General Chemistry I              Exam 3 Practice Problems

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

____ 1. Which statement is false?
   a. Ordinary chemical reactions do not involve changes in nuclei.
   b. Atomic nuclei are very dense.
   c. Nuclei are positively charged.
   d. Electrons contribute only little to the mass of an atom.
   e. The nucleus occupies nearly all the volume of an atom.

____ 2. The mass number of an atom is the number of __________ in the atom.
   a. protons
   b. neutrons
   c. protons plus the number of electrons
   d. protons plus the number of neutrons
   e. electrons plus the number of neutrons

____ 3. The atomic number of an atom is the number of __________ in the atom.
   a. protons plus the number of electrons
   b. neutrons
   c. protons
   d. protons plus the number of neutrons
   e. electrons plus the number of neutrons

____ 4. The atomic number of a certain element is 19, and its atomic weight is 39. An atom of the element contains __________ protons, __________ neutrons, and the chemical symbol for the element is __________.
   a. 19, 19, F
   b. 19, 20, F
   c. 19, 20, K
   d. 20, 19, K
   e. none of these

____ 5. An atom of the $^{23}$Na isotope contains __________ electrons.
   a. 23
   b. 12
   c. 11
   d. 10
   e. 13

____ 6. A(An) __________ is a region of space in which there is a high probability of finding an electron in an atom.
   a. shell
   b. atomic orbital
   c. core
   d. major energy level
   e. nucleus

____ 7. What is the total number of orbitals in the fourth energy level (n = 4.)
   a. 4
   b. 24
   c. 16
   d. 9
   e. 18
8. Which response includes all the following statements that are true, and no false statements?

I. Each set of \(d\) orbitals contains 7 orbitals.
II. Each set of \(d\) orbitals can hold a maximum of 14 electrons.
III. The first energy level contains only \(s\) and \(p\) orbitals.
IV. The \(s\) orbital in any shell is always spherically symmetrical.

a. I and II
b. I, III, and IV
c. IV
d. II and IV
e. III

9. What is the value of the angular momentum quantum number, \(l\), for the following orbital?

\[ \bigcirc \]

a. \(\frac{1}{2}\)
b. -1
c. 0
d. 1
e. 2

10. Which element has the electron configuration below?

\[
1s^22s^22p^63s^23p^63d^{10}4s^24p^3
\]

a. V
b. Ca
c. P
d. As
e. Se

11. Which of the following is the electron configuration of \(O^2^-\)?

a. \(1s^21p^62s^22p^6\)
b. \(1s^22s^22p^4\)
c. \(1s^22s^22p^33s^23p^6\)
d. \(1s^22s^22p^1\)
e. \(1s^22s^22p^43s^23p^4\)

12. Which one of the following electron configurations is incorrect?

a. \(\text{Cl}^-\) \(1s^22s^22p^63s^23p^6\)
b. \(\text{Ge} \quad [\text{Ar}]3d^{10}4s^23p^3\)
c. \(\text{Sc} \quad [\text{Ar}]3d^14s^2\)
d. \(\text{C} \quad [\text{He}]2s^22p^4\)
e. \(\text{N}^3^- \quad 1s^22s^22p^6\)

13. What is the electron configuration of oxygen, \(O\)?

\[
\begin{array}{ccc}
1s & 2s & 3s \\
\uparrow & \downarrow & \uparrow \uparrow \uparrow \\
\uparrow & \downarrow & \uparrow \downarrow \uparrow \uparrow \\
\end{array}
\]
14. Which of the following sets of quantum numbers could represent the "last" electron added to complete the electron configuration for a ground state atom of Br according to the Aufbau Principle.

\[
\begin{array}{c|c|c|c}
 n & l & m_l & m_s \\
\hline
 a. & 4 & 0 & 0 & \frac{1}{2} \\
 b. & 4 & 1 & 0 & -\frac{1}{2} \\
 c. & 4 & 1 & 1 & \frac{1}{2} \\
 d. & 4 & 1 & 2 & \frac{1}{2} \\
 e. & 4 & 2 & 1 & \frac{1}{2} \\
\end{array}
\]

15. What would be the outer electron configuration of halogens?

a. \(ns^2np^6\) \\
b. \(ns^2np^5\) \\
c. \(ns^2np^7\) \\
d. \(ns^2np^4\) \\
e. \(ns^2nd^5np^0\)

16. Which element has the largest atomic radius?

a. Al  \\
b. Si  \\
c. P  \\
d. S  \\
e. Cl

17. Which element has the smallest radius?

a. K  \\
b. Na  \\
c. Rb  \\
d. Mg  \\
e. Cl

18. Which element has the lowest first ionization energy?

a. F  \\
b. Cl  \\
c. Br  \\
d. I  \\
e. At

19. Which element has the highest first ionization energy?

a. Li  \\
b. Cs  \\
c. Cl  \\
d. I  \\
e. Ar
20. Which ion has the largest radius?
   a. Li^+
   b. Na^+
   c. Be^{2+}
   d. Mg^{2+}
   e. Al^{3+}

21. Which element has the lowest electronegativity?
   a. H
   b. Li
   c. Na
   d. K
   e. Cs

22. Which element has the highest electronegativity?
   a. 3Li
   b. 7N
   c. 19K
   d. 33As
   e. 56Ba

23. Below are some elements with their number of valence electrons. Which is incorrect?
   a. Be - 2
   b. Br - 5
   c. Li - 1
   d. Al - 3
   e. C - 4

24. Which Lewis dot notation for atoms and ions is correct for the reaction for the formation of calcium phosphide?
   a. Ca: + \cdot \cdot \rightarrow Ca^{2+}, [\cdot\cdot]^{2-}
   b. 2Ca: + 3 \cdot \cdot \rightarrow 2Ca^{2+}, 3[\cdot\cdot]^{3-}
   c. Ca: + \cdot K: \rightarrow Ca^{2+}, [\cdot K:]^{2-}
   d. 3Ca: + 2 \cdot K: \rightarrow 3Ca^{2+}, 2[\cdot K:]^{2-}
   e. 3Ca: + 2 \cdot \cdot \rightarrow 3Ca^{2+}, 2[\cdot\cdot]^{3-}

25. Which response includes all of the species listed below that have the electron configuration 2s^22p^6 in their highest occupied energy level?
   Ca^{2+}, Na^+, Ne, Ar, Cl^-, O^{2-}
   a. Ca^{2+}, Ne, and Cl^-
   b. Na^+, Ar, and Cl^-
   c. Na^+, Ne, and O^{2-}
   d. Ca^{2+}, Ar, and O^{2-}
   e. Na^+ and Cl^-

26. The Lewis dot formula for Br_2 shows
   a. a single covalent bond.
   b. a double covalent bond.
c. a triple covalent bond.
d. a single ionic bond.
e. a total of $8 \times 2 = 16$ electrons.

27. Which of the following is the correct Lewis dash formula for carbon diselenide?
   a. $\text{Se} - \text{C} - \text{Se}$
   b. $\text{Se} - \text{C} = \text{Se}$
   c. $\text{Se} - \text{C} - \text{Se}$
   d. $\text{Se} - \text{C} - \text{Se}$
   e. $\text{Se} - \text{C} - \text{Se}$

28. How many unshared pairs of electrons are in the outer shell of the central nitrogen atom of NH$_3$?
   a. 4
   b. 3
   c. 2
   d. 1
   e. 0

29. The number of unshared pairs of electrons in the outer shell of oxygen in Cl$_2$O is __________.
   a. one
   b. two
   c. three
   d. four
   e. zero

30. Draw the dot formula for ethylene, C$_2$H$_4$. Each carbon-hydrogen bond is a __________ bond and each carbon-carbon bond is a __________ bond.
   a. single, single
   b. single, double
   c. single, triple
   d. double, single
   e. double, double

31. Give the number of protons, neutrons, and electrons in the $^{34}$S$^{2-}$ ion.
   a. 16 p, 18 n, 16 e
   b. 16 p, 18 n, 14e
   c. 16 p, 16 n, 19 e
   d. 16 p, 18 n, 18 e
   e. 34 p, 16 n, 18 e

32. Which one of the following species is not isoelectronic with neon?
   a. Mg$^{2+}$
   b. Na$^+$
   c. O$^-$
   d. Cl$^-$
   e. Al$^{3+}$
33. Which ion has the largest radius?
   a. F⁻
   b. Cl⁻
   c. Br⁻
   d. I⁻
   e. At⁻

34. Arrange the following set of ions in order of increasing ionic radii.
   Ca²⁺, Cl⁻, K⁺, P³⁻, S²⁻
   a. Ca²⁺ < K⁺ < P³⁻ < S²⁻ < Cl⁻
   b. Ca²⁺ < K⁺ < Cl⁻ < S²⁻ < P³⁻
   c. K⁺ < Cl⁻ < Ca²⁺ < S²⁻ < P³⁻
   d. Cl⁻ < S²⁻ < P³⁻ < Ca²⁺ < K⁺
   e. P³⁻ < S²⁻ < Cl⁻ < K⁺ < Ca²⁺

35. Which comparison of electronegativities is not correct?
   a. Ge > Ga
   b. Ba > Cs
   c. O > N
   d. F > Cl
   e. B > C

36. Which Lewis Dot Formula below is incorrect?
   a. [Diagram of Lewis Dot Formula]
   b. [Diagram of Lewis Dot Formula]
   c. [Diagram of Lewis Dot Formula]
   d. [Diagram of Lewis Dot Formula]
   e. [Diagram of Lewis Dot Formula]

37. The valence shell is
   a. the highest energy level occupied by electrons.
   b. the set of orbitals used to make triple bonds.
   c. the orbitals belonging to the entire molecule.
   d. the lowest energy level occupied by electrons.
   e. the hard covering on crustaceans.

38. What is the electronic geometry for 6 regions of high electron density on a central atom?
   a. octahedral
   b. square planar
   c. trigonal bipyramidal
   d. tetrahedral
   e. trigonal planar
39. The phosphorus pentachloride molecule is nonpolar and contains no lone (unshared) electron pairs on the phosphorus atom. What are all of the possible Cl-P-Cl bond angles?
   a. 120°
   b. 180°
   c. 109.5°
   d. 90°, 120°, and 180°
   e. 90° and 180°

40. CH₄ is a nonpolar molecule. Which of the following similar molecules is also nonpolar?
   a. CH₃Cl
   b. CH₂Cl₂
   c. SiH₃Cl
   d. SiH₄
   e. SiH₂Cl₂

41. Which of the following statements about the valence bond theory is false?
   a. For an atom to share more than 8 electrons it must hybridize d orbitals.
   b. To make 4 single bonds, an atom will make 4 sp³ hybrid orbitals.
   c. The number of hybrid orbitals formed equals the number of high electron density regions.
   d. Trigonal planar molecules use sp² hybrid orbitals.
   e. Atoms that do not complete their octet use either sp³d or sp³d² hybrid orbitals.

42. The hybridization associated with the central atom of a molecule in which all the bond angles are 120° is __________.
   a. sp
   b. sp²
   c. sp³
   d. sp³d
   e. sp³d²

43. Which of the following molecules has 120° bond angles?
   a. BF₄⁻
   b. CF₄
   c. H₂O
   d. Bi₃
   e. NH₄⁺

44. Which response contains all of the following molecules that can be described as bent or angular molecules and none that have other shapes?
   BeI₂, SO₂, H₂S, PF₃, CO₂
   a. SO₂, H₂S
   b. BeI₂, SO₂
   c. BeI₂, PF₃, CO₂
   d. PF₃, CO₂
   e. another combination

45. Which of the following statements about molecules with octahedral electronic geometry is false?
   a. They are sp³d² hybridized.
   b. The molecular geometry is square planar if there are two lone pairs of electrons on the central atom.
   c. The bond angles are 90°, 120° or 180°.
   d. Octahedral geometry is symmetrical.
   e. If there are two lone pairs of electrons on the central atom they will be 180° apart.
46. How many sigma (σ) bonds and how many pi (π) bonds does the ethene molecule contain?

\[ \text{C}_2\text{H}_4, \quad \begin{array}{c} \text{H} \\ \text{C} \equiv \text{C} \\ \text{H} \end{array} \]

a. 4 σ, 2 π  
b. 5 σ, 2 π  
c. 5 σ, 1 π  
d. 5 σ, 0 π  
e. 8 σ, 2 π

47. Choose the species that is **incorrectly** matched with the **electronic** geometry about the central atom.

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Electronic Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. CF₄</td>
<td>tetrahedral</td>
</tr>
<tr>
<td>b. BeBr₂</td>
<td>linear</td>
</tr>
<tr>
<td>c. H₂O</td>
<td>tetrahedral</td>
</tr>
<tr>
<td>d. NH₃</td>
<td>tetrahedral</td>
</tr>
<tr>
<td>e. PF₃</td>
<td>pyramidal</td>
</tr>
</tbody>
</table>

48. Which molecule is **incorrectly** matched with the **molecular** geometry?

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Molecular Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. SF₆</td>
<td>octahedral</td>
</tr>
<tr>
<td>b. AsH₃</td>
<td>pyramidal</td>
</tr>
<tr>
<td>c. BCl₃</td>
<td>trigonal planar</td>
</tr>
<tr>
<td>d. AsF₅</td>
<td>trigonal bipyramidal</td>
</tr>
<tr>
<td>e. H₂S</td>
<td>linear</td>
</tr>
</tbody>
</table>

49. Which species is **incorrectly** matched with the **hybridization** at the central atom?

<table>
<thead>
<tr>
<th>Species</th>
<th>Hybridization at Central Atom</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. SO₂</td>
<td>sp²</td>
</tr>
<tr>
<td>b. CF₄</td>
<td>sp³</td>
</tr>
<tr>
<td>c. PF₅</td>
<td>sp³d²</td>
</tr>
<tr>
<td>d. SeO₄²⁻</td>
<td>sp³</td>
</tr>
<tr>
<td>e. HCN</td>
<td>sp</td>
</tr>
</tbody>
</table>

50. Which species is **incorrectly** matched with **bond angles**?

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Bond Angles</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. SiCl₄</td>
<td>109.5°</td>
</tr>
<tr>
<td>b. BeI₂</td>
<td>slightly less than 109°</td>
</tr>
<tr>
<td>c. SF₆</td>
<td>90° (and 180°)</td>
</tr>
<tr>
<td>d. AsF₅</td>
<td>90°, 120° (and 180°)</td>
</tr>
<tr>
<td>e. BF₃</td>
<td>120°</td>
</tr>
</tbody>
</table>
51. Which one of the following is a nonpolar molecule with polar bonds?
   a. H₂O
   b. NH₃
   c. PF₅
   d. CHCl₃
   e. none of these

52. Refer to Ch. 5 Values. What is the frequency of light having a wavelength of 4.50 \times 10^{-6} \text{ cm}?
   a. 2.84 \times 10^{-12} \text{ s}^{-1}
   b. 2.1 \times 10^{4} \text{ s}^{-1}
   c. 4.29 \times 10^{14} \text{ s}^{-1}
   d. 1.06 \times 10^{22} \text{ s}^{-1}
   e. 6.67 \times 10^{15} \text{ s}^{-1}

53. Refer to Ch. 5 Values. A police officer is measuring traffic speed with radar operating at 1.0 \times 10^{9} \text{ Hz}. What
   is the wavelength of this electromagnetic energy?
   a. 0.30 \text{ m}
   b. 0.30 \text{ nm}
   c. 0.30 \text{ Å}
   d. 3.30 \text{ m}
   e. 3 \times 10^{17} \text{ m}

54. Refer to Ch. 5 Values. What is the energy in joules of a photon of light of wavelength 3.75 \times 10^{3} \text{ Å}?
   a. 3.30 \times 10^{-13} \text{ J}
   b. 5.30 \times 10^{-19} \text{ J}
   c. 1.10 \times 10^{-17} \text{ J}
   d. 1.38 \times 10^{-14} \text{ J}
   e. 2.22 \times 10^{-11} \text{ J}

55. Refer to Ch. 5 Values. When an electron of an excited hydrogen atom falls from level \( n = 2 \) to level \( n = 1 \),
   what wavelength of light is emitted? \( R = 1.097 \times 10^7 \text{ m}^{-1} \)
   a. 18.2 \text{ Å}
   b. 970 \text{ Å}
   c. 4800 \text{ Å}
   d. 1215 \text{ Å}
   e. 1820 \text{ Å}

56. What is the de Broglie wavelength of a 16.0 lb shotput moving at a velocity of 7.26 m/s?
   a. 1.30 \times 10^{-38} \text{ m}
   b. 1.85 \times 10^{-30} \text{ m}
   c. 1.26 \times 10^{-35} \text{ m}
   d. 2.60 \times 10^{-36} \text{ m}
   e. 6.63 \times 10^{-31} \text{ m}

57. The Heisenberg Uncertainty Principle states that 
   a. no two electrons in the same atom can have the same set of four quantum numbers
   b. two atoms of the same element must have the same number of protons
c. it is impossible to determine accurately both the position and momentum of an electron simultaneously

d. electrons of atoms in their ground states enter energetically equivalent sets of orbitals singly before they pair up in any orbital of the set

e. charged atoms (ions) must generate a magnetic field when they are in motion
MULTIPLE CHOICE

1. ANS: E  PTS: 1  TOP: Fundamental Particles and the Nuclear Atom
2. ANS: D  PTS: 1  TOP: Mass Number and Isotopes
3. ANS: C  PTS: 1  TOP: Mass Number and Isotopes
4. ANS: C  PTS: 1  TOP: Mass Number and Isotopes
5. ANS: C  PTS: 1  TOP: Mass Number and Isotopes
6. ANS: B  PTS: 1  TOP: Quantum Numbers
7. ANS: C  PTS: 1  TOP: Atomic Orbitals
8. ANS: C  PTS: 1  TOP: Atomic Orbitals
9. ANS: D  PTS: 1  TOP: Atomic Orbitals
10. ANS: D  PTS: 1  TOP: Electron Configurations
11. ANS: A  PTS: 1  TOP: Electron Configurations
12. ANS: B  PTS: 1  TOP: Electron Configurations
13. ANS: E  PTS: 1  TOP: Electron Configurations
14. ANS: B  PTS: 1  TOP: Electron Configurations
15. ANS: B  PTS: 1  TOP: More About the Periodic Table
16. ANS: A  PTS: 1  TOP: Atomic Radii
17. ANS: E  PTS: 1  TOP: Atomic Radii
18. ANS: E  PTS: 1  TOP: Ionization Energy
19. ANS: E  PTS: 1  TOP: Ionization Energy
20. ANS: B  PTS: 1  TOP: Ionic Radii
21. ANS: E  PTS: 1  TOP: Electronegativity
22. ANS: B  PTS: 1  TOP: Electronegativity
23. ANS: B  PTS: 1  TOP: Lewis Dot Formulas of Atoms
24. ANS: E  PTS: 1  TOP: Formation of Ionic Compounds
25. ANS: C  PTS: 1  TOP: Formation of Ionic Compounds
26. ANS: A PTS: 1 TOP: Formation of Covalent Bonds
27. ANS: B PTS: 1 TOP: Lewis Formulas for Molecules and Polyatomic Ions
28. ANS: D PTS: 1 TOP: Lewis Formulas for Molecules and Polyatomic Ions
29. ANS: B PTS: 1 TOP: The Octet Rule
30. ANS: B PTS: 1 TOP: The Octet Rule
31. ANS: D PTS: 1 TOP: Mass Number and Isotopes
32. ANS: D PTS: 1 TOP: Ionic Radii
33. ANS: E PTS: 1 TOP: Ionic Radii
34. ANS: B PTS: 1 TOP: Ionic Radii
35. ANS: E PTS: 1 TOP: Electronegativity
36. ANS: B PTS: 1 TOP: Lewis Dot Formulas of Atoms
37. ANS: A PTS: 1 TOP: Valence Shell Electron Pair Repulsion (VSEPR) Theory
38. ANS: A PTS: 1 TOP: Valence Shell Electron Pair Repulsion (VSEPR) Theory
39. ANS: D PTS: 1 TOP: Valence Shell Electron Pair Repulsion (VSEPR) Theory
40. ANS: D PTS: 1 TOP: Polar Molecules: The Influence of Molecular Geometry
41. ANS: E PTS: 1 TOP: Valence Bond (VB) Theory
42. ANS: B PTS: 1 TOP: Valence Bond (VB) Theory
43. ANS: D PTS: 1 TOP: Trigonal Planar Electronic Geometry
44. ANS: A PTS: 1 TOP: Tetrahedral Electronic Geometry (AB2U2)
45. ANS: C PTS: 1 TOP: Octahedral Electronic Geometry
46. ANS: C PTS: 1 TOP: Compounds Containing Double or Triple Bonds
47. ANS: E PTS: 1 TOP: Summary of Electronic and Molecular Geometries
48. ANS: E PTS: 1 TOP: Summary of Electronic and Molecular Geometries
49. ANS: C PTS: 1 TOP: Summary of Electronic and Molecular Geometries
50. ANS: B PTS: 1 TOP: Summary of Electronic and Molecular Geometries
51. ANS: C PTS: 1 TOP: Polarity of Molecules
52. ANS: E PTS: 1 TOP: Electromagnetic Radiation
53. ANS: C PTS: 1 TOP: Electromagnetic Radiation
54. ANS: B  PTS: 1  TOP: Electromagnetic Radiation
55. ANS: D  PTS: 1  TOP: Atomic Spectra and the Bohr Atom
56. ANS: C  PTS: 1  TOP: The Wave Nature of the Electron
57. ANS: C  PTS: 1  TOP: The Quantum Mechanical Picture of the Atom