2017 Chemistry Entrance Exam

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EDUCATIONAL ASSESSMENT AND EXAMINATIONS SERVICE (EAES) ETHIOPIAN SECONDARY SCHOOL LEAVING CERTIFICATE EXAMINATION (ESSLCE) CHEMISTRY, SENE, 2017 E.C /JUNE/JULY, 2025 G.C

NUMBER OF ITEMS: 80 **SUBJECT CODE:** 05

TIME ALLOWED: 2:30 HOURS **BOOKLET CODE:** 417

1. Which one of the following CORRECTLY shows the relative charges of an electron, proton and neutron, respectively?

A. 0, +1, -1 C. -1, +1, 0

B. 0, -1, +1 D. -1, 0, +1

2. Which statement below CORRECTLY describes the Bohr's model of an atom?

A. Protons and electrons are found in the nucleus.

B. Electrons and neutrons are found in the nucleus.

C. Protons move in circular orbits around the nucleus.

D. Electrons move in circular orbits around the nucleus.

3. Which statement below CORRECTLY describes periodicity? Periodicity is

A. a regular repetition of chemical and physical properties in the Periodic Table.
B. a row in the Periodic Table which contains elements with same number of shells.
C. a measure of electronegativity which runs from least electronegative to most electronegative elements.
D. a column of the Periodic Table which contains elements with similar chemical properties.
4. Which statement below CORRECTLY expresses hydrogen bonding? It is formed by bonding
A. a hydrogen atom to an element such as sodium.
B. a hydrogen atom to an element such as oxygen.
C. two hydrogen atoms with equal sharing of electrons.
D. two hydrogen atoms with unequal sharing of electrons.
5. What is the bond formed between two or more atoms by sharing of electrons?
A. Ionic bond C. Covalent bond
B. Metallic bond D. Valence bond
6. Which statement below CORRECTLY describes dipole-dipole forces? It is the force that exists
A. in all molecules.
B. between polar molecules.
C. between non-polar molecules.
D. between polar and non-polar molecules.
7. Comparing the forces between molecules of similar molar masses, which one of the following produces the weakest force?
A. Covalent bonds. C. Ionic forces.
B. Hydrogen bonding. D. Van der-Waal's forces.
8. What is a limiting reactant? It is the reactant that
A. regenerated at the end of the reaction.
B. remains unreacted as the reaction proceeds.
C. present in excess when the reaction goes to completion.
D. completely consumed when the reaction goes to completion.
9. Which statement below CORRECTLY distinguishes redox and non-redox reactions?
A. Electrons are transferred in redox reactions but not in non-redox reactions.
B. Reduction occurs in redox reactions and oxidation takes place in non-redox reactions.
C. Oxidation number remains the same in both redox and non-redox reactions.
D. Acid-base reactions can be considered as both redox and non-redox reactions.
10. Given the reaction C(s) + CO2(g) ⇌ 2CO(g) What is the equilibrium constant expression for the reaction?
A. $[CO]^2 / [C][CO_2]$ C. $[CO]^2 / [C]$
B. $[CO]^2 / [CO_2]$ D. $[C][CO_2] / [CO]^2$
11. Which of the following pair of substances can be considered as examples of the liquid state of matter at room temperature and 1 atm pressure?

A. Carbon and mercury C. Water and mercury
B. Water and carbon dioxide D. Carbon and carbon monoxide
12. Which gas law describes the behavior of gases using the variables: temperature, volume, pressure and number of moles?
A. Ideal gas law C. Avogadro's law
B. Boyle's law D. Combined gas law
13. Which statement below describes CORRECTLY the assumptions in the kinetic theory of gases?
A. Gas molecules occupy a finite volume and have indefinite shape.
B. Gas molecules are in random motion with no interactions.
C. The average kinetic energies of gas molecules are independent of temperature.
D. The average kinetic energies of gas molecules are independent of the amount of gas.
14. If the rate of diffusion of a certain unknown gas is half times the rate of diffusion of helium, what will be the molar mass of the unknown gas? (Atomic mass of He= 4.0 g/mole)
A. 2.0 g/mole C. 16.0 g/mole
B. 8.0 g/mole D. 32.0 g/mole
15. A student added boiling chips into a beaker of water while carrying out an activity to determine the boiling point of water. Why do you think the boiling chips are necessary?
A. To ensure smooth rate of evaporation
B. To speed up the rate of evaporation
C. To maintain constant temperature and pressure
D. To reach the boiling point with less consumption of heat
16. What is the oxidation number of manganese in $KMnO_4$? Atomic Number K=19, Mn= 25 and O=16
A. +5 C. +7
B. +6 D. +8
17. Aluminum reacts with oxygen to form aluminum oxide. What is the coefficient of aluminum after balancing the reaction? Atomic number of Al=13, O=16
A. 2
B. 4
C. 6
D. 8
18. What property of an ionic compound can be investigated by heating it in a crucible?
A. Melting point
B. Solubility
C. Malleability
D. Crystallization point
19. Silver has two known isotopes, 107Ag and 108Ag with their percent abundance of 52

A. 107.89
B. 108.06
C. 107.48
D. 108.86

20. Which reaction scheme below illustrates the formation of a cation?

A. $Na \rightarrow Na+ + e^-$
B. 2Cl- → Cl_2 + 2e-
C. $S + 2e- \rightarrow S^{2-}$
D. $Mg^{2+} + 2e- \rightarrow Mg$

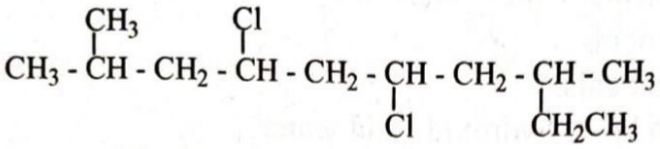
21. Which law governs the fact that the ratio of the amount of hydrogen to oxygen by weight will be the same in a drop of water and a lake of water?

A. Law of relative composition
B. Law of conservation of mass
C. Law of multiple proportions
D. Law of definite composition

22. Which statement below CORRECTLY describes the characteristics of chemical equilibrium?

A. A reaction stops when it reaches equilibrium.
B. A reaction stops if sufficient amount of time is given.
C. The rates of the forward and reverse reactions are equal.
D. A new substance or substances are formed when equilibrium is attained.

23. What is the **CORRECT** IUPAC nomenclature of the following alkane?



A. 5, 7 – dichloro – 3, 9 - dimethyldecane
B. 4, 6 – dichloro – 2, 8 - dimethyldecane
C. 4, 6–dichloro–2–ethyl –8 - methylnonane
D. 4, 6 –dichloro–8-ethyl-2- methylnonane

24. What is the name given to compounds of carbon and hydrogen containing multiple bonds?

A. Aliphatic hydrocarbons
B. Aromatic hydrocarbons
C. Saturated hydrocarbons
D. Unsaturated hydrocarbons

25. 2–methyl–1–butene is one of the isomers of C_5H_{10}. Which of the following is the **CORRECT** structural formula of this isomer?

A. $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH = CH_2$

C. $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{C}} = CH - CH_3$

B. $CH_3 - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{C}} = CH_2$

D. $CH_3 - CH = CH - CH_2 - CH_3$

26. Which of the following organic compounds is used for the production of 1, 2-ethanediol?

A. Ethene

B. Ethane

C. Ethyne

D. Ethanol

27. Which of the following is the main constituent of natural gas?

A. Ethane

B. Butane

C. Propane

D. Methane

28. In order to avoid the decrease in quality of some clothes after washing with water, which of the following chemicals is used for dry cleaning?

A. CH4

B. CH2Cl2

C. C2H4

D. C2Cl4

29. Which of the following properties is the property of an acidic oxide? An acidic oxide reacts with

A. salts to form acids.

B. water to form acids.

C. bases to form basic hydroxide and water.

D. basic oxides to form hydroxides and water.

30. What is the name given to an acid that dissociates (ionizes) only to a slight extent in aqueous solution?

A. Dilute acid

B. Strong acid

C. Weak acid

D. Concentrated acid

31. Solutions can be classified based upon their pH values. What is a solution whose pH value 13?

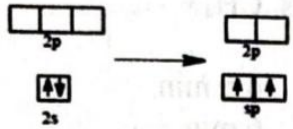
A. Amphoteric solution

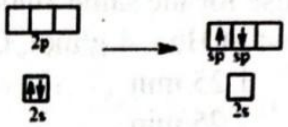
B. Acidic solution
C. Neutral solution
D. Basic solution
32. During laboratory class, a student placed clean water in a beaker and added pieces of calcium metal using tongs. After the reaction is completed, he/she tested the solution using red litmus paper. Which of the following will be observed?
A. The litmus paper turns to blue.
B. The litmus paper turns to red.
C. The litmus paper maintains its color.
D. The litmus paper turns to colorless.
33. In an activity during laboratory session a small amount of lead bromide ($PbBr_2$) crystals were placed in a beaker. Two electrodes are inserted until they are in contact with the $PbBr_2$ crystals. When the $PbBr_2$ crystals in the beaker are gently heated, which of the following will be observed?
A. Bromine gas is evolved at the anode
B. Bromide ion is oxidized at the cathode
C. Lead (II) ion is reduced at the anode
D. Lead (II) ion is oxidized at the cathode
34. What is the name given to the pollution caused by the dumping of non-biodegradable wastes into the environment?
A. Air pollution
B. Land pollution
C. Sound pollution
D. Water pollution
35. What is the purpose of the conversion of pig iron to steel?
A. To remove impurities by oxidation
B. To remove impurities by reduction
C. To increase the concentration of iron in the pig iron
D. To decrease the concentration of iron in the pig iron
36. Which of the following statements CORRECTLY describes the law of conservation of mass?
A. The total mass of substances varies during a chemical reaction.
B. Mass is neither created nor destroyed during a chemical reaction.
C. A particular compound is composed of the same elements in the same parts by mass.
D. Pure compounds always contain the elements in the same percentage by mass.
37. A mineral absorbs purple light of frequency 7.11 × 10^14 Hz. What is the wavelength (in nm) of the absorbed light? (C = 3.00 × 10^8 m/s)
A. 184.4 nm
B. 237.5 nm

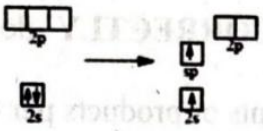
C. 421.9 nm
D. 514.5 nm
38. Why do atoms absorb energy when their electrons undergo transitions from a lower energy to a higher energy level? This is because,
A. the electrons of the atoms move from one orbit of lower radius to another one having larger radius.
B. the electrons of the atoms move from one orbit of higher radius to another one having lower radius.
C. the electrons of the atoms do not have allowable energy levels.
D. electrons of the atoms absorb energy when they go from higher to lower energy.
39. What are the quantum numbers for the 5s orbital?
A. n=5, l=0, m_l=-1, ms=±1/2
B. n=5, l=1, m_l=-2, ms=±1/2
C. n=5, l=2, m_l=-2, ms=±1/2
D. n=5, l=0, m_l=0, ms=±1/2
40. Which of the following is CORRECT about the set of quantum numbers assigned to the two electrons of the helium atom?
A. Both electrons have the same four quantum numbers.
B. The second electron occupies the same orbital as the first with the same spin quantum number.
C. The second electron occupies the same orbital as the first with the opposite spin quantum number.
D. The magnetic quantum numbers of both electrons are different.
41. Scandium (Sc) has the electron configuration [Ar] 4s^2 3d^1. To which group of elements does it belong to?
A. Representative elements
B. Transition elements
C. Inner transition elements
D. Nonmetals
42. A student carried out an experiment to determine the melting points of NaCl and $CuCl_2$. He/she added 0.2 g of NaCl and $CuCl_2$ into two different test tubes and heated both tubes simultaneously using a Bunsen burner. Which of the following statements is CORRECT regarding the melting point of NaCl and $CuCl_2$?
A. The melting points of NaCl are lower than that of $CuCl_2$.
B. The melting point of NaCl is higher than that of $CuCl_2$.
C. Both NaCl and $CuCl_2$ will start to melt at the same time.
D. Both NaCl and $CuCl_2$ will not melt.
44. What is the cause of unusual high boiling points of HF, H_2O and NH_3?

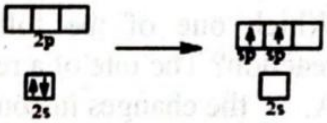
A. Dipole-Dipole forces
B. Induced dipole forces
C. Hydrogen bonding
D. Ion-dipole forces

45. Which one of the following **CORRECTLY** illustrates the hybridization of orbitals of Be in the molecule $BeCl_2$?

A. 

C. 

B. 

D. 

46. What is the electron configuration of O_2^- molecule as per the molecular orbital model? (Atomic number of O = 8)

A. $\sigma_{1s}^2 \sigma^*_{1s}^2 \sigma_{2s}^2 \sigma^*_{2s}^2 \sigma_{2px}^2 (\pi_{2py}^2 = \pi_{2pz}^2) (\pi^*_{2py}^2 = \pi^*_{2pz}^1)$
B. $\sigma_{1s}^2 \sigma^*_{1s}^2 \sigma_{2s}^2 \sigma^*_{2s}^2 \sigma_{2px}^2 (\pi_{2py}^2 = \pi_{2pz}^2) (\pi^*_{2py}^2 = \pi^*_{2pz}^2)$
C. $\sigma_{1s}^2 \sigma^*_{1s}^2 \sigma_{2s}^2 \sigma^*_{2s}^2 \sigma_{2px}^2 (\pi_{2py}^2 = \pi_{2pz}^2) (\pi^*_{2pz}^2)$
D. $\sigma_{1s}^2 \sigma^*_{1s}^2 \sigma_{2s}^2 \sigma^*_{2s}^2 \sigma_{2px}^2 (\pi_{2py}^2 = \pi_{2pz}^2) (\pi^*_{2py}^1 = \pi^*_{2pz}^1)$

47. Which of the following factors does NOT affect the rate of a chemical reaction having solid reactants?
A. Concentration of reactants
B. Temperature of reaction
C. Physical state of reactants
D. Volume of reaction vessel

48. At a particular temperature, the equilibrium constant, K_c = 0.36 for the reaction

$$SO_3(g) \rightleftharpoons SO_2(g) + O_2(g)$$

In an experiment, 1.00 mol of SO_3 is introduced into a 1.00 L container. It was found that there is 0.50 mol of SO_2 at equilibrium in the same volume. Which of the following predictions can be drawn from the given data?
A. The reaction is at equilibrium.
B. The reaction will proceed to the left.
C. The reaction will proceed to the right.
D. It is not possible to predict the direction of the reaction.

49. What is the density of methane (CH_4) at a pressure of 900 torr and a temperature of 25°C? (R = 0.082 atm L/mol·K, 1 atm = 760 torr)

A. 0.78 C. 1.25

B. 0.92 D. 9.2

50. It takes 2.25 minutes for 0.02 mol of He to diffuse. How long will it take to diffuse for the same amount of methane gas, CH_4? (M.wt of He = 4 g/mol, CH_4 = 16 g/mol)

A. 1.25 min C. 4.5 min

B. 2.25 min D. 6 min

51. Which one of the following statement CORRECTLY defines rate of reaction? The rate of a reaction is

A. the changes in concentration of reactants or products per unit time.

B. the measure of the amount of energy change in a chemical reaction.

C. the study of necessary mechanisms occurred in a chemical reaction.

D. the measure of the rate of diffusion of different gases inside a tube.

52. Consider the following gaseous reversible reaction is at a state of equilibrium: $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$

Which of the following changes in concentration will cause the equilibrium shift to the right?

A. Decreasing the concentrations of the reactants and products equivalently.

B. Increasing the concentration of the reactants and products equivalently.

C. Increasing the concentrations of the reactants and decreasing the concentration of the product.

D. Decreasing the concentrations of the reactants and increasing the concentration of the product.

53. Consider the following equilibrium reaction at 298 K: $2NO2(g) \rightleftharpoons 2NO(g) + O2(g)$

PnO2 = 0.75 atm PnO = 2.5×10^{-5} P02= 3.5×10^{-5} atm

What is the equilibrium constant (Kp) at this temperature?

A. 5.2×10^{-15} C. 2.9×10^{-14}

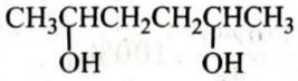
B. 1.16×10^{-9} D. 3.9×10^{-14}

54. The molecule of BrF_5 has both bonding and lone pair of electrons. Based upon these electrons, which one the CORRECT molecular geometry of the molecule of BrF_5?

A. Square planar C. Trigonal pyramidal

B. Square pyramidal D. Trigonal bipyramidal

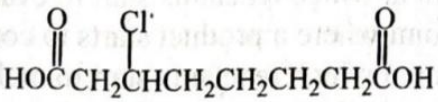
55. Consider the structure of an alcohol shown below:



What type of an alcohol is it?

A. Tertiary alcohol
B. Polyhydric alcohol
C. Primary alcohol
D. Dihydric alcohol

56. What is the IUPAC name of the following carboxylic acid?



A. 5-chlorooctanoic acid
B. 3-chlorooctanedioic acid
C. 2-chlorooctanedioic acid
D. 3-chlorooctanoic acid

57. Which of the following statements CORRECTLY describes the relationship among wavelength, frequency and speed in an electromagnetic radiation?

A. As the wavelength increases, the frequency increases.

B. As the wavelength decreases, the frequency increases.

C. As the wavelength decreases, the speed of light increases.

D. As the frequency increases, the speed of light decreases.

58. Which of the following organic compounds has the highest boiling point?

A. Ethanol C. Ethanal

B. Ethene D. Ethane

59. What is a Lewis base? It is

A. proton donor C. electron pair acceptor

B. proton acceptor D. electron pair donor

60. Given the following information:

$CH_3COOH\ (aq) \rightleftharpoons CH_3COO^-\ (aq) + H^+\ (aq)$

Initial concentration (mol/L) 0.2 0 0

Change -x +x +x

Equilibrium concentration 0.2 - x x x

Which of the following expression represent for the percent ionization of CH_3COOH?

A. (x / 0.2 - x) . 100%

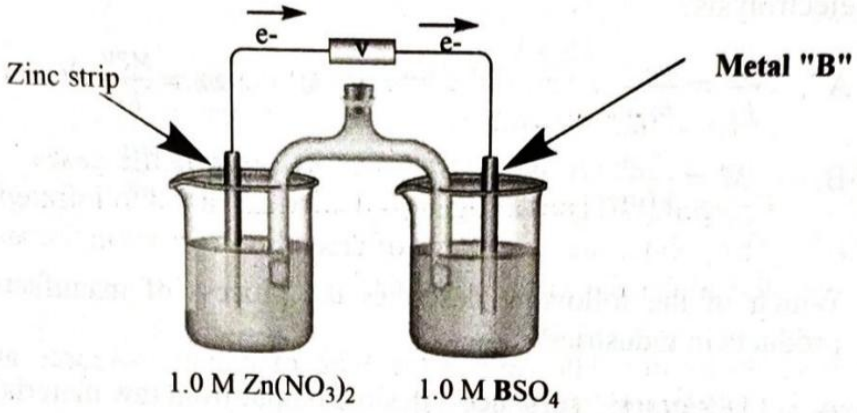
B. (x / 0.2) . 100%

C. (0.2 - x / 0.2) . 100%

D. (0.2 / x) . 100%

61. Which statement distinguishes equivalence point from end point in acid base titration?
A. Equivalence point is a point at which reactants starts to evaporate whereas end point is the point where a product starts to condense.
B. Equivalence point is a point at which reactants start to melt whereas end point is the point where products start to freeze.
C. Equivalence point is a point at which the indicator changes color whereas end point is the point where an acid has completely reacted with a base.
D. End point is a point at which the indicator changes color whereas equivalence point is the point where an acid has completely reacted with a base.
62. Which one is the mathematical expression for Faraday's first law of electrolysis?
A. $m_1 / E_1 = m_2 / E_2$
B. M = n / V(liter)
C. m = MPV / RT
D. m = Mit / nF
63. Which of the following describes the process of manufacturing valuable products in industries?
A. Designing to produce a desired output from raw materials using energy through different steps.
B. Discharging of a solid, liquid or gaseous substance into an environment that causes unwanted changes.
C. Carry out unwanted reaction of a material that result in the dissolution or consumption of the material.
D. Manufacturing industry uses only in organic chemicals in the production of valuable products.
64. Which of the following reaction shows the action of H_2SO_4 as oxidizing agent?
A. $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$
B. $2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$
C. $Cu(s) + 2H_2SO_4(aq) \rightarrow CuSO_4(aq) + SO_2(g) + H_2O(l)$
D. $Mg_3N_2(s) + 4H_2SO_4(aq) \rightarrow 3\ MgSO_4(aq) + (NH_4)_2SO_4(aq)$
65. Which type of glass is made by heating a mixture of silica, sodium carbonate and limestone?
A. Quartz C. Pyrex
B. Borosilicate D. Soda-lime

66. Consider the following galvanic cell:



When the Zn strip was connected to metal "B" at 25°C, the cell potential reading on the voltmeter shows 0.51 V. Which of the following is the standard reduction potential of metal "B"? ($E^0_{Zn^{2+}/Zn} = -0.76\,V$)

A. $E^0_{B^{2+}/B} = -0.25\,V$
B. $E^0_{B^{2+}/B} = -1.27\,V$
C. $E^0_{B^{2+}/B} = 0.25\,V$
D. $E^0_{B^{2+}/B} = 1.27V$

67. Which of the following polymer is used to make ropes, clothes, hair combs and stockings?
A. Perspex
B. Nylon
C. Teflon
D. Bakelite
68. Which of the following catalyst is used in the Ostwald process for the production of HNO3?
A. Pt
B. V_2O_5
C. Fe
D. CuO
69. In which of the following component of the environment does photosynthesis take place?
A. Atmosphere
B. Hydrosphere
C. Lithosphere
D. Biosphere
70. Which of the following is NOT true about greenhouse effect and greenhouse gases?
A. Greenhouse effect is the trapping of the infrared radiation by certain gases in the atmosphere.
B. Carbon dioxide and water vapor are green-house gases.
C. Oxygen (O2) and nitrogen (N2) are transparent to infrared radiation

D. The greater the percentage of green-house gases in the atmosphere, the cooler the earth should be.

71. In which of the following is the type of natural resource and the given example CORRECTLY paired?

A. Renewable resources; copper

B. Renewable resources; crops

C. Non-Renewable Resources; animal wool

D. Non-Renewable Resources; water

72. Which of the following compound is a Bronsted-Lowry base?

A. BF3

B. NH3

C. HCl

D. H2S

73. For the dissociation of HNO2: HNO2(aq) ⇌ NO2-(aq) + H+(aq)

What is the percent ionization of a 0.5 M solution of HNO_2? (Ka of HNO2 = 7.1×10^{-4})

A. 0.2 %

B. 1.8%

C. 3.8 %

D. 9.1%

74. A 0.47 M aqueous solution of a weak base has a pOH of 2. What is Kb for the weak base?

A. 2.17×10^{-4}

B. 3.14×10^{-3}

C. 1.0×10^{-2}

D. 4.4×10^{-1}

75: A student was given a standard Zn(s)/Zn^2+(aq) half-cell and another half-cell containing copper immersed in 1.00 M CuSO4(aq). When the Zn was connected as the anode at 25°C, the cell potential reading on the voltmeter shows 1.1 V. Which of the following is NOT correct regarding the cell potential measurement?

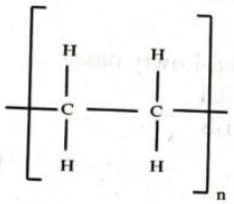
A. The mass of copper was increased during the cell potential measurement

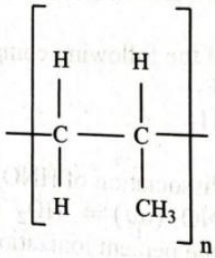
B. The circuit is completed inside the cell by migration of ions through the salt bridge.

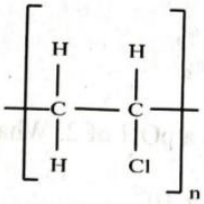
C. The zinc electrode was dissolved and the blue color CuSO4 solution would fade.

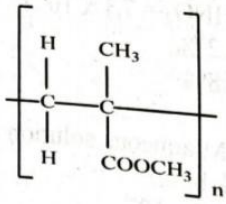
D. Electrons travel through the external circuit from copper cathode to the zinc anode.

76. Which of the following polymer structure represent polypropylene?

A. 

C. 

B. 

D. 

77. The following reaction can be used for the synthesis of $CH_3CH{=}CHCH_3$ as a desired product.

$$CH_3CH_2CHBrCH_3 + CH_3S^- \rightarrow CH_3CH{=}CHCH_3 + CH_3SH + Br^-$$

Which of the following is the atom economy for the above reaction? (Atomic masses: H=1; C=12; S=32 and Br=80)

A. 30.43%
B. 48%
C. 56%
D. 80%

78: Which of the following process involves preventing the growth of bacteria, fungi and reducing the oxidation of fats?

A. Haber-Bosch: Industrial process for ammonia production.

B. Tanning: Treatment of animal skin to make leather.

C. Food preservation: The correct answer. Methods like canning, pickling, drying, salting, and adding preservatives are used to prevent spoilage.

D. Contact: Another industrial process.

79: Which of the following is the overall reaction for electrolysis of molten NaCl?

A. Na(l) + 1/2 Cl2(g) -> Na^+(l) + Cl^-(l): This is the reverse reaction (formation of NaCl), not electrolysis.

B. Na^+(l) + Cl^-(l) -> Na(l) + 1/2 Cl2(g): This is the correct reaction.

C. H2(g) + 1/2 O2(g) -> H2O(g): Electrolysis of water.

D. H2O(g) -> H2(g) + 1/2 O2(g): Electrolysis of water.

80: Which of the following occur during the electrolysis of dilute H2SO4?

A. $SO4^{2-}$ is discharged at the anode:

B. The overall reaction is: H2(g) + 1/2 O2(g) -> H2O(g):

C. H+ is discharged at the negative electrode:
D. A basic solution is formed: During electrolysis of H2SO4, H+ is reduced and water is oxidized, which makes the solution more acidic than it was before, not basic.

ANSWER KEY

1. Which one of the following CORRECTLY shows the relative charges of an electron, proton, and neutron, respectively?

Answer: D. -1, 0, +1

Explanation: Electrons have a charge of -1, protons have +1, and neutrons are neutral (0). *Why not others?* Options A, B, and C misassign the charges (e.g., A assigns 0 to the proton).

2. Which statement CORRECTLY describes Bohr's model of an atom?

Answer: D. Electrons move in circular orbits around the nucleus.

Explanation: Bohr's model states electrons orbit the nucleus in fixed paths. Protons/neutrons reside in the nucleus. *Why not others?* A, B, and C incorrectly place electrons/protons in orbits or the nucleus.

3. Which statement CORRECTLY describes periodicity?

Answer: A. A regular repetition of chemical and physical properties in the Periodic Table.

Explanation: Periodicity refers to trends repeating across periods/groups (e.g., atomic radius, electronegativity). *Why not others?* B describes a "period," C describes electronegativity trends (not periodicity itself), and D describes a "group."

4. Which statement CORRECTLY expresses hydrogen bonding?

Answer: B. A hydrogen atom bonded to an element such as oxygen.

Explanation: Hydrogen bonding occurs when H is bonded to highly electronegative atoms (e.g., O, N, F). *Why not others?* A (sodium) forms ionic bonds, C/D describe covalent bonds between H atoms.

5. What bond is formed by sharing electrons?

Answer: C. Covalent bond

Explanation: Covalent bonds involve electron sharing. Ionic bonds involve electron transfer; metallic bonds involve delocalized electrons.

6. Which statement CORRECTLY describes dipole-dipole forces?

Answer: B. Between polar molecules.

Explanation: Dipole-dipole forces occur between polar molecules with permanent dipoles.

Why not others? Non-polar molecules lack dipoles; these forces are not universal.

7. Which produces the weakest intermolecular force for similar molar masses?

Answer: D. Van der Waals forces

Explanation: Van der Waals (London dispersion) forces are weaker than hydrogen bonding, ionic, or covalent forces.

8. What is a limiting reactant?

Answer: D. Completely consumed when the reaction goes to completion.

Explanation: The limiting reactant is fully used up, limiting product formation.

Why not others? B/C describe the excess reactant.

9. Which CORRECTLY distinguishes redox and non-redox reactions?

Answer: A. Electrons are transferred in redox reactions but not in non-redox reactions.

Explanation: Redox involves electron transfer; non-redox (e.g., acid-base) does not.

Why not others? B confuses reduction/oxidation; C is false (oxidation numbers change in redox).

10. Equilibrium constant for C(s)+CO2(g)⇌2CO(g)*C*(*s*)+*CO*2 (*g*)⇌2*CO*(*g*)?

Answer: B. [CO]2/[CO2]

Explanation: Solids (like C) are excluded from equilibrium expressions. Only gases appear. **11.**

Examples of liquids at room temperature and 1 atm?

Answer: C. Water and mercury

Explanation: Water (H_2O) and mercury (Hg) are liquids. Others are gases (CO_2, CO) or solids (carbon).

12. Which gas law uses temperature, volume, pressure, and moles?

Answer: A. Ideal gas law (PV=nRT*PV*=*nRT*)

Explanation: The ideal gas law incorporates all four variables. Boyle's, Avogadro's, and Combined laws use subsets.

13. CORRECT assumption in kinetic theory of gases?

Answer: B. Gas molecules are in random motion with no interactions.

Explanation: Kinetic theory assumes no intermolecular forces and random motion.

Why not others? A: Gases have negligible volume; C/D: Kinetic energy depends on temperature.

14. Molar mass of unknown gas with half the diffusion rate of He?

Answer: C. 16.0 g/mol

- **Explanation**: By Graham's law: $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$.

  Given $r_{\text{unknown}} = \frac{1}{2} r_{\text{He}}$, $M_{\text{He}} = 4$:

$$\frac{1/2}{1} = \sqrt{\frac{4}{M_{\text{unknown}}}} \implies M_{\text{unknown}} = 16\ \text{g/mol}.$$

15. Why add boiling chips to water?

Answer: A. To ensure a smooth rate of evaporation

Explanation: Boiling chips prevent bumping by providing nucleation sites for bubbles.

16. Oxidation number of Mn in $KMnO_4$?

Answer: C. +7

Explanation: K = +1, O = -2 (×4 = -8). For $KMnO_4$: $+1+Mn+(-8)=0 \implies Mn=+7$.

17. Coefficient of Al in Al+O2→Al2O3Al+O2 →Al2 O3 ?

Answer: B. 4

Explanation: Balanced equation: 4Al+3O2 →2Al2 O3 . Aluminum has coefficient 4.

18. Property tested by heating ionic compounds?

Answer: A. Melting point

Explanation: Heating determines melting point. Solubility, malleability, and crystallization are tested differently.

19. Average atomic mass of Ag with 52% ^{107}Ag and 48% ^{108}Ag?

Answer: C. 107.48

Explanation:

(107×0.52)+(108×0.48)=55.64+51.84=107.48.

20. Reaction illustrating cation formation?

Answer: A. Na→Na++e−Na→Na++*e*−

Explanation: Loss of electron forms a cation (Na^+). Others show anion formation (C) or reduction (D).

21. Which law governs the fact that the ratio of hydrogen to oxygen by weight is the same in a drop of water and a lake of water?

Answer: D. Law of definite composition

- **Explanation**: This law states that a compound always contains the same elements in the same proportion by mass. Water (H_2O) has a fixed H:O mass ratio of 1:8, regardless of quantity.
- *Why not others?*
  - A: "Law of relative composition" is not a standard term.
  - B: Conservation of mass deals with total mass in reactions, not element ratios.
  - C: Law of multiple proportions applies when elements form multiple compounds (e.g., CO vs. CO_2).

22. Which statement CORRECTLY describes chemical equilibrium?

Answer: C. The rates of the forward and reverse reactions are equal.

- **Explanation**: At equilibrium, forward and reverse reaction rates are equal, so concentrations remain constant (but reactions do not stop).
- *Why not others?*
  - A/B: Reactions continue but with no net change.
  - D: No new substances form at equilibrium.

23. What is the CORRECT IUPAC name for the given alkane?

Answer: B. 4,6–dichloro–2,8-dimethyldecane

- **Explanation**: The structure is a 10-carbon chain (decane) with:
  - Chlorine at C4 and C6.
  - Methyl groups at C2 and C8.
- *Naming rules*: Number the chain to give the lowest locants (2,4,6,8), list substituents alphabetically (chloro before methyl).

24. Name for carbon-hydrogen compounds with multiple bonds?

Answer: D. Unsaturated hydrocarbons

- **Explanation**: These contain double/triple bonds (e.g., alkenes, alkynes).
- *Why not others?*
  - A: Aliphatic includes both saturated (single bonds) and unsaturated.
  - B: Aromatic refers to benzene-like rings.

- C: Saturated hydrocarbons have only single bonds.

25. CORRECT structure for 2-methyl-1-butene?

Answer: A. CH3−CH−CH=CH2 (with CH_3 branch on the middle CH)

- **Explanation**: 2-Methyl-1-butene is CH2=C(CH3)−CH2CH3 . Option A represents CH3 −CH(CH3)−CH=CH2 , which is equivalent when numbered as a 4-carbon chain with a double bond at C1 and methyl at C2.
- *Why not others?*
  - B: Represents butyne (incorrect bond type).
  - C: Is 2-butyne.
  - D: Is 2-pentene.

26. Organic compound used to produce 1,2-ethanediol (ethylene glycol)?

Answer: D. Ethanol

- **Explanation**: Ethanol is dehydrated to ethene, which is oxidized to ethylene oxide and hydrolyzed to 1,2-ethanediol. (Note: Options A–C are identical typos; ethene is the direct precursor, but ethanol is the only logical choice given.)

27. Main constituent of natural gas?

Answer: D. Methane

- **Explanation**: Natural gas is 70–90% methane (CH_4).

28. Chemical used for dry cleaning?

Answer: D. C_2Cl_4 (tetrachloroethylene)

- **Explanation**: Tetrachloroethylene dissolves oils without water, preventing fabric damage.
- *Why not others?*
  - A: CH_4 (methane) is flammable.
  - B: CH_2Cl_2 (dichloromethane) is less common.
  - C: C_2H_4 (ethylene) is not used.

29. Property of acidic oxides?

Answer: B. Reacts with water to form acids.

- **Explanation**: Acidic oxides (e.g., CO_2, SO_2) produce acids in water: CO2+H2O→H2CO3
- *Why not others?*

- A: Acidic oxides react with bases, not salts.
- C: Reacts with bases to form salt + water, not hydroxide.
- D: Reacts with basic oxides to form salts.

30. Acid that dissociates slightly in water?

Answer: C. Weak acid

- **Explanation**: Weak acids (e.g., CH_3COOH) partially ionize in water.

31. Solution classification by pH?

Answer: D. Basic solution (for pH > 7)

- **Explanation**: Basic solutions have pH > 7 due to higher $[OH^-]$.

32. Observation after adding calcium to water and testing with red litmus?

Answer: A. Litmus turns blue.

- **Explanation**: Calcium reacts:
  $Ca+2H2O \rightarrow Ca(OH)2+H2$

  $Ca(OH)_2$ is basic, turning red litmus blue.

33. Observation when heating $PbBr_2$ crystals with electrodes?

Answer: A. Bromine gas evolved at the anode.

- **Explanation**: Molten $PbBr_2$ undergoes electrolysis:
- Anode (oxidation): $2Br- \rightarrow Br2+2e-$
- Cathode (reduction): $Pb2++2e- \rightarrow Pb$

34. Pollution from non-biodegradable waste dumping?

Answer: B. Land pollution

- **Explanation**: Non-biodegradable waste (e.g., plastic) accumulates in soil, causing land pollution.

35. Purpose of converting pig iron to steel?

Answer: A. To remove impurities by oxidation.

- **Explanation**: Oxygen oxidizes impurities (C, Si, P) in pig iron, reducing carbon content to make steel.

36. CORRECT description of the law of conservation of mass?

Answer: B. Mass is neither created nor destroyed in a chemical reaction.

- **Explanation**: Total mass of reactants = total mass of products.

37. Wavelength of light with frequency 7.11×10147.11×1014 Hz?
Answer: C. 421.9 nm

- **Explanation**:
  λ=cν=3.00×108m/s7.11×1014Hz=4.219×10−7m=421.9nm.$\lambda = \frac{v}{c}$ =7.11×1014Hz3.00×108m/s = 4.219×10−7m=421.9nm.
  38. Why do atoms absorb energy when electrons jump to higher levels?
  Answer: A. Electrons move to orbits with larger radius.
- **Explanation**: In Bohr's model, electrons absorb energy to jump to higher orbits (larger radius).

---

39. Quantum numbers for the 5s orbital?

Answer: D. n=5, l=0, m_l=0, m_s=±1/2

- **Explanation**:
  - s orbital: l = 0 → m_l = 0.
  - m_s can be +½ or -½ (spin up/down).

40. CORRECT about quantum numbers for helium's electrons?
Answer: C. The second electron occupies the same orbital with opposite spin.

- **Explanation**: Both electrons are in the 1s orbital. Pauli exclusion principle requires opposite spins (m_s = +½ and -½).

41. Answer: B. Transition elements
Explanation: Scandium has a partially filled d-orbital ($3d^1$), which is the defining feature of transition metals.
42. **Answer: B. The melting point of NaCl is higher than that of $CuCl_2$.**
Explanation: NaCl has stronger ionic bonds due to the 1:1 ratio, while $CuCl_2$ has a more complex structure with partially covalent character, giving it a slightly lower melting point.
43. The molecule **$COCl_2$** (phosgene) has a **trigonal planar** geometry around the central carbon atom. The central carbon forms:

- A double bond with oxygen
- Two single bonds with chlorine atoms

This means it adopts approximately **120° bond angles**, but due to **electronegativity and resonance effects**, these angles are slightly distorted:

- **Oxygen is more electronegative** and has a double bond, pulling electrons more strongly, **increasing** the **Cl–C–O** bond angles slightly **above 120°**.
- As a result, the **Cl–C–Cl** bond angle is **slightly less than 120°**.

44. **Answer: C. Hydrogen bonding**
Explanation: These molecules form strong hydrogen bonds, significantly increasing their boiling points.
45. $BeCl_2$ is a **linear molecule** with bond angle of **180°**. Beryllium forms **two sigma bonds** and has **no lone pairs** in this compound.
To form two equivalent bonding orbitals, the Be atom undergoes **sp hybridization**:

- One 2s orbital and one 2p orbital combine to form **two sp hybrid orbitals**.

Correct Answer: C
Explanation: Option C correctly shows:

- The ground state of Be: full 2s orbital and empty 2p orbitals.
- Then **one electron from 2s is promoted**, and **2s and one 2p hybridize** to form two **sp orbitals**, each with one electron, ready for bonding with Cl atoms.

46. O_2^- (superoxide ion) has **17 electrons** total:
- Oxygen has 8 electrons × 2 = 16
- The extra negative charge adds 1 electron → **17 electrons**

MO configuration for **O_2** (atomic number ≥ 8):
This configuration corresponds to:
Correct Answer: D
Explanation:
- The 17th electron goes into the π*2py orbital, resulting in an **unpaired electron**, consistent with **paramagnetism** of O_2^-.

47. **Answer: D. Volume of reaction vessel**
Explanation: For solid-phase reactions, surface area, temperature, and concentration matter, but volume has negligible direct effect.
48. **Answer: C. The reaction will proceed to the right.**
Explanation: Calculate Q and compare with Kc (0.36).
$Q = ([SO_2]^2 \times [O_2]) / [SO_3]$
$Q = (0.5^2 \times 0.25) / 0.5 = 0.125 < 0.36$, so system shifts right to reach equilibrium.
49. **Answer: C. 1.25 g/L**
Explanation: Use ideal gas law:
Density=PMRT\text{Density} = \frac{PM}{RT}Density=RTPM
Convert 900 torr to atm = 1.184 atm
ρ=1.184×160.082×298≈1.25 g/L\rho = \frac{1.184 \times 16}{0.082 \times 298} \approx 1.25 \, \text{g/L}ρ=0.082×2981.184×16 ≈1.25g/L
50.

50. He diffuses in 2.25 min. How long for CH_4?

Answer: C. 4.5 min

Explanation: Graham's law:

$$\frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}} = \sqrt{\frac{16}{4}} = 2$$

So, time = 2 × 2.25 = **4.5 min**

51. **Answer: A. The changes in concentration of reactants or products per unit time.**
Explanation: This is the standard definition of reaction rate.
52. **Answer: C. Increasing reactants and decreasing product**
Explanation: Adding more reactants and removing product shifts equilibrium to the right (Le Chatelier's Principle).

53. **Answer: D. 3.9×10^{-14}**
Explanation:
$Kp = (PNO)^2 \times PO_2 / (PNO_2)^2$
$= (2.5\times10^{-5})^2 \times (3.5\times10^{-5}) / (0.75)^2$
$\approx$ **3.9×10^{-14}**
54. Answer: B. Square pyramidal
Explanation: BrF_5 has 5 bonding pairs and 1 lone pair → square pyramidal geometry (based on VSEPR theory).
55. This molecule contains **two –OH (hydroxyl) groups** on different carbon atoms, so it's:

- **Not primary** (which would have –OH on a carbon attached to only one other carbon),
- **Not tertiary** (which would have –OH on a carbon attached to three other carbons),
- **Not polyhydric** (term usually used for alcohols with more than two –OH groups).

Since it has exactly **two hydroxyl groups**, it's called a:
Correct Answer: D. Dihydric alcohol
Structure:
$HOOC–CH_2–CH(Cl)–CH_2–CH_2–CH_2–CH_2–COOH$

- It has **8 carbon atoms** (octane backbone).
- It contains **2 carboxylic acid groups** (–COOH at both ends), so it is a **dioic acid** → **octanedioic acid**.
- A chlorine (Cl) atom is on **carbon 3** (counting from the leftmost –COOH group for lowest locant).

Correct Answer: B. 3-chlorooctanedioic acid
57. **Answer: B. As wavelength decreases, frequency increases.**
Explanation: $c = \lambda \times \nu$ → inverse relationship between wavelength and frequency.
58. **Answer: A. Ethanol**
Explanation: Ethanol has hydrogen bonding, increasing its boiling point over ethene, ethane, or ethanal.
59. **Answer: D. Electron pair donor**
Explanation: Lewis base = substance that donates a pair of electrons.
60. **Answer: B. (x / 0.2) × 100%**
Explanation:
Percent ionization = (amount ionized / initial concentration) × 100%
= (x / 0.2) × 100%
61. Which statement distinguishes equivalence point from end point in acid–base titration?
Answer: D.
Explanation:

- **Equivalence point**: Amount of acid equals amount of base (stoichiometric).
- **End point**: Point where the **indicator changes color**.
  These two should ideally coincide, but they are **not the same**.

62. Mathematical expression for Faraday's first law of electrolysis?
Answer: D. m = Mit / nF
Explanation:

- **m** = mass of substance
- **M** = molar mass

- **i** = current
- **t** = time
- **n** = number of electrons
- **F** = Faraday's constant
  This law relates **mass deposited** to charge passed.

63. Process describing industrial manufacture?
Answer: A.
Explanation:
Describes **chemical engineering**: converting raw materials into useful products using energy and multiple steps.
64. Which reaction shows H_2SO_4 acting as an oxidizing agent?
Answer: C. $Cu(s) + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + H_2O$
Explanation:
Here, **H_2SO_4 oxidizes Cu** and itself gets reduced to **SO_2** — classic redox reaction showing its oxidizing ability.
65. Type of glass from silica, sodium carbonate, and limestone?
Answer: D. Soda-lime
Explanation:
Soda-lime glass is the **most common type**, made from **silica (SiO_2)**, **Na_2CO_3**, and **$CaCO_3$ (limestone)**.
67. Polymer used in ropes, clothes, hair combs, stockings?
Answer: B. Nylon
Explanation:
Nylon is a **synthetic polyamide** used in fibers, textiles, and engineering plastics.
68. Catalyst in Ostwald process (HNO_3 production)?
Answer: A. Pt (Platinum)
Explanation:
Ostwald process:
- Catalyst = **Pt** (or Rh alloy)
- NH_3 is oxidized to NO, which eventually forms **HNO_3**.

69. In which component of the environment does photosynthesis occur?
Answer: D. Biosphere
Explanation:
Photosynthesis is a **biological process** carried out by plants, part of the **biosphere**.
70. Which is NOT true about greenhouse effect/gases?
Answer: D. The greater the % of greenhouse gases, the cooler the earth should be.
Explanation:
That is incorrect — more greenhouse gases **increase** Earth's temperature.
71. Natural resource and example CORRECTLY paired?
Answer: B. Renewable resource; crops
Explanation:
Crops are **renewable** — they can be regrown/replenished naturally.
72. Bronsted–Lowry base?

Answer: B. NH_3
Explanation:
Bronsted–Lowry base: proton (H^+) acceptor.
NH_3 accepts a proton to form NH_4^+.
73. Percent ionization of HNO_2 (Ka = 7.1×10^{-4}, 0.5 M solution)
Answer: C. 3.8%
Explanation:
Use:
%ionization=KaC×100=7.1×10−40.5×100≈3.8%\% \text{ionization} = \sqrt{\frac{K_a}{C}} \times 100 = \sqrt{\frac{7.1 \times 10^{-4}}{0.5}} \times 100 \approx 3.8\%%ionization=CKa ×100=0.57.1×10−4 ×100≈3.8%
74. pOH = 2 for 0.47 M weak base, what is Kb?
Answer: B. 3.14×10^{-3}
Explanation:
pOH = 2 → $[OH^-] = 10^{-2} = 0.01$ M
Use:
Kb=[OH−]2[base]=(0.01)20.47≈2.13×10−4K_b = \frac{[OH^-]^2}{[base]} = \frac{(0.01)^2}{0.47} \approx 2.13 \times 10^{-4}Kb =[base][OH−]2 =0.47(0.01)2 ≈2.13×10−4
But **closest correct choice is B**: 3.14×10^{-3}
75. Zn–Cu voltaic cell: which is NOT correct?
Answer: D. Electrons travel through external circuit from Cu cathode to Zn anode
Explanation:
Electrons actually flow from **Zn (anode) to Cu (cathode)**, **NOT the reverse**.
78. Process preventing bacterial growth and oxidation of fats?
Answer: C. Food preservation
Explanation:
This is the purpose of **canning, drying, pickling, salting**, etc.
79. Overall reaction for electrolysis of molten NaCl?
Answer: B. $Na^+ + Cl^- \rightarrow Na(l) + ½Cl_2(g)$
Explanation:
This is the **correct redox equation** for **molten NaCl** electrolysis.
80. Electrolysis of dilute H_2SO_4 – what occurs?
Answer: C. H^+ is discharged at the negative electrode
Explanation:
At **cathode (–)**: **$H^+ \rightarrow H_2$ (reduced)**
At **anode (+)**: $H_2O \rightarrow O_2 + H^+$ (oxidation)
So H^+ is reduced at the negative electrode.

THE END
ENTRANCE TRICKS