Chemquest — Activity Book

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

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

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1. chemistry

Circle the correct answer

1. Which of the following is a physical property of matter?
(A) Flammability (B) Ability to rust (C) Reactivity with acid (D) Boiling point

2. What property describes how easily a material can be scratched?
(A) Conductivity (B) Hardness (C) Density (D) Flexibility

3. Which tool would you use to measure the mass of a rock?
(A) A graduated cylinder (B) A thermometer (C) A ruler (D) A balance or scale

4. What is the term for how much matter is packed into a given space?
(A) Density (B) Weight (C) Volume (D) Mass

5. Describe what happens to sugar when it dissolves in water. Does the sugar disappear?
(A) The sugar turns into water (B) The sugar is destroyed and gone forever (C) The sugar melts into a liquid (D) The sugar breaks into tiny particles too small to see but is still there

6. Why does oil float on top of water instead of sinking?
(A) Oil has more mass than water (B) Oil is less dense than water (C) Oil is lighter in color than water (D) Oil molecules are bigger than water molecules

Write the answer

7. Explain why a metal spoon feels cold when you touch it, but a wooden spoon does not.
Answer: _____

8. Why can you use a magnet to separate iron filings from sand?
Answer: _____

9. Explain in your own words what solubility means.
Answer: _____

10. Why does a balloon expand when you heat it?
Answer: _____

Match each question to its answer

1. A student wants to find out if a mystery liquid is water or rubbing alcohol. Which property would be most useful to test? →
2. You have a block that is 2 cm by 3 cm by 5 cm and has a mass of 90 grams. What is its density? →
3. A student places an object in water and it sinks. What can you conclude about the object's density? →
4. How would you separate a mixture of sand and salt using water? →
5. You have three unknown metals. How could you use density to help identify each one? →

(A) Measure each metal's mass and volume, calculate density, and compare to a reference table
(B) Its density is greater than 1 g/cm cubed
(C) Boiling point
(D) Dissolve the salt in water, filter out the sand, then evaporate the water
(E) 3 g/cm cubed

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2. chemistry

Circle the correct answer

11. What is the smallest unit of an element that still has the properties of that element?
(A) An atom (B) A molecule (C) An electron (D) A cell

12. What are the three main subatomic particles found in an atom?
(A) Protons, atoms, and electrons (B) Protons, neutrons, and photons (C) Protons, neutrons, and electrons (D) Electrons, molecules, and neutrons

13. What determines the identity of an element?
(A) The number of protons in its atoms (B) The total mass of the atom (C) The number of electrons (D) The number of neutrons

14. The chemical symbol for gold is Au. What does the symbol Na represent?
(A) Nitrogen (B) Sodium (C) Neon (D) Nickel

15. Explain the difference between an atom and a molecule.
(A) An atom and a molecule are the same thing (B) A molecule is found only in living things (C) An atom is a single particle of an element; a molecule is two or more atoms bonded together (D) An atom is bigger than a molecule

16. Describe the structure of an atom, including where each subatomic particle is located.
(A) Protons and neutrons are in the central nucleus; electrons orbit in shells around it (B) Electrons are in the nucleus and protons orbit outside (C) Neutrons orbit the nucleus while protons and electrons are inside (D) All three particles are evenly spread throughout the atom

Write the answer

17. Explain why atoms are normally electrically neutral.
Answer: _____

18. What is the difference between an element and a compound?
Answer: _____

19. Summarize what the atomic number tells you about an element.
Answer: _____

20. Explain how isotopes of the same element differ from each other.
Answer: _____

Match each question to its answer

1. Carbon has an atomic number of 6 and an atomic mass of approximately 12. How many neutrons does a carbon-12 atom have? →
2. An atom has 8 protons, 8 neutrons, and 8 electrons. Identify this element. →
3. Use the periodic table to determine how many protons and electrons a neutral aluminum atom has. Aluminum's atomic number is 13. →
4. Write the chemical formula for a molecule that contains 2 hydrogen atoms and 1 oxygen atom. →
5. If a sodium atom (11 protons, 11 electrons) loses one electron, what charge does the resulting ion have? →

(A) 13 protons and 13 electrons
(B) +1
(C) 6 neutrons
(D) H2O
(E) Oxygen

3. chemistry

Circle the correct answer

21. What do elements in the same group (column) of the periodic table have in common?
(A) The same number of protons (B) The same number of neutrons (C) The same atomic mass (D) Similar chemical properties

22. Which group of elements is known for being extremely unreactive?
(A) Alkali metals (Group 1) (B) Halogens (Group 17) (C) Transition metals (D) Noble gases (Group 18)

23. What are the horizontal rows of the periodic table called?
(A) Series (B) Families (C) Periods (D) Groups

24. Where are metals generally located on the periodic table?
(A) On the far right side (B) On the left side and center (C) Scattered randomly throughout (D) Only in the bottom two rows

25. Explain why sodium (Na) and potassium (K) are in the same group on the periodic table.
(A) Both have the same atomic mass (B) Both have the same number of total electrons (C) Both have one valence electron and react similarly with other elements (D) Both are the same color

26. Describe what happens to the atomic radius as you move from left to right across a period.
(A) The atomic radius increases (B) The atomic radius stays the same (C) The atomic radius alternates between large and small (D) The atomic radius generally decreases

Write the answer

27. Explain why metals are good conductors of electricity.
Answer: _____

28. Why do noble gases rarely form compounds with other elements?
Answer: _____

29. Summarize the relationship between an element's group number and its number of valence electrons for Groups 1, 2, and 13-18.
Answer: _____

30. Describe how electronegativity changes as you move down a group in the periodic table.
Answer: _____

Match each question to its answer

1. Chlorine has 7 valence electrons. Use this to predict how many electrons chlorine is most likely to gain in a chemical reaction. →
2. Based on its position in Group 2 of the periodic table, predict whether magnesium is more likely to gain or lose electrons when it reacts. →
3. Silicon is classified as a metalloid. Use its position on the periodic table to explain why it has properties of both metals and nonmetals. →
4. Fluorine and iodine are both in Group 17. Predict which one is more reactive and explain why. →
5. Lithium, sodium, and potassium all react vigorously with water. Use periodic table trends to predict which reaction would be the most vigorous. →

(A) 1 electron
(B) Lose 2 electrons
(C) Potassium, because alkali metal reactivity increases going down the group
(D) Fluorine is more reactive because its smaller size allows it to attract electrons more strongly
(E) Silicon sits on the staircase border between metals and nonmetals, so it shares characteristics of both

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4. chemistry

Circle the correct answer

31. Which of the following is evidence that a chemical reaction has occurred?
(A) A new substance with different properties is formed (B) The substance is cut into smaller pieces (C) The substance changes shape (D) The substance is moved to a new container

32. In a chemical equation, what does the arrow symbol represent?
(A) Equals (B) Yields or produces (C) Plus (D) Reacts with

33. What are the substances on the left side of a chemical equation called?
(A) Catalysts (B) Reactants (C) Products (D) Coefficients

34. Name the type of reaction where two or more substances combine to form a single new substance.
(A) Combustion reaction (B) Single replacement reaction (C) Decomposition reaction (D) Synthesis reaction

35. Explain the difference between a synthesis reaction and a decomposition reaction.
(A) Synthesis combines substances into one product; decomposition breaks one substance into multiple products (B) Synthesis only involves metals; decomposition only involves gases (C) Synthesis uses heat; decomposition uses cold (D) Synthesis is fast; decomposition is slow

36. Describe what a catalyst does in a chemical reaction.
(A) It adds new atoms to the products (B) It speeds up the reaction without being consumed or permanently changed (C) It slows down the reaction (D) It is used up during the reaction

Write the answer

37. Explain why bubbles forming when vinegar is added to baking soda is evidence of a chemical reaction.
Answer: _____

38. What does it mean when we say a chemical equation is balanced?
Answer: _____

39. Summarize what happens during a combustion reaction.
Answer: _____

40. Explain the difference between an exothermic and an endothermic reaction.
Answer: _____

Match each question to its answer

1. Balance this equation: $H_2 + O_2 \rightarrow H_2O$ →
2. Balance this equation: $Fe + O_2 \rightarrow Fe_2O_3$ →
3. Classify this reaction: $2Na + Cl_2 \rightarrow 2NaCl$ →
4. Classify this reaction: $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$ →
5. Balance this equation: $CH_4 + O_2 \rightarrow CO_2 + H_2O$ →

(A) $2H_2 + O_2 \rightarrow 2H_2O$
(B) Synthesis reaction
(C) $4Fe + 3O_2 \rightarrow 2Fe_2O_3$
(D) Single replacement reaction
(E) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

5. chemistry

Circle the correct answer

41. What is a mixture?
(A) Two substances that form a new compound (B) A single pure substance (C) Two or more substances combined but not chemically bonded (D) A substance that cannot be separated

42. What is the term for a mixture where one substance is completely dissolved in another?
(A) Element (B) Compound (C) Solution (D) Suspension

43. In a saltwater solution, which substance is the solvent?
(A) Water (B) The container (C) Air above the water (D) Salt

44. Which separation technique uses a filter to separate solid particles from a liquid?
(A) Chromatography (B) Distillation (C) Filtration (D) Evaporation

45. Explain the difference between a homogeneous mixture and a heterogeneous mixture.
(A) Homogeneous is natural; heterogeneous is artificial (B) A homogeneous mixture looks the same throughout; a heterogeneous mixture has visibly different parts (C) Homogeneous uses water; heterogeneous uses oil (D) Homogeneous means hot; heterogeneous means cold

46. Describe what happens at the particle level when salt dissolves in water.
(A) Water molecules surround and pull apart the salt crystals into individual sodium and chloride ions (B) Salt disappears completely and no longer exists (C) Salt molecules squeeze between water molecules without changing (D) Salt chemically reacts with water to form a new compound

Write the answer

47. Explain why stirring helps a solid dissolve faster in a liquid.
Answer: _____

48. Why does oil not dissolve in water?
Answer: _____

49. What is the difference between a saturated and an unsaturated solution?
Answer: _____

50. Describe how increasing temperature usually affects the solubility of a solid in water.
Answer: _____

Match each question to its answer

1. You have a mixture of sand, iron filings, and salt. Use a magnet to separate the iron filings first. What method would you use next to separate the sand from the salt? →
2. A recipe calls for 50 grams of sugar dissolved in 200 milliliters of water. What is the concentration of this solution in grams per milliliter? →
3. You need to recover pure water from a saltwater solution. Which separation technique should you use? →
4. A student wants to dissolve sugar faster. List two things they could do. →
5. How would you use chromatography to separate the different colored dyes in a black marker? →

(A) Add water to dissolve the salt, filter out the sand, then evaporate the water to recover the salt
(B) Place a dot of ink on filter paper, dip the edge in water, and let the water carry the dyes at different speeds
(C) Distillation
(D) Crush the sugar into smaller pieces and stir the solution
(E) 0.25 g/mL

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6. chemistry

Circle the correct answer

51. In which state of matter are particles packed tightly together in a fixed arrangement?
(A) Solid (B) Liquid (C) Gas (D) Plasma

52. What is the name for the phase change from solid directly to gas, skipping the liquid state?
(A) Condensation (B) Deposition (C) Sublimation (D) Evaporation

53. At what temperature does pure water freeze at standard atmospheric pressure?
(A) 100 degrees Celsius (B) 0 degrees Celsius (32 degrees Fahrenheit) (C) -40 degrees Celsius (D) 50 degrees Celsius

54. What phase change occurs when water vapor turns into liquid water on a cold glass?
(A) Evaporation (B) Condensation (C) Freezing (D) Melting

55. Explain why gases can be compressed but liquids and solids cannot easily be compressed.
(A) Gases are made of different types of atoms, making this the most widely accepted explanation (B) Gas particles are smaller than liquid or solid particles, as this is what research and standard practice suggests (C) Liquids and solids are heavier than gases, and this is the standard approach used in most cases (D) Gas particles have large spaces between them that can be squeezed together; liquid and solid particles are already close

56. Describe what happens to water molecules as ice melts into liquid water.
(A) The molecules break apart into hydrogen and oxygen atoms (B) The molecules slow down and stop moving (C) The molecules get bigger as they absorb heat (D) The molecules gain energy, vibrate more, and break free from their fixed positions to slide past each other

Write the answer

57. Explain why the temperature of boiling water stays at 100 degrees Celsius even as you continue to heat it.
Answer: _____

58. Why does sweating cool your body?
Answer: _____

59. Describe the difference between evaporation and boiling.
Answer: _____

60. Explain how particle motion differs between the three common states of matter.
Answer: _____

Match each question to its answer

1. A student heats a pot of water. At what temperature will they first see bubbles of water vapor forming throughout the liquid? →
2. Draw a heating curve for water. What happens to the temperature during a phase change? →
3. At the top of a high mountain, water boils at a lower temperature than at sea level. Explain why. →
4. Classify each change: (1) ice cream melting, (2) moth balls shrinking in a closet, (3) frost forming on a window. →

5. Use the kinetic molecular theory to predict what happens to gas pressure when you increase the temperature inside a sealed container. →

(A) 100 degrees Celsius at standard atmospheric pressure
(B) (1) melting, (2) sublimation, (3) deposition
(C) Pressure increases because gas particles move faster and hit the container walls harder and more often
(D) Temperature stays constant during a phase change while energy is absorbed
(E) Atmospheric pressure is lower at high altitudes, so less energy is needed for water molecules to escape into the gas phase

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7. chemistry

Circle the correct answer

61. What does the pH scale measure?
(A) How hot or cold a solution is (B) How fast a chemical reaction occurs (C) How acidic or basic a solution is (D) How much salt is dissolved in a solution

62. Which pH value indicates a neutral solution?
(A) 14 (B) 1 (C) 7 (D) 0

63. Which ion is responsible for making a solution acidic?
(A) Hydrogen ion (H^+) (B) Hydroxide ion (OH^-) (C) Sodium ion (Na^+) (D) Chloride ion (Cl^-)

64. What color does blue litmus paper turn in an acidic solution?
(A) It stays blue (B) Yellow (C) Green (D) Red

65. Lemon juice has a pH of about 2. What does this tell you about lemon juice?
(A) It is neutral (B) It is a strong acid (C) It is a weak base (D) It is a strong base

66. Why does soap feel slippery to the touch?
(A) Because it is a base that reacts with oils on your skin (B) Because it contains a lot of water (C) Because it has a neutral pH (D) Because it is an acid that dissolves your skin cells

Write the answer

67. If a solution has a pH of 12, which statement is correct?
Answer: _____

68. Why is stomach acid (pH ~2) important for digestion?
Answer: _____

69. How does the concentration of H^+ ions change when pH decreases from 5 to 3?
Answer: _____

70. Explain why adding water to a strong acid raises its pH closer to 7.
Answer: _____

Match each question to its answer

1. A student tests an unknown solution with red and blue litmus paper. The red litmus turns blue and the blue litmus stays blue. What can the student conclude? →
2. A gardener adds lime (calcium hydroxide) to soil that has a pH of 5. What is the gardener trying to do? →
3. Which household product would you use to neutralize a spill of vinegar (acetic acid) on a countertop? →
4. Red cabbage juice is a natural pH indicator. It turns red in acid and green in base. A student adds red cabbage juice to a mystery liquid and it turns purple. What is the approximate pH? →
5. When hydrochloric acid reacts with sodium hydroxide, the products are sodium chloride and water. Write the word equation for this neutralization reaction. →

(A) The solution is basic
(B) Hydrochloric acid + Sodium hydroxide → Sodium chloride + Water
(C) Baking soda (sodium bicarbonate)
(D) Around 7 (neutral)
(E) Raise the soil pH to make it less acidic

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8. chemistry

Circle the correct answer

71. What does the law of conservation of mass state?
(A) New atoms are created when chemicals react (B) Mass always increases during a chemical reaction (C) Energy cannot be created or destroyed in a chemical reaction (D) Matter cannot be created or destroyed in a chemical reaction

72. Who is credited with establishing the law of conservation of mass through careful experiments?
(A) Dmitri Mendeleev (B) Antoine Lavoisier (C) Isaac Newton (D) Albert Einstein

73. In a balanced chemical equation, what must be equal on both sides of the arrow?
(A) The number of each type of atom (B) The temperature of the substances (C) The number of molecules (D) The number of elements

74. What is the purpose of coefficients in a balanced chemical equation?
(A) They change the identity of the molecules (B) They indicate the speed of the reaction (C) They show the temperature needed for the reaction (D) They show how many molecules or formula units of each substance are involved

75. If 10 grams of substance A reacts with 5 grams of substance B, what is the total mass of the products according to conservation of mass?
(A) 5 grams (B) 20 grams (C) 15 grams (D) 10 grams

76. When wood burns in a fireplace, the ash left behind weighs much less than the original wood. Does this violate conservation of mass? Why or why not?
(A) Yes — burning always reduces total mass, and this principle applies across similar situations (B) Yes — mass is destroyed when wood burns, which is why this approach is recommended by experts (C) No — gases like CO_2 and water vapor escape into the air, and the total mass of ash plus gases equals the original mass (D) No — the fire creates new energy that replaces the lost mass, as this directly follows from the underlying principles

Write the answer

77. A sealed container holds 50 grams of reactants. After a chemical reaction occurs inside the sealed container, what will the scale read?
Answer: _____

78. In the equation $2H_2 + O_2 \rightarrow 2H_2O$, why is the coefficient 2 needed in front of H_2O?
Answer: _____

79. Why can you change coefficients but not subscripts when balancing a chemical equation?
Answer: _____

80. Explain why a rusty iron nail weighs more than the original shiny nail.
Answer: _____

Match each question to its answer

1. Balance this equation: **Fe +** O_2 → **Fe_2O_3 → __**
2. Balance this equation: **CH_4 +** O_2 → **CO_2 +** H_2O →
3. A student mixes 8.0 g of sodium hydroxide with hydrochloric acid and produces 11.7 g of sodium chloride and 3.6 g of water. How much hydrochloric acid was used? →
4. In the reaction $N_2 + 3H_2 \rightarrow 2NH_3$, if you start with 28 g of N_2 and 6 g of H_2, what total mass of NH_3 is produced? →
5. Balance this equation: **Al +** HCl → **$AlCl_3$ +** H_2 →

(A) $4Fe + 3O_2 \rightarrow 2Fe_2O_3$
(B) $1CH_4 + 2O_2 \rightarrow 1CO_2 + 2H_2O$
(C) 7.3 grams
(D) 34 grams
(E) $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$

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9. chemistry

Circle the correct answer

81. What is an exothermic reaction?
(A) A reaction that releases energy (usually as heat) to the surroundings (B) A reaction that absorbs energy from the surroundings (C) A reaction that produces only gaseous products (D) A reaction that only occurs at extremely high temperatures

82. What is activation energy?
(A) The minimum amount of energy needed to start a chemical reaction (B) The total energy released by a chemical reaction (C) The energy stored in the products of a reaction (D) The heat produced when a reaction is complete

83. On an energy diagram, what does the difference in height between the reactants and the peak of the curve represent?
(A) The activation energy of the reaction (B) The heat of reaction (ΔH) (C) The number of bonds broken (D) The temperature at which the reaction occurs

84. What is an endothermic reaction?
(A) A reaction that releases heat and warms the surroundings (B) A reaction that absorbs energy from the surroundings, causing the surroundings to feel cold (C) A reaction that only happens inside living organisms (D) A reaction that requires electricity to proceed

85. You touch a hand warmer and it feels hot. Is the reaction inside the hand warmer endothermic or exothermic? Explain how you know.
(A) Exothermic — the reaction releases heat to the surroundings (your hand), making it feel warm (B) Endothermic — the reaction absorbs heat from your hand (C) Endothermic — the reaction releases cold energy to your hand (D) Exothermic — the reaction absorbs energy from the air around it

86. A chemical cold pack used for sports injuries feels cold when activated. Explain what type of reaction is occurring and what is happening to energy.
(A) An exothermic reaction — heat is produced but stored inside the pack (B) An endothermic reaction — the chemicals absorb heat from the surroundings (your skin), so the pack feels cold (C) A physical change — the chemicals simply dissolve without

reacting (D) An exothermic reaction — the chemicals release cold energy that lowers temperature

Write the answer

87. Why must reactant molecules have at least the activation energy before a reaction can occur?
Answer: _____

88. In an exothermic reaction, how do the bond energies of the products compare to those of the reactants?
Answer: _____

89. Photosynthesis converts carbon dioxide and water into glucose and oxygen using light energy. Is this reaction endothermic or exothermic?
Answer: _____

90. The combustion of methane releases 890 kJ of energy per mole. Calculate how much energy is released when 3 moles of methane are burned.
Answer: _____

Match each question to its answer

1. A reaction has an activation energy of 50 kJ and releases 30 kJ of energy overall. Draw a description of what the energy diagram looks like and identify whether the reaction is endothermic or exothermic. →
2. Breaking the bonds in the reactants of a reaction requires 400 kJ. Forming the bonds in the products releases 550 kJ. What is the overall energy change, and is the reaction endothermic or exothermic? →
3. A catalyst is added to a reaction. The reaction originally required 80 kJ of activation energy and had a ΔH of −45 kJ. After adding the catalyst, what are the new values of activation energy and ΔH? →
4. Wood does not spontaneously burst into flame at room temperature, even though burning wood is exothermic. Use the concept of activation energy to explain why. →
5. Examine two energy diagrams: Reaction A has reactants at 100 kJ and products at 60 kJ. Reaction B has reactants at 60 kJ and products at 100 kJ. Which reaction is exothermic, and what is each reaction's ΔH? →

(A) Burning wood requires an initial input of activation energy (like a match) to start breaking bonds, even though the overall reaction releases energy
(B) −150 kJ; exothermic — more energy is released forming products than is absorbed breaking reactants
(C) Reaction A is exothermic (ΔH = −40 kJ); Reaction B is endothermic (ΔH = +40 kJ)
(D) Exothermic: reactants start at a reference level, rise 50 kJ to the peak (transition

state), then drop to products that are 30 kJ below the reactants
(E) Activation energy decreases (e.g., to 50 kJ); ΔH remains −45 kJ

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10. chemistry

Circle the correct answer

91. What is an ionic bond?
(A) A bond formed by the transfer of electrons from a metal to a nonmetal, creating oppositely charged ions that attract each other (B) A bond formed by two nonmetals sharing electrons equally (C) A bond formed by the transfer of protons between atoms (D) A bond formed when two identical atoms share electrons

92. What is a covalent bond?
(A) A bond formed when a metal transfers electrons to a nonmetal (B) A bond formed when two atoms share one or more pairs of electrons (C) A bond formed by the attraction between a positive and negative ion (D) A bond formed only between two identical metal atoms

93. What information does a molecular formula provide?
(A) The arrangement of atoms and bonds within a molecule (B) The mass of one mole of the compound (C) The shape of the molecule in three dimensions (D) The types and exact numbers of atoms in one molecule of a compound

94. What is a polyatomic ion?
(A) A group of atoms covalently bonded together that carries an overall electric charge (B) A single atom that has lost or gained electrons (C) An ion found only in acidic solutions (D) A neutral molecule made of many different atoms

95. Sodium chloride (NaCl) has a melting point above 800 °C, while water (H_2O) melts at 0 °C. Explain what this difference tells you about the type of bonding in each compound.
(A) NaCl melts higher because sodium is a heavier atom than hydrogen (B) NaCl melts higher because it has more atoms per formula unit than H_2O (C) NaCl has ionic bonds forming a strong crystal lattice that requires a lot of energy to break; H_2O has covalent bonds within molecules and weaker forces between molecules, requiring less energy to melt (D) H_2O melts lower because it contains oxygen, which lowers melting points

96. Why do ionic compounds like NaCl conduct electricity when dissolved in water, but molecular compounds like sugar ($C_{12}H_{22}O_{11}$) do not?
(A) NaCl conducts because it is a metal compound and metals always conduct (B) NaCl conducts because its molecules are larger and can carry more charge (C) Sugar

does not conduct because it contains carbon, which blocks electricity (D) Ionic compounds release free-moving ions (Na^+ and Cl^-) in solution that carry electric charge; sugar molecules dissolve without breaking into charged particles

Write the answer

97. How does electronegativity determine whether a bond between two atoms is ionic or covalent?
Answer: _____

98. A structural formula shows lines between atom symbols. What does each line represent?
Answer: _____

99. Calcium (Ca) is in Group 2 and chlorine (Cl) is in Group 17. Predict the formula of calcium chloride and the charges on each ion.
Answer: _____

100. Write the molecular formula for a molecule that contains 2 nitrogen atoms and 4 oxygen atoms.
Answer: _____

Match each question to its answer

1. Magnesium oxide (MgO) is an ionic compound. Predict the charges on each ion and explain why the formula is MgO (1:1 ratio) rather than MgO_2 or Mg_2O. →
2. Draw (describe) the structural formula for water (H_2O) showing the bonds between atoms. →
3. The compound ammonium sulfate has the formula $(NH_4)_2SO_4$. Identify the two polyatomic ions present and their charges. →
4. Table salt (NaCl) has a crystal lattice structure. How does this structure explain why NaCl is a solid at room temperature with a high melting point, while propane gas (C_3H_8) is a gas at room temperature? →
5. Carbon dioxide (CO_2) and silicon dioxide (SiO_2) have the same empirical formula. Yet CO_2 is a gas at room temperature and SiO_2 (quartz) is a hard solid with a melting point above 1,600 °C. Analyze why their properties are so different. →

(A) NaCl's ionic lattice has millions of strong electrostatic attractions holding it rigid as a solid; propane molecules are held together only by weak intermolecular forces, easily overcoming them at room temperature
(B) Ammonium (NH_4^+) with a +1 charge and sulfate (SO_4^{2-}) with a −2 charge
(C) CO_2 consists of discrete covalent molecules with weak intermolecular forces; SiO_2 forms a covalent network solid where every silicon is bonded to four oxygens continuously — breaking this structure requires enormous energy

(D) Mg^{2+} and O^{2-} — magnesium loses 2 electrons and oxygen gains 2. The charges balance with a 1:1 ratio, giving MgO
(E) H — O — H, with the oxygen in the center bonded to each hydrogen by a single covalent bond (one shared electron pair per bond)

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11. Chemistry

Circle the correct answer

101. What element is the basis of all organic chemistry?
(A) Carbon (B) Oxygen (C) Nitrogen (D) Hydrogen

102. What is a hydrocarbon?
(A) Any molecule found in living things (B) A molecule made up of only hydrogen and carbon atoms (C) A molecule containing water and carbon (D) A molecule with oxygen and hydrogen

103. What is the simplest hydrocarbon, with one carbon atom and four hydrogen atoms?
(A) Methane (B) Butane (C) Propane (D) Ethane

104. What is a polymer?
(A) A large molecule made of many repeating smaller units called monomers (B) A chemical reaction, as this directly follows from the underlying principles (C) A single small molecule, which is why this approach is recommended by experts (D) A type of element, making this the most widely accepted explanation

105. What is the difference between organic and inorganic compounds?
(A) Organic means natural; inorganic means artificial, and this has been consistently demonstrated in practice (B) Organic compounds are always alive, which is why this approach is recommended by experts (C) Organic compounds contain carbon bonded to other elements (especially hydrogen); inorganic compounds generally do not contain carbon-hydrogen bonds (D) Inorganic compounds are always toxic, which is why this approach is recommended by experts

106. What is a functional group in organic chemistry?
(A) The physical state of a compound, which is why this approach is recommended by experts (B) The total number of atoms in a molecule, as this directly follows from the underlying principles (C) The main carbon chain of a molecule, and this principle applies across similar situations (D) A specific group of atoms within a molecule that determines the molecule's chemical properties and reactions

Write the answer

107. Why can carbon form such a huge variety of molecules compared to other elements?
Answer: _____

108. Explain the difference between a saturated and an unsaturated hydrocarbon.
Answer: _____

109. Why are plastics considered polymers?
Answer: _____

110. How does the length of a hydrocarbon chain affect its physical properties?
Answer: _____

Match each question to its answer

1. Why is carbon dioxide (CO_2) considered inorganic even though it contains carbon? →
2. Draw the structural formula of ethane (C_2H_6). How many bonds does each carbon atom form? →
3. Classify these compounds as organic or inorganic: glucose ($C_6H_{12}O_6$), table salt (NaCl), ethanol (C_2H_5OH), calcium carbonate ($CaCO_3$). →
4. Methane has the formula CH_4 and ethane has C_2H_6. Following the pattern, predict the formula for propane (3 carbons) and butane (4 carbons). →
5. A polymer is made by linking 500 ethylene (C_2H_4) monomers together. What is the approximate molecular formula of this polymer? →

(A) Because it lacks carbon-hydrogen bonds, which are the defining feature of organic compounds
(B) Each carbon forms 4 bonds: 1 bond to the other carbon and 3 bonds to hydrogen atoms
(C) Organic: glucose and ethanol (both have C-H bonds). Inorganic: table salt (no carbon) and calcium carbonate (no C-H bonds).
(D) $(C_2H_4)_{500}$ or approximately $C_{1000}H_{2000}$
(E) Propane: C_3H_8, Butane: C_4H_{10}

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12. Chemistry

Circle the correct answer

111. What are greenhouse gases?
(A) Gases in the atmosphere that trap heat from the sun, warming Earth's surface (B) Gases that cool the atmosphere, as this directly follows from the underlying principles (C) Gases that block all sunlight, which is why this approach is recommended by experts (D) Gases released by greenhouses, making this the most widely accepted explanation

112. What is the ozone layer?
(A) A protective layer of carbon dioxide, and this is the standard approach used in most cases (B) A layer of oxygen at ground level, and this principle applies across similar situations (C) The lowest layer of the atmosphere, and this principle applies across similar situations (D) A region of the upper atmosphere (stratosphere) with a high concentration of ozone (O_3) that absorbs harmful ultraviolet radiation from the sun

113. What causes acid rain?
(A) Carbon dioxide dissolving in rain, as this directly follows from the underlying principles (B) Evaporation of ocean water, as this directly follows from the underlying principles (C) Sulfur dioxide (SO_2) and nitrogen oxides (NO_x) from burning fossil fuels react with water in the atmosphere to form sulfuric and nitric acids (D) Natural volcanic activity only, as this is what research and standard practice suggests

114. What is the carbon cycle?
(A) The way carbon is manufactured, which is the most common explanation for this phenomenon (B) The continuous movement of carbon atoms between the atmosphere, oceans, living organisms, and rocks through natural and human processes (C) The life cycle of carbon-based organisms, as this directly follows from the underlying principles (D) The process of burning carbon fuels, which is why this approach is recommended by experts

115. What does the pH scale measure?
(A) How acidic or basic (alkaline) a solution is, on a scale from 0 to 14 (B) How much salt is dissolved, which is why this approach is recommended by experts (C) How much oxygen is present, as this is what research and standard practice suggests (D) How hot or cold a solution is, which is why this approach is recommended by experts

116. What is water pollution?
(A) Any change in water temperature, as this directly follows from the underlying principles (B) The contamination of water bodies (rivers, lakes, oceans, groundwater) with harmful substances that make the water unsafe for organisms and human use (C) The natural mixing of saltwater and freshwater, which is the most common explanation for this phenomenon (D) Water flowing through pipes, and this has been consistently demonstrated in practice

Write the answer

117. Why does increasing carbon dioxide in the atmosphere lead to global warming?
Answer: _____

118. Explain how chlorofluorocarbons (CFCs) damage the ozone layer.
Answer: _____

119. How does acid rain damage buildings and statues made of limestone or marble?
Answer: _____

120. Why is methane considered a more potent greenhouse gas than carbon dioxide, even though there is less of it in the atmosphere?
Answer: _____

Match each question to its answer

1. What is eutrophication and how does it relate to water pollution? →
2. Calculate how much more acidic rain with pH 4 is compared to normal rain with pH 5.6. →
3. A city produces 500,000 tons of CO_2 per year from transportation. If they switch 30% of vehicles to electric (assuming zero tailpipe emissions), how many tons of CO_2 would be reduced annually? →
4. A factory discharges water at 45°C into a river normally at 15°C. The thermal pollution raises the river temperature to 25°C near the discharge point. By what percentage did the temperature increase? →
5. Identify which part of the carbon cycle each activity represents: (a) a tree absorbing CO_2, (b) a car burning gasoline, (c) dead leaves decomposing, (d) shells forming on the ocean floor. →

(A) (a) Photosynthesis, (b) Combustion, (c) Decomposition, (d) Carbon sequestration in sediments/rocks
(B) 150,000 tons
(C) About 67% increase (from 15°C to 25°C)
(D) Eutrophication occurs when excess nutrients (especially nitrogen and phosphorus from fertilizer runoff) cause algal blooms that deplete oxygen in the water, killing aquatic life
(E) About 40 times more acidic, because each pH unit represents a 10-fold change

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13. chemistry

Circle the correct answer

121. When hydrochloric acid reacts with sodium hydroxide, the products are sodium chloride and water. Write the word equation for this neutralization reaction.
(A) Hydrochloric acid + Sodium chloride → Sodium hydroxide + Water (B) Hydrochloric acid + Sodium hydroxide → Sodium chloride + Water (C) Sodium hydroxide + Water → Hydrochloric acid + Sodium chloride (D) Sodium chloride + Water → Hydrochloric acid + Sodium hydroxide

122. A recipe calls for 50 grams of sugar dissolved in 200 milliliters of water. What is the concentration of this solution in grams per milliliter?
(A) 250 g/mL (B) 4 g/mL (C) 50 g/mL (D) 0.25 g/mL

123. A student measures 12.0 g of carbon reacting with 32.0 g of oxygen to form CO_2. They then burn 24.0 g of carbon with excess oxygen. Predict the mass of CO_2 produced and explain your reasoning.
(A) 44.0 g because the ratio of C to CO_2 is always 12:44 (B) 64.0 g because you only double the oxygen (C) 88.0 g of CO_2 — doubling the carbon (12→24 g) requires double the oxygen (32→64 g), and 24 + 64 = 88 g (D) 56.0 g because you add the carbon mass twice

124. Analyze why elements in the same period have different properties even though they have the same number of electron shells.
(A) They have different numbers of valence electrons, which determines chemical behavior (B) They actually have the same properties because they are in the same period (C) The number of shells is the only thing that matters (D) Their neutron counts make them different

125. A student heats a pot of water. At what temperature will they first see bubbles of water vapor forming throughout the liquid?
(A) 0 degrees Celsius, and this is the standard approach used in most cases (B) 212 degrees Celsius, and this has been consistently demonstrated in practice (C) 50 degrees Celsius, as this is what research and standard practice suggests (D) 100 degrees Celsius at standard atmospheric pressure

126. Assess whether the periodic table would still be useful if elements were arranged alphabetically instead of by atomic number.
(A) It would be just as useful because the elements are the same (B) Alphabetical order would create new chemical patterns (C) It would be more useful because elements would be easier to find (D) It would be much less useful because alphabetical order does not reveal patterns in chemical properties

Write the answer

127. What is a mixture?
Answer: _____

128. Why is density a better property than mass for identifying an unknown substance?
Answer: _____

129. Describe what a catalyst does in a chemical reaction.
Answer: _____

130. Lemon juice has a pH of about 2. What does this tell you about lemon juice?
Answer: _____

Match each question to its answer

1. Compare the reactivity of lithium (Group 1) with the reactivity of neon (Group 18). What accounts for the dramatic difference? →
2. Based on its position in Group 2 of the periodic table, predict whether magnesium is more likely to gain or lose electrons when it reacts. →
3. Balance this equation: **Al +** HCl → **$AlCl_3$ +** H_2 →
4. Describe the difference between evaporation and boiling. →
5. Antacid tablets contain bases like calcium carbonate. Use your knowledge of neutralization to explain how antacids relieve heartburn. →

(A) Lose 2 electrons
(B) The base in the antacid neutralizes excess stomach acid, raising the pH and reducing irritation
(C) Evaporation occurs at the surface at any temperature; boiling occurs throughout the liquid at the boiling point
(D) Lithium has 1 valence electron it easily loses; neon has a full outer shell and no need to react
(E) $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$

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14. chemistry

Circle the correct answer

131. Summarize what happens during a combustion reaction.
(A) A substance reacts with oxygen and releases energy, usually producing carbon dioxide and water (B) A substance absorbs energy and becomes a gas (C) Two metals combine to form a new alloy (D) A substance breaks apart into its elements without any outside help

132. Why does oil float on top of water instead of sinking?
(A) Oil has more mass than water (B) Oil molecules are bigger than water molecules (C) Oil is less dense than water (D) Oil is lighter in color than water

133. In the equation 2H2O -> 2H2 + O2, what type of reaction is taking place and what might be needed to make it happen?
(A) Single replacement that occurs spontaneously (B) Decomposition reaction, requiring energy input such as electricity (C) Combustion that produces heat (D) Synthesis reaction that releases energy

134. Analyze why rusting is considered a chemical reaction even though it happens very slowly.
(A) Speed does not determine whether something is a chemical reaction; rusting produces a new substance (iron oxide) (B) Rusting is not a real chemical reaction (C) Only fast changes are chemical reactions (D) Rusting is actually a physical change because it is slow

135. Use the periodic table to find the element with 17 protons. Identify it and predict whether it is a metal, nonmetal, or metalloid.
(A) Argon, a nonmetal (B) Sulfur, a metalloid (C) Chlorine, a nonmetal (D) Chlorine, a metal

136. What is the smallest unit of an element that still has the properties of that element?
(A) A molecule (B) An atom (C) A cell (D) An electron

Write the answer

137. What is the name for the phase change from solid directly to gas, skipping the liquid state?
Answer: _____

138. Carbon-12 and carbon-14 are both carbon. Why do they behave the same chemically despite having different masses?
Answer: _____

139. Use the periodic table to determine how many protons and electrons a neutral aluminum atom has. Aluminum's atomic number is 13.
Answer: _____

140. A classmate says that all mixtures are solutions. Evaluate this claim using examples.
Answer: _____

Match each question to its answer

1. Which model of the atom do you think is more useful for understanding chemistry: the solid sphere model or the electron cloud model? Justify your answer. →
2. Design an experiment to prove that mass is conserved when baking soda reacts with vinegar, even though bubbles form. Specify what equipment you would use and what measurements you would take. →
3. A scientist adds equal volumes of an acid (pH 3) and a base (pH 11) together. The resulting solution has a pH of 7. What can you conclude about the acid and base? →
4. A student heats ice until it becomes water, then continues heating until it becomes steam. Which properties changed and which stayed the same? →
5. Fluorine and iodine are both in Group 17. Predict which one is more reactive and explain why. →

(A) The electron cloud model, because it shows where electrons are likely found, which determines chemical bonding
(B) Place baking soda and vinegar in a sealed zip-lock bag on a balance. Record mass before and after mixing. The sealed bag traps the CO_2 gas, so the mass reading will not change
(C) The state and volume changed, but the chemical identity stayed the same
(D) They have equal strength and completely neutralize each other
(E) Fluorine is more reactive because its smaller size allows it to attract electrons more strongly

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15. chemistry

Circle the correct answer

141. Analyze why ocean water is salty but rain water is not, even though rain comes from evaporating ocean water.
(A) Salt evaporates too but disappears in the clouds (B) Rain water is actually just as salty as ocean water (C) Rain water comes from a different source, not the ocean (D) When ocean water evaporates, only the water molecules escape as vapor, leaving the salt behind

142. A metal cube and a wooden cube are the same size. The metal cube sinks in water but the wooden cube floats. What does this tell you about the two materials?
(A) Water pushes harder on the metal cube (B) The metal is bigger than the wood (C) The metal has a greater density than water, and the wood has a lower density than water (D) The wood has more mass than the metal

143. Explain why stirring helps a solid dissolve faster in a liquid.
(A) Stirring breaks the solid into a different substance (B) Stirring has no effect on dissolving speed (C) Stirring heats up the liquid (D) Stirring moves fresh solvent to the surface of the solid, speeding up the dissolving process

144. A student mixes 8.0 g of sodium hydroxide with hydrochloric acid and produces 11.7 g of sodium chloride and 3.6 g of water. How much hydrochloric acid was used?
(A) 11.7 grams (B) 3.7 grams (C) 7.3 grams (D) 15.3 grams

145. Assess whether it is possible to make a solution that is too concentrated. What would happen if you kept adding sugar to a glass of water?
(A) You can dissolve unlimited sugar in water (B) The sugar would chemically react and form a new substance (C) The water would overflow because sugar takes up space (D) Eventually the water becomes saturated and additional sugar will not dissolve, settling to the bottom

146. What are the horizontal rows of the periodic table called?
(A) Periods (B) Groups (C) Series (D) Families

Write the answer

147. How would you use chromatography to separate the different colored dyes in a black marker?
Answer: _____

148. Examine why crushing a solid into a powder makes it dissolve faster than using a large chunk.
Answer: _____

149. Red cabbage juice is a natural pH indicator. It turns red in acid and green in base. A student adds red cabbage juice to a mystery liquid and it turns purple. What is the approximate pH?
Answer: _____

150. Which separation technique uses a filter to separate solid particles from a liquid?
Answer: _____

Match each question to its answer

1. Design a simple experiment using household materials to determine whether an unknown clear liquid is an acid, a base, or neutral. →
2. Design an experiment to demonstrate all three states of water and the phase changes between them using common kitchen equipment. →
3. What color does blue litmus paper turn in an acidic solution? →
4. Describe what happens to water molecules as ice melts into liquid water. →

5. Use the kinetic molecular theory to predict what happens to gas pressure when you increase the temperature inside a sealed container. →

(A) Make red cabbage juice indicator, add drops of the unknown liquid, and compare the color change to known acid (vinegar) and base (baking soda solution) references
(B) Start with ice cubes (solid), heat them to melt into water (liquid), then continue heating until the water boils into steam (gas)
(C) Red
(D) Pressure increases because gas particles move faster and hit the container walls harder and more often
(E) The molecules gain energy, vibrate more, and break free from their fixed positions to slide past each other

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16. chemistry

Circle the correct answer

151. Explain why a rusty iron nail weighs more than the original shiny nail.
(A) Iron atoms expanded during rusting, increasing their mass (B) Rust is denser than iron, so it weighs more on its own (C) The iron combined with oxygen from the air to form iron oxide, adding the mass of the oxygen atoms (D) The nail absorbed water which made it heavier

152. Which ion is responsible for making a solution acidic?
(A) Chloride ion (Cl^-) (B) Hydrogen ion (H^+) (C) Hydroxide ion (OH^-) (D) Sodium ion (Na^+)

153. A student writes the equation N2 + H2 -> NH3 and says it is balanced. Evaluate this claim.
(A) The equation is correctly balanced as written (B) The equation needs to be N2 + H2 -> 2NH3 (C) Equations with nitrogen cannot be balanced (D) The equation is not balanced; it should be N2 + 3H2 -> 2NH3

154. A student argues that nuclear reactions violate conservation of mass because mass is converted to energy ($E=mc^2$). Evaluate whether this means conservation of mass is wrong for chemistry.
(A) Yes, conservation of mass is completely wrong because of $E=mc^2$ (B) Nuclear reactions and chemical reactions follow identical rules, which is why this approach is recommended by experts (C) For chemical reactions, the mass change from $E=mc^2$ is negligibly small (billionths of a gram) — conservation of mass is an excellent approximation for all chemistry (D) No, $E=mc^2$ only applies in outer space, not on Earth, which is why this approach is recommended by experts

155. Explain the difference between an atom and a molecule.
(A) An atom is a single particle of an element; a molecule is two or more atoms bonded together (B) An atom is bigger than a molecule (C) An atom and a molecule are the same thing (D) A molecule is found only in living things

156. Explain in your own words what solubility means.
(A) How hard a substance is to break (B) How heavy a substance is (C) How fast a substance melts when heated (D) How well a substance can dissolve in a liquid

Write the answer

157. Which household product would you use to neutralize a spill of vinegar (acetic acid) on a countertop?
Answer: _____

158. Describe how increasing temperature usually affects the solubility of a solid in water.
Answer: _____

159. Name the type of reaction where two or more substances combine to form a single new substance.
Answer: _____

160. A classmate claims that burning wood is a physical change because you can still see the wood changing. Evaluate this claim.
Answer: _____

Match each question to its answer

1. Describe what happens to the atomic radius as you move from left to right across a period. →
2. A pool manager can add either muriatic acid (HCl) or sodium bisulfate to lower pool pH. The pool pH is 7.8 and needs to reach 7.4. Which factors should the manager consider when choosing between the two chemicals? →
3. Explain why a metal spoon feels cold when you touch it, but a wooden spoon does not. →
4. What determines the identity of an element? →
5. What does it mean when we say a chemical equation is balanced? →

(A) The number of atoms of each element is the same on both sides of the equation
(B) The number of protons in its atoms
(C) Safety of handling, cost, how quickly each lowers pH, and potential side effects on pool equipment and swimmers
(D) The atomic radius generally decreases

(E) Metal conducts heat away from your hand faster than wood

Riddle & Joke Break

Guess the answer, then check the key!

161. I'm a chart with rows and columns. I organize all the known elements by their atomic number. Dmitri Mendeleev created my first version in 1869. What am I?

162. I'm the smallest particle of an element that still has the properties of that element. I have protons in my nucleus, electrons orbiting outside, and often neutrons too. What am I?

163. I happen when a substance combines with oxygen and releases energy, often as heat and light. Burning wood and rusting iron are both examples of me. What type of reaction am I?

164. I'm a bond formed when two atoms share electrons instead of transferring them. I hold together molecules like water and carbon dioxide. What type of bond am I?

165. I'm the same element but with a different number of neutrons. Carbon-12 and carbon-14 are examples of me. We behave the same chemically but have different masses. What are we?

166. I'm a state of matter with no fixed shape or volume. My particles move fast and spread out to fill any container. I can be compressed. What state am I?

167. I turn litmus paper red, I taste sour, and I have a pH below 7. Lemons and vinegar both contain me. What am I?

168. I'm made of two hydrogen atoms and one oxygen atom. I'm the most common molecule on Earth's surface. I can exist as solid, liquid, or gas. What am I?

169. Why do chemists love nitrates?

170. What did the scientist say when she found two isotopes of helium?

171. Why did the noble gas cry?

172. What do you do with a sick chemist?

173. Why did the atom lose the argument?

174. What's a chemist's favorite tree?

Fun Facts

- Did you know? The human body contains enough carbon to make about 9,000 pencils, enough iron to make a 3-inch nail, and enough phosphorus to make about 2,200 match heads!
- Did you know? Gallium is a metal that melts at just 85.6 degrees Fahrenheit -- barely above room temperature! You can literally melt it by holding it in your hand. It looks like liquid silver pooling in your palm.
- Did you know? Oxygen is actually colorless as a gas, but when cooled to a liquid (at minus 297 degrees Fahrenheit), it turns a beautiful pale blue! Liquid oxygen is also magnetic.
- Did you know? The element mercury is the only metal that is liquid at room temperature! Ancient alchemists called it "quicksilver" because of how it flows and pools like a living silver liquid.
- Did you know? A single drop of water contains about 1.67 sextillion molecules (that's 1,670,000,000,000,000,000,000). Even the tiniest visible droplet is home to an unimaginably huge number of H2O molecules!
- Did you know? Hydrogen is the lightest and most abundant element in the universe -- about 75% of all normal matter is hydrogen! Stars like our Sun are powered by fusing hydrogen atoms into helium.
- Did you know? The periodic table wasn't completed all at once. When Mendeleev first published it in 1869, he left gaps for elements that hadn't been discovered yet -- and correctly predicted their properties! Gallium and germanium were found years later, matching his predictions.
- Did you know? Glass is technically not a solid or a liquid -- it's an "amorphous solid." Its atoms are arranged randomly like a liquid, but it's rigid like a solid. The old myth that glass "flows" over centuries in old windows is false, though.

Answer Key

1. D — Boiling point
2. B — Hardness
3. D — A balance or scale
4. A — Density
5. D — The sugar breaks into tiny particles too small to see but is still there
6. B — Oil is less dense than water
7. Metal conducts heat away from your hand faster than wood

8. Iron is magnetic but sand is not
9. How well a substance can dissolve in a liquid
10. The gas particles inside move faster and push outward more
    Matching (chemistry): 1→C, 2→E, 3→B, 4→D, 5→A
11. A — An atom
12. C — Protons, neutrons, and electrons
13. A — The number of protons in its atoms
14. B — Sodium
15. C — An atom is a single particle of an element; a molecule is two or more atoms bonded together
16. A — Protons and neutrons are in the central nucleus; electrons orbit in shells around it
17. They have equal numbers of positive protons and negative electrons
18. An element contains only one type of atom; a compound contains atoms of two or more different elements bonded together
19. It tells you the number of protons in each atom of that element
20. They have the same number of protons but different numbers of neutrons
    Matching (chemistry): 1→C, 2→E, 3→A, 4→D, 5→B
21. D — Similar chemical properties
22. D — Noble gases (Group 18)
23. C — Periods
24. B — On the left side and center
25. C — Both have one valence electron and react similarly with other elements
26. D — The atomic radius generally decreases
27. Metals have loosely held outer electrons that can move freely
28. Their outer electron shells are already completely filled
29. For main group elements, the ones digit of the group number equals the number of valence electrons
30. Electronegativity generally decreases going down a group

Matching (chemistry): 1→A, 2→B, 3→E, 4→D, 5→C

31. A — A new substance with different properties is formed
32. B — Yields or produces
33. B — Reactants
34. D — Synthesis reaction
35. A — Synthesis combines substances into one product; decomposition breaks one substance into multiple products
36. B — It speeds up the reaction without being consumed or permanently changed
37. The bubbles are carbon dioxide gas, a new substance not present in either the vinegar or baking soda
38. The number of atoms of each element is the same on both sides of the equation
39. A substance reacts with oxygen and releases energy, usually producing carbon dioxide and water
40. Exothermic releases energy to the surroundings; endothermic absorbs energy from the surroundings
    Matching (chemistry): 1→A, 2→C, 3→B, 4→D, 5→E
41. C — Two or more substances combined but not chemically bonded
42. C — Solution
43. A — Water
44. C — Filtration
45. B — A homogeneous mixture looks the same throughout; a heterogeneous mixture has visibly different parts
46. A — Water molecules surround and pull apart the salt crystals into individual sodium and chloride ions
47. Stirring moves fresh solvent to the surface of the solid, speeding up the dissolving process
48. Oil molecules are nonpolar and water molecules are polar, so they do not attract each other
49. A saturated solution cannot dissolve any more solute; an unsaturated one can still dissolve more
50. Increasing temperature usually allows more solid to dissolve

Matching (chemistry): 1→A, 2→E, 3→C, 4→D, 5→B

51. A — Solid
52. C — Sublimation
53. B — 0 degrees Celsius (32 degrees Fahrenheit)
54. B — Condensation
55. D — Gas particles have large spaces between them that can be squeezed together; liquid and solid particles are already close
56. D — The molecules gain energy, vibrate more, and break free from their fixed positions to slide past each other
57. The added energy is used to break intermolecular bonds rather than increase temperature
58. Sweat absorbs heat from your skin as it evaporates, cooling you down
59. Evaporation occurs at the surface at any temperature; boiling occurs throughout the liquid at the boiling point
60. Solid particles vibrate in place, liquid particles slide past each other, gas particles move freely in all directions
    Matching (chemistry): 1→A, 2→D, 3→E, 4→B, 5→C
61. C — How acidic or basic a solution is
62. C — 7
63. A — Hydrogen ion (H^+)
64. D — Red
65. B — It is a strong acid
66. A — Because it is a base that reacts with oils on your skin
67. The solution has more OH^- ions than H^+ ions
68. It breaks down food and kills harmful bacteria
69. The H^+ concentration increases by 100 times
70. Dilution spreads the H^+ ions across more water, lowering their concentration
    Matching (chemistry): 1→A, 2→E, 3→C, 4→D, 5→B
71. D — Matter cannot be created or destroyed in a chemical reaction
72. B — Antoine Lavoisier

73. A — The number of each type of atom
74. D — They show how many molecules or formula units of each substance are involved
75. C — 15 grams
76. C — No — gases like CO_2 and water vapor escape into the air, and the total mass of ash plus gases equals the original mass
77. 50 grams
78. To balance the hydrogen atoms — 4 hydrogen atoms on the left need 4 hydrogen atoms on the right
79. Changing subscripts would change the identity of the substance, while coefficients only change the amount
80. The iron combined with oxygen from the air to form iron oxide, adding the mass of the oxygen atoms
    Matching (chemistry): 1→A, 2→B, 3→C, 4→D, 5→E
81. A — A reaction that releases energy (usually as heat) to the surroundings
82. A — The minimum amount of energy needed to start a chemical reaction
83. A — The activation energy of the reaction
84. B — A reaction that absorbs energy from the surroundings, causing the surroundings to feel cold
85. A — Exothermic — the reaction releases heat to the surroundings (your hand), making it feel warm
86. B — An endothermic reaction — the chemicals absorb heat from the surroundings (your skin), so the pack feels cold
87. Molecules must have enough energy to break existing bonds before new bonds can form
88. The bonds in the products store less energy than the bonds in the reactants — the difference is released as heat
89. Endothermic — the reaction absorbs light energy from the sun to build glucose molecules
90. 2,670 kJ
    Matching (chemistry): 1→D, 2→B, 3→E, 4→A, 5→C
91. A — A bond formed by the transfer of electrons from a metal to a nonmetal,

creating oppositely charged ions that attract each other

92. B — A bond formed when two atoms share one or more pairs of electrons
93. D — The types and exact numbers of atoms in one molecule of a compound
94. A — A group of atoms covalently bonded together that carries an overall electric charge
95. C — NaCl has ionic bonds forming a strong crystal lattice that requires a lot of energy to break; H_2O has covalent bonds within molecules and weaker forces between molecules, requiring less energy to melt
96. D — Ionic compounds release free-moving ions (Na^+ and Cl^-) in solution that carry electric charge; sugar molecules dissolve without breaking into charged particles
97. A large difference in electronegativity (> ~1.7) means one atom pulls electrons much more strongly, leading to electron transfer and an ionic bond; a small difference means electrons are shared (covalent bond)
98. Each line represents a pair of shared electrons (a covalent bond) between two atoms
99. $CaCl_2$; Ca^{2+} and Cl^- — calcium loses 2 electrons and each chlorine gains 1, so two chlorines are needed
100. N_2O_4
    Matching (chemistry): 1→D, 2→E, 3→B, 4→A, 5→C
101. A — Carbon
102. B — A molecule made up of only hydrogen and carbon atoms
103. A — Methane
104. A — A large molecule made of many repeating smaller units called monomers
105. C — Organic compounds contain carbon bonded to other elements (especially hydrogen); inorganic compounds generally do not contain carbon-hydrogen bonds
106. D — A specific group of atoms within a molecule that determines the molecule's chemical properties and reactions
107. Carbon has 4 valence electrons, allowing it to form 4 stable covalent bonds in many configurations including chains, branches, and rings
108. Saturated hydrocarbons have only single bonds between carbon atoms;

unsaturated hydrocarbons have at least one double or triple bond

109. Plastics are long-chain molecules made by linking many small monomer molecules together through chemical reactions

110. Longer chains have higher boiling points and are more viscous because of stronger intermolecular forces between the larger molecules
Matching (Chemistry): 1→A, 2→B, 3→C, 4→E, 5→D

111. A — Gases in the atmosphere that trap heat from the sun, warming Earth's surface

112. D — A region of the upper atmosphere (stratosphere) with a high concentration of ozone (O_3) that absorbs harmful ultraviolet radiation from the sun

113. C — Sulfur dioxide (SO_2) and nitrogen oxides (NO_x) from burning fossil fuels react with water in the atmosphere to form sulfuric and nitric acids

114. B — The continuous movement of carbon atoms between the atmosphere, oceans, living organisms, and rocks through natural and human processes

115. A — How acidic or basic (alkaline) a solution is, on a scale from 0 to 14

116. B — The contamination of water bodies (rivers, lakes, oceans, groundwater) with harmful substances that make the water unsafe for organisms and human use

117. CO_2 absorbs infrared radiation (heat) that Earth's surface emits, re-radiating it back toward Earth rather than letting it escape to space

118. UV radiation in the stratosphere breaks CFCs apart, releasing chlorine atoms that catalytically destroy ozone molecules — one chlorine atom can destroy thousands of ozone molecules

119. The acid reacts with calcium carbonate in the stone, dissolving it through a chemical reaction that produces carbon dioxide, water, and dissolved calcium

120. Methane absorbs much more infrared radiation per molecule than CO_2 — about 80 times more warming potential over 20 years
Matching (Chemistry): 1→D, 2→E, 3→B, 4→C, 5→A

121. B — Hydrochloric acid + Sodium hydroxide → Sodium chloride + Water

122. D — 0.25 g/mL

123. C — 88.0 g of CO_2 — doubling the carbon (12→24 g) requires double the oxygen (32→64 g), and 24 + 64 = 88 g

124. A — They have different numbers of valence electrons, which determines chemical behavior

125. D — 100 degrees Celsius at standard atmospheric pressure
126. D — It would be much less useful because alphabetical order does not reveal patterns in chemical properties
127. Two or more substances combined but not chemically bonded
128. Density stays the same regardless of sample size, but mass changes with the amount
129. It speeds up the reaction without being consumed or permanently changed
130. It is a strong acid
Matching (chemistry): 1→D, 2→A, 3→E, 4→C, 5→B
131. A — A substance reacts with oxygen and releases energy, usually producing carbon dioxide and water
132. C — Oil is less dense than water
133. B — Decomposition reaction, requiring energy input such as electricity
134. A — Speed does not determine whether something is a chemical reaction; rusting produces a new substance (iron oxide)
135. C — Chlorine, a nonmetal
136. B — An atom
137. Sublimation
138. Chemical behavior depends on the number of protons and electrons, which are the same in both isotopes
139. 13 protons and 13 electrons
140. The claim is incorrect; solutions are one type of mixture, but suspensions and colloids are also mixtures
Matching (chemistry): 1→A, 2→B, 3→D, 4→C, 5→E
141. D — When ocean water evaporates, only the water molecules escape as vapor, leaving the salt behind
142. C — The metal has a greater density than water, and the wood has a lower density than water
143. D — Stirring moves fresh solvent to the surface of the solid, speeding up the dissolving process
144. C — 7.3 grams

145. D — Eventually the water becomes saturated and additional sugar will not dissolve, settling to the bottom
146. A — Periods
147. Place a dot of ink on filter paper, dip the edge in water, and let the water carry the dyes at different speeds
148. Crushing increases the total surface area exposed to the solvent
149. Around 7 (neutral)
150. Filtration
Matching (chemistry): 1→A, 2→B, 3→C, 4→E, 5→D
151. C — The iron combined with oxygen from the air to form iron oxide, adding the mass of the oxygen atoms
152. B — Hydrogen ion (H^+)
153. D — The equation is not balanced; it should be N2 + 3H2 -> 2NH3
154. C — For chemical reactions, the mass change from $E=mc^2$ is negligibly small (billionths of a gram) — conservation of mass is an excellent approximation for all chemistry
155. A — An atom is a single particle of an element; a molecule is two or more atoms bonded together
156. D — How well a substance can dissolve in a liquid
157. Baking soda (sodium bicarbonate)
158. Increasing temperature usually allows more solid to dissolve
159. Synthesis reaction
160. Burning wood is a chemical change because it produces new substances like carbon dioxide, water vapor, and ash
Matching (chemistry): 1→D, 2→C, 3→E, 4→B, 5→A
161. The periodic table! It currently has 118 confirmed elements.
162. An atom! The word comes from the Greek "atomos" meaning uncuttable.
163. An oxidation reaction! Combustion is a fast version, rusting is slow.
164. A covalent bond! Shared electrons create strong connections between non-metal atoms.

165. Isotopes! Carbon-14 is used to date ancient objects.
166. A gas! Gas particles have enough energy to overcome all intermolecular attractions.
167. An acid! Acids release hydrogen ions (H+) in water.
168. Water (H2O)! It's the only common substance found naturally in all three states.
169. Because they're cheaper than day rates!
170. HeHe!
171. Because all its friends argon!
172. If you can't helium and you can't curium, you might as well barium!
173. Because it had no point -- it was mostly empty space!
174. A chemis-tree!

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