SAT Chemistry Subject Mock Test

PART A

Directions: Each set of lettered choices below refers to the numbered statements or questions immediately following it. Select the one lettered choice that best fits each statement and then fill in the corresponding circle on the answer sheet. A given choice may be used once, more than once, or not at all in each set.

Note: For all questions involving solutions, assume that the solvent is water unless otherwise stated. Throughout the test the following symbols have the definitions specified unless otherwise noted.

H = enthalpy	T = temperature	L = liter(s)
M = molar	V = volume	mL = milliliter(s)
n = number of moles	atm = atmosphere(s)	mm = millimeter(s)
P = pressure	g = gram(s)	mol = mole(s)
R = molar gas constant	J = joule(s)	V = volt(s)
S = entropy	kJ = kilojoule(s)	

Questions 1–4 refer to the following topics and relationships:

a) Br_2 and Hg
b) Cl_2 and F_2
c) NH_4^+ and H_3O^+
d) Li and Na
e) Diamond and graphite

1. These two compounds are in the liquid phase at room temperature.
2. These two compounds are non-polar covalent molecules.
3. These two compounds have network covalent bonds.
4. These two compounds are good reducing agents.

Questions 5–7 refer to the following topics and relationships:

a) $\Delta E°$ is positive
b) $\Delta S°$ is negative
c) $\Delta G°$ is positive
d) $K_{eq} \ll 1$
e) $K_a \gg 1$

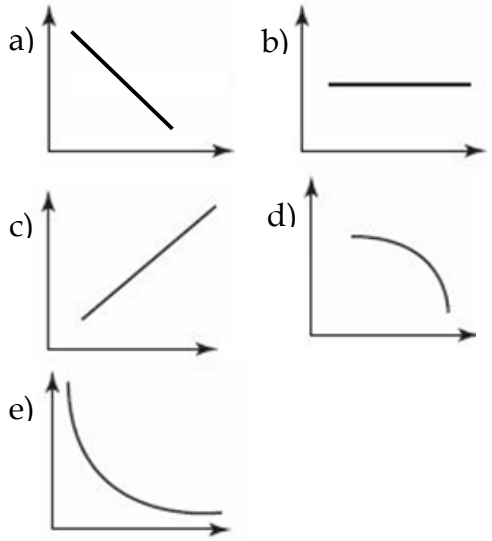
5. Indicates a strong acid
6. A reaction is nonspontaneous
7. Less chaos, disorder, and randomness

Questions 8–10 refer to the following topics and relationships:

a) 6.02×10^{23} molecules
b) 44.8 liters
c) 3.5 moles
d) 1.0 grams
e) 3.01×10^{23} atoms

8. 0.5 moles of H_2 at STP
9. 32 grams of O_2 at STP
10. 1.6 grams of CH_4 at STP

Questions 11–13 refer to the following topics and relationships:



11. Demonstrates the relationship between pressure (x-axis) and volume (y-axis) in Boyle's Law
12. Demonstrates the relationship between temperature (x-axis) and volume (y-axis) in Charles' Law
13. Demonstrates the relationship between temperature (x-axis) and pressure (y-axis) in Gay Lussac's Law

Questions 14–17 refer to the following topics and relationships:

a) Brownian movement
b) Litmus paper reaction
c) Phenolphthalein reaction
d) Hydrogen bonding
e) Tyndall Effect

14. The light scattering by particles in a colloid or particles in a fine suspension solution
15. The random motion of particles suspended in a fluid resulting from their collision
16. The pink color in a basic solution
17. Water creates stronger than normal surface tension.

Questions 18–21 refer to the following topics and relationships:

a) Purple color
b) Brown-orange color
c) Green color
d) Silver-gray color
e) Yellow-orange color

18. The color of mercury metal
19. The color of potassium permanganate solution
20. The flame color of sodium
21. The color of chlorine gas

Questions 22–25 refer to the following topics and relationships:

a) Alkali metals
b) Halogen
c) Noble gases
d) The carbon group
e) Transition metals

22. This group of elements is the least likely involved in the chemical reactions.
23. This group of elements reacts with water to release hydrogen.
24. This group of elements contains elements in gaseous, liquid, and solid states, in STP conditions.
25. Some of its elements show both the properties of both metals and non-metals.

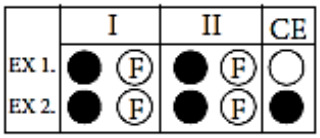
PART B

Directions: Each question below consists of two statements, I in the left-hand column and II in the right-hand column. For each question, determine whether statement I is true or false and whether statement II is true or false and then fill in the corresponding T or F circles on your answer sheet. Fill in circle CE only if statement II is a correct explanation of the true statement I.

On the actual Chemistry Test, the following type of question must be answered on a special section (labeled "Chemistry") at the lower left-hand corner of your answer sheet. These questions will be numbered beginning with 101 and must be answered according to the following directions.
Examples:

	I		II
EX 1.	H_2SO_4 is a strong acid	BECAUSE	H_2SO_4 contains sulfer.
EX 2.	An atom of oxygen is electrically neutral	BECAUSE	an oxygen atom contains an equal number of protons and electrons.

SAMPLE ANSWERS



101.	The element with an electron configuration of $[He]2s^1$ has a larger atomic radius than fluorine	BECAUSE	The element of $[He]2s^1$ has a greater nuclear charge than fluorine.
102.	Cl^- is the conjugate base of HCl	BECAUSE	A conjugate base is formed when an acid gains a proton.
103.	An electrolytic cell makes a nonspontaneous redox reaction	BECAUSE	An electrolytic cell uses an external current to push a redox reaction.
104.	An exothermic reaction has a negative ΔH	BECAUSE	In an exothermic reaction, the products have less potential energy than the reactants.
105.	CCl_4 is a polar molecule	BECAUSE	The dipoles for CCl_4 show counterbalance and symmetry.
106.	When 2 liters of oxygen gas react with 2 liters of hydrogen	BECAUSE	The coefficients in balanced equations of gaseous reactions

	completely, the limiting reactant is the oxygen		give the volume relationships of the reaction gases.
107.	At constant temperature, the relationship between pressure and volume is considered to be an inverse relationship for an ideal gas	BECAUSE	As pressure increases on a gas, the volume of the gas will decrease.
108.	A catalyst will change the heat of reaction	BECAUSE	A catalyst will lower the potential energy of the activated complex in a reaction.
109.	Propane is considered to be a saturated hydrocarbon	BECAUSE	Propene has a triple bond.
110.	Water is a polar substance	BECAUSE	The sharing of the bonding electrons in water is unequal.
111.	NH_3 can best be collected by water displacement.	BECAUSE	NH_3 is a polar substance.
112.	Molten KCl conducts electricity	BECAUSE	KCl has metallic bonding.
113.	Increasing the concentration of reactants will cause a reaction to proceed faster	BECAUSE	More reactants will lower the activation energy of a reaction.
114.	The oxidation state of Cr in $Al_2(Cr_2O_7)_3$ is +3	BECAUSE	As a neutral compound, the sum of oxidation numbers of all the atoms must equal zero.
115.	An 0.5 m of NaCl(aq) solution will freeze at a temperature below 272K	BECAUSE	As a solute is added to a solvent, the boiling point increases while the freezing point decreases.

PART C

Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and then fill in the corresponding circle on the answer sheet.

26. What is the molar mass of ethanol (C_2H_5OH)?
    a) 34.2
    b) 38.9
    c) 46.1
    d) 45.1
    e) 62.1

27. The shape of a PCl_3 molecule is described as
    a) bent.
    b) trigonal pyramidal.
    c) linear.
    d) trigonal planar.
    e) tetrahedral.

28. What is the general formula of the compound of alkaline earth metal oxide?
    a) M_2O
    b) MO
    c) MO_2
    d) M_2O_3
    e) M_3O_2

29. Which of the following is used to determine cell voltages when standard state conditions are not present?
    I. Nernst equation
    Il. spontaneous reaction
    III. reduction
    IV. oxidation
    V. electrolysis
    a) I
    b) II
    c) III
    d) IV
    e) V

30. $A + B \rightarrow 2C \ \Delta H = +150$ kcal
    $C \rightarrow 2D + 2E \ \Delta H = -450$ kcal
    $F \rightarrow 4D + 4E \ \Delta H = +725$ kcal
    According to the reactions above, what is the heat of reaction for $A + B \rightarrow F$?
    a) -1475 kcal
    b) +25 kcal
    c) -1025 kcal
    d) +325 kcal
    e) +300 kcal

31. Which of the following statements is true?
    a) Water has bent molecular geometry and one lone pair of electrons.
    b) Ammonia has trigonal pyramidal molecular geometry and two lone pairs of electrons.
    c) Methane has trigonal planar molecular geometry.
    d) Carbon dioxide is linear because it has one single bond and one triple bond.
    e) The carbon atoms in ethane are sp^3 hybridized.

32. When methane, CH_4, burns in excess oxygen, what would the product(s) be?
    a) CH_4O_2
    b) $CO + H_2O$
    c) $CO + CH_2OH$
    d) $CO_2 + H_2O$
    e) $CO_2 + 2H_2$

33. $2A(g) + B(g) + \text{Heat} \rightarrow 3C(g) + D(g)$
    According to the equation above, what

could be done to the reaction to shift the equilibrium to the right?

a) Increase the concentration of D.
b) Increase the concentration of C.
c) Increase the temperature.
d) Increase the pressure.
e) Remove B from the reaction.

34. The standard reduction potential of $Cu^{+2}(aq)$ is +0.34 V. What is the oxidation potential of Cu(s)?

a) +0.68 V
b) +0.34 V
c) – 0.34 V
d) – 0.68 V
e) None of the above

35. Sodium metal cannot be electrolyzed from an aqueous Na_2SO_4 solution because

a) the voltage needed is too high for any available instrument to achieve.
b) water is reduced to O_2 first.
c) Na^+ has a high reduction potential that keeps it from being reduced.
d) H^+ has a more favorable reduction potential than Na^+.
e) Na^+ does electrolyze, but it immediately reacts with water again.

36. Which of the following solutions is expected to be the weakest electrolyte?

a) HCl(aq)
b) HF(aq)
c) NaOH(aq)
d) KI(aq)
e) $HClO_4$(aq)

37. How many grams of Na_2SO_4 can be produced by reacting 98 g H_2SO_4 with 40 g NaOH?

a) 18 g
b) 36 g
c) 71 g
d) 142 g
e) 150 g

38. An atom has the following ionization energies:

I_1 = 589.8 kJ/mole
I_2 = 1145.4 kJ/mole
I_3 = 4912.4 kJ/mole
I_4 = 6491 kJ/mole

These values most likely correspond to which of the following elements?

a) Ne
b) Li
c) I
d) Ca
e) Al

39. Which of the following substances is used as a moderator in a nuclear reactor?

a) Marble
b) Hydrogen
c) Tritium
d) Graphite
e) Diamond

40. When an equal number of moles of each are mixed, which of the following can be used to prepare a buffer solution?

I. $Cu(NH_3)_4^{+2}$
II. KOH
III. HCO_3^-
IV. CO_3^{-2}
V. SO_3^{-2}

a) I and II only
b) II and III only
c) III and IV only
d) IV and V only
e) V and I only

41. An ideal gas has a volume of 10 L at 20 ℃ and 750 mm Hg. Which of the following expressions is needed to determine the volume of the same amount of gas at STP?

a) $10 \times (750/760) \times (0/20)$
b) $10 \times (750/760) \times (293/273)$
c) $10 \times (760/750) \times (0/20)$
d) $10 \times (760/750) \times (273/293)$
e) $10 \times (750/760) \times (273/293)$

42. Given $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s) + 820$ kJ, how much heat is released if 0.5 moles of sodium reacts completely with chlorine?
    a) 205.0 kJ
    b) 411 kJ
    c) 822 kJ
    d) 1,644 kJ
    e) 3,288 kJ

43. What is ΔH_{rxn} for the decomposition of 1 mole of sodium chlorate? (ΔH_f values are as follows: $NaClO_3(s) = -85.7$ kcal/mole; $NaCl(s) = -98.2$ kcal/mole; $O_2(g) = 0$ kcal/mole)
    a) −183.9 kcal
    b) −91.9 kcal
    c) +45.3 kcal
    d) +22.5 kcal
    e) −12.5 kcal

44. A solution is prepared in which $[Sr^{+2}] = [Ba^{+2}] = 4.0 \times 10^{-4}$ M. NaF is slowly added to the solution at 25 °C. The Ksp for BaF_2 is 2.4×10^{-5} and the Ksp for SrF_2 is 7.9×10^{-9} at 25 °C. Which of the following is true?
    I. The first compound that will precipitate is SrF_2.
    II. There is a concentration of F^- at which SrF_2 will precipitate but not BaF_2.
    III. There is no concentration of F^- at which SrF_2 and BaF_2 will both precipitate.
    a) I only
    b) II only
    c) I and II only
    d) II and III only
    e) I, II, and III

45. Which of the following pieces of glassware requires a careful reading of the meniscus?
    a) Watch glass
    b) Burette
    c) Beaker
    d) Flask
    e) Funnel

46. The valence electrons in the main group are
    a) all electrons in an atom beyond the preceding noble gas.
    b) all outermost electrons in a sublevel.
    c) s and any p electrons in the highest energy level or shell.
    d) electrons in the last unfilled sublevel.
    e) any electrons that can ionize.

47. How many milliliters of 1.5 M HCl are needed to titrate 30.0 mL of 1.0 M NaOH?
    a) 10.00 mL
    b) 30.00 mL
    c) 20.00 mL
    d) 35.00 mL
    e) 40.00 mL

48. Which of the following compounds is insoluble in water?
    a) $Ca(OH)_2$
    b) Fe_2S_3
    c) Na_2CO_3
    d) H_2SO_3
    e) $AuCl_3$

49. One reason for a double displacement reaction to go to completion is that

a) a product is soluble.
b) a product is given off as a gas.
c) the products can react with each other.
d) the products are miscible.
e) the products are a strong acid.

50. Which of the following is true of an electrolytic cell?
a) An electric current causes an otherwise non-spontaneous chemical reaction to occur.
b) Reduction occurs at the anode.
c) A spontaneous electrochemical reaction produces an electric current.
d) The electrode to which the electrons flow is where oxidation occurs.
e) None of the above

51. A gas at STP that contains 6.02×10^{23} atoms and forms diatomic molecules will occupy
a) 11.2 L.
b) 22.4 L.
c) 33.6 L.
d) 67.2 L.
e) 1.06 quarts.

52. The collision theory explains the reaction rates of chemical reactions using which of the following?
I. Activation energy
II. Molecule orientation
III. Potential energy curve
IV. Frequency
V. Activated complex
a) I and III only
b) II only
c) I, II, and IV only
d) IV only
e) I, III, and V only

53. The units of work are given as L atm. To convert L atm to the metric unit of joules, we need to know
a) Avogadro's constant.
b) Planck's constant.
c) the universal gas law constant in units of J mol^{-1} K^{-1}.
d) gravity constant.
e) All of the above

54. Which of the following statements is FALSE?
a) The empirical formula for butyne is C_2H_3.
b) The empirical formula for ammonia is NH_3.
c) The empirical formula of CH_2O is $C_6H_{12}O_6$.
d) Ionic compounds are written as empirical formulas.
e) The empirical and molecular formulas for methane are the same.

55. Which of the following organic structures is propane?
a) $CH_3—CH_2—CH_3$
b) $CH_3—CO—OH$
c) $CH_3—O—CH_2—CH_3$
d) $CH_3—CH_2—NH_2$
e) $CH_3—CO—CH_3$

56. What is the pH of a 0.100 M solution of K_2HPO_4? (For H_3PO_4, $pK_1 = 2.15$, $pK_2 = 7.20$, $pK_3 = 12.35$)
a) 1.00
b) 13.00
c) 9.78
d) 6.67
e) 4.10

57. An electron with the four quantum numbers 3, 2, −1, −½ may be the electron in an unfilled sublevel of
    a) Ti.
    b) Co.
    c) Pd.
    d) Fe.
    e) Ag.

58. Which of the following substances would dissociate completely when placed into excess amounts of distilled water?
    a) C_2H_5OH
    b) $HC_2H_3O_2$
    c) $LiNO_3$
    d) $Mg(OH)_2$
    e) All of these will dissociate completely in water.

59. Which of the following indicate(s) a basic solution?
    I. Litmus paper turns blue.
    II. Phenolphthalein turns pink.
    III. Hydronium ion concentration is greater than hydroxide ion concentration.
    a) I only
    b) II only
    c) III only
    d) I and II only
    e) I, II, and III

60. Based on the relationship of entropy to the degree of disorder of a system, which of the following processes may represent a decrease in entropy?
    I. The freezing of water
    II. The vaporization of water
    III. Sublimation (vaporization) of dry ice, solid CO_2
    IV. The extraction of Mg and pure water from seawater
    a) I and II only
    b) II and IV only
    c) I and IV only
    d) III only
    e) II and III only

61. Which two items are most closely related to each other?
    I. Osmotic pressure
    II. Freezing-point depression
    III. Vapor pressure
    IV. Raoult's law
    V. Henry's law
    a) I and III
    b) II and V
    c) III and IV
    d) IV and V
    e) V and I

62. Which of the following is the most likely to increase the rate of a reaction?
    a) Decreasing the temperature
    b) Increasing the volume of the reaction vessel
    c) Reducing the activation energy
    d) Decreasing the concentration of the reactant in the reaction vessel
    e) Reducing the pressure

63. Sodium carbonate (Na_2CO_3) is the least soluble in which of the following liquids?
    a) CH_3OH
    b) CF_3COOH
    c) H_2O
    d) $CH_3(CH_2)_4CH_3$
    e) $CHCl_3$

64. Which of the following solution(s) has/have a concentration of 1.0 M?
    I. 40 grams of sodium hydroxide is dissolved to make 1 liter of solution.
    II. 111 grams of calcium chloride is dissolved to make 1 liter of solution.
    III. 119 grams of potassium bromide is dissolved to make 1 liter of solution.
    a) I only
    b) III only
    c) I and III only
    d) II and III only
    e) I, II, and III

65. The emission of a beta particle results in a new element with the atomic number
    a) increased by 1.
    b) increased by 2.
    c) decreased by 1.
    d) decreased by 2.
    e) no change.

66. Which of the following is the acid anhydride of a monoprotic acid?
    a) CaO
    b) SO_3
    c) FeO
    d) CO_2
    e) N_2O_5

67. How many phosphine molecules are in two moles of phosphine?
    a) 1.807×10^{24}
    b) 3.476×10^{24}
    c) 1.171×10^{24}
    d) 1.204×10^{24}
    e) 2.414×10^{24}

68. Which of the following is a physical property?
    a) Flammability
    b) Magnetism
    c) A color change in clothes due to exposure to light
    d) Freezing
    e) Burning

69. Which molecule(s) below exhibit(s) resonance?
    I. AsF_5
    II. HNO_3
    III. SO_2
    a) I only
    b) II only
    c) II and III only
    d) III and IV only
    e) I, II, and III

70. All of the following may determine the molar masses. Which one requires ideal solution for the accurate results?
    a) Freezing-point depression
    b) Boiling-point elevation
    c) Osmotic pressure
    d) Vapor pressure
    e) Gas density