

Labsmith — Activity Book

A Spark & Anvil activity book — puzzles, questions, and fun from Labsmith.

Write in the book, circle your answers, and check the Answer Key at the back.

1. Forces & Motion

Circle the correct answer

1. What is a force?

(A) The speed of a moving object (B) The size of an object (C) A push or pull on an object (D) The weight of an object

2. What unit is used to measure force?

(A) Meter (m) (B) Newton (N) (C) Joule (J) (D) Kilogram (kg)

3. What is gravity?

(A) A force that pushes objects apart (B) A force that pulls objects toward each other (C) The speed at which objects fall (D) The weight of an object in space

4. What is friction?

(A) A force that opposes the motion of objects sliding against each other (B) A force that only acts on liquids (C) The pull of gravity on an object (D) A force that speeds up moving objects

5. How does increasing the strength of a force on an object affect its motion?

(A) The object moves in a circle (B) The object accelerates more — it changes speed or direction faster (C) The object's mass increases (D) The object slows down more gradually

6. Why does a heavy backpack feel harder to pick up than an empty one?

(A) Its shape creates more air resistance (B) It is made of stronger material (C) Friction between your hands and the straps increases (D) It has more mass, so gravity pulls it down with a greater force

Write the answer

7. Two teams play tug-of-war. Team A pulls with 200 N and Team B pulls with 200 N. What happens to the rope?

Answer: _____

8. Why does a ball roll farther on a smooth tile floor than on a rough carpet?

Answer: _____

9. A book sits on a table and does not move. Which statement correctly describes the forces on the book?

Answer: _____

10. A student pushes a toy car across a table. The car gradually slows down and stops. What force caused the car to stop?

Answer: _____

Match each question to its answer

1. You want a toy boat to move faster across a pool. Which change would BEST achieve this? →

2. A student drops two balls at the same time from the same height. Ball A has more mass than Ball B. Ignoring air resistance, which lands first? →

3. A soccer player kicks a ball east with 30 N. A gust of wind pushes it north with 0 N. In which direction does the ball move? →

4. A student pushes a box with 50 N to the right while friction pushes with 20 N to the left. What is the net force and direction? →

5. A student tests how surface type affects the distance a block slides. She slides the block on wood, tile, and carpet, each time using the same push. She measures the distance traveled. What is the independent variable? →

(A) 30 N to the right

(B) The type of surface (wood, tile, carpet)

(C) Increase the force pushing the boat forward

(D) They land at the same time

(E) East, because only the kick force acts on the ball

2. Forms of Energy

Circle the correct answer

11. What is energy?

(A) The force that holds atoms together (B) The weight of a moving object (C) The ability to do work or cause change (D) The temperature of an object

12. What is kinetic energy?

(A) The energy stored in food (B) The energy stored in a stretched spring (C) The energy from the sun (D) The energy of an object due to its motion

13. What is potential energy?

(A) Energy that is moving from one place to another (B) The energy released when fuel burns (C) Stored energy that has the potential to do work (D) The energy of light from a light bulb

14. Which of these is an example of thermal energy?

(A) The sound a bell makes when struck (B) The movement of a spinning top (C) Heat produced when you rub your hands together (D) Light from a candle flame

15. A roller coaster is at the top of a hill and then rolls down to the bottom. How does the energy change during the ride down?

(A) Kinetic energy decreases and potential energy increases (B) The total amount of energy doubles during the descent (C) Potential energy decreases and kinetic energy increases (D) Both potential and kinetic energy increase

16. Why does a campfire produce both light and heat?

(A) The fire borrows energy from the surrounding air (B) The wood gains energy from the oxygen in the air (C) Chemical energy stored in the wood is released and transformed into both light and thermal energy (D) Light energy from the sun is reflected by the flames

Write the answer

17. Sound is produced when objects vibrate. What type of energy is sound?

Answer: _____

18. A battery-powered flashlight shines light in a dark room. Trace the energy transformations that occur.

Answer: _____

19. Which has more kinetic energy: a 2 kg ball rolling at 3 m/s or a 1 kg ball rolling at 3 m/s?

Answer: _____

20. A student holds a 0.5 kg ball 2 meters above the ground. What happens to the ball's potential energy when she raises it to 4 meters?

Answer: _____

Match each question to its answer

1. A solar panel on a house produces electricity. What energy transformation is occurring? →

2. A student stretches a rubber band and then releases it, launching a paper ball across the room. Identify the energy transformation. →

3. A student claps two wooden blocks together and notices they feel warm afterward.

Where did the thermal energy come from? →

4. A student drops two identical balls from different heights. Ball A is dropped from 1 m; Ball B from 3 m. Predict: which ball will have more kinetic energy just before hitting the ground? Why? →

5. A scientist records the following: a pendulum at its highest point is slow; at its lowest point it is fastest. What pattern in energy transformation does this reveal? →

- (A) Elastic potential energy → kinetic energy of the paper ball
 - (B) Light energy from the sun is converted to electrical energy
 - (C) Kinetic energy from the clapping motion was converted to thermal energy by friction
 - (D) Ball B — it started with more potential energy, which converts to more kinetic energy during the fall
 - (E) Potential energy is highest at the top; kinetic energy is highest at the bottom — they continuously trade off
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3. Simple Machines

Circle the correct answer

21. What is a simple machine?

- (A) Any machine powered by electricity
- (B) A device that always reduces the distance over which a force is applied
- (C) A device with few or no moving parts that makes work easier by changing the size or direction of a force
- (D) A tool that creates energy from nothing

22. What is mechanical advantage?

- (A) The total weight a machine can hold
- (B) The speed at which a machine moves an object
- (C) The ratio of output force to input force produced by a machine
- (D) The amount of energy a machine creates

23. What type of simple machine is a seesaw?

- (A) A lever
- (B) A pulley
- (C) An inclined plane
- (D) A wedge

24. What is the fulcrum of a lever?

- (A) The length of the lever arm
- (B) The point where force is applied
- (C) The point where the load is placed
- (D) The fixed pivot point around which the lever rotates

25. How does an inclined plane make lifting a heavy object easier?

- (A) It converts potential energy to kinetic energy automatically
- (B) It reduces the total work required to move the object
- (C) It spreads the work over a longer distance, reducing the force needed at any point
- (D) It increases gravity so the object slides down on its own

26. A pulley system has 4 rope segments supporting the load. What is the mechanical advantage of this system?

(A) 1 — pulleys only change direction, not force (B) 4 — each rope segment shares the load equally (C) 8 — each rope segment doubles the force (D) 2 — pulleys always cut the force in half

Write the answer

27. A screw is a modified version of which simple machine?

Answer: _____

28. Why does a longer ramp (inclined plane) with the same height as a shorter ramp give a greater mechanical advantage?

Answer: _____

29. A worker uses a lever to lift a 600 N rock. The effort arm is 3 m and the load arm is 1 m. How much force does the worker need to apply?

Answer: _____

30. A ramp is 5 m long and rises 1 m high. What is the mechanical advantage of this ramp?

Answer: _____

Match each question to its answer

1. A construction crew needs to lift a 2000 N engine. They have a pulley with 4 rope segments. How much force do they need to pull? →

2. A student uses a wheel and axle (doorknob) to open a door. The wheel has a radius of 4 cm and the axle has a radius of 1 cm. What is the mechanical advantage? →

3. A student tests two levers with the same load. Lever A has a 2 m effort arm and a 1 m load arm. Lever B has a 4 m effort arm and a 1 m load arm. Which lever requires less effort, and why? →

4. A student measures the input force and output force for four simple machines: Machine W (input 50 N, output 100 N), Machine X (input 100 N, output 100 N), Machine Y (input 100 N, output 50 N), Machine Z (input 25 N, output 100 N). Which machine offers the greatest mechanical advantage? →

5. A student notices that when she uses a pulley to lift a box, she must pull the rope twice as far as the box rises. How does this relate to the mechanical advantage? →

(A) 500 N

(B) $MA = 2$ — the machine multiplies force by 2, but you must move the rope twice the distance

(C) 4

(D) Machine Z — $MA = 100 \div 25 = 4$

(E) Lever B — it has a larger effort arm, giving it a greater mechanical advantage ($MA = 4$ vs $MA = 2$)

4. States of Matter

Circle the correct answer

31. What are the three most common states of matter?
(A) Solid, liquid, and plasma (B) Solid, gas, and plasma (C) Solid, liquid, and gas
(D) Gas, plasma, and liquid
32. What is the process called when a solid changes directly into a gas without becoming a liquid first?
(A) Sublimation (B) Condensation (C) Evaporation (D) Deposition
33. What happens to the particles in a substance when it is heated?
(A) They move slower and get closer together (B) They move faster and spread farther apart (C) They stop moving entirely (D) They shrink in size
34. At what temperature does water boil at sea level?
(A) 212 degrees Fahrenheit only at high altitude (B) 100 degrees Celsius (C) 90 degrees Celsius (D) 110 degrees Celsius
35. Why does an ice cube float in water instead of sinking?
(A) Ice is heavier than water (B) Ice is less dense than liquid water (C) Ice repels liquid water (D) Ice has more particles than water
36. How does condensation differ from evaporation?
(A) Evaporation changes gas to liquid (B) Condensation is faster than evaporation (C) Condensation only happens at high temperatures (D) Condensation changes gas to liquid, while evaporation changes liquid to gas

Write the answer

37. Why can you smell perfume from across a room?
Answer: _____
38. What explains why a solid keeps its shape but a liquid takes the shape of its container?
Answer: _____
39. In an experiment, you observe water droplets forming on the outside of a cold glass on a warm day. Which phase change is occurring?
Answer: _____

40. You notice that a puddle on the sidewalk disappears on a sunny day even though the temperature never reached the boiling point of water. How is this possible?

Answer: _____

Match each question to its answer

1. If you place a thermometer in a pot of boiling water, what would you expect to happen to the temperature reading over time as the water continues to boil? →
2. You are asked to separate salt from a saltwater solution. Which process would you use? →
3. You fill a balloon with air and then place it in a freezer. Using what you know about gas behavior, predict what will happen to the balloon. →
4. You need to melt chocolate for a recipe, but you must do it slowly without burning it. Which method applies your knowledge of heat transfer and melting? →
5. A lab report says that a mystery substance melts at 0 degrees Celsius and boils at 100 degrees Celsius. Apply this data to identify the substance. →

- (A) Use a double boiler so the chocolate melts gently from the steam's heat
 - (B) Evaporate the water to leave the salt behind
 - (C) The balloon will shrink because the gas particles slow down and take up less space
 - (D) Water
 - (E) The temperature stays the same at 100 degrees Celsius until all the water boils away
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5. Chemical Reactions

Circle the correct answer

41. What is a chemical reaction?

- (A) When two liquids are mixed together (B) A process where substances change shape but stay the same (C) Any change that involves heat (D) A process where substances combine or break apart to form new substances with different properties

42. What does the law of conservation of mass state about chemical reactions?

- (A) Energy is always created during reactions (B) Some matter disappears during chemical reactions (C) Mass always increases during a reaction (D) Matter is neither created nor destroyed; the total mass of reactants equals the total mass of products

43. Which of the following is a common sign that a chemical reaction has occurred?

- (A) The substance dissolves in water (B) The substance gets larger (C) The substance changes shape (D) A color change, gas production, or temperature change

44. What are the substances that enter a chemical reaction called?

(A) Products (B) Reactants (C) Elements (D) Catalysts

45. Why is baking a cake considered a chemical reaction rather than a physical change?

(A) Because you mix the ingredients together, based on the established understanding in this subject area (B) Because the cake gets bigger in the oven, which is the most widely accepted explanation for this concept (C) The ingredients combine to form new substances with different properties that cannot be separated back into the original ingredients (D) Because the cake changes temperature, since this follows logically from the fundamental principles involved

46. How does a catalyst affect a chemical reaction?

(A) It is used up during the reaction (B) It speeds up the reaction without being consumed or permanently changed (C) It slows down the reaction (D) It adds more reactants to the mixture

Write the answer

47. Explain why rusting is considered a chemical reaction.

Answer: _____

48. Why does increasing the temperature generally speed up a chemical reaction?

Answer: _____

49. In the equation for photosynthesis, carbon dioxide and water are converted into glucose and oxygen using sunlight. What role does sunlight play in this reaction?

Answer: _____

50. If you mix baking soda and vinegar in an open container and weigh the container before and after the reaction, the mass appears to decrease. Does this violate the law of conservation of mass? Explain your reasoning.

Answer: _____

Match each question to its answer

1. You want to test whether crushing an antacid tablet makes it dissolve faster in water. Describe how you would set up a fair experiment. →

2. A student mixes two clear liquids together and the mixture turns yellow and feels warm. Apply the indicators of chemical reactions to determine if a chemical reaction occurred. →

3. Iron wool burns brightly when lit with a match. If the iron wool weighs 5 grams before burning and the resulting iron oxide weighs 7 grams, apply the law of conservation of mass to explain the weight increase. →

4. You need to slow down the rate at which a piece of fruit browns after being cut. Using your knowledge of reaction rates, which approach would work best? →
5. A recipe says to add yeast to warm water with sugar before adding it to bread dough. Apply your knowledge of chemical reactions to explain why warm water is specified instead of cold water. →

(A) Warm water provides the optimal temperature for yeast to carry out fermentation, producing carbon dioxide gas faster

(B) Coat the fruit in lemon juice, which contains an acid that slows the oxidation reaction

(C) Use two identical tablets and the same amount of water at the same temperature; crush one and leave the other whole, then time how long each takes to dissolve completely

(D) Yes, the color change and temperature increase are both indicators that a chemical reaction occurred

(E) The iron combined with 2 grams of oxygen from the air, so the total mass of reactants equals the total mass of products

6. Light & Sound Waves

Circle the correct answer

51. What type of wave is sound?

(A) An electromagnetic wave like light (B) A transverse wave that can travel through a vacuum (C) A longitudinal wave that requires a medium to travel through (D) A wave that only travels through solids

52. What is the speed of light in a vacuum?

(A) Approximately 30,000 kilometers per second (B) Approximately 300,000 kilometers per second (C) Approximately 343 meters per second (D) Approximately 300 kilometers per second

53. What property of a sound wave determines its pitch?

(A) Speed (B) Frequency (C) Wavelength only (D) Amplitude

54. What happens when light passes from air into water at an angle?

(A) The light bends, or refracts, because it changes speed (B) The light is completely absorbed by the water (C) The light bounces back into the air (D) The light speeds up and continues straight

55. Explain why we see a rainbow when sunlight passes through raindrops.

(A) Raindrops act as prisms, refracting white light and separating it into its component colors because each color bends at a slightly different angle (B) The water absorbs certain colors and reflects others, and this principle applies across similar situations (C) Raindrops create new light of different colors, and this has been consistently demonstrated in practice (D) Raindrops add color to the white light from the sun, as this directly follows from the underlying principles

56. Why does sound travel faster through steel than through air?

(A) Steel particles are much closer together, so vibrations transfer more quickly between them (B) Steel creates its own sound waves that add to the original (C) Steel is hotter than air, which speeds up sound (D) Sound waves are louder in steel

Write the answer

57. How does the amplitude of a sound wave relate to the loudness of the sound we hear?

Answer: _____

58. Why do objects appear to have color? For example, why does a red apple look red?

Answer: _____

59. What is the difference between a transverse wave and a longitudinal wave?

Answer: _____

60. An ambulance siren sounds higher-pitched as it approaches you and lower-pitched as it drives away. What causes this change?

Answer: _____

Match each question to its answer

1. You are designing a room that needs to reduce echo. Using your knowledge of sound wave behavior, which wall treatment would be most effective? →

2. You place a vibrating tuning fork near the surface of water in a bowl. Predict and explain what will happen to the water. →

3. Using your knowledge of light behavior, explain how you would use two mirrors to see around a corner. →

4. You have a red filter and a blue object. Apply your knowledge of light and color to predict what color the blue object will appear when viewed through the red filter. →

5. You notice that you can hear someone calling your name even when they are around a corner of a building. Apply your understanding of wave behavior to explain why. →

- (A) Sound waves diffract (bend) around obstacles and through openings, allowing them to spread around corners
 - (B) Position two mirrors at 45-degree angles to reflect light around the corner, creating a periscope-like arrangement
 - (C) The water will splash or ripple because the vibrating tuning fork transfers energy to the water through sound waves
 - (D) The blue object will appear very dark or black because the red filter blocks the blue light the object reflects
 - (E) Cover the walls with soft, porous materials like acoustic foam that absorb sound waves
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7. Electricity & Magnetism

Circle the correct answer

61. What is electric current?

- (A) The flow of electric charges (usually electrons) through a conductor
- (B) Static electricity stored in a battery
- (C) The heat produced by a wire
- (D) The brightness of a light bulb

62. What are the two poles of a magnet called?

- (A) Positive and negative
- (B) East and west
- (C) Top and bottom
- (D) North pole and south pole

63. What unit is used to measure electrical resistance?

- (A) Amperes
- (B) Watts
- (C) Ohms
- (D) Volts

64. What are the three essential components needed for a simple electric circuit to work?

- (A) An energy source (battery), a conductor (wire), and a load (like a light bulb) connected in a complete loop
- (B) A magnet, a switch, and a fuse, as this is what research and standard practice suggests
- (C) A generator, a transformer, and a resistor, which is why this approach is recommended by experts
- (D) Two batteries, a motor, and a computer, and this is the standard approach used in most cases

65. How does a series circuit differ from a parallel circuit in terms of how components are connected?

- (A) Series circuits are always more efficient than parallel circuits, which is the most common explanation for this phenomenon
- (B) Series circuits use more batteries than parallel circuits, which is the most common explanation for this phenomenon
- (C) Parallel circuits can only have two components, which is the most common explanation for this phenomenon
- (D) In a series circuit, components are connected

one after another in a single path; in a parallel circuit, components are connected in separate branches

66. Why is copper commonly used for electrical wiring instead of rubber?

(A) Rubber melts at low temperatures, as this is what research and standard practice suggests (B) Copper is an excellent conductor of electricity with very low resistance, while rubber is an insulator that resists the flow of current (C) Copper is cheaper than rubber, and this principle applies across similar situations (D) Copper is lighter than rubber, and this is the standard approach used in most cases

Write the answer

67. What is the relationship between electricity and magnetism as demonstrated by an electromagnet?

Answer: _____

68. Explain why a compass needle always points roughly north-south.

Answer: _____

69. How does increasing the voltage in a circuit affect the current, assuming resistance stays the same?

Answer: _____

70. Why do magnets attract iron objects but not aluminum or copper objects?

Answer: _____

Match each question to its answer

1. You have a battery, wires, and three identical light bulbs. If you connect all three bulbs in series and one bulb burns out, predict and explain what happens to the other two bulbs. →

2. You want to build an electromagnet that is as strong as possible using a battery, insulated wire, and an iron nail. Apply your knowledge to describe how to maximize its strength. →

3. Using Ohm's Law ($V = I \times R$), calculate the current flowing through a circuit with a 12-volt battery and a resistance of 4 ohms. →

4. You rub a balloon on your hair and it sticks to the wall. Apply your understanding of static electricity to explain why this happens. →

5. You have two identical batteries (1.5V each). How would you connect them to power a 3V device, and how would you connect them to make a single battery last longer for a 1.5V device? →

- (A) The other two bulbs will also go out because the circuit is broken at the burned-out bulb
 - (B) 3 amperes
 - (C) Connect in series (positive to negative) for 3V; connect in parallel (positive to positive, negative to negative) for 1.5V with longer battery life
 - (D) Wrap as many coils of wire tightly around the nail as possible, use a stronger battery, and ensure the iron nail is inside the coil
 - (E) Rubbing transfers electrons from your hair to the balloon, giving it a negative charge that induces a positive charge on the wall's surface, and opposite charges attract
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8. Advanced Scientific Method

Circle the correct answer

71. What is the purpose of a control group in an experiment?

- (A) To provide a baseline for comparison that shows what happens without the experimental treatment
- (B) To repeat the experimental group exactly
- (C) To make the experiment take longer
- (D) To add extra variables to the experiment

72. What is the difference between an independent variable and a dependent variable?

- (A) There is no difference; they are the same thing
- (B) The independent variable is the control; the dependent variable is the experiment
- (C) The independent variable is deliberately changed by the researcher; the dependent variable is measured to see if it changes in response
- (D) The independent variable is measured; the dependent variable is changed

73. What is a hypothesis in scientific research?

- (A) A testable, specific prediction about the relationship between variables based on prior knowledge or observation
- (B) The final conclusion of an experiment, and this is the standard approach used in most cases
- (C) A proven fact that scientists all agree on, making this the most widely accepted explanation
- (D) A random guess about what might happen, and this is the standard approach used in most cases

74. What does it mean for an experiment to be 'reproducible'?

- (A) Only the original scientist can repeat the experiment
- (B) The results must be identical every single time
- (C) The experiment can only be done once
- (D) Other scientists can follow the same procedure and obtain similar results

75. Explain why scientists run multiple trials of the same experiment rather than just one.

(A) Multiple trials reduce the impact of random error and chance variations, making results more reliable and statistically meaningful (B) Scientists run multiple trials because they enjoy repeating work (C) Multiple trials are only needed for biology experiments (D) One trial is usually enough if the scientist is careful

76. How does a scientific theory differ from a scientific law?

(A) A theory explains why something happens with a well-supported explanation; a law describes what happens with a consistent mathematical relationship (B) Theories are for biology and laws are for physics, and this has been consistently demonstrated in practice (C) A theory is an unproven guess while a law is proven fact, and this is the standard approach used in most cases (D) A law becomes a theory after enough evidence is collected, as this directly follows from the underlying principles

Write the answer

77. Why is it important to identify and control confounding variables in an experiment?

Answer: _____

78. What is the difference between accuracy and precision in scientific measurements?

Answer: _____

79. Explain why scientists use peer review before publishing their research.

Answer: _____

80. What role does observation play in the scientific method, and why is it important that observations be objective rather than subjective?

Answer: _____

Match each question to its answer

1. A student wants to test whether listening to music improves test scores. Design an experiment by identifying the independent variable, dependent variable, control group, and at least two variables that should be controlled. →

2. You collect the following data from an experiment on plant growth with fertilizer: Trial 1: 12 cm, Trial 2: 11 cm, Trial 3: 25 cm, Trial 4: 13 cm, Trial 5: 12 cm. Apply your knowledge of data analysis to determine the best measure of central tendency to report. →

3. Your hypothesis stated that plants watered with sugar water would grow taller than plants watered with plain water. Your results show no significant difference. Apply the scientific method to determine your next step. →

4. A news article claims that 'scientists have proven that eating chocolate every day prevents heart disease.' Apply your understanding of the scientific method to write a

more accurate summary of what the study likely showed. →

5. You need to present experimental data comparing the growth rates of plants under three different light conditions. Apply your knowledge of data representation to choose the most appropriate type of graph and explain why. →

(A) IV: listening to music during study. DV: test score. Control group: students who study in silence. Controlled variables: same test, same study time, same subject material, same study environment

(B) The median (12 cm) is best because Trial 3 appears to be an outlier that would skew the mean

(C) A bar graph is most appropriate because you are comparing distinct categories (three different light conditions) rather than showing a continuous trend

(D) Report the results honestly, evaluate possible sources of error, and consider modifying the hypothesis or experimental design for further testing

(E) A more accurate statement would be: 'A study found a correlation between regular chocolate consumption and lower rates of heart disease, but this does not prove causation'

9. Foundational Concepts Review

Circle the correct answer

81. Why does a heavy backpack feel harder to pick up than an empty one?

(A) It has more mass, so gravity pulls it down with a greater force (B) It is made of stronger material (C) Its shape creates more air resistance (D) Friction between your hands and the straps increases

82. A solar panel on a house produces electricity. What energy transformation is occurring?

(A) Electrical energy is converted to light energy (B) Light energy from the sun is converted to electrical energy (C) Thermal energy from the roof is converted to electrical energy (D) Chemical energy stored in the panels converts to light energy

83. What is the fulcrum of a lever?

(A) The point where the load is placed (B) The fixed pivot point around which the lever rotates (C) The length of the lever arm (D) The point where force is applied

84. You notice that a puddle on the sidewalk disappears on a sunny day even though the temperature never reached the boiling point of water. How is this possible?

(A) The water seeped underground through the concrete (B) Evaporation can occur at temperatures below the boiling point when surface particles gain enough energy to escape (C) The sun's rays destroyed the water molecules (D) Water can only

disappear if it reaches 100 degrees Celsius

85. A student mixes two clear liquids together and the mixture turns yellow and feels warm. Apply the indicators of chemical reactions to determine if a chemical reaction occurred.

(A) Yes, but only because of the color change; temperature does not matter (B) No, because the mixture is still a liquid (C) No, because both liquids were clear before mixing (D) Yes, the color change and temperature increase are both indicators that a chemical reaction occurred

86. How does the amplitude of a sound wave relate to the loudness of the sound we hear?

(A) Amplitude determines pitch, not loudness (B) Amplitude has no effect on how we perceive sound (C) Greater amplitude makes the sound higher-pitched (D) Greater amplitude means the sound wave carries more energy, producing a louder sound

Write the answer

87. What unit is used to measure electrical resistance?

Answer: _____

88. What is the purpose of a control group in an experiment?

Answer: _____

89. Design a simple experiment to determine whether the height of a ramp affects the speed of a ball at the bottom. Describe what you would change, what you would keep constant, and what you would measure.

Answer: _____

90. What is potential energy?

Answer: _____

Match each question to its answer

1. What type of simple machine is a seesaw? →

2. A company wants to ship temperature-sensitive medicine that must stay cold. They are choosing between regular ice and dry ice. Evaluate which option is better and why. →

3. You need to slow down the rate at which a piece of fruit browns after being cut. Using your knowledge of reaction rates, which approach would work best? →

4. What property of a sound wave determines its pitch? →

5. Explain why a compass needle always points roughly north-south. →

- (A) Frequency
 - (B) Earth has a magnetic field, and the compass needle, being a small magnet, aligns itself with Earth's magnetic field lines
 - (C) Coat the fruit in lemon juice, which contains an acid that slows the oxidation reaction
 - (D) Dry ice is better because it sublimates into gas instead of melting into liquid, keeping packages dry while providing colder temperatures
 - (E) A lever
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10. Applied Problem Solving

Circle the correct answer

91. A student finds that doubling the mass of a cart on a ramp (with the same push force) makes it accelerate only half as fast. Is this a reasonable result? Why?

- (A) Yes — more mass means more resistance to changes in motion, so the same force produces less acceleration (B) No — mass does not affect acceleration (C) Yes — heavier objects always move faster due to gravity (D) No — doubling mass should double acceleration

92. A student tests whether ball drop height affects how high a ball bounces. She drops balls from 10, 20, 30, and 40 cm. She records bounce heights of 7, 14, 21, and 28 cm. What pattern does the data show?

- (A) Bounce height equals drop height because energy is conserved (B) The ball bounces higher than it was dropped because of elastic energy (C) The bounce height is approximately 70% of the drop height — the ratio is constant (D) Bounce height increases, but not in a predictable pattern

93. Why does a longer ramp (inclined plane) with the same height as a shorter ramp give a greater mechanical advantage?

- (A) A longer ramp spreads the work over a greater distance, requiring less force at each point (B) A longer ramp stores more potential energy in its structure (C) A longer ramp is heavier so gravity helps more (D) A longer ramp creates more friction which actually slows the object

94. What happens to the particles in a substance when it is heated?

- (A) They move slower and get closer together (B) They move faster and spread farther apart (C) They stop moving entirely (D) They shrink in size

95. What are the substances that enter a chemical reaction called?

- (A) Elements (B) Catalysts (C) Reactants (D) Products

96. Explain why we see a rainbow when sunlight passes through raindrops.

(A) The water absorbs certain colors and reflects others, and this principle applies across similar situations (B) Raindrops add color to the white light from the sun, as this directly follows from the underlying principles (C) Raindrops act as prisms, refracting white light and separating it into its component colors because each color bends at a slightly different angle (D) Raindrops create new light of different colors, and this has been consistently demonstrated in practice

Write the answer

97. Using Ohm's Law ($V = I \times R$), calculate the current flowing through a circuit with a 12-volt battery and a resistance of 4 ohms.

Answer: _____

98. A student argues that since scientific theories can be revised or replaced, science is unreliable and we should not trust scientific findings. Evaluate this argument.

Answer: _____

99. How does increasing the strength of a force on an object affect its motion?

Answer: _____

100. A student measures the temperature of water before and after dropping a steel ball into it from a height of 2 meters. The water is very slightly warmer after. What energy transformation does this demonstrate?

Answer: _____

Match each question to its answer

1. Two ramps lead to the same loading dock height: Ramp A is 6 m long ($MA = 6$) and Ramp B is 3 m long ($MA = 3$). A worker must push a 300 N cart up each. Which statement best evaluates the situation? →

2. In an experiment, you observe water droplets forming on the outside of a cold glass on a warm day. Which phase change is occurring? →

3. Iron wool burns brightly when lit with a match. If the iron wool weighs 5 grams before burning and the resulting iron oxide weighs 7 grams, apply the law of conservation of mass to explain the weight increase. →

4. Why do objects appear to have color? For example, why does a red apple look red? →

5. Why do magnets attract iron objects but not aluminum or copper objects? →

(A) Ramp A requires less force (50 N vs 100 N) but more pushing distance; total work is the same on both ramps

(B) The iron combined with 2 grams of oxygen from the air, so the total mass of reactants equals the total mass of products

- (C) Iron is a ferromagnetic material whose atomic magnetic domains can align with an external magnetic field, while aluminum and copper are not ferromagnetic
- (D) Condensation
- (E) The apple absorbs all colors of light except red, which it reflects to our eyes
-

11. Critical Analysis & Evaluation

Circle the correct answer

101. A student wants to design an experiment to show that a larger force causes a cart to travel farther on a flat surface. What should the student keep constant to make this a fair test?

- (A) Only the mass of the cart must stay the same (B) The surface type should change each trial to test all conditions (C) The mass of the cart and the surface type must stay the same (D) The direction of the push must change each trial

102. A student is given three balls: tennis ball, rubber ball, and steel ball. She drops each from the same height and measures bounce height. What prediction can she make before running the experiment?

- (A) The steel ball will bounce highest because it is heaviest (B) The tennis ball will bounce highest because it is the lightest (C) All balls will bounce to the same height because they start from the same height (D) The rubber ball will likely bounce highest because it stores and returns elastic potential energy most efficiently

103. A construction crew needs to lift a 2000 N engine. They have a pulley with 4 rope segments. How much force do they need to pull?

- (A) 2000 N (B) 250 N (C) 8000 N (D) 500 N

104. You are asked to separate salt from a saltwater solution. Which process would you use?

- (A) Add more water to dilute the salt out (B) Filter the solution through a coffee filter (C) Evaporate the water to leave the salt behind (D) Freeze the solution so the salt floats to the top

105. You want to test whether crushing an antacid tablet makes it dissolve faster in water. Describe how you would set up a fair experiment.

- (A) Use two identical tablets and the same amount of water at the same temperature; crush one and leave the other whole, then time how long each takes to dissolve completely (B) Crush both tablets and compare them in hot and cold water, which is why this approach is recommended by experts (C) Use one tablet, crush half and dissolve in different containers, and this is the standard approach used in most cases (D) Use different brands of tablets in different amounts of water, and this is the

standard approach used in most cases

106. What happens when light passes from air into water at an angle?

(A) The light bounces back into the air (B) The light speeds up and continues straight (C) The light is completely absorbed by the water (D) The light bends, or refracts, because it changes speed

Write the answer

107. A friend says that touching a 9-volt battery to your tongue is safe but touching a car battery is dangerous, even though the car battery is only 12 volts. Evaluate why the small voltage difference matters so much.

Answer: _____

108. You collect the following data from an experiment on plant growth with fertilizer: Trial 1: 12 cm, Trial 2: 11 cm, Trial 3: 25 cm, Trial 4: 13 cm, Trial 5: 12 cm. Apply your knowledge of data analysis to determine the best measure of central tendency to report.

Answer: _____

109. A student conducts three trials of a ramp experiment and gets distances of 42 cm, 44 cm, and 43 cm. Another student gets 30 cm, 50 cm, and 45 cm. Which data set is more reliable and why?

Answer: _____

110. Which of these is an example of thermal energy?

Answer: _____

Match each question to its answer

1. A pulley system has 4 rope segments supporting the load. What is the mechanical advantage of this system? →

2. Two liquids are poured into the same beaker. Liquid A sinks to the bottom while Liquid B floats on top. Both are at the same temperature. What property explains their arrangement? →

3. A company claims their hand warmers generate heat 'without any chemical reaction.' The hand warmers contain iron powder, salt, and activated carbon. Evaluate whether this claim could be true. →

4. A student shines white light through a prism and observes that red light bends the least while violet light bends the most. Analyze why different colors of light refract by different amounts. →

5. You have two identical batteries (1.5V each). How would you connect them to power a 3V device, and how would you connect them to make a single battery last longer for a 1.5V device? →

- (A) The claim is false; the hand warmers work through an exothermic oxidation reaction where iron reacts with oxygen in the air to produce iron oxide and heat
- (B) Connect in series (positive to negative) for 3V; connect in parallel (positive to positive, negative to negative) for 1.5V with longer battery life
- (C) Liquid A has a greater density than Liquid B
- (D) Different colors have different wavelengths, and shorter wavelengths like violet are slowed down more by the prism material, causing them to bend more
- (E) 4 — each rope segment shares the load equally
-

12. Advanced Integration & Synthesis

Circle the correct answer

111. Why does a ball roll farther on a smooth tile floor than on a rough carpet?

- (A) The carpet pushes the ball sideways (B) The carpet creates more friction, which slows the ball down faster (C) The ball bounces more on tile (D) The tile floor has stronger gravity

112. Design an investigation to test how the height of a ramp affects the speed of a ball at the bottom. Identify all variables, describe how to measure speed, and explain what data would show that energy is being transformed.

- (A) Change: ramp surface. Control: ball type. Measure: temperature change of the ramp. (B) Change: ramp height. Control: ball mass, surface, release method. Measure speed at the bottom (e.g., using a timing gate or distance rolled). Greater height → faster speed shows PE converting to KE. (C) Change: ball type and height. Control: nothing. Measure: how loud the ball sounds at the bottom. (D) Change: ramp height and ball mass simultaneously. Control: surface. Measure: height the ball bounces after impact.

113. A ramp is 5 m long and rises 1 m high. What is the mechanical advantage of this ramp?

- (A) 25 (B) 1 (C) 0.2 (D) 5

114. Why can you smell perfume from across a room?

- (A) Sound waves push the perfume molecules (B) The perfume creates a vacuum that pulls air toward you (C) Light carries the smell particles to your nose (D) Gas particles spread out and move freely in all directions

115. A student conducts three trials of the same baking soda and vinegar reaction but gets different amounts of gas each time. Analyze what factors could explain the inconsistent results.

- (A) Baking soda expires and becomes less reactive each trial, making this the most

widely accepted explanation (B) Variations in the exact amounts of baking soda or vinegar measured, temperature differences, or incomplete mixing could cause inconsistent results (C) Chemical reactions always give random results, and this principle applies across similar situations (D) The law of conservation of mass does not apply to small experiments, and this is the standard approach used in most cases

116. You are designing a room that needs to reduce echo. Using your knowledge of sound wave behavior, which wall treatment would be most effective?

(A) Cover the walls with soft, porous materials like acoustic foam that absorb sound waves (B) Cover the walls with smooth glass panels (C) Paint the walls with shiny metallic paint (D) Install hard tile flooring and flat metal walls

Write the answer

117. What is electric current?

Answer: _____

118. A supplement company claims their product 'boosts immune function by 300%' based on a study they funded themselves. Evaluate the credibility of this claim by identifying potential sources of bias.

Answer: _____

119. Two teams play tug-of-war. Team A pulls with 200 N and Team B pulls with 200 N. What happens to the rope?

Answer: _____

120. A student compares the brightness of a light bulb powered by different battery sizes. Larger batteries produce brighter light. What energy relationship does this demonstrate?

Answer: _____

Match each question to its answer

1. A student notices that when she uses a pulley to lift a box, she must pull the rope twice as far as the box rises. How does this relate to the mechanical advantage? →

2. If you place a thermometer in a pot of boiling water, what would you expect to happen to the temperature reading over time as the water continues to boil? →

3. Design an experiment to test how temperature affects the rate of a chemical reaction between an antacid tablet and water. Include your hypothesis, variables, and procedure. →

4. Some people claim that playing music for plants helps them grow faster. From a physics perspective, evaluate whether sound waves could physically affect plant growth. →

5. Why is copper commonly used for electrical wiring instead of rubber? →

(A) Copper is an excellent conductor of electricity with very low resistance, while rubber is an insulator that resists the flow of current

(B) Sound waves carry energy that causes physical vibrations, and some research shows vibrations may stimulate certain growth responses, but the evidence is not conclusive and the effect, if real, is likely small

(C) Hypothesis: higher water temperature will make the tablet dissolve faster. Test identical tablets in water at three different temperatures, measuring the time until each tablet fully dissolves while keeping water volume and tablet brand constant

(D) The temperature stays the same at 100 degrees Celsius until all the water boils away

(E) $MA = 2$ — the machine multiplies force by 2, but you must move the rope twice the distance

13. Forces & Motion

Circle the correct answer

121. A student pushes a toy car across a table. The car gradually slows down and stops. What force caused the car to stop?

(A) The car ran out of force stored inside it (B) Gravity pulled the car downward into the table (C) Friction between the car's wheels and the table surface (D) Air pressure pushed the car backward

122. A student tests two levers with the same load. Lever A has a 2 m effort arm and a 1 m load arm. Lever B has a 4 m effort arm and a 1 m load arm. Which lever requires less effort, and why?

(A) Lever B — it is longer so gravity helps more (B) Lever B — it has a larger effort arm, giving it a greater mechanical advantage ($MA = 4$ vs $MA = 2$) (C) They require the same effort because the load arm is the same (D) Lever A — shorter levers are stronger

123. At what temperature does water boil at sea level?

(A) 90 degrees Celsius (B) 110 degrees Celsius (C) 100 degrees Celsius (D) 212 degrees Fahrenheit only at high altitude

124. A student notices that a glow stick glows brighter when placed in hot water and dimmer when placed in cold water. Analyze the relationship between temperature and the chemical reaction inside the glow stick.

(A) Cold water absorbs the light from the glow stick (B) Higher temperature increases the reaction rate inside the glow stick, producing more light per second; lower temperature slows it down (C) Hot water adds energy that creates more chemicals inside the glow stick (D) Temperature has no real effect; the glow stick was

just running out

125. A student builds two circuits: one with a long thin wire and one with a short thick wire. Both use the same battery and bulb. The bulb in the short thick wire circuit is brighter. Analyze why wire dimensions affect brightness.

(A) The long thin wire has more resistance, which reduces current and dims the bulb; the short thick wire has less resistance, allowing more current and a brighter bulb (B) The short wire heats up faster and makes the bulb brighter, as this is what research and standard practice suggests (C) The long wire loses voltage because electrons slow down over distance (D) The thick wire has more electrons inside it than the thin wire, which is the most common explanation for this phenomenon

126. In a parallel circuit with three light bulbs, you measure that the total current from the battery is 3 amps. Each bulb has the same resistance. Analyze how the current is distributed among the three bulbs.

(A) Each bulb receives 1 amp of current because in a parallel circuit with equal resistances, current divides equally among branches (B) The first bulb gets all 3 amps and passes it to the next (C) The last bulb gets the most current because it is closest to the battery (D) Each bulb gets 3 amps for a total of 9 amps

Write the answer

127. How does a scientific theory differ from a scientific law?

Answer: _____

128. A battery-powered flashlight shines light in a dark room. Trace the energy transformations that occur.

Answer: _____

129. Design an experiment to demonstrate all three common states of matter using only water and basic kitchen equipment. Describe the materials, procedure, and what you would observe at each stage.

Answer: _____

130. In a reaction between hydrochloric acid and sodium hydroxide, the products are water and table salt. The reaction also releases heat. Analyze what type of reaction this is and what the energy release tells you.

Answer: _____

Match each question to its answer

1. You place a vibrating tuning fork near the surface of water in a bowl. Predict and explain what will happen to the water. →
2. How does a series circuit differ from a parallel circuit in terms of how components are connected? →
3. Design a complete experiment to test whether the type of water (tap, distilled, or saltwater) affects how quickly a bean seed germinates. Include all essential components of experimental design. →
4. A science class has two ramp experiments. Experiment 1: change the ramp angle while keeping the cart mass the same. Experiment 2: change the cart mass while keeping the ramp angle the same. What is the same in both experiments that makes them fair tests? →
5. A student claims that a mirror reverses left and right but not up and down. Evaluate this claim by analyzing what a mirror actually does to an image. →

(A) The claim is misleading; a mirror actually reverses front and back, not left and right. The apparent left-right reversal is because we mentally flip ourselves to compare

(B) Each experiment changes only one variable at a time

(C) Plant 10 beans in each of 3 groups using the same soil and containers; water each group with a different water type using the same volume and schedule; measure days to germination; control temperature, light, and soil type; repeat the entire experiment twice

(D) In a series circuit, components are connected one after another in a single path; in a parallel circuit, components are connected in separate branches

(E) The water will splash or ripple because the vibrating tuning fork transfers energy to the water through sound waves

14. Forces & Motion

Circle the correct answer

131. A student tests how surface type affects the distance a block slides. She slides the block on wood, tile, and carpet, each time using the same push. She measures the distance traveled. What is the independent variable?

(A) The strength of the push (B) The type of surface (wood, tile, carpet) (C) The distance the block travels (D) The mass of the block

132. What is energy?

(A) The weight of a moving object (B) The force that holds atoms together (C) The temperature of an object (D) The ability to do work or cause change

133. A fiber optic cable can transmit data using light that bounces along the inside of a thin glass fiber, even around curves. Analyze which property of light makes this possible.

(A) Total internal reflection: light hitting the glass-air boundary at a shallow angle is completely reflected back inside the fiber (B) The light is absorbed and re-emitted at each bend (C) Light travels faster in curves than in straight lines (D) The glass is flexible enough to bend the light beams

134. A toy company claims their magnetic building blocks can 'generate electricity just by moving them.' Evaluate whether this claim has a scientific basis.

(A) The claim is false because only batteries can generate electricity (B) The claim is fully accurate and the blocks could power a light bulb, which is why this approach is recommended by experts (C) The claim has a scientific basis in electromagnetic induction: moving a magnet near a conductor can generate an electric current, but toy magnets and blocks likely produce negligible usable electricity (D) The claim is completely false because magnets cannot create electricity

135. Explain why scientists run multiple trials of the same experiment rather than just one.

(A) Multiple trials are only needed for biology experiments (B) One trial is usually enough if the scientist is careful (C) Multiple trials reduce the impact of random error and chance variations, making results more reliable and statistically meaningful (D) Scientists run multiple trials because they enjoy repeating work

136. What is the process called when a solid changes directly into a gas without becoming a liquid first?

(A) Condensation (B) Sublimation (C) Evaporation (D) Deposition

Write the answer

137. In the equation for photosynthesis, carbon dioxide and water are converted into glucose and oxygen using sunlight. What role does sunlight play in this reaction?

Answer: _____

138. Why does sound travel faster through steel than through air?

Answer: _____

139. Two identical containers hold the same amount of water. One is left open and the other is sealed with a lid. After 24 hours, the open container has less water. What does this tell you about the relationship between evaporation and an open versus closed system?

Answer: _____

140. You want to build an electromagnet that is as strong as possible using a battery, insulated wire, and an iron nail. Apply your knowledge to describe how to maximize its strength.

Answer: _____

Match each question to its answer

1. A student measures the input force and output force for four simple machines: Machine W (input 50 N, output 100 N), Machine X (input 100 N, output 100 N), Machine Y (input 100 N, output 50 N), Machine Z (input 25 N, output 100 N). Which machine offers the greatest mechanical advantage? →

2. A student uses a lever to lift a 400 N rock and measures that she applies 100 N of effort. What is the mechanical advantage, and if her effort arm is 2 m, how long is the load arm? →

3. What is the difference between a transverse wave and a longitudinal wave? →

4. You fill a balloon with air and then place it in a freezer. Using what you know about gas behavior, predict what will happen to the balloon. →

5. A student wants to test whether listening to music improves test scores. Design an experiment by identifying the independent variable, dependent variable, control group, and at least two variables that should be controlled. →

(A) MA = 4; load arm = 0.5 m

(B) The balloon will shrink because the gas particles slow down and take up less space

(C) Machine Z — MA = $100 \div 25 = 4$

(D) IV: listening to music during study. DV: test score. Control group: students who study in silence. Controlled variables: same test, same study time, same subject material, same study environment

(E) In a transverse wave, particles move perpendicular to the wave direction; in a longitudinal wave, particles move parallel to the wave direction

15. Forces & Motion

Circle the correct answer

141. Why does a campfire produce both light and heat?

(A) The fire borrows energy from the surrounding air (B) Chemical energy stored in the wood is released and transformed into both light and thermal energy (C) Light energy from the sun is reflected by the flames (D) The wood gains energy from the oxygen in the air

142. In a real pulley system, the measured mechanical advantage is 3.5 but the

theoretical MA is 4. What most likely explains the difference?

(A) The pulley was tested incorrectly — real MA always equals theoretical MA (B) The rope is too long, which decreases the mechanical advantage (C) The load is too heavy for the pulley to achieve its theoretical MA (D) Friction in the pulley reduces the actual force output, making the real MA lower than the theoretical value

143. You place a steel nail in a jar of vinegar. Apply your understanding of chemical reactions to predict what will happen over several days.

(A) The vinegar will turn into water (B) The vinegar will react with the iron in the nail, causing it to corrode and produce bubbles of hydrogen gas (C) Nothing will happen because steel does not react with vinegar (D) The nail will dissolve completely within one hour

144. Using your knowledge of light behavior, explain how you would use two mirrors to see around a corner.

(A) Stack the mirrors on top of each other to amplify the light (B) Position two mirrors at 45-degree angles to reflect light around the corner, creating a periscope-like arrangement (C) Shine a flashlight through the mirrors to bend the light (D) Place both mirrors facing each other to create infinite reflections

145. A student claims that when she stops pedaling her bicycle, it slows down because it 'runs out of energy.' Evaluate this claim.

(A) The claim is correct — once pedaling stops, all energy immediately disappears (B) The claim is partly wrong — the bicycle still has kinetic energy; it slows because friction converts that energy to heat (C) The claim is wrong — the bicycle stops because gravity pulls it down (D) The claim is correct — kinetic energy only exists while pedaling

146. You want to demonstrate to younger students how sound waves travel through different materials. Design a simple investigation using common classroom materials that shows sound travels at different speeds through solids, liquids, and gases.

(A) Have students shout at different distances and measure how far away they can be heard, and this is the standard approach used in most cases (B) Have students listen to a tapping sound through air, through water in a container, and by pressing their ear to a desk while tapping the other end, comparing the loudness and speed at which they hear each (C) Play music at different volumes and ask students which is loudest, and this principle applies across similar situations (D) Use a tuning fork at different temperatures to show speed changes, and this principle applies across similar situations

Write the answer

147. Explain why scientists use peer review before publishing their research.

Answer: _____

148. A cart on a ramp starts from rest and reaches the bottom. At the bottom, it has more speed than halfway down. What caused the cart's speed to increase?

Answer: _____

149. Some people attach magnets to their water pipes, claiming the magnets 'soften' the water and reduce mineral buildup. Evaluate this claim based on your understanding of how magnets interact with matter.

Answer: _____

150. You notice that you can hear someone calling your name even when they are around a corner of a building. Apply your understanding of wave behavior to explain why.

Answer: _____

Match each question to its answer

1. A student uses a wheel and axle (doorknob) to open a door. The wheel has a radius of 4 cm and the axle has a radius of 1 cm. What is the mechanical advantage? →
2. What are the three most common states of matter? →
3. A student stretches a rubber band and then releases it, launching a paper ball across the room. Identify the energy transformation. →
4. A student pushes a 500 N box up a 4 m ramp to a height of 1 m using 140 N of force. What is the actual mechanical advantage and the theoretical MA? Is the machine efficient? →
5. What are the three essential components needed for a simple electric circuit to work? →

(A) 4

(B) An energy source (battery), a conductor (wire), and a load (like a light bulb) connected in a complete loop

(C) Elastic potential energy → kinetic energy of the paper ball

(D) Actual MA = $500/140 \approx 3.57$; Theoretical MA = $4/1 = 4$; efficiency $\approx 89\%$ — fairly efficient

(E) Solid, liquid, and gas

16. Forces & Motion

Circle the correct answer

151. How does an inclined plane make lifting a heavy object easier?

(A) It converts potential energy to kinetic energy automatically (B) It increases gravity so the object slides down on its own (C) It spreads the work over a longer distance, reducing the force needed at any point (D) It reduces the total work required to move the object

152. Explain why rusting is considered a chemical reaction.

(A) The iron is dissolving in the rain water, which is why this approach is recommended by experts (B) Iron combines with oxygen and water to form iron oxide, a new substance with different properties than iron (C) Rust is just dirt sticking to the metal, and this principle applies across similar situations (D) Iron just changes color on the surface, which is why this approach is recommended by experts

153. A student wraps wire around a nail, connects it to a battery, and picks up 5 paper clips. Then she doubles the number of wire coils and picks up 12 paper clips. Analyze the relationship between the number of coils and the electromagnet's strength.

(A) Doubling the coils more than doubled the strength, indicating that the number of coils has a strong positive effect on electromagnet strength that may be more than directly proportional (B) Doubling the coils should have picked up exactly 10 clips, so the experiment failed, and this has been consistently demonstrated in practice (C) The battery got stronger over time, which explains the increase, which is the most common explanation for this phenomenon (D) The coils had no effect; it was random luck, and this principle applies across similar situations

154. Your school science fair requires you to write a research question, hypothesis, and experimental procedure for an original investigation. Create a complete research plan for testing whether the color of light affects the rate of photosynthesis in aquatic plants.

(A) Measure the water temperature instead of bubble count, as this is what research and standard practice suggests, which reflects the current consensus among experts in this field (B) Test different plants under the same light color, as this directly follows from the underlying principles, based on the established understanding in this subject area (C) Research question: How does light color affect photosynthesis rate in Elodea? Hypothesis: Red and blue light will produce more oxygen than green light because chlorophyll absorbs red and blue most. Procedure: Place equal Elodea sprigs in identical water-filled beakers under red, blue, green, and white light filters of equal intensity; count oxygen bubbles per minute over 15-minute periods; repeat three times per color (D) Use different light intensities for each color to make it fair, which is why this approach is recommended by experts, according to the standard framework used to analyze this topic

155. A soccer player kicks a ball east with 30 N. A gust of wind pushes it north with 0 N. In which direction does the ball move?

(A) Northeast, because both forces combine (B) The ball stops because east and north forces cancel (C) North, because wind is a natural force (D) East, because only the kick force acts on the ball

156. A student drops two identical balls from different heights. Ball A is dropped from 1 m; Ball B from 3 m. Predict: which ball will have more kinetic energy just before hitting the ground? Why?

(A) Ball A — it hits the ground sooner so it is moving faster when it lands (B) Ball B — it started with more potential energy, which converts to more kinetic energy during the fall (C) Ball B — gravity pulls harder on objects that are higher up (D) They have the same kinetic energy because they are identical balls

Write the answer

157. A recipe says to add yeast to warm water with sugar before adding it to bread dough. Apply your knowledge of chemical reactions to explain why warm water is specified instead of cold water.

Answer: _____

158. How does increasing the voltage in a circuit affect the current, assuming resistance stays the same?

Answer: _____

159. An engineer designing a toy car launcher wants maximum speed. She can either double the spring's strength or double the car's mass. Which change produces a faster car? Justify using energy reasoning.

Answer: _____

160. A student heats an ice cube and records the temperature every minute. The data shows the temperature staying at 0 degrees Celsius for several minutes even though heat is being added. What can you conclude from this pattern?

Answer: _____

Match each question to its answer

1. How does a catalyst affect a chemical reaction? →

2. Why does increasing the temperature generally speed up a chemical reaction? →

3. You rub a balloon on your hair and it sticks to the wall. Apply your understanding of static electricity to explain why this happens. →

4. If you mix baking soda and vinegar in an open container and weigh the container before and after the reaction, the mass appears to decrease. Does this violate the law of conservation of mass? Explain your reasoning. →

5. You want a toy boat to move faster across a pool. Which change would BEST achieve this? →

- (A) It speeds up the reaction without being consumed or permanently changed
 - (B) Rubbing transfers electrons from your hair to the balloon, giving it a negative charge that induces a positive charge on the wall's surface, and opposite charges attract
 - (C) No, the total mass is conserved; the missing mass is the carbon dioxide gas that escaped into the air
 - (D) Higher temperature gives particles more kinetic energy, causing them to collide more often and with greater force
 - (E) Increase the force pushing the boat forward
-

Answer Key

1. C — A push or pull on an object
2. B — Newton (N)
3. B — A force that pulls objects toward each other
4. A — A force that opposes the motion of objects sliding against each other
5. B — The object accelerates more — it changes speed or direction faster
6. D — It has more mass, so gravity pulls it down with a greater force
7. The rope does not move because the forces are balanced
8. The carpet creates more friction, which slows the ball down faster
9. The table pushes up on the book with the same force as gravity pulls it down
10. Friction between the car's wheels and the table surface
Matching (Forces & Motion): 1→C, 2→D, 3→E, 4→A, 5→B
11. C — The ability to do work or cause change
12. D — The energy of an object due to its motion
13. C — Stored energy that has the potential to do work
14. C — Heat produced when you rub your hands together
15. C — Potential energy decreases and kinetic energy increases
16. C — Chemical energy stored in the wood is released and transformed into both

light and thermal energy

17. Mechanical energy that travels as waves through matter
18. Chemical energy (battery) → electrical energy → light energy
19. The 2 kg ball — more mass means more kinetic energy at the same speed
20. The potential energy doubles because height doubled
Matching (Forms of Energy): 1→B, 2→A, 3→C, 4→D, 5→E
21. C — A device with few or no moving parts that makes work easier by changing the size or direction of a force
22. C — The ratio of output force to input force produced by a machine
23. A — A lever
24. D — The fixed pivot point around which the lever rotates
25. C — It spreads the work over a longer distance, reducing the force needed at any point
26. B — 4 — each rope segment shares the load equally
27. An inclined plane wrapped around a cylinder
28. A longer ramp spreads the work over a greater distance, requiring less force at each point
29. 200 N
30. 5
Matching (Simple Machines): 1→A, 2→C, 3→E, 4→D, 5→B
31. C — Solid, liquid, and gas
32. A — Sublimation
33. B — They move faster and spread farther apart
34. B — 100 degrees Celsius
35. B — Ice is less dense than liquid water
36. D — Condensation changes gas to liquid, while evaporation changes liquid to gas
37. Gas particles spread out and move freely in all directions
38. Particles in a solid are tightly packed and vibrate in place, while liquid particles slide past each other

39. Condensation
40. Evaporation can occur at temperatures below the boiling point when surface particles gain enough energy to escape
Matching (States of Matter): 1→E, 2→B, 3→C, 4→A, 5→D
41. D — A process where substances combine or break apart to form new substances with different properties
42. D — Matter is neither created nor destroyed; the total mass of reactants equals the total mass of products
43. D — A color change, gas production, or temperature change
44. B — Reactants
45. C — The ingredients combine to form new substances with different properties that cannot be separated back into the original ingredients
46. B — It speeds up the reaction without being consumed or permanently changed
47. Iron combines with oxygen and water to form iron oxide, a new substance with different properties than iron
48. Higher temperature gives particles more kinetic energy, causing them to collide more often and with greater force
49. Sunlight provides the energy needed to drive the chemical reaction
50. No, the total mass is conserved; the missing mass is the carbon dioxide gas that escaped into the air
Matching (Chemical Reactions): 1→C, 2→D, 3→E, 4→B, 5→A
51. C — A longitudinal wave that requires a medium to travel through
52. B — Approximately 300,000 kilometers per second
53. B — Frequency
54. A — The light bends, or refracts, because it changes speed
55. A — Raindrops act as prisms, refracting white light and separating it into its component colors because each color bends at a slightly different angle
56. A — Steel particles are much closer together, so vibrations transfer more quickly between them
57. Greater amplitude means the sound wave carries more energy, producing a louder sound

58. The apple absorbs all colors of light except red, which it reflects to our eyes
59. In a transverse wave, particles move perpendicular to the wave direction; in a longitudinal wave, particles move parallel to the wave direction
60. The Doppler effect: as the ambulance approaches, sound waves are compressed (higher frequency), and as it moves away, waves are stretched (lower frequency)
Matching (Light & Sound Waves): 1→E, 2→C, 3→B, 4→D, 5→A
61. A — The flow of electric charges (usually electrons) through a conductor
62. D — North pole and south pole
63. C — Ohms
64. A — An energy source (battery), a conductor (wire), and a load (like a light bulb) connected in a complete loop
65. D — In a series circuit, components are connected one after another in a single path; in a parallel circuit, components are connected in separate branches
66. B — Copper is an excellent conductor of electricity with very low resistance, while rubber is an insulator that resists the flow of current
67. An electric current flowing through a wire creates a magnetic field around it; coiling the wire and adding an iron core strengthens this field to create an electromagnet
68. Earth has a magnetic field, and the compass needle, being a small magnet, aligns itself with Earth's magnetic field lines
69. Increasing voltage increases the current proportionally, according to Ohm's Law
70. Iron is a ferromagnetic material whose atomic magnetic domains can align with an external magnetic field, while aluminum and copper are not ferromagnetic
Matching (Electricity & Magnetism): 1→A, 2→D, 3→B, 4→E, 5→C
71. A — To provide a baseline for comparison that shows what happens without the experimental treatment
72. C — The independent variable is deliberately changed by the researcher; the dependent variable is measured to see if it changes in response
73. A — A testable, specific prediction about the relationship between variables based on prior knowledge or observation
74. D — Other scientists can follow the same procedure and obtain similar results
75. A — Multiple trials reduce the impact of random error and chance variations,

making results more reliable and statistically meaningful

76. A — A theory explains why something happens with a well-supported explanation; a law describes what happens with a consistent mathematical relationship
77. Confounding variables are uncontrolled factors that could influence the dependent variable, making it impossible to determine whether changes are caused by the independent variable or the confounder
78. Accuracy is how close a measurement is to the true value; precision is how close repeated measurements are to each other
79. Peer review has other experts evaluate the methods, analysis, and conclusions to identify errors, biases, or flaws before the research is shared widely
80. Observations provide the raw data that drives hypotheses and conclusions; objective observations using measurements and instruments reduce personal bias and are verifiable by others
Matching (Advanced Scientific Method): 1→A, 2→B, 3→D, 4→E, 5→C
81. A — It has more mass, so gravity pulls it down with a greater force
82. B — Light energy from the sun is converted to electrical energy
83. B — The fixed pivot point around which the lever rotates
84. B — Evaporation can occur at temperatures below the boiling point when surface particles gain enough energy to escape
85. D — Yes, the color change and temperature increase are both indicators that a chemical reaction occurred
86. D — Greater amplitude means the sound wave carries more energy, producing a louder sound
87. Ohms
88. To provide a baseline for comparison that shows what happens without the experimental treatment
89. Change: ramp height. Keep constant: ball mass, ramp surface, release point method. Measure: ball speed or distance traveled at the bottom.
90. Stored energy that has the potential to do work
Matching (Foundational Concepts Review): 1→E, 2→D, 3→C, 4→A, 5→B
91. A — Yes — more mass means more resistance to changes in motion, so the same force produces less acceleration

92. C — The bounce height is approximately 70% of the drop height — the ratio is constant
93. A — A longer ramp spreads the work over a greater distance, requiring less force at each point
94. B — They move faster and spread farther apart
95. C — Reactants
96. C — Raindrops act as prisms, refracting white light and separating it into its component colors because each color bends at a slightly different angle
97. 3 amperes
98. The argument is flawed; the ability to revise theories based on new evidence is a strength of science, not a weakness, because it means science self-corrects and becomes more accurate over time
99. The object accelerates more — it changes speed or direction faster
100. Gravitational potential energy → kinetic energy → thermal energy (heating the water slightly)
Matching (Applied Problem Solving): 1→A, 2→D, 3→B, 4→E, 5→C
101. C — The mass of the cart and the surface type must stay the same
102. D — The rubber ball will likely bounce highest because it stores and returns elastic potential energy most efficiently
103. D — 500 N
104. C — Evaporate the water to leave the salt behind
105. A — Use two identical tablets and the same amount of water at the same temperature; crush one and leave the other whole, then time how long each takes to dissolve completely
106. D — The light bends, or refracts, because it changes speed
107. The danger comes from current, not just voltage; a car battery can deliver hundreds of amps due to its extremely low internal resistance, while a 9V battery can only deliver milliamps
108. The median (12 cm) is best because Trial 3 appears to be an outlier that would skew the mean
109. The first data set — the values are closer together, showing more consistency
110. Heat produced when you rub your hands together

Matching (Critical Analysis & Evaluation): 1→E, 2→C, 3→A, 4→D, 5→B

- 111. B — The carpet creates more friction, which slows the ball down faster
- 112. B — Change: ramp height. Control: ball mass, surface, release method. Measure speed at the bottom (e.g., using a timing gate or distance rolled). Greater height → faster speed shows PE converting to KE.
- 113. D — 5
- 114. D — Gas particles spread out and move freely in all directions
- 115. B — Variations in the exact amounts of baking soda or vinegar measured, temperature differences, or incomplete mixing could cause inconsistent results
- 116. A — Cover the walls with soft, porous materials like acoustic foam that absorb sound waves
- 117. The flow of electric charges (usually electrons) through a conductor
- 118. The claim has low credibility due to funding bias (the company has financial motivation to find positive results), likely lack of independent peer review, a vague metric ('immune function'), and an extraordinary claim requiring extraordinary evidence
- 119. The rope does not move because the forces are balanced
- 120. More chemical energy in larger batteries produces more electrical energy, which produces more light energy

Matching (Advanced Integration & Synthesis): 1→E, 2→D, 3→C, 4→B, 5→A

- 121. C — Friction between the car's wheels and the table surface
- 122. B — Lever B — it has a larger effort arm, giving it a greater mechanical advantage ($MA = 4$ vs $MA = 2$)
- 123. C — 100 degrees Celsius
- 124. B — Higher temperature increases the reaction rate inside the glow stick, producing more light per second; lower temperature slows it down
- 125. A — The long thin wire has more resistance, which reduces current and dims the bulb; the short thick wire has less resistance, allowing more current and a brighter bulb
- 126. A — Each bulb receives 1 amp of current because in a parallel circuit with equal resistances, current divides equally among branches
- 127. A theory explains why something happens with a well-supported explanation; a

law describes what happens with a consistent mathematical relationship

128. Chemical energy (battery) → electrical energy → light energy
129. Heat ice cubes in a pot: observe solid ice, then liquid water as it melts, then steam and water vapor as it boils, demonstrating all three states
130. It is a neutralization reaction that is exothermic, meaning the products have less chemical energy than the reactants and the difference is released as heat
Matching (Forces & Motion): 1→E, 2→D, 3→C, 4→B, 5→A
131. B — The type of surface (wood, tile, carpet)
132. D — The ability to do work or cause change
133. A — Total internal reflection: light hitting the glass-air boundary at a shallow angle is completely reflected back inside the fiber
134. C — The claim has a scientific basis in electromagnetic induction: moving a magnet near a conductor can generate an electric current, but toy magnets and blocks likely produce negligible usable electricity
135. C — Multiple trials reduce the impact of random error and chance variations, making results more reliable and statistically meaningful
136. B — Sublimation
137. Sunlight provides the energy needed to drive the chemical reaction
138. Steel particles are much closer together, so vibrations transfer more quickly between them
139. In an open system, water vapor escapes into the air, while in a closed system, evaporated water condenses back into the container
140. Wrap as many coils of wire tightly around the nail as possible, use a stronger battery, and ensure the iron nail is inside the coil
Matching (Forces & Motion): 1→C, 2→A, 3→E, 4→B, 5→D
141. B — Chemical energy stored in the wood is released and transformed into both light and thermal energy
142. D — Friction in the pulley reduces the actual force output, making the real MA lower than the theoretical value
143. B — The vinegar will react with the iron in the nail, causing it to corrode and produce bubbles of hydrogen gas
144. B — Position two mirrors at 45-degree angles to reflect light around the corner,

creating a periscope-like arrangement

145. B — The claim is partly wrong — the bicycle still has kinetic energy; it slows because friction converts that energy to heat
146. B — Have students listen to a tapping sound through air, through water in a container, and by pressing their ear to a desk while tapping the other end, comparing the loudness and speed at which they hear each
147. Peer review has other experts evaluate the methods, analysis, and conclusions to identify errors, biases, or flaws before the research is shared widely
148. Gravity pulled the cart down the ramp, applying a continuous net force
149. The claim is not well-supported scientifically; calcium and magnesium minerals in hard water are not ferromagnetic and would not be significantly affected by a magnetic field
150. Sound waves diffract (bend) around obstacles and through openings, allowing them to spread around corners
Matching (Forces & Motion): 1→A, 2→E, 3→C, 4→D, 5→B
151. C — It spreads the work over a longer distance, reducing the force needed at any point
152. B — Iron combines with oxygen and water to form iron oxide, a new substance with different properties than iron
153. A — Doubling the coils more than doubled the strength, indicating that the number of coils has a strong positive effect on electromagnet strength that may be more than directly proportional
154. C — Research question: How does light color affect photosynthesis rate in Elodea? Hypothesis: Red and blue light will produce more oxygen than green light because chlorophyll absorbs red and blue most. Procedure: Place equal Elodea sprigs in identical water-filled beakers under red, blue, green, and white light filters of equal intensity; count oxygen bubbles per minute over 15-minute periods; repeat three times per color
155. D — East, because only the kick force acts on the ball
156. B — Ball B — it started with more potential energy, which converts to more kinetic energy during the fall
157. Warm water provides the optimal temperature for yeast to carry out fermentation, producing carbon dioxide gas faster
158. Increasing voltage increases the current proportionally, according to Ohm's Law

159. Doubling the spring strength — more elastic potential energy converts to more kinetic energy; doubling mass reduces acceleration even if KE increases
160. The energy is being used to break the bonds between ice particles rather than raising the temperature
- Matching (Forces & Motion): 1→A, 2→D, 3→B, 4→C, 5→E
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