DO NOT OPEN

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CHEM 100 – Dr. McCorkle – Exam #2A ***KEY***

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.

Periodic Table of the Elements

PERIOD	GROUP 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 H 1.01																	2 He 4.00
2	3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IB	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	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 121.75	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 183.85	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)	104 Rf (267)	105 Db (268)	106 Sg (271)	107 Bh (270)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Uut (284)	114 Fl (289)	115 Uup (288)	116 Lv (293)	117 Uus (294)	118 Uuo (294)

Lanthanide Series *	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
Actinide Series **	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 (262)

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

1. The atomic number of an atom is equal to the number of the
   A) protons B) neutrons C) electrons
   D) protons & neutrons E) protons & electrons

2. What is the alkali metal in period 4?
   A) K B) Li C) Ca D) Ge E) Br

3. What is the mass number of an atom of copper that has 36 neutrons?
   A) 29 B) 36 C) 59 D) 63.55 **E) 65**

4. Of the elements Na, Mg, K, P, and As, the element with the largest atomic radius is:
   A) Na B) Mg **C) K** D) P E) As

5. Who is credited with the discovery of the electron?
   A) Ernest Rutherford B) James Chadwick **C) J.J. Thomson**
   D) Robert Millikan E) John Dalton

6. The elements sodium, magnesium, and silicon
   A) are isotopes of each other. **B) are in the same period of elements.**
   C) have the same number of neutrons. D) are in the same group of elements.
   E) have the same mass number.

7. The elements in group 2A(2) form ions with a charge of
   A) 1+ B) 1− **C) 2+** D) 2− E) 0

8. The strongest interactions between molecules of ammonia (NH_3) are
   A) ionic bonds **B) hydrogen bonds** C) covalent bonds
   D) dipole-dipole E) dispersion forces

9. Which of the following contains an ionic bond?
   A) CH_4 B) H_2O C) H_2 **D) CaO** E) NF_3

10. How many valence electrons does CO_3^{2-} have?
    A) 20 B) 22 **C) 24** D) 30 E) 32

11. What is the molar mass of $Mg_3(PO_4)_2$?
A) 119.28 g B) 198.87 g C) 230.87 g D) 231.90 g **E) 262.87 g**

12. What is the mass of 3.00 moles of NO_2?
A) 15.3 g B) 46.0 g C) 90.0 g D) 132 g **E) 138 g**

13. Classify the reaction $SO_3(g) + H_2(g) \rightarrow H_2SO_4(aq)$
A) combination B) decomposition C) single replacement
D) double replacement E) combustion

14. Classify the reaction $Fe + HCl \rightarrow FeCl_3 + H_2$
A) combination B) decomposition **C) single replacement**
D) double replacement E) combustion

15. How many orbitals are in the third energy level, n=3?
A) 1 B) 3 C) 5 **D) 9** E) 16

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. Place a box around your final answer.

16. Write the complete electron configuration of Ga. [2 points]

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$

17. Write the condensed (abbreviated) electron configuration of Bi. [2 points]

$[Xe] 6s^2 4f^{14} 5d^{10} 6p^3$

18. How many protons, neutrons, and electrons are in an isotope of chromium-52? [3 points]

Protons: ___**24**____ Neutrons: ___**28**____ Electrons: ___**24**____

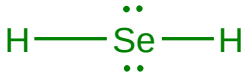
19. The fantastical element, Kentium, has three naturally occurring isotopes. The isotope Kt-104 (mass = 103.997 amu) makes up 26.54%, Kt-105 (mass = 104.953 amu) makes up 42.71%, and Kt-106 (mass = 105.926 amu) makes up 30.75%. Determine the average atomic mass of Kentium to two decimal places. [4 points]

= (0.2654×103.997) + (0.4271×104.953) + (0.3075×105.926)

= 105.00 amu

20. Consider the compound H_2Se.

a. Draw the Lewis structure: [2]



b. Determine the electron geometry: [2]

tetrahedral

c. Determine the molecular shape: [2]

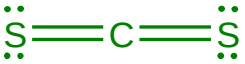
bent

d. Is the molecule polar or nonpolar? [2]

polar

21. Consider the compound CS_2.

a. Draw the Lewis structure: [2]



b. Determine the electron geometry: [2]

linear

c. Determine the molecular shape: [2]

linear

d. Is the molecule polar or nonpolar? [2]

nonpolar

22. Balance the following equations: [2 points each]

i. __2__ K_3PO_4 + __3__ $Ca(NO_3)_2$ → _____ $Ca_3(PO_4)_2$ + __6__ KNO_3

ii. _____ C_5H_8 + __7__ O_2 → __5__ CO_2 + __4__ H_2O

iii. _____ N_2H_4 + __2__ H_2O_2 → _____ N_2 + __4__ H_2O

23. How many hydrogen atoms are in 75.0 g of H_2O? [4 points]

$$\mathbf{75.0\ g} \times \frac{\mathbf{1\ mol\ H_2O}}{\mathbf{18.02\ g}} \times \frac{\mathbf{2\ mol\ H}}{\mathbf{1\ mol\ H_2O}} \times \frac{\mathbf{6.022 \times 10^{23}}}{\mathbf{1\ mol\ H}} = \mathbf{5.01 \times 10^{24}\ H\ atoms}$$

24. How many grams of NO are required to produce 145 g of N_2 in the following reaction? [4 points]

$$4\ NH_3(g) + 6\ NO(g) \rightarrow 5\ N_2(g) + 6\ H_2O(l)$$

$$\mathbf{145\ g\ N_2} \times \frac{\mathbf{1\ mol\ N_2}}{\mathbf{28.02\ g}} \times \frac{\mathbf{6\ mol\ NO}}{\mathbf{5\ mol\ N_2}} \times \frac{\mathbf{30.01\ g}}{\mathbf{1\ mol\ NO}} = \mathbf{186\ g}$$

25. How many kcal are produced when 24.0 g of O_2 react? [4 points]

$$CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(g) \qquad \Delta H = -218\ \text{kcal}$$

$$\mathbf{24.0\ g\ O_2} \times \frac{\mathbf{1\ mol\ O_2}}{\mathbf{32.00\ g}} \times \frac{\mathbf{-218\ kcal}}{\mathbf{2\ mol\ O_2}} = \mathbf{81.8\ kcal}$$

26. Name the following compounds: [2 points each]

i. $Ni(C_2H_3O_2)_6$ **nickel(VI) acetate**

ii. $Al_2(SO_3)_3$ **aluminum sulfite**

iii. N_2O_5 **dinitrogen pentaoxide**

iv. SnS_2 **tin(IV) sulfide**

v. Cu_2CO_3 **copper(I) carbonate**

27. Write the formula for the following compounds: [2 points each]

i. cobalt(III) chlorite **$Co(ClO_2)_3$**

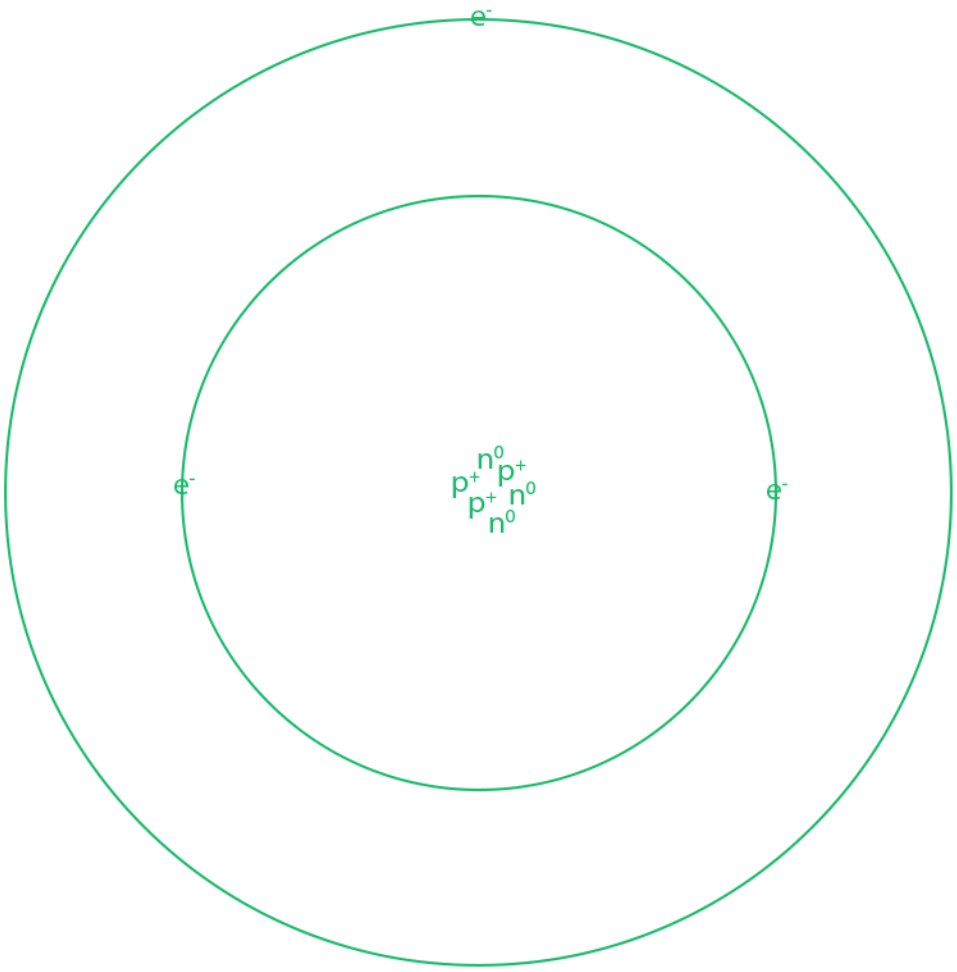
ii. triphosphorus heptafluoride **P_3F_7**

iii. cadmium cyanide **$Cd(CN)_2$**

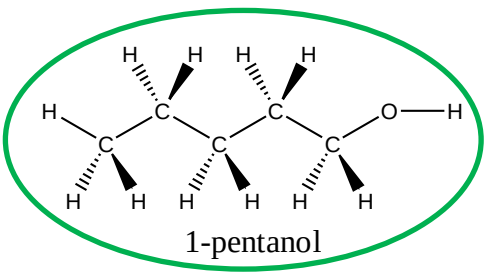
iv. iron(II) nitrate **$Fe(NO_3)_2$**

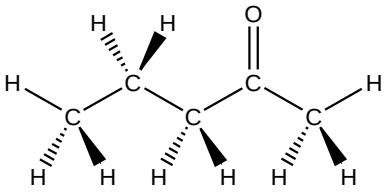
v. ammonium phosphite **$(NH_4)_3PO_3$**

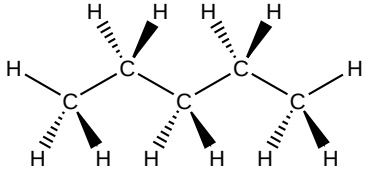
28. Use the space below to sketch a model of an atom of ^{6}Li. Label protons as $\mathbf{p^{+}}$, neutrons as $\mathbf{n^{0}}$, and electrons as $\mathbf{e^{-}}$. Include the proper numbers of each particle and arrange them in their approximate location within the atom. (You don't need to worry about drawing the atom to scale.) [5 points]



29. Circle the molecule below that will have the highest boiling point. [2 points]


1-pentanol


2-pentanone


pentane

30. ***Challenge Question:*** Aluminum reacts with oxygen to produce aluminum oxide. If 20.0 g of aluminum reacts with 50.0 g of oxygen to produce 26.3 g of aluminum oxide, what is the percent yield? [8 points]

$$4\ Al(s) + 3\ O_2(g) \rightarrow 2\ Al_2O_3(s)$$

$$20.0\ g \times \frac{1\ mol\ Al}{26.98\ g} \times \frac{2\ mol\ Al_2O_3}{4\ mol\ Al} \times \frac{101.96\ g}{1\ mol\ Al_2O_3} = 37.8\ g\ Al_2O_3$$

$$50.0\ g \times \frac{1\ mol\ O_2}{32.00\ g} \times \frac{2\ mol\ Al_2O_3}{3\ mol\ O_2} \times \frac{101.96\ g}{1\ mol\ Al_2O_3} = 106\ g\ Al_2O_3$$

$$\%\ yield = \frac{actual\ yield}{theoretical\ yield} \times 100 = \frac{26.3\ g}{37.8\ g} \times 100 = 69.6\%$$

Extra Credit: At what university did JJ Thomson, Ernest Rutherford, and James Chadwick earn their Nobel Prizes? [2 points]

Cambridge University

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 = 453.6 g

1 gal = 4 qt = 8 pt ≈ 3.785 L

1 L = 1000 cm^3

$T_K = T_{°C} + 273.15$

$T_{°F} = 1.8 \times T_{°C} + 32$

$T_{°C} = (T_{°F} - 32)/1.8$

1 cal = 4.184 J

1 Cal = 1000 cal

heat = m x SH x ΔT

Avogadro's # = 6.022×10^{23}

% yield = $\frac{actual\ yield}{theoretical\ yield} \times 100$

Electronegativity

H 2.1																	He –
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne –
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	Ar –
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.8	Ni 1.8	Cu 1.8	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	Kr –
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	Xe –
Cs 0.7	Ba 0.9	57–71 1.1–1.2	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.8	Bi 1.9	Po 2.0	At 2.2	Rn –
Fr 0.7	Ra 0.9																

Scratch Page
(to be handed in)