NAME (Print): _____

SIGNATURE: _____

Chemistry 320M/328M
Dr. Brent Iverson
1st Midterm
September 28, 2017

Please print the first three letters of your last name in the three boxes

Please Note: This test may be a bit long, but there is a reason. I would like to give you a lot of little questions, so you can find ones you can answer and show me what you know, rather than just a few questions that may be testing the one thing you forgot. **I recommend you look the exam over and answer the questions you are sure of first**, then go back and try to figure out the rest. Also make sure to **look at the point totals** on the questions as a guide to help budget your time.

You cannot use a red pen to take the exam. You must have your answers written in PERMANENT ink if you want a regrade!!!! This means no test written in pencil or ERASABLE INK will be regraded.

Please note: We routinely xerox a number of exams following initial grading to guard against receiving altered answers during the regrading process.

FINALLY, DUE TO SOME UNFORTUNATE RECENT INCIDENCTS YOU ARE NOT ALLOWED TO INTERACT WITH YOUR CELL PHONE IN ANY WAY. IF YOU TOUCH YOUR CELL PHONE DURING THE EXAM YOU WILL GET A "0" NO MATTER WHAT YOU ARE DOING WITH THE PHONE. PUT IT AWAY AND LEAVE IT THERE!!!

Page	Points	
1		(20)
2		(22)
3		(15)
4		(17)
5		(30)
6		(30)
7		(20)
8		(18)
9		(23)
10		(16)
11		(20)
12		(17)
13		(23)
14		(20)
15		(12)
16		(4)
Total		(307)

Student Honor Code

"As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity."

_____

(Your signature)

PERIODIC TABLE OF THE ELEMENTS

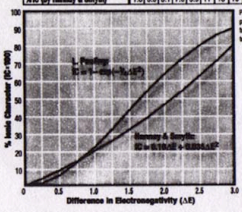
▼ Elementary Subatomic Particles

	Electron	Proton	Neutron	Photon	Neutrino
Symbol	e	P	n	γ	ν
Rest mass (kg)	9.1093897(54) x 10^{-31}	1.6726231(10) x 10^{-27}	1.6749286(10) x 10^{-27}	0	≈ 0
Molar mass (kg/mol)	5.4857990(13) x 10^{-7}	1.0072764(10) x 10^{-3}	1.0086649(14) x 10^{-3}	0	≈ 0
Particle-electron mass ratio	1	1836.152701(37)	1838.683662(40)	0	≈ 0
Particle-proton mass ratio	5.4461703(11) x 10^{-4}	1	1.001378404(9)	0	≈ 0
Particle-neutron mass ratio	5.438673x10^{-4}	0.998624	1	0	≈ 0
Specific charge (C/kg)	−1.7588196(53) x 10^{11}	9.5788309(29) x 10^{7}	0	0	0
Radius (m)	< 1 x 10^{-18}	8 x 10^{-16}	8 x 10^{-16}	0	≈ 0
Spin quantum number	1/2	1/2	1/2	1	1/2
Compton wavelength (m)	2.4263105B(22) x 10^{-12}	1.321410D2(12) x 10^{-15}	1.319591I0(12) x 10^{-15}	–	–
Magnetic moment (J/T); μ	928.47701(31) x 10^{-26}	1.410607I(47) x 10^{-26}	0.96623707(40) x 10^{-26}	0	0
In Bohr magnetons; μ/μ_B	1.0011596521I(10)	1.521032202(15) x 10^{-3}	1.0417363(25) x 10^{-3}	0	0
In nuclear magnetons; μ/μ_N	1838.282000(37)	2.792847386(63)	1.9130427(5/45)	0	0

Elementary particles are the fundamental constituents of energy and matter. The positron (e^+) is a positive-energy particle which has the same mass as an ordinary electron. The antineutrino ($\bar{\nu}$) has similar properties as that of a neutrino (ν) except its spin is directed along its direction of motion, whereas the neutrino's spin is always opposite to the direction of motion. Negative beta decay is the transformation of a neutron into a proton, a beta particle (negative electron) and a antineutrino ($n \rightarrow p + e^- + \bar{\nu}$). Positive beta decay involves the transformation of a proton into a neutron, a positron and a neutrino ($p \rightarrow n + \beta^+ + \nu$). The magnetic moment ($\mu$) of a particle can also be expressed as a dimensionless quantity by dividing it with either the Bohr magneton (μ_B = 9.2740154(31) x 10^{-24} J/T) or the nuclear magneton (μ_N = 5.0507699(17) x 10^{-27} J/T).

▼ % Ionic Character of a Single Chemical Bond

Difference in Electronegativity	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2
%IC (by L. Pauling)	0.2	1.0	2.2	3.9	6.1	8.6	12	15	18	22	26	30	34	39	43	47	51	56	59	63	67	70	73	76	79	82	84	86	88	89	91	92
%IC (by Hanney & Smyth)	1.6	3.3	5.1	7.0	8.9	11	13	15	17	20	22	24	27	29	32	35	37	40	43	46	49	52	55	59	62	65	68	72	76	80	83	87

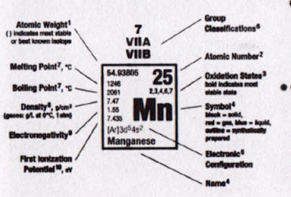


Percent ionic character describes the nature of a bond. Bonds possessing 50% or greater ionic character are commonly termed ionic; bonds with less than 50% ionic character are termed covalent. Pauling's equation was modified by Hanney & Smyth in order to achieve better agreement between experimental and calculated values. Transition from ionic to covalent binding is usually accompanied by a reduction in electrical conductance, melting point and boiling point.

1 IA	2 IIA	3 IIIA IIIB	4 IVA IVB	5 VA VB	6 VIA VIB	7 VIIA VIIB	8 VIIIA VIII	9 VIIIA VIII	10 VIIIA VIII	11 IB IB	12 IIB IIB	13 IIIB IIIA	14 IVB IVA	15 VB VA	16 VIB VIA	17 VIIB VIIA	18 VIII 0
1.00794 −259.34 −252.87 0.0899 2.20 13.598 1s¹	1 **H** Hydrogen																4.0026022 −272.2 (26 atm) −268.93 0.1785 – 24.587 1s²	2 **He** Helium
6.941 180.5 1342 0.534 0.98 5.392 [He]2s¹	3 **Li** Lithium	9.012182 1287 2471 1.8477 1.57 9.322 [He]2s²	4 **Be** Beryllium									10.811 2075 4000 2.31 2.04 8.298 [He]2s²2p¹	5 **B** Boron	12.011 4492* 3825* 2.25 2.55 11.260 [He]2s²2p²	6 **C** Carbon	14.00674 −210.00 −195.79 1.25046 3.04 14.534 [He]2s²2p³	7 **N** Nitrogen	15.9994 −218.79 −182.95 1.429 3.44 13.618 [He]2s²2p⁴	8 **O** Oxygen	18.9984032 −219.62 −188.12 1.69 3.98 17.422 [He]2s²2p⁵	9 **F** Fluorine	20.1797 −248.59 −246.08 0.9002 – 21.564 [He]2s²2p⁶	10 **Ne** Neon
22.989768 97.72 883 0.97 0.93 5.139 [Ne]3s¹	11 **Na** Sodium	24.3050 650 1090 1.74 1.31 7.646 [Ne]3s²	12 **Mg** Magnesium									26.981539 660.32 2519 2.702 1.61 5.986 [Ne]3s²3p¹	13 **Al** Aluminum	28.0855 1414 3265 2.33 1.90 8.151 [Ne]3s²3p²	14 **Si** Silicon	30.973762 44.15 277 1.82 2.19 10.486 [Ne]3s²3p³	15 **P** Phosphorus	32.066 115.21 444.60 2.07 2.58 10.360 [Ne]3s²3p⁴	16 **S** Sulfur	35.4527 −101.5 −34.04 3.214 3.16 12.967 [Ne]3s²3p⁵	17 **Cl** Chlorine	39.948 −189.35 −185.85 1.784 – 15.759 [Ne]3s²3p⁶	18 **Ar** Argon
39.0983 63.38 759 0.86 0.82 4.341 [Ar]4s¹	19 **K** Potassium	40.078 842 1484 1.54 1.00 6.113 [Ar]4s²	20 **Ca** Calcium	44.955910 1541 2830 2.989 1.36 6.54 [Ar]3d¹4s²	21 **Sc** Scandium	47.88 1668 3287 4.5 1.54 6.82 [Ar]3d²4s²	22 **Ti** Titanium	50.9415 1910 3407 5.96 1.63 6.74 [Ar]3d³4s²	23 **V** Vanadium	51.9961 1907 2671 7.20 1.66 6.766 [Ar]3d⁵4s¹	24 **Cr** Chromium	54.93805 1246 2061 7.47 1.55 7.435 [Ar]3d⁵4s²	25 **Mn** Manganese	55.847 1538 2861 7.86 1.83 7.870 [Ar]3d⁶4s²	26 **Fe** Iron	58.93320 1495 2927 8.92 1.88 7.86 [Ar]3d⁷4s²	27 **Co** Cobalt	58.6934 1455 2913 8.90 1.91 7.635 [Ar]3d⁸4s²	28 **Ni** Nickel	63.546 1084.62 2562 8.94 1.90 7.726 [Ar]3d¹⁰4s¹	29 **Cu** Copper	65.39 419.53 907 7.14 (20°C) 1.65 9.394 [Ar]3d¹⁰4s²	30 **Zn** Zinc	69.723 29.76 2204 5.904 1.81 5.999 [Ar]3d¹⁰4s²4p¹	31 **Ga** Gallium	72.61 936.25 2833 5.35 2.01 7.899 [Ar]3d¹⁰4s²4p²	32 **Ge** Germanium	74.92159 817* 614* 5.727 (25°C) 2.05 9.81 [Ar]3d¹⁰4s²4p³	33 **As** Arsenic	78.96 221 685 4.81 2.55 9.752 [Ar]3d¹⁰4s²4p⁴	34 **Se** Selenium	79.904 −7.2 58.8 3.119 2.96 11.814 [Ar]3d¹⁰4s²4p⁵	35 **Br** Bromine	83.80 −157.36 −153.22 3.74 – 13.999 [Ar]3d¹⁰4s²4p⁶	36 **Kr** Krypton
85.4678 38.31 688 1.532 0.82 4.177 [Kr]5s¹	37 **Rb** Rubidium	87.62 777 1382 2.6 0.95 5.866 [Kr]5s²	38 **Sr** Strontium	88.90585 1526 3336 4.469 1.22 6.38 [Kr]4d¹5s²	39 **Y** Yttrium	91.224 1855 4409 6.49 1.33 6.84 [Kr]4d²5s²	40 **Zr** Zirconium	92.90638 2477 4744 8.57 1.6 6.9 [Kr]4d⁴5s¹	41 **Nb** Niobium	95.94 2623 4639 10.2 2.16 7.099 [Kr]4d⁵5s¹	42 **Mo** Molybdenum	(97.9072) 2157 4265 11.5 1.9 7.28 [Kr]4d⁵5s²	43 **Tc** Technetium	101.07 2334 4150 12.3 2.2 7.37 [Kr]4d⁷5s¹	44 **Ru** Ruthenium	102.90550 1964 3695 12.4 2.28 7.46 [Kr]4d⁸5s¹	45 **Rh** Rhodium	106.42 1554.9 2963 12.02 2.20 8.34 [Kr]4d¹⁰	46 **Pd** Palladium	107.8682 961.78 2162 10.5 1.93 7.576 [Kr]4d¹⁰5s¹	47 **Ag** Silver	112.411 321.07 767 8.642 1.69 8.993 [Kr]4d¹⁰5s²	48 **Cd** Cadmium	114.818 156.60 2024 7.30 1.78 5.786 [Kr]4d¹⁰5s²5p¹	49 **In** Indium	118.710 231.93 2833 7.28 1.96 7.344 [Kr]4d¹⁰5s²5p²	50 **Sn** Tin	121.757 630.63 1587 6.684 (25°C) 2.05 8.641 [Kr]4d¹⁰5s²5p³	51 **Sb** Antimony	127.60 449.51 988 6.25 2.1 9.009 [Kr]4d¹⁰5s²5p⁴	52 **Te** Tellurium	126.90447 113.7 184.4 4.93 2.66 10.451 [Kr]4d¹⁰5s²5p⁵	53 **I** Iodine	131.29 −111.75 −108.04 5.89 – 12.130 [Kr]4d¹⁰5s²5p⁶	54 **Xe** Xenon
(223.0197) 27 677 – 0.7 – [Rn]7s¹	87 **Fr** Francium	(226.0254) 700 <1140 0.8 0.9 5.279 [Rn]7s²	88 **Ra** Radium	(227.0278) 1051 3198 10.07 1.1 6.9 [Rn]6d¹7s²	89 ** **Ac** Actinium	(261.11) – – – – – [Rn]5f¹⁴6d²7s²	104 Unq Unnilquadium	(262.114) – – – – – [Rn]5f¹⁴6d³7s²	105 Unp Unnilpentium	(263.118) – – – – – [Rn]5f¹⁴6d⁴7s²	106 Unh Unnilhexium	(262.12) – – – – – [Rn]5f¹⁴6d⁵7s²	107 Uns Unnilseptium	(265) – – – – – [Rn]5f¹⁴6d⁶7s²	108 Uno Unniloctium	(268) – – – – – [Rn]5f¹⁴6d⁷7s²	109 Une Unnilennium	(272) – – – – – [Rn]5f¹⁴6d⁸7s²	110 Uun Ununnium								

●	●●
140.115 799 3424 6.770 1.12 5.466 [Xe]4f¹5d¹6s²	58 **Ce** Cerium
232.0381 1750 4788 11.72 1.3 6.06 [Rn]6d²7s²	90 **Th** Thorium
140.90765 931 3510 6.773 1.13 5.422 [Xe]4f³6s²	59 **Pr** Praseodymium
231.03588 1572 – 15.37 1.5 5.89 [Rn]5f²6d¹7s²	91 **Pa** Protactinium
144.24 1016 3056 7.00 1.14 5.489 [Xe]4f⁴6s²	60 **Nd** Neodymium
238.0289 1135 4131 19.05 α,β 1.38 6.05 [Rn]5f³6d¹7s²	92 **U** Uranium
(144.9127) 1042 3000 7.264 1.13 5.554 [Xe]4f⁵6s²	61 **Pm** Promethium
(237.0482) 644 3228 19.816 1.28 5.8 [Rn]5f⁴6d¹7s²	93 **Np** Neptunium
150.36 1072 1700 7.536 1.17 5.631 [Xe]4f⁶6s²	62 **Sm** Samarium
(244.0642) 640 3228 19.816 1.28 5.8 [Rn]5f⁶7s²	94 **Pu** Plutonium
151.965 822 1596 5.244 1.2 5.666 [Xe]4f⁷6s²	63 **Eu** Europium
(243.0614) 1176 2607 13.67 1.3 5.993 [Rn]5f⁷7s²	95 **Am** Americium
157.25 1314 3264 7.901 1.20 6.141 [Xe]4f⁷5d¹6s²	64 **Gd** Gadolinium
(247.0703) 1345 – 13.51 1.3 6.02 [Rn]5f⁷6d¹7s²	96 **Cm** Curium
158.92534 1359 3221 8.230 1.2 5.842 [Xe]4f⁹6s²	65 **Tb** Terbium
(247.0703) 1050 – 14.78 1.3 6.23 [Rn]5f⁹7s²	97 **Bk** Berkelium
162.50 1411 2561 8.551 1.22 5.927 [Xe]4f¹⁰6s²	66 **Dy** Dysprosium
(251.0796) 900 – 15.1 1.3 6.30 [Rn]5f¹⁰7s²	98 **Cf** Californium
164.93032 1472 2694 8.795 1.24 6.018 [Xe]4f¹¹6s²	67 **Ho** Holmium
(252.083) 800 – – 1.3 6.42 [Rn]5f¹¹7s²	99 **Es** Einsteinium
167.26 1529 2862 9.066 1.24 6.101 [Xe]4f¹²6s²	68 **Er** Erbium
(257.0951) 1527 – – 1.3 6.50 [Rn]5f¹²7s²	100 **Fm** Fermium
168.93421 1545 1946 9.321 1.25 6.18436 [Xe]4f¹³6s²	69 **Tm** Thulium
(258.10) 827 – – 1.3 6.58 [Rn]5f¹³7s²	101 **Md** Mendelevium
173.04 824 1194 6.966 1.1 6.25394 [Xe]4f¹⁴6s²	70 **Yb** Ytterbium
(259.1009) 827 – – 1.3 6.65 [Rn]5f¹⁴7s²	102 **No** Nobelium
174.967 1663 3393 9.84 1.27 6.42549 [Xe]4f¹⁴5d¹6s²	71 **Lu** Lutetium
(262.11) 1627 – – – – [Rn]5f¹⁴6d¹7s²	103 **Lr** Lawrencium

*Indicates approximate values and/or inconsistent literature data.



Editors: T. K. Varga, M.A.Sc. & C. Bello, M.A.Sc.
Product No. LCH-04F **ISBN** 1-55080-073-6

PAPERTECH

The data for this reference guide were obtained from the latest scientific and government sources (IUPAC, CODATA, National Bureau of Standards, etc.). Estimated values and/or inconsistent data are marked with an asterisk (*).
1. Ratio of the average mass per atom of the element to 1/12 of the mass of an atom of ^{12}C. Round brackets indicate atomic weight of the most stable or best known isotope. 2. Number of protons in the nucleus of each atom of an element. 3. Number of charges an atom would have in a molecule (or an ionic compound) if electrons were transferred completely. 4. Names and symbols of elements 104-110 are those recommended by the International Union of Pure and Applied Chemistry (IUPAC)—alternative names have been proposed by other groups. 5. Distribution of electrons among the various atomic orbitals. 6. Two older group classifications systems still in use today rely on an A/B sorting scheme to categorize periodic properties. Because of the potential for confusion between these two systems (i.e., IIIA in one scheme is equal to IIIB in the other), IUPAC recommends the use of an unambiguous 1-18 group classification system. 7. Melting point: temperature at which solid and liquid phases coexist in equilibrium. Boiling point: temperature at which the vapor pressure of a liquid is equal to the external atmospheric pressure. Unless otherwise stated values are at 1 atm; TP = sublimation point at 1 atm; TP = triple point. 8. Mass of the substance divided by its volume (g/cm³ at 20°C for gases: g/L at 0°C, 1 atm). 9. Relative measure of the attraction of an atom in a chemical bond for the shared electrons. 10. Minimum energy to remove an electron from an isolated atom in its ground state (1eV = 96.487 kJ/mol).

Signature_____ Pg 1 _____(20)

1. (4 points) What is the most important question in Organic Chemistry?

2. (8 pts each) For the following molecular formula, draw complete Lewis line structures in which all atoms (even H atoms) are drawn, lines are used as bonds, all lone pairs are drawn AND ALL FORMAL CHARGES ARE INDICATED. Note you must infer the formal charges as we do not indicate them on the chemical formulas given

1) **$CH_3CH_2CHBrCH_2COCH_3$**

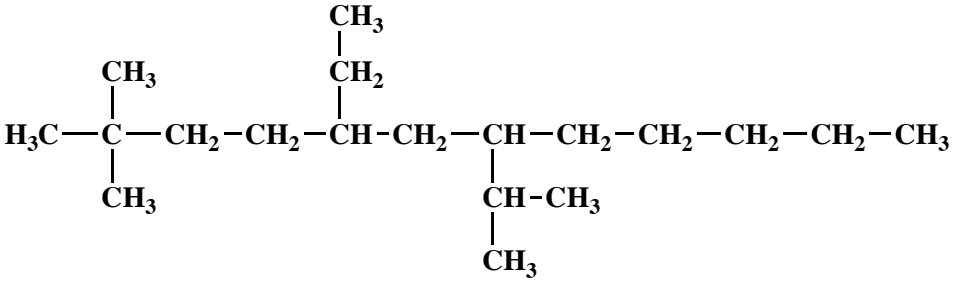
How many different stereoisomers are there for the above molecule? _____

2) **$CH_2OHCHNH_3CO_2CH_3$**

How many different stereoisomers are there for the above molecule? _____

3. Provide an acceptable IUPAC name for the following molecules. Do not designate R or S for these.

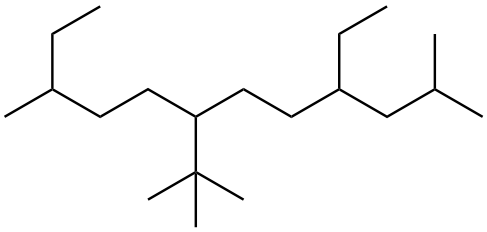
A) (6 pts)



_____

Although stereochemistry is not indicated on the above structure, how many stereoisomers are possible? _____

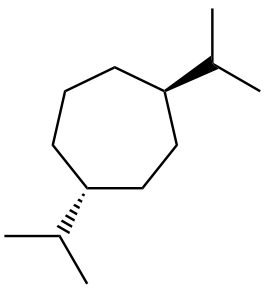
B) (6 pts)



_____

Although stereochemistry is not indicated on the above structure, how many stereoisomers are possible? _____

C) (10 pts)



_____

Is the molecule chiral? _____ **If you answered "yes", then in the box provided, draw the enantiomer of the above structure. If you answered "no" leave the box blank.**

4. (5pts each) For the following IUPAC names, draw the appropriate line angle drawing (you can ignore R and S for the first two, but not the bottom one).

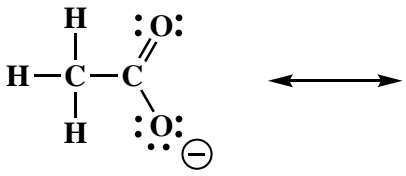
A) 3,3-diethyl-6-methyl-5-(1-methylpropyl)nonane

B) *cis*-1,3-di-*tert*-butylcyclohexane (Use wedges and dashes to indicate the appropriate stereochemistry at all chiral centers)

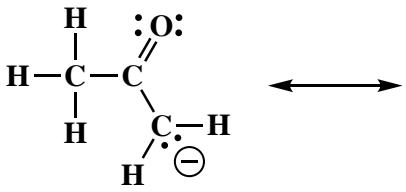
C) *(S)*-3-Ethyl-5-isopropyloctane (Use wedges and dashes to indicate the appropriate stereochemistry at all chiral centers)

5. (17 pts) The following molecules are best represented as the hybrid of contributing structures. **Draw the second important contributing structure** in the space provided, including all lone pairs and formal charges. **For the structure on the left, use arrows to indicate the movement of electrons to give the structure you drew.** Finally, if one of the two contributing structures makes a dominant (major) contribution to the resonance hybrid, **draw a circle around the dominant (major) contributor.** You might want to read these directions again to make sure you know what we want.

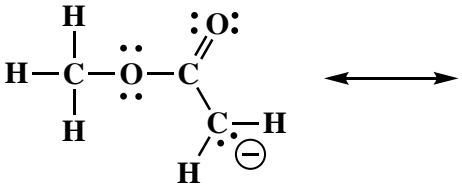
A.



B.



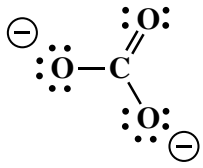
C.



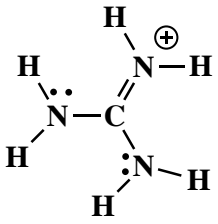
6. (10 pts each) The following molecules are best represented as the hybrid of three contributing structures. **Draw the other two important contributing structures** in the spaces provided, including all lone pairs and formal charges. **Use arrows on Structure 1 to indicate the movement of electrons to go from Structure 1 to your Structure 2, then put arrows on your Structure 2 to indicate the movement of electrons to go from your Structure 2 to your Structure 3.** There is **no need to draw any circles around any of these contributing structures**. You might want to read these directions again to make sure you know what we want.

A.

Structure 1 **Structure 2** **Structure 3**

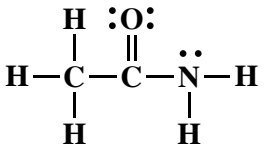


B.



7. (10 pts) I told you this would be here. The following amide molecule is best represented as the hybrid of three contributing structures. **Draw the other two important contributing structures** in the spaces provided, including all lone pairs and formal charges. **Use arrows on Structure 1 to indicate the movement of electrons to go from Structure 1 to your Structure 2, then put arrows on your Structure 2 to indicate the movement of electrons to go from your Structure 2 to your Structure 3.** There is **no need to draw any circles around any of these contributing strucures**. You might want to read these directions again to make sure you know what we want.

Structure 1 **Structure 2** **Structure 3**



8. (2 pts each) Fill in each blank with the word or words that best completes the sentences.

For organic chemistry, it is best to think of electrons as _____.

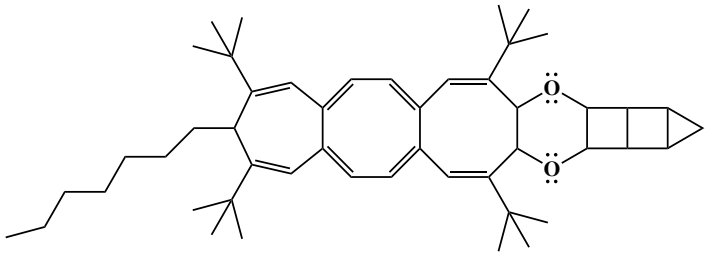
The electron density in molecules can be described mathematically by adding the wave functions of all the atomic orbitals for all the atoms in the entire molecule, an approach referred to as _____ _____ theory.

The wave functions for the valence atomic orbitals on each atom can be added together first, a process referred to as _____ , before looking for overlap with orbitals from other atoms. This approach is called _____ _____ theory.

You need to be able to think about all _____ bonding in molecules as being derived from the overlap of _____ orbitals and all pi bonding as being derived from overlap of unhybridized _____ orbitals.

Especially for charged molecules, it is stabilizing to have _____ electron density as well as charges delocalized over more than two atoms. This concept is usually referred to as "stabilization due to delocalization " or simply "_____ stabilization".

For pi bonding and therefore pi delocalization to occur over more than _____ atoms (i.e. pi-ways), parallel _____ orbitals are needed on ALL of the adjacent atoms involved, explaining why ALL of these atoms must be _____(or _____) hybridized and why these systems are planar.

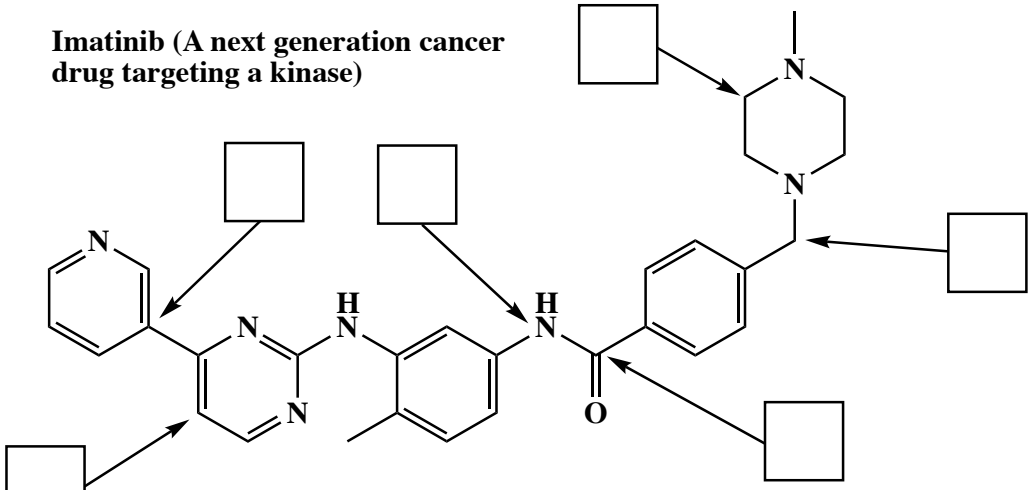


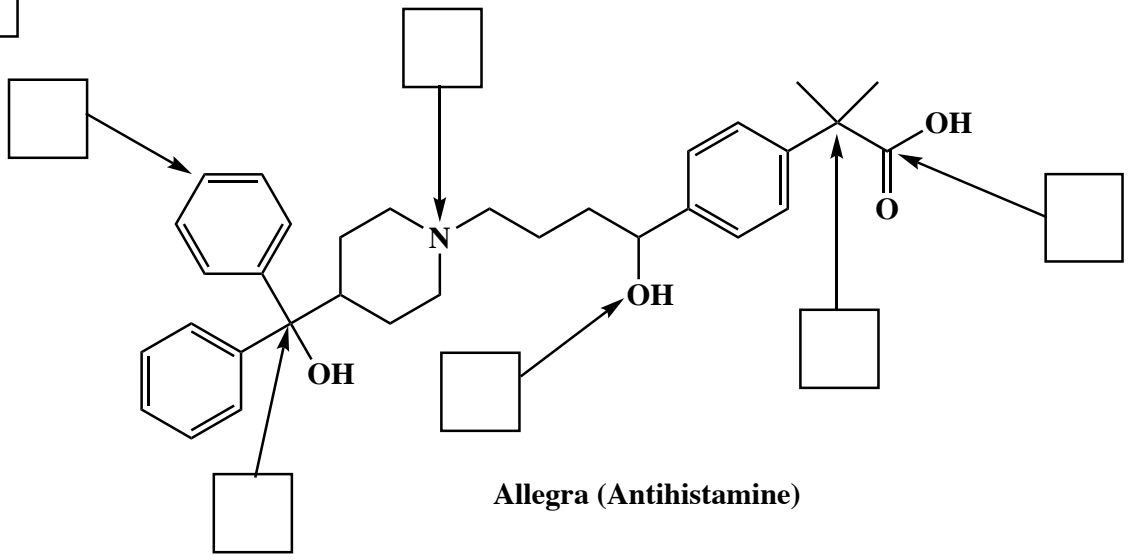
Breaking News: A new species of tiny crocodile was just discovered in a chemistry laboratory.

Latin Name: (3*Z*,4a*Z*,6*Z*,11a*Z*,13*Z*,14*Z*)-3,8,10,15-tetra-*tert*-butyl-9-heptyl-1a,1b,1c,2a,15a,16a,16b,16c-octahydro-1*H*,9*H*-cyclohepta[9,10]octaleno[3,4-*b*]cyclopropa[3',4']cyclobuta[1',2':3,4]cyclobuta[1,2-*e*][1,4]dioxine

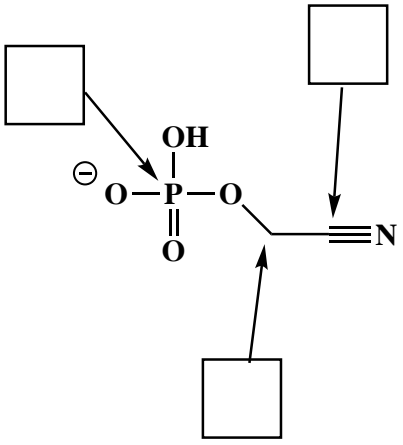
9. (1 pt each) In the boxes provided, write the hybridization state (i.e. sp^3, etc.)of the atoms indicated by the arrow.

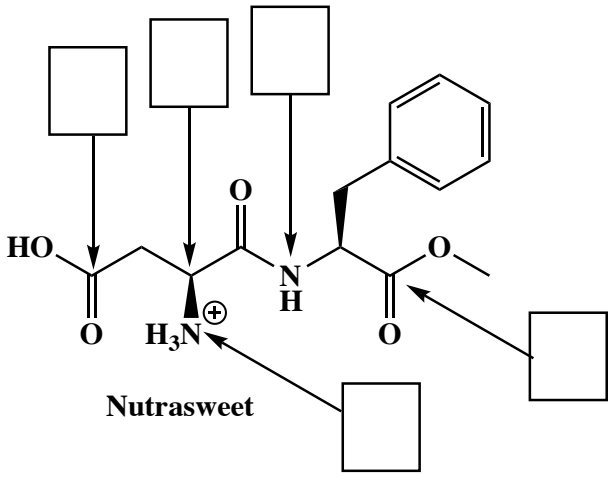
Imatinib (A next generation cancer drug targeting a kinase)





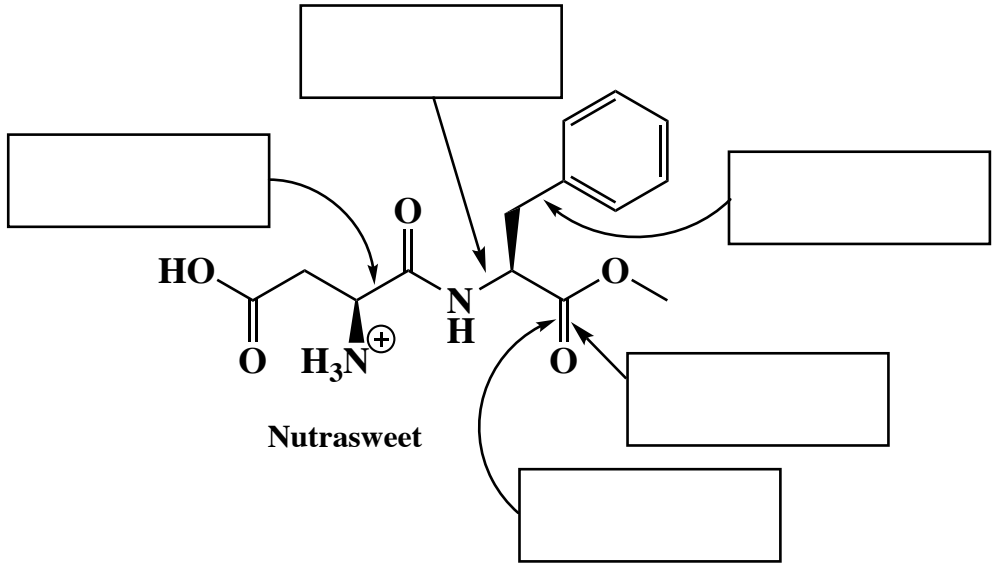
Allegra (Antihistamine)



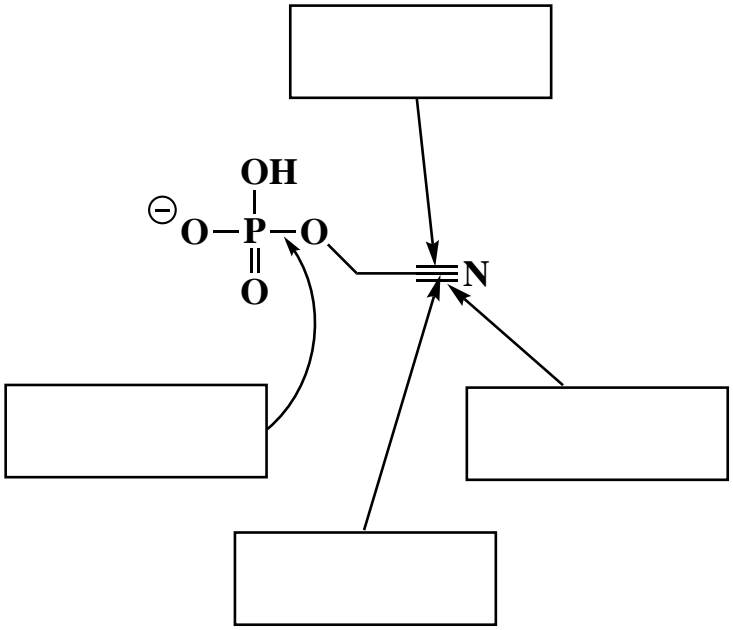


Nutrasweet

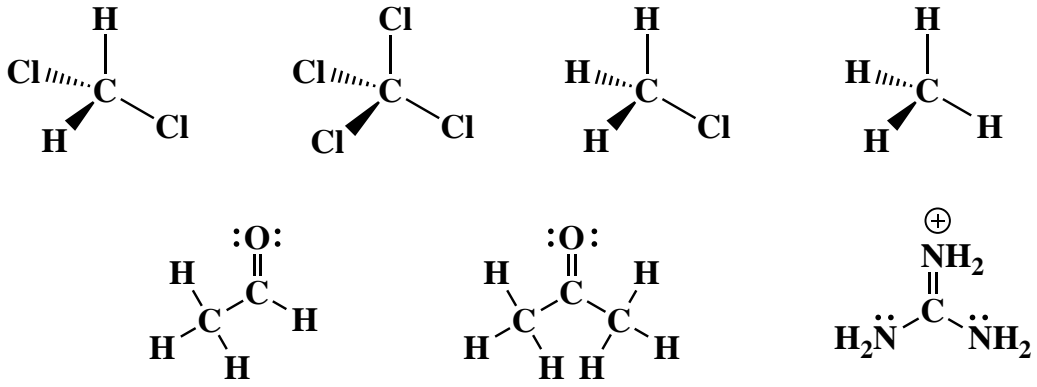
10. (2 pts each) Describe each bond indicated with an arrow as the overlap of orbitals. For example, an answer might be σ **Csp^3-Csp^3.**



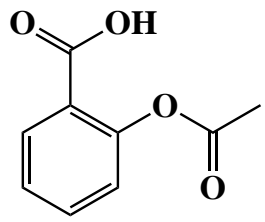
Nutrasweet



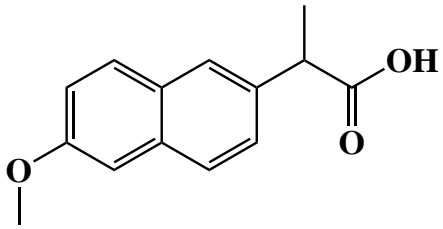
11. (8 pts) Circle any molecule that has an overall molecular dipole moment.



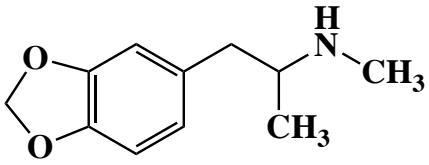
12. (15 pts) Circle all of the molecules that are chiral. Put an asterisk next to all chiral centers.



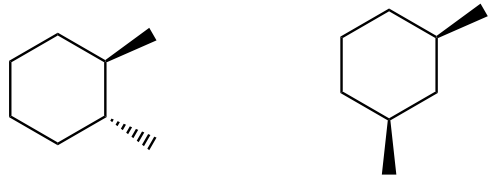
Aspirin

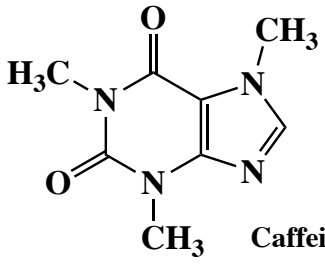


Naproxen (Aleve)

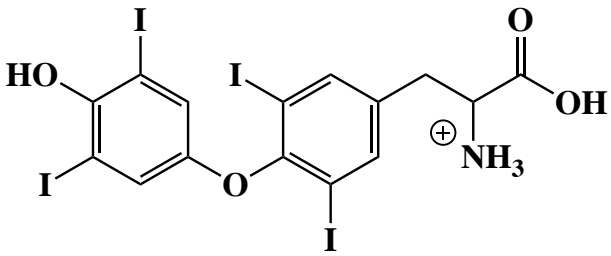


Ecstasy (MDMA)



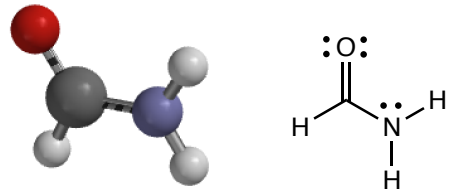


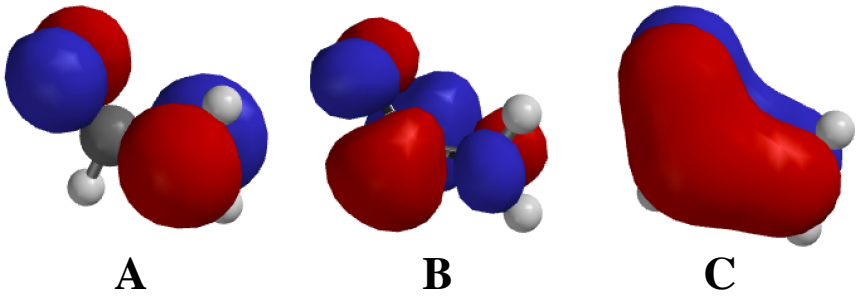
Caffeine



Levoxyl (thyroid treatment)

13. (2 pts each right answer) Below are three calculated pi orbitals for the amide molecule drawn.





A **B** **C**

We do not expect that you can calculate these orbitals on your own, but you should have some idea about what they mean. Orbitals define an area of space in which electron density is located as well as an associated energy.

A. **Which of the three orbitals; A, B, or C is the HIGHEST in energy?** _____

B. **Which of the three orbitals; A, B, or C is the LOWEST in energy?** _____

C. **In this amide, how many electrons are located in these pi orbitals?** _____

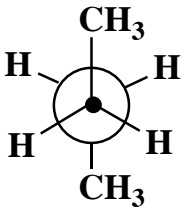
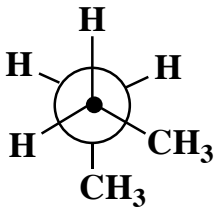
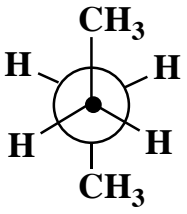
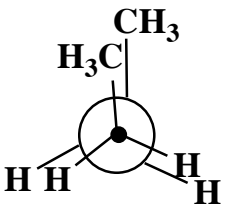
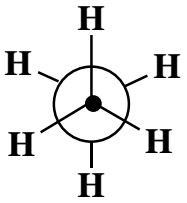
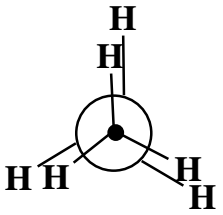
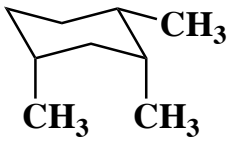
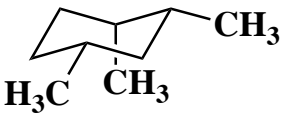
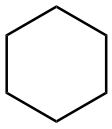
D. **Write the letters of the orbitals that are filled with electron pairs** _____

E. **What is the hybridization state of the N atom in this amide?** _____

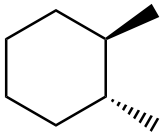
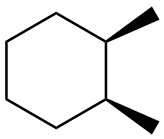
F. **Write the letter of the one orbital that best explains the N atom hybridization state you answered in part E** _____

G. **Write the letter of the one orbital that best explains why the C-N bond of the amide has highly restricted bond rotation** _____

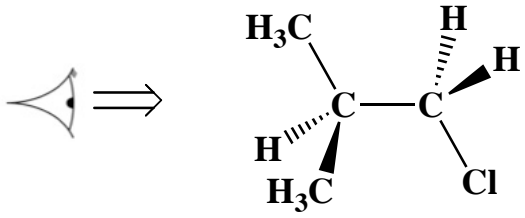
14. (20 pts) For each pair of molecules, circle the one that has LESS STRAIN, then put an "X" in the box under all the types of strain that explain(s) your answer:

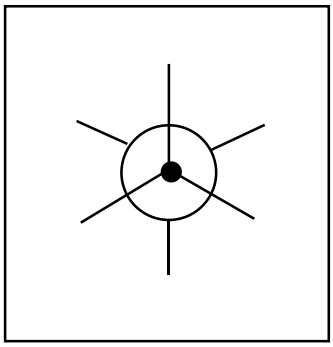
			Angle strain	Torsional strain	Steric strain
	**vs.**		☐	☐	☐
	**vs.**		☐	☐	☐
	**vs.**		☐	☐	☐
	**vs.**		☐	☐	☐
	**vs.**		☐	☐	☐

Think about this last one: Circle the molecule that will have the most stable *single* chair conformation.

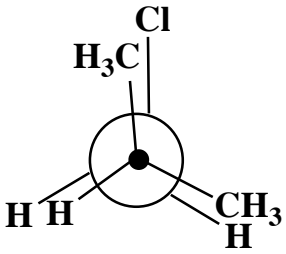
 **vs.**  ☐ ☐ ☐

15. (5 pts) Fill in the Newman projection for the conformation of 1-chloro-2-methylpropane shown.

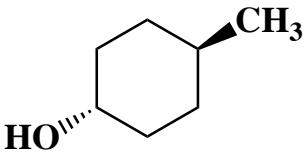


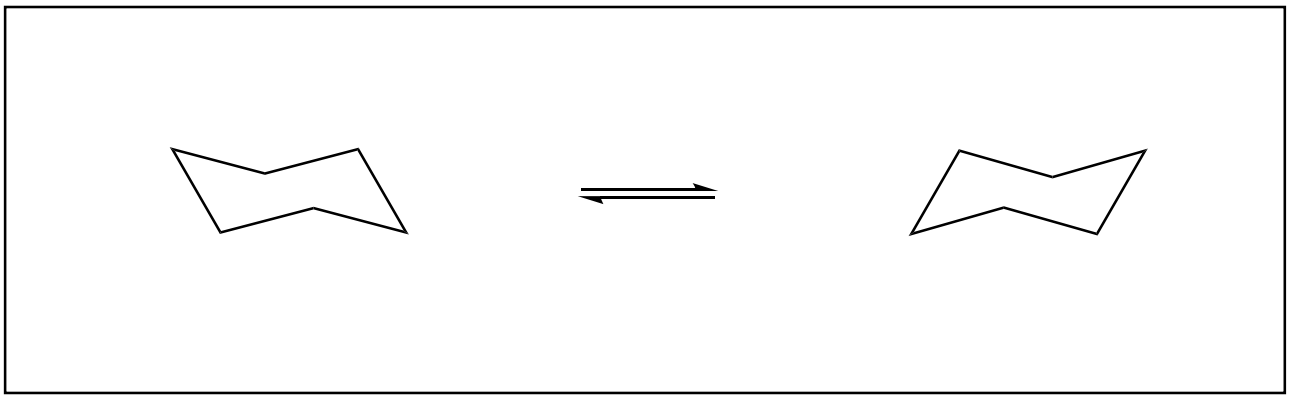


16. (5 pts) In the empty box draw the conformation of 1-chloro-2-methylpropane indicated by the Newman projection shown.

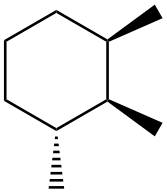


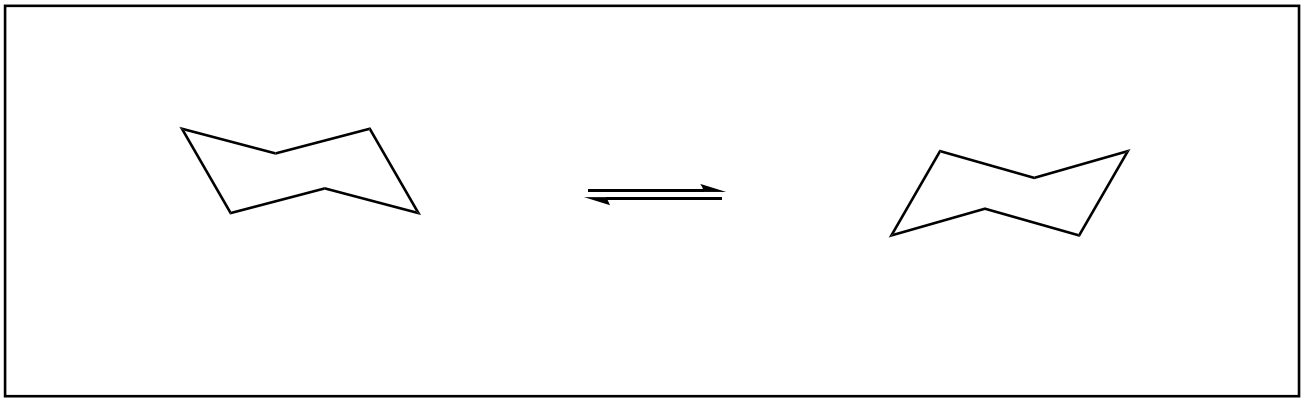
17. (7 pts) For the following cyclohexane derivative, draw the two alternative chair conformations on the chair templates we provided to help you. IF there is a difference in stability, draw a circle around the more stable conformation. If there is not any difference in stability, do not circle either chair form.



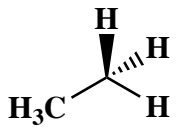


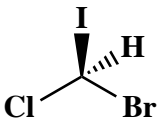
18. (7 pts) For the following cyclohexane derivative, draw the two alternative chair conformations on the chair templates we provided to help you. IF there is a difference in stability, draw a circle around the more stable conformation. If there is not any difference in stability, do not circle either chair form.

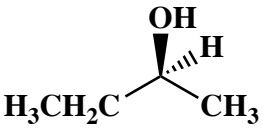


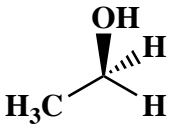


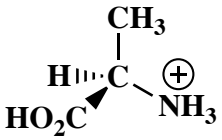
19. (2 pts each) Examine the following structures. For each molecule with a chiral center, assign the stereochemistry then write "R" or "S" as appropriate in the box provided below each structure. For all molecules that have no chiral centers, put an "X" in the box.

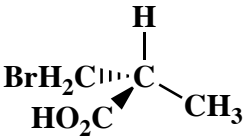


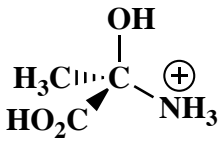


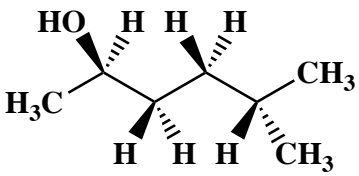






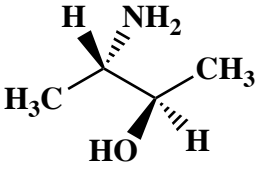


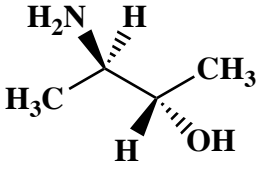




20. (20 pts) For each pair of molecules, on the line provided state the relationship between the two structures. Possible answers could be **enantiomers**, **diastereomers, consitutional isomers**, or **same molecule. Draw a circle around any meso compound.**

Relationship:





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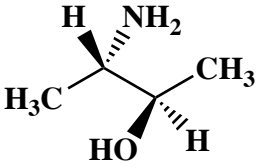

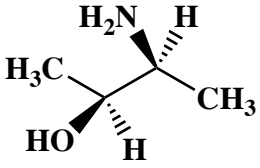

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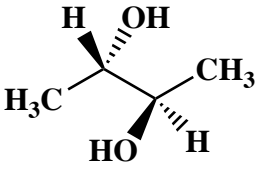

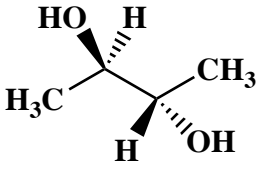

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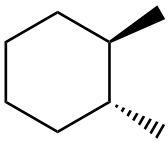

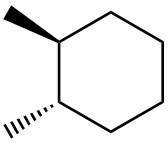

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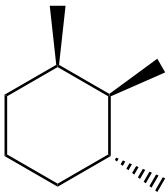

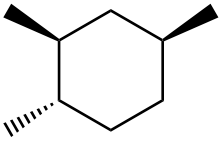

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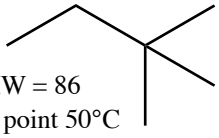
21. (16 pts total) Here is an "apply what you know" problem in the format of an MCAT style passage question. **In each case circle the single best answer.**

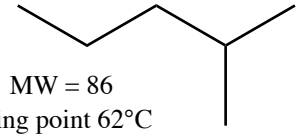
The boiling point for the sample of a pure compound depends primarily on both the attractive forces between molecules as well as overall molecular weight (MW). That is, the stronger the attraction between molecules and/or the larger the MW, the higher the boiling point. Consider the following set of molecules, listed with their respective boiling points and MW.

Molecule 1



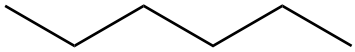
MW = 86
boiling point 50°C

Molecule 2



MW = 86
boiling point 62°C

Molecule 3



MW = 86
boiling point 69°C

1. (4 pts) Compare the structures of Molecule 1, Molecule 2 and Molecule 3. Choose the following that best describes this set of molecules.

A. They are best described as a set of constitutional isomers.
B. They are best described as a set of conformational isomers.
C. They are best described as a set of stereoisomers.
D. They are best described as a set of configurational isomers.

2. (4 pts) Compare the boiling point for Molecule 1 with that of Molecule 2 and Molecule 3. What explains this trend?

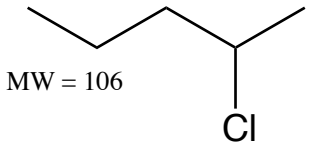
A. The attractive interactions between these alkanes are the result of transient induced dipoles.
B. The extent of attraction is dependent on the amount of surface area available to interact with other molecules.
C. Branching decreases surface area and simultaneously prevents close packing between molecules compared to straight chain alkanes.
D. A, B and C

3. (4 pts) Based on what you know about boiling points, predict which of the following will have the lowest boiling point.

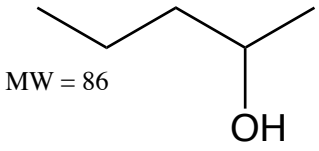
A. 2,2-Dimethylpropane
B. 2,2,3,3-Tetramethylbutane
C. Pentane
D. 2,2,3-Trimethylbutane

21. (continued)

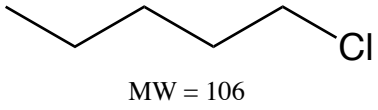
Molecule 4



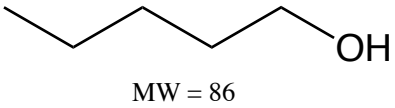
Molecule 5



Molecule 6



Molecule 7



4. (4 pts) Based on what you now know about boiling points, which statement best describes the relative boiling points of Molecules 4-7?

A. The boiling point of Molecule 4 will be higher than that of Molecule 6, and the boiling point of Molecule 5 will be higher than that of Molecule 7.
B. The boiling point of Molecule 4 will be exactly equal to that of Molecule 6 because they have the same MW, and the boiling point of Molecule 5 will be the same as Molecule 7 because they have the same MW.
C. The boiling point of Molecule 4 will be lower than that of Molecule 6, and the boiling point of Molecule 5 will be lower than that of Molecule 7.
D. Yay, you are finished with the exam!!

A good way to get ready for a 5K race is to remember that avoiding a running injury means being patient and increasing your distance slowly. Start by running as far as you can comfortably. Do not push it at the beginning. Let's say you can run 1 mile before feeling too out of breath. Run that 1 mile 2-3 times a week at first, making sure you have no foot or leg pain. If you do have foot/leg issues, try new running shoes fit by a professional. After you are comfortable running 1 mile for a week, try 1.25 miles for 2-3 times the next week. Then run to 1.5 miles, then 2.0 miles, then 2.5 miles each 2-3 times for a week. It will then be time for the race and you will make it!!!