Organic Chemistry - A Tenth Edition 10th edition McMurry Test Bank

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Organic Chemistry

ISBN 9781711471853 | Chapter 1: Structure and Bonding

Total Questions: 100

Multiple Choice

Q1.
What is the modern defining characteristic of an organic compound?

A) It contains carbon ✓ Correct
B) It is isolated from living organisms
C) It has a low melting point
D) It is insoluble in water

Rationale: Modern organic chemistry is defined as the study of carbon compounds.

Q2.
Which subatomic particles are found in the atomic nucleus?

A) Electrons and protons
B) Protons and neutrons ✓ Correct
C) Electrons and neutrons
D) Only protons

Rationale: The nucleus contains positively charged protons and neutral neutrons.

Q3.
For a neutral atom, the number of electrons is equal to the number of which particles?

A) Neutrons
B) Orbitals
C) Protons ✓ Correct
D) Isotopes

Rationale: A neutral atom has equal numbers of positively charged protons and negatively charged electrons.

Q4.
What does the atomic number (Z) specify?

A) The total number of protons and neutrons
B) The number of neutrons only
C) The number of protons in the nucleus ✓ Correct
D) The number of valence electrons only

Rationale: Atomic number is defined by the number of protons in the nucleus.

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Q5.

What does the mass number (A) represent?

A) The weighted average of isotopes
B) The total number of protons and neutrons ✓ Correct
C) The number of electrons in the valence shell
D) The number of protons only

Rationale: Mass number equals the sum of protons and neutrons in the nucleus.

Q6.

Atoms with the same atomic number but different mass numbers are called what?

A) Ions
B) Allotropes
C) Isomers
D) Isotopes ✓ Correct

Rationale: Isotopes are atoms of the same element that differ in neutron number and therefore mass number.

Q7.

What is atomic weight?

A) The mass number of the most abundant isotope
B) The weighted average of naturally occurring isotopes ✓ Correct
C) The total number of nucleons divided by two
D) The mass of one mole of atoms in grams only

Rationale: Atomic weight is the weighted average mass of an element's naturally occurring isotopes.

Q8.

Which unit is defined as one twelfth the mass of one atom of carbon-12?

A) Picometer
B) Angstrom
C) Dalton ✓ Correct
D) Mole

Rationale: One dalton, or unified atomic mass unit, is defined relative to carbon-12 in this way.

Q9.

An orbital is best defined as what?

A) A fixed circular path of an electron
B) A region of space where an electron is most likely to be found ✓ Correct
C) The exact location of an electron at one moment
D) A shell containing only paired electrons

Rationale: An orbital describes the volume of space around a nucleus where an electron is most likely to be found.

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Q10.

Which type of orbital has a spherical shape?

A) p orbital
B) d orbital
C) f orbital
D) s orbital ✓ Correct

Rationale: s orbitals are spherical with the nucleus at the center.

Q11.

Which type of orbital is described as dumbbell-shaped?

A) s orbital
B) p orbital ✓ Correct
C) d orbital
D) f orbital

Rationale: p orbitals have two lobes and a dumbbell-like shape.

Q12.

How many electrons can occupy a single orbital?

A) 1
B) 2 ✓ Correct
C) 4
D) 8

Rationale: Each orbital can hold a maximum of two electrons with opposite spins.

Q13.

How many electrons can the second electron shell hold?

A) 2
B) 6
C) 8 ✓ Correct
D) 18

Rationale: The second shell contains one 2s and three 2p orbitals for a total of 8 electrons.

Q14.

What is a node in a p orbital?

A) A region of maximum electron density
B) A point containing the nucleus only
C) A region of zero electron density ✓ Correct
D) A shared pair of electrons

Rationale: A node is a region where the probability of finding an electron is zero.

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Q15.

The three p orbitals within a shell are oriented how relative to one another?

A) Parallel
B) At 60° angles
C) Mutually perpendicular ✓ Correct
D) In a single plane

Rationale: The three p orbitals are oriented along perpendicular x, y, and z axes.

Q16.

Which principle states that the lowest-energy orbitals fill first?

A) Hund's rule
B) Pauli exclusion principle
C) Aufbau principle ✓ Correct
D) Octet rule

Rationale: The Aufbau principle states that electrons occupy lower-energy orbitals before higher-energy ones.

Q17.

Which principle states that two electrons in the same orbital must have opposite spins?

A) Pauli exclusion principle ✓ Correct
B) Hund's rule
C) Aufbau principle
D) Valence bond theory

Rationale: The Pauli exclusion principle requires paired electrons in one orbital to have opposite spins.

Q18.

Which rule states that electrons occupy equal-energy orbitals singly with parallel spins before pairing?

A) Aufbau principle
B) Hund's rule ✓ Correct
C) Octet rule
D) Lewis rule

Rationale: Hund's rule describes single occupation of degenerate orbitals before electron pairing occurs.

Q19.

What is the ground-state electron configuration?

A) The electron arrangement in an excited atom
B) The highest-energy arrangement of electrons
C) The lowest-energy arrangement of electrons in an atom ✓ Correct
D) The arrangement of electrons in a molecule only

Rationale: Ground-state electron configuration refers to the atom's lowest-energy electron arrangement.

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Q20.

Who proposed that carbon is tetravalent and can form chains in organic compounds?

A) Linus Pauling and G. N. Lewis
B) Jacobus van't Hoff and Joseph Le Bel
C) August Kekulé and Archibald Couper ✓ Correct
D) Niels Bohr and Erwin Schrödinger

Rationale: Kekulé and Couper independently proposed carbon tetravalence and carbon chain formation.

Q21.

Who proposed that the four bonds of carbon are directed toward the corners of a tetrahedron?

A) Kekulé and Couper
B) van't Hoff and Le Bel ✓ Correct
C) Lewis and Pauling
D) Hund and Pauli

Rationale: van't Hoff and Le Bel introduced the three-dimensional tetrahedral arrangement of carbon bonds.

Q22.

In a three-dimensional structural drawing, what does a dashed line represent?

A) A bond in the plane of the page
B) A bond coming out toward the viewer
C) A bond going behind the plane of the page ✓ Correct
D) A partial bond in resonance

Rationale: A dashed bond indicates a bond receding behind the plane of the page.

Q23.

Why do atoms form chemical bonds?

A) To increase atomic number
B) To become less stable
C) To achieve a lower-energy, more stable state ✓ Correct
D) To eliminate all lone pairs

Rationale: Bond formation lowers the energy of the system and increases stability.

Q24.

What is always true when a chemical bond forms?

A) Energy is absorbed
B) Energy is released ✓ Correct
C) Electrons are lost to the environment
D) The atoms become ions

Rationale: Bond formation releases energy because the bonded state is lower in energy.

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Q25.

An ionic bond is best described as what?

A) A bond formed by sharing electrons equally
B) A bond formed by overlap of p orbitals only
C) An attraction between oppositely charged ions ✓ Correct
D) A bond involving only carbon atoms

Rationale: Ionic bonds arise from electrostatic attraction between cations and anions.

Q26.

A covalent bond is best described as what?

A) Transfer of electrons from one atom to another
B) Sharing of an electron pair between atoms ✓ Correct
C) Attraction between two noble gases
D) Repulsion between two nuclei

Rationale: A covalent bond forms when atoms share electrons.

Q27.

What is a molecule?

A) Any collection of ions in a crystal lattice
B) A neutral collection of atoms held together by covalent bonds ✓ Correct
C) Any substance containing carbon
D) A charged species with an incomplete octet

Rationale: A molecule is a neutral assembly of atoms connected by covalent bonds.

Q28.

In a Lewis structure, valence electrons are represented by what?

A) Arrows
B) Colors
C) Dots ✓ Correct
D) Triangles

Rationale: Lewis structures use dots to represent valence-shell electrons.

Q29.

What term describes valence electrons not used in bonding?

A) Core electrons
B) Lone-pair electrons ✓ Correct
C) Bonding pairs
D) Sigma electrons

Rationale: Nonbonding valence electrons are called lone pairs.

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Q30.

How many covalent bonds does a neutral oxygen atom typically form in stable molecules?

A) 1
B) 2 ✓ Correct
C) 3
D) 4

Rationale: Oxygen typically forms two covalent bonds to complete its octet.

Q31.

According to valence bond theory, a covalent bond forms when what occurs?

A) A proton is transferred between atoms
B) Two filled orbitals repel each other
C) Two singly occupied orbitals overlap and the electrons pair ✓ Correct
D) A molecular orbital splits into atomic orbitals

Rationale: VB theory describes bond formation as overlap of singly occupied orbitals with electron pairing.

Q32.

A sigma (σ) bond is formed by what kind of overlap?

A) Sideways overlap of p orbitals
B) Head-on overlap along the internuclear axis ✓ Correct
C) Overlap of two antibonding orbitals
D) Overlap that creates a node between nuclei

Rationale: Sigma bonds arise from head-on overlap along the line connecting the nuclei.

Q33.

What is bond length?

A) The energy needed to break a bond
B) The angle between two bonds
C) The optimum distance between bonded nuclei ✓ Correct
D) The number of electrons in a bond

Rationale: Bond length is the internuclear distance at minimum energy in a bonded pair.

Q34.

What is bond strength?

A) The number of orbitals used in bonding
B) The energy released when a nucleus forms
C) The energy required to break a bond ✓ Correct
D) The charge separation in a bond

Rationale: Bond strength corresponds to the energy needed to separate bonded atoms.

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Q35.

Which statement best describes the hybridization of carbon in methane?

A) It uses four equivalent sp3 hybrid orbitals ✓ Correct
B) It uses three sp2 orbitals and one p orbital
C) It uses two sp orbitals and two p orbitals
D) It uses only unhybridized s orbitals

Rationale: Methane is explained by four equivalent sp3 hybrid orbitals on carbon.

Q36.

What is the approximate H–C–H bond angle in methane?

A) 90°
B) 109.5° ✓ Correct
C) 120°
D) 180°

Rationale: Methane has tetrahedral geometry with bond angles of about 109.5°.

Q37.

The carbon–carbon bond in ethane is formed by overlap of which orbitals?

A) Two p orbitals only
B) Two sp2 orbitals only
C) Two sp3 hybrid orbitals ✓ Correct
D) One s and one p orbital

Rationale: The C–C single bond in ethane is a sigma bond formed by sp3–sp3 overlap.

Q38.

What type of hybridization is present on each carbon atom in ethylene?

A) sp3
B) sp2 ✓ Correct
C) sp
D) dsp3

Rationale: Each carbon in ethylene is sp2-hybridized.

Q39.

A carbon–carbon double bond consists of which combination of bonds?

A) One σ bond and one π bond ✓ Correct
B) Two σ bonds
C) Two π bonds
D) One ionic bond and one σ bond

Rationale: A double bond contains one sigma bond and one pi bond.

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Q40.

In ethylene, the π bond is formed by what interaction?

A) Head-on overlap of sp2 orbitals
B) Sideways overlap of unhybridized p orbitals ✓ Correct
C) Transfer of electrons between carbons
D) Overlap of two s orbitals

Rationale: The π bond in ethylene comes from sideways overlap of p orbitals.

Q41.

What is the approximate geometry around each carbon atom in ethylene?

A) Tetrahedral
B) Trigonal planar ✓ Correct
C) Linear
D) Octahedral

Rationale: sp2-hybridized carbons have trigonal planar geometry with angles near 120°.

Q42.

What type of hybridization is present on each carbon atom in acetylene?

A) sp3
B) sp2
C) sp ✓ Correct
D) sp3d

Rationale: Each carbon in acetylene is sp-hybridized.

Q43.

A carbon–carbon triple bond consists of which combination of bonds?

A) One σ bond and one π bond
B) Three σ bonds
C) One σ bond and two π bonds ✓ Correct
D) Two σ bonds and one π bond

Rationale: A triple bond contains one sigma bond and two pi bonds.

Q44.

What is the bond angle around an sp-hybridized carbon atom, as in acetylene?

A) 90°
B) 109.5°
C) 120°
D) 180° ✓ Correct

Rationale: sp hybridization produces a linear arrangement with 180° bond angles.

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Q45.

Which statement best describes the hybridization of nitrogen in methylamine?

A) Nitrogen is sp-hybridized with two lone pairs
B) Nitrogen is sp2-hybridized with no lone pair
C) Nitrogen is sp3-hybridized with one lone pair ✓ Correct
D) Nitrogen is unhybridized in a linear arrangement

Rationale: Nitrogen in methylamine is described as sp3-hybridized and bears one lone pair.

Q46.

Which statement best describes the hybridization of oxygen in methanol?

A) Oxygen is sp3-hybridized with two lone pairs ✓ Correct
B) Oxygen is sp2-hybridized with one lone pair
C) Oxygen is sp-hybridized with no lone pairs
D) Oxygen is unhybridized with four bonds

Rationale: Oxygen in methanol is approximately sp3-hybridized and has two lone pairs.

Q47.

In molecular orbital theory, a bonding molecular orbital results from what kind of combination?

A) Subtractive combination of atomic orbitals
B) Additive combination of atomic orbitals ✓ Correct
C) Combination of only core orbitals
D) Combination that always creates a node between nuclei

Rationale: Bonding molecular orbitals arise from additive combination of atomic orbitals.

Q48.

What feature characterizes an antibonding molecular orbital?

A) It is lower in energy than the parent atomic orbitals
B) It concentrates electron density between nuclei
C) It contains a node between nuclei ✓ Correct
D) It can hold only one electron

Rationale: Antibonding molecular orbitals have a node between nuclei and are higher in energy.

Q49.

Which statement is correct for a skeletal structure?

A) Every carbon atom and every hydrogen atom must be written explicitly
B) Carbon atoms are assumed at line ends and intersections ✓ Correct
C) Only heteroatoms are omitted
D) Lone pairs are always shown on carbon

Rationale: In skeletal structures, carbon atoms are implied at line ends and junctions.

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Q50.

In a condensed structure, what is generally omitted from explicit drawing?

A) Only heteroatoms
B) Only multiple bonds
C) Carbon–carbon and carbon–hydrogen single bonds ✓ Correct
D) All lone pairs and all atoms

Rationale: Condensed structures typically omit explicit C–C and C–H single bonds for brevity.

Q51.

A pathology laboratory is evaluating a carbon-14 tracer used in a metabolic research protocol. Which statement best explains why carbon-14 is classified differently from carbon-12?

A) It has a different number of protons than carbon-12
B) It has a different number of neutrons than carbon-12 ✓ Correct
C) It has a different number of valence electrons than carbon-12
D) It has a different number of electron shells than carbon-12

Rationale: Isotopes of the same element have the same atomic number but differ in neutron number, giving different mass numbers.

Q52.

A pharmacist reviewing a molecular model of methane for a medicinal chemistry discussion asks why all four C–H bonds are equivalent. Which explanation is most accurate?

A) Carbon uses four equivalent sp3 hybrid orbitals arranged tetrahedrally ✓ Correct
B) Carbon uses one s orbital and three unhybridized p orbitals with identical energies
C) Carbon forms ionic bonds with hydrogen that average to the same length
D) Carbon alternates between single and double bonds to hydrogen very rapidly

Rationale: Methane's four identical bonds arise from overlap of four equivalent tetrahedrally oriented sp3 hybrid orbitals with hydrogen 1s orbitals.

Q53.

A clinician reviewing a structural formula of ethylene notes that the molecule is planar. Which bonding description accounts for this geometry?

A) Each carbon is sp3-hybridized with only sigma bonds
B) Each carbon is sp2-hybridized with one unhybridized p orbital forming a pi bond ✓ Correct
C) Each carbon is sp-hybridized with two pi bonds
D) Each carbon is unhybridized and uses only p orbitals

Rationale: In ethylene, each carbon is sp2-hybridized, giving trigonal planar geometry and one unhybridized p orbital for the π bond.

Q54.

A respiratory therapist compares acetylene and ethane in a safety training module. Which property is expected for the carbon–carbon bond in acetylene?

A) It is longer and weaker than the carbon–carbon bond in ethane
B) It is shorter and stronger than the carbon–carbon bond in ethane ✓ Correct
C) It has the same length but greater flexibility than the carbon–carbon bond in ethane
D) It is ionic rather than covalent

Rationale: A carbon–carbon triple bond is both shorter and stronger than a carbon–carbon single bond.

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Q55.
A student intern draws a p orbital as two lobes separated by an empty region. What is the correct term for that zero-electron-density region?

A) Valence shell
B) Hybrid axis
C) Node ✓ Correct
D) Bonding domain

Rationale: A node is the region of zero electron density separating the lobes of a p orbital.

Q56.
A nurse educator asks why sodium chloride is described differently from methane in a chemistry refresher. Which distinction is correct?

A) Sodium chloride is a molecule because it contains covalent bonds
B) Methane is ionic because carbon reaches an octet by electron transfer
C) Sodium chloride is held together by electrostatic attraction of ions, whereas methane is a covalent molecule ✓ Correct
D) Methane contains no shared electrons, unlike sodium chloride

Rationale: NaCl is an ionic compound formed by attraction between Na+ and Cl–, whereas methane is a molecule with shared-electron covalent bonds.

Q57.
A toxicology researcher is sketching formaldehyde, CH2O, from its formula before entering it into a database. Which line-bond structure is correct?

A) H3C–O
B) H–C≡O–H
C) H2C=O ✓ Correct
D) H–O–CH

Rationale: Formaldehyde contains a carbon–oxygen double bond and two hydrogens on carbon, giving H2C=O.

Q58.
A chemistry tutor asks a pre-health student to identify the geometry around carbon in acetylene. What is the best answer?

A) Tetrahedral with bond angles near 109.5°
B) Trigonal planar with bond angles near 120°
C) Linear with bond angles of 180° ✓ Correct
D) Bent with bond angles near 104.5°

Rationale: sp-Hybridized carbon in acetylene gives a linear arrangement with 180° bond angles.

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Q59.

During medication design training, a student is asked which rule states that electrons occupy equal-energy orbitals singly with parallel spins before pairing. Which rule applies?

A) Pauli exclusion principle
B) Aufbau principle
C) Hund's rule ✓ Correct
D) Octet rule

Rationale: Hund's rule states that electrons fill degenerate orbitals singly with parallel spins before pairing.

Q60.

A laboratory instructor asks why a covalent bond forms between two atoms. Which response is most accurate?

A) Bond formation always raises the energy of the system
B) Bond formation lowers the energy and increases the stability of the system ✓ Correct
C) Bond formation occurs only when electrons are completely transferred
D) Bond formation eliminates all lone-pair electrons

Rationale: Atoms bond because the bonded state is lower in energy and therefore more stable than the separated atoms.

Q61.

A biomedical researcher compares carbon and nitrogen when predicting simple bonding patterns in drug-like molecules. Why does neutral carbon typically form four covalent bonds while neutral nitrogen typically forms three?

A) Carbon has four valence electrons and needs four more for an octet, whereas nitrogen has five and needs three more ✓ Correct
B) Carbon has fewer electron shells than nitrogen
C) Nitrogen cannot form sigma bonds
D) Carbon always donates electrons while nitrogen always accepts electrons

Rationale: Typical bonding follows the number of electrons needed to complete an octet: four for carbon and three for nitrogen.

Q62.

A health informatics student is converting a structural image into text and sees a wedged bond and a dashed bond attached to carbon. What do these symbols indicate?

A) Double and triple bonds, respectively
B) Ionic and covalent bonds, respectively
C) Bonds coming out of and going behind the plane of the page, respectively ✓ Correct
D) Long and short bonds, respectively

Rationale: A wedge shows a bond projecting toward the viewer, while a dashed bond shows one receding behind the plane.

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Q63.

A medicinal chemistry team is comparing sigma and pi bonds when discussing reactivity. Which statement correctly distinguishes them?

A) Sigma bonds arise from sideways overlap, and pi bonds arise from head-on overlap

B) Sigma bonds are cylindrically symmetrical about the internuclear axis, whereas pi bonds have electron density above and below that axis ✓ Correct

C) Pi bonds are stronger than sigma bonds because they always overlap more effectively

D) Sigma bonds can form only from s orbitals

Rationale: σ bonds form by head-on overlap along the internuclear axis, while π bonds arise from sideways p-orbital overlap with density above and below the axis.

Q64.

A hospital educator asks why carbon is uniquely central to organic chemistry. Which explanation is best?

A) Carbon is the heaviest common biological element

B) Carbon can share four valence electrons and bond extensively to itself to form chains and rings ✓ Correct

C) Carbon forms only ionic bonds in living systems

D) Carbon has the largest atomic radius among biologically important elements

Rationale: Carbon's tetravalency and ability to bond strongly to other carbons enable immense structural diversity.

Q65.

A student reviewing molecular orbital theory for a pharmacy entrance course asks what makes an antibonding molecular orbital unfavorable for bonding. Which answer is correct?

A) It places electron density primarily between nuclei

B) It has lower energy than the contributing atomic orbitals

C) It contains a node between nuclei that prevents electron density from stabilizing the bond ✓ Correct

D) It can hold only one electron

Rationale: Antibonding orbitals have a node between nuclei, so electrons there do not stabilize the internuclear region.

Q66.

A clinician sees the condensed formula (CH3)2CHCH2CH3 in a pharmacology handout. Which interpretation is correct?

A) It represents a five-carbon chain with a methyl branch on the second carbon ✓ Correct

B) It represents a straight six-carbon chain

C) It represents a four-carbon ring

D) It represents a molecule containing a carbon–carbon double bond

Rationale: (CH3)2CHCH2CH3 corresponds to 2-methylbutane, a five-carbon structure with a methyl substituent on carbon 2.

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Q67.

A chemical safety officer compares methanol and methylamine. Which statement about oxygen and nitrogen hybridization in these molecules is most accurate?

A) Both atoms are approximately sp3-hybridized and contain lone pairs occupying hybrid orbitals ✓ Correct

B) Both atoms are sp-hybridized and linear

C) Oxygen is sp2-hybridized while nitrogen is always unhybridized

D) Nitrogen cannot have a lone pair in an organic molecule

Rationale: In methanol and methylamine, oxygen and nitrogen are commonly described as approximately sp3-hybridized with lone pairs in sp3 orbitals.

Q68.

A premedical student is asked why the carbon–carbon double bond in ethylene is not twice as strong as the single bond in ethane. What is the best explanation?

A) The second bond is ionic rather than covalent

B) The pi bond from sideways overlap is weaker than the sigma bond from head-on overlap ✓ Correct

C) Double bonds contain fewer electrons than single bonds

D) Bond strength is unrelated to orbital overlap

Rationale: The π component of a double bond results from less effective sideways overlap and contributes less strength than a σ bond.

Q69.

A molecular biology student is told that a p orbital has positive and negative lobes. What do these signs represent?

A) Actual positive and negative charges on the electron cloud

B) Different oxidation states of the atom

C) Algebraic signs of the wave function that affect orbital combination ✓ Correct

D) Regions that must contain paired and unpaired electrons

Rationale: The plus and minus labels indicate the algebraic sign of the wave function, which determines constructive or destructive overlap.

Q70.

A graduate nursing student asks why hydrogen is limited to one covalent bond in simple organic molecules. Which explanation is correct?

A) Hydrogen has one valence electron and needs one more to reach the helium configuration ✓ Correct

B) Hydrogen has no valence electrons available for bonding

C) Hydrogen must obey the octet rule and therefore makes eight bonds

D) Hydrogen forms one bond because it has one neutron

Rationale: Hydrogen reaches a stable duet by sharing one additional electron, so it typically forms one covalent bond.

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Q71.
A radiopharmacy lab is selecting the correct isotope notation for an atom with 6 protons and 8 neutrons. Which isotope is being described?

A) Carbon-6
B) Carbon-8
C) Carbon-12
D) Carbon-14 ✓ Correct
Rationale: Mass number equals protons plus neutrons, so 6 + 8 = 14, giving carbon-14.

Q72.
A medical device company uses a hydrocarbon gas model in training. Which hybridization is expected for each carbon in ethane, CH3CH3?

A) sp on both carbons
B) sp2 on both carbons
C) sp3 on both carbons ✓ Correct
D) Unhybridized p orbitals only on both carbons
Rationale: Each carbon in ethane forms four single bonds and is therefore sp3-hybridized.

Q73.
A chemistry support specialist is checking a student's electron configuration for carbon. Which ground-state configuration is correct?

A) 1s2 2s2 2p2 ✓ Correct
B) 1s2 2s1 2p3
C) 1s2 2p4
D) 1s2 2s2 2p4
Rationale: Carbon has six electrons, which fill as 1s2 2s2 2p2 in the ground state.

Q74.
A pharmacist is reviewing phosphine, PH3, in a toxic exposure case. Based on valence considerations, how many covalent bonds does phosphorus form in phosphine?

A) One
B) Two
C) Three ✓ Correct
D) Five
Rationale: Phosphorus has five valence electrons and typically forms three bonds in PH3 to complete an octet.

Q75.
A student is interpreting a skeletal structure in a medicinal chemistry chart. According to standard skeletal notation, what is assumed at the end of an unlabeled line?

A) An oxygen atom
B) A carbon atom with enough hydrogens to complete valence ✓ Correct
C) A nitrogen atom with one lone pair
D) A charged atom that must be labeled separately
Rationale: In skeletal structures, unlabeled line ends and intersections are assumed to be carbon atoms with implied hydrogens.

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Q76.
A hospital-based research team is comparing possible structures for a new volatile anesthetic intermediate. They need a molecule with a linear carbon center and two unhybridized p orbitals remaining on that carbon. Which hybridization fits this requirement?

A) sp3
B) sp2
C) sp ✓ Correct
D) dsp3

Rationale: sp hybridization leaves two unhybridized p orbitals and gives linear geometry.

Q77.
A medicinal chemist wants to predict the geometry around the carbonyl carbon in formaldehyde before modeling receptor binding. What geometry should be assigned to that carbon?

A) Tetrahedral, because carbon always forms four sigma bonds
B) Trigonal planar, because the carbon is sp2-hybridized in a double bond ✓ Correct
C) Linear, because the carbonyl bond contains a pi bond
D) Bent, because oxygen has lone pairs

Rationale: The carbonyl carbon in formaldehyde is sp2-hybridized and therefore trigonal planar.

Q78.
A nursing student compares the bond energies of H–H bond formation and bond breaking. Which statement is correct?

A) The same amount of energy released on bond formation must be absorbed to break the bond ✓ Correct
B) Bond formation absorbs energy, but bond breaking releases it
C) Bond energy changes only apply to ionic bonds
D) Breaking a bond requires no energy if the atoms are neutral

Rationale: Bond formation releases energy, and the same magnitude of energy must be supplied to break that bond.

Q79.
A biomedical engineering student is asked to identify the likely bond angle around each carbon in propene, CH3CH=CH2. Which set is most appropriate?

A) About 109.5° at all three carbons
B) About 120° at all three carbons
C) About 109.5° at the CH3 carbon and about 120° at the two alkene carbons ✓ Correct
D) About 180° at the CH3 carbon and about 120° at the alkene carbons

Rationale: The methyl carbon is sp3 with tetrahedral angles, while the two double-bonded carbons are sp2 with trigonal planar angles.

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Q80.

A pharmacist is comparing a saturated hydrocarbon with an alkene during a drug synthesis review. Which structural feature is unique to the alkene carbon–carbon double bond?

A) Two sigma bonds between the carbons

B) One sigma bond and one pi bond between the carbons ✓ Correct

C) One pi bond only between the carbons

D) An ionic interaction between the carbons

Rationale: A double bond consists of one σ bond and one π bond between the same two atoms.

Q81.

A public health researcher is reviewing an infographic that labels an orbital as the region where an electron spends 90% to 95% of its time. Which interpretation is correct?

A) The orbital is a fixed circular path of the electron

B) The orbital is a probability distribution describing likely electron location ✓ Correct

C) The orbital is the exact position of the electron at all times

D) The orbital is a measure of atomic mass

Rationale: An orbital represents a region of space where an electron is most likely to be found, not a fixed path.

Q82.

A student in a pharmacology bridge course asks why carbon in methane does not achieve stability by gaining or losing four electrons. Which answer is best?

A) Carbon cannot undergo electron transfer under any conditions

B) Gaining or losing four electrons would require too much energy, so carbon typically shares electrons instead ✓ Correct

C) Carbon already has a full valence shell in methane

D) Hydrogen prevents carbon from forming an octet

Rationale: For carbon, transfer of four electrons is energetically unfavorable, so it usually forms covalent bonds by sharing electrons.

Q83.

A laboratory scientist is comparing the expected geometry of methylamine and methanol for a spectroscopy exercise. Which statement is most accurate?

A) Both central heteroatoms are approximately tetrahedral in electron arrangement because they are sp3-hybridized ✓ Correct

B) Both central heteroatoms are linear because lone pairs repel bonding pairs equally

C) Nitrogen is planar while oxygen is linear

D) Oxygen is trigonal planar while nitrogen is tetrahedral

Rationale: Nitrogen in methylamine and oxygen in methanol are commonly described as sp3-hybridized with approximately tetrahedral electron arrangements.

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Q84.

A chemistry TA asks a student to compare the 2p orbitals within the same shell. Which statement is correct?

A) They differ in shape but not orientation

B) They are identical in energy and oriented along mutually perpendicular directions ✓ Correct

C) They are identical in orientation but differ in principal quantum number

D) Only one 2p orbital can exist in a shell

Rationale: The three p orbitals in a shell have equal energy and are oriented along perpendicular axes.

Q85.

A drug development team is evaluating whether a carbon atom in a candidate molecule is likely to be sp2-hybridized. Which observation would support that conclusion?

A) The carbon forms four single bonds with bond angles near 109.5°

B) The carbon is part of a triple bond with 180° bond angles

C) The carbon is part of a double bond and shows approximately 120° bond angles ✓ Correct

D) The carbon carries no valence electrons

Rationale: sp2 hybridization is associated with double bonds and trigonal planar geometry near 120°.

Q86.

A student is asked to identify the correct reason a pi bond cannot form from overlap of two s orbitals. What is the best answer?

A) s orbitals do not contain electrons

B) Pi bonds require sideways overlap, which is characteristic of parallel p orbitals ✓ Correct

C) s orbitals can overlap only in ionic compounds

D) Pi bonds always involve d orbitals

Rationale: π bonds arise from sideways overlap of parallel p orbitals, not from spherical s orbitals.

Q87.

A hospital educator wants a simple example of a molecule in which carbon is tetrahedral and represented with wedge-and-dash notation. Which molecule is the best choice from the chapter content?

A) Methane ✓ Correct

B) Ethylene

C) Acetylene

D) Hydrogen

Rationale: Methane has an sp3-hybridized tetrahedral carbon and is commonly illustrated with wedge-and-dash geometry.

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Q88.

A medicinal chemistry student is comparing line-bond and Lewis structures. Which feature is shown explicitly in a Lewis structure but often omitted in a simple line-bond structure?

A) Atomic symbols for carbon

B) Lone-pair electrons on heteroatoms ✓ Correct

C) The presence of single bonds

D) The identity of heteroatoms

Rationale: Lewis structures explicitly show valence electrons, including lone pairs, which are commonly omitted in line-bond drawings.

Q89.

A research fellow is analyzing acetonitrile-like bonding and asks how many electron pairs are shared in a carbon–nitrogen triple bond. What is the correct answer?

A) One pair

B) Two pairs

C) Three pairs ✓ Correct

D) Four pairs

Rationale: A triple bond consists of three shared electron pairs.

Q90.

A pharmacy student is told that the 4s orbital fills before the 3d orbitals in many ground-state configurations. Which principle governs filling lower-energy orbitals first?

A) Hund's rule

B) Octet rule

C) Aufbau principle ✓ Correct

D) Pauli exclusion principle

Rationale: The Aufbau principle states that electrons occupy the lowest-energy orbitals available first.

Q91.

A clinical chemistry trainee is asked to predict whether C2H7 can represent a neutral stable organic molecule using normal valence rules. What is the best conclusion?

A) Yes, because carbon can expand its octet in second-row compounds

B) Yes, because hydrogen can form two bonds when attached to carbon

C) No, because satisfying normal valences for two carbons and seven hydrogens would require an impossible bonding pattern ✓ Correct

D) No, because molecules cannot contain an odd number of hydrogens

Rationale: Two neutral tetravalent carbons cannot be combined with seven hydrogens without violating standard valence rules.

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Q92.

A biochemistry instructor asks why sp3 hybrid orbitals form stronger directional bonds than unhybridized s orbitals alone. Which explanation is best?

A) sp3 orbitals are symmetrical and therefore nonreactive

B) sp3 orbitals are unsymmetrical, with a large lobe that overlaps more effectively with another orbital ✓ Correct

C) sp3 orbitals contain more electrons than other orbitals

D) sp3 orbitals eliminate internuclear repulsion entirely

Rationale: The large directional lobe of an sp3 hybrid orbital allows more effective overlap and stronger bonding.

Q93.

A student reviewing molecular orbital theory for ethylene is asked which molecular orbital is occupied in the carbon–carbon pi system. Which answer is correct?

A) The higher-energy pi antibonding MO only

B) Both the bonding and antibonding pi MOs equally

C) The lower-energy pi bonding MO, while the pi antibonding MO is unoccupied ✓ Correct

D) Neither, because pi electrons remain in atomic orbitals

Rationale: In ethylene, the π bonding MO is filled and the higher-energy π antibonding MO is vacant.

Q94.

A healthcare simulation student must infer hydrogens from a skeletal drug fragment. A carbon at a three-way intersection with only single bonds and no heteroatom labels is assumed to have how many hydrogens?

A) Zero

B) One ✓ Correct

C) Two

D) Three

Rationale: A three-way carbon intersection has three bonds shown, so one hydrogen is implied to complete carbon's valence of four.

Q95.

A medicinal chemist evaluates whether a proposed structure containing a carbon–carbon triple bond inside a five-membered ring is likely to be stable. Which chapter-based reasoning best supports rejecting it?

A) Triple-bonded carbons prefer tetrahedral geometry

B) Triple-bonded carbons require linear geometry, which is incompatible with a small ring such as cyclopentyne ✓ Correct

C) Triple bonds can form only when hydrogen is attached to both carbons

D) Ring compounds cannot contain any multiple bonds

Rationale: sp-Hybridized carbons in a triple bond require near-180° geometry, which small rings cannot accommodate well.

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Q96.

A student compares the central carbon in allene-like systems with the carbon in carbon dioxide. Which hybridization should be assigned to a carbon that forms two double bonds in a row?

A) sp3
B) sp2
C) sp ✓ Correct
D) dsp2

Rationale: A carbon with two double bonds, as in allene or CO2, is best described as sp-hybridized.

Q97.

A pharmacology trainee is asked to identify the outer-shell electron count for oxygen when drawing Lewis structures. How many valence electrons does neutral oxygen have?

A) Four
B) Five
C) Six ✓ Correct
D) Eight

Rationale: Oxygen is a group 6A element and has six valence electrons.

Q98.

A hospital laboratory mentor asks a student to choose the most appropriate representation for quickly sketching a large organic molecule while omitting most carbon and hydrogen labels. Which format is preferred?

A) Full electron-density surface
B) Skeletal structure ✓ Correct
C) Nuclear isotope notation
D) Orbital box diagram

Rationale: Skeletal structures are the standard shorthand for large organic molecules because carbons and attached hydrogens are implied.

Q99.

A medicinal chemistry case review compares methane, ethylene, and acetylene. Which trend in C–H bond strength is most consistent with the chapter data?

A) Methane > ethylene > acetylene
B) Acetylene > ethylene > methane/ethane-type single-bond carbons ✓ Correct
C) All C–H bond strengths are identical regardless of hybridization
D) Ethane > methane > acetylene

Rationale: C–H bond strength increases from sp3 to sp2 to sp hybridization, with acetylene having the strongest C–H bond among these examples.

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Q100.

A graduate student preparing a teaching slide needs to justify why a carbon atom in a three-dimensional organic drawing can be represented as tetrahedral rather than planar. Which evidence is most directly relevant?

A) Carbon's nucleus contains protons and neutrons

B) A carbon with four single bonds is described by four sp3 hybrid orbitals directed toward the corners of a tetrahedron ✓ Correct

C) All atoms with four valence electrons are planar

D) Double bonds are always stronger than single bonds

Rationale: The sp3 hybridization model directly explains the tetrahedral arrangement of a carbon bearing four single bonds.

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