

DOK PROGRESSION GUIDE • NGSS SCIENCE

High School Science

Every NGSS performance expectation in the high school PEs, tested once in high school, with a Test Bank question at DOK 1, DOK 2 and DOK 3, and the clicks to find more.

DOK 1 Recall

DOK 2 Skills & concepts

DOK 3 Strategic thinking

DOK 4 Extended thinking

For high school science teachers. Organized by domain, core idea (DCI) and performance expectation (PE), the way the Test Bank files science.

achievementtestbank.com ·
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How to use this booklet

Depth of Knowledge (DOK) describes the kind of thinking a question asks for, not how hard it is. For each performance expectation (PE), this booklet shows one question at DOK 1, DOK 2 and DOK 3, so you can see the climb from recalling an idea to using evidence and reasoning with it, and then pick questions at the level your students need next.

The four DOK levels

DOK 1 • Recall

Recall a fact, term or property, or carry out a routine one-step procedure. Read a value straight from a table or graph.

DOK 2 • Skills & concepts

Decide how to approach it and use two or more steps: compare, classify, interpret data, or move between representations.

DOK 3 • Strategic thinking

Reason and plan: justify an answer, critique an argument, use evidence, or solve a problem with no routine path.

DOK 4 • Extended thinking

Carry out an extended investigation that connects several ideas, conditions or sources. The Test Bank tags science questions DOK 1 to 3, so this booklet shows those three levels.

Reading a PE page

1. The heading names the disciplinary core idea (DCI), the performance expectation (PE) code and its wording.
2. The DOK ladder shows the levels this guide gives an example for. Every PE has a DOK 1, DOK 2 and DOK 3 example.
3. One example question at each level, lowest first, with the answer shown. Read them top to bottom to see how the thinking climbs.
4. "Why DOK n" explains in one sentence what makes the question that level, so you can spot the same thing in your own questions.
5. "Find more like this" lists the exact Test Bank clicks that generate more questions for the same PE at the same level.

The state science test item specifications do not assign DOK levels to PEs, so the levels here come from the Test Bank's own DOK tags. Every example was then checked by hand against the DOK definitions above. Where no Test Bank question truly fit a level, we wrote one; those are marked "Written for this guide."

Finding these questions in the Test Bank

Every example page ends with the exact clicks. Science is filed by course, subject, core idea and PE. The courses are Biology (Life Science), Chemistry or Physics (Physical Science) and Earth Science.

One PE at one DOK level

[Create questions](#) › [Course](#) › [Subject](#) › [Disciplinary core idea \(DCI\)](#) › [Performance expectation \(PE\)](#) › [Practice and crosscutting concept \(optional\)](#) › [Options: DOK 1, 2 or 3](#) › [Generate](#)

Pick a practice and crosscutting concept to narrow the questions further, or leave them open for any.

Engineering Design (ETS1)

Engineering Design is not tied to one course.

[Create questions](#) › [Course: All](#) › [HS Engineering Design](#) › [ETS1](#) › [PE](#) › [Options: DOK](#) › [Generate](#)

Questions you have saved

Saved questions are filed the same way in your Item Bank.

[More](#) › [Item Bank](#) › [Course](#) › [Discrete or task](#) › [Subject](#) › [Core idea \(DCI\)](#) › [Performance expectation \(PE\)](#) › [DOK](#)

Tip: to move a class up the ladder, generate the same PE at the next DOK level. To check that an idea is secure before going further, generate a set at DOK 1.

All performance expectations at a glance

Every PE has an example question at DOK 1, DOK 2 and DOK 3 in this booklet.

Life Science

PE		DOK 1	DOK 2	DOK 3	DOK 4
HS-LS1-1	Construct an explanation for how the structure of DNA determines the structure of proteins				—
HS-LS1-2	Develop and use a model to illustrate the hierarchical organization of interacting systems				—
HS-LS1-3	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis				—
HS-LS1-4	Use a model to illustrate the role of cellular division and differentiation in producing and maintaining complex organisms				—
HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy				—
HS-LS1-6	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and lipids				—
HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules are broken releasing energy				—
HS-LS2-1	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems				—
HS-LS2-2	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations				—
HS-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions				—
HS-LS2-4	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem				—
HS-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere				—
HS-LS2-6	Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms				—
HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity				—
HS-LS2-8	Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce				—
HS-LS3-1	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits				—
HS-LS3-2	Make and defend a claim based on evidence that inheritable genetic variations may result from new genetic combinations through meiosis				—
HS-LS3-3	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population				—

PE		DOK 1	DOK 2	DOK 3	DOK 4
HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence				—
HS-LS4-2	Construct an explanation based on evidence that the process of evolution primarily results from four factors				—
HS-LS4-3	Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion				—
HS-LS4-4	Construct an explanation based on evidence for how natural selection leads to adaptation of populations				—
HS-LS4-5	Evaluate the evidence supporting claims that changes in environmental conditions may result in the emergence of new species				—
HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity				—

Physical Science

PE		DOK 1	DOK 2	DOK 3	DOK 4
HS-PS1-1	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level				—
HS-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states				—
HS-PS1-3	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces				—
HS-PS1-4	Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy				—
HS-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs				—
HS-PS1-6	Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium				—
HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction				—
HS-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay				—
HS-PS2-1	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration				—
HS-PS2-2	Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system				—
HS-PS2-3	Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision				—
HS-PS2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects				—
HS-PS2-5	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current				—
HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials				—
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other				—

PE		DOK 1	DOK 2	DOK 3	DOK 4
	component(s) and energy flows in and out of the system are known				
HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects)	●	●	●	—
HS-PS3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy	●	●	●	—
HS-PS3-4	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution	●	●	●	—
HS-PS3-5	Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction	●	●	●	—
HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media	●	●	●	—
HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information	●	●	●	—
HS-PS4-3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model	●	●	●	—
HS-PS4-4	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter	●	●	●	—
HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information	●	●	●	—

Earth & Space Science

PE		DOK 1	DOK 2	DOK 3	DOK 4
HS-ESS1-1	Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy				—
HS-ESS1-2	Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe				—
HS-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements				—
HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system				—
HS-ESS1-5	Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks				—
HS-ESS1-6	Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history				—
HS-ESS2-1	Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features				—
HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems				—
HS-ESS2-3	Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection				—
HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate				—
HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes				—
HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere				—
HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth				—
HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity				—
HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios				—
HS-ESS3-3	Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity				—
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems				—

PE		DOK 1	DOK 2	DOK 3	DOK 4
HS-ESS3-5	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems				—
HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity				—

Engineering Design

PE		DOK 1	DOK 2	DOK 3	DOK 4
HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants				—
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering				—
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts				—
HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem				—

NGSS DOMAIN

Life Science

24 performance expectations, grouped by disciplinary core idea. In the Test Bank, choose the Biology course, then HS Life Science.

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HS-LS1-1 Construct an explanation for how the structure of DNA determines the structure of proteins

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall one fact: the order of bases in a gene sets the order of amino acids in a protein. No data or reasoning is needed, so it is recall.

A gene is a section of DNA that carries the instructions for making one protein. A student reads that the order of the four bases (A, T, C, and G) in a gene is very important. What does the order of bases in a gene directly determine?

- ☒ The order of amino acids in the protein that the gene codes for ✓
- ☐ The number of chromosomes found in each of the body's cells
- ☐ The order of sugar units in the starch that a cell stores
- ☐ The kinds of fat molecules that make up the cell membrane

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DOK 2 · Skills & concepts

Why DOK 2: Students must connect two ideas, the same DNA in every cell and different genes turned on, to explain why cells with identical DNA make different proteins.

A muscle cell and a nerve cell in the same person contain the same DNA sequences, yet they look different and do different jobs. A student writes an explanation for this. Which statements correctly explain how the cells become specialized? Select all that apply.

☐ Muscle and nerve cells must have different DNA sequences because they do different jobs.

☐ If a gene's base sequence is changed, no protein can ever be made from that gene.

☒ The two cells make different proteins, even though they carry the same genes. ✓

☒ The base order of each expressed gene sets the amino acid order of its protein. ✓

☒ Different genes are turned on in muscle and nerve cells, so they make different proteins. ✓

☐ Nerve cells removed their muscle genes from their DNA once they became nerve cells.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students choose the claim the evidence supports, explain the cause, and then identify what result would weaken the claim, which requires reasoning about evidence.

Use the drop-down menus to complete the statement.

At an aquarium in Mexico City, researchers watch an axolotl regrow a lost front leg. Cells near the wound divide and form new bone, muscle, and skin. Tests show the new muscle cells have the same DNA sequence as the new skin cells. But the two kinds of cells make different proteins. This evidence best supports the claim that

cells with the same DNA can make different proteins ▾. The new cells become different

kinds of cells because they turn on different genes ▾. A result that would weaken this

claim is finding new muscle cells that have DNA unlike the skin cells ▾.

Drop-down 1 choices: regrowing a leg changes the animal's DNA

muscle and skin cells have different genes

cells with the same DNA can make different proteins ✓

Drop-down 2 choices: they turn on different genes ✓

they lose genes they do not need

they receive different DNA

Drop-down 3 choices: have DNA unlike the skin cells ✓

make muscle proteins

have the same DNA as bone cells

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Test Bank question

HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall which body system each organ or tissue belongs to and its basic job. Each row is a one-step fact check.

A veterinarian at a dairy farm in Tulare County explains how different parts of a cow's body help turn grass into milk. Select True or False for each statement.

	True	False
The rumen, a stomach chamber where microbes break down grass, is part of the digestive system.	☒	☐
The blood vessels that carry absorbed nutrients to the udder are part of the digestive system.	☐	☒
The jaw muscles that grind cud are part of the muscular system.	☒	☐
The heart belongs to the digestive system because it moves nutrients.	☐	☒
The lining of the small intestine absorbs nutrients into the blood.	☒	☐

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students apply a given model of three interacting systems (digestive, circulatory, skeletal) to explain an observation, linking several steps rather than recalling one fact.

Grace raises laying hens in Georgia. Eggshells are made mostly of calcium. Her model of calcium in a hen: the digestive system absorbs calcium from feed into the blood, the blood carries calcium to the shell gland of the reproductive system, and the bones store calcium and can release it into the blood. Grace fed one flock a low-calcium feed for a month, and at first the hens kept laying eggs with normal shells. Based on the model, which explanation best accounts for the normal shells?

- ☐ The shell gland made new calcium on its own, so the hens did not need any from feed.
- ☒ Calcium released from the hens' bones entered the blood and was carried to the shell gland. ✓
- ☐ The stomach stored a month of calcium and passed it straight to the shell gland without the blood.
- ☐ The hens' leg muscles made extra calcium to replace the calcium missing from the feed.

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Test Bank question

After heavy rain, part of a squash field in the Central Valley stays flooded for three days. The squash plants in the flooded area wilt, even though their roots sit in water. Root cells need oxygen to release energy, and waterlogged soil has very little oxygen. In a greenhouse, a farmer grows squash in flooded pots. He bubbles air into half the pots and not into the others.

Part A: Which prediction best fits the farmer's greenhouse test?

Choose one answer.

- ☐ Plants in both groups will stay firm, because their roots are surrounded by water.
- ☐ Plants without air will wilt less, because their leaves will get extra water.
- ☒ Plants with air bubbled in will wilt less, because their roots can keep taking in water. ✓
- ☐ Plants in both groups will wilt, because the water around the roots is the same.

Part B: Which evidence or idea best supports your prediction in Part A?

Choose one answer.

- ☐ Flooded soil holds more water, so the leaves will always get more of it.
- ☐ The root system and shoot system work separately in squash plants.
- ☒ Root cells need oxygen for energy to take in water and send it to the leaves. ✓
- ☐ Leaves take in water from the air, so roots are not needed on flooded days.

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Test Bank question

HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasisExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students identify the one data point that shows a return to a set point, using the basic definition of a feedback mechanism.

A student measured her resting heart rate: 72 beats per minute. She ran on a treadmill for 5 minutes, and right after stopping her heart rate was 145 beats per minute. Over the next 10 minutes, it slowly decreased back to 72 beats per minute. Which piece of evidence best shows a feedback mechanism returning her body to a stable state?

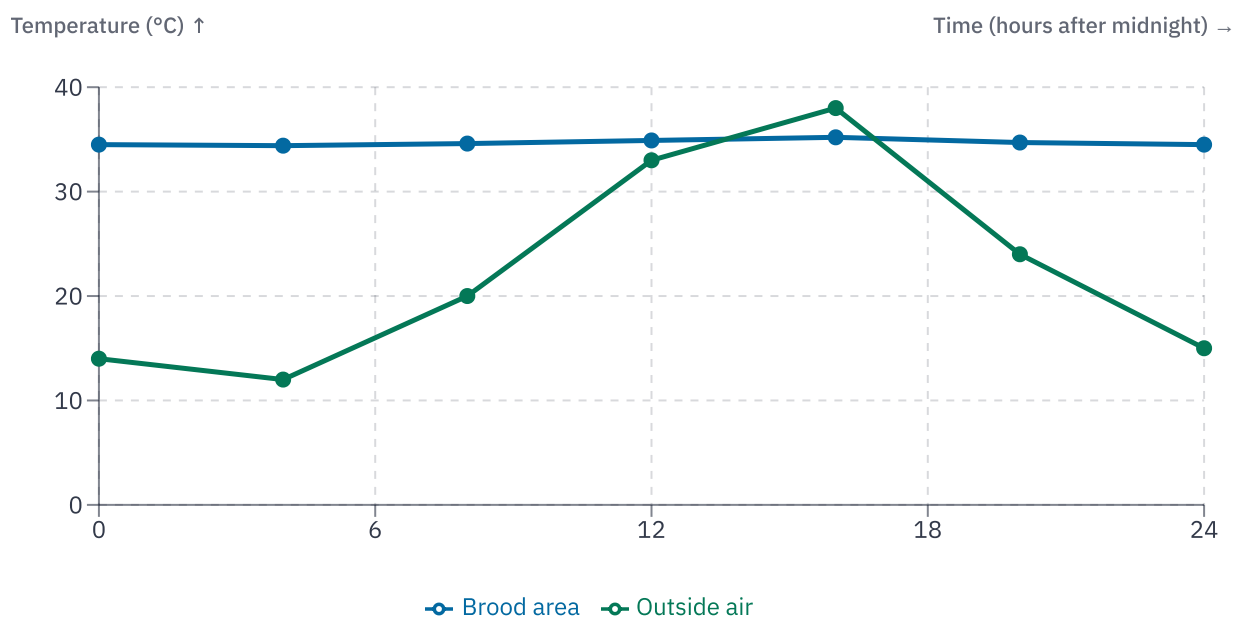
- ☐ Her resting heart rate was 72 beats per minute before she began to run.
- ☐ Her heart rate rose to 145, which shows her body could not stay stable.
- ☒ Her heart rate fell back to 72 within 10 minutes after she stopped running. ✓
- ☐ Her heart rate was higher right after running than it was at rest.

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Test Bank question

A beekeeper in Fresno put one temperature sensor in the center of a hive's brood area, where young bees develop. She put another sensor outside the hive. The graph shows readings every 4 hours for one day. Which conclusion is best supported by the graph?

Hive Brood Temperature and Outside Air Temperature Over One Day



- ☐ The brood area warmed and cooled by about as much as the outside air did.
- ☒ The bees kept the brood area near 35°C while outside air changed by over 20°C. ✓
- ☐ The brood area stayed steady only because the outside air never changed.
- ☐ The brood area was coolest at hour 16, when the outside air was hottest.

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LS1-3

DOK 2

Generate

Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students critique an investigation plan and decide which changes would improve accuracy and precision, which requires planning and reasoning about experimental design.

The pupil of the eye gets smaller in bright light, which keeps the light reaching the back of the eye in a safe range. Three students tested this response. Each held a millimeter ruler next to a partner's eye. They read pupil width once after 1 minute in a dim room and once after 1 minute under a bright lamp. Which changes would most improve the accuracy and precision of their measurements? Select all that apply.

Pupil Width in Dim and Bright Light

Partner	Dim room (mm)	Bright lamp (mm)
Lena	7	3
Omar	6	3
Yuki	7	2

- ☒ Photograph each eye next to a scale and measure the pupil from the photo. ✓
- ☐ Round every reading to the nearest centimeter to make the values simpler.
- ☒ Have two students read each pupil and compare their readings. ✓
- ☐ Let each student choose how bright the lamp should be for a partner.
- ☐ Stop after the first partner, since the pattern is already clear.
- ☒ Take several readings in each condition and average them for each person. ✓

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Test Bank question

HS-LS1-4 Use a model to illustrate the role of cellular division and differentiation in producing and maintaining complex organisms

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall basic facts: mitosis increases cell number, daughter cells have identical DNA, and different genes are expressed in different cell types.

In a plant lab, Mateo takes one cell from an orchid leaf and places it on a growth gel. The cell divides over and over. Months later it has grown into a whole orchid with roots, stems, and leaves. Choose the missing values from the drop-down menus.

Question about the new orchid	Answer
Process that increased the number of cells	Blank 1
DNA in a root cell compared with the original leaf cell	Blank 2
Why root cells and leaf cells look different	Blank 3

Blank 1 (Row 1, Answer):

mitosis ▼

Blank 2 (Row 2, Answer):

identical ▼

Blank 3 (Row 3, Answer):

different genes are expressed ▼

Drop-down 1 choices: meiosis fertilization **mitosis ✓**

Drop-down 2 choices: **identical ✓** half as much different

Drop-down 3 choices: they lost different genes they have different chromosomes

different genes are expressed ✓

FIND MORE LIKE THIS

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students explain why specialized cells differ from the stem cells that made them, then choose the evidence that supports that explanation.

A model of skin repair after a scrape shows skin stem cells in the bottom layer, called the basal layer, dividing. The daughter cells move upward. As they move, they change shape and job, and they become flat, protective cells at the surface.

Part A: What best explains why the flat surface cells look and work so differently from the basal stem cells that made them?

Choose one answer.

- ☐ The surface cells went through meiosis, which changed their genetic material.
- ☐ The surface cells lost half of their chromosomes as they moved away from the basal layer.
- ☐ The surface cells contain sister chromatids, while basal cells contain homologous chromosomes.
- ☒ The surface cells have the same DNA as the basal cells but turn different genes on and off. ✓

Part B: Which evidence, if found, best supports your answer to Part A?

Choose one answer.

- ☒ Surface cells and basal cells from the same skin have matching DNA. ✓
- ☐ Basal cells divide often, but surface cells do not divide.
- ☐ Surface cells are flat, while basal cells are rounder.
- ☐ Surface cells have half as many chromosomes as basal cells.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students coordinate two changing data sets over time, dividing cells and fin growth, to build a supported claim and pick the evidence that links them.

Researchers in a Pasadena, California, lab clip the tail fins of zebrafish. Every two days, they count the dividing cells in a sample near the cut and measure how much fin has grown back.

Dividing Cells and Fin Regrowth After Clipping

Day after clipping	Dividing cells per sample	Fin regrown (mm)
1	5	0
3	60	0.5
5	45	1.5
7	15	2.5

Part A: Which claim is best supported by the data?

Choose one answer.

- ☐ The number of dividing cells rose steadily during the whole week.
- ☒ The fin grew fastest after a burst of cell division near the cut. ✓
- ☐ The fin regrew without cell division, since dividing cells dropped by day 7.
- ☐ The fin stopped growing by day 7 because no cells were dividing.

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

- ☐ Only 5 cells per sample were dividing on day 1.
- ☒ Dividing cells peaked on day 3, and the fin grew most between days 3 and 7. ✓
- ☐ Dividing cells dropped from 60 to 15 between day 3 and day 7.
- ☐ The fin was 2.5 mm longer on day 7 than on day 1.

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Test Bank question

HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy

Examples at:

DOK 1

DOK 2

DOK 3

DOK 4

DOK 1 · Recall

Why DOK 1: Students recall the inputs and energy source of photosynthesis and that atoms are conserved. Each blank is a single remembered fact.

Use the drop-down menus to complete the statement.

Zara grows cyanobacteria, tiny bacteria that carry out photosynthesis, in a flask near a sunny lab window. The carbon atoms in the sugar the cyanobacteria make come from

carbon dioxide ▼

. During photosynthesis, the total number of atoms in the flask

stays the same ▼

. The sugar stores chemical energy that came from

absorbed light ▼

.

Drop-down 1 choices: carbon dioxide ✓ the sunlight the glass flask

Drop-down 2 choices: decreases stays the same ✓ increases

Drop-down 3 choices: the water absorbed light ✓ new atoms

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Test Bank question

A student uses a computer model of photosynthesis in a water plant. The student can change the amount of light the plant gets. The model shows the mass of glucose made and the O₂ released. It also shows that CO₂ and water start with less stored chemical energy than the glucose and O₂ made at the end. Each time the student raises the light, both glucose made and O₂ released go up. Use the computer model to answer both parts.

Part A: Which statement best describes what happens to energy during photosynthesis?

Choose one answer.

- ☐ Glucose appears from nothing, and light energy is only used to make O₂.
- ☐ The chemical energy already in CO₂ is rearranged into glucose, with none added.
- ☐ Light energy disappears and turns into the O₂ gas that the plant releases.
- ☒ Light energy is changed into chemical energy that is stored in glucose. ✓

Part B: Which evidence from the model best supports your answer to Part A?

Choose one answer.

- ☐ Light energy is fully used up, so no energy is left in the glucose or the O₂.
- ☐ More O₂ is made than glucose, which shows light mainly breaks apart water.
- ☐ The CO₂ used matches the glucose made, which shows a one-step process.
- ☒ The products store more energy than the inputs, and more light makes more glucose. ✓

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate two competing explanations against an energy diagram and justify which one the model supports, which is critiquing with evidence.

A student made an energy diagram of photosynthesis in a leaf. The reactants (CO_2 and water) are on the left at a low energy level. The products (glucose and O_2) are on the right at a higher energy level. The only energy input shown is an arrow for absorbed light. Two classmates explain the gap between the levels. Omar says it is energy the plant took in with water from the soil. Grace says it is absorbed light energy, now stored as chemical energy in glucose. Which evaluation of the two explanations is best supported by the energy diagram?

- ☐ Neither is correct, because the gap shows energy that the plant loses as heat in the reaction.
- ☒ Grace is correct, because absorbed light is the only energy input, and the products store more. ✓
- ☐ Omar is correct, because water enters through the roots and carries energy up to the leaves.
- ☐ Both are correct, because light and soil water each add an equal share of the stored energy.

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Test Bank question

HS-LS1-6 Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and lipids

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall the ways a plant can use glucose atoms, such as building starch, cellulose, and amino acids with soil nitrogen.

A potato plant makes glucose in its leaves by photosynthesis. It takes in water and nitrogen-containing ions from the soil through its roots. Which statements correctly describe how the plant can use atoms from its glucose? Select all that apply.

- ☐ It must take in all of its amino acids whole from the soil.
- ☒ It can use glucose atoms to build cellulose for the walls of its cells. ✓
- ☐ It can change glucose carbon atoms into the nitrogen its proteins need.
- ☒ It can link glucose units into starch that is stored in the potatoes. ✓
- ☐ It can use glucose atoms only for energy and never to build new molecules.
- ☒ It can combine glucose atoms with soil nitrogen to build amino acids. ✓

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students explain at a basic level how glucose atoms are rearranged and combined with nitrogen to build amino acids and proteins for repair.

A student plays soccer for two hours, and afterward her leg muscles are sore from tiny tears in the muscle fibers. Her coach says her body breaks down glucose to release energy during exercise, but it also needs to build new protein to repair the fibers. Glucose is made of carbon, hydrogen, and oxygen atoms. Explain how atoms from glucose can help repair her muscle fibers instead of only being used for energy.

Model response: When glucose is broken down, its carbon, hydrogen, and oxygen atoms are not destroyed. Her cells can rearrange these atoms and combine them with nitrogen from other foods to build amino acids. The amino acids are joined into new proteins that repair the damaged muscle fibers.

Rubric: 2 points: Explains that glucose atoms are rearranged and combined with nitrogen to form amino acids, and that the amino acids are joined into proteins that repair the muscle. 1 point: Explains only that glucose atoms form amino acids, or only that new proteins repair the muscle, without linking the two. 0 points: Says glucose is used only for energy, or gives no relevant explanation.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate a claim by comparing quantities, 30 kg of fat gained versus 12 kg eaten, and conclude the pig must have built fat from starch.

On a farm in North Carolina, a young pig ate 300 kg of feed while growing. The feed was mostly corn starch and contained 12 kg of fat. During that time the pig gained 30 kg of body fat. A student claims: "Animals can't make their own fat; all of the pig's fat came from fat in its feed." Which statement best evaluates the student's claim?

- ☐ Supported: the feed contained fat, so that fat is where the pig's fat came from.
- ☐ Supported: the pig ate far more feed than the amount of fat it gained.
- ☐ Not supported: the pig's fat came from the air, since fat contains oxygen.
- ☒ Not supported: the pig gained more fat than its feed held, so it built fat from starch. ✓

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Test Bank question

HS-LS1-7 Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules are broken releasing energy

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students fill in the parts of a respiration model from memory: the reactants, the net energy release, and that atoms are rearranged, not created.

A veterinarian at a racetrack in Arcadia describes how a racehorse's muscle cells get usable energy from the food the horse eats. Choose the missing values from the drop-down menus.

Model component	Description
Reactants (inputs)	Blank 1
Bond changes	Bonds in glucose and oxygen break; new bonds form in carbon dioxide and water
Products (outputs)	carbon dioxide and water
Energy result	Blank 2
Matter change	Blank 3

Blank 1 (Row 1, Description): glucose and oxygen ▼

Blank 2 (Row 4, Description): net release, captured as ATP and heat ▼

Blank 3 (Row 5, Description): atoms rearranged, none created or destroyed ▼

Drop-down 1 choices: carbon dioxide and water ATP and heat **glucose and oxygen ✓**

Drop-down 2 choices: energy created from matter energy stored in carbon dioxide

net release, captured as ATP and heat ✓

Drop-down 3 choices: atoms turned into energy for the muscles atoms destroyed as the food is used up

atoms rearranged, none created or destroyed ✓

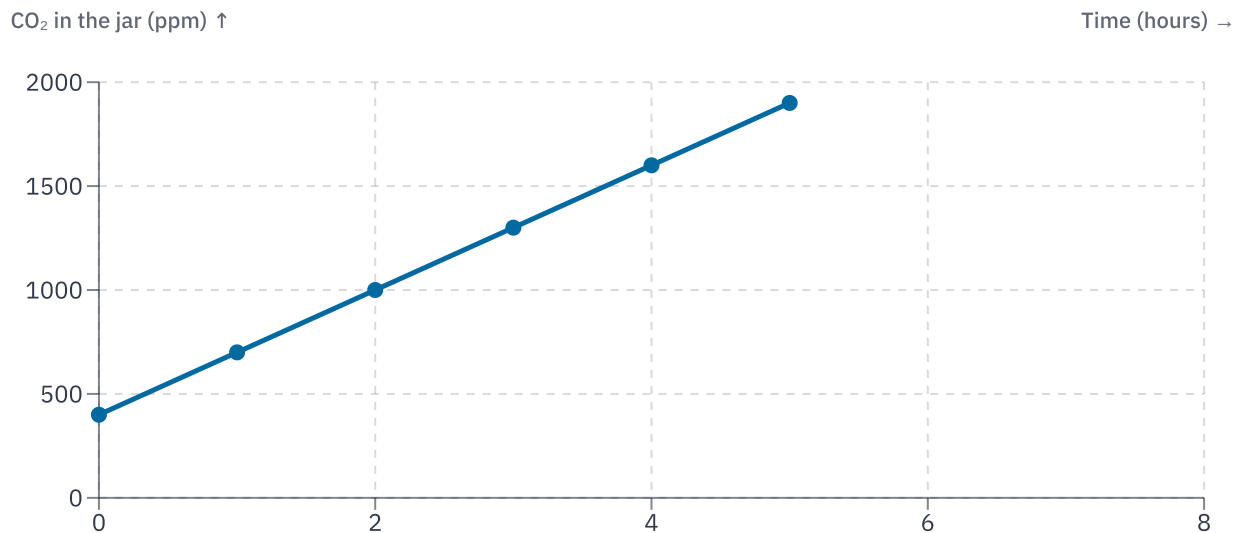
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DOK 2 · Skills & concepts

Why DOK 2: Students interpret a steady rise on a graph and connect it to cellular respiration in the seeds, linking data to a process.

A student named Julia put sprouting corn seeds in a sealed jar with a CO₂ sensor. She recorded the CO₂ in the jar every hour for 5 hours. Which conclusion is best supported by the graph?

CO₂ in a Sealed Jar of Sprouting Corn Seeds



- ☒ The seeds' cells kept breaking down stored food with O₂, giving off CO₂ at a steady rate. ✓
- ☐ The seeds' cells created new carbon atoms as they grew, so the CO₂ in the jar kept rising.
- ☐ The seeds' cells stopped respiring once the jar was sealed, so the CO₂ came from the air.
- ☐ The seeds' cells made CO₂ by photosynthesis, which adds about 300 ppm of CO₂ each hour.

FIND MORE LIKE THIS

DOK 3 · Strategic thinking

Why DOK 3: Students must reason that lost body mass leaves as carbon dioxide and water, rejecting tempting ideas that matter becomes energy, and back it with evidence.

Emperor penguin males in Antarctica stand on their eggs for about four months in winter and eat nothing. A research team weighed males at the start and end of this fast. They also measured the air the penguins breathed out.

Emperor Penguin Males Before and After a Winter Fast

Measurement	Start of fast	End of fast
Average body mass (kg)	38	23
Breathing out CO ₂ and water vapor?	Yes	Yes

Part A: Where did most of the penguins' lost mass go?

Choose one answer.

- ☐ It was destroyed as the cells used up the fat for energy.
- ☐ It was changed into heat energy that kept the eggs warm.
- ☐ It was changed into the ATP stored in the penguins' muscles.
- ☒ It left as CO₂ and water made by respiring stored fat. ✓

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

- ☐ The penguins huddled together to share heat in the freezing wind.
- ☐ The penguins lost about 15 kg while fasting on the ice.
- ☒ The penguins used O₂ and breathed out CO₂ and water vapor the whole time. ✓
- ☐ The penguins' body temperature stayed near 38 °C all winter.

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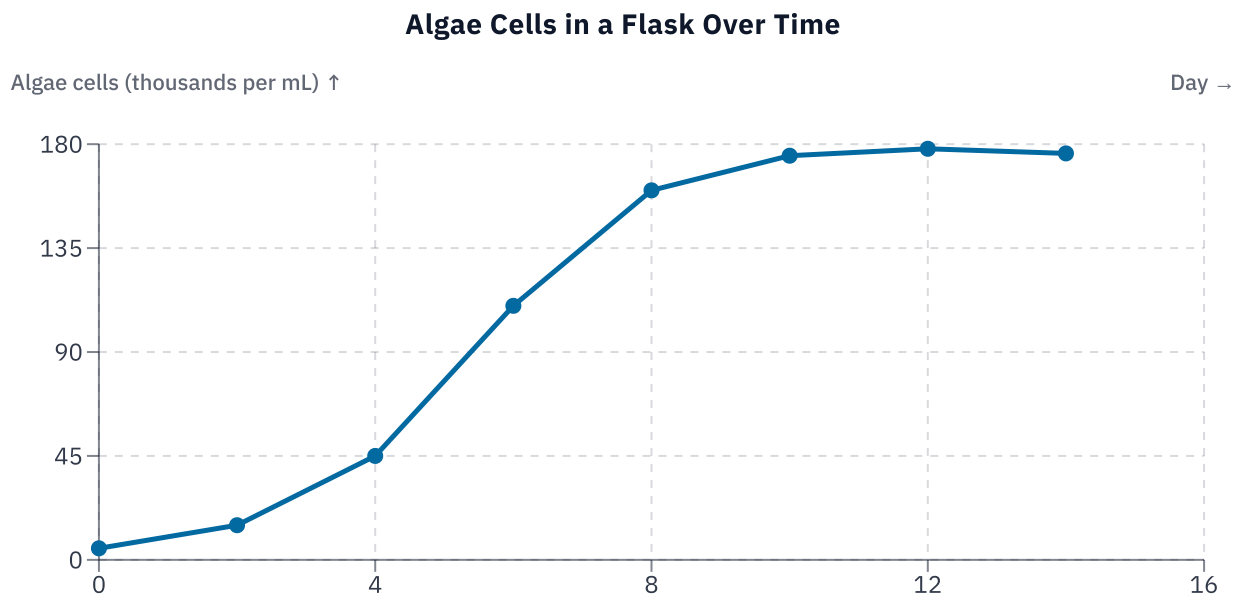
HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems

Examples at: **DOK 1** **DOK 2** **DOK 3** **DOK 4**

DOK 1 · Recall

Why DOK 1: Students read the level where the growth curve flattens directly off the graph to find carrying capacity.

A student grows green algae in a flask of nutrient water under a lamp. She counts the algae cells every two days. The graph shows her results. Based on the graph, what is the approximate carrying capacity of the flask for algae?



☒ About 175 thousand cells per mL ✓

☐ About 350 thousand cells per mL

☐ About 45 thousand cells per mL

☐ About 110 thousand cells per mL

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Test Bank question

On the Carrizo Plain in California, a team measures the seeds on the ground each fall and counts giant kangaroo rats, which eat these seeds. Their results are in the table.

Seeds and Kangaroo Rats on the Carrizo Plain

Year	Seeds (kg per hectare)	Kangaroo rats per hectare
1	60	12
2 (drought)	20	4
3	45	9
4	80	16

Part A: Which statement best describes the relationship in the data?

Choose one answer.

- ☐ Rat numbers stayed near 16 per hectare every year of the study.
- ☐ Rat numbers rose in the years when the seed supply fell.
- ☒ Rat numbers rose and fell with the seed supply, about 1 rat per 5 kg of seeds. ✓
- ☐ Rat numbers did not depend on how many seeds were on the ground.

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

- ☒ In the drought year, seeds fell to 20 kg and rats fell to 4. ✓
- ☐ The highest count in the study was 16 rats per hectare.
- ☐ The team counted kangaroo rats every fall for four years.



Giant kangaroo rats gather seeds and store them in burrows.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students calculate percent change, test whether the change is even, predict a new value, and reason about effects on a predator, drawing several conclusions from the data.

In a lab, a team raised brine shrimp from a salt lake in tanks at four different salt levels. The team recorded the highest shrimp density each tank could maintain. Eared grebes, a kind of bird, feed on these shrimp in the lake. Select True or False for each statement.

Highest Stable Brine Shrimp Density at Four Salt Levels

Salt level (grams per liter)	Highest stable density (shrimp per cubic meter)
70	30,000
85	26,000
100	18,000
115	9,000

	True	False
Salt level is an abiotic factor that affects the shrimp's carrying capacity.	☒	☐
Raising the salt level from 70 to 115 grams per liter lowered the highest density by 70%.	☒	☐
Each 15 gram per liter increase in salt lowered the density by the same amount.	☐	☒
Lowering the salt level from 100 to 85 grams per liter would likely let the density rise toward 26,000.	☒	☐
A change in shrimp numbers would have no effect on the grebes that eat them.	☐	☒

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Test Bank question

HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students read the steady population value and recall that food and space set carrying capacity. Each blank is a single step.

Use the drop-down menus to complete the statement.

A class raises guppies in a 100-liter tank with the same amount of food each day. The population grows for a few months and then stays between 58 and 62 fish for the rest of the year. The carrying capacity of the tank is about guppies. After it levels off, the population that number. The number of guppies the tank can support is set mainly by .

Drop-down 1 choices:

Drop-down 2 choices:

Drop-down 3 choices:

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students must pick the correct starting value and apply a proportional change (270×1.5) to estimate the new population, a two-step use of a math model.

Scientists studied a moose population in a forest for 20 years. In Years 1–5, the forest had enough food and shelter to support 450 moose. In Year 6, a big fire destroyed 40% of the forest, and afterward the forest could support only 270 moose because there was less food. By Year 15, the forest had grown back, and the amount of food plants was 50% higher than right after the fire. If the number of moose the forest can support is proportional to its food, about how many moose can the forest support now?

- ☐ 270 moose, because a forest damaged by fire can never support more moose again
- ☒ 405 moose, because food is 50% above the after-fire level, and $270 \times 1.5 = 405$ ✓
- ☐ 450 moose, because carrying capacity always returns to its original number
- ☐ 675 moose, because food is 50% higher than before, and $450 \times 1.5 = 675$

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students analyze 20 years of counts to identify a cycle and judge which conclusions about the population are justified and which go too far.

A team counts snowshoe hares in a study plot in an Alaska forest for 20 years. Select True or False for each statement.

Snowshoe Hares Counted in a Study Plot

Year	Hares counted
1	400
3	1,200
5	700
8	150
10	500
13	1,100
15	600
18	180
20	450

	True	False
The hare population rose and fell in a cycle about 10 years long.	☒	☐
Because the population crashed to 150, the forest lost its ability to support hares.	☐	☒
Each crash was followed by a recovery.	☒	☐
The peaks show that the plot's carrying capacity is fixed at 1,200 hares.	☐	☒
A single year's count is a poor estimate of the long-term population level.	☒	☐

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Test Bank question

HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recognize the basic fact that yeast break down glucose with or without oxygen and release carbon dioxide either way.

A baker notices that yeast cells used to make bread dough produce carbon dioxide gas both when oxygen is present in the dough and when the dough is sealed in an airtight container with limited oxygen. The baker wants to explain how yeast cells release energy from glucose under both conditions. Which statement best describes the evidence for how matter and energy flow through yeast cells in these two different situations?

- ☒ Yeast cells use different pathways to break down glucose and release energy depending on whether oxygen is available, and both pathways produce carbon dioxide as a waste product. ✓
- ☐ Yeast cells in the sealed container do not actually respire; instead, the carbon dioxide comes from the flour reacting with water.
- ☐ Yeast cells release more total energy from glucose in the sealed container because the lack of oxygen forces them to use a more efficient energy pathway.
- ☐ Yeast cells only break down glucose to release energy when oxygen is available, so the sealed container must have allowed oxygen to enter through the dough.

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Test Bank question

A student watches yeast cells ferment glucose in a sealed container with no oxygen. Carbon dioxide bubbles form, and ethanol builds up in the liquid. Which statement correctly explains both the flow of energy and the cycling of matter in this system?

- ☒ The yeast release some energy from glucose for life processes, and the atoms of glucose are rearranged into carbon dioxide and ethanol. ✓
- ☐ The yeast release no energy because there is no oxygen, and the glucose atoms stay in the liquid as unused sugar.
- ☐ Energy cycles through the yeast just as it does in plant cells, and the carbon atoms are destroyed as the sugar is used.
- ☐ The glucose is turned completely into energy that the yeast store, so no matter leaves the yeast cells as waste.

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Test Bank question

In Japan, a farm team compared two rice fields. Field A was kept flooded all season. Field B was drained for two weeks in midsummer, letting air into the soil. Field A gave off far more methane than Field B. Field B gave off more carbon dioxide during the dry weeks. Rice grew well in both fields.

Part A: Which claim best explains the difference in gases?

Choose one answer.

- ☒ Flooding kept oxygen out, so decomposers broke matter down without oxygen. ✓
- ☐ Rice plants make methane by photosynthesis in flooded water.
- ☐ Flooding added energy to the soil, so decomposers made methane.
- ☐ Draining the field stopped all decomposition in the soil.

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

- ☐ Field A was kept flooded with water for the whole season.
- ☒ After air entered Field B's soil, it gave off more CO₂ and less methane. ✓
- ☐ The two fields were side by side on the same farm in Japan.
- ☐ Rice plants grew well in both fields during the whole season.

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Test Bank question

HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students compare given energy values and recall that energy enters through producers and is not recycled. Each row needs one step.

Scientists measured the energy stored each year in a salt marsh food chain, in kcal per square meter: cordgrass 6,000, planthoppers that feed on cordgrass 450, and spiders that eat planthoppers 30. Select True or False for each statement.

	True	False
The cordgrass stores more energy than the planthoppers and spiders combined.	☒	☐
The spiders store more energy than the planthoppers.	☐	☒
Energy released as heat by the spiders is taken back up by the cordgrass.	☐	☒
Energy enters this food chain when cordgrass captures sunlight.	☒	☐

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Test Bank question

A student named Oliver tracked the energy in the milkweed leaves eaten by a monarch caterpillar in a garden in Minnesota. Which conclusions are supported by Oliver's data? Select all that apply.

Energy Budget for a Monarch Caterpillar

Where the energy went	Energy (J)
Energy in milkweed eaten	100
Lost in droppings	50
Lost as heat from respiration	30
Stored as new body mass	20

☐ The 30 J lost as heat will be reused by the milkweed plant.

☐ The caterpillar stored all the energy in the leaves it ate.

☒ Half of the energy it ate left in its droppings. ✓

☒ A bird eating the caterpillar could get at most 20 J of this energy. ✓

☐ The caterpillar stored more energy than it lost as heat.

☒ The caterpillar stored 20% of the energy it ate as new body mass. ✓

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students use multi-year data on both carbon and energy to evaluate a claim, reasoning that carbon cycles while energy does not return.

A team studied carbon and energy in a small prairie over five years. Each year, they measured how much carbon the plants took in from the air and how much sunlight energy the plants captured. They also tracked how much of each returned to where it came from. A student claims that carbon and energy both cycle in the prairie. Which evaluation of the student's claim is best supported by the data?

Carbon and Energy in a Prairie Plot Each Year

Year	Carbon taken in by plants (kg)	Carbon returned to the air (kg)	Sunlight energy captured (MJ)	Energy returned as sunlight (MJ)
1	500	480	20,000	0
2	520	510	21,000	0
3	490	495	19,500	0
4	510	500	20,500	0
5	505	500	20,200	0

- ☒ Not supported, because carbon returns to the air but no energy returns as sunlight. ✓
- ☐ Not supported, because carbon is used up and energy is recycled.
- ☐ Supported, because carbon and energy amounts both stay about the same each year.
- ☐ Supported, because the plants take in both carbon and energy each year.

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Test Bank question

HS-LS2-5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall that carbon dioxide is a reactant in photosynthesis. One fact answers the question.

Growers at a tomato greenhouse in Leamington, Ontario, pump extra carbon dioxide (CO₂) into the air inside the greenhouse on sunny days. The tomato plants grow faster when they do. Why does adding CO₂ help the plants grow?

- ☐ CO₂ replaces the oxygen the plants would otherwise need for respiration.
- ☐ CO₂ keeps the plants from respiring, so they save more of their sugar.
- ☒ CO₂ is a reactant in photosynthesis, which the plants use to build sugar. ✓
- ☐ CO₂ is a product of photosynthesis, so the plants release it as they grow.

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Test Bank question

Use the drop-down menus to complete the statement.

At Clear Lake, a water-quality technician measures dissolved carbon dioxide near a thick mat of algae at noon and again at midnight. At noon, dissolved carbon dioxide is

lower ▼

because the algae's

photosynthesis ▼

outpaces respiration. At midnight,

carbon dioxide is

higher ▼

because respiration continues in the dark.

Drop-down 1 choices: higher **lower ✓** the same

Drop-down 2 choices: **photosynthesis ✓** evaporation decomposition

Drop-down 3 choices: zero **higher ✓** lower

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Test Bank question

Researchers in Illinois measure carbon dioxide in the air just above a large cornfield in midsummer. Make a claim that explains the difference between noon and midnight. Support your claim with evidence from the data. Explain your reasoning about when corn plants photosynthesize and when they respire.

Carbon Dioxide Above an Illinois Cornfield in Midsummer

Time	Carbon dioxide (parts per million)
Noon	370
Midnight	430

Model response: Claim: At noon, the corn's photosynthesis removes more carbon dioxide than respiration adds, but at midnight photosynthesis stops and only respiration continues. Evidence: Carbon dioxide was 370 ppm at noon and 430 ppm at midnight. Reasoning: Photosynthesis needs light, so it only happens in the day. Cellular respiration happens day and night in the corn plants and soil organisms, so at night nothing removes the carbon dioxide they release and it builds up.

Rubric: 2 points: The response includes all required elements: Claims photosynthesis outpaces respiration at noon and only respiration occurs at midnight; cites 370 and 430 ppm; reasons that photosynthesis needs light while respiration happens day and night.

1 point: The response gives a correct claim with evidence or reasoning, but not both or the response gives a correct claim only, or evidence only. Credit for "Reasoning: photosynthesis needs light, while cellular respiration happens day and night" requires "Claim: at noon photosynthesis removes more carbon dioxide than respiration adds; at midnight only respiration occurs".

0 points: Claims plants respire only at night or gives no relevant answer. No correct required element; the response is incorrect, too vague to earn credit, irrelevant, blank, or only copies the prompt without answering.

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Test Bank question

HS-LS2-6 Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall the meaning of invasive species and read basic facts from the passage. Each statement is a direct check.

After World War II, brown tree snakes accidentally arrived on the Pacific island of Guam, most likely in military cargo. The snakes ate birds and eggs, and most of Guam's native forest bird species disappeared from the wild. Select True or False for each statement.

	True	False
The brown tree snake is an invasive species on Guam.	☒	☐
The snake increased the number of forest bird species on Guam.	☐	☒
Losing birds that spread seeds could change which plants grow in Guam's forests.	☒	☐
Guam's forests kept the same types of birds after the snakes arrived.	☐	☒

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Eelgrass beds in an estuary in Oregon shrank over one year. A biologist claims that a change in a physical, nonliving factor caused the loss. Which observation, if true, best supports her claim?

- ☐ Sea otters ate more of the crabs that dig up eelgrass roots.
- ☐ An invasive snail that grazes on eelgrass spread across the mudflats.
- ☒ Mud from a flood clouded the water and cut the light reaching the eelgrass. ✓
- ☐ A new kind of shorebird that eats eelgrass seeds began nesting nearby.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students weigh several data columns to judge whether an ecosystem recovered after a large disturbance and reject conclusions the data do not support.

Part of a Kansas prairie was plowed and farmed for corn for 40 years, then abandoned. Thirty years later, a team compares the old field with nearby prairie that was never plowed. Select True or False for each statement.

Plants in an Abandoned Cornfield and Never-Plowed Prairie

Area	Native prairie plant species	Nonnative plant species	Soil organic matter
Never-plowed prairie	85	4	6%
Old field, 30 years after farming	30	22	3%

	True	False
Thirty years after farming ended, the old field has not returned to its original prairie community.	☒	☐
Plowing and farming for 40 years was a large disturbance to the prairie ecosystem.	☒	☐
The old field has more plant species in total than the never-plowed prairie.	☐	☒
Lower soil organic matter could help explain why prairie plants have been slow to return.	☒	☐
Because the old field now has 52 plant species, it is just as healthy as the never-plowed prairie.	☐	☒

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Test Bank question

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students match each solution to the type of human impact it reduces, recalling the standard categories.

A state wildlife agency lists solutions it uses to protect biodiversity. Each solution targets one type of human impact. Choose the missing values from the drop-down menus.

Solution	Type of impact it reduces
Washing boats before they move to a new lake	Blank 1
Limits on how many rockfish anglers can keep	Blank 2
A filter on a factory drain pipe	Blank 3
A wildlife bridge that reconnects forest on both sides of a highway	Blank 4

Blank 1 (Row 1, Type of impact it reduces): Introduction of nonnative species ▼

Blank 2 (Row 2, Type of impact it reduces): Overexploitation ▼

Blank 3 (Row 3, Type of impact it reduces): Pollution ▼

Blank 4 (Row 4, Type of impact it reduces): Habitat destruction ▼

Drop-down 1 choices: Habitat destruction **Introduction of nonnative species ✓** Pollution

Overexploitation

Drop-down 2 choices: **Overexploitation ✓** Pollution Habitat destruction

Introduction of nonnative species

Drop-down 3 choices: Habitat destruction **Pollution ✓** Overexploitation

Introduction of nonnative species

Drop-down 4 choices: Overexploitation Pollution Introduction of nonnative species

Habitat destruction ✓

FIND MORE LIKE THIS

DOK 2 · Skills & concepts

Why DOK 2: Students interpret test data, computing a percent change and comparing outcomes, to judge how well a solution worked.

Albatrosses and other seabirds dive for baited hooks on longline fishing boats and drown. A fishing fleet in Alaska tested streamer lines, colorful ropes that flap over the baited hooks to scare birds away. The team counted catches per 100,000 hooks. Select True or False for each statement.

Catch per 100,000 Hooks With and Without Streamer Lines

Setup	Seabirds caught	Target fish caught
No streamer lines	50	4,000
Streamer lines	10	4,000

	True	False
Streamer lines cut the number of seabirds caught by 80%.	☒	☐
Streamer lines did not lower the fleet's catch of target fish.	☒	☐
Accidentally catching seabirds is a human impact on biodiversity.	☒	☐
Streamer lines lowered the target fish catch by 80%.	☐	☒
Since some seabirds were still caught, the streamer lines failed.	☐	☒

FIND MORE LIKE THIS

California tiger salamanders cross a road near Stanford each winter to reach breeding ponds, and many are killed by cars. Biologists built two small tunnels under the road with low walls that guide salamanders to the tunnels. They counted salamanders at the road over two winters. Make a claim about whether the tunnels reduced the impact of the road on the salamanders. Support your claim with evidence from the data, and suggest one way to refine the design.

California Tiger Salamanders at the Road

Winter	Salamanders killed on the road	Salamanders that used the tunnels
Before tunnels	60	0
After tunnels	12	110

Model response: The tunnels reduced the road's impact on the salamanders. Road deaths fell from 60 to 12, an 80% drop, and 110 salamanders used the tunnels to cross safely. Because 12 were still killed, the design could be refined with longer guide walls or another tunnel where salamanders still reach the road.

Rubric: 2 points: The response includes all required elements: Claim that the tunnels reduced the road's impact; evidence from the data (road deaths fell from 60 to 12, about 80%, and 110 used the tunnels); a reasonable refinement (longer walls, more tunnels, fixing gaps, or monitoring).

1 point: The response includes one or two of the three required elements above, but not all three. Credit for "Suggests a refinement, such as longer walls, more tunnels, or checking tunnel use" requires "Claim: the tunnels reduced the road's impact".

0 points: None. No correct required element; the response is incorrect, too vague to earn credit, irrelevant, blank, or only copies the prompt without answering.

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Test Bank question

HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce

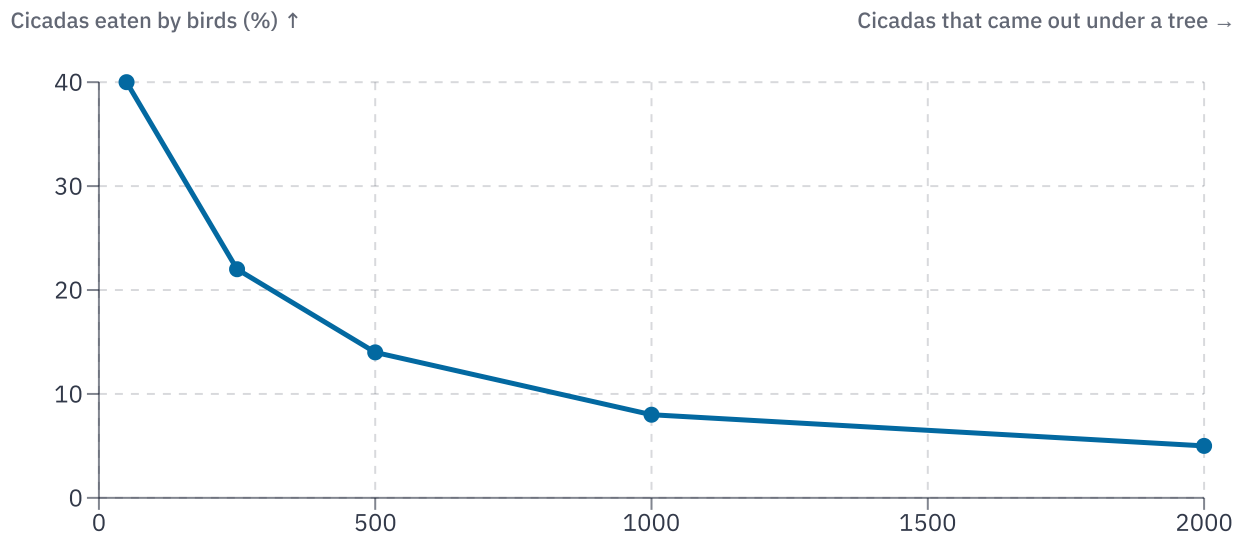
Examples at: **DOK 1** **DOK 2** **DOK 3** **DOK 4**

DOK 1 · Recall

Why DOK 1: Students read the trend straight off the graph: as more cicadas emerge, a smaller percent are eaten.

Periodical cicadas come out of the ground in huge numbers every 17 years. In an Illinois forest, a team counted how many cicadas came out under each tree and what percent birds ate. Which statement does the graph support?

Percent of Periodical Cicadas Eaten by Birds



☐ Where more cicadas came out, a larger percent of them were eaten.

☐ Birds ate almost all of the cicadas under the busiest trees.

☐ Birds ate the same percent of cicadas under every tree.

☒ Where more cicadas came out, a smaller percent of them were eaten. ✓

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Test Bank question

A scientist studied meerkats in the Kalahari Desert for 5 years. Meerkats in groups of 15 to 30 survived about 76% of the time each year. The few meerkats living alone survived about 18% of the time. In groups, some meerkats act as lookouts and give an alarm call when they see a hawk or jackal, and the whole group runs to its burrows.

Part A: Which claim is best supported?

Choose one answer.

- ☐ Each meerkat must choose group life or solo life forever.
- ☐ Meerkats alone survive better because they do not share food.
- ☒ Living in a group raises a meerkat's chance of surviving each year. ✓
- ☐ Group living helps every kind of animal survive the same amount.

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

- ☒ About 76% of group meerkats survived each year, and 18% of lone ones. ✓
- ☐ Lookouts give an alarm call when they see a hawk or jackal.
- ☐ Groups of meerkats in the study had between 15 and 30 members.
- ☐ Some group members act as lookouts while other members dig.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students judge the strength of each piece of evidence, spotting confounded and anecdotal data, which requires evaluating evidence rather than reading it.

A wildlife biologist claims that pronghorn fawns in larger herds are less likely to be killed by coyotes. She gathers information from several sources. Match each piece of information to the column for how well it supports her claim.

	Strong evidence	Weak evidence	Not relevant
Across 5 years, collared fawns in herds of 10 or more were killed by coyotes less often than collared fawns in herds of 2 or 3 on the same range.	☒	☐	☐
In a second study, fawns in large herds survived their first summer more often than fawns in small herds sharing the same range.	☒	☐	☐
Pronghorn can run faster than 80 kilometers per hour.	☐	☐	☒
In one survey, the larger herds were mostly on range where coyotes had been removed.	☐	☒	☐
A rancher once saw a coyote chase a fawn away from a herd.	☐	☒	☐
Pronghorn eat sagebrush in winter.	☐	☐	☒

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Test Bank question

HS-LS3-1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall the definitions of gene, protein, and trait and sort each item. Each sort is a single fact.

Keepers at a zoo in San Diego learn how a single DNA change makes some tigers white. Sort each item into the correct column.

	Gene	Protein	Trait
A different version of the pigment gene	☒	☐	☐
The DNA code of the pigment gene	☒	☐	☐
An orange coat with black stripes	☐	☐	☒
An enzyme that makes orange pigment	☐	☒	☐
A white coat on a white tiger	☐	☐	☒
A protein that moves pigment into hair	☐	☒	☐

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Test Bank question

Jada volunteers with a sea turtle program in Florida. Loggerhead sea turtles do not have sex chromosomes. Instead, the temperature of the sand while the eggs develop decides whether a hatchling becomes male or female. Warm nests produce mostly females, and cool nests produce mostly males.

Part A: Which question best clarifies how warm sand leads to female hatchlings?

Choose one answer.

- ☒ Does warmth turn on genes for building female body parts in the embryos? ✓
- ☐ Does the warm sand change the DNA letters in the embryos' genes?
- ☐ Do the embryos in warm nests get a different set of chromosomes?
- ☐ Are the eggs in the warm nests laid by older mother turtles?

Part B: Which finding would best support a yes answer to the question in Part A?

Choose one answer.

- ☒ Embryos in warm sand make much more of an enzyme needed for ovaries to form. ✓
- ☐ Male and female hatchlings have the same number of chromosomes.
- ☐ Nests on dark sand are often warmer than nests on pale sand.
- ☐ Eggs in warm nests hatch a few days sooner than eggs in cool nests.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students compare three questions, choose the best one, and explain why the others are weaker, using evidence about shared DNA.

Students studying why human liver cells and skin cells differ write three questions. Question 1: "Do liver cells have different genes than skin cells?" Question 2: "Which genes are turned on in liver cells but off in skin cells, and what turns them on?" Question 3: "Are liver cells more important than skin cells?" Liver cells and skin cells in one person have the same DNA. Choose the question that best clarifies why the cells differ. Explain why it is best and why the other two are weaker.

Model response: Question 2 is best. The cells have the same DNA, so Question 1 is weaker because we already know they have the same genes. The difference must come from gene expression, and Question 2 asks which genes are turned on and what signal turns them on. Question 3 is weaker because it is an opinion and cannot be measured, so it is not a science question.

Rubric: 2 points: The response includes all required elements: Chooses the question about which genes are turned on, uses the shared DNA to show why the gene-difference question is weaker, and explains that gene expression causes the difference or that the importance question is not scientific.

1 point: The response includes one or two of the three required elements above, but not all three. Credit for "Explains that gene expression causes the difference or that the third question is not scientific" requires "Chooses the question about which genes are turned on".

0 points: None. No correct required element; the response is incorrect, too vague to earn credit, irrelevant, blank, or only copies the prompt without answering.

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Test Bank question

HS-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from new genetic combinations through meiosis

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall how meiosis creates variation: random assortment and crossing over. No data analysis is needed.

A plant breeder is developing new varieties of wheat by crossing two parent plants with different traits. During sexual reproduction, meiosis occurs in the parent plants, producing gametes. The breeder observes that offspring plants show new combinations of traits not seen in either parent plant. Which statements correctly explain how genetic variation in the offspring can result from meiosis? Select all that apply.

- ☐ The variation observed in offspring must have resulted from exposure of the parent plants to radiation, which is the only environmental factor that causes mutations.
- ☐ The new trait combinations in offspring prove that mutations occurred in the parent plants' body cells during their lifetime and were inherited by the offspring.
- ☒ Meiosis causes genetic variation in offspring because it produces gametes with different combinations of alleles from the parents. ✓
- ☒ During meiosis, new genetic combinations are produced because homologous chromosomes separate, and alleles are distributed randomly into different gametes. ✓
- ☒ Crossing over during meiosis exchanges segments of DNA between homologous chromosomes, creating new genetic combinations that are passed to offspring. ✓

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DOK 2 · Skills & concepts

Why DOK 2: Students interpret cross results to name independent assortment as the cause and pick the new trait combinations as evidence.

A plant breeder crossed a true-breeding summer squash with yellow, long fruit and one with white, round fruit. In her squash variety, yellow is dominant to white and round is dominant to long, and the two genes are on different chromosomes. The offspring plants were crossed with each other, and the breeder counted the next generation.

Squash Fruit Types in the Second Generation

Fruit type	Number of plants
Yellow, round	180
Yellow, long	62
White, round	58
White, long	20

Part A: Which process best explains the new fruit types?

Choose one answer.

- ☒ Independent assortment of the color and shape alleles during meiosis ✓
- ☐ Differences in sunlight on different plants
- ☐ New mutations caused by the garden soil
- ☐ Crossing over that joined color and shape into one gene

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

- ☐ The first original parent had yellow, long fruit.
- ☐ The breeder counted 320 plants in the second generation.
- ☐ Yellow, round plants were the most common type of plant.
- ☒ Yellow, round and white, long plants appeared, unlike both parents. ✓

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate several pieces of information as strong, weak, or irrelevant support for a mutation claim, including spotting confounding factors.

A student claims that a pesticide in a pond caused heritable mutations in leopard frogs. She gathers several pieces of information. Match each piece of information to the column that shows how well it supports her claim.

	Strong evidence	Weak evidence	Not relevant
In a lab, frogs exposed to the pesticide produced offspring with more DNA changes than unexposed frogs	☒	☐	☐
One frog from the pesticide pond had an extra leg	☐	☒	☐
Tadpoles of frogs from the pesticide pond had new traits far more often than tadpoles of frogs from a clean pond, in 3 years of sampling	☒	☐	☐
The pesticide pond is also warmer and has more parasites than the clean pond	☐	☒	☐
Leopard frogs eat insects	☐	☐	☒

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Test Bank question

HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a populationExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students carry out a routine probability calculation for a one-gene cross ($1/2 \times 1/2 = 1/4$).

At a school garden in Albuquerque, Kamal crosses two pea plants with purple flowers. Both plants are Pp. Purple (P) is dominant over white (p).

Part A: What is the probability that one offspring plant will have white flowers?

Choose one answer.

☐ 50%☒ 25% ✓☐ 0%☐ 75%

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

☒ Each parent passes on p half the time, and $1/2 \times 1/2 = 1/4$. ✓☐ Half of the alleles in the parents are p, so half the plants are white.☐ Purple is dominant, so three of every four plants must be purple.☐ White is recessive, so white plants cannot come from purple parents.**FIND MORE LIKE THIS**[Create questions](#) > [Biology](#) > [HS Life Science](#) > [LS3](#) > [LS3-3](#) > [DOK 1](#) > [Generate](#)

Test Bank question

A biologist crosses many pairs of pink snapdragons. Flower color shows incomplete dominance: RR plants are red, RW plants are pink, and WW plants are white. Of 900 offspring, 225 are red, 450 are pink, and 225 are white. Which statements are supported by the data and the principles of probability? Select all that apply.

- ☐ Pink is the most common color, so the allele for pink must be dominant in snapdragons.
- ☒ The 1:2:1 prediction describes expected proportions but cannot say what color any one seedling will be. ✓
- ☐ Because the pink plants are an in-between color, the trait must involve a third, pink allele.
- ☐ A gardener who grows only 8 seeds from this cross should get exactly 2 red, 4 pink, and 2 white plants.
- ☒ If two pink plants are crossed, about 25% red, 50% pink, and 25% white offspring are expected. ✓
- ☒ The phenotype ratio matches the genotype ratio because neither allele masks the other. ✓

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Test Bank question

Diego crosses two pea plants that are both Pp for flower color. Purple (P) is dominant over white (p). Using probability, he expects $\frac{3}{4}$ of the offspring to be purple and $\frac{1}{4}$ to be white, so for 120 offspring he expects 90 purple and 30 white. He grows 120 offspring and counts 84 purple and 36 white. Diego claims: "My results do not match 90 and 30, so flower color in these plants does not follow the rules of inheritance."

Part A: Which statement best evaluates Diego's claim?

Choose one answer.

- ☒ The claim is not supported, because 84 to 36 is close to the expected 90 to 30, and chance makes small differences likely. ✓
- ☐ The claim is supported, because any result other than exactly 90 to 30 means the parents could not both be Pp.
- ☐ The claim is supported, because getting 36 white plants shows that white must be the dominant color.
- ☐ The claim is not supported, because every cross of two Pp plants always gives exactly 3 purple for every 1 white.

Part B: Which evidence or reasoning best supports your answer to Part A?

Choose one answer.

- ☒ Each offspring has a $\frac{1}{4}$ chance of being white, so the white count varies around 30; 36 out of 120 is 30%, near the expected 25%. ✓
- ☐ There were more purple plants (84) than white plants (36) in the garden.
- ☐ Purple (P) is dominant over white (p) in pea plants.
- ☐ Both parent plants in the cross had purple flowers.

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Written for this guide

HS-LS4-1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidenceExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students read and compare two percentages from the table to find the pair with more matching DNA.

A scientist compared the same stretch of DNA in four kinds of songbirds. The American robin and the European blackbird belong to the same genus of thrushes. The house sparrow and the northern cardinal belong to other songbird families. Which fact from the table best shows that the American robin and the European blackbird share a more recent common ancestor than the robin and the house sparrow?

DNA Match Between Pairs of Songbirds

Pair of birds	Matching DNA (%)
American robin and European blackbird	96
American robin and house sparrow	86
American robin and northern cardinal	86
House sparrow and northern cardinal	90

☒ The robin and blackbird match 96 percent, more than the robin and sparrow's 86. ✓☐ The robin matches the sparrow and the cardinal equally, at 86 percent each.☐ The sparrow and cardinal match 90 percent, so one must be the other's ancestor.☐ The robin and blackbird live on different continents, so they cannot be related.**FIND MORE LIKE THIS**[Create questions](#)

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Test Bank question

Use the drop-down menus to complete the statement.

Dolphins and tuna both have streamlined bodies, fins, and tails for fast swimming. Dolphins breathe air with lungs, feed their young milk, and have finger bones inside their flippers.

Tuna breathe with gills and have no finger bones. The similar body shapes of dolphins and

tuna are an example of **convergent** evolution. The lungs, milk, and finger bones show

that dolphins are more closely related to **land mammals than to tuna**. This case shows

that **outward body shape** can mislead scientists about relationships.

Drop-down 1 choices: divergent **convergent ✓** reverse

Drop-down 2 choices: sharks than to land mammals **land mammals than to tuna ✓**
tuna than to land mammals

Drop-down 3 choices: bone patterns DNA sequences **outward body shape ✓**

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Test Bank question

Scientists claim that birds evolved from small meat-eating dinosaurs. The table lists some evidence. Evaluate the claim that birds evolved from small meat-eating dinosaurs. Support your evaluation with evidence from the table, and explain why a difference such as teeth does not disprove the claim.

Evidence Comparing Birds and Small Meat-Eating Dinosaurs

Evidence	Small meat-eating dinosaurs	Modern birds
Hollow bones	Yes	Yes
Wishbone (fused collarbones)	Yes	Yes
Feathers	Found on fossils from China over 120 million years old	Yes
Teeth	Yes	No

Model response: The claim is supported. Birds and small meat-eating dinosaurs both have hollow bones and a wishbone, and fossils from China over 120 million years old show dinosaurs with feathers. Birds lack teeth, but that does not disprove the claim, because traits can be lost over time as a lineage changes, and early birds like Archaeopteryx still had teeth.

Rubric: 2 points: The response includes all required elements: Evaluates the claim as supported; evidence from the table (hollow bones, wishbone, feathered dinosaur fossils); reasoning that traits such as teeth can be lost over time as a lineage changes.

1 point: The response includes one or two of the three required elements above, but not all three. Credit for "Reasoning: traits can be lost over time as a lineage changes, so missing teeth fits evolution" requires "Evaluates the claim as supported".

0 points: None, or rejects the claim only because birds lack teeth. No correct required element; the response is incorrect, too vague to earn credit, irrelevant, blank, or only copies the prompt without answering.

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Test Bank question

HS-LS4-2 Construct an explanation based on evidence that the process of evolution primarily results from four factors

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall basic natural selection facts, such as inherited variation and that individuals do not change on purpose.

In some streams on the island of Trinidad, a fish called the pike cichlid eats guppies. Brightly colored male guppies are easier for it to see. In streams with these predators, biologists find that most male guppies are dull. In streams without them, many males are bright. Select True or False for each statement.

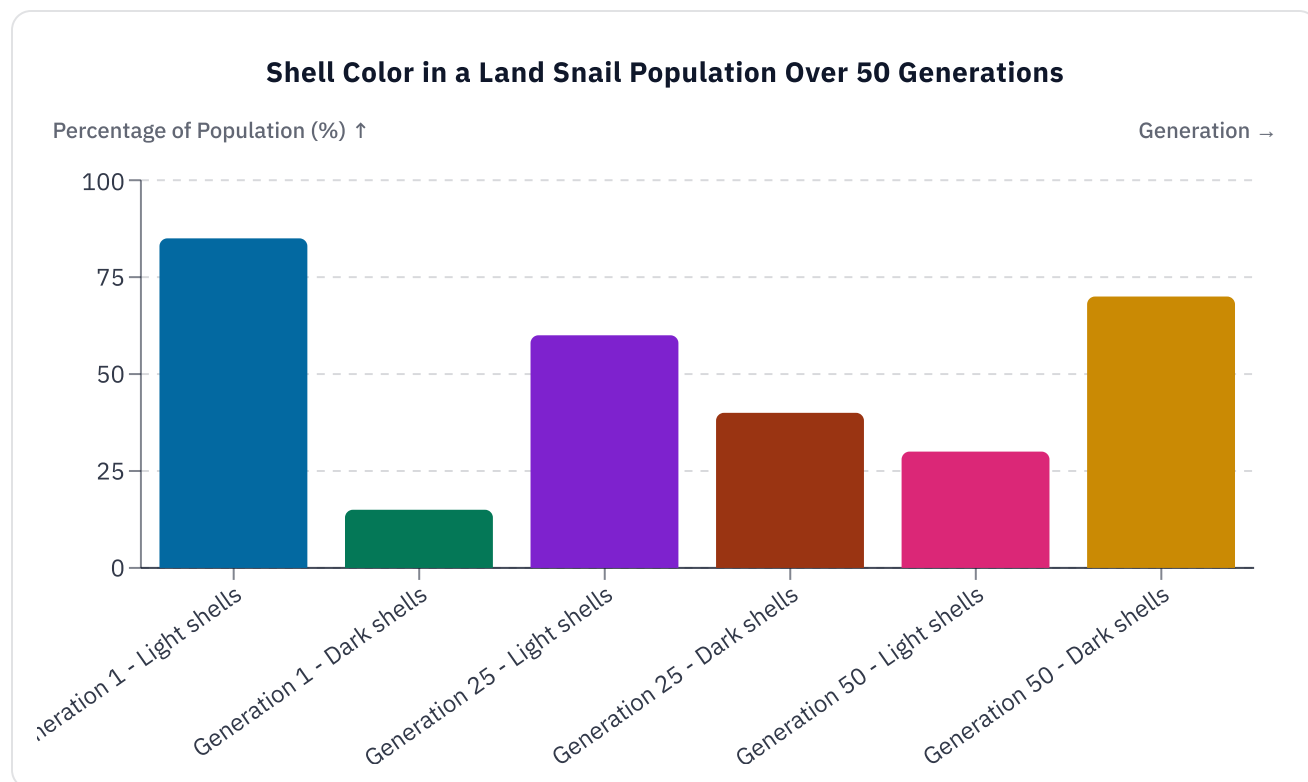
	True	False
Male guppies vary in color because of inherited genes.	☒	☐
Dull males in predator streams are more likely to live long enough to mate.	☒	☐
Guppies in predator streams became dull because each male faded his colors on purpose.	☐	☒
Bright color can never help a male guppy leave offspring.	☐	☒

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Test Bank question

A population of land snails varies in shell color, and shell color is inherited. The snails live in a forest where the soil became darker because of industrial pollution. Birds hunt the snails by sight. The graph shows the percent of light and dark snails at three generations. Which statement best explains why dark shells became more common?



- ☒ Dark shells were harder for birds to see on dark soil, so dark snails survived and bred more. ✓
- ☐ The darkening soil caused mutations that turned the shells of many adult snails dark.
- ☐ Snails darkened their shells during their lives to match the soil and passed this on.
- ☐ Dark-shelled snails were stronger, so they won more fights for food than light snails.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students critique a student model, deciding which parts are correct and which contain misconceptions, which requires evaluating reasoning.

Dandelions in a city park in Toronto are mowed every week, while dandelions in a nearby unmowed field are not. A student named Noah wrote a model to explain why park dandelions now flower on much shorter stems. His teacher asks the class to find the parts of his model that should be revised. Which parts of Noah's model are incorrect and should be revised? Select all that apply.

☐ Short dandelions in the park made more seeds than tall ones.

☐ Mowers cut off tall flower heads before they could make seeds.

☒ Each park dandelion learned to grow short stems to avoid the mower. ✓

☐ Dandelions in the park varied in stem height, and height is inherited.

☒ Park dandelions became shorter so that the species would not die out. ✓

☒ Mowing caused mutations that made every park dandelion short. ✓

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Test Bank question

HS-LS4-3 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportionExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students subtract two percentages and recall that heritable resistance spreads when resistant individuals survive. Each blank is one step.

Use the drop-down menus to complete the statement.

Oysters in a bay on the East Coast were struck by a deadly oyster disease. Some oysters carry heritable resistance. Researchers found that resistant oysters rose from 10% to 50% of the population over 15 years. The share of resistant oysters rose by percentage points. This happened because resistance is and resistant oysters .

Drop-down 1 choices: 5 50**Drop-down 2 choices:** caused by the disease learned**Drop-down 3 choices:** grew shells over the disease chose cleaner water

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Test Bank question

A population of leaf beetles was studied over 40 years in a forest where a fungal disease turned tree bark from light gray to dark gray. Researchers recorded the percentage of beetles with dark-colored wings versus light-colored wings each decade. Data showed dark-winged beetles increased from 12% to 78% of the population, while light-winged beetles decreased from 88% to 22% over the same period. Camouflage studies confirmed dark-winged beetles were caught by birds far less often on dark bark. Decide whether each statement about this pattern is True or False.

	True	False
The increase in dark-winged beetles over time is a statistical pattern that supports the explanation that dark coloration improved survival on dark bark.	☒	☐
Because the percentage of dark-winged beetles rose while bark darkened, this pattern by itself proves darker bark directly caused the wing color change, with no other explanation possible.	☐	☒
Individual beetles changed their own wing color during their lifetimes to better match the darker bark.	☐	☒
The wing-color variation existed in the population before the bark darkened, due to mutation and normal genetic variation among individuals.	☒	☐
Because dark-winged beetles survived bird predation more often, they were more likely to reproduce and pass the trait to offspring, increasing its proportion in the population.	☒	☐

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Test Bank question

Guppies in Trinidad live in streams. Downstream pools have pike cichlids, which eat guppies, and upstream pools have few predators. Males with more colored spots attract more mates but are easier for predators to see. Spot number is inherited. Researchers moved guppies from a predator pool into two separate upstream pools with few predators. After 15 generations, males in both new pools averaged 13 spots, compared with 9 before. Males in the original pool still averaged 9.

Part A: Which claim is best supported by the results?

Choose one answer.

- ☒ With few predators, males with more spots left more young, so spot number rose. ✓
- ☐ Spot number rose by chance, since moving fish often causes random changes.
- ☐ Predators in the original pool caused the spots of those males to fade.
- ☐ Males grew more spots during their lives once they were safe from predators.

Part B: Which evidence best argues against the idea that the change happened by chance?

Choose one answer.

- ☐ The researchers counted the spots after 15 generations had passed.
- ☐ Males with more spots are easier for predators to see and catch.
- ☒ The same increase happened in both of the separate upstream pools. ✓
- ☐ The guppies were moved from a pool that has pike cichlids in it.

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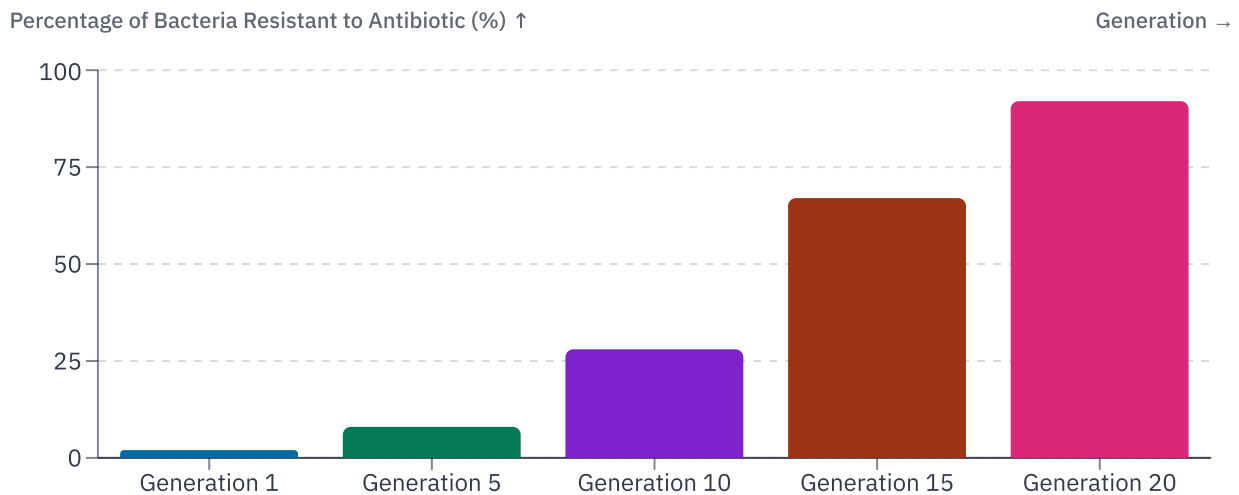
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Test Bank question

HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populationsExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall**

Why DOK 1: Students recognize the standard explanation of natural selection for antibiotic resistance; it checks recall of the mechanism.

A hospital tracks a bacterial population exposed to the same antibiotic over 20 generations. The graph shows the percentage of bacteria with resistance genes increases a lot over time. Which statement best explains why this happens?

Antibiotic Resistance in Bacterial Population Over Time

- ☐ The antibiotic stays the same strength the whole time, so every bacterium becomes resistant at the same steady pace.
- ☐ Bacteria that survive the antibiotic gain resistance during their own lifetime and then pass that new trait to their offspring.
- ☐ The antibiotic slowly gets stronger each generation, which forces every bacterium's genes to change so it can survive.
- ☒ Bacteria with resistance genes survive and reproduce when exposed to the antibiotic, so the resistance gene becomes more common in the population. ✓

FIND MORE LIKE THIS

DOK 2 · Skills & concepts

Why DOK 2: Students explain what a common-garden result shows and connect a trait to survival in a new habitat, a two-part explanation.

Puerto Rican crested anoles from cities have longer limbs than those from forests, even when both are hatched in the same lab. Explain what the lab result shows, and explain how city surfaces could make long limbs more common.

Model response: Because lizards hatched in the same lab still differed, the difference is inherited. On smooth walls and wide surfaces, long-limbed lizards can run and grip better, so they escape predators and survive and reproduce more, making long limbs more common in cities.

Rubric: 2 points: explains that the lab result shows the limb difference is inherited, and that long limbs help lizards run or grip on smooth city surfaces so they survive and reproduce more. 1 point: gives only one of these ideas. 0 points: says limbs grew longer from climbing, or gives no reasoning.

FIND MORE LIKE THIS

Kelp forests off Alaska were nearly wiped out when sea otters were hunted almost to extinction, because sea urchins, which eat kelp, were no longer eaten by otters. Where otters later returned, urchins became scarce and kelp grew back. Researchers found that kelp growing where urchins had been common for decades made more of a bitter chemical in its tissue than kelp in areas where urchins had always been rare.

Part A: A researcher claims the difference is an adaptation. Which statement describes how natural selection would produce it?

Choose one answer.

- ☐ Kelp made more chemical because it was grazed during its own life.
- ☒ Urchin grazing favored kelp that made more of the bitter chemical. ✓
- ☐ Otters made the kelp bitter by eating the urchins near it.
- ☐ The bitter chemical has no effect on which kelp survives.

Part B: Which additional evidence would best support the claim that the difference is inherited?

Choose one answer.

- ☐ Urchins eat much more kelp when otters are not around to eat them.
- ☒ Kelp from both areas grown in one tank still differed in the chemical. ✓
- ☐ Sea otters float on their backs to crack open the urchins they catch.
- ☐ Kelp forests give shelter to many kinds of young fish in summer.

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Test Bank question

HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in the emergence of new speciesExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students recall that human changes to the environment can cause population decline and extinction. Each blank is a direct fact.

Use the drop-down menus to complete the statement.

Passenger pigeons once flew in flocks of millions across eastern North America. In the 1800s, people hunted them heavily and cut down the forests where they nested. The last passenger pigeon died in 1914. Hunting and forest loss **harmed ▼** the pigeons. Their numbers **fell ▼**. This shows that **human changes to the environment ▼** can lead to extinction.

Drop-down 1 choices: helped did not affect **harmed ✓****Drop-down 2 choices:** stayed steady **fell ✓** rose**Drop-down 3 choices:** competition with other bird species **human changes to the environment ✓**
slow natural climate cycles**FIND MORE LIKE THIS**[Create questions](#) > [Biology](#) > [HS Life Science](#) > [LS4](#) > [LS4-5](#) > [DOK 1](#) > [Generate](#)

Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students apply what they know about salt tolerance to predict how a sudden environmental change shifts which species are common.

Many small lagoons on the California coast are cut off from the ocean by a sandbar for part of the year, so their water is fairly fresh. At one lagoon, a large storm broke through the sandbar, and ocean water flowed in, making the lagoon much saltier. A student group had netted fish there before the storm. Which result would they most likely find when they net fish after the storm?

- ☐ All fish became less common, since storms always harm living things.
- ☒ Ocean fish became more common, while freshwater fish became less common. ✓
- ☐ All fish became more common, since the storm brought in fresh water.
- ☐ Freshwater fish became more common, while ocean fish became less common.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate an argument line by line and find the flawed reasoning about whether a population of two females can recover.

Only two northern white rhinos are alive today, and both are female. Kofi wrote an argument about whether they can avoid extinction. Select the line of his argument that makes a reasoning mistake.

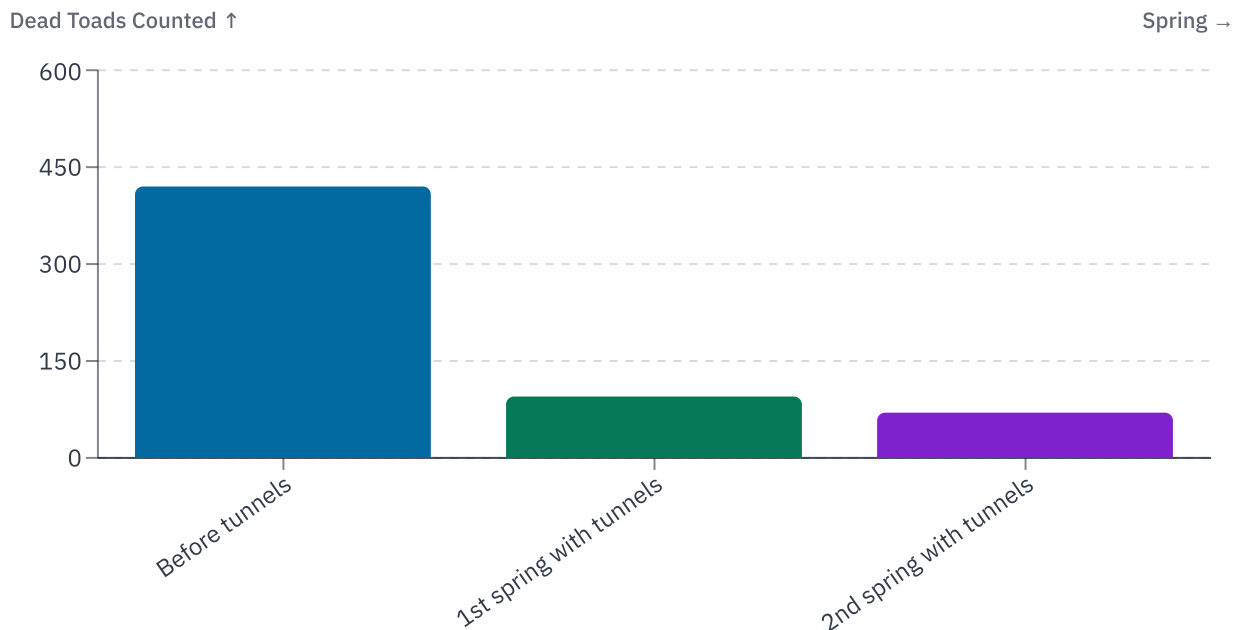
- ☐ Poaching for horns cut northern white rhinos from thousands of animals to just a few.
- ☐ The last male died in 2018, leaving only two females, a mother and her daughter.
- ☒ Since two females are still alive, the population can recover naturally if they are well protected. ✓
- ☐ Scientists are trying to use stored eggs and cells to create new rhino embryos.

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Test Bank question

HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversityExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students read the bar heights directly to see that road deaths fell after the tunnels were built.

Every spring, toads cross a busy road to reach the pond where they breed, and many are hit by cars. A town built tunnels under the road with low walls that guide the toads into them. Volunteers counted the toads found dead on the road each spring. Which statement is best supported by the graph?

Toads Found Dead on the Road Each Spring

- ☐ The tunnels stopped every toad from being killed on the road.
- ☐ About the same number of toads were killed before and after.
- ☒ Far fewer toads were killed on the road after the tunnels were built. ✓
- ☐ More toads were killed on the road after the tunnels were built.

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students interpret simulation results comparing two rules and decide what the model does and does not show.

A fishery simulated two rules for a fish stock. Rule A limits the total catch each year. Rule B protects young fish by requiring larger net holes. After 20 simulated years, the average stock was 40 percent higher under Rule B than under Rule A. Select True or False for each statement.

	True	False
Both rules are human actions meant to reduce a harmful human impact.	☒	☐
Protecting young fish lets more fish reach breeding age.	☒	☐
The result shows Rule B will produce exactly 40 percent more fish in the real ocean.	☐	☒
Scientists might test a plan that combines both rules.	☒	☐
Overfishing does not affect fish populations.	☐	☒

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students critique revisions to a simulation and judge which change would make it a poor test of the solution, which requires reasoning about model design.

Red-cockaded woodpeckers nest only in cavities they dig in old, living pines, and logging removed many of those trees. A team revised its simulation of the birds and wrote these notes. Select the revision that would make the simulation a poor test of the solution.

- ☐ Version 1 of our model tracked woodpecker family groups in a pine forest.
- ☐ We learned that the birds nest only in cavities in old, living pines.
- ☐ In Version 2, we added artificial nest cavities placed in pines as a variable we can change.
- ☒ We also set Version 2 so woodpecker numbers can never go down, to keep the results clear. ✓

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Test Bank question

NGSS DOMAIN

Physical Science

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HS-PS1-1 Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy levelExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 • Recall****Why DOK 1:** Students read the last number in each electron arrangement straight from the table to find valence electrons, a single recall-and-read step.

A chemistry teacher labels six element samples and models their neutral atoms. The table lists electron populations from the innermost to outermost occupied level. Match each element to the column showing the number of electrons in its outermost level.

Element	Electrons in occupied levels, inner to outer
Cl	2, 8, 7
Ca	2, 8, 8, 2
F	2, 7
S	2, 8, 6
Mg	2, 8, 2
O	2, 6

	2 valence electrons			6 valence electrons			7 valence electrons		
Chlorine (Cl)		☐			☐		☒		
Calcium (Ca)		☒			☐		☐		
Fluorine (F)		☐			☐		☒		
Sulfur (S)		☐			☒		☐		
Magnesium (Mg)		☒			☐		☐		
Oxygen (O)		☐			☒		☐		

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students must locate each pair on the periodic table, decide whether a group or period trend applies, and then compare, which takes several reasoning steps.

A periodic-table model places Li, Na, K, and Cs in Group 1 in Periods 2, 3, 4, and 6, respectively. Mg and Cl are in Period 3 in Groups 2 and 17. F and Ne are in Period 2 in Groups 17 and 18. The first ionization energy is the energy needed to remove one outer electron. Use the model to predict which comparisons are correct. Select all that apply.

☐ Magnesium has a higher first ionization energy than chlorine.

☒ Neon has a higher first ionization energy than fluorine. ✓

☒ Lithium has a higher first ionization energy than sodium. ✓

☐ Potassium has a higher first ionization energy than sodium.

☒ Chlorine has a higher first ionization energy than sodium. ✓

☐ Cesium has a higher first ionization energy than lithium.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students must critique a plausible claim and build an evidence-based argument linking energy levels, distance, and shielding to reactivity.

A student claims: "Fluorine and iodine both have 7 valence electrons, so they should react with sodium at the same rate." Evaluate the student's claim. Use the structure of fluorine and iodine atoms to support your evaluation.

Model response: The claim is incorrect. Fluorine and iodine both have seven valence electrons, but fluorine is much smaller because it has fewer energy levels, so its outer level is closer to the nucleus. An extra electron added to fluorine feels a stronger pull, while iodine's outer level is far away and shielded by many inner electrons. So fluorine reacts with sodium much faster than iodine.

Rubric: 2 points: The response includes all required elements: states the claim is incorrect because fluorine reacts faster; uses atomic structure as evidence (fluorine is smaller, with fewer energy levels, outer level closer to the nucleus); explains that an added electron is attracted more strongly by fluorine (iodine's is farther and shielded).

1 point: The response includes one or two of the three required elements above, but not all three. Credit for "Reasoning: an added electron is attracted more strongly by fluorine (iodine's is shielded)" requires "States that the claim is incorrect (fluorine reacts faster)".

0 points: none. No correct required element; the response is incorrect, too vague to earn credit, irrelevant, blank, or only copies the prompt without answering.

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Test Bank question

HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron statesExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students recall that a Group 1 metal gives its one valence electron to a Group 17 nonmetal, a direct recall of a basic pattern.

Potassium metal reacts with liquid bromine to form potassium bromide. Potassium is in Group 1 and bromine is in Group 17. Which statement best describes what happens to electrons in this reaction?

- ☒ Each potassium atom gives one electron to a bromine atom. ✓
- ☐ Each potassium atom gives seven electrons to a bromine atom.
- ☐ Each bromine atom gives one electron to a potassium atom.
- ☐ Potassium and bromine atoms share a pair of electrons equally.

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Test Bank question

Magnesium metal burns in nitrogen gas to form solid magnesium nitride, Mg_3N_2 , according to the pattern: $3 \text{Mg} + \text{N}_2 \rightarrow \text{Mg}_3\text{N}_2$. Match each statement to the correct column based on whether it correctly uses valence electron patterns and periodic trends to explain this reaction.

	Correctly explains the formation of magnesium nitride	Does not correctly explain the reaction
Since magnesium and nitrogen are both nonmetals, they share electrons equally to form a covalent bond in Mg_3N_2 .	☐	☒
Nitrogen has 5 valence electrons and gains 3 electrons to complete an octet, forming a N^{3-} ion.	☒	☐
A ratio of 3 Mg^{2+} ions to 2 N^{3-} ions is needed because the total positive charge ($3 \times 2+$) must equal the total negative charge ($2 \times 3-$).	☒	☐
Magnesium has 2 valence electrons and loses both to form a stable Mg^{2+} ion with a full outer shell.	☒	☐
All elements, including hydrogen and helium, gain or lose electrons until they have exactly 8 valence electrons.	☐	☒

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students combine two clues, a formula and a reactivity ranking, to identify an unknown and justify it with electron-transfer reasoning.

An unknown Group 2 metal reacts with cold water faster than magnesium but more slowly than strontium, and forms XCl_2 . Explain why calcium is the most likely element using group position and electron transfer.

Model response: The formula XCl_2 shows a 2+ metal ion and two valence electrons, placing X in Group 2. The reaction pattern increases down that group. Calcium lies between magnesium and strontium; its outer electrons are farther out than magnesium's and are lost more easily. Calcium therefore fits both clues.

Rubric: 2 points: identifies Group 2 and calcium, connects XCl_2 to loss of two electrons, and uses calcium's position between Mg and Sr to explain relative reaction behavior. 1 point: gives the correct identification or a valid formula/group-position explanation, but does not connect both clues. 0 points: gives no correct relevant information.

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Test Bank question

HS-PS1-3 Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forcesExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students recall that melting point is the bulk property that reflects the strength of attractions between particles.

A student wants to compare how strongly ions attract each other in table salt (NaCl), magnesium oxide (MgO), and calcium chloride (CaCl₂). Which measurement would give the best evidence about the strength of the electrical forces between the ions?

- ☒ The melting point of each sample, because stronger forces need more heat ✓
- ☐ The mass of each sample, because heavier samples have stronger forces
- ☐ The color of each sample, because color shows how strong bonds are
- ☐ The volume of each sample, because weaker forces make a sample bigger

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students must predict an outcome and explain the relationship between melting point and particle attractions, connecting a bulk measurement to particle-level forces.

A student wants to compare how strongly particles attract each other in table salt (NaCl), which is made of positive and negative ions, and in candle wax, which is made of nonpolar molecules. She plans to heat each substance at the same rate and measure its melting point. Predict which substance will have the higher melting point, and explain how its melting point shows the strength of the attractions between its particles.

Model response: Table salt will have the higher melting point. Melting takes energy to overcome the electrical attractions that hold particles in place in a solid. The positive and negative ions in salt attract each other strongly, so much more energy, and a higher temperature, is needed to melt it than to melt wax, whose nonpolar molecules attract each other weakly. A higher melting point means stronger attractions between particles.

Rubric: 2 points: Predicts that table salt has the higher melting point AND explains that melting requires energy to overcome the attractions between particles, so a higher melting point shows stronger attractions.

1 point: Predicts table salt correctly but gives no reasoning or unclear reasoning about energy and attractions, OR gives the correct reasoning with a missing or incorrect prediction.

0 points: Incorrect prediction and no correct reasoning (for example, says melting is a chemical change), or the response is blank or off topic.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate an investigation plan and its claim, deciding which controls, inferences, and cross-checks make the evidence trustworthy.

A student places equal drops of water, rubbing alcohol, and nail polish remover on a dish and times how long each takes to evaporate. She then claims that the evaporation times rank the attractions between particles. Select True or False for each statement.

	True	False
The drops should be the same size and at the same temperature.	☒	☐
The liquid that evaporates slowest likely has the strongest attractions.	☒	☐
Comparing her ranking with the boiling points of the liquids would help check the claim.	☒	☐
Placing one dish in sunlight and the others in shade would improve the test.	☐	☒

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Test Bank question

HS-PS1-4 Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students apply the basic rule that a reaction that cools its surroundings absorbs more energy breaking bonds than it releases forming them.

Diego mixes baking soda with vinegar in a paper cup. The mixture fizzes, and the cup feels cooler in his hand. Which statement best explains why the mixture gets cooler, using bond breaking and bond forming?

- ☒ Breaking the reactant bonds absorbs more energy than forming the product bonds releases. ✓
- ☐ Forming the product bonds absorbs more energy than breaking the reactant bonds releases.
- ☐ Breaking the reactant bonds releases energy, and that energy escapes with the gas bubbles.
- ☐ Forming the product bonds releases more energy than breaking the reactant bonds absorbs.

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Test Bank question

Why DOK 2: Students subtract bond-energy totals to find the net change, then interpret where the energy goes and what stays conserved.

Ms. Reyes's class models a hydrogen fuel-cell car. The reaction is $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$, and each water molecule has two O–H bonds. The table gives the class's totals from average bond energies. Choose the missing values from the drop-down menus.

Part of the model	Value
Energy absorbed breaking 2 mol of H–H bonds and 1 mol of O=O bonds (kJ)	1370
Energy released forming 4 mol of O–H bonds (kJ)	1852
Net energy change of the reacting system	Blank 1
Where the net energy goes	Blank 2
Total energy of the system plus its surroundings	Blank 3

Blank 1 (Row 3, Value): 482 kJ lost ▼

Blank 2 (Row 4, Value): out to the motor and surroundings ▼

Blank 3 (Row 5, Value): stays the same ▼

Drop-down 1 choices: 3222 kJ lost 482 kJ gained **482 kJ lost ✓**

Drop-down 2 choices: into the system from the car nowhere, because it is destroyed
out to the motor and surroundings ✓

Drop-down 3 choices: increases by 482 kJ **stays the same ✓** decreases by 482 kJ

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students must evaluate several claims about a real device against both the bond model and conservation of energy, reasoning about each with numbers.

A delivery drone runs on a hydrogen fuel cell, $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, which releases 482 kJ per 2 mol of H_2 . Students write claims about the drone's energy. Sort each claim by whether it is consistent with conservation of energy and the bond model.

	Consistent	Not consistent
The cell releases 482 kJ; the motor does 290 kJ of work and 192 kJ becomes heat	☒	☐
The cell releases 482 kJ; the motor does 500 kJ of work	☐	☒
Doubling the hydrogen releases 964 kJ	☒	☐
The cell releases 482 kJ, and 100 kJ of it is destroyed by friction	☐	☒
The chemical energy drops 482 kJ while the surroundings gain 482 kJ	☒	☐
The cell's chemical energy rises as it powers the drone	☐	☒

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Test Bank question

HS-PS1-5 Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall that fewer reactant particles per volume means fewer collisions, a direct application of the collision idea.

A student notices that the reaction between zinc and hydrochloric acid bubbles quickly at first, then more and more slowly, even though the temperature stays the same. Which statement best explains why the reaction slows down?

- ☒ As acid is used up, fewer acid particles remain in each milliliter, so collisions happen less often. ✓
- ☐ As the reaction goes on, the acid particles lose kinetic energy, so they hit the zinc more gently.
- ☐ As the reaction goes on, the activation energy rises, so fewer collisions can succeed.
- ☐ As bubbles form, the zinc gets colder, so its particles stop colliding with the acid.

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Test Bank question

A student investigated how temperature affects the rate of a decomposition reaction. She measured the time it took for a fixed amount of hydrogen peroxide to completely decompose at different temperatures. The table shows her results. Choose the missing values from the drop-down menus.

Temperature (°C)	Volume of O ₂ Gas Produced (mL)	Time for Complete Reaction (min)	Reaction Rate (mL/min)
15	80	16	Blank 1
25	80	8	Blank 2
35	80	4	Blank 3
45	80	2	Blank 4

Blank 1 (Row 1, Reaction Rate (mL/min)):

5.0 ▼

Blank 2 (Row 2, Reaction Rate (mL/min)):

10.0 ▼

Blank 3 (Row 3, Reaction Rate (mL/min)):

20.0 ▼

Blank 4 (Row 4, Reaction Rate (mL/min)):

40.0 ▼

Drop-down 1 choices: 0.2 5.0 ✓ 10.0 16.0

Drop-down 2 choices: 0.1 8.0 10.0 ✓ 16.7

Drop-down 3 choices: 0.05 4.0 20.0 ✓ 28.3

Drop-down 4 choices: 0.025 2.0 20.0 40.0 ✓

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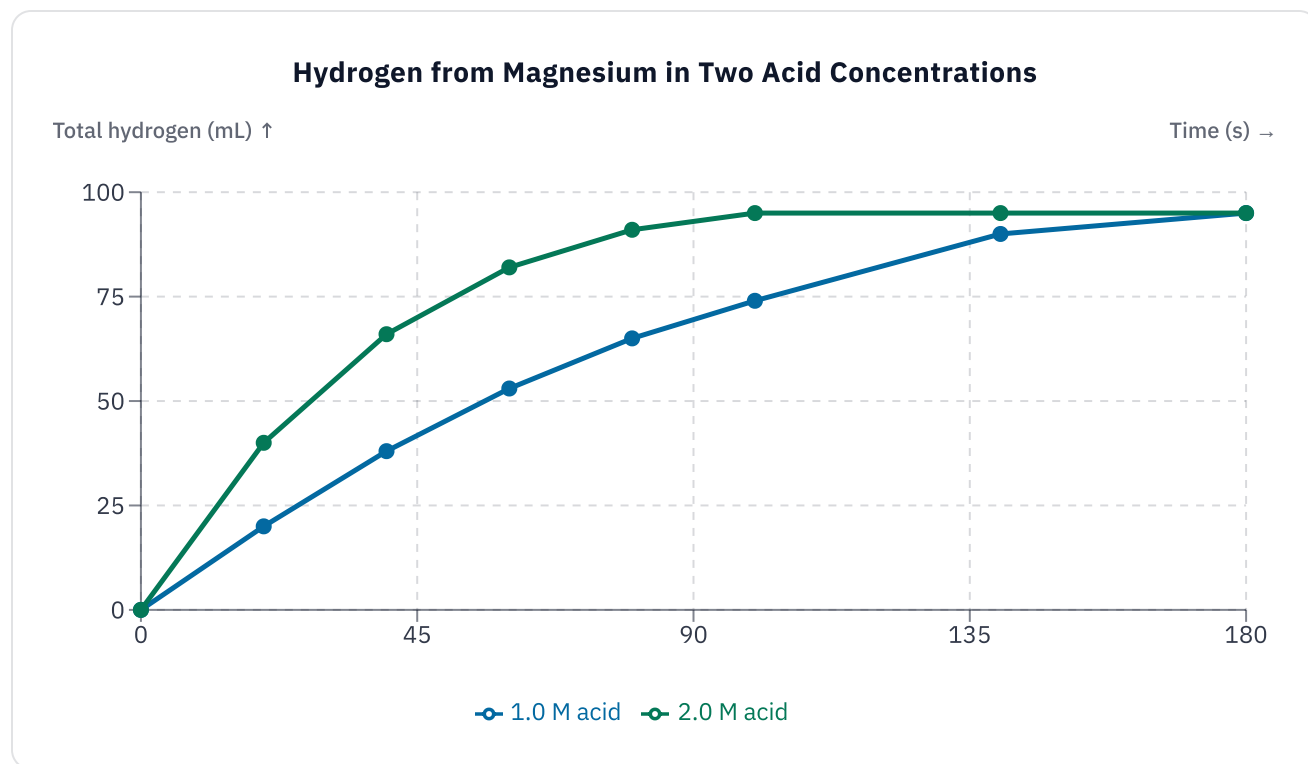
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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students must draw a conclusion from two features of the graph, early slope and final plateau, and separate rate from total amount.

A student reacts identical 0.10 g strips of magnesium with excess 1.0 M and 2.0 M hydrochloric acid at the same temperature. The graph shows the total hydrogen collected over time. Which conclusion is best supported by the graph?



- ☐ Both acids react at the same rate, because they end at the same volume.
- ☒ The 2.0 M acid starts about twice as fast, but both make the same total gas. ✓
- ☐ The 2.0 M acid makes about twice as much total gas as the 1.0 M acid.
- ☐ The 1.0 M acid starts faster, but the 2.0 M acid makes more gas overall.

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Test Bank question

HS-PS1-6 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall the basic response of an equilibrium to added reactant and that rates become equal again.

Use the drop-down menus to complete the statement.

The reaction $\text{Fe}^{3+} + \text{SCN}^- \rightleftharpoons \text{FeSCN}^{2+}$ makes a red solution. Adding more SCN^- makes the forward reaction go **faster** for a while, so the solution turns **deeper** red.

Eventually, the forward and reverse rates become **equal** again.

Drop-down 1 choices: slower **faster ✓** backward

Drop-down 2 choices: the same lighter **deeper ✓**

Drop-down 3 choices: **equal ✓** zero unequal

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Test Bank question

A student is designing a system to produce ammonia by the reversible reaction $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$, which releases heat. The system is at equilibrium. The student wants more ammonia at equilibrium without adding more reactants. Which single change would best accomplish this goal?

☐ Increase the container volume so the molecules have more room to react

☒ Decrease the temperature of the reaction system ✓

☐ Add a catalyst so the forward reaction makes ammonia faster

☐ Raise the temperature so more collisions have enough energy

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Test Bank question

A team of climbers spends three weeks at 5,000 m, where the air has about half the oxygen pressure of sea level. Blood tests show their hemoglobin levels rose by about 10 %. In blood, $\text{Hb} + \text{O}_2 \rightleftharpoons \text{HbO}_2$.

Part A: How does the rise in hemoglobin help the climbers?

Choose one answer.

☐ It stops HbO_2 from breaking apart

☒ It shifts the equilibrium back toward HbO_2 ✓

☐ It adds O_2 to the air they breathe

☐ It works as a catalyst for O_2 binding

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

☐ A catalyst raises the amount of product at equilibrium.

☐ HbO_2 cannot release oxygen once it forms.

☒ Hb is a reactant, so adding more of it shifts the balance forward. ✓

☐ Lower O_2 pressure shifts the balance toward HbO_2 .

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Test Bank question

HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 • Recall

Why DOK 1: Students add reactant masses and recall that atoms are not created or destroyed, a routine one-step application.

A student reacts 56 g of iron with 32 g of sulfur in a closed tube: $\text{Fe} + \text{S} \rightarrow \text{FeS}$. Both react completely. Match each statement to the correct column.

	Correct	Incorrect
The FeS formed has a mass of 88 g.	☒	☐
The FeS formed has a mass of 56 g.	☐	☒
The tube and its contents weigh the same before and after.	☒	☐
Every iron atom ends up in the FeS.	☒	☐
Some sulfur atoms were destroyed.	☐	☒
Heating the tube added mass to the iron.	☐	☒

FIND MORE LIKE THIS

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Test Bank question

A student burns 4.8 g of magnesium completely in oxygen: $2 \text{ Mg} + \text{O}_2 \rightarrow 2 \text{ MgO}$. The molar masses are $\text{Mg} = 24$, $\text{O}_2 = 32$, and $\text{MgO} = 40$ g/mol. Which statements are correct? Select all that apply.

- ☐ The MgO formed has less mass than the Mg and O_2 that reacted, because heat and light leave.
- ☒ The 4.8 g of Mg forms 8.0 g of MgO. ✓
- ☒ For every 2 Mg atoms that react, the 2 O atoms of one O_2 molecule join them. ✓
- ☒ About 3.2 g of O_2 reacts with the 4.8 g of Mg. ✓
- ☐ 0.20 mol of O_2 reacts, since each Mg atom needs one O_2 molecule.
- ☐ The reaction makes 4.8 g of MgO, since the mass of the metal is conserved.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students reconcile two experiments that seem to disagree and decide which conclusions the combined evidence supports.

Two students heat 43.3 g of mercury oxide: $2\text{HgO} \rightarrow 2\text{Hg} + \text{O}_2$. Student A uses a sealed vessel and finds no change in total mass. Student B uses an open dish and finds that 3.2 g is lost. Which conclusions are supported? Select all that apply.

☐ Only Student A's result is valid.

☒ Both results agree with conservation of mass. ✓

☒ The oxygen gas produced has a mass of 3.2 g. ✓

☐ Student B's result shows that 3.2 g of atoms were destroyed.

☒ The mercury left behind has a mass of about 40.1 g. ✓

☐ Student A's vessel must have gained 3.2 g of air.

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Test Bank question

HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall what beta decay does to the proton count and identify the new element, a single routine step.

Iodine-131 (53 protons) is used in medicine. It decays by beta decay, in which a neutron becomes a proton and an electron is given off. What nucleus is produced?

☒ Xenon-131 ✓

☐ Xenon-132

☐ Tellurium-131

☐ Iodine-130

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students must track protons and mass number through three decay steps in order, applying different rules at each step.

A nucleus of radon-222 (86 protons) undergoes alpha decay, then alpha decay again, then beta decay. Identify the final nucleus, and show how the protons and mass number change at each step.

Model response: The first alpha decay turns radon-222 into polonium-218: the protons drop from 86 to 84 and the mass number drops from 222 to 218. The second alpha decay makes lead-214, with 82 protons and mass number 214. The beta decay turns a neutron into a proton, so the protons rise to 83 and the mass number stays 214. The final nucleus is bismuth-214.

Rubric: 2 points: identifies bismuth-214 and shows the proton and mass number after each step (84/218, 82/214, 83/214). 1 point: one of these. 0 points: neither.

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Test Bank question

Thorium-232 (90 protons) decays through a series of alpha and beta decays to lead-208 (82 protons).

Part A: How many alpha and beta decays occur?

Choose one answer.

☒ 6 alpha and 4 beta ✓

☐ 8 alpha and 6 beta

☐ 4 alpha and 4 beta

☐ 6 alpha and 0 beta

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

☐ The number of alphas equals the number of betas.

☒ A 24 drop takes 6 alphas; they leave 78 protons, so 4 betas. ✓

☐ Each decay lowers the mass number by 4.

☐ Beta decays lower the proton number.

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DOK 3

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Test Bank question

HS-PS2-1 Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration

 Examples at: DOK 1 DOK 2 DOK 3 DOK 4

DOK 1 · Recall

Why DOK 1: Students divide net force by mass for each row, a routine one-step use of Newton's second law.

A student pulls a 25 kg shopping cart with different net forces and records the acceleration. The mass stays the same in every trial. Choose the missing values from the drop-down menus.

Net force (N)	Mass of cart (kg)	Acceleration (m/s ²)
50	25	Blank 1
100	25	Blank 2
150	25	6
200	25	Blank 3

Blank 1 (Row 1, Acceleration (m/s²)): 2 ▼

Blank 2 (Row 2, Acceleration (m/s²)): 4 ▼

Blank 3 (Row 4, Acceleration (m/s²)): 8 ▼

Drop-down 1 choices: 0.5 2 ✓ 1250

Drop-down 2 choices: 0.25 4 ✓ 2500

Drop-down 3 choices: 0.125 8 ✓ 50

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Test Bank question

Engineers test a 1,200 kg car on a level track. The road pushes forward on the tires with a force of 3,600 N. Air resistance and rolling friction act backward. The table shows the car's speed. Select True or False for each statement.

Test Car Speed on a Level Track

Time (s)	Speed (m/s)
0	0
2.0	5.0
4.0	10.0
6.0	15.0

	True	False
The car's acceleration is 2.5 m/s^2 .	☒	☐
The net force on the car is 3,000 N.	☒	☐
Air resistance and rolling friction together are about 600 N.	☒	☐
The 3,600 N forward push from the road is the net force on the car.	☐	☒
Because the car's speed keeps increasing, the net force on it must also keep increasing.	☐	☒

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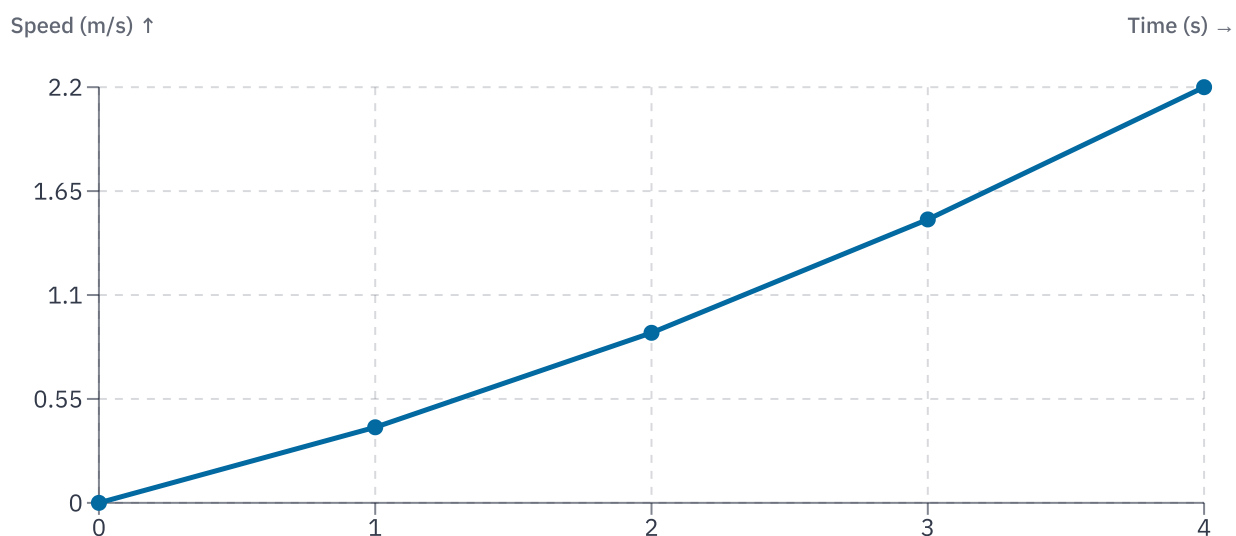
Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students notice the graph's slope increases while thrust is constant and reason that the mass must be decreasing, a non-routine inference.

A cart carries a bottle where baking soda and vinegar react. The CO_2 gas builds pressure and forces liquid out through a nozzle at the back. A force sensor shows the thrust stays about the same during the run, and friction is small. The graph shows the cart's speed. Which conclusion is best supported?

Speed of a Reaction-Powered Cart



- ☐ The acceleration is constant, because the thrust stays about the same during the run.
- ☐ The thrust must be rising, because the cart's speed keeps increasing during the run.
- ☒ The slope grows because liquid leaves the cart, so the same thrust acts on less mass. ✓
- ☐ The cart gains mass from the CO_2 gas, which is why its speed rises faster over time.

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Test Bank question

HS-PS2-2 Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall the conditions for momentum conservation and the meaning of internal and external forces.

Two gliders collide on a frictionless air track. The system is the two gliders. Select True or False for each statement.

	True	False
The total momentum of the two gliders is conserved in the collision.	☒	☐
Momentum is conserved only if the gliders stick together.	☐	☒
Friction from the track, if there were any, would be an external force on the system.	☒	☐
The forces the gliders exert on each other are internal forces.	☒	☐
The internal forces between the gliders change the system's total momentum.	☐	☒

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students calculate total momentum of two moving cars and then use it to find the combined speed, a two-step calculation.

Use the drop-down menus to complete the statement.

On a slick road, a 1,200 kg car moving at 10 m/s bumps into an 800 kg car moving the same direction at 5.0 m/s, and the bumpers lock. The total momentum of the two cars is

16,000 kg·m/s ▼

. Right after the bump, the locked cars move at

8.0 m/s ▼

Drop-down 1 choices:

8,000 kg·m/s

12,000 kg·m/s

16,000 kg·m/s ✓

Drop-down 2 choices:

7.5 m/s

8.0 m/s ✓

10 m/s

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students judge data quality across trials, separate measurement error from a real anomaly, and propose a cause, drawing conclusions from multiple pieces of evidence.

A chemistry class collides dry ice pucks that glide on a thin layer of CO₂ gas. The totals before and after four trials are shown in the table. Which statements are supported? Select all that apply.

Total Momentum in Four Dry Ice Puck Trials

Trial	Before (kg·m/s)	After (kg·m/s)
1	0.100	0.099
2	0.140	0.137
3	0.120	0.084
4	0.080	0.079

☐ Trial 3 lost momentum because heat from the sublimating dry ice carried it away.

☒ Friction from the bench, if a gas layer thinned, could explain Trial 3. ✓

☒ Trial 3 lost about 30% of its momentum, which points to an external force. ✓

☐ All four trials prove that the CO₂ gas adds momentum to the pucks.

☐ The data show that momentum is never conserved when dry ice pucks collide.

☒ Trials 1, 2, and 4 are consistent with conservation within a few percent. ✓

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Test Bank question

HS-PS2-3 Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collisionExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students recall that a cushion reduces force by lengthening stopping time while momentum change stays the same.

In a car crash, the airbag fills with nitrogen gas made when sodium azide breaks down. How does the gas-filled airbag reduce the force on the passenger?

- ☒ It lengthens the time over which the passenger stops. ✓
- ☐ It makes the passenger stop more quickly than the dashboard would.
- ☐ The nitrogen gas makes the passenger lighter.
- ☐ It reduces the passenger's change in momentum.

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students compute force for six designs from momentum change and time and classify each against a design limit.

An engineering class tests six package designs by dropping a packed object inside each one. Each row gives the object's momentum change and the time the packing takes to stop it. A design passes only if the average force on the object is 50 N or less. Sort each design by the average force on the object.

	100 N	50 N	25 N
Design 1: $\Delta p = 2.0 \text{ kg}\cdot\text{m/s}$, $\Delta t = 0.04 \text{ s}$	☐	☒	☐
Design 2: $\Delta p = 1.0 \text{ kg}\cdot\text{m/s}$, $\Delta t = 0.04 \text{ s}$	☐	☐	☒
Design 3: $\Delta p = 0.5 \text{ kg}\cdot\text{m/s}$, $\Delta t = 0.01 \text{ s}$	☐	☒	☐
Design 4: $\Delta p = 2.0 \text{ kg}\cdot\text{m/s}$, $\Delta t = 0.02 \text{ s}$	☒	☐	☐
Design 5: $\Delta p = 0.5 \text{ kg}\cdot\text{m/s}$, $\Delta t = 0.02 \text{ s}$	☐	☐	☒
Design 6: $\Delta p = 1.0 \text{ kg}\cdot\text{m/s}$, $\Delta t = 0.01 \text{ s}$	☒	☐	☐

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students must find impulse as an area, separate peak from average force, and use the results to evaluate design claims.

An engineer records force-time graphs for two catches of identical balls thrown at the same speed. Both graphs are triangles. Catch A has a peak force of 800 N and lasts 0.015 s. Catch B has a peak force of 200 N and lasts 0.060 s. Select True or False for each statement.

	True	False
Both catches give the ball the same impulse.	☒	☐
The average force in catch B is 100 N.	☒	☐
The average force in catch A is 800 N.	☐	☒
Catch B stopped a ball with more momentum than catch A.	☐	☒
Catch B is more likely to have used a padded mitt.	☒	☐

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Test Bank question

HS-PS2-4 Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects

Examples at: DOK 1 DOK 2 DOK 3 DOK 4

DOK 1 · Recall

Why DOK 1: Students apply the inverse-square rule directly to given distances and recall that gravitational forces come in equal pairs.

A satellite weighs 2,000 N on Earth's surface, one Earth radius from Earth's center. Select True or False for each statement.

	True	False
At two Earth radii from Earth's center, the gravitational force on it is 500 N.	☒	☐
At three Earth radii from Earth's center, the force is about 222 N.	☒	☐
At two Earth radii from Earth's center, the force is 1,000 N.	☐	☒
The satellite pulls on Earth with the same size force that Earth pulls on it.	☒	☐
Far out in space, the gravitational force on the satellite becomes exactly zero.	☐	☒

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Test Bank question

Use the drop-down menus to complete the statement.

Planet W has four times Earth's mass and twice Earth's radius. The gravity at its surface is

the same as ▼

the gravity at Earth's surface, so a person who weighs 500 N on Earth

would weigh

500 N ▼

on Planet W.

Drop-down 1 choices: the same as ✓

four times

twice

Drop-down 2 choices: 500 N ✓

1,000 N

2,000 N

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DOK 2 >

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Test Bank question

Earth's mass is 81 times the Moon's, and their centers are 384,000 km apart. A spacecraft travels from Earth to the Moon.

Part A: About how far from Earth are the two pulls on the spacecraft equal?

Choose one answer.

☐ 375,000 km

☐ 379,000 km

☐ 192,000 km

☒ 346,000 km ✓

Part B: Which reasoning best supports your answer to Part A?

Choose one answer.

☐ The distances split 81 to 1, but only for a light spacecraft.

☒ The distances split $\sqrt{81} = 9$ to 1, since the pulls depend on $1/d^2$. ✓

☐ The masses differ by 81, so the distances split 81 to 1.

☐ The pulls are equal halfway, since both bodies pull on the same spacecraft.

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Test Bank question

HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric currentExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students identify the simple cause-and-effect shown when a field appears only while current flows.

A student designed an investigation to test what causes a magnetic field. She wrapped wire around an iron nail, connected it to a battery, and observed that a compass needle near the nail deflected. She then disconnected the battery and observed that the compass needle returned to its original position. Based on this investigation, which statement correctly describes the cause-and-effect relationship?

- ☒ The magnetic field near the nail was caused by the electric current flowing through the wire. ✓
- ☐ The magnetic field near the nail was caused by the presence of the iron nail itself.
- ☐ The compass needle's deflection was caused by a static magnetic field that existed before the battery was connected.
- ☐ The return of the compass needle to its original position was caused by the iron nail producing an electric current.

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Test Bank question

Use the drop-down menus to complete the statement.

A magnet is pushed into a coil connected to a galvanometer at different speeds, and faster pushes give larger deflections. This shows that a changing magnetic field ▾ is the cause of the induced current. If the magnet is then held still inside the coil, the needle will show no deflection ▾.

Drop-down 1 choices: the coil's resistance a steady magnetic field **a changing magnetic field ✓**

Drop-down 2 choices: show a large deflection **show no deflection ✓** keep deflecting more

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students plan their own investigation, choosing variables, controls, and the result that would count as evidence.

Coil A is connected to a battery and switch, and coil B is connected to a galvanometer. Plan an investigation to find out how the distance between the two coils affects the current induced in coil B when the switch is closed. Name the independent and dependent variables, two variables you would control, and what result would show that the field reaching coil B is weaker at larger distances.

Model response: The independent variable is the distance between the coils, such as 1, 2, 4 and 8 cm. The dependent variable is the peak galvanometer reading in coil B each time the switch is closed. I would keep the same battery (so the same current in coil A) and the same two coils, and I would close the switch the same way each time and repeat each distance. If the peak reading gets smaller as the distance increases, that shows the changing field reaching coil B is weaker farther away.

Rubric: 2 points: The response includes all required elements: names the distance as the independent variable and the peak galvanometer reading as the dependent variable; controls variables such as the battery and the coils; states that smaller peak readings at larger distances would show a weaker field.
1 point: The response includes one or two of the three required elements above, but not all three. Credit for "States that a smaller peak reading at larger distances would show a weaker field" requires "Names distance as the independent variable and the peak galvanometer reading as the dependent variable".
0 points: no correct element. No correct required element; the response is incorrect, too vague to earn credit, irrelevant, blank, or only copies the prompt without answering.

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Test Bank question

HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall that weak forces between long polymer chains let them slide, explaining stretchiness.

A plastic grocery bag stretches a lot before it tears. Which feature of its structure explains this?

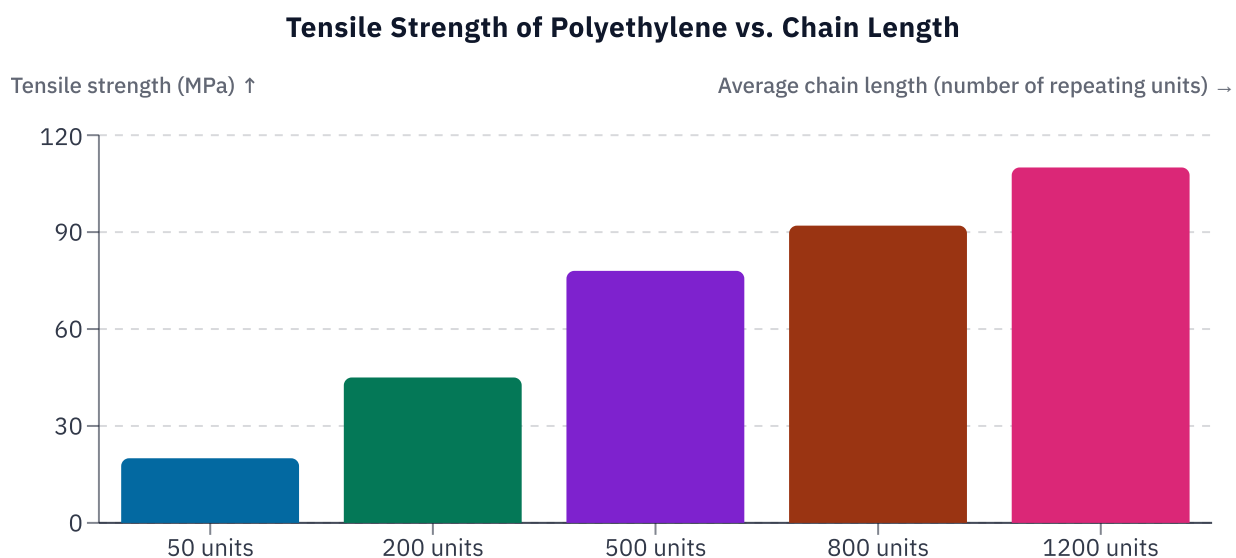
- ☐ Its atoms form a rigid network of bonds in all directions.
- ☐ Its free electrons move apart when the bag is pulled.
- ☐ Its ions line up and repel each other when it is pulled.
- ☒ Its long chains slide past each other under weak forces. ✓

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Test Bank question

An engineer is picking plastic for a cable sleeve. It must resist tearing but still bend around corners. The graph shows how tensile strength changes as the plastic's chain length grows. Which statement best explains why longer chains make the plastic stronger?



- ☐ Longer chains have more electrons, so they push away from nearby chains and stop sliding.
- ☐ Longer chains let electrons move freely through the plastic, forming strong metallic bonds.
- ☒ Longer chains touch more neighbors, so more weak attractions add up to hold them together. ✓
- ☐ Longer chains form covalent bonds with neighboring chains, joining the plastic into one molecule.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students reason about two molecular factors at once, pore size and surface chemistry, to evaluate how a designed material works.

A jacket has a PTFE membrane with pores far smaller than raindrops but far larger than single water molecules. Select True or False for each statement.

	True	False
Rain beads up on PTFE because its fluorine-covered chains are nonpolar.	☒	☐
Raindrops cannot pass through the pores because they are too large.	☒	☐
Sweat vapor can escape because single water molecules fit through the pores.	☒	☐
A cotton membrane with the same pores would keep rain out just as well.	☐	☒
PTFE keeps rain out because it attracts water and holds it.	☐	☒

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Test Bank question

HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known

Examples at:

DOK 1

DOK 2

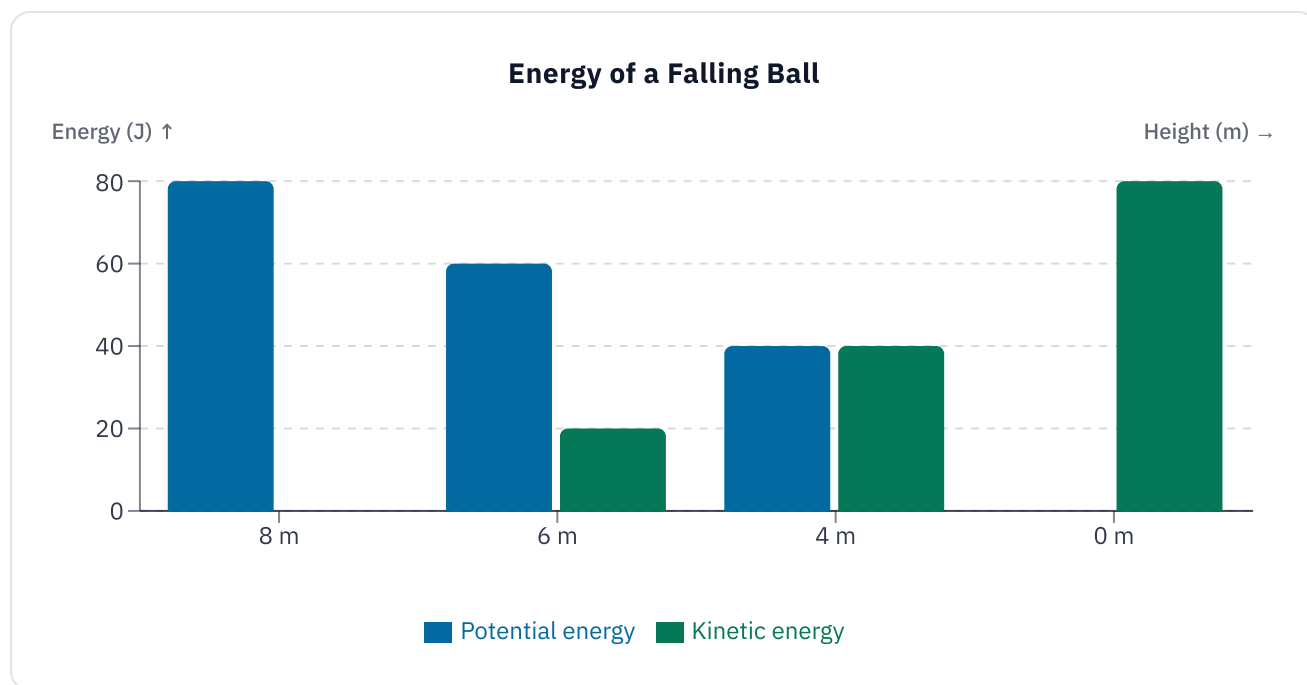
DOK 3

DOK 4

DOK 1 · Recall

Why DOK 1: Students read and add values straight from the bar graph to see that the total stays the same.

The graph shows the gravitational potential energy and kinetic energy of a falling ball at several heights, with no air resistance. Which conclusion is best supported?



- ☐ Potential energy stays constant.
- ☐ The total energy grows as the ball falls.
- ☒ The two energies always add to 80 J. ✓
- ☐ Kinetic energy is greatest at the top.

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students calculate starting and ending energy and subtract to find the energy transferred out, a multi-step energy accounting.

A 50 kg skier starts at rest at the top of a 20 m slope and reaches the bottom at 18 m/s. How much energy became thermal energy through friction and air resistance? Use $g = 10 \text{ m/s}^2$.

☐ 10,000 J

☒ 1,900 J ✓

☐ 8,100 J

☐ 0 J

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Test Bank question

A student designs a system to deliver light using three stages: a generator (80 % efficient), power lines (90 % efficient) and a bulb (25 % efficient). The student wants to raise the overall efficiency.

Part A: Which change would raise the overall efficiency the most?

Choose one answer.

☐ Raise the power lines to 99 %

☒ Replace the bulb with a 50 % LED ✓

☐ Add a fourth stage

☐ Raise the generator to 90 %

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

☐ Generators produce the most energy in any system.

☐ Adding more stages always adds energy.

☒ With the LED, 18 % rises to about 36 %. ✓

☐ Power lines are the longest part of the system.

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Test Bank question

HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects)

 Examples at: DOK 1 DOK 2 DOK 3 DOK 4

DOK 1 • Recall

Why DOK 1: Students recall where motion energy and position energy are greatest on a simple swing.

A student models a playground swing that is pulled back, released, and swings to the other side. Match each description to the column for the form of energy that is greatest at that moment.

	Kinetic energy is greatest	Gravitational potential energy is greatest
The swing stops for an instant on the far side	☐	☒
The swing passes through its lowest point	☒	☐
The swing is held back before release	☐	☒
The swing is moving at its top speed	☒	☐
The seat is at its highest point	☐	☒
The seat is closest to the ground	☒	☐

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students apply how spring energy grows with compression and then connect stored energy to launch height, translating between quantities.

A spring launcher sends a ball straight up. The height reached depends on how far the spring is compressed. Choose the missing values from the drop-down menus.

Compression (cm)	Relative stored energy	Height (m)
1	1	0.2
2	Blank 1	Blank 2
3	Blank 3	Blank 4

Blank 1 (Row 2, Relative stored energy):

4 ▼

Blank 2 (Row 2, Height (m)):

0.8 ▼

Blank 3 (Row 3, Relative stored energy):

9 ▼

Blank 4 (Row 3, Height (m)):

1.8 ▼

Drop-down 1 choices:

2

4 ✓

8

Drop-down 2 choices:

0.4

0.6

0.8 ✓

Drop-down 3 choices:

3

6

9 ✓

Drop-down 4 choices:

0.6

0.9

1.8 ✓

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DOK 2

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students track energy across several bounces, work forward and backward through the table, and account for energy leaving the system.

A 0.50 kg ball is dropped from 2.0 m onto a floor. Each bounce reaches a lower peak. The table tracks gravitational potential energy (PE) at each peak and energy transferred to thermal energy and sound since the previous peak. Use $g = 10 \text{ m/s}^2$. Choose the missing values from the drop-down menus.

Peak	Height (m)	PE at peak (J)	Energy to thermal and sound since last peak (J)
Release	2.0	10	—
First bounce	1.6	Blank 1	Blank 2
Second bounce	1.28	Blank 3	Blank 4
Third bounce	Blank 5	5.12	Blank 6

Blank 1 (Row 2, PE at peak (J)):

8 ▼

Blank 2 (Row 2, Energy to thermal and sound since last peak (J)):

2 ▼

Blank 3 (Row 3, PE at peak (J)):

6.4 ▼

Blank 4 (Row 3, Energy to thermal and sound since last peak (J)):

1.6 ▼

Blank 5 (Row 4, Height (m)):

1.024 ▼

Blank 6 (Row 4, Energy to thermal and sound since last peak (J)):

1.28 ▼

Drop-down 1 choices: 4 8 ✓ 9 16

Drop-down 2 choices: 0 2 ✓ 8 10

Drop-down 3 choices: 3.2 6.0 6.4 ✓ 12.8

Drop-down 4 choices: 0.8 1.6 ✓ 2 3.2

Drop-down 5 choices: 0.512 0.96 1.024 ✓ 2.048

Drop-down 6 choices: 0 1.28 ✓ 1.6 2.56

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Test Bank question

HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students identify the input and output energy forms of a simple device and recall that wasted energy is transferred, not destroyed.

Use the drop-down menus to complete the statement.

A student designs a hand-crank flashlight: turning a crank spins a small generator, which lights an LED. After a few minutes of cranking, the device feels slightly warm. In this

system, the useful energy conversion is energy into energy, and the warmth shows that some energy is to the surroundings as thermal energy.

Drop-down 1 choices:

Drop-down 2 choices:

Drop-down 3 choices:

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Test Bank question

A student designs a device that uses a small generator attached to a skateboard wheel. The skateboard rolls down a ramp and across a flat floor, and the generator powers an LED. Which statements correctly describe energy in this device? Select all that apply.

☐ Reducing friction in the wheel and generator would send more energy to the LED. ✓

☐ The input is gravitational potential energy, which becomes kinetic energy, then electrical energy. ✓

☐ The LED's light and heat account for all of the skateboard's starting energy.

☐ Electrical energy that does not light the LED is destroyed inside the generator.

☐ A heavier generator would convert all of the kinetic energy without any losses.

☐ Friction at the wheels and heating in the generator wires move energy to the surroundings. ✓

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Test Bank question

A student attaches a small generator to a skateboard's wheel axle to power an LED. At the bottom of a ramp, the wheels spin fast, but the LED is dimmer than the wheel speed would suggest, and the axle bearings feel warm.

Part A: Which statement best explains why the LED is dimmer than expected?

Choose one answer.

- ☒ Friction in the bearings turns some motion into heat, not electricity. ✓
- ☐ The ramp's potential energy goes straight to light, skipping electricity.
- ☐ The wheels' energy is destroyed as the skateboard slows down.
- ☐ The generator creates energy, but the LED cannot use all of it.

Part B: Which design change would best address this problem?

Choose one answer.

- ☐ Wrap insulation around the warm generator.
- ☐ Use an LED that needs less electrical power.
- ☒ Install better bearings and lubricate the axle. ✓
- ☐ Use a heavier skateboard on the same ramp.

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Test Bank question

HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distributionExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 • Recall****Why DOK 1:** Students recognize the basic measurement needed to show energy spreading: repeated temperatures of both objects.

Sam wants to show thermal energy spreading between a warm towel and a cold can inside a closed cooler. Select the plan step that gives the best evidence.

☒ Read a thermometer on each object every 2 minutes. ✓☐ Read the towel's temperature at the start only.☐ Weigh the can before and after the test.☐ Leave the lid open so the air can mix.

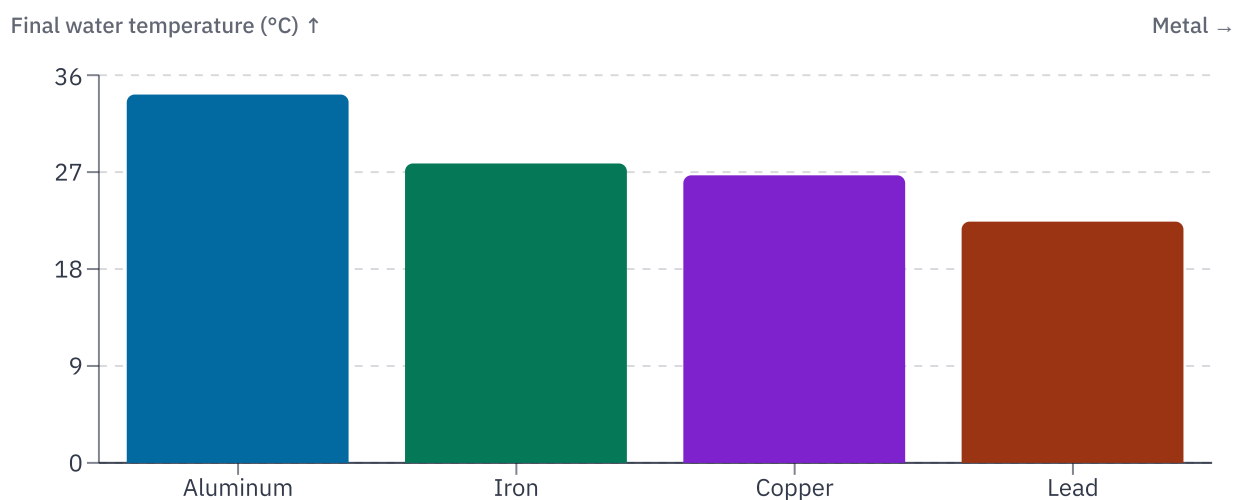
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Test Bank question

Equal 100 g samples of four metals are heated to 100°C and each dropped into 100 g of water at 20°C in identical calorimeters. The graph shows the final water temperatures. Which metal has the highest specific heat?

Final Water Temperature for Four Metal Samples



- ☐ The iron sample
- ☐ The lead sample
- ☒ The aluminum sample ✓
- ☐ The copper sample

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate a claim using several trials, judge whether differences are meaningful, and explain small shortfalls.

A student tests the claim that energy lost by hot water equals energy gained by cold water. The table shows her calorimeter data and the final temperature predicted if no energy escapes. Which conclusions are supported? Select all that apply.

Predicted and Measured Final Temperatures

Trial	Hot water	Cold water	Predicted final (°C)	Measured final (°C)
1	100 g at 70°C	100 g at 20°C	45	44.6
2	50 g at 80°C	150 g at 20°C	35	34.4
3	150 g at 60°C	50 g at 20°C	50	49.3

- ☐ Trial 3 shows that energy was created.
- ☒ The small shortfalls suggest a little energy escaped. ✓
- ☒ Each result is within 1°C of the prediction. ✓
- ☐ The cold water gained more energy than the hot water lost.
- ☒ The data support the claim that energy lost equals energy gained. ✓
- ☐ Trial 1 shows the result is always halfway between.

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Test Bank question

HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 • Recall

Why DOK 1: Students recall the field patterns of positive charges, negative charges, and bar magnets.

Match each description to the column for the object whose field it describes.

	Positive charge		Negative charge		Bar magnet	
A positive test charge is pulled in		☐		☒		☐
A positive test charge is pushed away		☒		☐		☐
Lines leave one pole and enter the other		☐		☐		☒
Lines point straight out in all directions		☒		☐		☐
Lines point straight in from all directions		☐		☒		☐
Lines form closed loops		☐		☐		☒

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Test Bank question

DOK 2 • Skills & concepts

Why DOK 2: Students explain the relationship between stored field energy and kinetic energy as charges attract, then pick the supporting reason.

A physics student sets up two small charged spheres on a frictionless track. Sphere A is fixed in place and carries a negative charge. Sphere B carries a positive charge and is free to slide along the track. Sphere B is initially held at rest 8 cm from Sphere A, then released. Because the spheres have opposite charges, the electric field around Sphere A exerts an attractive force on Sphere B, pulling it toward Sphere A. As Sphere B slides closer, its speed increases.

Part A: As Sphere B moves closer to Sphere A, what happens to the energy stored in the electric field of the two-sphere system and the kinetic energy of Sphere B?

Choose one answer.

- ☐ The stored field energy stays the same because only Sphere B is moving.
- ☐ The stored field energy decreases and the kinetic energy of Sphere B also decreases.
- ☐ The stored field energy increases while the kinetic energy of Sphere B increases.
- ☒ The stored field energy decreases while the kinetic energy of Sphere B increases. ✓

Part B: Which statement best supports your answer to Part A?

Choose one answer.

- ☐ Electric field lines always push charged objects in the same direction the lines point, causing speed to increase.
- ☒ As the distance between oppositely charged objects decreases, the attractive force does work on Sphere B, converting stored field energy into kinetic energy. ✓
- ☐ Positively charged Sphere B is attracted toward Sphere A because Sphere A acts like the north pole of a magnet.
- ☐ The magnetic field between the spheres only exists in the space outside the spheres, so energy is transferred from outside sources.

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DOK 2



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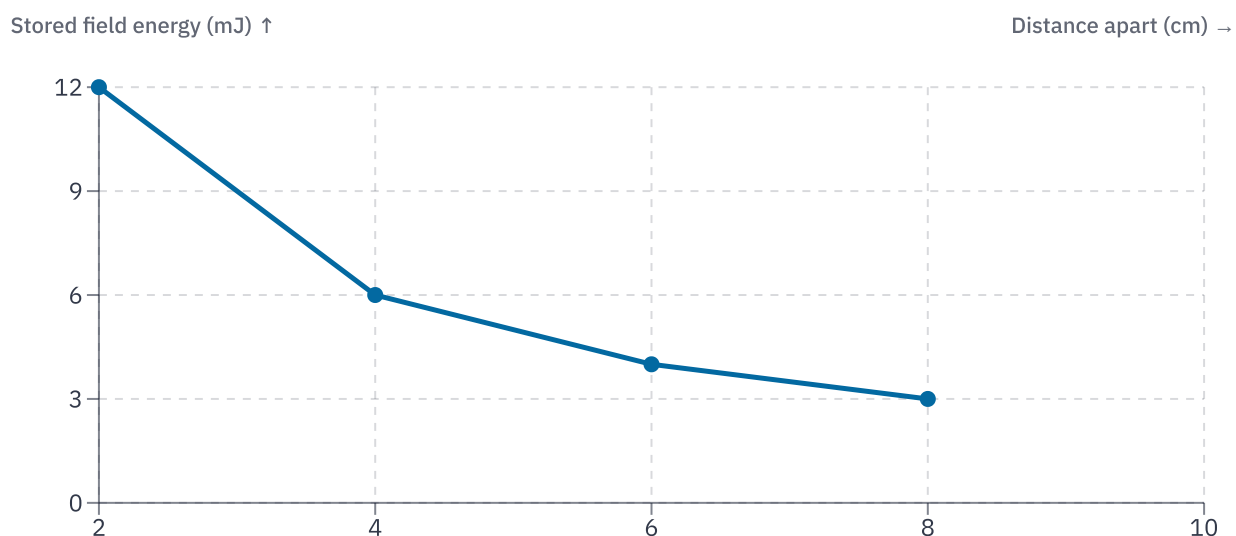
Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students use the graph and energy conservation to test a numeric prediction and explain why it is too high.

Two spheres with like charges are held 2 cm apart, then one is released on a frictionless track. The graph shows the stored field energy at several distances. A student predicts the sphere will have 12 mJ of kinetic energy at 8 cm. Which evaluation is supported?

Stored Field Energy Between Two Like Charges



☒ Too high, since only 9 mJ has been released by 8 cm. ✓

☐ Too high, since the sphere has only 3 mJ at 8 cm.

☐ Correct, since all 12 mJ has been released by 8 cm.

☐ Too low, since the sphere has 15 mJ at 8 cm.

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Test Bank question

HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various mediaExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students rearrange the wave equation and do one division, a routine procedure.

A marine biologist studies whale songs traveling through ocean water. She observes that a particular whale call has a frequency of 20 Hz and travels at a speed of 1,480 meters per second through seawater. Using the mathematical relationship $v = f \lambda$, what is the wavelength of this whale song in seawater?

☐ 1,500 meters☐ 1,460 meters☒ 74 meters ✓☐ 29,600 meters**FIND MORE LIKE THIS**[Create questions](#)

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students calculate two wavelengths from speed and period and explain that the speed change causes the wavelength change.

At Pismo Beach, the crests of an ocean swell pass a buoy every 12 s. Offshore, the swell travels 18 m/s. Near shore the water is shallow, and the swell slows to 6.0 m/s. Calculate the wavelength of the swell offshore and near shore. Explain what causes the wavelength to change.

Model response: Offshore wavelength is 216 m; nearshore wavelength is 72 m. The period stays the same at 12 s. Lower speed gives shorter wavelength nearshore.

Rubric: 2 points: Calculates both wavelengths and explains that lower speed at the same period causes shorter wavelength nearshore.

1 point: Gives at least one correct required calculation or explanation but not all required elements.

0 points: Gives no correct required element, is irrelevant, or is blank.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students reason about a non-routine case where wavelength is fixed and speed changes, then explain the cause of the pitch change.

Use the drop-down menus to complete the statement.

An organ pipe in a church is modeled in the same resonant mode with wavelength of 1.30 m, set by the length of the pipe. On a cool 10 °C morning, sound travels 337 m/s in the church. On a warm 30 °C afternoon, sound travels 349 m/s. On the cool morning the pipe plays about . On the warm afternoon its pitch , because .

Drop-down 1 choices:

Drop-down 2 choices:

Drop-down 3 choices:

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Test Bank question

HS-PS4-2 Evaluate questions about the advantages of using a digital transmission and storage of information

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students sort each question as an advantage or disadvantage of digital storage, recalling basic features of digital files.

A music streaming app must decide how to store songs: as digital files, or as old-style analog vinyl grooves. Look at each question below. Decide if it is asking about an advantage or a disadvantage of digital storage.

	Advantage	Disadvantage
Question about digital storage: Will the song sound just as clear after being copied 1,000 times?	☒	☐
Question about digital storage: Could someone copy the song and share it without asking permission?	☐	☒
Question about digital storage: Can the song file be sent to millions of phones almost instantly?	☒	☐
Question about digital storage: Could the whole song file get deleted by accident with one click?	☐	☒

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students convert units and compute download time, then connect the result to the trade-off of compression.

A movie file made with lossy compression is 3 GB. The internet connection carries 100 megabits per second, and 1 GB equals 8,000 megabits. How long does the download take?

☐ 30 seconds

☐ 16 minutes

☒ 4 minutes ✓

☐ 40 minutes

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate a real backup plan, reasoning through different failure cases to judge its strengths and weaknesses.

The Patel family keeps its photos on a phone. The phone syncs automatically to a cloud account, and once a month the family also copies all the photos to a laptop. Evaluate this backup plan. Select True or False for each statement.

	True	False
The plan keeps exact copies of the photos in more than one place.	☒	☐
If the laptop's drive fails, the family loses all of its photos.	☐	☒
If a photo is deleted on the phone, the synced cloud copy may be deleted too.	☒	☐
Because the files are digital, the family never needs to check its backups.	☐	☒
The monthly laptop copy protects a photo deleted by mistake last week, if the photo was taken before the last monthly copy.	☒	☐

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Test Bank question

HS-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model

 Examples at: DOK 1 DOK 2 DOK 3 DOK 4

DOK 1 · Recall

Why DOK 1: Students match each tool to the model of light it uses, recalling which behaviors are wave-like and which are particle-like.

Chemists use light in many lab tools. Match each tool to the column for the model of light that best explains how it works.

	Wave model	Particle model
A detector that counts single photons from a sample	☐	☒
A UV lamp that breaks bonds to kill germs	☐	☒
A grating that spreads light into a spectrum	☒	☐
X-ray crystallography that maps atoms in a crystal	☒	☐

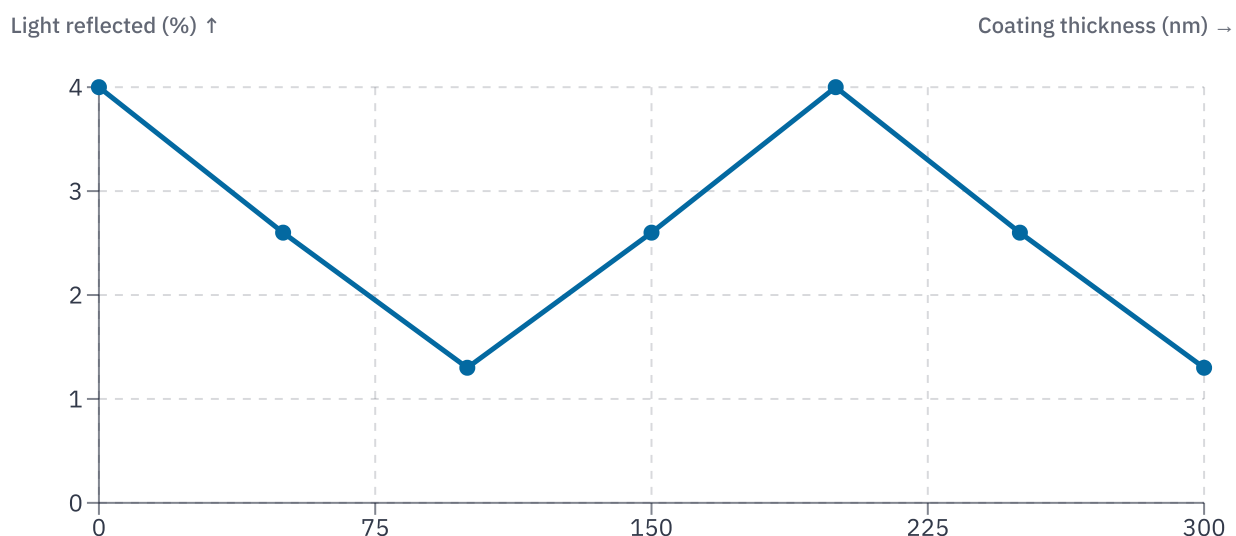
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Test Bank question

A chemist coats glass lenses with thin layers of magnesium fluoride (MgF_2) of different thicknesses. For each coating, she measures the percent of green light reflected from the lens. Which claim is best supported by the graph?

Green Light Reflected by Glass with an MgF_2 Coating



- ☐ The coating reflects the same amount at every thickness, so it has no effect.
- ☐ Photons collide inside the coating, so a 100 nm layer stops the most light.
- ☒ Reflection rises and falls with thickness, so reflected waves add and cancel. ✓
- ☐ Thicker coatings always absorb more photons, so reflection keeps dropping.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate a claim by weighing two experiments, explaining what each supports and why one model alone cannot account for all the evidence.

A class does two experiments with light. Experiment 1: Green laser light passes through two narrow slits and makes a pattern of bright and dark bands on a screen. Making the laser brighter makes the bright bands brighter, but the dark bands stay dark. Experiment 2: The same green light shines on a clean metal plate and knocks electrons out of it. Red light does not knock out any electrons from the same plate, even when the red light is made much brighter. A student claims, "Experiment 1 proves that light is only a wave, so the results of Experiment 2 must be a mistake." Evaluate the student's claim. Use evidence from both experiments to explain which model of light each experiment supports.

Model response: The claim is not correct. In Experiment 1, the bright and dark bands come from light waves from the two slits adding together in some places and canceling in others, which supports the wave model. In Experiment 2, whether electrons are knocked out depends on the color (frequency) of the light, not its brightness. In the particle model, light comes in photons, and each photon's energy depends on its frequency. Each red photon has too little energy to free an electron, so adding more red photons does not help, while each green photon has enough. A wave-only model would predict that very bright red light should eventually free electrons, so Experiment 2 is not a mistake. Light shows both kinds of behavior, so scientists use the wave model to explain interference and the particle model to explain how light transfers energy to electrons.

Rubric: 2 points: States that the claim is not correct AND explains that Experiment 1 (interference bands) supports the wave model AND explains that Experiment 2 supports the particle model because each photon's energy depends on frequency, not brightness.

1 point: States that the claim is not correct and explains only one experiment correctly, OR correctly links both experiments to the wave and particle models without evaluating the claim.

0 points: Agrees with the claim, gives no correct link between either experiment and a model, or is blank or off topic.

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HS-PS4-4 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matterExamples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall****Why DOK 1:** Students recall that higher frequency means more energy per photon and pick the one correct claim.

A student reads an article about electromagnetic waves and human tissue. The article makes four claims about how the frequency of a wave affects tissue. Which claim is correct?

- ☐ Radio waves have a high frequency, so they ionize atoms in tissue and cause the most damage.
- ☒ Ultraviolet light has a higher frequency than visible light, so each photon can damage DNA. ✓
- ☐ Microwaves heat tissue, and heating harms cells in the same way that ionizing does.
- ☐ Only X-rays and gamma rays give energy to tissue, and other waves pass through with no effect.

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students compare photon energies across UVA, UVB, and visible light and use that to judge an advertising claim.

A tanning salon says, "Our beds give off mostly UVA, which is gentler than UVB, so our tans are safe." A student looks up that UVA has a longer wavelength than UVB and that UVA photons can still break bonds in DNA. Select True or False for each statement.

	True	False
Each UVA photon carries less energy than each UVB photon.	☒	☐
Because UVA is gentler than UVB, it cannot harm skin.	☐	☒
Each UVA photon carries more energy than a photon of visible light.	☒	☐
The student's research supports the salon's claim that tans are safe.	☐	☒

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate the validity of several pieces of evidence and justify which one actually supports the claim.

A student claims that window glass protects people from sunburn. Select the piece of evidence that best supports this claim.

- ☐ People sitting by a window feel warm on sunny days.
- ☒ A UV meter reads much lower behind glass than outside at the same moment. ✓
- ☐ Window glass looks clear and lets in plenty of daylight.
- ☐ Office workers rarely go outside during the middle of the day.

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Test Bank question

HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students classify familiar devices by the wave principle that makes each work, a recall task.

Engineers group devices by the physics that makes them work. Some carry light through glass, some cancel waves, and some turn photons into current. Sort the devices into the three groups.

	Total internal reflection	Interference	Absorption of photons
Solar panel	☐	☐	☒
Anti-glare coating on glasses	☐	☒	☐
Endoscope that carries light into the body	☒	☐	☐
Fiber optic internet cable	☒	☐	☐
Photodiode in a light meter	☐	☐	☒
Noise-canceling headphones	☐	☒	☐

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Test Bank question

An engineer winds a fiber optic cable around spools of different sizes and measures how much light gets through. On a 10 cm spool, 96% gets through. On a 2 cm spool, 80% gets through. On a 1 cm spool, only 40% gets through.

Part A: Why does less light get through on the smallest spool?

Choose one answer.

- ☒ In a tight bend, light hits the edge too steeply to reflect back in. ✓
- ☐ The smallest spool holds a longer piece of fiber than the others.
- ☐ The light slows down in tight bends and cannot reach the end in time.
- ☐ Tight bends make the glass absorb light and give it off as heat.

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

- ☐ The engineer used three different spools.
- ☒ Light getting through drops sharply as the bend gets tighter. ✓
- ☐ The fiber carries light from one end to the other.
- ☐ 96% of the light gets through on the largest spool.

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Test Bank question

Engineers are building an infrared methane sensor for use outdoors in humid air. At the shorter wavelength, 3.3 micrometers, methane absorbs strongly and water vapor barely absorbs. At the longer wavelength, 7.7 micrometers, methane absorbs strongly and water vapor also absorbs strongly. Which wavelength should the sensor use? Justify your choice.

Model response: The sensor should use the shorter wavelength, 3.3 micrometers. There, methane absorbs strongly and water vapor barely absorbs, so a change in the light reaching the detector comes from methane alone. At the longer wavelength, water vapor also absorbs strongly, so on a humid day the extra absorption by water would make the sensor read more methane than is really there.

Rubric: 2 points: The response includes all required elements: chooses the shorter wavelength (3.3 micrometers), cites that water vapor barely absorbs there but absorbs strongly at the longer wavelength, and explains that water absorbing at the longer wavelength would change the reading and be mistaken for methane.

1 point: The response includes one or two of the three required elements above, but not all three. Credit for "Explains that water absorbing at the chosen wavelength would change the reading and be mistaken for methane" requires "Chooses the shorter wavelength (3.3 micrometers)".

0 points: none. No correct required element; the response is incorrect, too vague to earn credit, irrelevant, blank, or only copies the prompt without answering.

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Test Bank question

NGSS DOMAIN

Earth & Space Science

19 performance expectations, grouped by disciplinary core idea. In the Test Bank, choose the Earth Science course, then HS Earth Science.

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HS-ESS1-1 Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall that the Sun is powered by nuclear fusion and that mass becomes energy, a single fact with no reasoning required.

Use the drop-down menus to complete the sentences.

The Sun's energy comes from **nuclear fusion** . In this process, a tiny amount of **mass** is changed into a large amount of energy.

Drop-down 1 choices: **nuclear fusion** ✓ chemical burning radioactive decay

Drop-down 2 choices: heat oxygen **mass** ✓

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students must apply $E = mc^2$ in two steps, squaring c and then multiplying by the mass, to connect fusion to the Sun's energy output.

Each second, the Sun turns about 4.2×10^9 kg of mass into energy. The energy made from a mass m is $E = mc^2$, where $c = 3.0 \times 10^8$ m/s. About how much energy does the Sun release each second?

☐ 1.3×10^{18} joules

☐ 1.3×10^{28} joules

☒ 3.8×10^{26} joules ✓

☐ 3.8×10^{17} joules

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students weigh each piece of evidence against two competing models of the Sun's future and decide which evidence favors one model over the other.

Two students model how the Sun will change in the future.

Student A: "The Sun will shine the same until its hydrogen is gone, then it will suddenly go dark."

Student B: "The Sun will slowly brighten, then swell into a red giant, then shrink into a white dwarf."

Which pieces of evidence support Student B's model over Student A's? Select all that apply.

☐ The Sun has shone for about 4.6 billion years.

☒ The Sun has brightened by about 30% since it formed. ✓

☒ Astronomers see red giants and white dwarfs with about the Sun's mass. ✓

☐ The Sun is mostly hydrogen and helium.

☒ When core hydrogen runs low, the core shrinks and heats up enough to fuse helium. ✓

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Test Bank question

HS-ESS1-2 Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students compare two wavelengths and recall that a shift to a longer wavelength is a redshift meaning the galaxy is moving away.

A galaxy's hydrogen line appears at 672 nm. In a lab, the same line is at 656 nm. Describe the shift in the line and what it tells about the galaxy's motion.

Model response: The line has shifted to a longer wavelength, by 16 nm, which is a redshift. This means the galaxy is moving away from Earth.

Rubric: 2 points: Identifies the shift as a redshift (a shift to a longer wavelength) and concludes that the galaxy is moving away from Earth.

1 point: Identifies the shift correctly or the direction of motion correctly, but not both.

0 points: Does not correctly describe the shift or the motion, for example says the galaxy is moving toward Earth or that it looks red.

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Test Bank question

Astronomers measure the spectrum of light from a distant galaxy. The hydrogen and helium lines form the same pattern as in an Earth lab, but every line is shifted toward the red end of the spectrum. Which statements correctly explain how these observations support the Big Bang theory? Select all that apply.

- ☒ The redshift shows the galaxy is moving away, which fits a universe that is expanding. ✓
- ☐ The galaxy is moving away, which shows that its stars and atoms have grown larger over time.
- ☐ The redshift shows the galaxy has turned red as it moved farther away from Earth.
- ☒ The line pattern shows hydrogen and helium, so the same elements exist far beyond Earth. ✓
- ☒ The galaxy's motion and makeup together fit a universe that began hot and dense. ✓
- ☐ The redshift shows the galaxy is hotter than nearby galaxies, so it formed earlier.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students must combine three separate lines of evidence (redshift pattern, microwave background, hydrogen-helium ratio) into one written explanation of the Big Bang.

Scientists look at light from hundreds of distant galaxies. Almost all of them have spectral lines shifted toward longer, redder wavelengths compared with the same lines made in a lab on Earth, and farther galaxies show a bigger shift. Scientists also find faint microwave radiation filling all of space, and they find hydrogen and helium everywhere in about the same ratio. Use this evidence to explain the Big Bang theory. Describe what the redshift pattern shows about how galaxies are moving and what the microwave radiation and the hydrogen-to-helium ratio show about the early universe.

Model response: The redshift shows that galaxies are moving away from us, because their light waves are stretched. Since farther galaxies show more redshift, space itself is expanding and carrying galaxies apart. If we run the expansion backward, the universe must once have been much smaller, hotter and denser. The microwave radiation is the cooled glow left from that hot early stage, and the hydrogen-to-helium ratio matches the amounts of helium that would have formed by fusion in the first few minutes, while the universe was hot and dense. Together, these clues support a universe that began hot and dense and has been expanding and cooling ever since.

Rubric: 2 points: Explains that the redshift pattern (larger redshift at greater distance) shows galaxies moving apart in an expanding universe, and connects the microwave radiation and the hydrogen-to-helium ratio to a hot, dense early universe.

1 point: Correctly explains either the redshift pattern as expansion or the microwave radiation and hydrogen-to-helium ratio as evidence of a hot, dense early universe, but not both.

0 points: Gives no correct explanation, for example says redshifted galaxies look red, that all elements formed at the Big Bang, or that expansion makes atoms grow.

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Test Bank question

HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall**

Why DOK 1: Students recall the single fact that helium nuclei fuse to make carbon in a Sun-like star.

Near the end of its life, a star like the Sun has a core that is hot enough to fuse helium. Which element is mainly made when helium nuclei fuse?

☐ Hydrogen☐ Iron☒ Carbon ✓☐ Gold

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students must relate two variables, star mass and core conditions, to explain why some stars build heavier elements than others.

Use the drop-down menus to complete the statement.

A researcher makes a chart of star mass and the heaviest element each star can fuse in its core. The chart would show that more massive ▾ stars can fuse heavier elements. This is because their cores are hotter and denser ▾.

Drop-down 1 choices: less massive older **more massive ✓**

Drop-down 2 choices: cooler and larger **hotter and denser ✓** made of iron

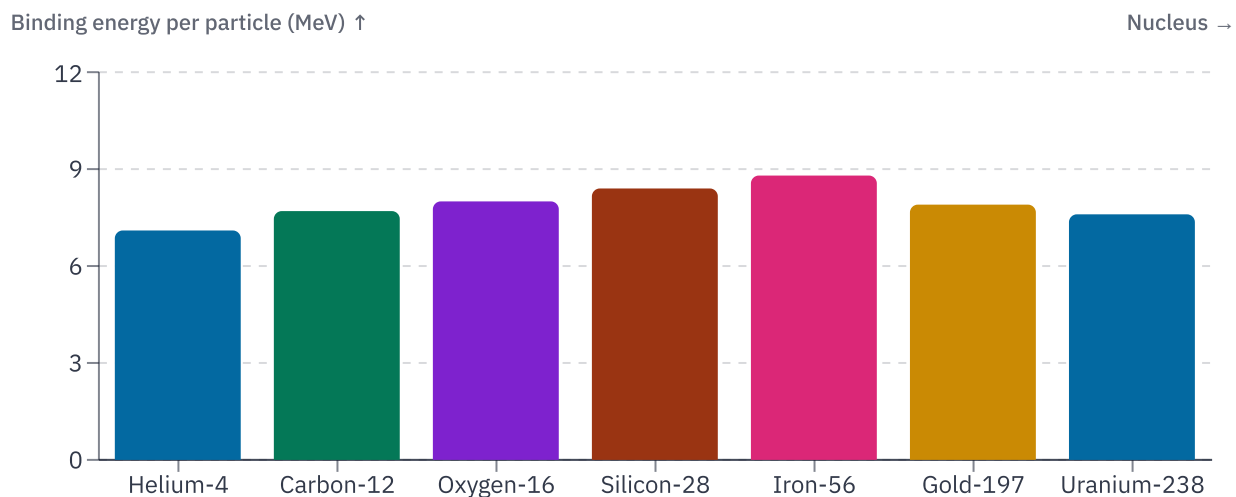
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Test Bank question

A student says, "Stars could make gold in their cores if they just got hot enough." Answer both parts.

Binding Energy per Particle in the Nucleus



Part A: Is the student's claim supported?

Choose one answer.

☒ No, because making gold by fusion takes in energy. ✓

☐ No, because stars cannot fuse anything past helium.

☐ Yes, because hotter cores can fuse any element.

☐ Yes, because gold has the most binding energy.

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

☐ Helium-4 has the lowest value on the graph.

☐ Gold-197 is heavier than iron-56.

☐ Silicon-28 has a higher value than carbon-12.

☐ Binding energy per particle falls from iron to gold.



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DOK 3



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Test Bank question

HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall**

Why DOK 1: Students recall basic facts about elliptical orbits and Kepler's second law, such as faster motion near the Sun.

A comet moves on a long, stretched ellipse around the Sun. Which statements about the comet are correct? Select all that apply.

- ☐ The Sun is at the center of its ellipse.
- ☐ It moves at the same speed the whole time.
- ☒ It moves slowest when it is farthest from the Sun. ✓
- ☒ It moves fastest when it is closest to the Sun. ✓
- ☐ It moves fastest when it is farthest from the Sun.
- ☒ Its distance from the Sun changes during its orbit. ✓

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students use ellipse geometry in two steps to find the far distance, then apply Kepler's second law to compare speeds.

Use the drop-down menus to complete the statement.

Halley's Comet has an average distance (semi-major axis) of 17.8 AU. Its closest distance to the Sun is 0.6 AU. For an ellipse, the closest and farthest distances add up to twice the average distance. The comet's farthest distance from the Sun is about AU. At that point it moves than at its closest point.

Drop-down 1 choices: 17.2 18.4

Drop-down 2 choices: at the same speed faster

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students must plan how to run Kepler's third law backward, from a required period to an unknown distance, a non-routine multi-step problem.

Engineers want a satellite that orbits Earth once every 24 hours so it stays over one spot. A satellite 6,700 km from Earth's center takes 1.5 hours per orbit. About how far from Earth's center must the 24-hour satellite be?

☐ About 107,000 km

☒ About 42,000 km ✓

☐ About 1,700,000 km

☐ About 27,000 km

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Test Bank question

HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall that continents grow by adding crust at their edges, which explains old centers and young margins.

The rock in the center of North America is billions of years old. The rock near the west coast is much younger. Which statement explains this pattern?

- ☐ The west coast formed first, and the center formed later.
- ☒ Pieces of crust were added to the edge of an old core over time. ✓
- ☐ The rock in the center formed at a mid-ocean ridge.
- ☐ Erosion near the coast wore away old rock and reset its age.

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students convert rock ages and distance into a spreading rate with unit conversion, then compare it with GPS data.

Use the drop-down menus to complete the statement.

A GPS station on one side of a ridge moves away from it by 3 cm each year. Rock 600 km from the ridge on that side is 20 million years old. The rock ages give a rate of

cm per year, which the GPS rate.

Drop-down 1 choices:

Drop-down 2 choices:

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students judge which conclusions the age data alone can justify and which need more evidence, reasoning about the limits of the data.

Scientists find a seamount chain whose ages rise toward the west. A student lists possible conclusions. Sort each conclusion by whether the ages alone justify it.

	Justified by the ages alone	Needs more evidence
The volcanoes formed one after another.	☒	☐
The plate moved at exactly 5 cm per year.	☐	☒
The plate moved west over a fixed hotspot.	☐	☒
The hotspot will stay active forever.	☐	☒
Either the plate moved west or the hotspot moved east.	☒	☐

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Test Bank question

HS-ESS1-6 Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students read ages from a list and compare each one to 4 billion years, a direct look-up with no interpretation.

A student looks up the ages of several samples. Which samples are older than 4 billion years? Select all that apply.

☒ Jack Hills zircon crystals, 4.4 billion years ✓

☒ Allende meteorite grains, 4.57 billion years ✓

☐ Greenland Isua rocks, 3.8 billion years

☐ Moon mare lava, 3.3 billion years

☒ Moon highland rocks, 4.4 billion years ✓

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students turn an isotope ratio into a fraction left, count half-lives, compute an age and say what it means for early Earth.

A zircon from Earth's oldest crust has 1 atom of uranium-235 for every 63 atoms of lead-207. Uranium-235 has a half-life of about 0.7 billion years, and the zircon had no lead-207 when it formed. Calculate the age of the zircon. Show your work and explain what the age tells about early Earth.

Model response: With 1 parent for every 63 daughters, 1 out of 64 of the original uranium-235 is left, which is $1/64 = (1/2)^6$, or six half-lives. The age is $6 \times 0.7 = 4.2$ billion years. This shows that Earth had solid crust at least 4.2 billion years ago, only a few hundred million years after it formed.

Rubric: 2 points: Finds that $1/64$ of the parent is left (six half-lives) and an age of about 4.2 billion years with work shown, and explains that Earth had solid crust by then.

1 point: Gives the correct age without work or without the explanation, or uses the correct method but makes an arithmetic error.

0 points: Gives an incorrect age with no correct method, or no response.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students draw conclusions about Earth's origin by combining ages and chemical makeup from three different kinds of samples.

A geologist compares a 4.57-billion-year-old meteorite, a 4.4-billion-year-old Moon rock, and a 4.0-billion-year-old Earth rock. The meteorite and Moon rock have similar amounts of certain elements, while the Earth rock has different amounts. Select True or False for each statement.

	True	False
The meteorite and Moon rock likely came from similar early material.	☒	☐
The Earth rock's different makeup shows Earth's crust changed.	☒	☐
The meteorite's age proves Earth has never changed.	☐	☒
The ages show Earth's crust formed after the solar system began.	☒	☐

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Test Bank question

HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students name one internal process and one surface process and state what each did, recalling basic terms.

Kauai, one of the Hawaiian Islands, was built by volcanoes about 5 million years ago. Today it has deep canyons carved by rivers. Name the internal process and the surface process that shaped Kauai, and explain what each did.

Model response: The internal process was volcanism: magma from a hotspot rose and erupted, building the island. The surface process was erosion by rivers, which has cut deep canyons into the island since it stopped erupting.

Rubric: 2 points: Names volcanism (or rising magma over a hotspot) as the internal process that built the island and river erosion as the surface process that carved the canyons. 1 point: Names only one process correctly, or names both without explaining what each did. 0 points: Neither process is correct.

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Test Bank question

The table shows two bodies of water formed by plates spreading apart. A rate of 1 cm per year equals 10 km every million years. Which statement is supported by the table?

Two Spreading Features

Feature	Width (km)	Spreading rate (cm per year)
Atlantic Ocean	4,500	2.5
Red Sea	300	1.5

- ☐ Both features formed in about the same time.
- ☒ The Atlantic took about 9 times as long to open as the Red Sea. ✓
- ☐ The Red Sea took longer to open than the Atlantic.
- ☐ The Atlantic opened in about 18 million years.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students combine several clues about rock ages and active processes to reason how processes on different time scales shape one landscape.

A geologist is modeling the Cascade Range in the Pacific Northwest. The range has rock formations more than 50 million years old and volcanic peaks less than 2 million years old. Rivers are deepening valleys between the peaks today, and an ocean plate is still sinking beneath North America and feeding the volcanoes. Which statement best describes how processes at different time scales shape this landscape?

☒ Subduction has built the range over tens of millions of years, while rivers reshape its valleys over thousands of years. ✓

☐ Subduction acts faster than river erosion, so the peaks will keep rising no matter how fast the rivers cut.

☐ River erosion formed both the young peaks and the deep valleys, so a single process on one time scale shaped the range.

☐ The young peaks formed at the surface and the old rocks formed inside Earth, so subduction no longer shapes the range.

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Test Bank question

HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall how water vapor and warming affect each other and identify the feedback as amplifying.

Warmer air can hold more water vapor, and water vapor is a greenhouse gas. Select True or False for each statement.

	True	False
Warming adds water vapor to the air.	☒	☐
More water vapor traps more heat.	☒	☐
This is a balancing feedback.	☐	☒
This feedback links the ocean and the atmosphere.	☒	☐

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Test Bank question

Scientists tracked a permafrost site for 30 years. Which conclusions are supported by the data? Select all that apply.

Permafrost Site Data

Year	Summer thaw depth (m)	Methane released (g per m ² per year)
1990	0.5	4
2005	0.8	9
2020	1.2	16

- ☐ Thaw depth stayed about the same.
- ☒ Thaw depth more than doubled over 30 years. ✓
- ☒ Methane release rose as thaw depth increased. ✓
- ☐ Methane release fell as the ground thawed deeper.
- ☒ Methane release grew faster in the later 15 years. ✓

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students must reason about which study design separates two possible causes, planning a fair test rather than recalling a fact.

A scientist wants to show that dust on snow, not warmer air, is the main reason a mountain snowpack melts early. Which study would best test this?

- ☐ Measure the air temperature at one site for one spring.
- ☐ Count how many dust storms occurred in the last decade.
- ☒ Compare melting of cleaned and dusty snow plots side by side. ✓
- ☐ Survey skiers about when the snow seemed to melt.

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Test Bank question

HS-ESS2-3 Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~**DOK 1 · Recall**

Why DOK 1: Students recall the basic convection model: heated rock becomes less dense and rises, cooled rock sinks, moving the plates.

Use the drop-down menus to complete the model of thermal convection in Earth's mantle.

In a model of Earth's interior, heat from radioactive decay causes mantle rock near the core-mantle boundary to become **less dense ▼** and rise, while cooler rock near the crust becomes **denser ▼** and sinks. This cycling of matter carries thermal energy from the interior toward the surface and drives the motion of **tectonic plates ▼** at the surface.

Drop-down 1 choices: more dense **less dense ✓** fully melted

Drop-down 2 choices: liquid less dense **denser ✓**

Drop-down 3 choices: the solid inner core the liquid outer core **tectonic plates ✓**

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Test Bank question

Seismic waves show that Earth's mantle is solid rock. Yet the Pacific Plate above it moves about 8 cm a year. Answer both parts.

Part A: What mainly moves the plate?

Choose one answer.

- ☒ Slow convection in the solid mantle ✓
- ☐ The crust shrinking as it cools at night
- ☐ The inner core spinning under the plate
- ☐ Liquid iron in the outer core pushing up

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

- ☐ S waves do not pass through the outer core, which shows it is liquid.
- ☒ Seismic images show hot rock rising under ridges and cold slabs sinking. ✓
- ☐ The inner core is solid and is the hottest layer of Earth's interior.
- ☐ Volcanoes along the plate's edges erupt hot magma onto the surface.

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Test Bank question

At the Mid-Atlantic Ridge, new crust forms evenly on both sides, and magnetic stripes in the crust match on both sides. A scientist wants to explain both the spreading and the stripes. Answer both parts.

Part A: Which explanation accounts for both?

Choose one answer.

☒ Mantle convection spreads plates; core convection flips the field. ✓

☐ Mantle convection causes both the spreading and the field.

☐ Core convection spreads plates; mantle convection flips the field.

☐ Neither is caused by convection inside Earth.

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

☒ Seismic waves show a liquid outer core and a solid mantle. ✓

☐ Spreading rates are different at different ridges.

☐ The inner core is hotter than the outer core.

☐ New crust forms evenly on both sides of the ridge.

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Test Bank question

HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall the cause and effect of the greenhouse effect: more carbon dioxide traps outgoing heat.

A climate scientist explains why Earth's average surface temperature rose during the 20th century. Which statement correctly describes a cause and its effect?

- ☐ Melting sea ice reflects more sunlight, so the Arctic warms faster.
- ☐ Earth moved closer to the Sun each year, so it received more sunlight.
- ☒ More carbon dioxide traps outgoing heat, so the surface warms. ✓
- ☐ A steady tilt of Earth's axis made every summer warmer than the last.

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students calculate total energy gained from an imbalance and explain, at a basic level, why oceans slow surface warming.

Earth has an energy imbalance of about 1 W/m^2 . Earth's surface area is about $5.1 \times 10^{14} \text{ m}^2$. Calculate the extra energy Earth gains each second. Explain where most of this energy goes and why surface temperature rises only slowly.

Model response: Multiplying 1 W/m^2 by $5.1 \times 10^{14} \text{ m}^2$ gives about $5.1 \times 10^{14} \text{ W}$, or 5.1×10^{14} joules every second. About 90 percent of this energy goes into the oceans. Water can store a great deal of heat, so the ocean warms slowly and holds back the rise in surface temperature.

Rubric: 2 points: Calculates about $5.1 \times 10^{14} \text{ W}$ (joules per second) AND explains that most of the energy goes into the oceans, which store heat and slow surface warming. 1 point: Gives the correct calculation OR the correct explanation, but not both. 0 points: Neither the calculation nor the explanation is correct.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate each prediction by reasoning about how fast each climate driver acts, applying time scales to new situations.

A student makes predictions about Earth's climate after different changes. Sort each prediction as reasonable or not reasonable.

	Reasonable	Not reasonable
Orbital changes will not cause an ice age within the next century	☒	☐
A big eruption next year would cool Earth for about two years	☒	☐
A smaller tilt will cool Earth within ten years	☐	☒
Continued emissions will keep warming Earth for decades	☒	☐
A strong El Niño will end global warming	☐	☒

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Test Bank question

HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes

Examples at:

DOK 1

DOK 2

DOK 3

DOK 4

DOK 1 · Recall

Why DOK 1: Students identify independent, dependent and controlled variables, a routine classification of investigation parts.

A class plans an investigation of how water temperature affects how fast limestone dissolves. Sort each item by its role in the investigation.

	Independent variable		Dependent variable		Controlled variable	
Length of time in the water	☐		☐		☒	
Size of the limestone chips	☐		☐		☒	
Temperature of the water	☒		☐		☐	
Mass lost by the limestone	☐		☒		☐	
Amount of water in each cup	☐		☐		☒	

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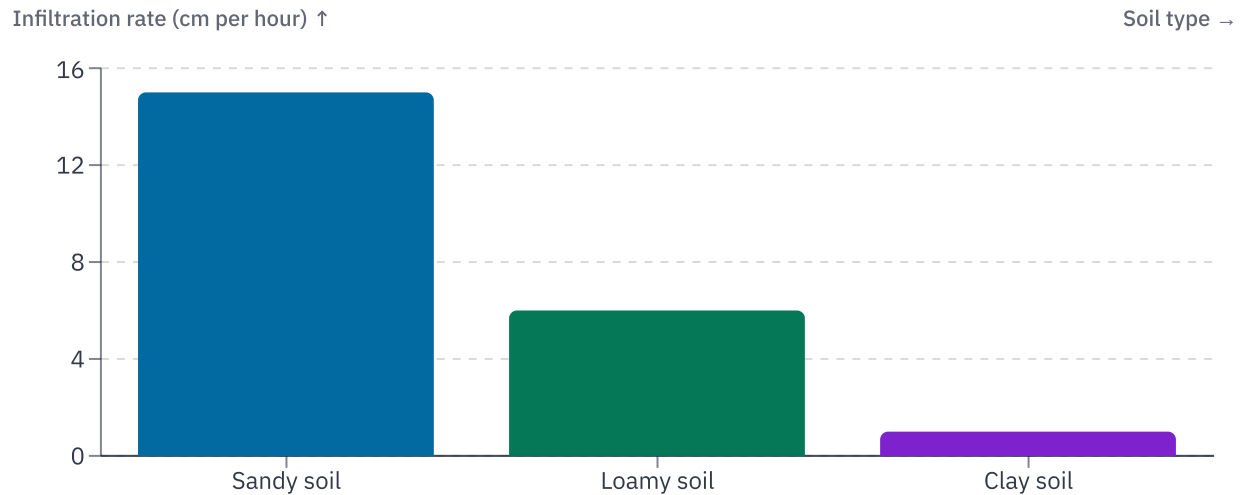
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Test Bank question

A student investigates how the structure of different soils affects how quickly water soaks in. The graph shows the infiltration rate for three soils. Which statement best explains the pattern in the data?

Water Infiltration Rates Through Different Soil Types



- ☒ Sand has larger spaces between grains, so water moves in faster than through clay's tiny spaces. ✓
- ☐ Clay is denser and harder than sand, so the water cannot push its way into clay as easily.
- ☐ Clay grains are larger and block the water, while small sand grains let the water slip past.
- ☐ Sand grains soak water up inside themselves, while clay grains repel water so it runs off.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students design a complete investigation, choosing variables, controls, repeated trials and a prediction, which takes planning.

A student wants to find out whether water temperature affects how fast limestone dissolves in slightly acidic water. Design an investigation. Include the independent and dependent variables, at least two controlled variables, how you will make the results reliable, and the result you would expect if warmer water dissolves limestone faster.

Model response: I would put limestone chips of the same size and mass in slightly acidic water at 5 °C, 20 °C, and 40 °C. The independent variable is water temperature, and the dependent variable is mass lost. I would keep the water's pH, the volume of water, and the number of days the same. I would use three chips at each temperature and average the mass lost. If warmer water dissolves limestone faster, the 40 °C chips would lose the most mass and the 5 °C chips the least.

Rubric: 2 points: The response includes all required elements: Names temperature as the independent variable and mass lost as the dependent variable, gives at least two controls, includes repeated trials or averaging, and states the expected result.

1 point: The response includes one, two, or three of the four required elements above, but not all four.

0 points: No valid design. No correct required element; the response is incorrect, too vague to earn credit, irrelevant, blank, or only copies the prompt without answering.

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Test Bank question

HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall which reservoir in the carbon cycle stores the most carbon.

A model of Earth's carbon cycle lists how much carbon each reservoir stores. Which reservoir stores the most carbon?

- ☐ The deep ocean below 1,000 meters
- ☐ The atmosphere as carbon dioxide gas
- ☒ Sedimentary rocks such as limestone ✓
- ☐ Forests and other land plants

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students apply the carbon cycle to a new case, explaining the process and tracing carbon through three Earth systems.

A gardener plows her garden every year. After each harvest, she leaves the soil bare with no plants until the next planting season. Over several years, she notices the soil has less carbon in it. Use the carbon cycle to explain what is causing this carbon loss and which Earth systems the carbon moves through as it leaves the soil.

Model response: The soil loses carbon mainly through decomposition. When the soil is bare and plowed, air reaches the dead plant matter more easily. Bacteria and fungi break down that matter faster, and their respiration releases carbon dioxide gas into the air. Because no plants are growing, photosynthesis cannot pull that carbon dioxide back out of the air and put it back into the soil. So the carbon moves from the geosphere (soil) through the biosphere (decomposers) into the atmosphere (carbon dioxide gas), instead of cycling back into the ground.

Rubric: 2 points: Names decomposition (respiration by soil bacteria and fungi) as the cause, and traces carbon from the soil through decomposers into the atmosphere as carbon dioxide, noting that no plants take it back in. 1 point: Names decomposition or respiration, or traces the path from soil to air, but not both. 0 points: Names no valid process and gives no correct path, or says the carbon is destroyed.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students use the numbers to show carbon lost from plants matches carbon gained by air, and justify which process explains the change.

A student models carbon in a forest watershed before and after a wildfire. The table shows carbon in two pools. Soil and stream carbon stayed about the same. Answer both parts.

Carbon in a Forest Watershed (metric tons)

Carbon pool	Before fire	After fire
Trees and plants	850	300
CO ₂ in the air above the forest	120	670

Part A: Which process best explains the change shown in the table?

Choose one answer.

- ☒ Combustion released carbon from plant tissue into the air ✓
- ☐ Respiration by trees released stored carbon into the air
- ☐ Decomposition of dead leaves moved carbon into the soil
- ☐ Volcanism released geosphere carbon into the air

Part B: Which evidence best supports your answer to Part A?

Choose one answer.

- ☐ Plant carbon was 850 tons before the fire.
- ☐ Soil and stream carbon stayed about the same.
- ☒ Plant carbon fell by 550 tons, and air carbon rose by 550 tons. ✓
- ☐ Air carbon above the forest rose to 670 tons after the fire.

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Test Bank question

HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth

Examples at: [DOK 1](#) [DOK 2](#) [DOK 3](#) [DOK 4](#)

DOK 1 • Recall

Why DOK 1: Students recall basic facts about how photosynthetic microbes changed oxygen in Earth's air.

Scientists studied oxygen levels and fossils of photosynthetic organisms over Earth's history. Select True or False for each statement.

	True	False
Photosynthetic microorganisms in the oceans gradually changed the air by releasing oxygen.	☒	☐
The amount of oxygen in the air has stayed about the same for 4.6 billion years.	☐	☒
Before photosynthetic organisms spread, the air had about as much oxygen as today.	☐	☒
Fossils of oxygen-making cyanobacteria are evidence that life changed the air.	☒	☐

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Test Bank question

Use the drop-down menus to complete the statement.

Rock layers show that 2.5 billion years ago, oxygen in the air was less than 1 percent of today's level. Photosynthetic microorganisms first appeared around 3.5 billion years ago, and oxygen began rising a great deal about 2.4 billion years ago. This evidence suggests that the spread of photosynthetic organisms ▼ caused a gradual rise in oxygen ▼ in the air over time. The low-oxygen conditions of early Earth ended as life changed the air ▼.

Drop-down 1 choices: changes in Earth's distance from the Sun

the spread of photosynthetic organisms ✓ volcanic eruptions

Drop-down 2 choices: a rise in carbon dioxide a drop in nitrogen a gradual rise in oxygen ✓

Drop-down 3 choices: ended because the Sun grew hotter ended as life changed the air ✓

stayed the same

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students must reason about which new findings would break the link between cause and effect, critiquing a scientific claim.

Scientists claim that cyanobacteria caused oxygen to build up in the air about 2.4 billion years ago. Which new findings would weaken this claim? Select all that apply.

- ☒ A nonliving process is found that could release that much oxygen. ✓
- ☐ Banded iron formations are found in rocks older than 2.4 billion years.
- ☒ The oldest signs of cyanobacteria turn out to be younger than 2.0 billion years. ✓
- ☐ Red, rusted soils are found only in rocks younger than 2.3 billion years.
- ☐ Stromatolites are found in rocks 3.5 billion years old.
- ☒ Oxygen stayed flat during the times when cyanobacteria spread the fastest. ✓

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Test Bank question

HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students sort items using the definition of a natural hazard versus a natural resource, which is recall and classification.

California has many natural hazards and many natural resources. Which items are natural hazards that affect where and how people live? Select all that apply.

☐ Gold deposits in the Sierra Nevada

☒ Wildfires in dry hills ✓

☒ Earthquakes along the San Andreas Fault ✓

☐ Fertile soil in the Central Valley

☒ Winter floods in river valleys ✓

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Test Bank question

The table shows rainfall and population for a farming county over five decades. Sort each statement by whether the data support it.

Farming County Records

Decade	Average rainfall (cm per year)	Population
1900s	55	12,000
1910s	52	13,000
1920s	50	13,500
1930s	32	8,000
1940s	48	9,500

	Supported	Not supported
Population did not fully recover by the 1940s.	☒	☐
Rainfall had no link to population in any decade.	☐	☒
Population rose during the drought decade.	☐	☒
Population grew while rainfall stayed near 50 cm.	☒	☐
Population fell by about 40% in the drought decade.	☒	☐

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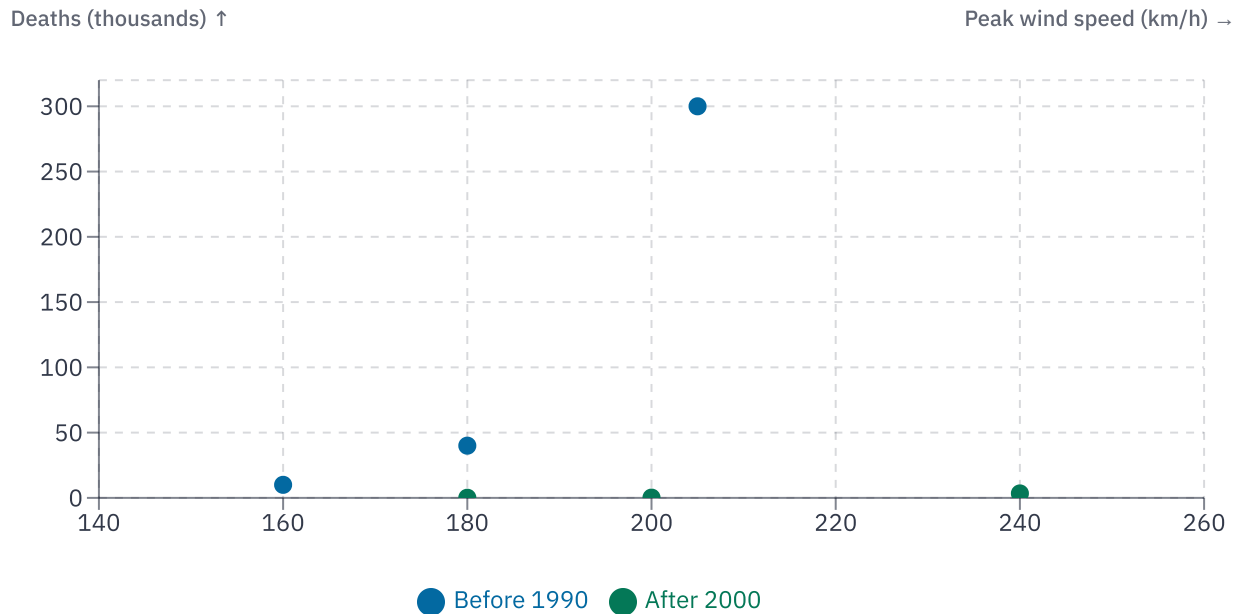
Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students combine graph data with information about shelters to rule out a tempting explanation and draw a supported conclusion.

The graph shows cyclone strength and deaths for several storms in Bangladesh. Shelters were rare before 1990 and common after 2000. Which conclusion is best supported by the graph?

Cyclone Deaths vs. Wind Speed



- ☐ Deaths rose after shelters became common.
- ☒ After 2000, even strong storms killed far fewer people. ✓
- ☐ After 2000, storms were weaker, so fewer people died.
- ☐ Wind speed alone explains the number of deaths.

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Test Bank question

HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall a basic fact about mineral resources: recycling aluminum avoids the energy needed to extract metal from new ore.

Aluminum can be made from newly mined bauxite ore or from recycled aluminum cans. Compared with making aluminum from new ore, recycling aluminum cans

- ☒ uses much less energy, because the metal does not have to be extracted from ore again. ✓
- ☐ uses much more energy, because the cans must be melted.
- ☐ creates new aluminum atoms, increasing the total amount of aluminum on Earth.
- ☐ requires mining more bauxite ore than making new aluminum does.

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Written for this guide

Rosa evaluates lithium-resource alternatives. A battery-recovery plan supplies 30 lithium units at cost 75 and freshwater use 5. B uses a new extraction site, supplying 30 at cost 55 and freshwater use 20. The watershed limit is 10 units. Another student argues that the lowest direct cost always gives the best resource-management solution.

Compare two claims. Use the data and the science to decide. Decide whether each statement is justified. Select True or False for each statement.

	True	False
Prefer B solely because its direct price is lower. Failed environmental or social limits can always be offset by savings. Equal service, extraction impacts, resource depletion, safety, reliability and long-term monitoring are irrelevant to the cost–benefit judgment.	☐	☒
Reject every plan that has any tradeoff. A resource-management technology must remove all costs, risks and uncertainty instantly. Meeting required criteria can never justify choosing a plan that needs upkeep or leaves a residual environmental impact.	☐	☒
Recovery can reduce demand for new extraction and associated water withdrawal. Recycling efficiency, battery collection and competing watershed needs limit the benefit.	☒	☐
Prefer A under the freshwater limit. Recovery meets the same lithium demand with lower withdrawal pressure, while collection and processing costs remain tradeoffs.	☒	☐

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students must write a recommendation, explain the science linking recycling to lower energy use, and state a limitation, building an evidence-based argument.

Grace evaluates aluminum-resource alternatives. A recycling plan supplies 100 metal units at cost 65 and energy use 20. B uses new ore, supplying 100 at cost 60 and energy use 70. The community requires energy use below 40 units. Another student argues that the lowest direct cost always gives the best resource-management solution.

Compare two claims. Use the data and the science to decide. State your conclusion. Explain the science that connects it to the data. State a limit or assumption.

Model response: Prefer A under the energy limit. Recycling provides the same metal service with lower processing-energy demand, despite a slightly higher direct cost. Recovering metal from used products can avoid some ore extraction and energy-intensive primary processing. Collection and contamination still constrain recovery rates. Compare benefits at the stated service level and enforce the required limits before weighing preferences. Check reliability, environmental and social effects, uncertainty and long-term costs. The recommendation is conditional on these criteria and the supplied evidence.

Rubric: One point each for an evidence-based conclusion, scientific reasoning, and the relevant limitation or assumption.

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Test Bank question

HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recognize which line is a rule of a simulation, using the basic meaning of a rule versus a starting value or output.

A student describes a trout simulation. Which line is a rule of the simulation?

- ☐ The stream starts with 5,000 trout.
- ☒ Each year, births add 12% to the trout population. ✓
- ☐ After 30 years, 2,100 trout remain.
- ☐ Trout live in cold, clean mountain streams.

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Test Bank question

Why DOK 2: Students explain how one management choice changes both a fish population and a community, relating several parts of a simulation.

A spreadsheet simulation tracks how fishing intensity (the percent of the fish population caught each year) affects a fish population and the fishing community that depends on it over 20 years. At 15% a year, the fish population stays near 10,000. At 25% a year, the fish population falls to 3,000 by Year 20, and the community loses income as some fishers leave the region. Explain how the simulation shows the relationship among fishing intensity, the fish population, and the community, and identify whether raising the intensity to 25% produces a stable or a changing system.

Model response: Fishing intensity is the resource management choice. At 15% a year, the fish reproduce about as fast as they are caught, so the population stays near 10,000 and fishers keep a steady income. At 25%, fish are removed faster than they reproduce, so the population falls to 3,000 by Year 20, and the fishing community loses income and some fishers leave. The increase from 15% to 25% turns a stable system into a changing one, and the drop in fish (biodiversity) directly causes the drop in human sustainability.

Rubric: 2 points: Explains that at 15% the catch is balanced by reproduction so the system is stable, that at 25% the catch exceeds reproduction so the fish decline and the system changes, and connects the fish decline to the community's loss of income. 1 point: Explains why one rate is stable or changing, or links the fish decline to community income, but does not do both. 0 points: Does not correctly relate fishing intensity to the fish population or the community.

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Test Bank question

A park's program sets a deer hunting quota each year based on that year's deer count. It also tracks a plant biodiversity index. Which statement best describes the management program?

Deer Management Program

Year	Deer population	Hunting quota	Biodiversity index
1	500	50	80
2	600	100	75
3	550	60	78
4	520	55	80

- ☐ It is a negative feedback that makes the plants decline each year.
- ☒ It is a negative feedback that brings the herd and plants back toward balance. ✓
- ☐ It is a positive feedback that makes the herd grow larger each year.
- ☐ It has no feedback, since the quota never changes with the herd.

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Test Bank question

HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students sort each project by its main goal, a direct classification of familiar solutions.

A county lists projects that reduce human impacts on the environment. Sort each project by its main goal.

	Reduces air pollution	Reduces water pollution	Protects habitat
Electric trucks at the port	☒	☐	☐
Fences keeping cattle out of streams	☐	☒	☐
A wildlife bridge over a freeway	☐	☐	☒
Upgraded sewage treatment	☐	☒	☐
Low-emission burners at a factory	☒	☐	☐
Restoring a tidal marsh	☐	☐	☒

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Test Bank question

A city compares three ways to reduce stormwater runoff from a 10-hectare neighborhood. Which conclusions are supported by the table? Select all that apply.

Stormwater Designs

Design	Runoff captured (%)	Cost (\$ million)	Land needed (hectares)
Green roofs	40	6	0
Bioswales	55	3	1
Detention pond	70	2	3

☐ The detention pond captures the most runoff.☐ The detention pond needs the least land.☐ Green roofs are the only design that needs no land.☐ The bioswales cost half as much as the green roofs.☐ The green roofs capture the most runoff per dollar.**FIND MORE LIKE THIS**[Create questions](#)[Earth Science](#)[HS Earth Science](#)[ESS3](#)[ESS3-4](#)[DOK 2](#)[Generate](#)

Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate whether a solution can meet its stated goal by weighing the size of the problem it targets against the whole.

A city bans plastic straws and says this will "solve ocean plastic pollution." Studies estimate that straws make up about 0.03% of the plastic entering the ocean each year, while sources such as lost fishing gear and packaging make up much larger shares. Which evaluation of the city's claim is best supported?

- ☒ Not supported; straws are a tiny share of ocean plastic. ✓
- ☐ Supported; straws are among the most common beach litter items.
- ☐ Supported; removing any one source stops ocean plastic from growing.
- ☐ Not supported; paper straws will add as much ocean waste instead.

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Test Bank question

HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall what an emissions scenario means in climate modeling, a single definition.

Climate scientists run their models under several scenarios, such as low emissions and high emissions. What does a scenario describe?

- ☐ The exact temperature for a future year
- ☐ A record of past weather at one station
- ☒ One possible path of future human emissions ✓
- ☐ A list of the model's computer programs

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students calculate two rates of glacier loss from data, compare them and project forward, which takes several steps.

Scientists measured the area of a Montana glacier: 3.0 km² in 1966, 2.4 km² in 1998, and 1.6 km² in 2015. Select True or False for each statement.

	True	False
The glacier lost about 0.02 km ² per year from 1966 to 1998.	☒	☐
The glacier lost about 0.05 km ² per year from 1998 to 2015.	☒	☐
The rate of loss slowed after 1998.	☐	☒
At the 1998–2015 rate, the glacier would be gone about 34 years after 2015.	☒	☐

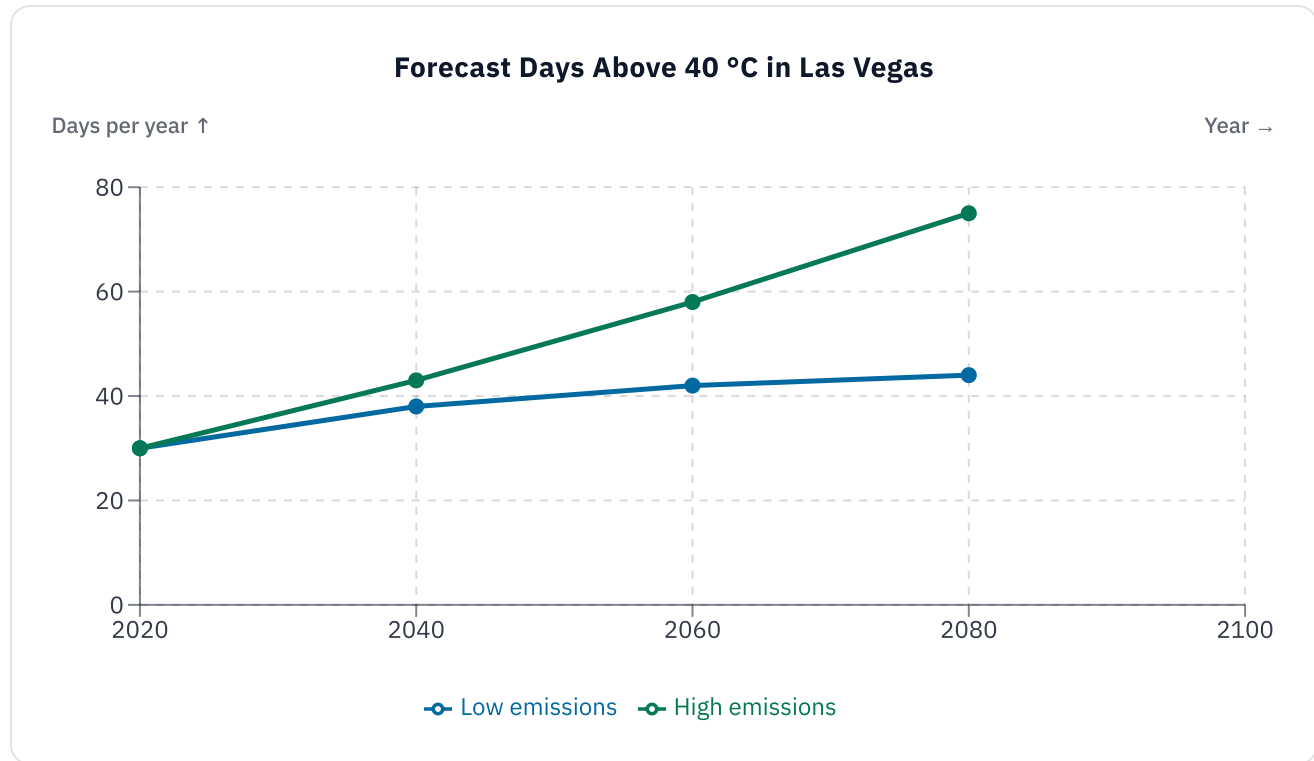
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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students evaluate a claim against model forecasts for two scenarios, using the growing gap between them as evidence.

The graph shows a model forecast of summer days above 40 °C in Las Vegas under two scenarios. A council member claims that emission choices will not matter until after 2080. Which evaluation of the claim is best supported by the graph?



☐ Not supported; low emissions reduce hot days below 30.

☐ Supported; the gap first appears only after 2080.

☐ Supported; both lines start at 30 days in 2020.

☒ Not supported; the gap is already 16 days by 2060. ✓

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Test Bank question

HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall the term for a loop that makes the starting change larger: positive feedback.

A model shows that warming thaws Arctic permafrost. Microbes then break down the thawed soil and release CO₂ and methane, which cause more warming. Which term best describes this part of the model?

☐ Negative feedback

☒ Positive feedback ✓

☐ Steady state

☐ Carbon sink

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Test Bank question

Why DOK 2: Students use a carbon budget in several steps, subtracting two sinks and converting carbon to a CO₂ rise for each decade.

A carbon budget model gives yearly values for three decades. Adding 2.1 billion metric tons (Gt) of carbon to the air raises CO₂ by 1 ppm. Round to one decimal place. Choose the missing values from the drop-down menus.

Decade	Emissions (Gt)	Ocean uptake (Gt)	Land uptake (Gt)	Carbon staying in air (Gt)	CO ₂ rise (ppm per year)
1970s	5.0	1.5	1.4	2.1	Blank 1
2000s	8.0	2.2	2.4	Blank 2	Blank 3
2010s	10.8	2.9	3.3	Blank 4	2.2

Blank 1 (Row 1, CO₂ rise (ppm per year)): 1.0 ▼

Blank 2 (Row 2, Carbon staying in air (Gt)): 3.4 ▼

Blank 3 (Row 2, CO₂ rise (ppm per year)): 1.6 ▼

Blank 4 (Row 3, Carbon staying in air (Gt)): 4.6 ▼

Drop-down 1 choices: 0.5 1.0 ✓ 1.1 2.0

Drop-down 2 choices: 1.7 3.4 ✓ 3.5 6.8

Drop-down 3 choices: 0.8 1.6 ✓ 1.7 3.2

Drop-down 4 choices: 2.3 4.6 ✓ 4.7 9.2

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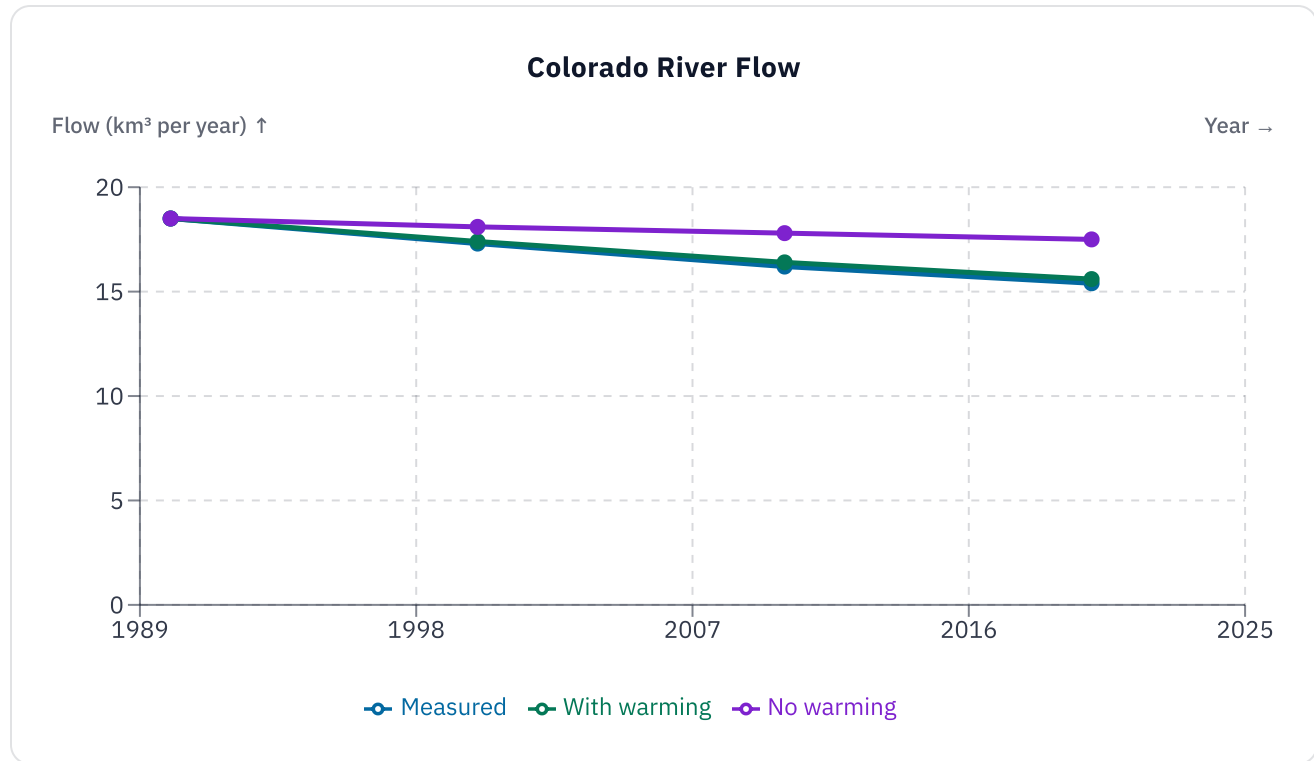
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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students compare measured data with two model runs to separate the effect of warming from precipitation and estimate its share.

The graph shows measured flow of the Colorado River and two model runs. One run includes the measured warming, and one holds temperature at its 1990 level. Both use measured precipitation. Which conclusion is best supported by the graph?



- ☐ Less precipitation explains all of the drop in flow.
- ☐ Warming explains none of the drop in flow.
- ☐ Warming has raised the river's flow since 1990.
- ☒ Warming explains about two-thirds of the drop in flow. ✓

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Test Bank question

NGSS CORE IDEA ETS1

Engineering Design

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HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students identify the problem statement that repeats the stated numbers and community needs, which is recognizing given information rather than reasoning about it.

Aisha defines criteria for a city flood-management challenge. Flood risk is a global challenge with local watershed causes. The plan must retain 500 m³ of runoff in the design storm, cost no more than \$200,000, and preserve emergency travel routes. Residents prioritize preventing home flooding and preserving a park used for cultural gatherings. The draft goal says only that the plan should make the city greener.

Specify measurable criteria and constraints that address the documented societal need. Which engineering problem definition is supported?

- ☐ Assume the vendor's proposal satisfies every community's needs, then measure an unrelated feature; there is no reason to specify constraints or investigate which people receive the benefits and costs.
- ☐ Ask only which design appears largest or most attractive, and accept a preference as proof of performance without measurements of the documented need, reliability or resource use.
- ☐ Ask only which design has the smallest cost, ignoring the numerical performance requirement and safety limit; societal and environmental needs can be omitted because price determines success.
- ☒ Ask which plan retains at least 500 m³ in the design storm within \$200,000, preserves emergency routes, and reduces home flooding while maintaining access to the cultural gathering space. ✓

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Test Bank question

DOK 2 · Skills & concepts

Why DOK 2: Students must sort several statements, deciding which ones correctly connect measurable criteria, safety limits and community needs, which takes interpretation beyond recall.

Leila defines criteria for reducing highway air exposure. Air pollution is a global health challenge. Schools near a highway need a design that reduces the specified pollutant exposure by at least 30%, costs no more than \$50,000, and does not block emergency access. Residents prioritize reliable reductions at the school entrance and do not want traffic diverted onto another neighborhood's streets. A proposal ranks barriers by height alone.

Specify measurable criteria and constraints that address the documented societal need. Which statements are scientifically justified? Select all that apply.

- ☐ Ask only which design appears largest or most attractive, and accept a preference as proof of performance without measurements of the documented need, reliability or resource use.
- ☐ Ask which intervention cuts the specified exposure by at least 30% within \$50,000 while preserving emergency access and avoiding transfer of exposure to a neighboring community. ✓
- ☐ Prioritize non-negotiable safety and resource limits, document stakeholder needs, and collect comparable evidence before selecting a solution; the cheapest or largest design is not automatically optimal. ✓
- ☐ Exposure depends on emissions and pollutant transport, not barrier height alone; a measurable reduction and safety limit must be considered alongside reliability and who bears the remaining exposure. ✓
- ☐ Ask only which design has the smallest cost, ignoring the numerical performance requirement and safety limit; societal and environmental needs can be omitted because price determines success.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students calculate a criterion from data, combine numerical and community needs into a problem definition, and justify which requirement cannot be traded off using evidence.

A coastal town is planning a new drinking-water supply. Freshwater shortage is a global challenge, and the town's wells are becoming salty as sea level rises. The town has 20,000 residents who use an average of 150 liters of water per person per day. The town can spend at most \$12 million. State law requires drinking water to contain less than 250 mg/L of chloride. One option, a desalination plant, would use large amounts of electricity and would return very salty brine to a bay where local families fish. A community survey shows residents care most about a reliable supply during droughts and affordable water bills.

Write a problem definition for the engineers. In your answer:

- (1) State at least two quantitative criteria or constraints, calculating any value you need from the data.
- (2) State at least one qualitative criterion based on the community's needs.
- (3) Explain which requirement must be treated as non-negotiable and why, using evidence from the scenario.

Model response: The design must supply at least 3,000,000 liters per day (20,000 residents $\times$ 150 L), cost no more than \$12 million, and deliver water with less than 250 mg/L chloride. Qualitative criteria: the supply should stay reliable during droughts, keep water bills affordable, and avoid harming the bay where families fish (for example, by managing brine). The chloride limit is non-negotiable because it is a legal health standard; a design that fails it cannot be used no matter how cheap it is. Preferences such as lower energy use or lower bills can be traded off against each other once the required limits are met.

Rubric: One point for two correct quantitative criteria or constraints (including 3,000,000 L per day), one point for a qualitative criterion tied to community needs, and one point for justifying which requirement is non-negotiable with evidence.

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HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall why engineers break a complex problem into smaller parts, a basic fact about the design process with no data to interpret.

Engineers are designing a flood-protection system for a city. They break the large problem into smaller problems, such as storing rainwater upstream, enlarging storm drains and raising emergency roads. Why do engineers break a complex problem into smaller problems?

- ☒ Smaller problems can be solved and tested one at a time, and then the solutions are combined and checked as a whole system. ✓
- ☐ Each smaller problem can ignore the criteria and constraints of the whole project.
- ☐ Once every smaller part works by itself, the combined system never needs to be tested.
- ☐ Breaking a problem into parts removes all trade-offs between cost, safety and reliability.

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DOK 2 · Skills & concepts

Why DOK 2: Students judge each statement about how bridge subsystems interact, deciding whether a damper can replace supports, which requires applying a concept rather than recalling it.

Maya decomposes a bridge-retrofit challenge. A bridge must support traffic loads, resist wind motion and allow safe evacuation during repair. Deck, supports, dampers and access routes interact.

Break the problem into smaller subproblems. Check how the parts work together against the criteria and constraints. Decide whether each statement is justified. Select True or False for each statement.

	True	False
Break the challenge into load-bearing, vibration-control and safe-access subproblems, then verify that the combined retrofit meets the full traffic and safety criteria.	☒	☐
A damper carries the traffic loads as well as reducing motion, so adding dampers can stand in for supports that are too weak.	☐	☒
Add dampers to stop the swaying in wind, and once the measured motion is low enough, treat the supports and the traffic loads as needing no further check.	☐	☒
Loads transfer through connected structural parts. A damper affects motion but cannot replace adequate supports, and repair closures can change access even when structural tests pass.	☒	☐

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students choose a decomposition plan and then justify it by reasoning about how intake, reuse, treatment and pipe losses interact within one shared water budget.

Rosa decomposes a sustainable water-supply challenge. A community must provide safe water while preserving river habitat under drought. Supply intake, treatment, reuse and distribution all share the same water budget.

Break the problem into smaller subproblems. Check how the parts work together against the criteria and constraints.

Part A: Which decomposition plan is supported?

Choose one answer.

- ☐ Count reused water as new water from outside the system, so the shared river budget and the pipe losses never need to be checked against demand.
- ☐ Design treatment for the best possible water quality, and treat the whole supply challenge as solved once the treated water is safe to drink.
- ☐ Take as much river water as the community's demand needs during the drought, since protecting the river habitat is a separate problem for someone else to solve.
- ☒ Break the challenge into intake limits, treatment quality, reuse and distribution, then check the combined design against demand and the protected environmental reserve. ✓

Part B: Which reasoning supports that conclusion?

Choose one answer.

- ☐ Losses from the distribution pipes are always too small to change a supply budget, so they can be left out of every calculation.
- ☐ Treatment adds new water to the supply as it cleans it, so building more treatment capacity means the community has more water to use.
- ☒ Withdrawal and reuse affect source demand, while treatment determines safety. Distribution losses can invalidate a supply calculation even when each component meets its local target. ✓
- ☐ Reusing treated water increases how much new water must be taken from the river, so reuse makes the shared water budget worse.

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Test Bank question

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts

Examples at: **DOK 1** **DOK 2** **DOK 3** ~~DOK 4~~

DOK 1 · Recall

Why DOK 1: Students recall what a trade-off means in engineering design, a single definition with no data or decision to make.

When engineers evaluate competing solutions to a real-world problem, they often must accept a trade-off. What is a trade-off in engineering design?

- ☐ A requirement that every possible design meets at no extra cost.
- ☒ Giving up some of one desired quality, such as low cost, to gain more of another, such as safety or reliability. ✓
- ☐ A test result showing that a design is perfect on every criterion.
- ☐ The rule that the cheapest design should always be chosen.

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DOK 2 · Skills & concepts

Why DOK 2: Students must rule out the unsafe design, then multiply and add weighted ratings from a table to compare designs, a multistep procedure applied to data.

Engineers rate four designs for a school cooling system from 1 (poor) to 5 (good). They find Design D fails the required safety test. The other three pass. Rule out unsafe designs first. Multiply each rating by its weight and add. The weights show how much each goal matters to the community.

Which safe design has the best weighted score?

Design A, Design B, Design C, and Design D by Criterion

Criterion (weight)	Design A	Design B	Design C	Design D
Cost (1)	2	5	4	3
Durability (1)	3	5	3	1
Ease of repair (4)	3	4	2	5

☐ Design C

☐ Design D

☐ Design A

☒ Design B



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HS Engineering Design



ETS1



ETS1-3



DOK 2



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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students weigh a cheaper, higher-output dam against a required fish-passage limit and must justify their recommendation with the science of energy and river habitat.

Carlos uses a stormwater-network simulation. The model uses rainfall timing, storage and drain capacity as inputs. It reports peak flow and emergency-route inundation. Added upstream storage reduces peak flow, but one longer storm still floods an escape route.

Use the model's rules. Check its assumptions.

Part A: Which model prediction is supported?

Choose one answer.

- ☐ Test only the short storm in the model, because the length of a storm does not change how much water reaches the drains or the escape routes.
- ☐ Reject upstream storage completely, since any flood design that fails in one storm is useless, whatever it does to peak flow in the other storms.
- ☒ Use the simulation to compare peak flow and route safety across storms, and refine the design for the longer-storm failure. ✓
- ☐ Use the simulation to choose the added storage now, because it lowers peak flow in the 2-hour storm, so the longer storm and the escape routes need no more study.

Part B: Which reasoning supports that conclusion?

Choose one answer.

- ☐ Peak flow depends only on how much rain falls in total, not on how the rain and the stored water are timed during a storm.
- ☒ Storage delays runoff but has finite capacity. Storm duration and connected flow paths determine whether retained water reduces or merely postpones downstream flooding. ✓
- ☐ Water released from upstream storage cannot reach the downstream drains or the emergency routes, whatever the flow paths.
- ☐ Upstream storage removes runoff from the system for good, so the storage can never fill up, however long the storm lasts.

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Test Bank question

HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem

Examples at: [DOK 1](#) [DOK 2](#) [DOK 3](#) [DOK 4](#)

DOK 1 · Recall

Why DOK 1: Students identify which quantity a simulation calculates, a direct reading of the model's description with no interpretation of results.

A city uses a computer simulation to study traffic pollution near schools. The model takes the number of vehicles per hour, the emission rate of each vehicle type, and wind speed and direction. It then calculates the air-pollution level at each school. Which of these is an output of the simulation?

- ☐ Number of vehicles per hour
- ☐ Wind speed and direction
- ☒ Air-pollution level at each school ✓
- ☐ Emission rate of each vehicle type

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DOK 2 · Skills & concepts

Why DOK 2: Students interpret a table of simulation outputs, comparing each area to the limit to see that a low city average hides one neighborhood that fails.

Tyler uses a transit-and-exposure simulation. The model uses travel demand, vehicle emissions and street airflow as inputs. Its outputs are access and pollution exposure. A transit plan lowers average exposure but leaves one neighborhood above the required limit.

Use the model's rules. Check its assumptions. Which model prediction is supported?

Transit-plan model outputs

Area	Pollution exposure ($\mu\text{g}/\text{m}^3$)	Required limit ($\mu\text{g}/\text{m}^3$)
City average	28	40
Neighborhood A	35	40
Neighborhood B	46	40

- ☒ Use neighborhood exposure and access outputs to refine the plan; a lower average alone does not show that all required community limits are met. ✓
- ☐ Leave the neighborhood above the limit out of the comparison, because one area with high exposure is an outlier that does not reflect the plan.
- ☐ Use the model to adopt the transit plan now, because the citywide average exposure falls below the required limit, so each neighborhood does not need to be checked.
- ☐ Reject the simulation and the transit plan, since no model can predict exactly what one person breathes, so its neighborhood outputs cannot guide the design.

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Test Bank question

DOK 3 · Strategic thinking

Why DOK 3: Students decide how to use simulation results across different storms and justify it by reasoning that finite storage only delays runoff in longer storms.

Carlos uses a stormwater-network simulation. The model uses rainfall timing, storage and drain capacity as inputs. It reports peak flow and emergency-route inundation. Added upstream storage reduces peak

flow, but one longer storm still floods an escape route.

Use the model's rules. Check its assumptions.

Part A: Which model prediction is supported?

Choose one answer.

- ☐ Test only the short storm in the model, because the length of a storm does not change how much water reaches the drains or the escape routes.
- ☐ Reject upstream storage completely, since any flood design that fails in one storm is useless, whatever it does to peak flow in the other storms.
- ☒ Use the simulation to compare peak flow and route safety across storms, and refine the design for the longer-storm failure. ✓
- ☐ Use the simulation to choose the added storage now, because it lowers peak flow in the 2-hour storm, so the longer storm and the escape routes need no more study.

Part B: Which reasoning supports that conclusion?

Choose one answer.

- ☐ Peak flow depends only on how much rain falls in total, not on how the rain and the stored water are timed during a storm.
- ☒ Storage delays runoff but has finite capacity. Storm duration and connected flow paths determine whether retained water reduces or merely postpones downstream flooding. ✓
- ☐ Water released from upstream storage cannot reach the downstream drains or the emergency routes, whatever the flow paths.
- ☐ Upstream storage removes runoff from the system for good, so the storage can never fill up, however long the storm lasts.

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Test Bank question

Sources

- Performance expectations and disciplinary core ideas: NGSS Lead States (2013), Next Generation Science Standards: For States, By States. <https://www.nextgenscience.org>

- State science test (CAST) item specifications: these describe PEs and item clusters but do not assign DOK levels.
- DOK level definitions: Webb Depth of Knowledge, as used by Smarter Balanced, summarised on the "How to use" page.
- Example questions: the AchieveMetrics Test Bank, reviewed for this guide.

AchieveMetrics Test Bank · DOK Progression Guide · High School Science · October 2026 edition.

