PRACTICE EXAM 16: PHYSICAL SETTING/CHEMISTRY SIMULATION (85 QUESTIONS)

Passage A — Questions 1–5. Sodium (Na) is a soft, silvery metal with atomic number 11 and a mass number of 23 for its most common isotope. It reacts vigorously with water and is never found uncombined in nature. In compounds, sodium forms an ion with a +1 charge.

1. According to the passage, the number of protons in a sodium atom is

A. 23

B. 11

C. 12

D. 1

2. For the common isotope described, the number of neutrons in a sodium atom is

A. 11

B. 12

C. 23

D. 34

3. Sodium forms a +1 ion because it tends to

A. lose one electron

B. gain one electron

C. lose two electrons

D. share electrons

4. A neutral sodium atom has the electron configuration

A. 2-8

B. 2-8-8-1

C. 2-8-1

D. 2-7-2

5. Based on the passage, sodium is best classified as

A. a reactive metal

B. a noble gas

C. a nonmetal

D. a metalloid

Passage B — Questions 6–9. A student adds potassium nitrate to 100 grams of water at different temperatures and records how much dissolves. At 20 °C, 32 grams dissolve; at 40 °C, 64 grams dissolve; and at 60 °C, 110 grams dissolve. The student notes that when a hot saturated solution is cooled, solid crystals reappear.

6. The data show that as temperature increases, the solubility of potassium nitrate

A. increases

B. decreases

C. stays the same

D. increases, then decreases

7. In this investigation, the independent variable is the

A. mass of solid that dissolves

B. type of solid used

C. volume of the beaker

D. temperature of the water

8. Crystals reappear when the solution is cooled because the solubility of the solid

A. increases as it cools

B. is unaffected by cooling

C. decreases as it cools

D. turns into a gas

9. A solution holding all 110 grams dissolved at 60 °C, with no more able to dissolve, is best described as

A. unsaturated

B. dilute

C. supersaturated

D. saturated

Passage C — Questions 10–13. Methane (CH_4), the main component of natural gas, burns in oxygen to release energy used for heating and cooking. The balanced equation is $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$. The reaction gives off heat and light.

10. The reaction described is best classified as

A. decomposition

B. combustion

C. synthesis

D. neutralization

11. Because the reaction gives off heat, it is classified as

A. endothermic

B. exothermic

C. nuclear

D. neutral

12. In the equation, the coefficient 2 in front of O_2 indicates

A. two molecules of oxygen gas

B. two atoms of oxygen

C. two grams of oxygen

D. two moles of methane

13. According to the equation, the products of the reaction are

A. methane and oxygen

B. only water

C. carbon dioxide and water

D. carbon and hydrogen

Passage D — Questions 14–16. A laboratory technician tests several household liquids. Lemon juice turns blue litmus paper red and has a pH of 2. A solution of baking soda turns red litmus blue and has a pH of 9. Pure water has a pH of 7.

14. Based on its pH and litmus result, lemon juice is classified as

A. a base

B. an acid

C. neutral

D. a salt

15. The baking soda solution, with a pH of 9, is classified as

A. acidic

B. neutral

C. basic

D. a strong acid

16. Pure water, with a pH of 7, is classified as

A. acidic

B. basic

C. neutral

D. a strong base

Passage E — Questions 17–20. A radioactive isotope used in medical imaging has a half-life of 6 hours. A hospital receives a 160-milligram sample. The isotope decays by emitting beta particles, gradually changing into a stable element.

17. After 6 hours, the mass of the radioactive isotope remaining is

A. 80 mg

B. 160 mg

C. 40 mg

D. 0 mg

18. After 18 hours (three half-lives), the mass remaining is

A. 80 mg

B. 40 mg

C. 30 mg

D. 20 mg

19. The beta particles emitted by this isotope are

A. helium nuclei

B. protons

C. high-speed electrons

D. neutrons

20. The change of the isotope into a different stable element is called

A. ionization

B. transmutation

C. sublimation

D. neutralization

Passage F — Questions 21–24. A weather balloon is filled with helium gas at ground level, where the temperature is warm and the pressure is high. As the balloon rises, the surrounding air pressure drops and the temperature falls. The balloon is observed to expand as it climbs.

21. The balloon expands mainly because, as it rises, the lower surrounding pressure allows the gas to

A. cool down

B. become denser

C. lose mass

D. increase in volume

22. The relationship between the gas pressure and volume in this situation is described as

A. directly related

B. inversely related

C. unrelated

D. always equal

23. As the temperature of the gas falls, the average kinetic energy of its particles

A. increases

B. stays the same

C. decreases

D. becomes zero

24. Helium is chosen for the balloon partly because it is

A. denser than air

B. highly reactive

C. flammable

D. less dense than air and nonflammable

Passage G — Questions 25–28. Sodium chloride (table salt) forms when sodium transfers an electron to chlorine, producing positive and negative ions arranged in a repeating lattice. Solid salt does not conduct electricity, but when melted or dissolved in water, it conducts well. Salt has a high melting point.

25. The bond formed in sodium chloride is classified as

A. covalent

B. metallic

C. hydrogen

D. ionic

26. Sodium chloride has a high melting point because of the

A. weak forces between molecules

B. sharing of electrons

C. strong attractions between its ions

D. mobile electrons

27. Dissolved salt conducts electricity because dissolving

A. destroys the ions

B. removes all charges

C. frees the ions to move

D. makes the water nonpolar

28. Solid sodium chloride does not conduct electricity because its ions are

A. locked in fixed positions

B. completely neutral

C. shared equally

D. converted to gas

Passage H — Questions 29–32. A student investigates how surface area affects reaction rate. In one trial, a single large piece of zinc is added to acid; in another, the same mass of powdered zinc is added to identical acid. The powdered zinc reacts much faster, producing gas bubbles more quickly. The student keeps the acid concentration and temperature the same in both trials.

29. The data support the conclusion that increasing surface area

A. increases the reaction rate

B. decreases the reaction rate

C. has no effect on the rate

D. stops the reaction

30. To make this a fair test, the student kept constant the

A. surface area of the zinc

B. acid concentration and temperature

C. reaction rate

D. amount of gas produced

31. The powdered zinc reacts faster because it provides more

A. mass of zinc

B. surface area for collisions

C. acid concentration

D. heat energy

32. The gas bubbles produced when zinc reacts with acid are most likely

A. oxygen

B. carbon dioxide

C. hydrogen

D. nitrogen

Passage I — Questions 33–36. In Period 3 of the periodic table, the elements range from sodium, a soft reactive metal on the left, to chlorine, a reactive nonmetal on the right, ending with argon, an unreactive noble gas. Moving from left to right, the atoms become smaller and hold their electrons more tightly.

33. According to the passage, as you move from left to right across Period 3, the atomic radius

A. increases

B. stays the same

C. doubles

D. decreases

34. The statement that atoms "hold their electrons more tightly" toward the right means the ionization energy

A. decreases

B. increases

C. stays constant

D. drops to zero

35. Within Period 3, sodium is best described as

A. a noble gas

B. a reactive metal

C. a reactive nonmetal

D. a metalloid

36. Argon is unreactive because it has

A. one valence electron

B. seven valence electrons

C. a full outer electron shell

D. a positive charge

Passage J — Questions 37–40. A student slowly heats a beaker of ice and records the temperature. The ice warms to 0 °C and stays there while it melts. After melting, the liquid water warms steadily to 100 °C, where it stays constant while it boils into steam.

37. The temperature stays constant at 0 °C while the ice melts because the added energy is used to

A. raise the temperature

B. cool the ice

C. lower the pressure

D. change the solid into a liquid

38. The change from ice to liquid water at 0 °C is called

A. boiling

B. condensation

C. melting

D. sublimation

39. The constant temperature at 100 °C represents the substance's

A. boiling point

B. freezing point

C. melting point

D. room temperature

40. As heating continues, the water passes through the states in the order

A. solid, liquid, gas

B. gas, liquid, solid

C. liquid, solid, gas

D. solid, gas, liquid

Passage K — Questions 41–44. In the reaction $2\ H_2 + O_2 \rightarrow 2\ H_2O$, hydrogen gas reacts with oxygen gas to form water. A chemist notes that the gram-formula mass of water is 18 grams per mole and that one mole of any substance contains 6.02×10^{23} molecules.

41. According to the equation, the mole ratio of hydrogen gas to water produced is

A. 1 to 1

B. 2 to 2

C. 2 to 1

D. 1 to 2

42. The mass of 2 moles of water is

A. 18 g

B. 9 g

C. 20 g

D. 36 g

43. The number of molecules in one mole of water is

A. 18

B. 2

C. 6.02×10^{23}

D. 3.01×10^{23}

44. The combining of hydrogen and oxygen into water is best classified as a

A. decomposition reaction

B. single-replacement reaction

C. synthesis reaction

D. double-replacement reaction

Passage L — Questions 45–48. Hydrocarbons are organic compounds containing only carbon and hydrogen. Methane (CH_4) has only single bonds and is the simplest member of the alkane family. Ethene (C_2H_4) contains a double bond, while ethyne (C_2H_2) contains a triple bond.

45. Because it contains only single bonds, methane is classified as an

A. alkene

B. alkane

C. alkyne

D. alcohol

46. Containing a double bond, ethene is classified as an

A. alkene

B. alkane

C. alkyne

D. acid

47. Containing a triple bond, ethyne is classified as an

A. alkene

B. alkyne

C. alkane

D. ester

48. According to the passage, all of these compounds are hydrocarbons because they contain only

A. carbon and oxygen

B. carbon and hydrogen

C. hydrogen and oxygen

D. carbon and nitrogen

Passage M — Questions 49–52. A student heats 100 grams of water and measures its temperature rise. The specific heat of water is 4.18 joules per gram per kelvin. The student finds that adding 4,180 joules of heat raises the water's temperature by 10 kelvin.

49. Using $q = mC\Delta T$, the heat needed to raise 100 g of water by 10 K is

A. 4,180 J

B. 418 J

C. 41,800 J

D. 100 J

50. The specific heat of 4.18 J/g·K represents the energy needed to raise the temperature of

A. one mole of water by 1 K

B. 100 grams of water by 10 K

C. one gram of water by 1 K

D. one liter of water by 100 K

51. The instrument used to measure heat changes like this in a reaction is a

A. calorimeter

B. barometer

C. thermometer only

D. manometer

52. Because the water absorbs heat and its temperature rises, this process is

A. exothermic

B. a chemical change

C. combustion

D. endothermic

Passage N — Questions 53–56. A student is given a mixture of sand, salt, and water. The salt is dissolved in the water, but the sand is not. The student plans to separate the mixture using filtration to remove the sand and evaporation to recover the salt.

53. Filtration can separate the sand because the sand is

A. an insoluble solid

B. dissolved in the water

C. chemically bonded to water

D. a gas

54. Evaporation recovers the salt because, as the water evaporates, the salt

A. is left behind as a solid

B. evaporates with the water

C. turns into a gas

D. reacts with the air

55. Before separation, the dissolved saltwater is classified as a

A. compound

B. pure element

C. heterogeneous mixture

D. homogeneous mixture

56. The sand-and-water portion, with visibly separate parts, is classified as a

A. compound

B. homogeneous mixture

C. pure substance

D. heterogeneous mixture

Passage O — Questions 57–60. In a simple battery, zinc metal loses electrons while copper ions gain electrons. The flow of electrons through a wire provides electrical energy. The half-reaction $Zn \rightarrow Zn^{2+} + 2e^-$ occurs at one electrode.

57. In the half-reaction $Zn \rightarrow Zn^{2+} + 2e^-$, zinc loses electrons, so it undergoes

A. reduction

B. oxidation

C. neutralization

D. condensation

58. Because copper ions gain electrons, they undergo

A. oxidation

B. sublimation

C. ionization

D. reduction

59. A reaction that transfers electrons between substances, like this one, is classified as a(n)

A. oxidation-reduction reaction

B. neutralization reaction

C. decomposition reaction

D. phase change

60. A battery converts chemical energy into

A. nuclear energy

B. sound energy

C. light energy only

D. electrical energy

Passage P — Questions 61–64. A student seals 10 grams of baking soda and 20 grams of vinegar in a closed flask and records the total mass as 30 grams. After the two react and produce gas, the student measures the sealed flask again and finds the mass is still 30 grams.

61. The mass stays at 30 grams because the reaction follows the law of

A. definite proportions

B. conservation of mass

C. constant pressure

D. multiple proportions

62. This law states that mass is neither created nor

A. measured

B. destroyed

C. weighed

D. balanced

63. If the student had used an open container instead, the measured mass after the reaction would appear to

A. increase

B. stay exactly the same

C. decrease as gas escaped

D. double

64. The production of gas from the baking soda and vinegar is evidence of a

A. physical change

B. phase change

C. change of state

D. chemical change

Passage Q — Questions 65–68. A chemist prepares a solution by dissolving 2 moles of sodium hydroxide in enough water to make 1 liter of solution. Later, the chemist adds more water to dilute it. Molarity is defined as moles of solute per liter of solution.

65. The molarity of the original solution is

A. 0.5 M

B. 1 M

C. 4 M

D. 2 M

66. Adding more water to the solution will cause its concentration to

A. increase

B. decrease

C. stay the same

D. double

67. Because it produces hydroxide ions in solution, sodium hydroxide is classified as a

A. base

B. acid

C. salt

D. neutral substance

68. In this solution, the sodium hydroxide is the

A. solvent

B. precipitate

C. solute

D. catalyst

Passage R — Questions 69–72. Chlorine occurs naturally as two isotopes: chlorine-35, which makes up about 75% of samples, and chlorine-37, which makes up about 25%. Both isotopes have 17 protons. The average atomic mass listed on the periodic table is about 35.5.

69. Both isotopes are chlorine because they have the same number of

A. neutrons

B. electrons only

C. mass numbers

D. protons

70. Chlorine-35 and chlorine-37 differ in their number of

A. neutrons

B. protons

C. electrons

D. energy levels

71. The average atomic mass is closer to 35 than to 37 because chlorine-35 is

A. more abundant

B. less abundant

C. heavier

D. radioactive

72. The number of neutrons in an atom of chlorine-37 is

A. 17

B. 35

C. 37

D. 20

Passage S — Questions 73–76. In a sealed container, a reversible reaction reaches equilibrium when the forward and reverse reactions occur at the same rate. A chemist observes that adding more reactant causes the system to produce more product until a new balance is reached.

73. At equilibrium, the forward and reverse reactions occur at

A. different rates

B. zero rate

C. random rates

D. equal rates

74. Adding more reactant causes the equilibrium to shift toward

A. the reactants

B. no direction

C. the products

D. forming a solid

75. At equilibrium in the sealed container, the concentrations of reactants and products

A. continually rise

B. continually fall

C. drop to zero

D. remain constant

76. Equilibrium can be reached because the container is

A. open to the air

B. heated continuously

C. cooled rapidly

D. sealed (a closed system)

Passage T — Questions 77–80. Copper is widely used in electrical wiring and cooking pots. It is shiny, can be drawn into thin wires, and conducts both heat and electricity well. These properties result from the mobile electrons in metallic bonding.

77. The ability of copper to be drawn into thin wires is called

A. brittleness

B. ductility

C. conductivity

D. luster

78. Copper conducts electricity well because of its

A. fixed electrons

B. ionic lattice

C. mobile electrons

D. covalent bonds

79. The shiny appearance of copper is a property called

A. luster

B. malleability

C. density

D. ductility

80. The bonding that holds copper atoms together is classified as

A. ionic

B. covalent

C. metallic

D. hydrogen

Passage U — Questions 81–85. Carbon dioxide released from burning fossil fuels is a greenhouse gas that traps heat in the atmosphere. Sulfur dioxide from the same fuels reacts with water in the air to form acid rain, which lowers the pH of lakes. Limestone is sometimes added to acidic lakes to raise the pH.

81. Carbon dioxide is described as a greenhouse gas because it

A. cools the atmosphere

B. blocks all sunlight

C. produces oxygen

D. traps heat in the atmosphere

82. Acid rain lowers the pH of lakes, making them more

A. basic

B. acidic

C. neutral

D. saturated

83. Limestone is added to acidic lakes because it acts as a base that

A. neutralizes the acid and raises the pH

B. lowers the pH further

C. adds more acid

D. has no effect on pH

84. The reaction of sulfur dioxide with water to form an acid changes the rain's

A. pH

B. mass

C. color

D. temperature

85. The reaction between limestone (a base) and the acid in a lake is best classified as

A. combustion

B. decomposition

C. neutralization

D. synthesis

Practice Exam 16 – Explained Answer Key

1. B — The atomic number, given as 11, equals the number of protons in a sodium atom. The proton count defines the element. This is the fingerprint that makes the atom sodium.
2. B — The number of neutrons equals mass number minus atomic number, so 23 − 11 = 12. The mass number counts protons plus neutrons. Subtracting the protons isolates the neutrons.
3. A — Sodium forms a +1 ion by losing one electron, its single valence electron. Removing one negative charge leaves a net +1. This gives sodium a stable, noble-gas-like configuration.
4. C — Sodium's 11 electrons fill as 2-8-1, with two in the first level, eight in the second, and one in the third. Lower levels fill first. This leaves one valence electron in the outer level.
5. A — Sodium is a reactive metal, being soft, silvery, and quick to react with water. It loses electrons readily, the hallmark of a reactive metal. Its position on the far left confirms this.
6. A — The dissolved amount rises from 32 to 110 grams as temperature increases, so solubility increases. More thermal energy helps the solvent dissolve more solute. This is typical of solid solutes.
7. D — The independent variable is the factor the student deliberately changes, here the temperature of the water. Solubility is being tested against temperature. Only this variable is varied between trials.
8. C — Crystals reappear on cooling because the solubility of the solid decreases as temperature drops. The solution can no longer hold all the dissolved solute. The excess comes out as crystals.
9. D — A solution holding the maximum dissolved solute with no more able to dissolve is saturated. It is at the solubility limit. Any additional solute would not dissolve.
10. B — A hydrocarbon reacting with oxygen to form carbon dioxide and water is a combustion reaction. Methane burning in oxygen fits this definition. Combustion releases heat and light.
11. B — Because the reaction gives off heat, it is exothermic. The products hold less energy than the reactants, and the difference is released. Exothermic reactions transfer heat outward.
12. A — The coefficient 2 in front of O_2 indicates two molecules of oxygen gas. Coefficients count whole molecules or formula units. Each O_2 molecule contains two oxygen atoms.

13. C — The products, written to the right of the arrow, are carbon dioxide and water. These are the new substances formed. Methane and oxygen are the reactants.
14. B — Lemon juice turns blue litmus red and has a pH of 2, identifying it as an acid. Acids have a pH below 7 and turn blue litmus red. The low pH confirms its acidity.
15. C — The baking soda solution, with a pH of 9, is basic. Values above 7 indicate basicity. It also turns red litmus blue, a property of bases.
16. C — Pure water, with a pH of exactly 7, is neutral. Its hydrogen and hydroxide ion concentrations are equal. A pH of 7 is the midpoint of the scale.
17. A — After one half-life of 6 hours, half the 160-milligram sample remains, leaving 80 mg. Each half-life reduces the mass by half. The sample halves once in 6 hours.
18. D — After 18 hours, three half-lives have passed, so 160 → 80 → 40 → 20 mg. Each interval halves the remaining mass. Three halvings leave 20 mg.
19. C — Beta particles are high-speed electrons emitted from the nucleus. They carry a −1 charge. Beta emission raises the atomic number by one.
20. B — The change of the isotope into a different element is called transmutation. It alters the number of protons. This occurs in nuclear, not chemical, reactions.
21. D — The balloon expands because the lower surrounding pressure allows the gas to increase in volume. With less external pressure, the gas pushes outward. This follows Boyle's law.
22. B — As pressure decreases and volume increases, the two are inversely related. The product of pressure and volume stays roughly constant. This is Boyle's law behavior.
23. C — As the temperature falls, the average kinetic energy of the gas particles decreases. Temperature measures average kinetic energy. Cooler particles move more slowly.
24. D — Helium is chosen because it is less dense than air and nonflammable. Its low density lets the balloon rise, and its inertness makes it safe. Unlike hydrogen, it will not burn.
25. D — The transfer of an electron from sodium to chlorine forms an ionic bond. The resulting ions attract each other in a lattice. Electron transfer is the signature of ionic bonding.
26. C — Sodium chloride has a high melting point because of the strong attractions between its ions. These electrostatic forces require much energy to overcome. Strong ionic bonding raises the melting point.
27. C — Dissolved salt conducts electricity because dissolving frees the ions to move. Mobile charged particles carry the current. In solution, the ions are no longer locked in place.
28. A — Solid sodium chloride does not conduct because its ions are locked in fixed positions. They cannot move to carry a current. Only when melted or dissolved do the ions become mobile.
29. A — The powdered zinc reacting faster supports the conclusion that increasing surface area increases the reaction rate. More exposed surface allows more collisions. Surface area directly affects rate.
30. B — To make a fair test, the student kept the acid concentration and temperature constant. Controlling these isolates surface area as the variable. Only surface area should differ between trials.
31. B — The powdered zinc reacts faster because it provides more surface area for collisions. More exposed surface lets more acid particles collide with the zinc. This increases the reaction rate.
32. C — When a metal like zinc reacts with acid, it produces hydrogen gas. The bubbles are hydrogen. This is a typical metal-acid reaction.
33. D — Moving left to right across Period 3, the atoms become smaller, so the atomic radius decreases. The increasing nuclear charge pulls electrons in more tightly. This shrinks the atoms.

34. B — Holding electrons more tightly toward the right means the ionization energy increases. More energy is needed to remove an electron. This is the trend across a period.
35. B — Sodium is a reactive metal, soft and quick to react. It loses electrons readily, the mark of a reactive metal. It sits on the far left of Period 3.
36. C — Argon is unreactive because it has a full outer electron shell. The complete octet gives little tendency to react. This stability makes argon a noble gas.
37. D — The temperature stays constant at 0 °C because the added energy is used to change the solid into a liquid. During a phase change, energy breaks attractions rather than raising temperature. This produces the flat region.
38. C — The change from ice to liquid water at 0 °C is called melting. Solid becomes liquid as particles gain enough energy to move. It occurs at the melting point.
39. A — The constant temperature at 100 °C represents the boiling point. The liquid changes to gas while the temperature holds steady. This plateau marks boiling.
40. A — As heating continues, the water passes through solid, then liquid, then gas. Energy is added to melt and then boil the substance. This is the order of states with increasing energy.
41. B — The equation shows 2 H_2 producing 2 H_2O, a mole ratio of 2 to 2. Coefficients give the ratio of substances. The balanced equation sets this relationship.
42. D — The mass of 2 moles of water is $2 \times 18 = 36$ grams. Each mole has a mass of 18 grams. Multiplying by the number of moles gives the total mass.
43. C — One mole of water contains 6.02×10^{23} molecules, Avogadro's number. This constant defines the number of particles in a mole. It applies to any substance.
44. C — Hydrogen and oxygen combining into a single product, water, is a synthesis reaction. Simpler substances join into a more complex one. The single product marks synthesis.
45. B — Methane, with only single bonds, is classified as an alkane. Alkanes are saturated hydrocarbons. The single bonds define the class.
46. A — Ethene, containing a double bond, is classified as an alkene. The double bond and "-ene" ending define the class. Alkenes are unsaturated.
47. B — Ethyne, containing a triple bond, is classified as an alkyne. The triple bond and "-yne" ending define the class. Alkynes are unsaturated.
48. B — All of these compounds are hydrocarbons because they contain only carbon and hydrogen. This is the defining feature of hydrocarbons. Other elements would place them in a different class.
49. A — Using $q = mC\Delta T$, the heat is $100 \times 4.18 \times 10 = 4{,}180$ J. The heat scales with mass, specific heat, and temperature change. This matches the value given.
50. C — A specific heat of 4.18 J/g·K is the energy to raise one gram of water by one kelvin. The units express energy per gram per kelvin. This is the meaning of specific heat.
51. A — A calorimeter is the instrument used to measure heat changes in a reaction. It captures the energy absorbed or released. This makes it central to calorimetry.
52. D — Because the water absorbs heat and warms, the process is endothermic. Drawing in energy is the mark of an endothermic process. The absorbed heat raises the temperature.
53. A — Filtration separates the sand because the sand is an insoluble solid. It does not dissolve and is trapped by the filter. The dissolved salt passes through with the water.
54. A — Evaporation recovers the salt because, as the water evaporates, the salt is left behind as a solid. The dissolved salt does not evaporate with the water. The solid salt remains in the container.
55. D — The dissolved saltwater is a homogeneous mixture because its composition is uniform throughout. The salt is evenly distributed and indistinguishable. This is the definition of a homogeneous mixture.

56. D — The sand-and-water portion, with visibly separate parts, is a heterogeneous mixture. Its composition is not uniform. The sand and water are easily distinguished.
57. B — In $Zn \rightarrow Zn^{2+} + 2e^-$, zinc loses electrons, so it undergoes oxidation. Losing electrons raises the oxidation number. Oxidation is the loss of electrons.
58. D — Because copper ions gain electrons, they undergo reduction. Gaining electrons lowers the oxidation number. Reduction is the gain of electrons.
59. A — A reaction that transfers electrons between substances is an oxidation-reduction reaction. Oxidation and reduction occur together. This is the basis of how batteries work.
60. D — A battery converts chemical energy into electrical energy. The redox reaction drives a flow of electrons. That flow of electrons is the electric current.
61. B — The mass stays at 30 grams because the reaction follows the law of conservation of mass. Mass is not created or destroyed in the sealed flask. The products have the same mass as the reactants.
62. B — The law states that mass is neither created nor destroyed in a chemical reaction. Atoms are only rearranged. This is why the total mass stays constant.
63. C — In an open container, the produced gas would escape, so the measured mass would decrease. The escaping gas carries mass away from the container. The mass only appears to decrease because the gas leaves.
64. D — The production of gas from baking soda and vinegar is evidence of a chemical change. A new substance, the gas, has formed. New substances signal a chemical change.
65. D — Molarity is moles per liter, so 2 moles in 1 liter gives 2 M. Dividing the moles of solute by the volume gives the concentration. This is the original molarity.
66. B — Adding more water dilutes the solution, so its concentration decreases. The same solute is spread through more volume. Dilution lowers the molarity.
67. A — Because it produces hydroxide ions in solution, sodium hydroxide is a base. Bases release OH^- ions in water. This gives the solution a pH above 7.
68. C — The sodium hydroxide is the solute because it is the substance being dissolved. The water is the solvent. The solute is dispersed throughout the solvent.
69. D — Both isotopes are chlorine because they have the same number of protons, 17. The proton count defines the element. Their shared atomic number keeps them the same element.
70. A — Chlorine-35 and chlorine-37 differ in their number of neutrons. The different mass numbers reflect different neutron counts. The proton count stays the same.
71. A — The average atomic mass is closer to 35 because chlorine-35 is more abundant. The weighted average leans toward the more common isotope. Its 75% abundance pulls the average down toward 35.
72. D — The number of neutrons in chlorine-37 is $37 - 17 = 20$. The mass number minus the proton count gives the neutrons. Subtracting isolates the neutrons.
73. D — At equilibrium, the forward and reverse reactions occur at equal rates. This balance keeps concentrations constant. Both reactions continue even though no net change is seen.
74. C — Adding more reactant shifts the equilibrium toward the products. The system consumes the added reactant by making more product. This follows Le Châtelier's principle.
75. D — At equilibrium, the concentrations of reactants and products remain constant. The equal forward and reverse rates keep them steady. No net change in amounts occurs.
76. D — Equilibrium can be reached because the container is sealed, a closed system. Nothing enters or leaves, allowing the reverse reaction to occur. A closed system is required for equilibrium.

77. B — The ability of copper to be drawn into thin wires is called ductility. Ductile metals can be stretched without breaking. This property results from metallic bonding.
78. C — Copper conducts electricity well because of its mobile electrons. These delocalized electrons carry the current. Metallic bonding provides them.
79. A — The shiny appearance of copper is a property called luster. Metals reflect light, giving them a shine. Luster is a physical property of metals.
80. C — The bonding that holds copper atoms together is metallic. Metal atoms share a sea of mobile electrons. This bonding explains copper's conductivity and malleability.
81. D — Carbon dioxide is a greenhouse gas because it traps heat in the atmosphere. It absorbs and re-emits infrared energy. This warming effect drives climate concerns.
82. B — Acid rain lowers the pH of lakes, making them more acidic. A lower pH indicates greater acidity. The dissolved acids increase the hydrogen-ion concentration.
83. A — Limestone acts as a base that neutralizes the acid and raises the pH. The base reacts with and removes excess hydrogen ions. This restores healthier conditions in the lake.
84. A — The reaction of sulfur dioxide with water forms an acid, changing the rain's pH. The dissolved acid lowers the pH. This is what makes the rain acidic.
85. C — The reaction between limestone (a base) and the acid in a lake is a neutralization reaction. An acid and a base react to produce a salt and water. This raises the pH toward neutral.