugars could be used as fuel to make electricity, whereas a carbohydrate such as starch was too complex.
- ◉ Some types of bacteria can be used to generate electricity under oxygen-free conditions.
- ○ The amount of electricity generated by microbial fuel cells is too small to be of any use.

a cyst, and the larva develops within that cyst until it is ready for an independent life. The fish is harmed by the parasite infesting the tissues of the gills. When the larva hatches from the gill cyst, it settles into the riverbed to develop into an adult mussel.

3 How do mussel larvae get to the gill of a fish? In most cases, mussels and fish do not interact. However, in *Lampsilis*, one genus of *Unionidae*, there must have been ancestor mussels that, because of random mutation, developed so that part of their extended surface slightly resembled a small fish—the favorite food of big fish. One of the signature elements that fish recognize in their prey is the eyes. Gradually, over generations, these mussels developed a fish-like lure with an eyespot, which is a dark dot that mimics the appearance of a fish eye. When a big fish approaches to eat the lure, the female clam releases her eggs into the big fish's mouth.

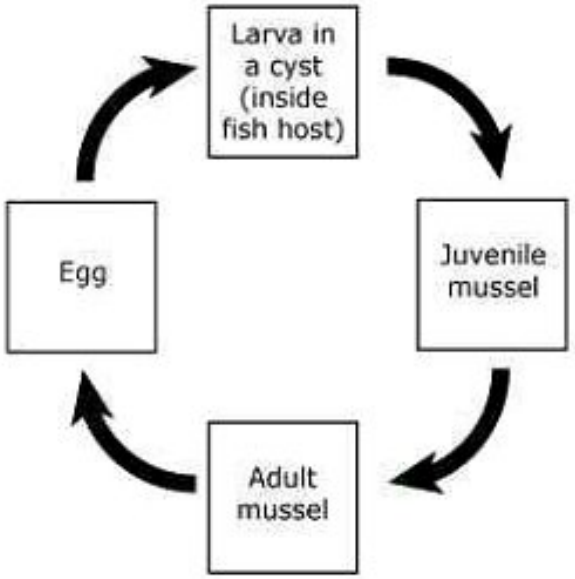


An incomplete life cycle of a freshwater mussel is shown below.

Based on the passage, complete the life cycle of the freshwater mussel.

Click on the stage of development you want to select and drag it into the correct box.

Mussel Life Cycle



1 In June 2012, an experimental airplane completed the first solar-powered intercontinental flight. The milestone voyage, from Madrid to Morocco, took 19 hours. The experimental airplane's cruising speed was just 71 kilometers per hour (kph), below the minimum speed on many American highways and far lower than the cruising speed of a large commercial jet airplane—which is nearly 917 kph, or 255 meters per second.

Characteristic	Jet Airplane	Experimental Airplane
Mass	396,890 kg	1,600 kg
Cruising speed	917 kph	71 kph
Fuel used	11 liters per km	0
Flight range	12,800 km	2,500 km
Maximum altitude	10,600 m	8,500 m

2 The experimental airplane carries nearly 12,000 solar cells, which power the plane's four electric motors. The solar cells, mounted on the wings, use sunlight to generate electricity. Photons from the Sun hit the solar cells and are absorbed by semiconductors. Electrons from atoms in the semiconductor are energized by the photons and break free from the atoms. This change causes an electric potential difference, and electric current flows to cancel that difference. The result is electricity that can be stored or used by the aircraft's electric motors.

3 During the day, the solar-powered plane uses its motors to climb through the atmosphere, reaching altitudes of up to 8,500 meters. At night, the plane glides down toward land, converting the potential energy gained during its ascent into

Calculator Reference

The relationship between velocity (v), distance (d), and time (t) is given in the equation.

$$v = \frac{d}{t}$$

The distance from Paris to Berlin is 877 kilometers. Which statement correctly describes the flight times of the jet airplane and the experimental airplane from Paris to Berlin?

You may use the calculator.

- (●) The jet airplane takes about 0.95 hours, but the experimental airplane takes about 12.4 hours.
- ( ) The jet airplane takes about 1.04 hours, but the experimental airplane takes about 12.4 hours.
- ( ) The jet airplane takes about 1.04 hours, but the experimental airplane takes about 8.09 hours.
- ( ) The jet airplane takes about 0.95 hours, but the experimental airplane takes about 8.09 hours.

Recording

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Which of the following is the primary energy source for the experimental airplane?

- ○ batteries
- ◉ sunlight
- ○ electrons
- ○ gasoline

Read the brief passage about heat.

After Benjamin Franklin argued that electricity was a fluid, the scientific community started discussing other phenomena as being related to fluids. In 1787, Lavoisier developed the idea that heat was an invisible fluid called a caloric fluid. This fluid would leave a hot substance and travel to a colder substance.

Later, in 1783, Lavoisier demonstrated that oxygen was required for combustion.

In 1798, Count Rumford observed that the process of boring out cannons from brass cylinders continuously produced heat. He also found the brass filings produced from the drilling process contained enough heat to boil water while retaining their weight.

In the early 1940s, James Joule discovered that heat could be produced by moving a wire through a magnetic field.

Which statement from the passage refutes Lavoisier's idea that heat is a fluid that leaves a hot substance and travels to a colder substance?

- "He also found the brass filings produced from the drilling process contained enough heat to boil water while retaining their weight."
- "James Joule discovered that heat could be produced by moving a wire through a magnetic field."
- "Lavoisier demonstrated that oxygen was required for combustion."
- "Count Rumford observed that the process of boring out cannons from brass cylinders continuously produced heat."

Recording

Venus, Earth, and Mars have carbon dioxide (CO_2) in their atmospheres. CO_2 absorbs infrared energy and traps heat in the planets' atmospheres. The higher the amount of CO_2 in an atmosphere, the more heat will be trapped. The density of the atmosphere is the mass of the air in every cubic meter at the surface. The table below gives the percents of CO_2 in the planets' atmospheres, the amount of CO_2 in each atmosphere relative to Earth's, and the atmospheric densities of several planets. The table also includes data for the hypothetical Planet L and Planet V.

Planet	Percent of CO_2 in Atmosphere	Density of Atmosphere at Surface (kg/m^3)	Amount of CO_2 in Atmosphere Relative to Earth's (Earth's = 1.0)
Venus	96.5	65	130,000
Earth	0.04	1.22	1.0
Mars	95.3	0.02	39
Planet L	20	0.002	0.82
Planet V	0.005	15	1.5

Based on the table, use the drop-down menus to make the following statement correct.

[Mars ▼] experiences the least warming effect from CO_2 because it has the [smallest percent ▼] of CO_2 in its atmosphere.

The equation for photosynthesis is often written as shown below.

Based on this equation, what does the triangle symbol represent?

- chloroplast
- oxygen
- heat
- light

Recording

Appe	
round, yellow seeds	315
round, green seeds	108
wrinkled, yellow seeds	101
wrinkled, green seeds	32

William Bateson and his colleagues designed a similar experiment using heterozygous pea plants. Bateson crossed plants that were heterozygous for flower color and pollen shape. These experiments resulted in numbers of offspring that did not match Mendel's 9:3:3:1 ratio. The number and appearance of the offspring are shown in the table. Bateson concluded that some traits are not inherited independently.

Appearance of Offspring	Number of Offspring
purple flowers with long pollen grains	284
purple flowers with round pollen grains	21
red flowers with long pollen grains	21
red flowers with round pollen grains	55

How do the results of Bateson's experiment affect the interpretation of Mendel's experimental results?

- Bateson's experimental results show that Mendel's conclusions were incomplete.
- Bateson's experiments studied different traits than Mendel's so Bateson's results could not challenge or support Mendel's conclusions.
- Bateson's experiments resulted in different ratios of traits in the offspring, confirming Mendel's conclusion.
- Bateson's experimental results show that Mendel's conclusions were incorrect.

A researcher conducted an investigation about how the human body changes during exercise. The researcher's procedure is outlined below.

Experimental Procedure:

1. Observe and record the body temperature, breathing rate, and heart rate of a test subject at rest.
2. The subject jumps rope for 10 minutes.
3. Every two minutes, the researcher records the body temperature, breathing rate, and heart rate of the test subject.
4. Repeat procedure with additional subjects.

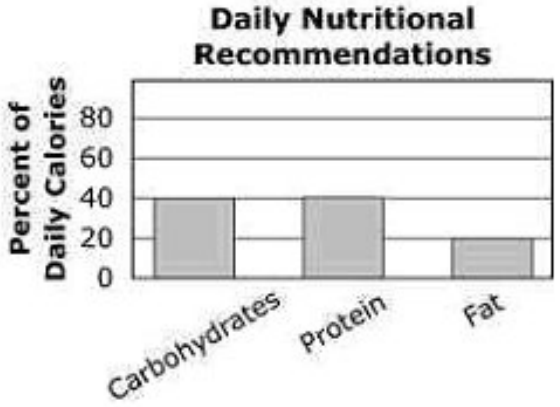
Which hypothesis is suitable for this investigation?

- ○ Subjects at rest have better health than subjects that exercise.
- ◉ Body temperature, breathing rate, and heart rate increase with exercise.
- ○ Body temperature, breathing rate, and heart rate depend on the health of the subject.
- ○ Many of the body's systems respond to exercise.

Protein	10%–35%	200–700	50–175
Fat	20%–35%	400–700	44–78

Which graph fulfills the nutritional recommendations?

You may use the calculator.



Recording

1 In 1908, a huge explosion known as the Tunguska Event flattened trees for miles across a remote area of Russia. Scientists now think an asteroid or a comet entered Earth's atmosphere, causing the explosion. Ice core samples from an ice sheet in Greenland reveal signs of this enormous explosion: deposits of ammonia equal to 5 micrograms per square meter. But how exactly did these telltale molecules form?

- Hypothesis 1: The Tunguska explosion started forest fires, known to produce ammonia. Data indicates that such fires would have deposited an amount of ammonia over the Northern Hemisphere equaling 0.1 micrograms per square meter.
- Hypothesis 2: Up to 1% of the object's mass might have been ammonia, and this ammonia might have spread over the Northern Hemisphere. Approximately 0.00005 micrograms of ammonia per square meter are predicted by this hypothesis.
- Hypothesis 3: Since many compounds form in the presence of high heat, the ammonia could have been produced as the falling object heated the atmosphere. However, heat alone is not sufficient to cause the formation

What natural process is required to connect the ice core data to the Tunguska Event?

- ○ the movement of glaciers due to gravity
- ○ the cycling of carbon in forest fires
- ○ the interaction of comets with the solar wind
- ◉ the constant mixing of the atmosphere

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Which statement describes a weakness of the investigation in the passage?

- ○ A few micrograms of ammonia is insufficient evidence for a conclusion.
- ○ The Greenland ice sheet is far away from the site of the explosion in Russia.
- ◉ Several of the hypotheses rely on unproven processes or estimated values.
- ○ None of the hypotheses are directly related to the ice core data.

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Calculator Reference

Scientists have estimated the mass of the object that caused the Tunguska Event at 5×10^7 kilograms (kg).

If the object was a comet in which 1% of total mass was ammonia, how much ammonia did the comet contain?

Type your answer in the box.

You may use the calculator.

500000 kg

Recording

Which sentence describes a difference between artificial selection and natural selection?

- In natural selection, there is variation within the population of organisms; in artificial selection, there is no variation within the population or organisms.
- In natural selection, reproductive success is driven by naturally occurring processes; in artificial selection, reproductive success is driven by human-imposed processes.
- In natural selection, variation is heritable; in artificial selection, variation is not heritable.
- In natural selection, there is differential reproduction; in artificial selection, there is not differential reproduction.

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Hypothesis 4 ▾ best explains the ammonia deposits found in ice core samples from the time of the Tunguska Event. The evidence that best supports the validity of this hypothesis is the match between measured and predicted amounts of ammonia. ▾

Calculator Reference

Not all changes to the DNA sequence of a gene cause changes in the protein the gene encodes. One reason for this is the redundancy of the genetic code. Many of the amino acids that compose proteins are encoded by more than one codon. The table shows the DNA codons that encode three different amino acids.

Amino Acid	DNA Codons
isoleucine	ATA, ATC, ATT
tyrosine	TAC, TAT
valine	GTA, GTC, GTG, GTT

How many different combinations of DNA codons would result in a 3-amino-acid chain containing one of each of the amino acids from the table?

You may use the calculator.

- ○ 3
- ○ 9
- ◉ 24
- ○ 6

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You may use the calculator.

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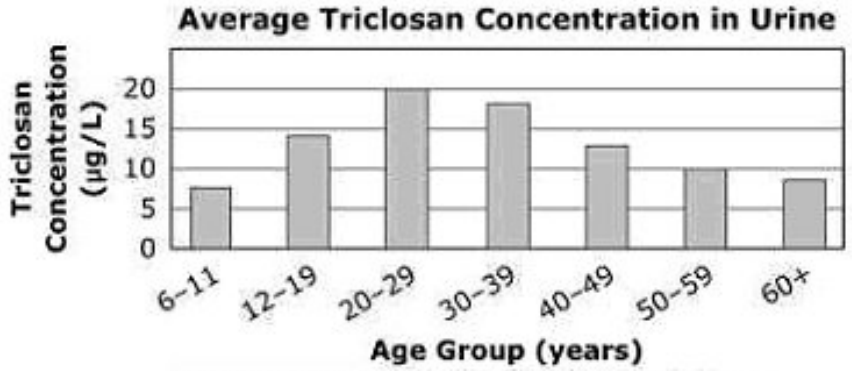
Recording

Triclosan is an antimicrobial chemical used in many personal care items such as hand soap. Because of its chemical properties, small amounts of the substance can be absorbed through the skin. Recent concerns about exposure to triclosan have resulted in research about its safety. The concentration of triclosan in a person's body can be determined by a urinalysis. The graph shows results from a study that sought to determine average exposure to triclosan in the U.S. population.



Data is based on information from the National Institute of Environmental Health Sciences.

Which statement is supported by the results in the graph?

- (●) Triclosan concentration in urine is highest in the 30- to 39-year-old age group.
- ( ) Triclosan concentration does not vary significantly among different age groups.
- ( ) Increased levels of triclosan in urine are related to increased age.
- ( ) People aged 20–29 likely use more products containing triclosan.

Recording

Mr. Scott has been diagnosed with hemochromatosis. He reads the following information on medical websites.

> Hereditary hemochromatosis is a genetic disease that alters the body's ability to regulate iron absorption. Common symptoms include tiredness, joint pain, abdominal pain, skin darkening, hair loss, and weakness.
>
> Hereditary hemochromatosis is usually caused by a common gene mutation known as C282Y. But other mutations that cause this disease have also been identified, including one known as H63D.
>
> A child who inherits two copies of a mutated gene (one from each parent) is highly likely to develop the disease. However, not all people who have two mutated copies develop signs and symptoms of hereditary hemochromatosis.
>
> People who inherit only one copy of the mutated gene are carriers, but usually have no symptoms, or have very mild symptoms since one correct copy of the gene appears to adequately regulate iron absorption.
>
> Sources: National Human Genome Research Institute/U.S. National Library of Medicine

Which statement correctly summarizes this information?

- (●) Hemochromatosis is a recessive genetic disease, but the expression differs in individuals.
- ( ) Hemochromatosis is a dominant genetic disease that can be caused by several different alleles.
- ( ) Hemochromatosis is a dominant genetic disease caused by a single mutation.
- ( ) Hemochromatosis is a recessive genetic disease, but is caused by a lack of iron.

Various species of birds from the genus *Agapornis* possess differing behaviors. These behaviors differ in a way that can be used to infer how the species are related and how they have evolved over time.

For example, the three lovebird species considered to be the most primitive all build simple nests in preexisting cavities. The three middle species all build elaborate nests with tops, and one even digs out a cavity for the nest. The four modern species build cuplike nests. These nests are more complex than those built by the primitive species but less complex than those built by the middle species.

William Dilger conducted an investigation to show that the nest-building behaviors of these birds were genetic rather than learned behaviors. In his investigation, Dilger used two different species of lovebird that readily mate with each other—Fischer's lovebird and the peach-faced lovebird. Fischer's lovebird is a species of modern lovebird while the peach-faced lovebird is a slightly more primitive species.

Fischer's lovebird carries small pieces of nesting material in its beak. The small size of the nesting material is the reason for the simpler cuplike nests of Fischer's lovebird. The peach-faced lovebird cuts long strips of nesting material, which is then tucked into the feathers on the back of the bird. These long strips of nesting material will often fall out of the bird's feathers. However, the long strips of material allow the peach-faced lovebird to build an elaborate nest.

The hybrid offspring of these two species has difficulty building nests. The hybrid offspring will cut long strips of material like its peach-faced parent. However, the hybrid offspring will attempt to carry the material in its beak and have difficulty flying. If it does attempt to place the material in the feathers of its back, the material falls out because the bird does not properly secure the material in its feathers.

According to the passage, which statement about hybrid lovebirds is true?

- (●) Nest-building behavior in hybrid lovebirds is a mixture of the parents' behaviors.
- ( ) Hybrid lovebirds use nest-building material in ways they learn from the parents.
- ( ) Nest-building behavior can be used to determine evolutionary relationships between lovebird species.
- ( ) Hybrid lovebirds build complex nests using smaller pieces of nest-building material.

Step 1

Identify study site.

↓

Step 2

Identify plant species that will be monitored.

↓

Step 3

Collect initial population counts of *Sphagnum* moss and other plant species and initial pH readings of water.

↓

Step 4

Visit site and collect data on plant species and pH of water over 12 months.

↓

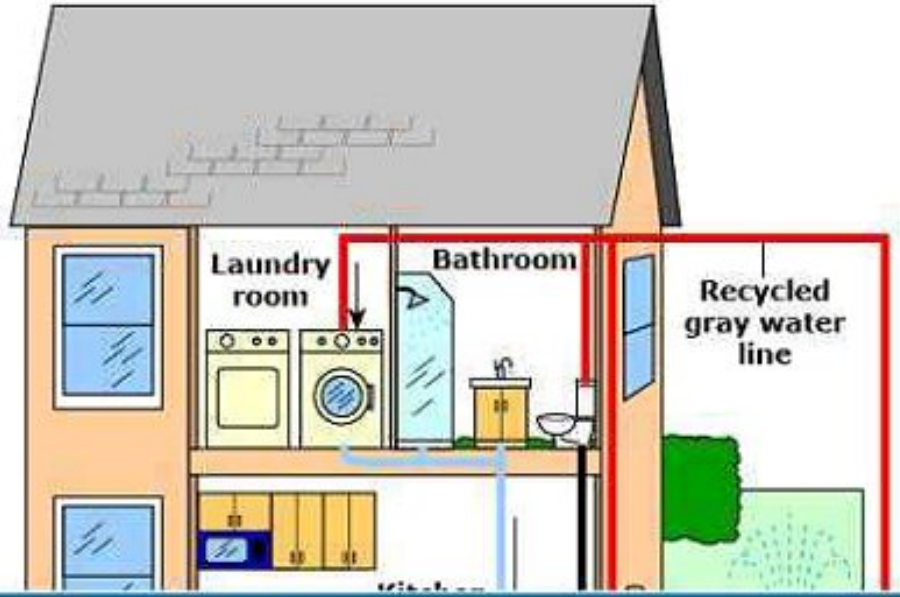
Step 5

Analyze data to determine whether plant populations change as pH changes at study site.

Identify target pH for study.

1 It is estimated that 32–38% of the water consumed in the United States is used for irrigation. Severe water shortages in many areas mean that recycling water will be necessary for continued landscape irrigation. One potential source of water is gray water—wastewater recycled from relatively clean sources such as bathtubs and clothes washers.

2 Collecting gray water does not require a specialized system. For example, bathtub water can be saved and poured on grass or hoses can be connected to a clothes washer and run directly outside. However, commercial systems are available that attach directly to a home's existing wastewater line. Sensors are placed throughout the house to ensure that only gray water is collected. The water is then sent through filters and exposed to UV light to eliminate harmful bacteria. The treated gray water is used primarily for landscape irrigation, although some limited human uses exist. The figure shows one way a gray water collection system can function in a home.

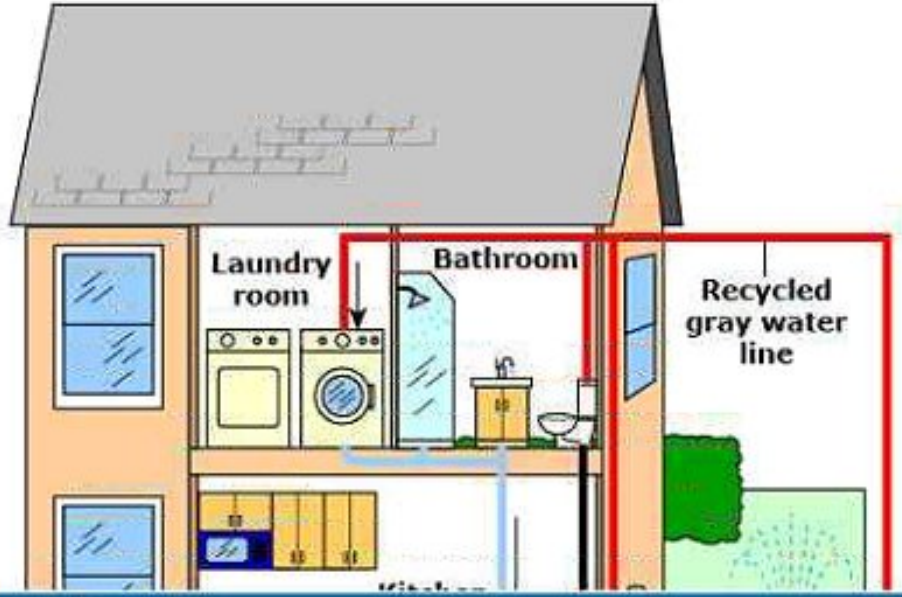


Which pathway could water follow as it flows through the house shown in the diagram?

- ○ outside faucet → recycled gray water line → toilet → recycled gray water line → clothes washer → main sewer line
- ◉ shower → gray water collection line → gray water filter and storage tank → recycled gray water line → clothes washer
- ○ clothes washer → recycled gray water line → gray water filter and storage tank → gray water collection line → shower
- ○ toilet → main sewer line → gray water filter and storage tank → recycled gray water line → clothes washer

1 It is estimated that 32–38% of the water consumed in the United States is used for irrigation. Severe water shortages in many areas mean that recycling water will be necessary for continued landscape irrigation. One potential source of water is gray water—wastewater recycled from relatively clean sources such as bathtubs and clothes washers.

2 Collecting gray water does not require a specialized system. For example, bathtub water can be saved and poured on grass or hoses can be connected to a clothes washer and run directly outside. However, commercial systems are available that attach directly to a home's existing wastewater line. Sensors are placed throughout the house to ensure that only gray water is collected. The water is then sent through filters and exposed to UV light to eliminate harmful bacteria. The treated gray water is used primarily for landscape irrigation, although some limited human uses exist. The figure shows one way a gray water collection system can function in a home.



Which statement best describes the use of gray water depicted in the diagram?

- ○ Humans should avoid contact with gray water and use it only for outdoor plants.
- ○ Humans may use gray water for all activities as long as it is sent through filters and exposed to ultraviolet light.
- ○ Humans may use gray water in the kitchen while preparing food but should not bathe in gray water.
- ◉ Humans may use gray water for certain activities as long as humans do not ingest or bathe in it.

Recording

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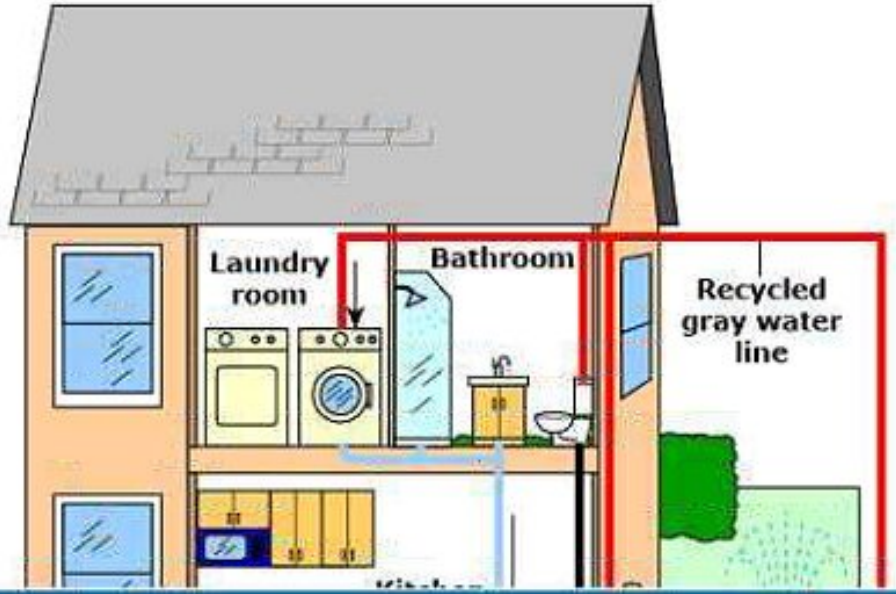
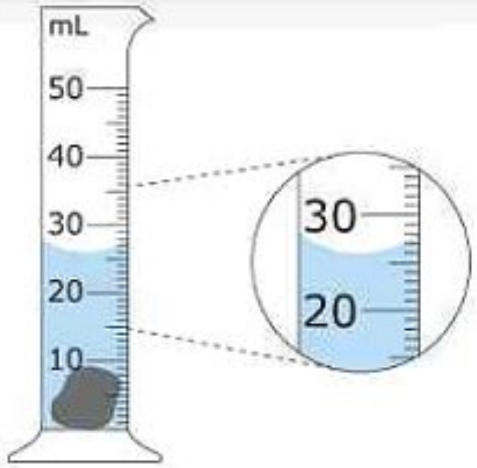


Which text from the passage best supports the conclusion that gray water should be used primarily for landscape irrigation rather than other purposes?

- ● ". . . gray water can contain additives such as laundry bleach not found in fresh water . . ." (paragraph 3)
- ○ ". . . bathtub water can be saved and poured on grass or hoses can be connected to a clothes washer and run directly outside." (paragraph 2)
- ○ "Severe water shortages in many areas mean that recycling water will be necessary for continued landscape irrigation." (paragraph 1)
- ○ "In most of the studies, gray water allowed plants to survive and grow at nearly normal rates." (paragraph 3)

Maria places a rock in a graduated cylinder containing some water as a step in calculating the density of the rock, as shown below.



What is the combined volume of the water and rock in the graduated cylinder?

- 26 mL
- 15 mL
- 30 mL
- 9 mL

Recording

A kneepad manufacturer tested a new kneepad design for use in industrial settings. In order to be rated for the intended use, the kneepads each needed to withstand a force of 100 newtons (N) on the outside of the kneepad without distorting the inside by more than 5 millimeters. During testing, the force on each kneepad was steadily increased until the kneepad failed. The table shows the manufacturer's results from testing 100 of the kneepads.

Kneepad Testing Results

Tested Force (N)	Number of Failures
0–129.99	0
130–134.99	5
135–139.99	17
140–144.99	53
145–149.99	22
150–154.99	3

If these results correctly predict the performance of this kneepad design, what is the probability that one of the kneepads will require a force of 145 N or greater to cause failure?

You may use the calculator.

- ○ 22%
- ○ 75%
- ◉ 25%
- ○ 53%

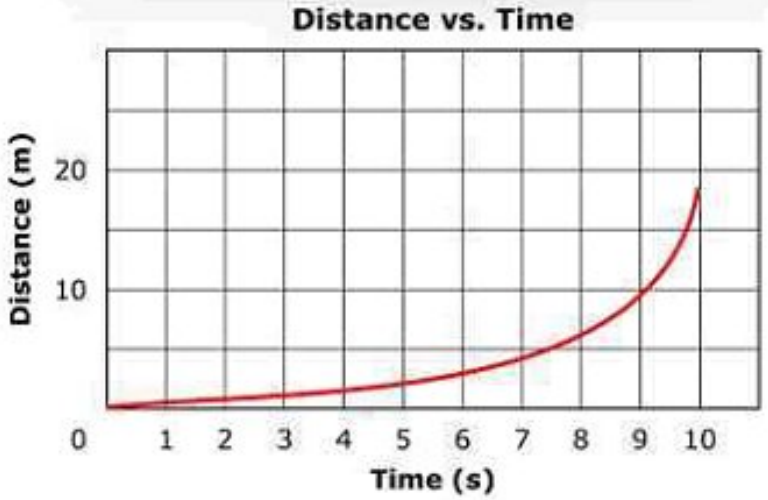
A researcher measured the heart rates of 20 male athletes and 20 female athletes before and immediately after 30 minutes of continuous strenuous exercise. The strenuous exercise included running for 15 minutes and bicycling for 15 minutes. The researcher recorded the data in the table.

Gender	Number of Athletes	Mean Heart Rate Before Exercise (beats per min)	Mean Heart Rate After Exercise (beats per min)
male	20	58	145
female	20	57	138

Which statement is a valid conclusion from the data?

- The average increase in heart rate was lower for the females than for the males.
- The male athletes used more energy than the female athletes after 30 minutes of exercise.
- Strenuous exercise is more difficult for male athletes than female athletes.
- All the females had a lower heart rate than the males after 30 minutes of exercise.

Look at the distance vs. time graph of an object in motion.



Which statement describes the motion of the object for the first 10 seconds?

- (●) The object is accelerating.
- ( ) The object is doubling its speed every two seconds.
- ( ) The object is moving at a constant speed.
- ( ) The object is increasing its height.

Calculator Reference

S06816537

Different types of light bulbs use different amounts of electricity. Electricity use is measured in kilowatt hours (kWh). The electricity use per hour (kWh) of an electrical device can be calculated using the following equation:

$$\text{kWh} = \frac{\text{device wattage}}{1000 \text{ watts}} \times \text{time (h)}$$

A 60W light bulb used .48 kilowatt hours of electricity.

How long was the light bulb on?

You may use the calculator.

- (●) 8 hours
- ( ) 28.8 hours
- ( ) 0.125 hours
- ( ) 0.48 hours

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Which hypothesis was Dilger testing in his experiment?

- If a hybrid offspring carries nesting material in its beak, then it is more closely related to modern lovebirds.
- If behavior in lovebirds is genetic, then a hybrid offspring will display a mixture of behaviors.
- If lovebird species can interbreed, then a hybrid offspring will have a mixture of behaviors.
- If hybrid offspring have a mixture of behaviors, then the species are within the same genus.