

Chemistry, 2018 EC, entrance exam, version 4

Grade 12 · Chemistry · 2018 E.C.

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1. Modern atomic theory contradicts Dalton's atomic theory in stating that: (1)
- A. When elements combine, their atoms unite in small whole number ratio to form compound.
 - B. All substances are made up of very small particles called atoms.
 - C. Atoms of different elements have different properties.
 - D. ✓ **Atom can split into smaller particles.**

Answer: D

Dalton's atomic theory stated that atoms are indivisible, whereas modern atomic theory shows that atoms can be split into subatomic particles (protons, neutrons, and electrons) and undergo nuclear division.

2. The atomic nucleus was discovered with the help of an experiment called:_____. (1)
- A. The deflection of cathode ray experiment.
 - B. ✓ **The Alpha particles scattering experiment.**
 - C. The discharge tube experiment.
 - D. The oil drop experiment.

Answer: B

Ernest Rutherford discovered the atomic nucleus through his famous alpha-particle scattering experiment, where he bombarded thin gold foil with alpha particles.

3. Which experiment provide evidence that atom is mostly empty space and led to the discovery of the atomic nucleus? (1)
- A. Millikan's oil drop experiment
 - B. Bohr's hydrogen atom experiment
 - C. ✓ **Rutherford's gold foil experiment**
 - D. Thomson's cathode ray tube experiment

Answer: C

Rutherford's gold foil experiment showed that most alpha particles passed straight through the foil, indicating that the atom is mostly empty space, while a few were deflected at large angles by a dense, positively charged nucleus.

4. An element has electron configuration of $[\text{Kr}]5s^24d^4$. To which group and period respectively does the element belong in the Modern periodic table? (1)
- A. Group IVB and period 4
 - B. Group IIB and period 5
 - C. Group VB and period 6
 - D. ✓ **Group VIB and period 5**

Answer: D

The highest principal quantum number is 5, indicating that the element is in Period 5. The sum of the outer s and d electrons is $2 + 4 = 6$, which places it in Group VIB (Group 6) of the transition metals.

5. The characteristic similarities of elements in the same period is: (1)
- A. They all have the same electron configuration
 - B. They all have the same valence electrons
 - C. ✓ **They all have the same number of energy level**
 - D. They all have similar chemical properties

Answer: C

Elements in the same period of the periodic table have their valence electrons in the same outermost energy level (or shell), meaning they have the same number of energy levels.

6. Which One of the following statement is not true about Mendeleev's periodic table? (1)
- A. Arranged elements in order of increasing atomic masses
 - B. It was proposed in 1869 and predicted many new elements
 - C. Wrong order of atomic masses would be observed
 - D. ✓ **The position of isotopes and noble gases are available**

Answer: D

Mendeleev's periodic table did not have designated positions for isotopes (which were undiscovered at the time and would disrupt the order by atomic mass) or noble gases (which were only discovered and added later).

7. According to modern periodic law, the periodic properties of elements are periodic functions of their_____. (1)
- A. Atomic sizes
 - B. ✓ **Atomic numbers**
 - C. Atomic masses
 - D. Mass numbers

Answer: B

The modern periodic law states that the physical and chemical properties of the elements are periodic functions of their atomic numbers, unlike Mendeleev's law which used atomic masses.

8. An element 'A' is found in group IIIA and an element 'B' is found in group VIA. The compound formed with these two elements will have the formula: (1)
- A. A_2B_6
 - B. A_6B_2
 - C. ✓ **A_2B_3**
 - D. A_3B_2

Answer: C

An element 'A' in Group IIIA has a common valency of +3, and element 'B' in Group VIA has a common valency of -2. Combining them in a neutral compound yields the formula A_2B_3 .

9. The atomic number of elements Na, Cl, Al and K are 11, 17, 13 and 19 respectively. Which of the following statement is not true? (1)
- A. The ionization potential of K is smaller than that of Na
 - B. ✓ **The electron affinity of Cl is smaller than that of Al**
 - C. Chlorine has the highest effective nuclear charge than that of K
 - D. The metallic character of K is greater than that of Na

Answer: B

Chlorine (Cl) is a highly electronegative non-metal and has a very high (more exothermic) electron affinity compared to aluminum (Al), which is a metal. Therefore, the statement that Cl's electron affinity is smaller than Al's is incorrect.

10. Out of the elements ${}^7\text{N}$, ${}_{11}\text{Na}$, ${}_{17}\text{Cl}$, and ${}_{15}\text{P}$: (1)
- A. N, Na and P are found in the same period
 - B. Cl and N have the same number of energy level
 - C. ✓ **N and P are found in the same group**
 - D. Na and Cl are found in the same group

Answer: C

Nitrogen (${}^7\text{N}$) has 5 valence electrons (Group VA/15) and phosphorus (${}_{15}\text{P}$) also has 5 valence electrons (Group VA/15), so they are in the same group.

11. Which of the following is not the advantages of periodic classification of elements in studying chemistry? (1)
- A. It helps to predict physical and chemical properties, reactivities, and types of compound form.
 - B. It clearly show trends in properties of elements across a periods and down the groups.
 - C. It simplifies the study of elements by grouping those with similar chemical behavior.
 - D. ✓ **It arranges isotopes of an element in different location.**

Answer: D

In the modern periodic table, isotopes of the same element are placed in the same position because they have the same atomic number, so arranging them in different locations is not an advantage or characteristic of the table.

12. What are the real cause of chemical bonding? (1)
- A. Increasing the potential energy of unstable atoms
 - B. Complete the transfer of electrons from one atom to another.
 - C. ✓ **Attending stable electron configurations.**
 - D. Sharing electrons between atom of different elements.

Answer: C

The fundamental driving force for chemical bonding is for atoms to attain a stable, lower-energy electron configuration, typically resembling a noble gas configuration (octet rule).

13. Which one of the following is the characteristics of most ionic compounds? (1)
- A. They are generally liquid or gases at ordinary temperature.
 - B. ✓ **They conduct electric current when in molten or aqueous solution.**
 - C. They have relatively low melting and boiling points.
 - D. They are soluble in non polar solvents

Answer: B

Most ionic compounds are solid at room temperature and have high melting points, but they conduct electricity when melted (molten) or dissolved in water (aqueous) because their ions become free to move.

14. Covalent bonds are typically formed between atoms with: (1)
- A. ✓ **High ionization energy and high electron negativity**
 - B. Low ionization energy and high electron negativity
 - C. High ionization energy and low electron negativity
 - D. Low ionization energy and low electron negativity

Answer: A

Covalent bonds typically form between non-metal atoms with high ionization energies (meaning they do not easily lose electrons) and high electronegativities (meaning they strongly attract shared electron pairs).

15. Which one of the following compounds represent atoms bonded covalently? 1. N_2O_2 2. NH_3 3. MgBr_2 4. BaO 5. SO_3 (1)
- A. 1, 3 and 5
B. ✓ 1, 2 and 5
C. 3 and 4
D. 1, 2 and 3

Answer: B

N_2O_2 , NH_3 , and SO_3 consist purely of non-metals sharing electrons, making them covalent compounds. MgBr_2 and BaO contain metals combined with non-metals, which form ionic bonds.

16. A type of chemical bonding that results from the mutual attraction between positively charged metal nuclei and the surrounding freely moving sea of electrons is named as: (1)
- A. Covalent
B. Dative
C. Ionic
D. ✓ **Metallic**

Answer: D

Metallic bonding is defined as the electrostatic attraction between positively charged metal ions and the delocalized 'sea' of freely moving electrons.

17. What type of intermolecular force is responsible for high boiling of water? (1)
- A. Dipole-dipole interaction
B. ✓ **Hydrogen bonding**
C. London or dispersion forces
D. Covalent bonding

Answer: B

Hydrogen bonding is an exceptionally strong type of dipole-dipole intermolecular force that exists between water molecules, causing water to have a remarkably high boiling point.

18. The correct balanced chemical equation for the reaction: Phosphorus + oxygen → phosphorus(V) oxide is: (1)
- A. ✓ **$\text{P}_4 + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10}$**
B. $\text{P}_5 + \text{O}_2 \rightarrow \text{P}_2\text{O}_5$
C. $5\text{P} + \text{O}_2 \rightarrow \text{P}_5\text{O}_2$
D. $2\text{P} + \text{O}_2 \rightarrow 2\text{PO}$

Answer: A

Phosphorus exists elementally as P_4 molecules, and phosphorus(V) oxide has the molecular formula P_4O_{10} . The correctly balanced equation is $\text{P}_4 + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10}$.

19. Chemical equation must be balanced to satisfy which one of the following law? (1)
- A. Conservation of energy
B. Definite proportion
C. ✓ **Conservation of mass**
D. Multiple proportion

Answer: C

A chemical equation must be balanced to obey the Law of Conservation of Mass, which states that mass is neither created nor destroyed, so the number of each type of atom must remain equal on both sides.

20. Which one of the following is an example of a single displacement reaction? (1)
- A. $\text{CaO(s)} + \text{SiO}_2 \rightarrow \text{CaSiO}_3\text{(s)}$
B. $2\text{NaHCO}_3\text{(aq)} \rightarrow \text{Na}_2\text{CO}_3\text{(s)} + \text{CO}_2\text{(g)} + 2\text{H}_2\text{O(l)}$
C. ✓ **$2\text{KI(aq)} + \text{F}_2\text{(g)} \rightarrow 2\text{KF(aq)} + \text{I}_2\text{(g)}$**
D. $\text{H}_2\text{SO}_4\text{(aq)} + 2\text{KOH(aq)} \rightarrow \text{K}_2\text{SO}_4\text{(aq)} + 2\text{H}_2\text{O(l)}$

Answer: C

In reaction C, elemental fluorine (F_2) displaces iodine (I) from potassium iodide (KI) to form potassium fluoride (KF) and elemental iodine (I_2), which is a classic single displacement reaction.

21. Which of the following statements is correct? (1)
- A. The oxidizing agent is always oxidized in oxidation and reduction reaction
 - B. The reducing agent is always reduced in oxidation and reduction reaction
 - C. The oxidizing agent in oxidation and reduction reaction always loses electrons
 - D. ✓ **A reducing agent in oxidation and reduction reaction always loses electrons**

Answer: D

By definition, a reducing agent reduces another substance by donating (losing) electrons, and consequently, the reducing agent itself undergoes oxidation.

22. Calculate the formula mass of hydrated sodium carbonate ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$) (atomic mass of Na=23, C=12, O=16, H=1) (1)
- A. 326
 - B. ✓ **286**
 - C. 274
 - D. 142

Answer: B

The formula mass is calculated as: $\text{Na} (23 \times 2) + \text{C} (12) + \text{O} (16 \times 3) + 10 \times \text{H}_2\text{O} (10 \times 18) = 46 + 12 + 48 + 180 = 286$.

23. Which solute particles dispersed in water are increasing in size in a mixture? (1)
- A. Suspension, Colloid, Solution
 - B. Solution, Suspension, Colloid
 - C. Colloid, Solution, Suspension
 - D. ✓ **Solution, Colloid, Suspension**

Answer: D

The solute particle size increases in the order of Solution ($< 1 \text{ nm}$), Colloid (1 to 1000 nm), and Suspension ($> 1000 \text{ nm}$).

24. How can you best increase the solubility of a gas in liquid? (1)
- A. Increasing both the temperature and the pressure
 - B. Decreasing both the temperature and the pressure
 - C. Increasing the temperature and decreasing the pressure
 - D. ✓ **Decreasing the temperature and increasing the pressure**

Answer: D

According to Henry's law and Le Chatelier's principle, the solubility of a gas in a liquid increases with decreasing temperature (since dissolution of gases is exothermic) and increasing pressure.

25. In which of the following case will the dissolution of sugar be the most rapid? (1)
- A. Powdered sugar in cold water
 - B. Sugar crystal in hot water
 - C. ✓ **Powdered sugar in hot water**
 - D. Sugar crystal in cold water

Answer: C

The rate of dissolution increases with higher surface area (powdered sugar instead of crystal) and higher temperature (hot water instead of cold water).

26. The solubility of NaCl in water at 20°C is 40g in 100g of water. A solution that contains 20g of NaCl in 50g of water at 20°C is _____. (1)
- A. Unsaturated
 - B. ✓ **Saturated**
 - C. Super saturated
 - D. Diluted

Answer: B

A solubility of 40g in 100g of water is equivalent to 20g in 50g of water. Thus, this solution is exactly saturated.

27. How many grams of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) must be dissolved in 660g of ethanol ($\text{C}_2\text{H}_5\text{OH}$) to prepare a 4.40×10^{-4} molality of solution? (1)
- A. 0.560g
B. ✓ 0.0522g
C. 2.430g
D. 3.661g

Answer: B

Using the formula Molality = moles of solute / kg of solvent, we get moles of glucose = $4.40 \times 10^{-4} \text{ mol/kg} \times 0.660 \text{ kg} = 2.904 \times 10^{-4} \text{ mol}$. Multiplying by the molar mass of glucose (180 g/mol) gives 0.0523 g, which corresponds to option B.

28. A solution is said to be in equilibrium if and only if: (1)
- A. It forms suspension
B. It dissolves more solutes
C. ✓ Its rate of dissolution is equal to the rate of crystallization
D. Solute-solvent interaction is less than that of solute-solute interaction

Answer: C

A saturated solution exists in a state of dynamic equilibrium where the rate of dissolution of the solute equals the rate of its crystallization.

29. What is the concentration of sodium hydroxide required to react completely with equal volume of 0.5M of phosphoric acid solution? If 0.25L of H_3PO_4 is used? $\text{H}_3\text{PO}_4(\text{aq}) + 3\text{KOH}(\text{aq}) \rightarrow \text{K}_3\text{PO}_4 + 3\text{H}_2\text{O}$ (1)
- A. 0.375M
B. 0.125M
C. ✓ 1.5M
D. 2.5M

Answer: C

One mole of phosphoric acid requires three moles of hydroxide base for complete neutralization. Since equal volumes are used, the concentration of the base must be three times that of the acid ($3 \times 0.5 \text{ M} = 1.5 \text{ M}$).

30. What is the mass percentage of methanol in a solution prepared by adding 32g of methanol to 18g of water? (1)
- A. 16%
B. ✓ 64%
C. 50%
D. 32%

Answer: B

The mass percentage of methanol is calculated as $(\text{mass of methanol} / \text{total mass}) \times 100\% = (32\text{g} / (32\text{g} + 18\text{g})) \times 100\% = 64\%$.

31. A compound formed when an acidic oxide react with a basic oxide is: (1)
- A. Acid
B. ✓ Salt
C. Base
D. Oxide

Answer: B

The reaction between an acidic oxide (like CO_2) and a basic oxide (like Na_2O) produces a salt (like Na_2CO_3).

32. Which of the following statement is true about oxide? (1)
- A. ✓ All basic oxides are metallic oxides
B. Amphoteric oxides are basic oxides
C. All non-metallic oxides are acidic oxides
D. Oxides are ternary compounds

Answer: A

All basic oxides are metallic oxides, because non-metals do not form basic oxides (only acidic or neutral ones).

33. What is the concentration of hydrogen ions in 0.0001 M NaOH aqueous solution? (1)

- A. $2.0 \times 10^{-4} \text{ M}$
B. ✓ $1.0 \times 10^{-10} \text{ M}$
C. $1.0 \times 10^{-8} \text{ M}$
D. $1.0 \times 10^{-14} \text{ M}$

Answer: B

Since NaOH is a strong base, $[\text{OH}^-] = 10^{-4} \text{ M}$. Using $K_w = [\text{H}^+][\text{OH}^-] = 10^{-14}$, we find $[\text{H}^+] = 10^{-14} / 10^{-4} = 10^{-10} \text{ M}$.

34. Which one of the following acid is used as electrolyte in a car battery? (1)

- A. Hydrochloric acid
B. Nitric acid
C. ✓ **Sulphuric acid**
D. Phosphoric acid

Answer: C

Sulphuric acid (H_2SO_4) is used as the electrolyte in standard lead-acid car batteries.

35. The idea of atoms as the smallest particles of substances was proposed by: (1)

- A. James Chadwick B. ✓ John Dalton
C. Ernest Rutherford D. J.J Thomson

Answer: B

John Dalton formulated the first modern scientific atomic theory, proposing that all matter is composed of small, indivisible particles called atoms.

36. A sample of water taken from ice, rain or ocean has the same ratio by mass of hydrogen and oxygen. This chemical fact explain the law of: (1)

- A. Mass action
B. Conservation of mass
C. ✓ **Definite proportion**
D. Multiple proportion

Answer: C

The fact that a chemical compound always contains its component elements in a fixed ratio by mass is the statement of the Law of Definite Proportion (or Constant Composition).

37. All cathode rays are the same regardless of the nature of material used as electrode within the discharge tube. (1)
This observation indicates that:

- D. ✓ Cathode rays are building block of all matter.**

Answer: D

Because cathode rays (electrons) are identical regardless of the material of the electrodes, they must be a fundamental component of all atoms and matter.

38. Calculate RAM for naturally occurring Mg if the isotope distribution is 78.99% ^{24}Mg , 10.00% ^{25}Mg and 11.01% ^{26}Mg ; accurate masses are 23.99, 24.99 and 25.98 respectively. (1)

- A. 26.51
B. ✓ 24.31
C. 22.41
D. 25.35

Answer: B

The relative atomic mass is calculated as $(0.7899 \times 23.99) + (0.1000 \times 24.99) + (0.1101 \times 25.98) = 24.31$.

39. Which of the following electron transitions requires the smallest energy to be absorbed by the hydrogen atom? (1)
- A. from $n = 1$ to $n = 2$ B. from $n = 2$ to $n = 3$
C. from $n = 3$ to $n = 4$ D. ✓ from $n = 4$ to $n = 5$

Answer: D

According to the Bohr model, energy levels in hydrogen get closer together as the principal quantum number n increases; thus, the transition from $n = 4$ to $n = 5$ requires the smallest energy change.

40. The normal human eye responds to visible light of wavelength ranging from about 390nm to 710nm. What is the frequency range of the human eye? (1)
- A. 7.7×10^{14} Hz to 4.2×10^{14} Hz B. ✓ 4.2×10^{14} Hz to 7.7×10^{14} Hz
C. 1.3×10^{-15} Hz to 2.4×10^{-15} Hz D. 2.4×10^{-15} Hz to 1.3×10^{15} Hz

Answer: B

Using the relation $c = f \cdot \lambda$, the frequencies corresponding to 710 nm and 390 nm are 4.2×10^{14} Hz and 7.7×10^{14} Hz, respectively, showing a range from lowest to highest in option B.

41. Which of the following statements is TRUE? (1)
- A. Ultraviolet light has longer wavelength than visible light
B. The energy of radiation decreases as the wavelength decreases
C. ✓ **The frequency of radiation increases as the wavelength decreases**
D. Wave number of an electromagnetic radiation increases as wavelength increases

Answer: C

Frequency and wavelength are inversely proportional, meaning that the frequency of electromagnetic radiation increases as the wavelength decreases.

42. Which of the following set of quantum numbers is permissible? (1)
- A. $n=3, l=3, m_l=-2, m_s=-1/2$ B. $n=2, l=0, m_l=-1, m_s=+1/2$
C. ✓ **$n=2, l=0, m_l=0, m_s=+1/2$** D. $n=0, l=0, m_l=1, m_s=-1/2$

Answer: C

For option C, $n=2$ is valid, $l=0$ is within range (0 to $n-1$), $m_l=0$ is valid for $l=0$, and $m_s=+1/2$ is a valid spin state. Other options violate quantum mechanical rules (e.g., l cannot equal n).

43. An element has electron configuration of $[\text{Kr}]5s^2 4d^{10} 5p^5$. To which group and period respectively does the element belong in the Modern periodic table? (1)
- A. Group IVA and period 4 B. Group VA and period 7
C. Group IIA and period 5 D. ✓ **Group VIIA and period 5**

Answer: D

The highest energy shell is $n = 5$ (period 5), and the outer shell contains $2 + 5 = 7$ valence electrons, placing it in Group VIIA (Group 17).

44. Which one of the following ionic compound has the highest lattice energy? (1)
- A. NaCl B. NaBr
C. ✓ **NaF** D. NaI

Answer: C

Lattice energy is inversely proportional to the distance between ions. Since fluoride (F^-) is the smallest halide ion, NaF has the shortest interionic distance and thus the highest lattice energy.

45. Which of the following compound contain ionic, covalent and coordinate covalent bond all in one? (1)
- A. KCl
B. MgCO_3
C. ✓ NH_4Cl
D. HCOOH

Answer: C

Ammonium chloride (NH_4Cl) contains ionic bonds between NH_4^+ and Cl^- , polar covalent bonds within NH_3 , and a coordinate covalent bond formed when NH_3 donates its lone pair to an H^+ ion.

46. Which of the following molecule is polar covalent molecule? (1)
- A. CO_2
B. CCl_4
C. PCl_5
D. ✓ NH_3

Answer: D

NH_3 is a polar molecule because of its asymmetric trigonal pyramidal shape and the presence of a lone pair of electrons on the nitrogen atom, which creates a net dipole moment. In contrast, CO_2 , CCl_4 , and PCl_5 are highly symmetrical, causing their bond dipoles to cancel out and making them nonpolar.

47. The species in the following set do not include which one of the following geometry? SiCl_4 , BrF_4^- , SF_6 , NO_3^- (1)
- A. Octahedral
B. Tetrahedral
C. ✓ Trigonal pyramidal
D. Square planar

Answer: C

SiCl_4 is tetrahedral, SF_6 is octahedral, and BrF_4^- is square planar (with two lone pairs on the central Br atom). NO_3^- is trigonal planar, meaning that a trigonal pyramidal geometry is not represented in this set of species.

48. The type of hybridization of the central atom in ClF_3 and SF_6 are __ and __ respectively? (1)
- A. sp^3d and sp^3
B. ✓ sp^3d and sp^3d^2
C. sp^3 and sp^3d
D. sp^2 and sp^3d^2

Answer: B

The central chlorine atom in ClF_3 has 3 bonding pairs and 2 lone pairs (steric number 5), giving it sp^3d hybridization. The central sulfur atom in SF_6 has 6 bonding pairs and 0 lone pairs (steric number 6), giving it sp^3d^2 hybridization.

49. Which of the following statement is incorrect? (1)
- A. A molecule may be nonpolar, although all the bonds in it are polar
B. ✓ If a molecule BF_3 is nonpolar, the orbitals on B are sp^3 hybridized
C. In a crystal ammonium bromide there are ionic and covalent bond
D. In ammonium ion NH_4^+ , all the bond lengths are identical

Answer: B

In BF_3 , the central boron atom is bonded to three fluorine atoms with no lone pairs, meaning it has a trigonal planar geometry and is sp^2 hybridized, not sp^3 .

50. In which of the following molecules the dispersion or London force is the most constant? (1)
- A. CH_3Cl and CO
B. ✓ Ar and CCl_4
C. H_2O and NH_3
D. HCl and CHCl_3

Answer: B

Both argon (Ar) and carbon tetrachloride (CCl_4) are nonpolar species. Consequently, the only intermolecular forces acting between their respective molecules are London dispersion forces.

51. As atoms bonded to each other, they: (1)
- A. Decrease their potential energy, thus creating less stable arrangement of matter.
 - B. ✓ **Decrease their potential energy, thus creating more stable arrangement of matter.**
 - C. Increase their potential energy, thus creating less stable arrangement of matter.
 - D. Increase their potential energy, thus creating more stable arrangement of matter.

Answer: B

As atoms bond with each other, they release energy and decrease their potential energy, which leads to a more stable chemical system.

52. Metallic bonding is formed between: (1)
- A. ✓ **Elements of low electronegativities**
 - B. Elements of small atomic sizes
 - C. Elements of high electronegativities
 - D. Elements of high electron affinities

Answer: A

Metallic bonding occurs among metal atoms, which are characterized by having low electronegativities and low ionization energies, allowing their valence electrons to be delocalized in a electron sea.

53. Which of the following molecule or ion is least stable? (1)
- A. CN
 - B. CN^-
 - C. O_2
 - D. ✓ **F_2**

Answer: D

Based on molecular orbital theory, F_2 has a bond order of 1, while O_2 , CN, and CN^- have bond orders of 2, 2.5, and 3, respectively. A lower bond order corresponds to a weaker bond and thus lower stability.

54. According to molecular orbital theory which one of the following is paramagnetic? (1)
- A. ✓ **NO**
 - B. F_2
 - C. NO^+
 - D. Be_2

Answer: A

According to molecular orbital theory, species with an odd number of total valence electrons, like NO (which has 15 electrons), contain unpaired electrons and are paramagnetic.

55. Identify the wrong statement from the following alternatives: (1)
- A. F_2 molecule is diamagnetic
 - B. The bond order of N_2 is 3
 - C. ✓ **The bond energy of CN^- is less than that of O_2**
 - D. The bond length of F_2 is greater than that of N_2

Answer: C

CN^- is isoelectronic with N_2 and has a bond order of 3, whereas O_2 has a bond order of 2. Since CN^- has a higher bond order, its bond energy is greater than that of O_2 , making statement C incorrect.

56. Molecules are held together in a crystal by: (1)
- A. Hydrogen bonds
 - B. ✓ **Van der Waal's attraction**
 - C. Electrostatic attraction
 - D. Dipole-dipole attraction

Answer: B

Molecular crystals consist of molecules held together by weak intermolecular attractions, collectively referred to as Van der Waals forces.

57. At high temperatures the particles of a gas: (1)
- A. Move slower and hit the walls of their container less often.
 - B. ✓ **Move faster and hit the walls of their container more frequently**
 - C. Move faster and hit the walls of their container less frequently
 - D. Don't move at all and don't hit the walls of their container.

Answer: B

An increase in temperature increases the average kinetic energy of gas molecules, causing them to move faster and collide with the walls of the container more frequently and with greater force.

58. According to the kinetic-molecular theory, particles of a gas (1)
- A. Attract each other but they do not collide
 - B. Repel each other and they collide
 - C. ✓ **Neither attract nor repel each other but they collide**
 - D. Neither attract nor repel each other and they do not collide

Answer: C

According to the kinetic-molecular theory of ideal gases, gas particles exert no attractive or repulsive forces on one another, but they do undergo elastic collisions.

59. Which one of the following statements is NOT true about acids? (1)
- A. Brønsted-Lowry acid is a proton donor
 - B. ✓ **Lewis acid is an electron pair donor**
 - C. Lewis acid is an electron pair acceptor
 - D. Arrhenius acid furnishes hydronium ion in aqueous solution

Answer: B

By definition, a Lewis acid is an electron pair acceptor, whereas a Lewis base is an electron pair donor, making statement B incorrect.

60. Which of the following is the conjugate acid of hydrogen phosphate ion, (HPO_4^{2-})? (1)
- A. H_3PO_4
 - B. PO_4^{3-}
 - C. ✓ **H_2PO_4^-**
 - D. HPO_4^{2-}

Answer: C

The conjugate acid of a base is formed by adding one proton (H^+) to it. Adding H^+ to hydrogen phosphate (HPO_4^{2-}) yields dihydrogen phosphate (H_2PO_4^-).

61. What is the pH of a 5×10^{-6} M solution of $\text{Ba}(\text{OH})_2$? (1)
- A. ✓ **9**
 - B. 11
 - C. 12
 - D. 10

Answer: A

$\text{Ba}(\text{OH})_2$ is a strong base that fully dissociates to yield two OH^- ions per formula unit. Thus, $[\text{OH}^-] = 2 \times (5 \times 10^{-6} \text{ M}) = 1 \times 10^{-5} \text{ M}$, giving a pOH of 5 and a pH of $14 - 5 = 9$.

62. A 1.0M solution of a weak acid is found to dissociate by only 1.4%. Which of the following acid is it likely to be: (1)
- A. HNO_2 , $K_a = 6.91 \times 10^{-4}$ B. ✓ **HCOOH , $K_a = 1.96 \times 10^{-4}$**
- C. HF , $K_a = 7.2 \times 10^{-4}$ D. CH_3COOH , $K_a = 1.82 \times 10^{-5}$

Answer: B

For a weak acid with a dissociation fraction of 1.4% ($\alpha = 0.014$) and concentration $C = 1.0 \text{ M}$, the acid dissociation constant is $K_a \approx C \times \alpha^2 = 1.0 \times (0.014)^2 = 1.96 \times 10^{-4}$, which corresponds to HCOOH .

63. If KOCl is added to a solution of HOCl , which of the following statements is true? (1)
- A. ✓ **The pH of the solution will increase** B. The pH of the solution will decrease
- C. The equilibrium will not be affected D. The pH will remain the same

Answer: A

Adding KOCl introduces OCl^- ions, which shifts the dissociation equilibrium of HOCl ($\text{HOCl} \rightleftharpoons \text{H}^+ + \text{OCl}^-$) to the left due to the common ion effect, decreasing the $[\text{H}^+]$ and thereby increasing the pH.

64. Buffer solution have consistent acidity and alkalinity because: (1)
- A. They have fixed value of pH
- B. They have excess of H^+ or OH^- ions
- C. The acids and alkalies are shielded from attack by other ions
- D. ✓ **They give unionized acids or bases on the reaction with added acid or base**

Answer: D

Buffer solutions resist changes in pH because any added strong acid (H^+) or strong base (OH^-) reacts with the buffer components to produce weakly-dissociating (unionized) weak acids or bases.

65. Which of the following salts will yield a basic solution on dissolution in water? (1)
- A. A salt of weak acid and weak base B. ✓ **A salt of weak acid and strong base**
- C. A salt of strong acid and strong base D. A salt of strong acid and weak base

Answer: B

A salt formed from a weak acid and a strong base undergoes anion hydrolysis, where the conjugate base of the weak acid reacts with water to produce hydroxide ions (OH^-), making the solution basic.

66. What molarity of 50mL H_2SO_4 is required to neutralize 200mL of 0.5M NaOH ? (1)
- A. ✓ **1M** B. 4N
- C. 2M D. 0.5M

Answer: A

The neutralization reaction is $\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$. Neutralizing 200 mL of 0.5 M NaOH (100 mmol of NaOH) requires 50 mmol of H_2SO_4 , which in a 50 mL solution corresponds to a molarity of 1.0 M.

67. Which of the following titration will have an equivalent point of pH less than 7? (1)
- A. ✓ **Strong acid with weak base** B. Weak acid with weak base
- C. Strong acid with strong base D. Weak acid with strong base

Answer: A

The titration of a strong acid with a weak base results in an acidic salt at the equivalence point due to the hydrolysis of the conjugate acid of the weak base, which yields a pH less than 7.

68. For the reaction: $\text{H}_2\text{S} + \text{HNO}_3 \rightarrow \text{S} + \text{NO} + \text{H}_2\text{O}$, what is the coefficient H_2S and NO respectively after balancing redox reaction by oxidation number method? (1)

- A. 2 and 4
B. ✓ 3 and 2
C. 3 and 4
D. 4 and 2

Answer: B

Balancing the redox reaction gives: $3\text{H}_2\text{S} + 2\text{HNO}_3 \rightarrow 3\text{S} + 2\text{NO} + 4\text{H}_2\text{O}$. The coefficients for H_2S and NO are 3 and 2, respectively.

69. Consider the following oxidation-reduction reaction equation: $2\text{H}_2\text{O}(\text{l}) + \text{Al}(\text{s}) + \text{MnO}_4^-(\text{aq}) \rightarrow \text{Al}(\text{OH})_4^-(\text{aq}) + \text{MnO}_2(\text{s})$. What are the reducing and the oxidizing agents in this reaction? (1)

- A. $\text{Al}(\text{s})$ is the reducing agent and H_2O is the oxidizing agent
B. $\text{Al}(\text{s})$ is the oxidizing agent and H_2O is the reducing agent
C. $\text{Al}(\text{s})$ is the oxidizing agent and $\text{MnO}_4^-(\text{aq})$ is the reducing agent
D. ✓ **$\text{Al}(\text{s})$ is the reducing agent and $\text{MnO}_4^-(\text{aq})$ is the oxidizing agent**

Answer: D

Aluminium (Al) is oxidized from an oxidation state of 0 to +3, meaning it acts as the reducing agent. Manganese in MnO_4^- is reduced from +7 to +4, meaning MnO_4^- acts as the oxidizing agent.

70. The anode reaction is the same in all of the following electrolysis process except: (1)

- A. ✓ **Electrolysis of dilute NaCl solution**
B. Electrolysis of conc. HCl solution
C. Electrolysis of brine solution
D. Electrolysis of molten MgCl_2

Answer: A

In the electrolysis of dilute NaCl , water is oxidized at the anode to produce oxygen gas (O_2). In the other three processes, chloride ions are oxidized at the anode to produce chlorine gas (Cl_2).

71. Which of the following conduct electricity without undergoing any chemical change? (1)

- A. Potassium chloride solution
B. Hydrochloric acid solution
C. Molten magnesium chloride
D. ✓ **Copper metal**

Answer: D

Copper metal is a metallic conductor, which conducts electricity through the movement of free electrons without undergoing any chemical alteration, whereas electrolytic conductors (like solutions or molten salts) conduct via ions and undergo chemical changes at the electrodes.

72. Two cells are connected in series. One cell contains Ag_2SO_4 and the other cell contains $\text{Al}(\text{NO}_3)_3$. If 12g of Al is deposited on one cell, how many grams of Ag is deposited on the other cell? (Atomic mass of $\text{Ag} = 108\text{g/mole}$ and $\text{Al} = 27\text{g/mole}$) (1)

- A. ✓ **144g**
B. 24g
C. 12g
D. 36g

Answer: A

According to Faraday's second law of electrolysis, the masses of substances deposited by the same quantity of electricity are proportional to their equivalent weights. With equivalent weights of Al ($27/3 = 9\text{ g/eq}$) and Ag ($108/1 = 108\text{ g/eq}$), the mass of Ag deposited is $12\text{ g} \times (108/9) = 144\text{ g}$.

73. The two standard electrode potentials involved in the nickel-cadmium rechargeable cell are given below. (1)
Calculate the ΔG° of the cell. ($F = 96500 \text{ C}$) $\text{NiO}_2(\text{s}) + 2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{Ni}(\text{OH})_2(\text{s}) + 2\text{OH}^-$ $E^\circ = +0.49\text{V}$; $\text{Cd}(\text{OH})_2(\text{s}) + 2\text{e}^- \rightarrow \text{Cd}(\text{s}) + 2\text{OH}^-(\text{aq})$ $E^\circ = -0.76\text{V}$
- A. -184.6 KJ
B. -153.0 KJ
C. ✓ -241.3 KJ
D. -206.8 KJ

Answer: C

The standard cell potential is $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}} = 0.49 \text{ V} - (-0.76 \text{ V}) = 1.25 \text{ V}$. Using $\Delta G^\circ = -nFE^\circ_{\text{cell}}$, we get $-2 \times 96500 \text{ C} \times 1.25 \text{ V} = -241250 \text{ J} = -241.3 \text{ kJ}$.

74. Which of the following is not the characteristic of Chemical industries? (1)
- A. Consume large quantities of energy during manufacturing process.
B. Use safe operation method during manufacturing process
C. Test their product during and after manufacturing
D. ✓ **Providing transport services to customers**

Answer: D

The primary characteristics of chemical industries involve raw material processing, high energy consumption, safety operations, and product quality testing; providing transport services is a logistics service and not a core characteristic of chemical manufacturing.

75. In the production of ammonia, which condition would increase the yield of ammonia according to this reaction? (1)
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ $\Delta H = -92.2 \text{ KJ/mol}$
- A. High temperature and low pressure
B. High temperature and high pressure
C. ✓ **Low temperature and high pressure**
D. Low temperature and low pressure

Answer: C

According to Le Chatelier's principle, because the synthesis of ammonia is exothermic ($\Delta H < 0$), low temperature favors the forward reaction. Furthermore, because the reaction results in a decrease in the number of moles of gas (from 4 to 2), high pressure shifts the equilibrium to the right, maximizing the yield of ammonia.

END OF THE MARKING KEY

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