BENCHMARK SC.B.1.4.1

Strand B	Energy
Standard 1	The student recognizes that energy may be changed in form with varying efficiency.
Benchmark SC.B.1.4.1	The student understands how knowledge of energy is fundamental to all the scientific disciplines (e.g., the energy required for biological processes in living organisms and the energy required for the building, erosion, and rebuilding of the Earth). This benchmark also assesses SC.B.1.4.2.[3]
Item Type(s)	MC, GR, SR
Benchmark Clarification	The student identifies and applies energy types and transformations in biotic and abiotic systems.
Content Limits	Items will NOT require unit conversions to compare data. Items may require the student to understand energy principles in life, physical, and earth and space science contexts.
Stimulus Attributes	Items may provide the student with data in chart, drawing, equation, graph, or picture form.
Response Attributes	Items will describe units in which the answer is to be given.
Sample MC Item	Our Sun is a medium-size star producing energy from nuclear fusion reactions. Much of this energy is emitted throughout the solar system. Other stars throughout the universe also emit energy from their nuclear reactions. Which type of energy is received on Earth from the Sun and other stars? A. nuclear energy B. chemical energy C. mechanical energy ★D. electromagnetic energy

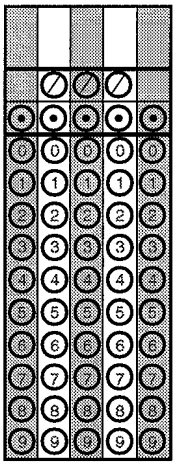
[3] The complete text for SC.B.1.4.2 is "The student understands that there is a conservation of mass and energy when matter is transformed."

Sample GR Item

A ball is dropped from a height of 20 meters (m) above the ground. As the ball falls, it increases in speed. At what height above the ground, in meters, are the kinetic and potential energies of the ball equal?

Answer

10



Sample SR Item

Dave lives near Lake Superior. During the summer, while listening to the radio, he heard the weather announcer say that temperatures would be cooler by the lakefront and warmer inland. Explain in terms of an energy transfer (or transfers) why the area near the lakefront would be cooler than the inland area.

Correct and Complete Response

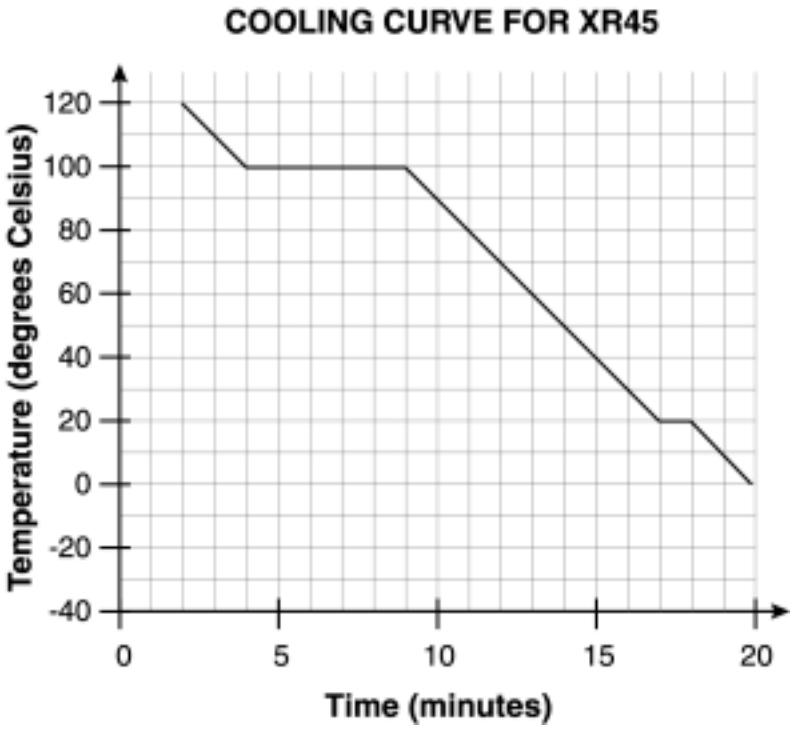
Heat is transferred to bodies of water more slowly than to land. Therefore, more heat is needed to warm up water. Temperature in and around the water stays at a more constant temperature; therefore, the temperature is cooler near the lake on a warm day.

BENCHMARK SC.B.1.4.3

Strand B	Energy
Standard 1	The student recognizes that energy may be changed in form with varying efficiency.
Benchmark SC.B.1.4.3	The student knows that temperature is a measure of the average translational kinetic energy of motion of the molecules in an object.
Item Type(s)	MC, GR
Benchmark Clarification	None specified.
Content Limits	Items may use heating or cooling curves to describe properties of matter. Items may address the relationship between: • temperature and the average kinetic energy of molecules in an object; • the average kinetic energy of molecules in an object and its state/phase of matter; and • temperature of an object and its state/phase of matter.
Stimulus Attributes	None specified.
Response Attributes	Items will describe units in which the answer is to be given.
Sample MC Item	Tall buildings are often made of steel girders, which are thick bars of an iron compound. The girders are affected by temperature changes. If a 200-meter-long steel girder is heated from 20 degrees Celsius (ºC) to 40°C, the girder will increase in length by nearly 5 centimeters (cm). Why does the girder become longer? A. The increase in temperature causes the atoms to ionize and separate. B. The increase in temperature causes a phase change in the iron atoms. ★C. The increase in temperature increases the kinetic energy of atoms in the steel girder. D. The increase in temperature causes the magnetized atoms of steel to repel each other.

Sample GR Item

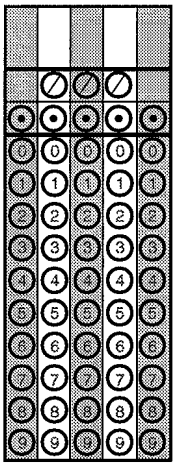
Elena, a chemist for a large chemical company, is in charge of determining the temperature at which a new chemical, XR45, undergoes phase changes. The graph shown below represents data she collected during her investigation of XR45.



At what temperature, in degrees Celsius (ºC), does the chemical XR45 condense to liquid form?

Answer

100



BENCHMARK SC.B.1.4.4

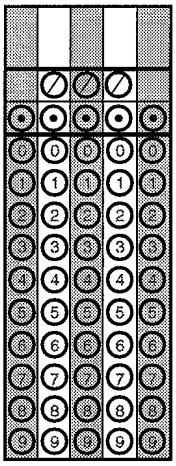
Strand B	Energy
Standard 1	The student recognizes that energy may be changed in form with varying efficiency.
Benchmark SC.B.1.4.4	The student knows that as electrical charges oscillate, they create time-varying electric and magnetic fields that propagate away from the source as an electromagnetic wave.
Item Type(s)	MC, GR
Benchmark Clarification	The student identifies electromagnetic radiation, including visible light, X-rays, gamma rays, and radio and television waves, that results from the interaction of electric and magnetic fields.
Content Limits	Items will NOT address the mathematical nature of this interaction between electric and magnetic fields.
Stimulus Attributes	None specified.
Response Attributes	Items will describe units in which the answer is to be given.
Sample MC Item	When Dawn has dental X-rays, a lead shield is used to cover her body. What properties of X-rays make it necessary to shield the body? A. X-rays have more crests than visible light. ★B. X-rays have higher energy than visible light. C. X-rays have lower amplitude than visible light. D. X-rays have longer wavelength than visible light.

Sample GR

A radio wave with a frequency of 30 000 hertz (Hz) is sent from an astronaut on the Moon to Earth. The wave travels at 300 000 kilometers per second (km/s) and reaches Earth in 1.2 seconds (s). How many of these radio wavelengths can fit between the astronaut and Earth?

Answer

36 000



BENCHMARK SC.B.1.4.7

Strand B	Energy
Standard 1	The student recognizes that energy may be changed in form with varying efficiency.
Benchmark SC.B.1.4.7	The student knows that the total amount of usable energy always decreases, even though the total amount of energy is conserved in any transfer. This item also assesses benchmark SC.B.1.4.6.[4]
Item Type(s)	MC, GR
Benchmark Clarification	The student identifies that no energy transfer is 100 percent efficient and some energy is always emitted as heat.
Content Limits	None specified.
Stimulus Attributes	Items may provide the student with data on energy transfers in chart, diagram, graph, or picture form.
Response Attributes	Items will describe units in which the answer is to be given.
Sample MC Item	Gasoline is a mixture of several different molecules. The energy used to move a car forward is always less than the energy in the gasoline molecules that were burned. What happened to the energy that did not move the car forward? ★A. Some energy is converted to heat. B. Some energy is converted to matter. C. The energy is cooled by the water in the radiator. D. The energy is collected by the catalytic converter.

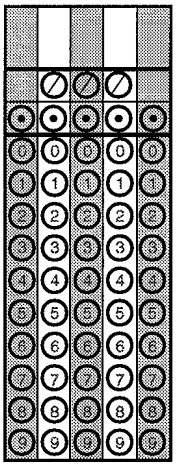
[4] The complete text for SC.B.1.4.6 is "The student knows that the first law of thermodynamics relates the transfer of energy to the work done and the heat transferred."

Sample GR Item

An engine produces 55 000 joules (J) of energy by burning fuel. The work done by the energy amounts to 42 000 J. How many joules of energy are released as thermal energy?

Answer

13 000



BENCHMARK SC.B.2.4.1

Strand B	Energy
Standard 2	The student understands the interaction of matter and energy.
Benchmark SC.B.2.4.1	The student knows that the structure of the universe is the result of interactions involving fundamental particles (matter) and basic forces (energy) and that evidence suggests that the universe contains all of the matter and energy that ever existed.
Item Type(s)	MC
Benchmark Clarification	The student identifies the results of interactions between subatomic particles and describes the four basic forces (electromagnetic, gravitational, strong, weak) in the universe.
Content Limits	Items will NOT require the student to quantify energy changes. Items will NOT assess the student's knowledge of the Big Bang Theory. Items may address conservation of mass and energy in the universe or on some smaller scale.
Stimulus Attributes	None specified.
Response Attributes	None specified.
Sample MC Item	During the fusion reaction that occurs in the Sun, hydrogen (H) protons are combined to form helium (He). The total mass of the He formed is less than the mass of the H atoms used. Energy is given off in this process. Which of the following is the relationship between mass and energy in this process? A. Mass and energy have been gained. B. Mass and energy have been released. C. Energy has been converted into mass. ★D. Mass has been converted into energy.