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Practice Questions

Try all 30 first, then check the answer key at the back.

1. Refer to the table of elements below. Which element, essential for building bone tissue in the human body, has an atomic number of 20? Element Atomic Number Hydrogen 1 Carbon 6 Oxygen 8 Calcium 20

A. Hydrogen
B. Carbon
C. Oxygen
D. Calcium

2. The main components contained within the nucleus of a human body cell are:

A. Nucleotides and lipids
B. Cytoplasm and enzymes
C. DNA and proteins
D. Ribosomes and mitochondria

3. In the context of human physiology, which category would a pure sample of oxygen atoms used for cellular respiration belong to?

A. a mixture
B. an element
C. a compound
D. an isotope

4. In the structure of a water molecule, which subatomic particle of an oxygen atom determines that it is oxygen?

A. Chemical bonds
B. Electrons
C. Ions
D. Neutrons

5. Examine the following data on subatomic particles. Which particle defines the identity of an element by its number and possesses a positive charge? Particle Charge Mass (amu) Electron Negative 0.0005 Neutron Neutral 1 Proton Positive 1

A. Electron
B. Neutron
C. Isotope
D. Proton

6. What is an atomic orbital?

A. A physical boundary that contains an electron.
B. The exact spot where an electron resides permanently.
C. The region around an atom's nucleus where electrons are likely to be found.
D. A rigid structure that encases an atom's electrons.

7. In a covalent bond formation, what is the maximum number of electrons that can fill the 3s orbital of an atom?

A. 8
B. 2
C. 6
D. 4

8. Analyze the following biochemical reactions important for nerve function. Which element or compound is most likely to donate electrons? Consider the possible electron transfer roles listed. Substance Reaction Type Possible Electron Transfer Cu Redox Donates electrons Mg Redox Donates electrons N None Cl Acid-base Accepts electrons

A. Mg
B. Cu
C. N and Mg
D. Cl

9. Calculate the maximum number of electrons that can occupy the third electron shell for sulfur, given its atomic number is 16. Element Atomic Number Sulfur 16

A. 8
B. 32
C. 16
D. 18

10. Examine the following elements. Which element is most likely to form an ionic bond by losing an electron? Element Atomic Number Group Number Sodium (Na) 11 1 Calcium (Ca) 20 2 Nitrogen (N) 7 15 Chlorine (Cl) 17 17

A. Nitrogen (N)
B. Chlorine (Cl)
C. Sodium (Na)
D. Calcium (Ca)

11. Blood serum calcium levels are critical in human physiology. Calculate the average atomic weight of calcium, considering it is made up of the following isotopes. Isotope Abundance (%) Atomic Mass (amu) $$^{40}Ca$$ 97 40.078 $$^{44}Ca$$ 2 43.955 $$^{48}Ca$$ 1 47.953

A. 42.953 amu
B. 40.234 amu
C. 40.752 amu
D. 39.078 amu

12. How many neutrons does the most common isotope of carbon have?

A. 6
B. 12
C. 4
D. 8

13. Consider a group of minerals, each containing iron atoms. Despite exhibiting various chemical properties, what fundamental atomic characteristic do their iron atoms share?

A. They have the same number of electrons.
B. They have the same atomic mass.
C. They have identical energy levels.
D. They have the same number of protons.

14. Two chemical compounds, A and B, are composed of atoms that are isotopes of each other. Which of the following is true about the chemical properties of compounds A and B?

A. They react differently with oxygen.
B. They have different melting points.
C. They exhibit similar chemical properties.
D. They have distinctly different chemical properties.

15. Consider the following statements about ionization energy and bonding tendencies of elements. I. Alkali metals have high ionization energy and tend to form covalent bonds. II. Halogens have high ionization energy and often form covalent bonds. III. Alkali metals have low ionization energy, making them likely to form ionic bonds. Element Groups Ionization Energy Characteristic Bonding Tendency Alkali Metals Low Likely to form ionic bonds Halogens High Often form covalent bonds

A. I and II
B. II and III
C. I and III
D. I

16. In which of the following states can hydrogen form intermolecular hydrogen bonds? I. Gaseous state II. Liquid state III. Solid state

A. I and III
B. III
C. I
D. II and III

17. Which element from the provided data is most likely to form a stable compound by gaining electrons? Element Tendency Fluorine Gains electrons easily Sodium Loses electrons easily Carbon Shares electrons Neon Stable, does not gain or lose Potassium Loses electrons easily

A. Sodium
B. Carbon
C. Neon
D. Fluorine

18. Consider the synthetic element Xylenium, which has an electron configuration similar to carbon. Under what condition can Xylenium form multiple bonds with another element?

A. If the first bond is unstable
B. If Xylenium does not pair all its electrons
C. If Xylenium has enough valence electrons
D. It cannot form multiple bonds

19. If a nitrogen atom has five valence electrons, what is the maximum number of covalent bonds it can form?

A. 1
B. 8
C. 5
D. 2

20. Analyze the following table on ion charges and their physiological roles in neurons. Which cation is crucial for initiating action potentials? Ion Charge type Impact on Neuron Sodium (Na■) Positive Essential for action potentials Potassium (K■) Positive Regulates repolarization Chloride (Cl■) Negative Inhibitory synaptic transmission Calcium (Ca²■) Positive Neurotransmitter release

A. Sodium (Na■)
B. Chloride (Cl■)
C. Potassium (K■)
D. Calcium (Ca²■)

21. Consider the process of NaCl dissolving in water. Which statements are true regarding the behavior of ions and physiological effects? I. Na■ is a cation and Cl■ is an anion. II. When NaCl dissolves, the concentration of ions in the solution decreases. III. The increase in Na■ concentration in cells may affect osmolarity. IV. Cl■ ions are expelled from cells to maintain balance. Process Description Dissolving NaCl dissociates to form Na■ and Cl■ in water Ion Type Na■ is a cation; Cl■ is an anion Effect Increases ionic concentration affecting osmolarity

A. I and II
B. IV
C. II only
D. I and III

22. In human bodily fluids, which of the following ions is considered a cation? Ion Type Charge Example Ion Cation Positive Potassium (K+) Anion Negative Chloride (Cl−)

A. Phosphate (PO■^{3}■)
B. Bicarbonate (HCO■■)
C. Potassium (K+)
D. Chloride (Cl−)

23. Which of the following atoms is most likely to participate in an ionic bond with calcium, an atom with 2 valence electrons?

A. Fluorine (7 valence electrons)
B. Argon (8 valence electrons)
C. Oxygen (6 valence electrons)
D. Boron (3 valence electrons)

24. In the human body, electrolytes are crucial for nerve transmission and muscle contraction. Which ionic bond forms between two common electrolytes to create table salt?

A. Sodium ion (Na■) and Chloride ion (Cl■)
B. Potassium ion (K■) and Magnesium ion (Mg^{2}■)
C. Calcium ion (Ca^{2}■) and Phosphate ion (PO■^{3}■)
D. Hydrogen ion (H■) and Hydroxide ion (OH■)

25. Refer to the following table on types of bonds in common molecules. Nutrient Element Type Electronegativity Difference Bond Type Water Oxygen and Hydrogen Small Carbon Dioxide Carbon and Oxygen Small Sodium Chloride Sodium and Chlorine Large Methane Carbon and Hydrogen Small What type of bond is present in methane (CH■) based upon the electronegativity difference?

A. Hydrophobic
B. Nonpolar covalent
C. Ionic
D. Polar covalent

26. Given the following data on the solubility of different compounds in water, which are the factors that positively impact the solubility of ionic compounds? I. Interaction with water molecules due to partial charges II. Complete dissociation into ions III. Strong covalent bonds between atoms

A. II
B. III
C. III and I
D. I and II

27. Examine the list of different salts and their characteristics below. Based on the presence and magnitude of partial charges (∆+ and ∆–), which compound is expected to be most soluble in water at physiological conditions (pH 7.4, 37°C)? Table of compounds: - Compound A: neutral covalent molecule, no significant partial charges (no ∆+ or ∆–). - Compound B: ionic/polar salt with pronounced partial charges (clear ∆+ on one end and clear ∆– on the other). - Compound C: weakly polar molecule with small partial charges (small ∆+ and ∆–). - Compound D: nonpolar, hydrophobic salt-like molecule with minimal charge separation.

A. Compound D
B. Compound B
C. Compound A
D. Compound C

28. Analyze the following data on ion locations in blood plasma. Determine the likely transport mechanism for $$\text{Na}^+$$ ions based on their location and common transport processes. Ion Location in blood plasma Transport mechanism $$\text{Na}^+$$ In blood plasma Via ion channels $$\text{K}^+$$ Inside red blood cells Na-K pump $$\text{Ca}^{2+}$$ In blood plasma Calcium channels $$\text{Cl}^-$$ In blood plasma Chloride channels

A. Via ion channels
B. Direct diffusion through the plasma membrane
C. Via ATP-powered pumps
D. Active transport involving vesicles

29. Examine the following table of mineral components found in bone tissue. Identify the predominant type of bond that holds together the ionic compounds listed. Mineral Component Primary Ions Involved Bond Type Hydroxyapatite Calcium, Phosphate Carbonate Calcium, Carbon Fluoride Calcium

A. Polar Covalent Bond
B. Non-polar Covalent Bond
C. Metallic Bond
D. Ionic Bond

30. Considering the unique properties of water, which property is heavily influenced by hydrogen bonds, and results in water having a higher boiling point than expected? Property Influence of Hydrogen Bonds Boiling point Surface tension Viscosity Density

A. Viscosity
B. Density
C. Boiling point
D. Surface tension

Answer Key & Explanations

1. D — Calcium
The element with an atomic number of 20 is Calcium. Calcium is essential for building and maintaining bone tissue in the human body.

2. C — DNA and proteins
The nucleus of a human body cell houses DNA (deoxyribonucleic acid) which contains genetic instructions, and proteins which help in maintaining its structure and regulating access to the DNA.

3. B — an element
Oxygen, when consisting of a pure sample of its atoms, is classified as an element because it is made up of only one type of atom. In human physiology, this distinction is important for understanding respiratory processes.

4. A — Chemical bonds
An oxygen atom is defined as such because it has 8 protons. Protons are positively charged and have a significant role in defining the atomic number of an element, thereby determining its identity.

5. D — Proton
The number of protons in an atom's nucleus defines the identity of the element. Protons have a positive charge and a mass of one atomic mass unit, contrary to electrons which are negatively charged and neutrons which are neutral.

6. C — The region around an atom's nucleus where electrons are likely to be found.
An atomic orbital is a region of space around the nucleus where there is a high probability of finding an electron. This concept helps explain the distribution of electrons in an atom and their role in chemical bonding and interactions.

7. B — 2
Each 's' orbital, including the 3s orbita, can hold a maximum of 2 electrons. During covalent bond formation, electrons occupy the lowest available energy orbitals, and no orbital can have more electrons than its capacity allows.

8. A — Mg
Mg is most likely to donate electrons because it is an alkaline earth metal, similar to strontium, and participates in redox reactions.

9. D — 18
The capacity of an electron shell is determined by $$2 \times n^2$$, where $$n$$ is the principal quantum number of the shell. For the third shell (n=3), the maximum number of electrons it can hold is $$2 \times 3^2 = 18$$. Sulfur does not use the full capacity of the third shell, but the question asks for the maximum potential number.

10. C — Sodium (Na)
Sodium (Na) is in Group 1, which means it has one valence electron. Elements in Group 1 readily lose one electron to achieve a stable noble gas electron configuration, making them likely to form ionic bonds.

11. B — 40.234 amu
The average atomic weight is calculated as follows: (97% of 40.078 amu) + (2% of 43.955 amu) + (1% of 47.953 amu). Average atomic weight = $$0.97 \times 40.078 + 0.02 \times 43.955 + 0.01 \times 47.953$$ Average atomic weight = 38.87566 + 0.8791 + 0.47953 = 40.23429 Rounded to three decimal places, the answer is 40.234 amu.

12. A — 6
The most common isotope of carbon is Carbon-12, which has an atomic number of 6. The number of neutrons is calculated as the mass number minus the atomic number. For Carbon-12, the number of neutrons is 12 - 6 = 6.

13. D — They have the same number of protons.
The key atomic characteristic that all iron atoms would share across the minerals is the same number of protons. This number defines the element as iron, which is element number 26 on the periodic table. Any differences in the number of neutrons would result in isotopes, but the proton number remains unchanged.

14. C — They exhibit similar chemical properties.
Since compounds A and B are composed of isotopes, they contain atoms with the same number of electrons and protons but different numbers of neutrons. The chemical properties of a compound are primarily determined by electron interactions and configurations, not by neutrons, which means that compounds A and B should have similar chemical properties.

15. B — II and III
Alkali metals have low ionization energy, making them lose electrons easily and typically form ionic bonds. Halogens have high ionization energy and often form covalent bonds by gaining or sharing electrons.

16. D — II and III
Hydrogen bonds typically form in liquid and solid states where molecules are held closely together. In the gaseous state, molecules are too far apart to form stable hydrogen bonds, so statement I is false. Statements II and III are true as hydrogen can form these intermolecular bonds in both liquid and solid states.

17. D — Fluorine
Fluorine is highly electronegative and readily gains electrons to achieve a stable electron configuration, while the other elements are either more inclined to lose electrons, share electrons, or already stable as in the case of neon.

18. C — If Xylenium has enough valence electrons
Xylenium can form multiple bonds if it has sufficient valence electrons, similar to how elements like carbon and nitrogen can form double or triple bonds.

19. A — 1
Nitrogen has five valence electrons and needs three more to complete an octet, so it can form a maximum of three covalent bonds.

20. A — Sodium (Na■)
Sodium (Na■) plays a critical role in depolarization, which is essential for the initiation of action potentials in neurons.

21. D — I and III
NaCl dissociates into Na■ and Cl■ ions in water. Na■ is a cation, and Cl■ is an anion. When NaCl dissolves, the ion concentration in solution increases. Increased intracellular Na■ can impact osmolarity, while Cl■ generally remains in solution to maintain charge balance.

22. C — Potassium (K+)
Potassium ions (K+) are positively charged, meaning they are cations. Chloride, phosphate, and bicarbonate ions are negatively charged, making them anions.

23. C — Oxygen (6 valence electrons)
Calcium has 2 valence electrons and tends to lose them to achieve a stable electron configuration. Oxygen, having 6 valence electrons, is most likely to gain electrons to complete its valence shell, making it most likely to form an ionic bond with calcium.

24. A — Sodium ion (Na■) and Chloride ion (Cl■)
Sodium ions (Na■) and chloride ions (Cl■) form an ionic bond to create sodium chloride (NaCl), commonly known as table salt. This bond is a typical example of how a positively charged ion (cation) and a negatively charged ion (anion) come together to form a stable compound.

25. B — Nonpolar covalent
Methane (CH■) is composed of carbon and hydrogen, which have a minimal electronegativity difference. This results in a nonpolar covalent bond where electrons are shared equally.

26. D — I and II
Ionic compounds dissolve well in water because water's polar nature can stabilize the ions formed upon dissociation. While I describes a characteristic of polar covalent compounds, ionic compounds fully dissociate in water (II), enhancing their solubility.

27. B — Compound B
Polar compounds with larger partial charges (greater $\Delta+$ and $\Delta-$) interact more strongly with water via ion-dipole and dipole-dipole interactions and therefore tend to be more soluble in water. Compound B has pronounced partial charges, so it should be the most soluble under physiological conditions.

28. A — Via ion channels
Sodium ions ($$\text{Na}^+$$) are typically transported via specific ion channels that allow passage through the cell membrane due to their charge and size. Direct diffusion is unlikely for charged particles like ions, which require channel-mediated transport. ATP-powered pumps are more commonly associated with pumping ions against concentration gradients (e.g., Na-K pump), not facilitating diffusion in blood plasma. Active transport involving vesicles is a mechanism for larger molecules and not typically related to ion transport like it is with $$\text{Na}^+$$, $$\text{K}^+$$, $$\text{Ca}^{2+}$$, or $$\text{Cl}^-$$.

29. D — Ionic Bond
The mineral components in bone tissue, such as hydroxyapatite, are primarily held together by ionic bonds. This is because these compounds involve metal ions, like calcium, and non-metal ions, such as phosphate or carbonate, that exhibit significant differences in electronegativity.

30. C — Boiling point
Hydrogen bonds significantly affect the boiling point of water, making it higher than expected for such a small molecular weight. The intermolecular attractions caused by hydrogen bonds require more energy (heat) to break as water transitions from liquid to gas.

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