

DO NOT OPEN

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CHEM 110 – Dr. McCorkle – Final Exam

While you wait, please complete the following information:

Name:

Student ID: _____

Turn off cellphones and stow them away. No headphones, mp3 players, hats, sunglasses, food, drinks, restroom breaks, graphing calculators, programmable calculators, or sharing calculators. Grade corrections for incorrectly marked or incompletely erased answers will not be made.

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4	¥	Ca	Sc	Ħ	>	ა	Mn	Fe	8	Ni	CU	Zn	Ga	Ge	As	Se	Br	Kr
	39.10	40.08	44.96	47.88	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.39	69.72	72.61	74.92	78.97	79.90	83.80
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
പ	Rb	S	7	Zr	ЧN	Мо	Tc	Ru	Rh	Pd	Ag	8	<u>_</u>	Sn	Sb	Te	_	Xe
	85.47	87.62	88.91	91.22	92.91	95.95	(98)	101.07	102.91	106.42	107.87	112.41	114.82	118.71	121.75	127.60	126.90	131.29
	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
9	ട്	Ba	ra *	H ///	Ta	N	Re	S	F	Pt	Au	ВН	F	Рb	: 10 10	Ро	At	Rn
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Periodic Table of the Elements

PERIOD

Multiple Choice – Choose the answer that best completes the question. Use an 815-E Scantron to record your response. [2 points each]

- 1. A chemical change occurs when
 - A) methane gas is burned.
 - B) paper is shredded.
 - C) water is vaporized.
 - D) salt is dissolved in water.
 - E) powdered lemonade is stirred into water.
- 2. Determine the number of protons, neutrons, and electrons in the following: $^{40}_{18}$ X

A) $p^+ = 18$	$n^0 = 18$	$e^{-} = 12$
B) $p^+ = 18$	$n^0 = 22$	e ⁻ = 18
C) $p^+ = 22$	$n^0 = 18$	$e^{-} = 18$
D) $p^+ = 18$	$n^0 = 22$	$e^{-} = 40$
E) $p^+ = 40$	$n^0 = 22$	$e^{-} = 18$

3. Which of the following numbers contains the designated CORRECT number of significant figures?

A) 0.04300	5 significant figures
B) 0.00302	2 significant figures
C) 156 000	2 significant figures
D) 1.04	2 significant figures
D = 1.04	2 significant figures
E) 3.0650	4 significant figures

- 4. What is the molarity of a solution that contains 3.25 moles of NaNO₃ in 250. mL of solution?
 A) 3.25 M
 B) 6.50 M
 C) 0.0130 M
 D) 13.0 M
 E) 2.60 M
- 5. How many milliliters of 0.266 *M* LiNO₃ solution are required to make 150.0 mL of 0.075 *M* LiNO₃ solution?

A) 53 mL B) 19 mL C) 35 mL D) 42 mL E) 24 mL

- 6. While traveling, an airplane passenger placed a bag of potato chips in his checked luggage. Later after landing, he opened his luggage and discovered the bag had exploded and potato chips were everywhere. Which law is this an example of?
 - A) Avogadro's Law
 - B) Ideal Gas Law
 - C) Charles's Law
 - D) Boyle's Law
 - E) Dalton's Law

7. Which of the following sings on q and w represent a system that is doing work on the surroundings, as well as gaining heat from the surroundings.

A) q = +, w = B) q = -, w = +
C) q = +, w = +
D) q = -, w = E) None of these represent the system referenced above.

- 8. Calculate the energy of the orange light emitted, per photon, by a neon sign with a frequency of 4.89×10^{14} Hz.
 - A) 3.09×10⁻¹⁹ J
 - B) $6.14 \times 10^{-19} \text{ J}$
 - C) $3.24 \times 10^{-19} \text{ J}$
 - D) 1.63×10⁻¹⁹ J
 - E) $5.11 \times 10^{-19} \text{ J}$
- 9. For n = 2, what are the possible values of *l*?
 - A) 0
 - B) 0, 1
 - C) 0, 1, 2
 - D) -1, 0, +1
 - E) -2, -1, 0, +1, +2
- 10. Which element corresponds to the electron configuration $1s^22s^22p^63s^23p^64s^13d^5$?
 - A) titanium
 - B) vanadium
 - C) chromium
 - D) manganese
 - E) iron
- 11. Which compound has the longest carbon-carbon bond?
 - A) CH₃CH₃
 - B) CH₂CH₂
 - C) HCCH
 - D) All bond lengths are the same

- 12. Identify the bond with the lowest bond energy.
 - A) Si=O
 - B) N=N
 - C) C=C
 - D) C=N
 - E) O=O
- 13. A molecule that is sp³d hybridized and has a molecular geometry of seesaw has ______ bonding groups and ______ lone pairs around its central atom.
 - A) 5, 1
 - B) 4, 2
 - C) 4, 1
 - D) 3, 2
 - E) 2, 3
- 14. Capillary action occurs because
 - A) cohesive forces are greater than adhesive forces.
 - B) cohesive forces equal adhesive forces.
 - C) adhesive forces are greater than cohesive forces.
 - D) surface tension is high.
 - E) surface tension is low.
- 15. The strongest interactions between nonpolar molecules of ethane (C_2H_6) are
 - A) ionic bonds
 - D) dipole-dipole

B) hydrogen bondsE) dispersion forces

C) covalent bonds

Calculations – Write your initials in the upper-right corner of every page that contains work. For full credit show all work and write neatly; give answers with correct significant figures and units. For calculations, place a box around your final answer.

16. A doctor's order is 0.125 g of ampicillin. The liquid suspension on hand contains 0.250 μg ampicillin/5.0 mL of suspension. How many deciliters of the suspension are required? [5 pts]

17. A 5.00-L tank contains helium gas at 1.50 atm. If the volume is changed to 1.75×10^3 mL, what is the pressure of the gas in torr? [4]

- 18. Name the following compounds: [2 points each]
 - a. Al₂(CO₃)₃
 - b. P₃O₇
 - c. $H_3N(aq)$

Write the formula for the following compounds:

- d. tetrasulfur octafluoride
- e. phosphorous acid
- f. titanium(IV) perchlorate

- 19. Consider the molecule ICl_4^- :
 - a. Draw the Lewis structure, including any resonance structures: [2 points]

- b. Assign formal charges to each atom in the structure(s) above: [2]
- c. Electron geometry? [2]
- d. What is the hybridization of the central atom? [2]
- e. Molecular geometry? [2]
- f. Draw ICl_4^- three-dimensionally using wedge notation AND label all bond angles: [4]

e. Is the molecule polar or nonpolar? Explain. [2]

20. How many milliliters of 0.200 *M* NaOH are required to completely neutralize 5.00 mL of 0.100 *M* H₂SO₄? (*Hint: Write a balanced chemical equation first.*) [5 points]

21. Briefly explain why methanol has a higher boiling point than formaldehyde. [3]



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22. Suppose 316.0 g aluminum sulfide reacts with 493.0 g of water according to the following equation:

 $Al_2S_3(s) + 6 H_2O(l) \rightarrow 2 Al(OH)_3(s) + 3 H_2S(g)$

What mass of the excess reactant remains? [8 points]

23. Consider the following phase diagram:



- a) Label the solid, liquid, and gas regions. [3 points]
- b) Label the triple point. [1]
- c) What is the approximate boiling point of this substance at standard pressure? Draw lines to indicate how you would determine this. [2]
- d) Are there any conditions under which the substance would undergo sublimation? If so, what are they? [2]
- e) Describe what happens to the substance at 125 K if its pressure is slowly increased from 100 mmHg to 800 mmHg. [2]

24. How much heat (kJ) is needed to raise the temperature of 25.0 g of ethanol (C₂H₅OH) from -135° C to -50° C? [7 points]

Constant	Value
$\Delta H_{ m fus}$	5.02 kJ/mol
$\Delta H_{\rm vap}$	38.56 kJ/mol
s (solid)	0.97 J/g·°C
s (liquid)	2.44 J/g·°C
s (gas)	1.88 J/g·°C
Boiling point	78.1°C
Melting point	-114°C

Extra Credit: On the very first day of class we discussed the scientific method and this quote by a famous scientist: "*No amount of experimentation can ever prove me right; a single experiment can prove me wrong.*" Who said it? [2 points]

Dr. McCorkle

Formulas & Constants (you may or may not need)

1 inch = 2.54 cm (exact)	1 mile = 5280 ft ≈ 1.609 km	1 kg ≈ 2.205 lb
1 lb = 16 oz ≈ 453.6 g	1 gal = 4 qt = 8 pt ≈ 3.785 L	$1 L = 1000 cm^3$
K = °C + 273.15	°F = 1.8 x °C + 32	°C = (°F – 32)/1.8
1 cal = 4.184 J	1 Cal = 1000 cal	$q = m \times C \times \Delta T$
Avogadro's # = 6.022×10^{23}	Molar volume = 22.4 L	$R = 0.08206 \frac{L \cdot atm}{mol \cdot K}$
$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$	$u_{\rm rms} = \sqrt{\frac{3{ m RT}}{M}}$	$KE = \frac{1}{2}mv^2 = \frac{3}{2}RT$
1 atm = 760 mmHg	1 mmHg = 1 torr	$P_{Total} = P_1 + P_2 + \dots$
$P_A = X_A \cdot P_{Total}$	PV = nRT	$\Delta E = q + w$
$w = -P\Delta V$	$q = C \times \Delta T$	$q = m \times s \times \Delta T$
$\Delta H^{\circ}_{rxn} = \Sigma[n \ \Delta H^{\circ}_{f}(products)] - \Sigma[n \ \Delta H^{\circ}_{f}(r)]$	reactants)]	R = 8.314 J/mol•K
$h = 6.626 \times 10^{-34} J \cdot s$	c = 2.9979×10 ⁸ m/s	$R_{\rm H} = 2.18 \times 10^{-18} {\rm J}$
$1 \text{ Hz} = \text{s}^{-1}$	$\lambda = \frac{h}{mv}$	$\Delta x \times m \Delta v \ge \frac{h}{4\pi}$
$E_{photon} = h\mathbf{v} = \frac{hc}{\lambda}$	$E_{photon} = R_H \left[\left(\frac{1}{n_{final}^2} \right) - \left(\frac{1}{n_{initial}^2} \right) \right]$	

Electronegativity

1 H																Decrea
2.1 3	4	Î										5	6	7	8	9
Li	Be											B	C	N	0	F
1.0	1.5					Increa	isina -	-				2.0	2.5	3.0	3.5	4.0
11 Na	12 Mg					. Tribitor	101113					13 Al	14 Si	15 P	16 S	17 Cl
0.9	1.2											1.5	1.8	2.1	2.5	3.0
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br
0.8	1.0	1.3	1.5	1.6	1.6	1.5	1.8	1.9	1.9	1.9	1.6	1.6	1.8	2.0	2.4	2.8
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53
0.8	1.0	1.2	1.4	1.6	1.8	1.9	2.2	2.2	2.2	1.9	1.7	1.7	1.8	1.9	2.1	2.5
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 TI	82 Pb	83 Bi	84 Po	85 At
0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.2	2.2	2.2	2.4	1.9	1.8	1.9	1.9	2.0	2.2
87 Fr	88 Ra	89 Ac										Elec	ctronega	ativities	of the E	lements
0.7	0.9	1.1														

Scratch Page

(to be handed in)