ISASP IOWA STATEWIDE ASSESSMENT of STUDENT PROGRESS

Science – Released Operational Items

Prepared by Iowa Testing Programs

Released Operational ISASP Science Items—Item Level Data

The percent of Iowa students that answered the item correctly.

The non-keyed responses that attracted Iowa students.

If none listed, all distractors were evenly chosen.

Grade 5 Review Items						
Item ID	**Percent Correct**	**Domain**	**DOK**	**Standard**	**Key**	**Primary Distractor(s)**
SC210520	47	LS	2	3-LS4-3	B	A, C
SC210524	46	LS	2		A	C
SC210525	45	LS	3		D	

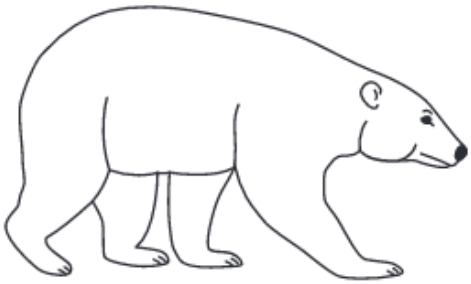
Depth of Knowledge Level

Science Grade 5 Review Items						
Item ID	**Percent Correct**	**Domain**	**DOK**	**Standard**	**Key**	**Primary Distractor(s)**
SC2105529_4	83	LS	2	3-LS4-3	D	
SC2105522_4	84	LS	2		D	
SC2105526_2	55	LS	2		B	C,D
SC2105640_2	61	PS	2	5-PS1-3	B	C
SC2105644_3	73	PS	3		C	
SC2105641_4	67	PS	2		D	
SC2105643_3	47	PS	2		C	A
SC2105502_1	75	ES	3	4-ESS2-2	A	B
SC2105503_3	49	ES	3		C	B
SC2105506_3	38	ES	3		C	B,D
SC2305451_1	67	ES	3	5-ESS2-1	A	
SC2305446_4	61	ES	2		D	
SC2305447_1	43	ES	3		A	B,C
SC2305453_4	39	ES	3		D	
SC2305702_4	66	PS	2	4-PS3-1	D	
SC2305701_4	56	PS	2		D	
SC2305704_3	54	PS	2		C	B,D

PolarBearsandSloths

Polar Bears and Sloths

A student observed the following pictures of a polar bear and a sloth while researching their characteristics.



The student recorded some of the characteristics in Table 1.

Table 1. Characteristics of Polar Bears and Sloths

Characteristic	Polar Bear	Sloth
Class	Mammal	Mammal
Weight	1,600 pounds	8–17 pounds
Fur	Thick and clear	Tan or brown
Claws	Sharp	Long and curved
Food	Meat	Mostly plants
Swimmers	Yes	Yes
Habitat	Arctic	Tropical forest

The student then researched features of Arctic and tropical forest habitats. The student recorded the climate of each habitat and "Yes" or "No" for each of the other features in Table 2.

Table 2. Features of Arctic and Tropical Forest Habitats

Features	Arctic	Tropical Forest
Climate	Cold and icy	Hot and wet
Trees	No	Yes
Ocean	Yes	No
Plants and Animals	No	Yes

SC2105529_4

After completing her research on polar bears and sloths, the student would most likely agree that mammals live

A. in large groups.

B. close to the equator.

C. near their offspring.

D. in different habitats.

SC2105522_4

The student read that a sloth's fur can sometimes be a greenish color from an overgrowth of algae. Why would having greenish-colored fur be an advantage for a sloth?

A. It protects the sloth from severe weather.

B. It signals predators of the sloth's location.

C. It makes the sloth recognizable to its young.

D. It helps the sloth blend in with its surroundings.

SC2105526_2

After reading the following definitions, the student claimed that sloths are herbivores.

> An animal that eats mainly plants is called an herbivore.
> An animal that eats mainly meat is called a carnivore.
> An animal that eats plants and meat is called an omnivore.

What information from Table 1 and Table 2 can be used as evidence to support the student's claim?

A. A sloth weighs less than a polar bear.

B. A sloth's diet consists mainly of plants.

C. The tropical forest has more plant species than the Arctic.

D. Mammals living in tropical forests eat more plants than meat.

RocksandWater

Rocks and Water

A student performed an investigation involving rocks and water. The student poured 50 milliliters (mL) of water into each of four marked containers. The student added a different number of rocks to each container. The rocks in each container sunk below the water level. The student recorded the final volume of the water in each container in the following table.

Container	Starting Volume (mL)	Number of Rocks	Final Volume (mL)
S	50	1	72
T	50	2	81
U	50	3	90
V	50	4	102

SC2105640_2

Why did the student put rocks in a container of water?

A. To change the water into a different substance

B. To measure the amount of space the rocks took up

C. To determine how much water the container holds

D. To see whether the rocks would break up into smaller pieces

SC2105644_3

The student removed the two rocks from Container T. The student dried the rocks and placed them on a scale to find their weight. Why did the student dry the rocks before placing them on the scale?

A. To calculate the weight of the water inside the rocks

B. To stop the water from chemically reacting with the rocks

C. To prevent the water from affecting the weight of the rocks

D. To identify the weight of each mineral that makes up the rocks

SC2105641_4

Imagine if the student had started with 100 mL of water in Container S and added the same rock. What would the final volume of the water in Container S most likely be?

A. 72 mL

B. 78 mL

C. 100 mL

D. 122 mL

SC2105643_3

The student put three objects in a container with 50 mL of water. Based on the final volume of water in the container, the volume of the three objects was 40 mL. The volume of the three objects was closest to the volume of the rocks in which container?

A. Container S

B. Container T

C. Container U

D. Container V

NumberofEarthquakes

Earthquakes

A student researching earthquakes for a school project gathered earthquake data from around the world. The student used the data to make two tables. Table 1 includes the number of earthquakes in 11 U.S. states in 2015. Table 2 lists the number of earthquakes worldwide registering within four different magnitude ranges. The magnitude is a number that represents the relative size of an earthquake. One scale used to measure an earthquake's magnitude is called the Richter scale, which includes values increasing in size from 0–10. The two tables are shown below.

Table 1. Number of Earthquakes in 2015

Region	State	Number of Earthquakes
West	Alaska	1,575
	California	130
	Hawaii	53
	Nevada	172
	Utah	4
Midwest	Iowa	0
	Kansas	60
South	Florida	0
	Texas	21
Northeast	Maryland	0
	Vermont	0

Table 2. Number of Earthquakes at Certain Magnitudes by Year

Magnitude	1990	1991	1992	1993	1994	1995	1996	1997	1998
8+	0	0	0	0	0	0	0	0	0
7 - 7.9	0	1	1	2	0	1	2	0	0
6 - 6.9	2	4	15	9	4	6	4	6	3
5 - 5.9	64	49	72	62	64	45	100	63	62

SC2105502_1

The student researched the number of earthquakes per year in each state in 2014. How many earthquakes did Florida most likely have in 2014?

A. 0

B. 50

C. 150

D. 200

SC2105503_3

The student lives in the Midwest region. Based on the information in the tables, is it likely that there has been a magnitude 9 earthquake in the region in which the student lives?

A. Yes, the Midwest region has a magnitude 9 earthquake each year.

B. Yes, most of the earthquakes in the Midwest region have a magnitude of 8 or more.

C. No, earthquakes in the Midwest region typically register lower on the Richter scale.

D. No, earthquakes that occur in the Midwest region are felt in the South region.

SC2105506_3

The student read about the observed effects of earthquakes at certain magnitudes. The student wrote some of them in the following chart.

Magnitude	Observed Effect
5	Walls crack
6	Furniture moves
7	Some buildings collapse
8	Many buildings destroyed
9	Very rare, and could cause extreme damage

Then the student made the following claim based on the information in the chart and in Table 2.

> Many buildings were destroyed worldwide in the earthquakes that occurred from 1990 to 1998.

What data can be used as evidence to challenge the student's claim?

A. Most of the earthquakes that happened could not be felt.

B. Some of the world's worst earthquakes occurred during this time.

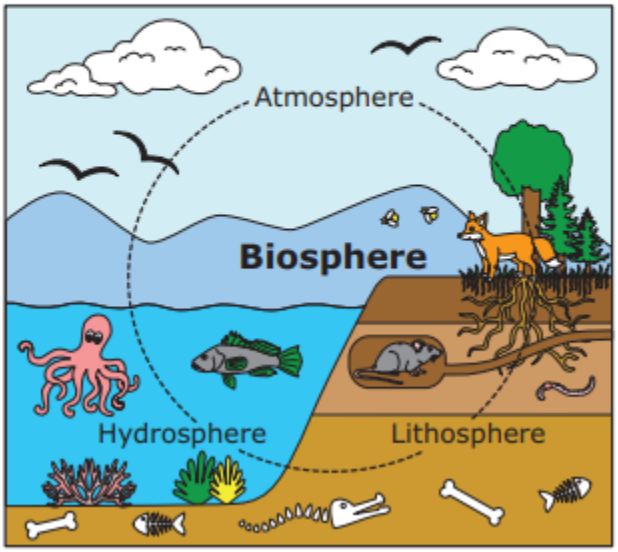
C. There were no magnitude 8 earthquakes recorded during this time.

D. The magnitude 5 earthquakes that occurred caused structural damage.

BiosphereModel

Biosphere Model

A group of students reviewed the following model of Earth's biosphere, which includes the hydrosphere, atmosphere, and lithosphere.



SC2305451_1

The students observed the trees in the model. They made a claim about how the trees directly interact with the atmosphere. Which claim did the students most likely make?

A. Trees take in carbon dioxide and release oxygen.

B. The roots of trees help prevent soil erosion in land.

C. Trees produce food including fruit, seeds, and nuts.

D. The trees in a forest provide shelter for many species.

SC2305446_4

A student made a list of some animals that burrow in the lithosphere. Which animal was most likely included on the student's list?

A. Pelican

B. Dolphin

C. Kangaroo

D. Chipmunk

SC2305447_1

In the model, the biosphere is in the center of the dashed circle because the biosphere is

A. where life exists in the other spheres.

B. a small area between the other spheres.

C. a well-defined area within the atmosphere.

D. controlled by wind patterns in the atmosphere.

SC2305453_4

The students read the following information about the forest fire in Yellowstone National Park in 1988.

> Increased erosion of the loose soil may have led to increased soil particles in stream water, making the water muddier.

Given that a double-headed arrow (↔)means that the cause and effect relationship goes in both directions, which relationship is described in the information the students read about Yellowstone National Park?

A. Atmosphere ↔ biosphere

B. Hydrosphere ↔ biosphere

C. Lithosphere ↔ atmosphere

D. Lithosphere ↔ hydrosphere

ImpactCraters

Impact Craters

A pair of students performed an investigation to learn about impact craters. The students followed the procedures described below.

Procedures:

1. Pour flour into a large pan so that it is about 8 centimeters (cm) deep.
2. Pat the flour so that it is completely flat.
3. Hold a glass marble 30 cm above the pan and drop it.
4. Carefully remove the marble from the pan.
5. Measure the diameter and depth of the crater the marble made.
6. Repeat steps 1–5 two times.
7. Record the average diameter and depth of the craters.
8. Repeat the procedures for dropping the marble from 60, 90, and 200 cm.

Crater Data

Height of Drop (cm)	Crater Size	
	Average Diameter (cm)	Average Depth (cm)
30	2.0	0.8
60	2.3	2.2
90	2.5	3.3
200	3.5	3.8

SC2305702_4

Which type of force acted on the glass marble when it was dropped?

A. Elastic force

B. Magnetic force

C. Electrical force

D. Gravitational force

SC2305701_4

Consider the following definition.

Kinetic energy is the energy of motion.

Based on this definition, the marble dropped from which height had the most kinetic energy?

A. 30 cm

B. 60 cm

C. 90 cm

D. 200 cm

SC2305704_3

After completing Step 8, the students dropped the marble from a height of 150 cm three times. What was the average diameter of the crater?

A. Less than 2.0 cm

B. Between 2.3 cm and 2.5 cm

C. Between 2.5 cm and 3.5 cm

D. Greater than 3.5 cm

Science Grade 8 Review Items						
Item ID	**Percent Correct**	**Domain**	**DOK**	**Standard**	**Key**	**Primary Distractor(s)**
SC2108520_3	79	ES	1	MS-ESS3-1	C	
SC2108521_4	60	ES	2		D	A
SC2108526_4	56	ES	3		D	C
SC2108529_3	57	ES	3		C	A
SC2108524_1	62	ES	2		A	C
SC2108045_3	50	LS	2	MS-LS2-1	C	B,D
SC2108038_3	66	LS	2		C	B,D
SC2108041_1	72	LS	2		A	
SC2108086_3	64	PS	2	MS-PS1-1	C	A
SC2108080_1	63	PS	2		A	C
SC2108081_3	51	PS	2		C	B
SC2308485_2	74	ES	2	MS-ESS2-4	B	
SC2308490_3	64	ES	3		C	
SC2308488_4	48	ES	2		D	B
SC2288230_2	70	PS	3	MS-PS3-1	B	
SC2288226_4	50	PS	2		D	B
SC2288231_4	56	PS	2		D	
SC2288227_4	51	PS	2		D	C

EarthsResources

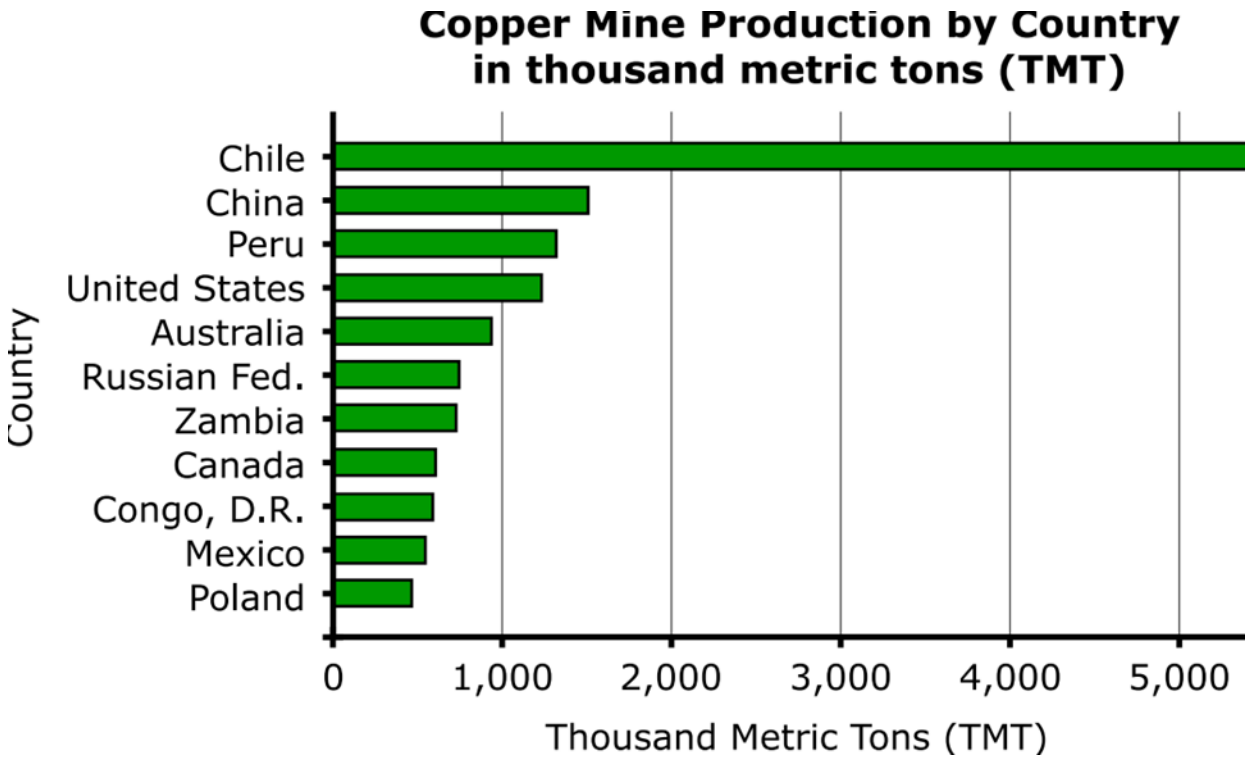
Earth's Resources

A student read about some of Earth's natural resources including minerals such as gold, copper, and iron; fossil fuels such as coal and petroleum; natural gas; light; and water. The student researched the percentage of coal produced in different countries in 2009 and recorded the percentages in the table.

Percentage of Coal Produced

Country	Percent (%)
United States	25
Russia	18
China	13
Australia	9
India	7
Germany	5
Other	23

Then the student researched copper production and made the following bar graph of the top 11 copper-producing countries in 2012. The copper mine production is reported in thousands of metric tons (TMT).


Copper Mine Production by Country
in thousand metric tons (TMT)
Country
Chile
China
Peru
United States
Australia
Russian Fed.
Zambia
Canada
Congo, D.R.
Mexico
Poland
0
1,000
2,000
3,000
4,000
5,000
Thousand Metric Tons (TMT)

SC2108520_3

The student made a claim about the information in the Percentage of Coal Produced table. Which claim did the student most likely make about the information in the table?

A. China produced twice as much coal as Australia.

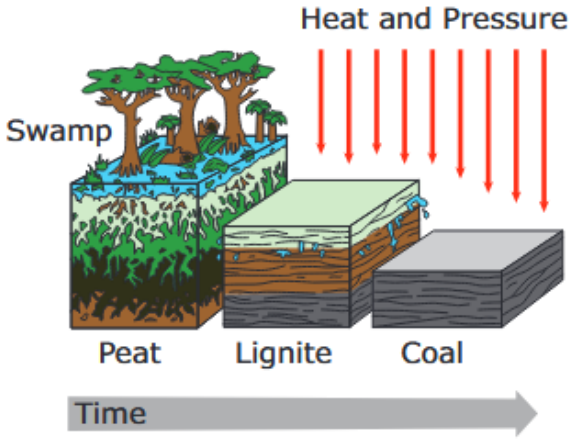
B. Several countries produced the same amount of coal.

C. Coal was produced in at least seven countries worldwide.

D. India used coal as its primary resource for making electricity.

SC2108521_4

The student made the following poster of coal formation. The student included peat and lignite on the poster. Peat is plant remains partly decayed in water and lignite is formed from peat.



Based on the student's poster, coal formation typically begins in an environment with

A. dry air, little precipitation, and a lack of vegetation.

B. mountains, lava, rock fragments, and rootless mosses.

C. cold temperatures, strong winds, and low-growing shrubs.

D. saturated soil, standing water, and water-tolerant vegetation.

SC2108526_4

The student claimed that in 2012 the United States produced more copper than any country in the world. What data from the bar graph can be used as evidence to challenge the student's claim?

A. The United States produced more copper than Austrailia.

B. Four countries each produced more than 1,000 TMT of copper.

C. Seven of the countries produced less copper than the United States.

D. Chile produced about 4,000 TMT more copper than the United States.

SC2108529_3

What would the student most likely learn in an internet search about the worldwide production of iron ore?

A. Chile produces the world's largest supply of iron ore.

B. Each country has the same amount of iron ore as it has coal.

C. The distribution of iron ore is different from the distribution of coal or copper.

D. Iron ore is produced in one country and distributed to other countries around the world.

SC2108524_1

The student wrote the following definitions.

Renewable resources – Natural resources that cannot be used up Nonrenewable resources – Natural resources that are used faster than they are formed

The student made a list of renewable resources based on these definitions. Which natural resources were most likely included in the student's list of renewable resources?

A. Air, light, plants, and wind

B. Salt, oil, aluminum, and air

C. Coal, natural gas, light, and plants

D. Plants, water, animals, and diamonds

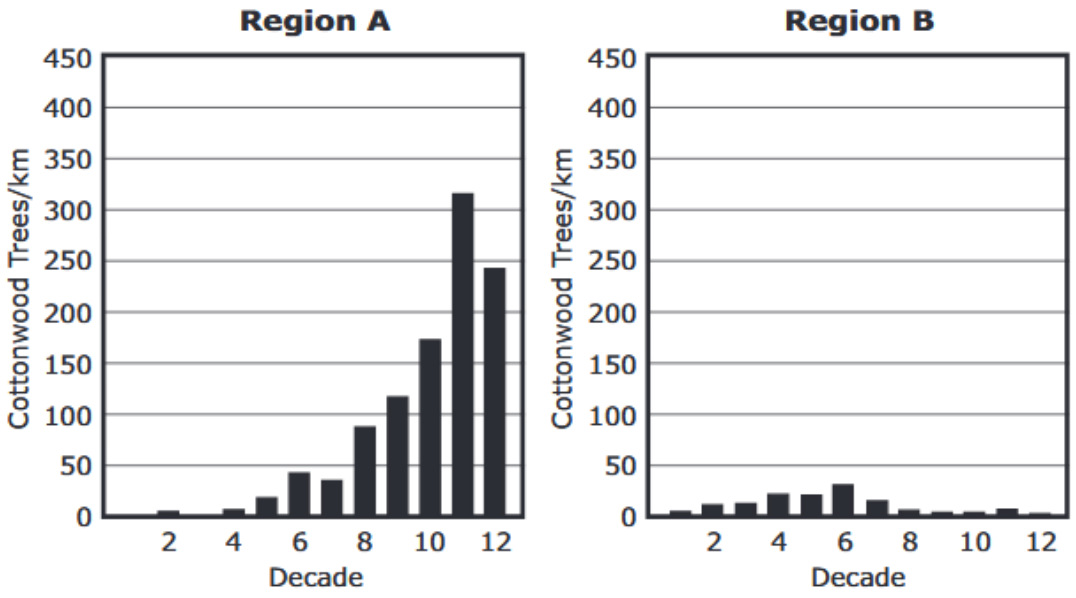
CougarsandCottonwoodTrees

Cougars and Cottonwood Trees

Researchers reviewed graphs of cottonwood tree data from two similar regions along a river. The data represent the number of full-grown cottonwood trees per kilometer (km) observed during 12 consecutive decades. A common food chain in the two regions is shown in the following model:

Cottonwood Tree ⟶ Mule Deer ⟶ Cougar

Although cougars once inhabited both regions, the cougar population declined in Region B due to an increase in human activity. The graphs for Region A and Region B are shown below.



SC2108045_3

Which characteristic of cottonwood trees is best supported by evidence from the information provided?

A. The leaves of cottonwood trees turn yellow in the fall.

B. Young cottonwood trees grow six feet or more each year.

C. Cottonwood trees are able to live in or near water-soaked soil.

D. The wood of a cottonwood tree is weak and prone to disease.

SC2108038_3

Based on the cottonwood tree data from each region, what were the researchers most likely studying?

A. The dependence of mule deer on the nearby river

B. The average life expectancy of mule deer and cougars

C. The effect of the cougar population on cottonwood trees

D. The size of cottonwood trees compared to other tree species

SC2108041_1

Assuming there is no catastrophic change, which mathematical expression would best describe the number of cottonwood trees in Region A and Region B during Decade 13?

A. $\text{Cottonwood Trees}_{\text{RegionA}} > \text{Cottonwood Trees}_{\text{RegionB}}$

B. $\text{Cottonwood Trees}_{\text{RegionA}} < \text{Cottonwood Trees}_{\text{RegionB}}$

C. $\text{Cottonwood Trees}_{\text{RegionA}} \geq \text{Cottonwood Trees}_{\text{RegionB}}$

D. $\text{Cottonwood Trees}_{\text{RegionA}} = \text{Cottonwood Trees}_{\text{RegionB}}$

Molecules

A student obtained a molecular model kit to study the structure of molecules. The kit included color-coded spheres and connecting rods. The spheres represent atoms and the rods represent bonds. The student counted each part in the kit and made the following key.

Molecular Model Kit Key

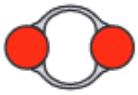
Part of Kit		Structure Represented	Number of Parts in Kit
Spheres	White – One Hole 	Hydrogen Atom	30
	Red – Two Holes 	Oxygen Atom	10
	Black – Four Holes 	Carbon Atom	12
Rods		Single Bond	32
		Double Bond	28

The student read the following information provided in the kit:

- Molecular models help visualize the shape of molecules.
- The number of holes in each sphere represents the maximum number of bonds an atom forms. For example, a hydrogen atom forms one bond.
- A molecule is a group of one or more atoms bonded together.
- Each molecule is complete and stable when the holes in each sphere are filled and every rod ends in a hole.

The student used the parts of the kit to make models of six molecules. A picture of each molecule is shown below.

Molecular Models

Molecule (Chemical Formula)	Picture of Molecule
Hydrogen (H_2)	
Oxygen (O_2)	
Methane (CH_4)	
Methanol (CH_3OH)	
Ethane (C_2H_6)	
Ethene (C_2H_4)	

SC2108086_3

The chemical formula of water is H_2O. Which parts of the kit should the student use to make a molecular model of H_2O?

A. One white sphere, two red spheres, and one small rod

B. One black sphere, three red spheres, and two large rods

C. Two white spheres, one red sphere, and two small rods

D. Two black spheres, one red sphere, and one large rod

SC2108080_1

The number of white spheres in the molecular model kit implies that hydrogen is

A. present in many molecules.

B. interchangeable with oxygen.

C. double bonded to other atoms.

D. rarely used to build molecules.

SC2108081_3

What is the maximum number of hydrogen molecules the student could build with the molecular model kit?

A. 5

B. 10

C. 15

D. 20

WaterCycleModel

Water Cycle Model

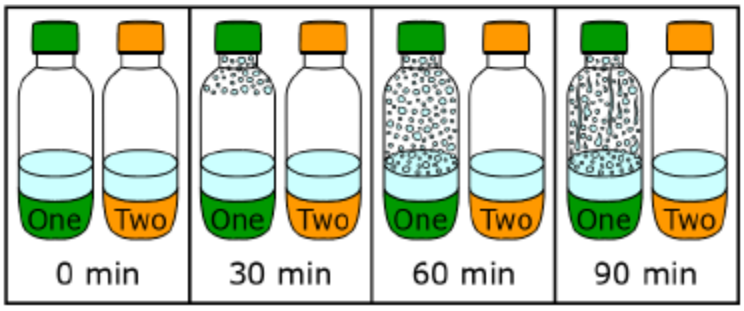
A pair of students performed an investigation to study the water cycle. They constructed a simple model using two clear plastic bottles and water.

The students followed the procedures listed below.

1. Label Bottle One and Bottle Two.
2. Add 200 milliliters (mL) of room temperature water to each bottle, and sealeach bottle with a cap.
3. Place Bottle One in direct sunlight and Bottle Two in shade.
4. Observe Bottle One and Bottle Two at 0 minutes (min), 30 min, and 60 min.
5. Move Bottle One to the shade next to Bottle Two.
6. Observe Bottle One and Bottle Two after 30 min.

The students recorded their observations of Bottle One and Bottle Two and took photographs at each 30 min interval. The students edited the photographs by putting Bottle One and Bottle Two next to each other for each observation. The photographs are shown below.

Photographs of Bottle One and Bottle Two Every 30 Min



SC2308485_2

The students made the following claim.

Water vapor rises when it evaporates.

Which bottle and time can be used as evidence to best support this claim?

A. Bottle One, 0 min

B. Bottle One, 30 min

C. Bottle Two, 60 min

D. Bottle Two, 90 min

SC2308490_3

The students observed that some of the water droplets inside Bottle One increased in size between 60 min and 90 min. Why did the water droplets most likely increase in size?

A. The rate of evaporation increased as the water cooled.

B. The droplets started to freeze as the temperature decreased.

C. More water vapor condensed as the sides of the bottle cooled.

D. Gravity changed the size of the droplets in the absence of light.

SC2308488_4

What did the students most likely learn by comparing Bottle One and Bottle Two throughout the investigation?

A. The rate of evaporation was dependent upon the amount of water inside the bottle.

B. The total volume of water inside the bottle varied depending on the intensity of heat.

C. The temperature of the water inside the bottle was unaffected by the amount of sunlight.

D. The amount of sunlight shining on the bottle was directly related to the rate of evaporation.

RubberBandLauncher

Rubber Band Launcher

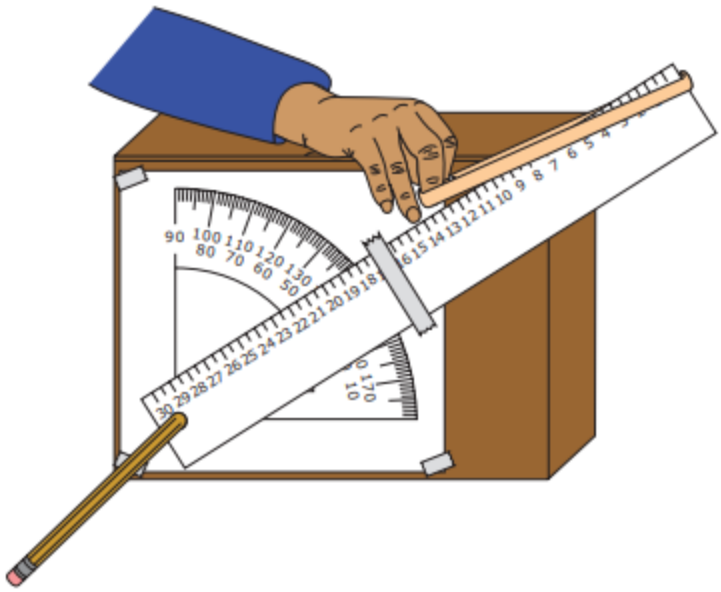
A group of students performed an investigation to study the question, “How does the angle at which a rubber band is launched influence the kinetic energy of the rubber band?”

The students began by collecting a small box, a printed template of a protractor, a ruler with holes, rubber bands of various sizes, a pencil, and tape.

Then the students assembled the rubber band launcher based on the following instructions.

1. Tape the template of a protractor to the side of a box.
2. Poke a hole in the box at the bottom corner of the protractor template.
3. Stick the pencil into the hole.
4. Add a ruler that can pivot on the pencil.
5. Adjust the ruler to obtain the desired angle and secure it with tape.
6. Attach the rubber band at the top of the ruler.
7. Stretch the rubber band the desired amount and measure the angle of the ruler in degrees (°).
8. Release the rubber band.
9. Record the launch time of the rubber band in seconds (s).
10. Measure the distance the rubber band traveled in meters (m).
11. Calculate the velocity in meters per second (m/s).

A picture of the students’ rubber band launcher is shown in the following figure.



After each of the 10 trials, the students recorded their data in the table below.

Rubber Band Launcher Data

Trial	Launch Angle (°)	Launch Time (s)	Distance Traveled (m)	Velocity (m/s)
1	0	0.25	2.5	10.0
2	10	0.38	3.1	8.2
3	20	0.68	4.2	6.2
4	30	1.2	4.4	3.7
5	40	1.5	5.8	3.9
6	50	2.0	4.6	2.3
7	60	2.2	3.0	1.4
8	70	3.0	2.2	0.73
9	80	3.1	1.5	0.48
10	90	3.5	0.5	0.14

SC2288230_2

The students read the following definition of potential energy.

> Potential energy is the stored energy an object has due to its position.

Based on this definition, the potential energy of the rubber band was the greatest when it was

A. flying through the air.

B. stretched to its launching position.

C. on the ground after it was launched.

D. put on the ruler before being stretched.

SC2288226_4

What did the students most likely try to keep constant throughout the 10 trials?

A. Launch time of the rubber band

B. Launch angle of the rubber band

C. Distance the rubber band traveled

D. Distance the rubber band was stretched

SC2288231_4

Why was the distance the rubber band traveled in Trial 5 greater than the distance the rubber band traveled in Trial 10?

A. The rubber band traveled higher in the air in Trial 5 than in Trial 10.

B. The rubber band took longer to hit the ground in Trial 5 than in Trial 10.

C. The speed at which the rubber band traveled was less in Trial 5 than in Trial 10.

D. The students launched the rubber band from a smaller angle in Trial 5 than in Trial 10.

SC2288227_4

Which claim about the relationship between the launch angle and the velocity of the rubber band is best supported by the students' data?

A. The launch angle had little effect on the velocity of the rubber band.

B. The launch angle and the velocity of the rubber band were proportional.

C. As the launch angle increased, the velocity of the rubber band increased.

D. As the launch angle increased, the velocity of the rubber band decreased.

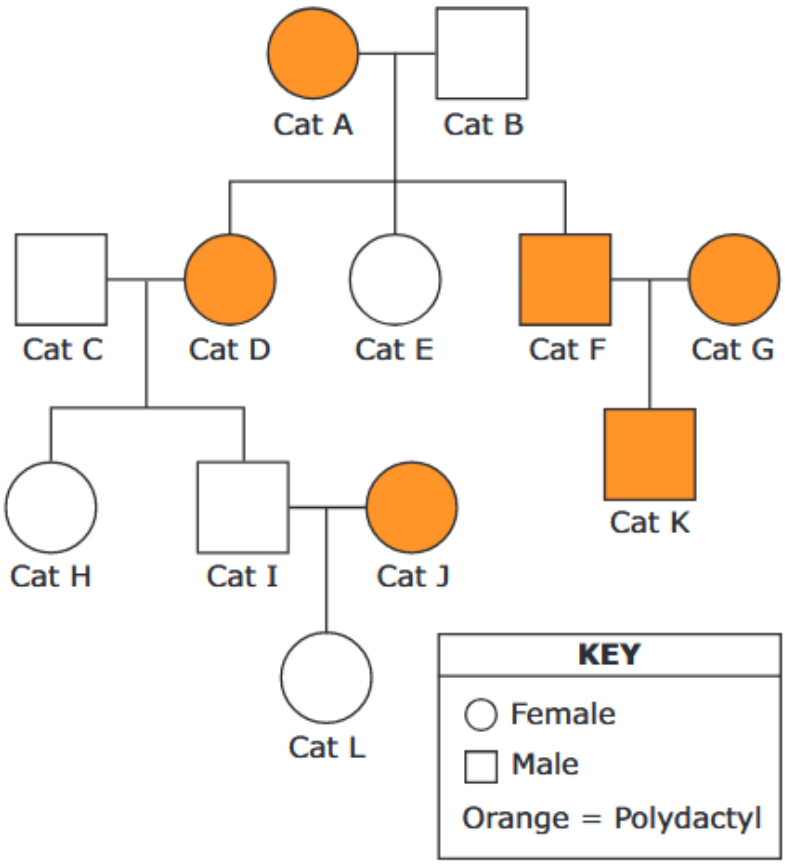
Science Grade 10 Review Items						
Item ID	**Percent Correct**	**Domain**	**DOK**	**Standard**	**Key**	**Primary Distractor(s)**
SC2110525_2	80	LS	2	HS-LS3-1	B	
SC2110522_2	71	LS	2		B	D
SC2110526_1	80	LS	2		A	
SC2110130_2	43	ES	3	HS-ESS1-1	B	A,D
SC2110132_3	50	ES	2		C	B
SC2110138_2	47	ES	3		B	A
SC2110104_4	64	PS	2	HS-PS3-3	D	
SC2110106_3	55	PS	3		C	D
SC2110105_4	44	PS	2		D	C
SC2110109_2	65	PS	2		B	C
SC2110503_3	60	PS	2	HS-PS1-3	C	
SC2110505_4	51	PS	2		D	
SC2110501_2	67	PS	2		B	
SC2110502_2	59	PS	2		B	
SC2310402_1	39	ES	3	HS-ESS3-1	A	
SC2310401_3	45	ES	3		C	
SC2310250_4	46	LS	2	HS-LS1-3	D	A
SC2310252_3	47	LS	2		C	D
SC2310251_4	59	LS	2		D	C
SC2310249_4	64	LS	2		D	

PolydactylCats

Polydactyl Cats

Polydactylism is a condition caused by the mutation of a gene that leads to the expression of additional fingers or toes. The mutation is located on a dominant allele, and the degree to which it is expressed in offspring can vary depending on the alleles both parents have for the gene. Some cats can have an extra toe if only one of their parents carries the allele, while other cats can have several extra toes if both parents carry the allele. This type of genetic transfer is known as incomplete dominance. Below is a pedigree for one family of cats from an area known for its polydactyl cats.

Polydactyl Cat Pedigree



SC2110525_2

The capital letter “P” represents the polydactyl allele and the lowercase letter “p” represents the normal allele. Based on the following Punnett square, what are the chances that a polydactyl (Pp) cat and a non-polydactyl (pp) cat will have an offspring with polydactylism?

	p	p
P	Pp	Pp
p	pp	pp

A. 1/4

B. 2/4

C. 3/4

D. 4/4

SC2110522_2

Which claim about Cat H and Cat I is best supported by the information presented in the pedigree?

A. Cat H has polydactylism and Cat I does not.

B. Cat H and Cat I are siblings without polydactylism.

C. Cat H has a sibling with polydactylism and Cat I does not.

D. Cat H and Cat I can pass the gene for polydactylism on to their offspring.

SC2110526_1

Cat D has polydactylism. Which claim best explains why Cat D has polydactylism?

A. Cat D's mother was a polydactyl cat.

B. Cat D grew extra toes after it was born.

C. Both of Cat D's grandfathers were polydactyl cats.

D. Both of Cat D's parents had the allele for polydactylism.

SunLifeSpan

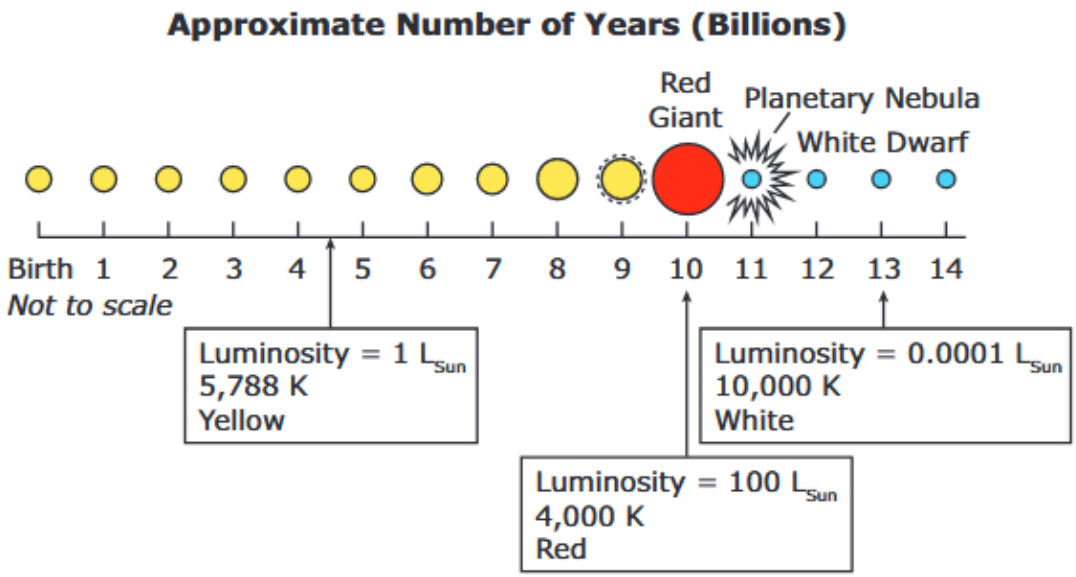
Stars

Stars are the fundamental building blocks of galaxies. They are extremely hot gaseous bodies made of mostly hydrogen and helium. The types, or classes, of stars differ in mass, temperature, luminosity (brightness), and lifespan as shown in the table below. The values range from the largest, hottest, and brightest Class O stars to the smallest, coolest, and least luminous Class M stars. The Sun is classified as a Class G star, which is somewhere in the middle of this range. In the table, mass and luminosity are expressed in units relative to the Sun. M_{Sun} is one times the mass of the Sun and L_{Sun} is one times the luminosity of the Sun. Surface temperature is measured in Kelvin (K) and lifespan is measured in years.

Characteristics of Stars

Class	Mass (M_{Sun})	Surface Temperature (K)	Luminosity (L_{Sun})	Lifespan (Years)
O	>16	33,000	30,000	11 million
B	2.1 – 16	10,000 – 33,000	25 – 30,000	11 million – 1 billion
A	1.4 – 2.1	7,500 – 10,000	5 – 25	1 billion – 2.2 billion
F	1.04 – 1.4	6,000 – 7,500	1.5 – 5	2.2 billion – 10 billion
G	0.8 – 1.04	5,200 – 6,000	0.6 – 1.5	10 billion – 30 billion
K	0.45 – 0.8	3,700 – 5,200	0.08 – 0.6	30 billion – 200 billion
M	0.075 – 0.45	2,000 – 3,700	0.0001 – 0.08	200 billion – 10 trillion

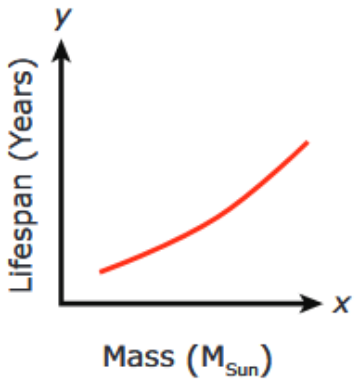
Evidence suggests that the Sun, a main sequence star, is about 4.6 billion years old and close to halfway through its life cycle. In another 5 to 6 billion years, it will likely run out of hydrogen, expand into a red giant with a radius reaching approximately 1 AU (the current distance between the Earth and Sun), and collapse into a white dwarf as illustrated in the diagram below.


Approximate Number of Years (Billions)
Red Giant
Planetary Nebula
White Dwarf
Birth 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Not to scale
Luminosity = 1 L Sun
5,788 K
Yellow
Luminosity = 100 L Sun
4,000 K
Red
Luminosity = 0.0001 L Sun
10,000 K
White

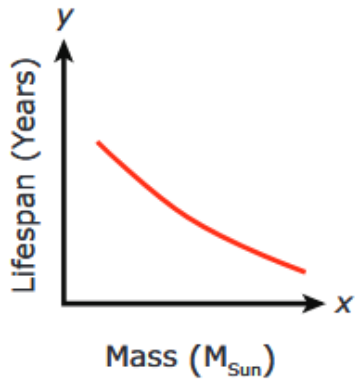
SC2110130_2

Which graph best illustrates the relationship between a star's mass and its expected lifespan?

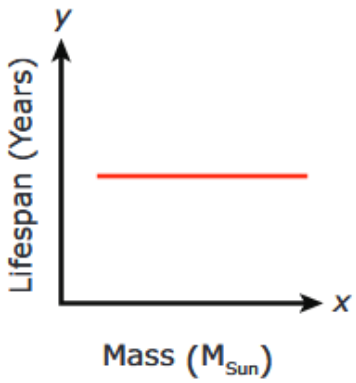
A.



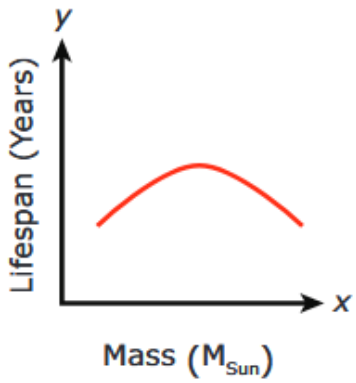
B.



C.



D.



SC2110132_3

Consider the following claim.

> The smallest stars are the hottest and brightest.

What information from the table provides supporting evidence that challenges this claim?

A. Class M stars are the least massive stars with a lifespan up to 10 trillion years.

B. Class B stars are nearly twice as hot as the Sun even though they have a shorter lifespan than the Sun.

C. Class O stars have a mass greater than 16 M_{Sun}, a surface temperature of at least 33,000 K, and a luminosity of 30,000 L_{Sun}.

D. Class A stars could be classified as Class F stars if their mass is 1.4 M_{Sun}, their surface temperature is 7,500 K, and their luminosity is 5 L_{Sun}.

SC2110138_2

The diameter of the Sun is 1,391,020 kilometers (864,340 miles). The diameter of some of the largest stars is about 3,218,688,000 kilometers (2,000,000,000 miles). Compared to the Sun, the lifespan of these stars is about

A. twice as long.

B. 1,000 times shorter.

C. 1,000,000,000,000 years longer.

D. shorter by a few hundred years.

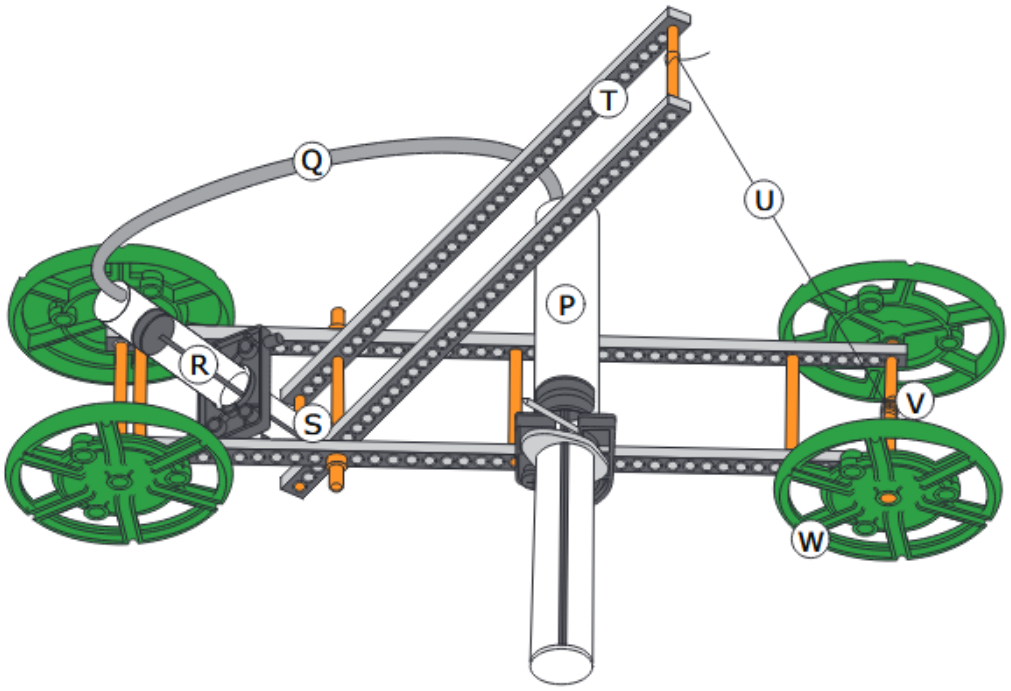
YeastMobile

Yeast Mobile

A student read about the use of biomass fuels, or biofuels, when researching alternative automobile fuels. The student wrote the following notes about biofuels:

- Biofuels are renewable, organic-based fuels obtained from biomass (plants, animal waste, or leftover residue from mills and processing centers).
- Biomass is converted into biofuels through a chemical process called fermentation.
- During fermentation, certain molecules are broken down anaerobically, or without oxygen (O_2).
- The products of fermentation in plants and yeast include ethanol (C_2H_5OH) and carbon dioxide (CO_2).

Then the student gathered the materials needed to build a yeast mobile, which is a small model on wheels that can move using one of the byproducts of fermenting yeast and sugar.



The student conducted four trials using two brands of yeast and two types of sugar. The student added 1.0 gram (g) of Brand Red yeast and 2.0 g of sucrose to 25 milliliters (mL) of warm water. The student swirled the mixture and quickly added it to Chamber P on the yeast mobile. The student recorded the

distance the yeast mobile moved in meters (m). The student repeated the same procedures using different combinations of Brand Red yeast, Brand Blue yeast, sucrose, and dextrose. The student's results are listed in the table below. When yeast is added to a sugar solution, enzymes in the yeast convert the sugar into ethanol (C_2H_5OH) and carbon dioxide (CO_2).

Trial	Brand of Yeast	Type of Sugar	Distance (m)
One	Red	Sucrose	0.23
Two	Red	Dextrose	3.4
Three	Blue	Sucrose	0.45
Four	Blue	Dextrose	6.2

SC2110104_4

Which type of energy transfer occurs in the yeast mobile?

A. Light energy → chemical energy

B. Electrical energy → thermal energy

C. Mechanical energy → nuclear energy

D. Chemical energy → mechanical energy

SC2110106_3

Why did the yeast mobile move the farthest in Trial Four?

A. The student added more sugar to the water.

B. The temperature of the water was the highest.

C. The combination of yeast and sugar produced the most CO_2.

D. The Brand Blue yeast contained more enzymes than the Brand Red yeast.

SC2110105_4

What determines the direction the yeast mobile moves?

A. The length of Lever T

B. The diameter of Wheel W

C. The amount of pressure built up in Chamber P

D. The way in which String U is wound around Axle V

SC2110109_2

The student added the following notes about biofuels:

- In the United States, ethanol is made mostly from corn.
- There are advantages and disadvantages of using corn to make ethanol.

Then the student wrote these four statements.

1. Corn can be produced at a rate equivalent to the demand for corn.
2. A significant amount of land is needed to grow enough corn to make ethanol.
3. Production of ethanol is dependent on the quality of the growing season of corn.
4. Using corn to make ethanol can reduce the amount of biomass waste.

Which of these four statements are advantages of using corn to make ethanol?

A. 1 and 2 only

B. 1 and 4 only

C. 2 and 3 only

D. 3 and 4 only

Corrosion of Iron

A pair of students studying the corrosion of iron (Fe) conducted an investigation.

1. The students obtained 10 different colorless solutions from their teacher. They added 5 milliliters (mL) of each solution to 10 labeled test tubes and placed them in a test tube rack.

2. The students dipped a glass stirring rod in the solution in Test Tube 1 and touched it to a piece of universal indicator paper. They allowed the indicator paper to dry and observed its final color. Universal indicator paper turns red in the presence of an acid (pH < 7) and blue in the presence of a base (pH > 7). The students repeated Step Two for the other nine solutions and recorded their results in the table below.

3. The students added a shiny iron nail to each test tube. They capped each test tube and set them on the lab counter overnight.

4. The next day, the students observed the final appearance of each nail. Then they added one drop of 0.1 molar (M) potassium ferricyanide ($K_3Fe(CN)_6$) to each test tube. Potassium ferricyanide forms a bright blue precipitate in the presence of Fe^{2+} ions. They observed the color of each solution and recorded their observations in the following table.

Corrosion of Fe Metal into Fe^{2+} Ions

Test Tube	Solution	Final Color of Universal Indicator	Final Appearance of Nail	Final Color with Potassium Ferricyanide ($K_3Fe(CN)_6$)
1	Sodium Hydroxide (NaOH)	Blue	Shiny	Clear
2	Sodium Chloride (NaCl)	No Change	Corroded	Blue
3	Hydrogen Chloride (HCl)	Red	Corroded	Blue
4	Sodium Carbonate (Na_2CO_3)	Blue	Shiny	Clear
5	Hydrogen Sulfate (H_2SO_4)	Red	Corroded	Blue
6	Sodium Oxalate ($Na_2C_2O_4$)	Blue	Shiny	Clear
7	Potassium Nitrate (KNO_3)	No Change	Corroded	Blue
8	Hydrogen Nitrate (HNO_3)	Red	Corroded	Blue
9	Trisodium Phosphate (Na_3PO_4)	Blue	Shiny	Clear
10	Distilled Water (H_2O)	No Change	Corroded	Blue

SC2110503_3

Which claim about Test Tube 1 best supports the students' observations?

A. The solution contained Fe^{2+} ions.

B. The iron nail corroded in the solution.

C. The basic solution did not corrode the iron nail.

D. The potassium ferricyanide reacted with the iron nail.

SC2110505_4

Which test tube was the control in the students' investigation?

A. Test Tube 4

B. Test Tube 5

C. Test Tube 8

D. Test Tube 10

SC2110501_2

One of the students claimed they could use a single stirring rod during the investigation, but the student's partner disagreed. Why did the student's partner disagree?

A. They did not have enough stirring rods to use a different one in each solution.

B. The solutions could become contaminated from using a single stirring rod.

C. The stirring rod could break before they tested the pH of each solution.

D. The acids in some of the test tubes could corrode the stirring rod.

SC2110502_2

The students added 10 mL of hydrogen sulfate (H_2SO_4) to a clean test tube. They checked the pH of the solution and added a shiny iron nail. They capped the test tube and set it on the lab counter until the next day. Was there evidence of corrosion in the test tube?

A. Yes, the nail completely dissolved.

B. Yes, the nail appeared dull and rusty.

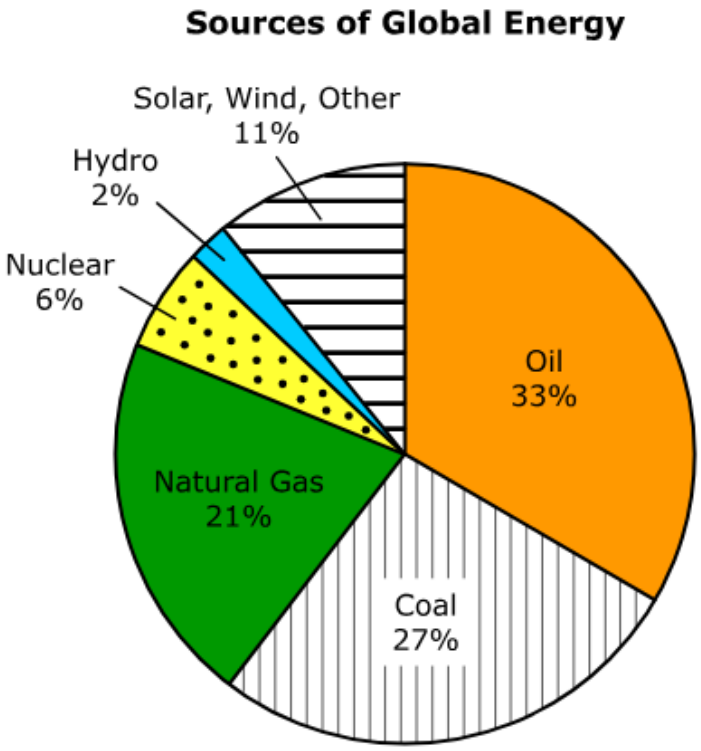
C. No, the iron nail does not react with hydrogen sulfate.

D. No, the students forgot to add potassium ferricyanide.

SourcesofGlobalEnergy

Sources of Global Energy

A student observed the following pie chart of sources of global energy from a certain year while conducting research.



The student also observed the following table of the capacity factors of different energy sources during that same year. The capacity factor is the percentage (%) of time that a plant is operating at maximum power during a year.

Energy Source	Capacity Factor (%)
Solar	24.9
Wind	35.4
Coal	40.2
Hydropower	41.5
Natural gas	56.6
Geothermal	74.3
Nuclear	92.5

SC2310402_1

The student toured the local nuclear power plant. The tour guide told her that a nuclear reactor produces one gigawatt (GW) of electricity during a certain period. Based on the data in the capacity factor table, about how many one-GW coal plants would be needed to generate close to the same amount of power as a nuclear power plant with one reactor during that certain period?

A. Two

B. Four

C. Six

D. Eight

SC2310401_3

The student read an article from an energy sources journal. The author of the article stated, “Nuclear power plants typically require less maintenance than other types of power plants. Nuclear power plants are designed to operate for around 1.5 to 2 years before they need refueling.” How do the data in the capacity factor table support what the author wrote in the article?

A. Upkeep is required at a nuclear power plant 92.5% of the time in which it operates during a year.

B. The backup power source at a nuclear power plant produces 24.5% more energy than solar plants.

C. Nuclear power plants operate at maximum power almost 20% more than geothermal power plants.

D. Energy production at a nuclear power plant is 92.5% less efficient than it is at the other power plants.

CoreBodyTemperature

Core Body Temperature

Researchers performed two experiments to determine how the temperature of the room influenced a person's core body temperature when sleeping. For each set of conditions, the researchers monitored the core body temperature of volunteers throughout the night while they slept.

Experiment One

Volunteers were randomly divided into two groups. Each volunteer slept in a quiet room while researchers monitored their core body temperature in degrees Celsius (°C) for eight hours. For volunteers in Group A, the room temperature was held constant at 26°C throughout the night. For volunteers in Group B, the room temperature started at 26°C and then increased to 32°C after four hours. A graph of the results is shown in Figure 1.

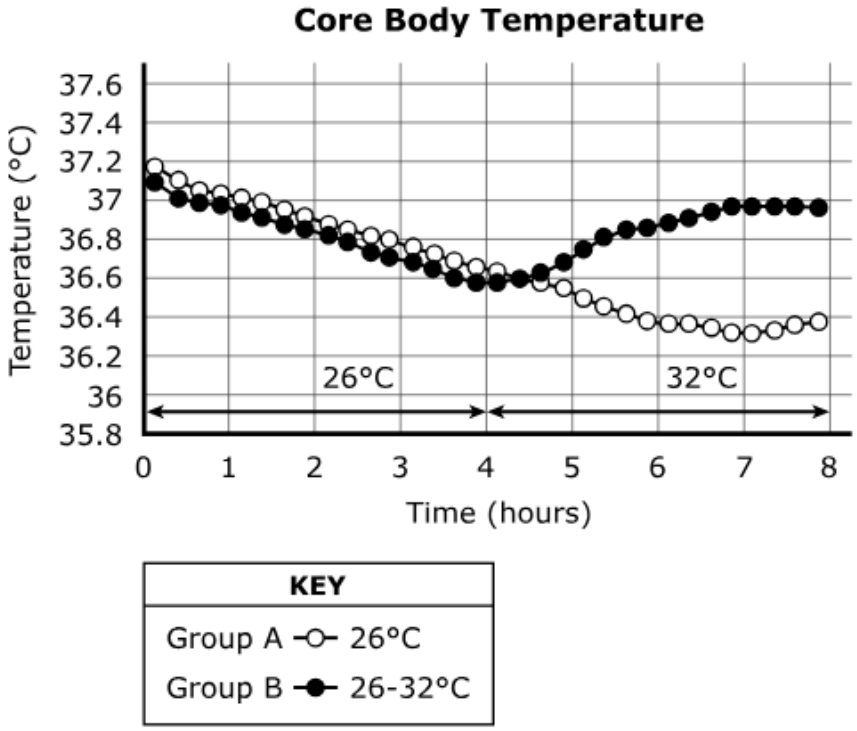


Figure 1 Core body temperature for volunteers in Groups A and B

Experiment Two

Volunteers were divided into two groups. Each volunteer slept in a quiet room while researchers monitored core body temperature for eight hours. For volunteers in Group C, the room temperature was held constant at 26°C throughout the night. For volunteers in Group D, the room temperature started at 32°C and then decreased to 26°C after four hours. A graph of the results is shown in Figure 2.

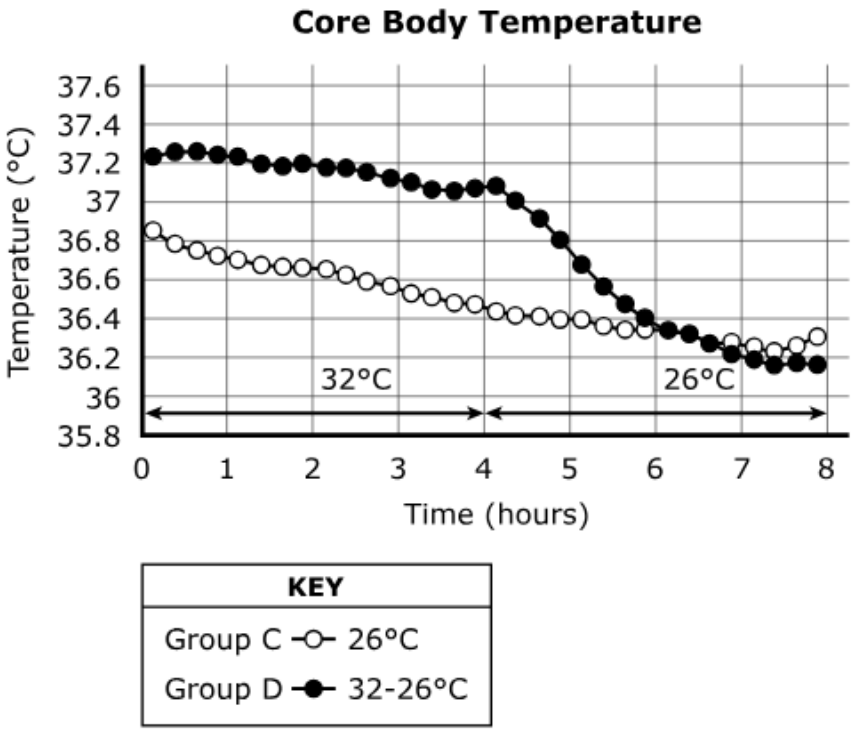


Figure 2 Core body temperature for volunteers in Groups C and D

SC2310250_4

The researchers would most likely agree that the purpose of Experiment One was to

A. understand why core body temperature starts to decrease when a person falls asleep.

B. monitor how long it takes a person to fall asleep under different light and dark conditions.

C. compare core body temperature and heart rate during the longest phase of the sleep cycle.

D. analyze how a higher room temperature affects a person's core body temperature while sleeping.

SC2310252_3

The results of Experiment One provide the strongest support for which claim about core body temperature during sleep?

A. A person's core body temperature is 5°C higher during the day than during the night.

B. Core body temperature decreases to 34°C before leveling off after a person falls asleep.

C. A person's core body temperature decreases unless the temperature of the room increases.

D. Changes in a person's core body temperature are independent of the temperature of the room.

SC2310251_4

What is the main difference between Experiment One and Experiment Two?

A. The participants in Experiment One were volunteers and the participants in Experiment Two were fellow researchers.

B. The independent variable in Experiment One was room temperature and the independent variable in Experiment Two was light.

C. The core body temperature was monitored for eight hours in Experiment One and the respiration rate was monitored for four hours in Experiment Two.

D. The researchers increased the temperature in some of the rooms in Experiment One and decreased the temperature in some of the rooms in Experiment Two.

SC2310249_4

Which condition mattered least to the researchers across the four groups?

A. Hours of darkness in each room

B. Types of clothing worn to sleep in

C. Thickness of blankets used at night

D. Distance from each room to the bathroom