CHEM 112 **Exam II** **October 3rd, 2022**

INSTRUCTIONS (Read and follow carefully)

Using only a #2 pencil (do not use ink) on the gray side of the "Grade Master Answer Sheet," complete the following:

1. Your **First and Last Name** in the "Name" section of the sheet.

2. Depending on your instructor, print "**Lipatov**" OR "**Zhu**" in the "Teacher" section.

3. In the "Student ID Number" write down your student ID from your Grubby card. Darken the corresponding rectangle with the number. See example →

4. There are multiple versions of the test.

DO NOT LOOK AT OTHER TESTS OR SCANTRONS.

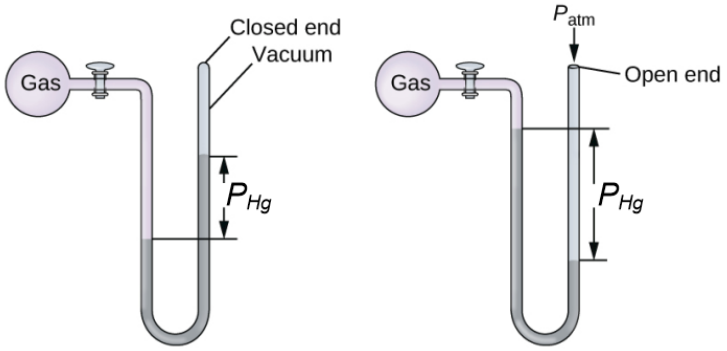
5. Darken the corresponding rectangle on the answer scantron sheet for all your answers. Your instructor will keep original answer sheets. Also, mark the answer on your test sheet, as this will be your only record of your answers.

6. There are 34 questions on the exam, and printing has been done on both sides of the page. Answer all questions (each answer has the same point value) but budget your time so that you do not spend too much time on any one question. You are provided with scratch paper. There is only one correct answer to each question. A question for which more than one answer is marked will be counted wrong. It is to your advantage to answer every question, so make sure every question has been answered before you hand in your answer sheet. Remember, some answers are rounded. Pick the closest one.

7. When you are finished with the exam, turn in only your "Grade Master Answer Sheet" and make sure that all of the information requested above has been provided and correctly filled in on the form.

8. Answers will be posted on D2L following the exam, and test grades will be on D2L by the end of the week.

9. It is in your best interest to save this copy of your test for question or answer issues later.



PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	GROUP																	
1	1 H 1.008																	2 He 4.003
2	3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
3	11 Na 22.990	12 Mg 24.305											13 Al 26.981	14 Si 28.085	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
4	19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.630	33 As 74.922	34 Se 78.971	35 Br 79.904	36 Kr 83.798
5	37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.95	43 Tc [98]	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
6	55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po [209]	85 At [210]	86 Rn [222]
7	87 Fr [223]	88 Ra [226]	89 Ac [227]															

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]	103 Lr [266]

Temperature Conversion

$^oF = 9/5(^oC) + 32$

$^oC = 5/9(^oF - 32)$

$K = 273.15 + ^oC$

Constants

$N = 6.0223 \times 10^{23}$

$c = 3.00 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ J·s

Energy and Electromagnetic Wave

$v = c / \lambda$

$E = h(c/\lambda)$

$E = hv$ $\quad Hz = s^{-1}$

Gas Law

$PV = nRT$ $\quad P_1V_1/T_1 = P_2V_2/T_2$

$R = 0.0821$ L•atm/ mol•K

STP gas law = 0 ^{o}C, 1atm

1atm = 760torr = 760 mmHg

Colligative Properties

$\Delta T_f = iK_fm$

$\Delta T_b = iK_bm$

Thermodynamics

$\Delta H^o_{rxn} = \Sigma n\Delta H^o_f$ (products)-$\Sigma m\Delta H^o_f$(reactants)

$\Delta E = \Delta H - P\,\Delta V$

$q_1 = -q_2$ $\quad w = -P\Delta V$ $\quad 1L•atm = 101.3J$

$C = m·s$ $\quad q = m·s·\Delta t$ $\quad E = q + w$

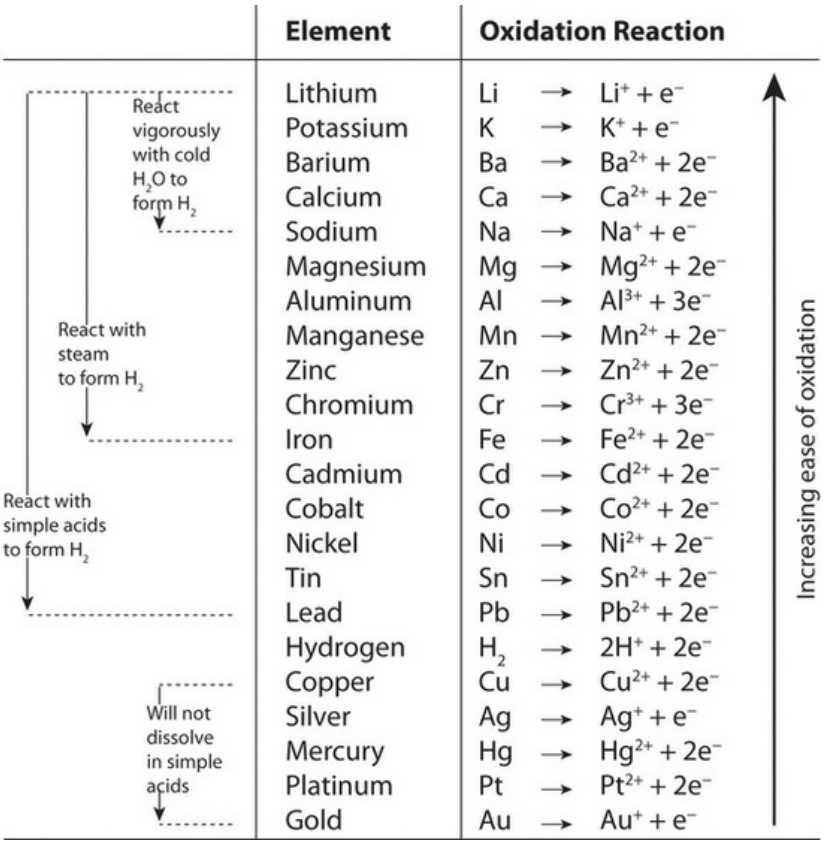
Soluble Compounds

1. All salts of the alkali metals (Group 1A) are soluble.
2. All salts containing NH_4^+, NO_3^-, ClO_4^-, ClO_3^-, and $C_2H_3O_2^-$ are soluble.
3. All chlorides, bromides, and iodides (salts containing Cl^-, Br^-, or I^-) are soluble except when combined with Ag^+, Pb^{2+}, and Hg_2^{2+} (note the subscript 2).
4. All salts containing SO_4^{2-} are soluble except those of Pb^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, and Hg_2^{2+}.

Insoluble Compounds

5. All metal hydroxides (ionic compounds containing OH^-) and all metal oxides (ionic compounds containing O^{2-} are insoluble except those of Group 1A and those of Ca^{2+}, Sr^{2+}, and Ba^{2+}.
   - When metal oxides do dissolve, they react with water to form hydroxides. The oxide ion, O^{2-}, does not exist in water. For example:

     $Na_2O(s) + H_2O \longrightarrow 2NaOH(aq)$
6. All salts containing PO_4^{3-}, CO_3^{2-}, SO_3^{2-} and S^{2-} are insoluble except those of Group 1A and NH_4^+



Element	Oxidation Reaction
Lithium	$Li \rightarrow Li^+ + e^-$
Potassium	$K \rightarrow K^+ + e^-$
Barium	$Ba \rightarrow Ba^{2+} + 2e^-$
Calcium	$Ca \rightarrow Ca^{2+} + 2e^-$
Sodium	$Na \rightarrow Na^+ + e^-$
Magnesium	$Mg \rightarrow Mg^{2+} + 2e^-$
Aluminum	$Al \rightarrow Al^{3+} + 3e^-$
Manganese	$Mn \rightarrow Mn^{2+} + 2e^-$
Zinc	$Zn \rightarrow Zn^{2+} + 2e^-$
Chromium	$Cr \rightarrow Cr^{3+} + 3e^-$
Iron	$Fe \rightarrow Fe^{2+} + 2e^-$
Cadmium	$Cd \rightarrow Cd^{2+} + 2e^-$
Cobalt	$Co \rightarrow Co^{2+} + 2e^-$
Nickel	$Ni \rightarrow Ni^{2+} + 2e^-$
Tin	$Sn \rightarrow Sn^{2+} + 2e^-$
Lead	$Pb \rightarrow Pb^{2+} + 2e^-$
Hydrogen	$H_2 \rightarrow 2H^+ + 2e^-$
Copper	$Cu \rightarrow Cu^{2+} + 2e^-$
Silver	$Ag \rightarrow Ag^+ + e^-$
Mercury	$Hg \rightarrow Hg^{2+} + 2e^-$
Platinum	$Pt \rightarrow Pt^{2+} + 2e^-$
Gold	$Au \rightarrow Au^+ + e^-$

Name: _____ Class: _____ Date: _____ ID: A

Chem 112 **Exam II** **Fall 2022**

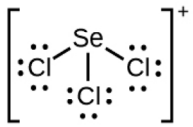
Solution

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

____ 1. Identify the transition metal ion and the number of electrons with the following electron configuration, [Ar]$3d^7$.
total # of e^- = 18 + 7 = 25 e^-, since it is a transition metal ion, the answer is (e)
a. cobalt and 27 electrons
b. cobalt (I) ion and 26 electrons
c. cobalt (III) ion and 24 electrons
d. manganese and 25 electrons
e. cobalt (II) ion and 25 electrons

____ 2. Based on the geometry of the molecule IF_5, what are the bond angles of F–I–F?
Lewis structure
a. 180°
b. 120°
c. 90°
d. 109.5°
e. Can not be determined.
e^- regions shape: octehedral
molecular shape: square pyramidal

____ 3. What is the molecular shape and polarity for xenon tetrafluoride?
a. square planar and non-polar
b. trigonal bipyramid and non-polar
c. tetrahedral and non-polar
d. tetrahedral and polar
e. square planar and polar
Lewis structure
e^- region shape = octehedra
molecular shape square planar
Dipoles cancel out nonpolar

____ 4. The Lewis structure of $SeCl_3^+$: is:
a.

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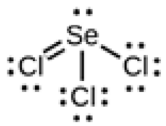
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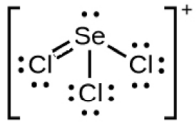
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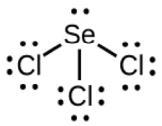
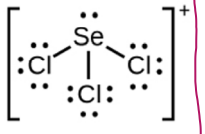

e.


____ 5. Which of the following is an ionic compound? metal + nonmetal
a. CuZn
b. Na_2O
c. CO_2
d. HCl
e. CO

____ 6. How many σ-bonds and π-bonds, respectively, are in a $COCl_2$ molecule?
a. 2 σ-bonds and 2 π-bonds
b. 4 σ-bonds and 0 π-bonds
c. 3 σ-bonds and 2 π-bonds
d. 3 σ-bonds and 1 π-bond
e. 2 σ-bond and 1 π-bond
double bonds: 1 σ bond, 1 π bond

____ 7. Draw a Lewis structure for the SF_5^- molecule. What is the set of hybrid orbitals used by the sulfur atom for bonding?
6 e^- regions → 6 hybrid orbitals
a. sp^3
b. sp^3d
c. sp^2
d. sp^5
e. sp^3d^2
sp^3d^2

____ 8. According to periodic trends, which metal has the lowest ionization energy?
a. Cs
b. K
c. Na
d. Li
e. Rb
IE increases
IE decreases

____ 9. Using VSEPR theory, predict the molecular shape and bond angles in BCl_3.
a. bent, 120°
b. trigonal pyramidal, 120°
c. trigonal planar, 90°
d. trigonal pyramidal, 109.5°
e. trigonal planar, 120°

3 e⁻ regions, all bonding pairs → trigonal planar

____ 10. How many polar bonds does CCl_4 have in its structure?
a. 5
b. 2
c. 4
d. 0
e. 1

all C–Cl bonds are polar

____ 11. In the Lewis structure below, M and X represent various elements in the third period of the periodic table. The formula of the compound is:

$[M^{2+}][:\ddot{X}:]^{2-}$

group 2 → Mg^{2+}; group 16 → S^{2-}

a. CaO
b. MgP
c. CaS
d. MgS
e. MgO

____ 12. What is the electron configuration of Cu^+ and Cu^{2+} ?
a. [Ar]$3d^9 4s^1$ and [Ar]$3d^9$
b. [Ar]$3d^8 4s^2$ and [Ar]$3d^8 4s^1$
c. [Ar]$3d^9 4s^1$ and [Ar]$3d^8 4s^1$
d. [Ar]$3d^{10}$ and [Ar]$3d^9$
e. [Ar]$3d^9 4s^1$ and [Ar]$3d^7 4s^2$

Cu: [Ar] $4s^1 3d^{10}$
Cu^+: [Ar] $3d^{10}$
Cu^{2+}: [Ar] $3d^9$

____ 13. Which of the following is not permitted as a plausible orbital designation according to quantum theory.
a. 2d
b. 6p
c. 4f
d. 5f
e. 1s

____ 14. Which element below has four valence electrons in its Lewis symbol?
a. sulfur
b. iron
c. germanium
d. indium
e. zinc

group 14 elements

____ 15. An FM radio station found at 103.1 on the FM dial broadcasts at a frequency of $1.031 \times 10^8\ s^{-1}$ (103.1 MHz). What is the wavelength of these radio waves in meters?
a. 2.908×10^6 m
b. 2.908 m
c. 2.908×10^4 m
d. 34.27 m
e. 3.427×10^{-1} m

$\lambda = \frac{c}{\nu} = \frac{3.00 \times 10^8\ m/s}{1.031 \times 10^8\ s^{-1}} = 2.908\ m$

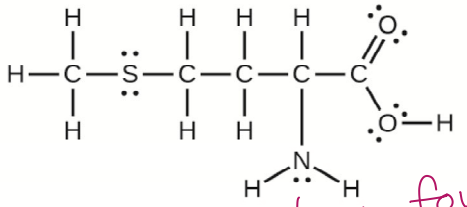
____ 16. Draw the Lewis structure for the hydronium ion (H_3O^+) and determine the molecular geometry. Predict the bonding angle of H-O-H according to the VSEPR model.
a. 120 °
b. 109.5°
c. 180°
d. Slightly smaller than 109.5°
e. Slightly greater than 109.5°

$[H-\ddot{O}(H)-H]^+$

• trigonal pyramidal
• lone pair pushes bonding pair closer, bond angle less than 109.5°

____ 17. Based on the valence bond theory, HCl is formed by
a. overlapping the 1s orbital of H and $3p_z$ orbital of Cl to form a single σ bond.
b. overlapping the 1s orbital of H and $2p_z$ orbital of Cl to form a single π bond.
c. overlapping the 1s orbital of H and $3p_z$ orbital of Cl to form a single π bond.
d. overlapping the 2s orbital of H and $3p_z$ orbital of Cl to form a single σ bond.
e. overlapping the 1s orbital of H and $2p_z$ orbital of Cl to form a single σ bond.

____ 18. What is the hybridization type of nitrogen?



four e⁻ regions, four hybrid orbitals
sp^3

a. sp^3d
b. sp^2
c. sp^3
d. sp
e. sp^3d^2

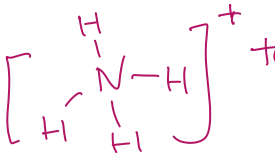
____ 19. The compound HCl is:
a. Ionic
b. Metallic
c. Polar covalent
d. Not enough info
e. Nonpolar covalent

____ 20. According to the octet rule, which of the elements will have a tendency to lose 2 electrons?
a. potassium, K
b. sulfur, S
c. cesium, Cs
d. oxygen, O
e. strontium, Sr

group 2 elements

____ 21. Identify which of the following molecules has a double bond.
a. HF
b. O_2
c. N_2
d. H_2
e. Br_2

____ 22. According to VSEPR theory, the shape of an ammonium ion, NH_4^+, is most similar to:
a. CH_4 tetrahedral
b. BH_3 trigonal planar
c. NH_3 trigonal pyramidal
d. N_2 linear
e. CO_2 linear



tetrahedral

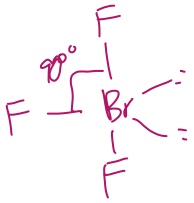
____ 23. What is the ground-state electron configuration of calcium?
a. $1s^22s^22p^63s^23p^64s^2$
b. $1s^22s^22p^63s^23p^54s^1$
c. $1s^22s^22p^63s^2$
d. $1s^22s^22p^6$
e. $1s^22s^22p^63s^24s^8$

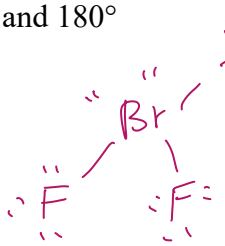
____ 24. Which of the following elements have a tendency to gain electrons?
a. N, O, Al
b. Cl, O, F
c. Cl, F, Ga
d. Na, K, Ca
e. Cl, B, Al

nonmetal

____ 25. According to periodic trends, which element is the most electronegative?
a. Cl
b. O
c. F
d. S
e. Ne

____ 26. Draw the Lewis structure of BrF_3, and then determine the bond angle(s) of F–Br–F.
a. 60°
b. 90° and 120°
c. 45°
d. 120°
e. 90° and 180°





e⁻ region shape
trigonal bipyramidal
• lone pairs are at the equatorial position
molecular shape
T-shaped

____ 27. A bright violet line occurs at 435.8 nm in the emission spectrum of mercury vapor. What is energy of one photon of this light?

a. 4.56×10^{-28} J
b. 6.88×10^{23} J
c. 4.56×10^{-10} J
d. 4.56×10^{-19} J
e. 6.88×10^{14} J

$E = h\nu = h\frac{c}{\lambda} = \frac{6.63\times10^{-34}\ J\cdot s \times 3.00\times10^{8}\ m/s}{435.8\ nm \times \frac{10^{-9}\ m}{1\ nm}}$

____ 28. A single electron occupies a subshell and has the quantum numbers n = 3, l = 0, m_l = 0, m_s = +½. Which of the following is an acceptable set of quantum numbers for the next electron added to this subshell? (Hint: draw an orbital diagram)

n, l, m_l, m_s

a. 3, 1, -1, -1/2
b. 3, 0, 0, +1/2
c. 3, 0, 0, -1/2
d. 3, 2, 0, +1/2
e. 3, 1, 0, +1/2

n=3 ↑↓ 3S ___ ___ ___ 3P

____ 29. Which of the following is true about Fe^{2+}?

a. Fe^{2+} is paramagnetic with 0 unpaired e^-
b. Fe^{2+} is paramagnetic with 4 unpaired e^-
c. Fe^{2+} is diamagnetic.
d. Fe^{2+} is paramagnetic with 2 unpaired e^-
e. Fe^{2+} is paramagnetic with 5 unpaired e^-

[Ar]$3d^6$ ↿ ↑ ↑ ↑ ↑ 3d

____ 30. In what block, group, and period on the periodic table can the atom with a $1s^22s^22p^63s^23p^64s^23d^{10}4p^5$ ground-state electron configuration be found?

a. p-block, group 17, and period 4
b. d-block, group 7, and period 5
c. p-block, group 17, and period 3
d. p-block, group 17, and period 5
e. d-block, group 7, and period 4

____ 31. According to periodic trends, arrange the following ions, potassium K^+, magnesium Mg^{2+}, and aluminum Al^{3+} in order of increasing ionic size.

[He] [Ar] [He]

a. $K^+ < Al^{3+} < Mg^{2+}$
b. cannot predict the size trend
c. $Al^{3+} < Mg^{2+} < K^+$
d. $K^+ < Mg^{2+} < Al^{3+}$
e. $Al^{3+} < K^+ < Mg^{2+}$

____ 32. Which element has the electron configuration $1s^22s^22p^63s^23p^64s^23d^5$?

Z = 35

a. Tc
b. Mo
c. Mn
d. Fe
e. Cr

____ 33. Which of the following would be polar?

a. CH_4
b. BF_3
c. C_2H_2
d. CO_2
e. methanol, CH_3OH

____ 34. Due to periodicity, which element would you expect to behave most like sodium?

a. aluminum
b. barium
c. calcium
d. oxygen
e. potassium