

CHEMISTRY 102A/102C
Hour Exam I
February 22, 2017
T. Hummel

NAME _____

SIGNATURE _____

SECTION _____

FORM "A"

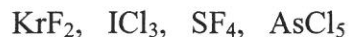
This exam is made up of an answer sheet, two cover sheets and 8 numbered pages. Below are instructions for coding the answer sheet. The last page of this exam contains some useful equations and constants, plus the periodic table.

On the answer sheet:

1. Use #2 pencil. Erase cleanly.
2. Print your **NAME** in the appropriate designated spaces, then blacken in the letter boxes below each printed letter, last name first, then your first name initial.
3. Fill in your university **ID** number under **STUDENT NUMBER**.
4. Under **SECTION** write the five digit number that corresponds to your section designation, and then blacken in the corresponding number of boxes. **For 102A students**, the numbers are: AQA = 00011, AQB = 00012, AQC = 00013, AQD = 00014, AQE = 00015, AQF = 00016, AQG = 00017, AQH = 00018, AQI = 00019, AQJ = 00020, AQK = 00021, AQL = 00022, AQM = 00023, AQN = 00024. **For 102C students**, the numbers are CQ1 = 00031, CQ2 = 00032, CQ3 = 00033, CQ4 = 00034, CQ5 = 00035, CQ6 = 00036, CQ7 = 00037, CQ8 = 00038, CQ9 = 00039, CQA = 00041, CQB = 00042, CQC = 00043, CQD = 00044, CQE = 00045.
5. Under **NETWORK ID** print your University Network ID beginning on the left hand side with box #1, and then blacken in the corresponding letters, numbers and/or dashes under each character. Do not fill in a character for any unused boxes.
6. Under **TEST FORM** blacken the letter corresponding to the form designated on the upper left hand corner of the exam booklet.
7. Your TA's name should be printed for **INSTRUCTOR** and write your section number for **SECTION** in the lines provided.
8. **Sign** your name (do not print) on the line provided. Print your name underneath it.
9. **Mark** only one answer per question and do not use the answer sheet for scratch paper or make any stray marks on it. Erase cleanly if you wish to change an answer. The exam itself can be used for scratch paper.

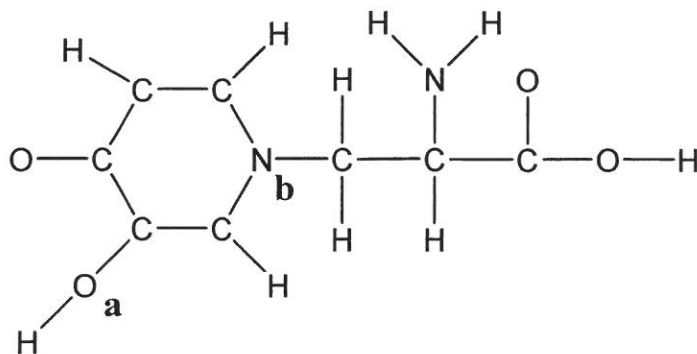
Work carefully and efficiently. If your answer differs from one given in the last proper significant figure, mark that answer as correct and not the response "none of these". All questions are worth the same.

1. What do the following molecules all have in common?



- a) All have 90° bond angles.
- b) All have central atoms that are dsp^3 hybridized.
- c) All are polar.
- d) All have octahedral shape.
- e) All have 109° bond angles.

Mimosine, $\text{C}_8\text{H}_{10}\text{N}_2\text{O}_4$, is a natural **organic** compound found in large quantities in the seeds and foliage of legume plants and has been shown to inhibit hair growth and hair loss in mice. Complete the Lewis structure of mimosine and answer the next two questions.



2. How many carbon atoms are sp^3 hybridized?
- a) 2 b) 3 c) 5 d) 7 e) 8
3. What are the approximate bond angles about the oxygen atom labeled **a** and nitrogen atom labeled **b**, respectively?
- a) 109° ; 109° b) 180° ; 120° c) 180° ; 90° d) 109° ; 120° e) 180° ; 109°

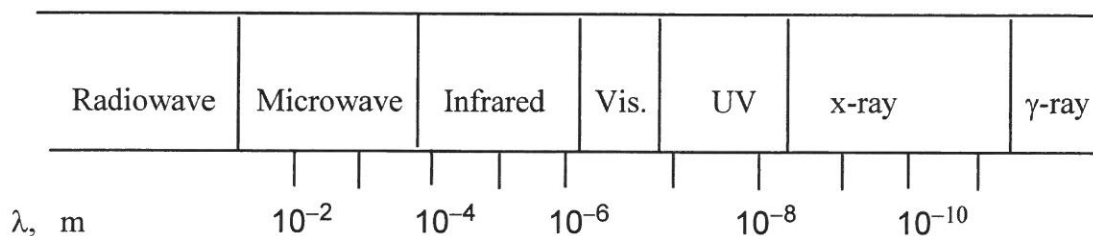
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4. Which of the following atoms/ions has the largest number of unpaired electrons in the ground state?
- a) K b) Zn^{2+} c) Mn d) Cr e) As

5. Which of the following is **not** the correct chemical formula for the compound named?
- a) phosphorus trioxide P_2O_3 b) sodium sulfite Na_2SO_3
c) ammonium nitrate NH_4NO_3 d) perchloric acid $HClO_4$
e) copper(II) acetate $Cu(C_2H_3O_2)_2$
6. How many of the following four statements (I-IV) is/are **true**?
- I. One reason covalent bonds form is that the shared electrons between two atoms are simultaneously attracted by two different nuclei.
II. The ionic compound NaCl does not exist as Na^{2+} and Cl^{2-} ions because it takes too much energy to form the Na^{2+} and Cl^{2-} ions.
III. As the electronegativity difference between two elements increases, the bond between those two elements becomes more ionic.
IV. The bond between any two different nonmetals is always a polar covalent bond.
- a) 0 (None are true.) b) 1 c) 2 d) 3
e) 4 [All four statements (I-IV) are true].
7. Which of the following statements regarding ionization energies is **true**?
- a) Longer wavelength electromagnetic radiation is required to ionize Cl as compared to Cs.
b) Shorter wavelength electromagnetic radiation is required to ionize S as compared to Se.
c) More energetic photons of electromagnetic radiation are required to ionize K as compared to Mg.
d) Higher frequency electromagnetic radiation is required to ionize Ca as compared to P.
e) Electromagnetic radiation having a faster velocity is required to ionize Cl as compared to Ne.
8. Which of the following plant fertilizer compounds contains only covalent bonds?
- a) $(NH_4)_2SO_4$ b) $Ca_3(PO_4)_2$ c) K_2O d) KCl e) P_2O_5
9. In each of the following, nitrogen is/are the central atom(s). In which compound/ion are the bond angles about the central nitrogen(s) **not** approximately 120° ?
- a) NO_3^- b) NO_2^- c) N_3^- d) $H-N-N-H$ e) NFO

10. Which of the following orbitals can hold the most electrons?
a) 1s b) 1p c) 1d d) 2d e) 3f

11. Which of the following statements is **false**?
a) Calcium is an alkali metal.
b) Bromine is a nonmetal.
c) A fifty pound sample of rocks is a heterogeneous mixture.
d) When water is heated until it boils, a physical change has occurred.
e) A compound consists of atoms of more than one type of element.

12. Consider the following electromagnetic radiation spectrum.



What type of electromagnetic radiation has a frequency of $2 \times 10^{14} \text{ s}^{-1}$?

- a) microwave b) infrared c) ultraviolet (UV)
d) x-ray e) γ -ray
13. Which of the following correctly ranks the elements beryllium, boron, nitrogen and oxygen in order of **increasing** ionization energy?
a) $\text{Be} < \text{B} < \text{N} < \text{O}$ b) $\text{O} < \text{N} < \text{Be} < \text{B}$ c) $\text{N} < \text{O} < \text{B} < \text{Be}$
d) $\text{Be} < \text{B} < \text{O} < \text{N}$ e) $\text{B} < \text{Be} < \text{O} < \text{N}$
14. An ion has an excited state electron configuration of $[\text{Ar}]4s^23d^{10}4p^45s^14f^1$. Which of the following could be this ion?
a) Ga^{4-} b) As^{3+} c) Kr^+ d) Ge^{2+} e) Br^-

15. Consider the following molecules:



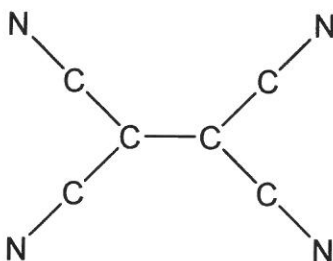
Which molecule(s) has/have tetrahedral shape and which molecule(s) is/are polar?

- a) SeF_4 has tetrahedral shape and XeF_4 is polar.
b) SiF_4 has tetrahedral shape and SeF_4 is polar.
c) XeF_4 has tetrahedral shape and SiF_4 is polar.
d) All of these molecules have tetrahedral shape and all of these molecules are polar.
e) All of these molecules have tetrahedral shape and all of these molecules are nonpolar.
16. Which of the following shapes do **not** require the central atom to use d orbital(s) to form the hybrid orbitals?
- a) T-shape b) see-saw c) square planar
d) square pyramid e) trigonal pyramid
17. A piece of indium with a mass of 16.6 g is submerged in 46.3 cm^3 of water in a graduated cylinder. The water level increases to 48.6 cm^3 . From this data, what is the density of indium to the correct number of significant figures?
- a) 7.217 g/cm^3 b) 7.22 g/cm^3 c) 7.2 g/cm^3
d) 0.139 cm^3/g e) 0.1 cm^3/g
18. The table below gives the numbers of electrons, protons, and neutrons in atoms or ions of several elements (A-G). Which statement is **incorrect** regarding these atoms or ions?

<u>Atom or Ion of Element</u>	A	B	C	D	E	F	G
# of electrons	9	1	18	18	1	10	82
# of protons	9	1	19	17	1	8	82
# of neutrons	10	1	20	18	2	8	125

- a) D and F are anions.
b) C is a cation.
c) B and E are isotopes of each other.
d) G is ${}^{207}_{82}\text{Pb}$.
e) The compound formed between A and E would be ionic.

19. A metal, M, reacts with phosphorus forming a binary compound M_xP_y . If the molar mass of the binary compound is about 148 g/mol, which of the following is the metal?
- a) sodium
 - b) potassium
 - c) aluminum
 - d) calcium
 - e) barium
20. The **organic** compound tetracyanoethylene has the following skeletal structure:



- How many of the carbon-carbon bonds in tetracyanoethylene is/are formed from overlap of an sp hybrid orbital on one carbon with an sp^2 hybrid orbital on the other carbon?
- a) 0 (none)
 - b) 1
 - c) 2
 - d) 4
 - e) 5
-
21. Consider a sample of hydrogen atoms where every hydrogen atom in the sample has the electron in the $n = 5$ energy state. What is the total number of different energetic photons of electromagnetic radiation that could possibly be emitted as the $n = 5$ electron returns to the ground state for the various hydrogen atoms?
- a) 1
 - b) 5
 - c) 8
 - d) 10
 - e) infinite
22. Consider a sample of hydrogen atoms where every hydrogen atom in the sample has the electron in the $n = 5$ energy state. Of all the possible transitions as the $n = 5$ electron returns to the ground state, calculate λ for the longest wavelength emission.
- a) 6.73 m
 - b) 7.46×10^{-6} m
 - c) 4.05×10^{-6} m
 - d) 9.50×10^{-8} m
 - e) 1.62×10^{-12} m
-

23. How many atoms of oxygen are in 3.10 g of calcium phosphate?
- a) 4.81×10^{22} O atoms b) 1.26×10^{19} O atoms c) 7.50×10^{20} O atoms
d) 6.02×10^{22} O atoms e) 6.02×10^{21} O atoms
24. Molecules that exhibit delocalization of bonding electrons have surprising stability. Which of the following is **not** a characteristic of molecules that exhibit delocalization?
- a) Molecules with delocalized bonding electrons contain one or more multiple bonds.
b) Molecules with delocalized bonding electrons have unhybridized p atomic orbitals.
c) The electrons that form the sigma (σ) bonds are the delocalized bonding electrons.
d) Molecules with delocalized bonding electrons contain sp^2 and/or sp hybridized atoms.
e) Molecules that exhibit resonance generally exhibit delocalization of bonding electrons.
25. Which of the following four statements (a-d) concerning the Lewis structure of PF_3Cl_2 is **false**? Phosphorus is the central atom.
- a) The molecular shape of PF_3Cl_2 is trigonal bipyramid.
b) Phosphorus must violate the octet rule in PF_3Cl_2 .
c) Some of the bond angles in PF_3Cl_2 are approximately 120° .
d) The polarity of PF_3Cl_2 depends on the spatial arrangement of the fluorine and chlorine atoms.
e) None of the above four statements (a-d) is false.
26. A solution of NaOH was standardized with KHP with the following results.
- | | |
|---------|--------------------------|
| Trial 1 | 0.095 ± 0.001 M NaOH |
| Trial 2 | 0.096 ± 0.001 M NaOH |
| Trial 3 | 0.095 ± 0.001 M NaOH |
- Later it was determined that the actual molarity of the solution was 0.159 M NaOH. The results of the three trials were:
- a) accurate but not precise
b) precise but not accurate
c) accurate and precise
d) neither precise nor accurate

27. Which of the following statements is **false**?
- a) The radius of I^- is larger than the radius of I.
 - b) The electronegativity of chlorine is greater than the electronegativity of potassium.
 - c) In general, the electron affinity of the halogens is more exothermic (more negative) than the electron affinity of the noble gases.
 - d) The radius of Ca^{2+} is larger than the radius of S^{2-} .
 - e) The radius of K is larger than the radius of K^+ .
28. In theory, how many different elements in the ground state can have exactly 12 electrons in various s orbitals, have exactly 30 electrons in various d orbitals, and have two or more unpaired electrons?
- a) 0 b) 1 c) 2 d) 3 e) 5
29. Which of the following statements (a-d) from Dalton's atomic theory is no longer true?
- a) Elements are made up of tiny particles called atoms.
 - b) Atoms are neither created nor destroyed in chemical reactions.
 - c) All atoms of a given element are identical.
 - d) A given compound always has the same relative numbers and types of atoms.
 - e) All of these statements (a-d) are true according to modern atomic theory.
30. Consider the following **unbalanced** reaction:
- $$Eu(s) + HF(g) \rightarrow EuF_3(s) + H_2(g)$$
- What is the sum of the coefficients of the reactants and products in the best balanced equation?
- a) 6 b) 8 c) 10 d) 13
 - e) The sum of the coefficients in the best balanced equation is greater than 13.

31. Bromine exists naturally as a mixture of ^{79}Br (atomic mass = 78.95 amu) and ^{81}Br (atomic mass = 80.95 amu). Which of the following is the approximate relative abundance of each bromine isotope in nature? Assume natural bromine contains only these two isotopes. Hint: reference the periodic table for the average atomic mass of Br.
- 5% ^{79}Br and 95% ^{81}Br
 - 25% ^{79}Br and 75% ^{81}Br
 - 50% ^{79}Br and 50% ^{81}Br
 - 75% ^{79}Br and 25% ^{81}Br
 - 95% ^{79}Br and 5% ^{81}Br
32. A 100.00-g sample of a binary compound between an unknown element E and hydrogen contains 91.27 g E and 8.73 g H by mass. If the formula is E_3H_8 , what is the identity of element E?
- boron
 - silicon
 - bromine
 - phosphorus
 - zirconium (Zr)
33. How many of the following compounds/ions must be exceptions to the octet rule? Te is element #52.
- TeBr_2^{2-} , TeS_2 , TeBr_3^- , TeS_4^{2-} , TeBr_6
- 1
 - 2
 - 3
 - 4
 - 5 (All must be exceptions to the octet rule.)
34. Place the following elements and ions in order of increasing size (smallest to largest).
- As^- , Se , Cl , Ar^+
- $\text{Ar}^+ < \text{Cl} < \text{Se} < \text{As}^-$
 - $\text{Se} < \text{As}^- < \text{Cl} < \text{Ar}^+$
 - $\text{Cl} < \text{As}^- < \text{Se} < \text{Ar}^+$
 - $\text{Cl} < \text{Se} < \text{As}^- < \text{Ar}^+$
 - $\text{Ar}^+ < \text{Cl} < \text{As}^- < \text{Se}$
35. My answers for this Chemistry 102 exam should be graded with the answer sheet associated with:
- Form A
 - Form B
 - Form C
 - Form D
 - Form E

USEFUL CONSTANTS/EQUATIONS

$$R_H = 2.178 \times 10^{-18} \text{ J}$$

$$c = \lambda \nu$$

$$E = h\nu = hc/\lambda$$

$$N = 6.022 \times 10^{23}$$

$$c = 2.998 \times 10^8 \text{ m/sec}$$

$$1 \text{ kHz} = 1000 \text{ Hz} = 1000 \text{ s}^{-1}$$

$$1 \text{ J} = 1 \text{ kg m}^2/\text{sec}^2$$

$$1 \text{ mL} = 1 \text{ cm}^3$$

$$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{sec}$$

$$E_n = -R_H Z^2 (1/n^2), Z = \text{atomic number}$$

$$\lambda = h/mv \quad (\text{de Broglie equation})$$

$$1 \text{ pm} = 1 \times 10^{-12} \text{ m}; 1 \text{ nm} = 1 \times 10^{-9} \text{ m}$$

$$\text{Density} = \text{mass/volume}$$

$$\text{Mass \% of A} = \frac{\text{mass of A}}{\text{total mass}} \times 100$$

$$\Delta E = -R_H Z^2 \left(\frac{1}{n_2^2} - \frac{1}{n_1^2} \right)$$

PERIODIC TABLE OF THE ELEMENTS

1 1A	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	18 8A		
1 H 1.008	2 He 4.003											3 Li 6.941	4 Be 9.012	5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95		
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80		
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3		
55 Cs 132.9	56 Ba 137.3	57 La [†] 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po 209	85 At 210	86 Rn 222		
87 Fr 223	88 Ra 226	89 Ac [†] 227	104 Rf 261	105 Db 262	106 Sg 266	107 Bh 262	108 Hs 265	109 Mt 266	110 Ds 271	111	112								
†Lanthanides		58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 145	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0				
†Actinides		90 Th 232.0	91 Pa 231	92 U 238	93 Np 244	94 Pu 242	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 260				