

Chemistry 150

Exam 4

Be sure to put your name on each page. This page can be removed from your exam so that you will have a Periodic Table handy throughout the exam, it does not need to be turned in. Show all your work for problems which require any sort of calculation, no credit will be given for answers without work shown. If you have shown a significant amount of work or multiple drawings for a problem, draw a box around what you consider your final answer.

Avogadro's Number = 6.022×10^{23} units/mol

$32.00^\circ\text{F} = 0.000^\circ\text{C} = 273.15\text{K}$

1 foot = 12 inches

1 inch = 2.54cm (exactly)

1 pound = 453.6 g = 16 ounces

1 amu = 1.6605×10^{-24} g

Masses of subatomic particles:

Proton $1.00728\text{amu} = 1.6726 \times 10^{-24}$ g

Neutron $1.00866\text{amu} = 1.6749 \times 10^{-24}$ g

Electron $0.000549\text{amu} = 9.1094 \times 10^{-28}$ g

Density of Water = $1.000^{\text{g}}/\text{mL}$

$R = 0.08206$ L \cdot atm/mol \cdot K

$PV = nRT$

1 calorie = 4.184 J = 0.001Calorie

| | | | | | | | | | | | | | | | | | | | | | |
|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|--------------------------|---------------------------|---------------------------|
| 1 H 1.0079 | | | | | | | | | | | | | | | | | 2 He 4.0026 | | | | |
| 3 Li 6.941 | 4 Be 9.0122 | | | | | | | | | | | | | | | 5 B 10.811 | 6 C 12.011 | 7 N 14.007 | 8 O 15.999 | 9 F 18.998 | 10 Ne 20.180 |
| 11 Na 22.990 | 12 Mg 24.305 | | | | | | | | | | | | | | | 13 Al 26.982 | 14 Si 28.086 | 15 P 30.974 | 16 S 32.066 | 17 Cl 35.453 | 18 Ar 39.948 |
| 19 K 39.098 | 20 Ca 40.078 | 21 Sc 44.956 | 22 Ti 47.88 | 23 V 50.942 | 24 Cr 51.996 | 25 Mn 54.938 | 26 Fe 55.847 | 27 Co 58.933 | 28 Ni 58.69 | 29 Cu 63.546 | 30 Zn 65.39 | 31 Ga 69.723 | 32 Ge 72.61 | 33 As 74.922 | 34 Se 78.96 | 35 Br 79.904 | 36 Kr 83.80 | | | | |
| 37 Rb 85.468 | 38 Sr 87.62 | 39 Y 88.906 | 40 Zr 91.224 | 41 Nb 92.906 | 42 Mo 95.94 | 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 | | | | |
| 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) | | | | |
| 87 Fr (223) | 88 Ra 226.03 | 89 Ac 227.03 | 104 Rf (261) | 105 Db (262) | 106 Sg (263) | 107 Bh (262) | 108 Hs (265) | 109 Mt (266) | 110 (269) | 111 (272) | 112 (277) | | 114 | | 116 | | | | | | |

| | | | | | | | | | | | | | |
|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 58 Ce 140.12 | 59 Pr 140.91 | 60 Nd 144.24 | 61 Pm (145) | 62 Sm 150.36 | 63 Eu 151.97 | 64 Gd 157.25 | 65 Tb 158.93 | 66 Dy 162.50 | 67 Ho 164.93 | 68 Er 167.26 | 69 Tm 168.94 | 70 Yb 173.04 | 71 Lu 174.97 |
| 90 Th 232.04 | 91 Pa 231.04 | 92 U 238.03 | 93 Np 237.05 | 94 Pu (244) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (251) | 99 Es (252) | 100 Fm (258) | 101 Md (258) | 102 No (259) | 103 Lr (260) |

Multiple Choice: Circle the letter of the most correct response. (5pts each)

- Which of the following is **not** a possible set of quantum numbers?
 - $n = 4, \ell = 2, m_\ell = -1$
 - $n = 1, \ell = 0, m_\ell = 0$
 - $n = 3, \ell = 1, m_\ell = -1$
 - $n = 2, \ell = 2, m_\ell = 0$
 - $n = 2, \ell = 1, m_\ell = 0$
- A covalent bond:
 - Always contains a metal
 - Always has high bond energy
 - Involves sharing electrons
 - Is always polar
 - Forms ions in solution
- Electronegativity
 - Is the negative charge of an ion
 - Is the energy required to remove a *pair* of electrons from an atom
 - Is a measure of how strongly an atom attracts electrons in a covalent bond
 - Is determined by assigning one electron to each atom of a bond
 - Is the energy required to remove an electron from an atom in the gas phase
- What orbital hybridization gives a ***T-shaped molecular shape***?
 - sp
 - sp^2
 - sp^3
 - sp^3d
 - sp^3d^2
- Electronegativity **increases**:
 - As the quantum number “n” increases
 - As atoms get larger
 - In the center of the Periodic Table
 - Top to bottom on the Periodic Table
 - Left to right across the Periodic Table
- Which of the following X-H bonds would you expect to be the ***shortest***?
 - HI
 - CH₄
 - HCl
 - H₂S
 - H₂
- Which of the following *atoms* is the ***smallest***?
 - Te
 - Li
 - Cu
 - Ca
 - P
- Which of the following *ions* is the ***smallest***?
 - Be²⁺
 - C⁴⁺
 - Al³⁺
 - F⁻
 - Na⁺
- Which of the following would you expect to have the ***lowest*** first ionization energy?
 - Na
 - Mg
 - Si
 - P
 - Ar

10. Which of the following has the **most polar** bonds?

- a. F_2
- b. CO_3^{2-}
- c. CN^-
- d. GeS_2
- e. $TeBr_6$

Problems:

For each of the following, write out a correct electron configuration. You may use noble gas shorthand notation for species below the 2nd row of the Periodic Table. (7pts each)

11. Calcium, Ca

12. Vanadium, V

13. Phosphide ion, P^{3-}

14. Manganese(II) ion, Mn^{2+}

15. What are the 3 most likely charges (+ or -) of a silicon (Si) ion? Explain your answers. (12pts)

16. Phosphorus pentafluoride, PF_5 , and tetrafluorophosphide ion, PF_4^- , both exhibit trigonal bipyramidal electronic geometry, but the F-P-F angles in PF_4^- are not exactly 90° , 120° and 180° . Describe how these angles deviate (smaller/larger than expected) and explain why they deviate from the ideal angles of a trigonal bipyramid. (12pts)

For each of the following, draw a correct Lewis Structure, determine the formal charge on each atom, name the electronic geometry, draw an appropriate VSEPR structure, and show the dipole moment of any polar molecules/ions. (12pts each)

17. XeOF₄

18. PO₄³⁻

19. HCN

20. PoCl₄