NAME (Print): _____

SIGNATURE: _____

Chemistry 320M/328M
Dr. Brent Iverson
1st Midterm
September 27, 2012

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 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!!!

Honor Code

The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

_____

(Your signature)

Page	Points	
1		(20)
2		(22)
3		(15)
4		(15)
5		(20)
6		(30)
7		(32)
8		(16)
9		(20)
10		(14)
11		(39)
12		(20)
13		(12)
14		(4)
Total		(279)
%		
T Score		
HW		
Total Grade		

(HW score + Exam Grade) ⟹

PERIODIC TABLE OF THE ELEMENTS

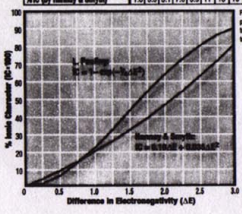
▼ Elementary Subatomic Particles

	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(12) x 10^{-3}	1.0086649(4(14) x 10^{-3}	0	≈ 0
Particle-electron mass ratio	1	1836.152701(37)	1838.683662(40)	0	≈ 0
Particle-proton mass ratio	5.44617013(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)	2.4263105(22) x 10^{-12}	1.321410(12(12) x 10^{-15}	1.3195910(12) x 10^{-15}	–	–
Magnetic moment (μ/T); μ	928.47701(31) x 10^{-26}	1.41060761(47) x 10^{-26}	0.9662370(40) x 10^{-26}	0	0
In Bohr magnetons; μ/μ_B	1.0011596521(10)	1.521032202(15) x 10^{-3}	1.0416736(25) x 10^{-3}	0	0
In nuclear magnetons; μ/μ_N	1838.282000(37)	2.792847356(63)	1.91304275(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 the 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 Hannay & 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 Hannay & 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																		18 VIII 0
1.00794 −259.34 −252.87 0.0899 2.20 13.598 $1s^1$	1 H Hydrogen	2 IIA										13 IIIB IIIA	14 IVB IVA	15 VB VA	16 VIB VIA	17 VIIB VIIA	4.0026022 −272.2 (26 atm) −268.93 0.1785 – 24.587 $1s^2$	2 He Helium
6.941 180.5 1342 0.534 0.98 5.392 [He]$2s^1$	3 Li Lithium	9.012182 1287 2471 1.8477 1.57 9.322 [He]$2s^2$ Beryllium										10.811 2075 – 2.31 8.296 [He]$2s^2 2p^1$	12.011 4492* 3825* 2.25 2.55 11.260 [He]$2s^2 2p^2$	14.00674 −210.00 −195.79 1.25046 3.04 14.534 [He]$2s^2 2p^3$	15.9994 −218.79 −182.95 1.429 3.44 13.618 [He]$2s^2 2p^4$	18.9984032 −219.62 −188.12 1.69 3.98 17.422 [He]$2s^2 2p^5$	20.1797 −248.59 −246.08 0.0002 – 21.564 [He]$2s^2 2p^6$	10 Ne Neon
22.989768 97.72 883 0.97 0.83 5.139 [Ne]$3s^1$	11 Na Sodium	24.3050 650 1090 1.74 1.31 7.646 [Ne]$3s^2$ Magnesium										26.981539 660.32 2519 2.702 1.61 5.986 [Ne]$3s^2 3p^1$ Aluminum	28.0855 1414 3265 2.33 1.90 8.151 [Ne]$3s^2 3p^2$ Silicon	30.973762 44.15 277 1.82 2.19 10.486 [Ne]$3s^2 3p^3$ Phosphorus	32.066 115.21 444.60 2.07 2.58 10.360 [Ne]$3s^2 3p^4$ Sulfur	35.4527 −101.5 −34.04 3.214 3.16 12.967 [Ne]$3s^2 3p^5$ Chlorine	39.948 −189.35 −185.85 1.784 – 15.759 [Ne]$3s^2 3p^6$ Argon
39.0983 63.38 759 0.86 0.82 4.341 [Ar]$4s^1$	19 K Potassium	40.078 842 1484 1.54 1.00 6.113 [Ar]$4s^2$ Calcium	44.955910 1541 2830 2.989 1.36 6.54 [Ar]$3d^1 4s^2$ Scandium	47.88 1668 3287 4.5 1.54 6.82 [Ar]$3d^2 4s^2$ Titanium	50.9415 1910 3407 5.96 1.63 6.74 [Ar]$3d^3 4s^2$ Vanadium	51.9961 1907 2671 7.20 1.66 6.766 [Ar]$3d^5 4s^1$ Chromium	54.93805 1246 2061 7.47 1.55 7.435 [Ar]$3d^5 4s^2$ Manganese	55.847 1538 2861 7.86 1.83 7.870 [Ar]$3d^6 4s^2$ Iron	58.93320 1495 2927 8.92 1.88 7.86 [Ar]$3d^7 4s^2$ Cobalt	58.6934 1455 2913 8.90 1.91 7.635 [Ar]$3d^8 4s^2$ Nickel	63.546 1084.62 2562 8.94 1.90 7.726 [Ar]$3d^{10} 4s^1$ Copper	65.39 419.53 907 7.14 (20°C) 1.65 9.394 [Ar]$3d^{10} 4s^2$ Zinc	69.723 29.76 2204 5.095 1.81 5.999 [Ar]$3d^{10} 4s^2 p^1$ Gallium	72.61 938.25 2833 5.35 2.01 7.899 [Ar]$3d^{10} 4s^2 p^2$ Germanium	74.92159 817* 614* 5.727 (85°C) 2.18 9.81 [Ar]$3d^{10} 4s^2 p^3$ Arsenic	78.96 221 685 4.81 2.55 9.752 [Ar]$3d^{10} 4s^2 p^4$ Selenium	79.904 −7.2 58.8 3.119 2.96 11.814 [Ar]$3d^{10} 4s^2 p^5$ Bromine	83.80 −157.36 −153.22 3.74 – 13.999 [Ar]$3d^{10} 4s^2 p^6$ Krypton
85.4678 38.31 688 1.532 0.82 4.177 [Kr]$5s^1$	37 Rb Rubidium	87.62 777 1382 2.6 0.95 5.806 [Kr]$5s^2$ Strontium	88.90585 1526 3336 4.469 1.22 6.38 [Kr]$4d^1 5s^2$ Yttrium	91.224 1855 4409 6.49 1.33 6.84 [Kr]$4d^2 5s^2$ Zirconium	92.90638 2477 4744 8.57 1.6 6.9 [Kr]$4d^4 5s^1$ Niobium	95.94 2623 4639 10.2 2.16 7.099 [Kr]$4d^5 5s^1$ Molybdenum	(97.9072) 2157 4265 11.5 1.9 7.28 Tc [Kr]$4d^5 5s^2$ Technetium	101.07 2334 4150 12.3 2.2 7.37 [Kr]$4d^7 5s^1$ Ruthenium	102.90550 1964 3695 12.4 2.28 7.46 [Kr]$4d^8 5s^1$ Rhodium	106.42 1554.9 2963 12.02 2.20 8.34 [Kr]$4d^{10}$ Palladium	107.8682 961.78 2162 10.5 1.93 7.576 [Kr]$4d^{10} 5s^1$ Silver	112.411 321.07 767 8.642 1.69 8.993 [Kr]$4d^{10} 5s^2$ Cadmium	114.818 156.60 2072 7.30 1.78 5.786 [Kr]$4d^{10} 5s^2 p^1$ Indium	118.710 231.93 2833 7.28 1.96 7.344 [Kr]$4d^{10} 5s^2 p^2$ Tin	121.757 630.63 1587 6.684 (99°C) 2.05 8.641 [Kr]$4d^{10} 5s^2 p^3$ Antimony	127.60 449.51 988 6.25 2.1 9.009 [Kr]$4d^{10} 5s^2 p^4$ Tellurium	126.90447 113.7 184.4 4.93 2.66 10.451 [Kr]$4d^{10} 5s^2 p^5$ Iodine	131.29 −111.75 −108.04 5.89 – 12.130 [Kr]$4d^{10} 5s^2 p^6$ Xenon
132.90543 28.44 671 1.879 0.79 3.894 [Xe]$6s^1$	55 Cs Cesium	137.327 727 1897 3.594 0.89 5.212 [Xe]$6s^2$ Barium	138.9055 920 3455 6.146 1.10 5.577 [Xe]$5d^1 6s^2$ Lanthanum	178.49 2233 4603 13.31 1.3 7.0 [Xe]$4f^{14} 5d^2 6s^2$ Hafnium	180.9479 3017 5458 16.6 1.5 7.89 [Xe]$4f^{14} 5d^3 6s^2$ Tantalum	183.84 3422 5555 19.35 2.36 7.98 [Xe]$4f^{14} 5d^4 6s^2$ Tungsten	186.207 3180 5596 20.5 1.9 7.88 [Xe]$4f^{14} 5d^5 6s^2$ Rhenium	190.23 3033 5012 22.61 2.2 8.7 [Xe]$4f^{14} 5d^6 6s^2$ Osmium	192.22 2446 4428 22.65 2.20 9.1 [Xe]$4f^{14} 5d^7 6s^2$ Iridium	195.08 1768.4 3825 21.45 2.28 9.0 [Xe]$4f^{14} 5d^9 6s^1$ Platinum	196.96654 1064.18 2856 19.31 2.54 9.225 [Xe]$4f^{14} 5d^{10} 6s^1$ Gold	200.59 −38.83 356.72 13.546 2.00 10.437 [Xe]$4f^{14} 5d^{10} 6s^2$ Mercury	204.3833 304 1473 11.85 2.04 6.108 [Xe]$4f^{14} 5d^{10} 6s^2 p^1$ Thallium	207.2 327.46 1749 11.34 2.33 7.416 [Xe]$4f^{14} 5d^{10} 6s^2 p^2$ Lead	208.98037 271.40 1564 9.78 2.02 7.289 [Xe]$4f^{14} 5d^{10} 6s^2 p^3$ Bismuth	(208.9824) 254 962 9.196 2.0 8.42 [Xe]$4f^{14} 5d^{10} 6s^2 p^4$ Polonium	(209.9871) 302 – – 2.2 – 10.748 [Xe]$4f^{14} 5d^{10} 6s^2 p^5$ Astatine	(222.0176) −71 −61.7 9.73 – – 10.748 [Xe]$4f^{14} 5d^{10} 6s^2 p^6$ Radon
(223.0197) 27 677 – 0.7 – [Rn]$7s^1$	87 Fr Francium	(226.0254) <1140 5.8 0.9 5.279 [Rn]$7s^2$ Radium	89 ** Ac Actinium	(261.11) – – – – – [Rn]$5f^{14} 6d^2 7s^2$ Unnilquadium	104 Unq Unnilpentium	(262.114) – – – – – [Rn]$5f^{14} 6d^3 7s^2$	105 Unp Unnilhexium	(263.118) – – – – – [Rn]$5f^{14} 6d^4 7s^2$	106 Unh Unnilseptium	(262.12) – – – – – [Rn]$5f^{14} 6d^5 7s^2$	107 Uns Unniloctium	(265) – – – – – [Rn]$5f^{14} 6d^6 7s^2$	108 Uno Unnilennium	(266) – – – – – [Rn]$5f^{14} 6d^7 7s^2$	109 Une Unnilunium	(272) – – – – – [Rn]$5f^{14} 6d^8 7s^2$	110 Uun Ununnium	

*indicates approximate values and/or inconsistent literature data.

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
140.115 798 3424 6.710 1.12 5.466 [Xe]$4f^1 5d^1 6s^2$ Cerium	58 Ce	140.90765 931 3510 6.773 1.13 5.42 [Xe]$4f^3 6s^2$ Praseodymium	59 Pr	144.24 1016 3068 7.00 1.14 5.489 [Xe]$4f^4 6s^2$ Neodymium	60 Nd	(144.9127) 1042 3000 7.264 1.13 5.554 Pm [Xe]$4f^5 6s^2$ Promethium	61	150.36 1072 1700 7.536 1.17 5.631 [Xe]$4f^6 6s^2$ Samarium	62 Sm	151.965 822 1596 5.244 1.2 5.666 [Xe]$4f^7 6s^2$ Europium	63 Eu	157.25 1314 3264 7.901 1.20 5.141 [Xe]$4f^7 5d^1 6s^2$ Gadolinium	64 Gd	158.92534 1359 3221 8.230 1.2 5.842 [Xe]$4f^9 6s^2$ Terbium	65 Tb	162.50 1411 2561 8.551 1.22 5.927 [Xe]$4f^{10} 6s^2$ Dysprosium	66 Dy	164.93032 1472 2694 8.80 1.23 6.018 [Xe]$4f^{11} 6s^2$ Holmium	67 Ho	167.26 1529 2862 9.066 1.24 6.101 [Xe]$4f^{12} 6s^2$ Erbium	68 Er	168.93421 1545 1946 9.321 1.25 6.184(b) [Xe]$4f^{13} 6s^2$ Thulium	69 Tm	173.04 824 1194 6.966 – 6.25304 [Xe]$4f^{14} 6s^2$ Ytterbium	70 Yb	174.967 1663 3393 9.84 1.27 5.42589 [Xe]$4f^{14} 5d^1 6s^2$ Lutetium	71 Lu
232.0381 1750 4788 11.72 1.3 6.08 [Ra]$6d^2 7s^2$ Thorium	90 Th	231.03588 1572 – 15.37 1.5 5.89 [Rn]$5f^2 6d^1 7s^2$ Protactinium	91 Pa	238.0289 1135 4131 19.05±0.02 1.38 6.05 [Rn]$5f^3 6d^1 7s^2$ Uranium	92 U	(237.0482) 644 3909 26.45 1.36 6.19 Np [Rn]$5f^4 6d^1 7s^2$ Neptunium	93	(244.0642) 640 3228 19.816 1.28 5.8 Pu [Rn]$5f^6 7s^2$ Plutonium	94	(243.0614) 1176 2607 13.67 1.3 5.993 Am [Rn]$5f^7 7s^2$ Americium	95	(247.0703) 1345 – 13.51 1.3 6.02 Cm [Rn]$5f^7 6d^1 7s^2$ Curium	96	(247.0703) 1050 – 14.78 1.3 6.23 Bk [Rn]$5f^9 7s^2$ Berkelium	97	(251.0796) 900 – – 1.3 6.30 Cf [Rn]$5f^{10} 7s^2$ Californium	98	(252.083) 860 – – 1.3 6.42 Es [Rn]$5f^{11} 7s^2$ Einsteinium	99	(257.0951) 1527 – – 1.3 6.50 Fm [Rn]$5f^{12} 7s^2$ Fermium	100	(258.10) 827 – – 2.3 1.3 6.58 Md [Rn]$5f^{13} 7s^2$ Mendelevium	101	(259.1009) 827 – – 2.3 1.3 6.65 No [Rn]$5f^{14} 7s^2$ Nobelium	102	(262.11) 1627 – – 2.3 1.3 6.10 Lr [Rn]$5f^{14} 6d^1 7s^2$ Lawrencium	103

The data for this reference guide were obtained from the latest scientific and governmental sources (IUPAC, CODATA, National Bureau of Standards, etc.). Italicized 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 other group classifications systems still in use today rely on an A/B coding 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).

PAPERTECH

Editors: T. K. Varga, M.A.Sc. & C. Bello, M.A.Sc.

Product No. LCH-04F

ISBN 1-55080-073-6

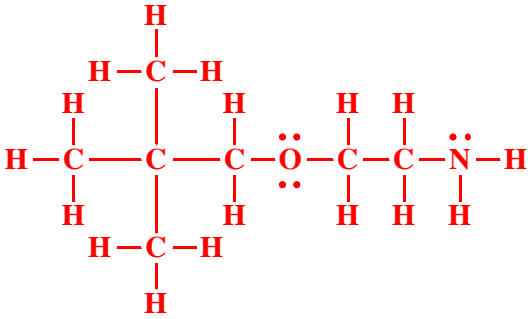
Signature_____ Pg 1 _____(20)

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

Where are the electrons?

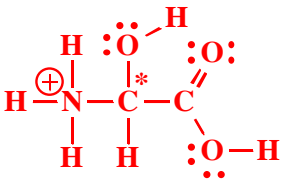
2. (8 pts each) For the following molecular formula, draw complete Lewis line structures in which all atoms (even H atoms) are drawn, lines are used as bonds, all lone pairs are drawn AND ALL FORMAL CHARGES ARE INDICATED. Note you must infer the formal charges as we do not indicate them on the chemical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

1) **$(CH_3)_3CCH_2OCH_2CH_2NH_2$**



How many different stereoisomers are there for the above molecule? **1**

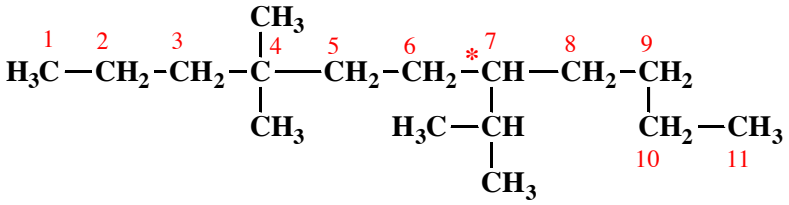
2) **$H_3NCHOHCO_2H$**



How many different stereoisomers are there for the above molecule? **2**

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

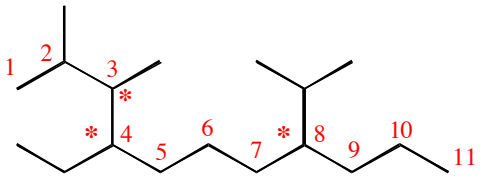
A) (6 pts)



7-isopropyl-4,4-dimethylundecane
or 4,4-dimethyl-7-(1-methylethyl)undecane

Although stereochemistry is not indicated on the above structure, how many stereoisomers are possible? **2**

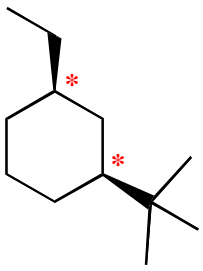
B) (6 pts)

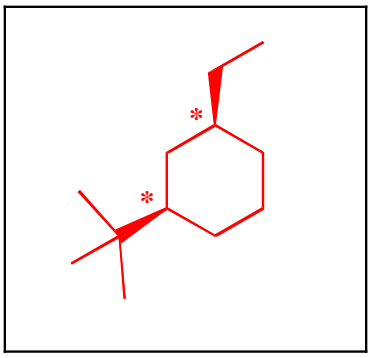


4-ethyl-8-isopropyl-2,3-dimethylundecane
or 4-ethyl-2,3-dimethyl-8-(1-methylethyl)undecane

Although stereochemistry is not indicated on the above structure, how many stereoisomers are possible? **8**

C) (10 pts)



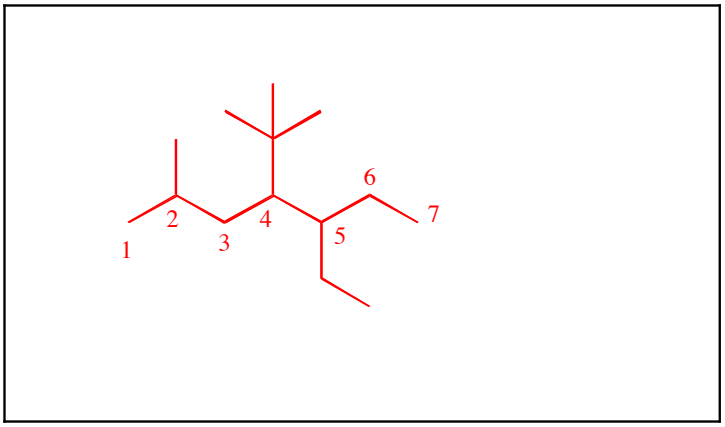


***cis*-1-*tert*-butyl-3-ethylcyclohexane**
or *cis*-1-ethyl-3-(1,1-dimethylethyl)cyclohexane

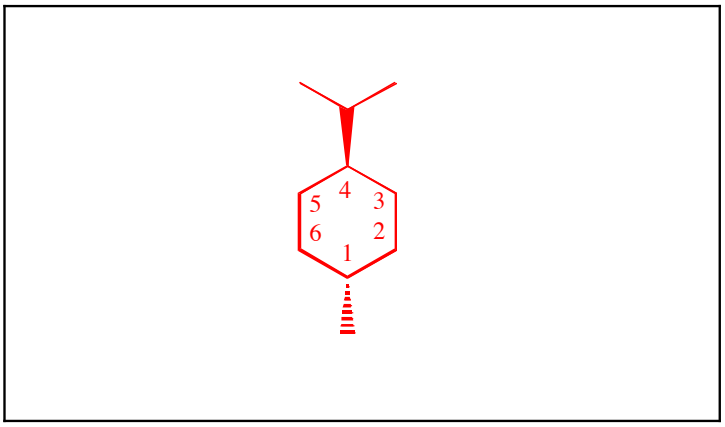
Is the molecule chiral? **Yes** **If you answered yes, then in the box provided, draw the enantiomer of the above structure.**

5. (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).

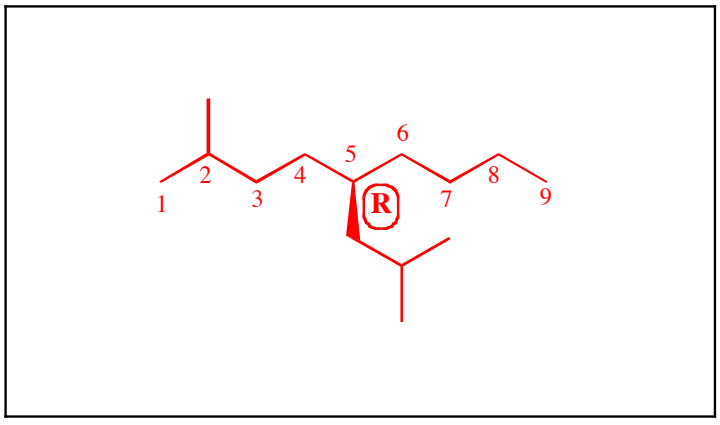
A) 4-*tert*-Butyl-5-ethyl-2-methylheptane



B) *trans*-1-Methyl-4-(1-methylethyl)cyclohexane

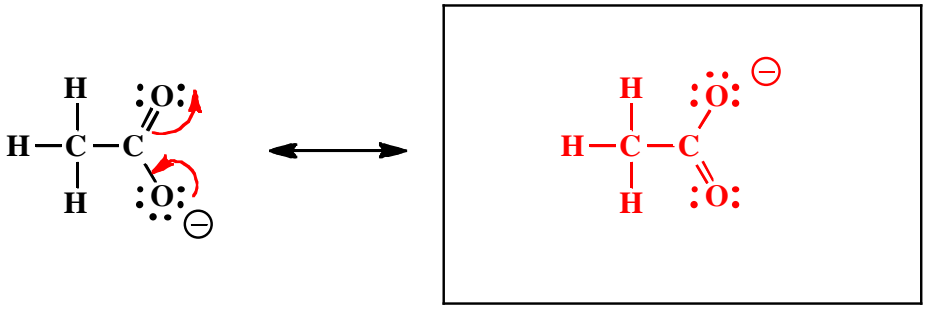


C) *(R)*-5-Isobutyl-2-methylnonane (Use wedges and dashes to indicate the appropriate stereochemistry at all chiral centers)

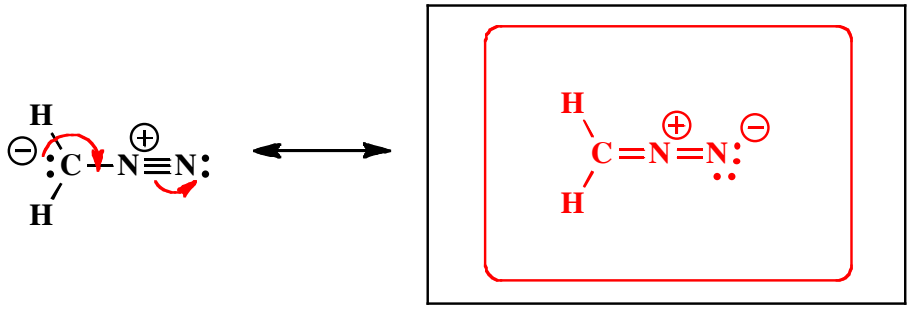


6. (5pts each) The following molecules are best represented as the hybrid of contributing structures. **Draw the second important contributing structure** in the space provided, including all lone pairs and formal charges. **For the structure on the left, use arrows to indicate the movement of electrons 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.

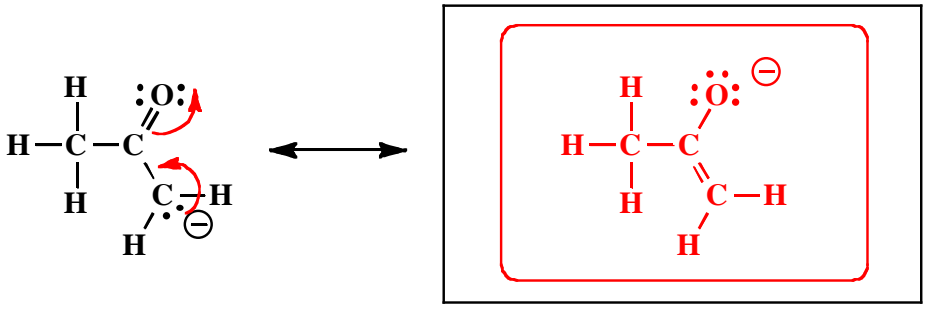
A.



B.

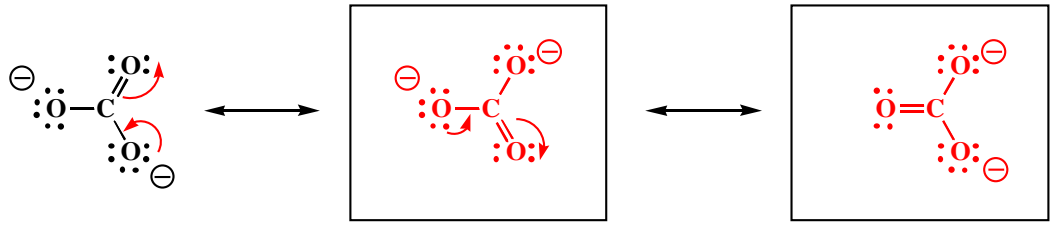


C.

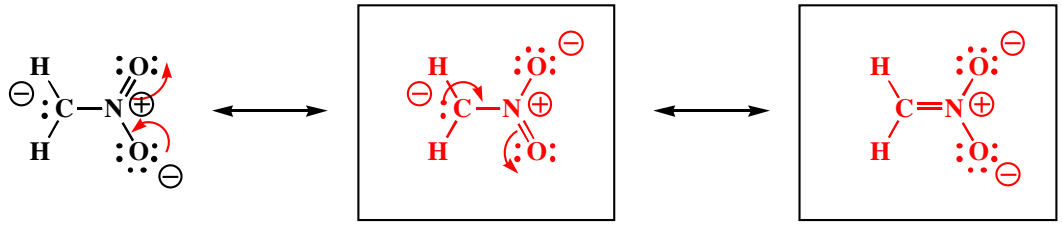


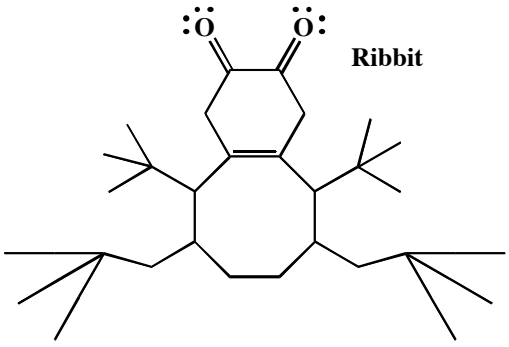
7. (10 pts each) The following molecules are best represented as the hybrid of three contributing structures. **Draw the second and third important contributing structures** in the spaces provided, including all lone pairs and formal charges. **For the two structures on the left in each problem, use arrows to indicate the movement of electrons to give the structures you drew.** 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.

A.



B.





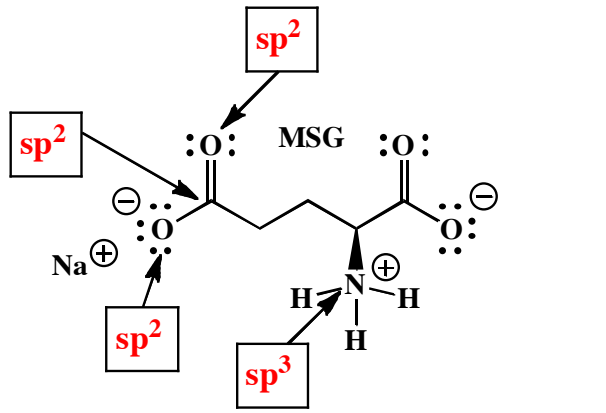
8. (2 pts each) Fill in each blank with the word or words that best completes the sentences.

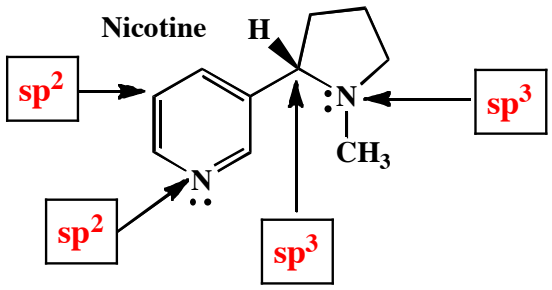
For organic chemistry, it is best to think of ___electrons___ **as waves.**

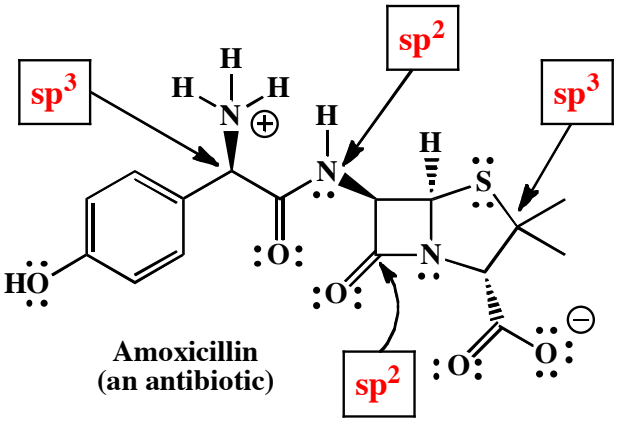
According to the valence bond approach, the atomic orbitals on each atom are combined first to create ___hybridized___ **orbitals, that overlap to create** ___sigma___ **bonds.**

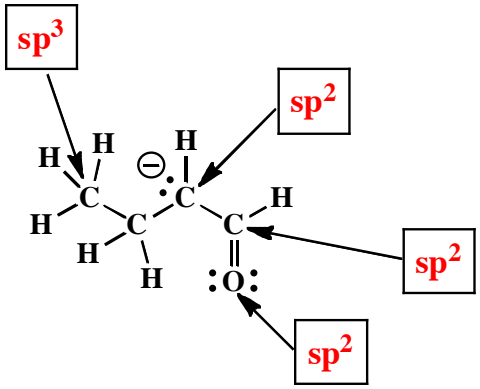
Three (or more) atom "pi-ways" are the situation resonance ___contributing___ **structures are usually trying to describe. For pi bonding and therefore pi delocalization to occur over more then two atoms (i.e. pi-ways), parallel and overlapping** ___2p___ **orbitals are needed on ALL of the adjacent atoms involved. As a result, all of the atoms involved in pi-ways are usually** ___sp^2___ **hybrized, and NEVER** ___sp^3___ **hybridized.**

9. (1 pt each) For the following molecules, write the hybridization state of each atom indicated by the arrow.

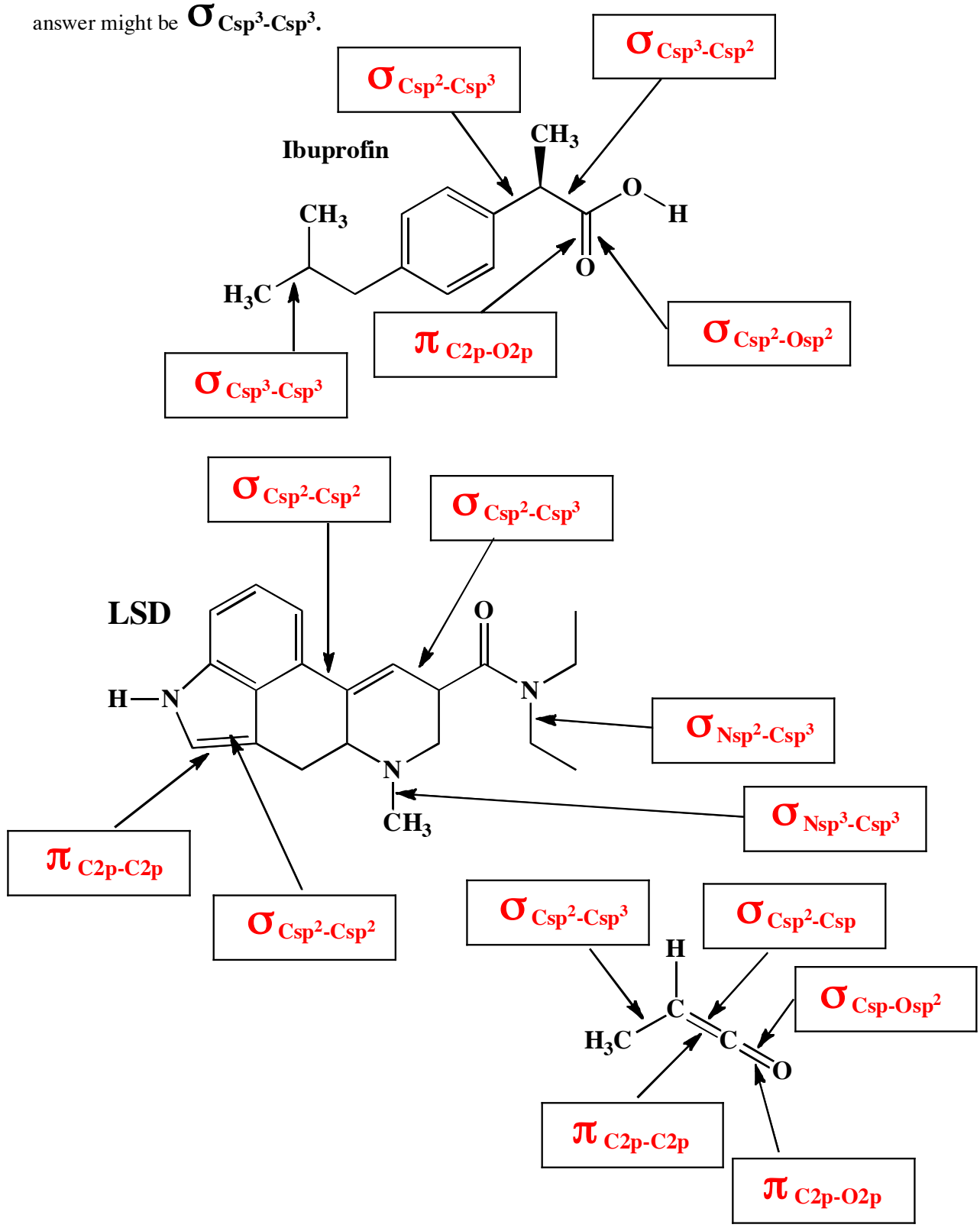




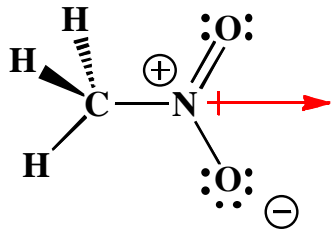


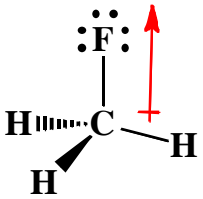


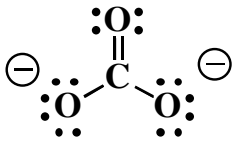
10. (2 pts each) Describe each bond indicated with an arrow as the overlap of orbitals. For example, an answer might be $\sigma_{Csp^3\text{-}Csp^3}$.



11. (2 pts each) For the following molecules, use the dipole moment symbol ⟶ to show the direction of the molecular dipolemoment in all molecules that have an overall molecular dipole. Note for this one you do NOT need to draw the individual bond dipole moments, just the overall molecular dipole moment,

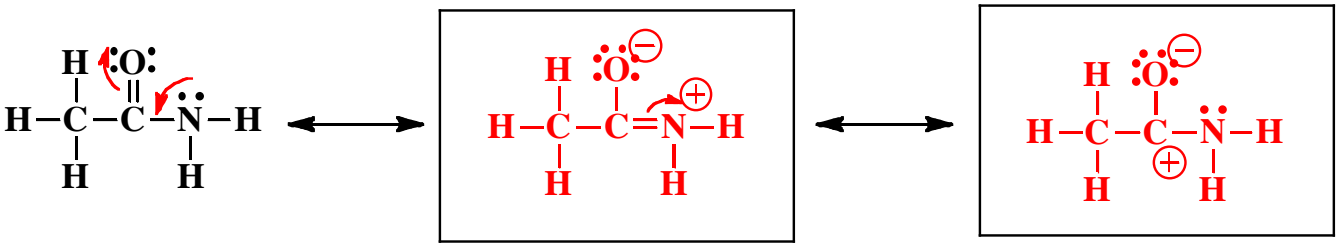




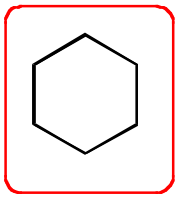
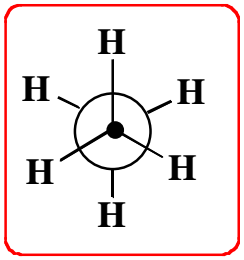
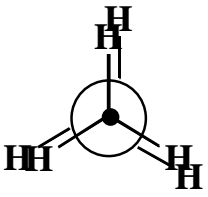
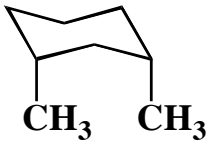
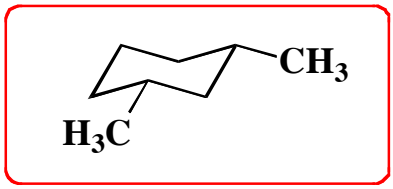
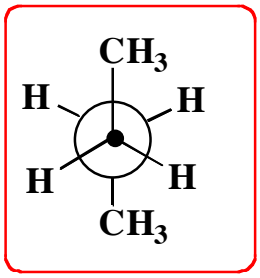
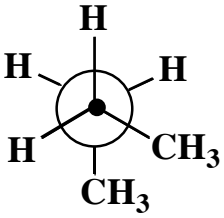
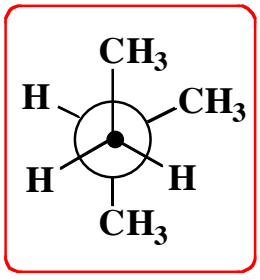
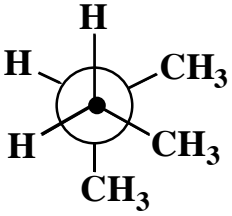


none
(contributing structures distribute negative charge equally on all O atoms)

12. (10 pts) The following molecule is best represented as the hybrid of three contributing structures. **Draw the second and third important contributing structures** in the spaces provided, including all lone pairs and formal charges. **For the two structures on the left use arrows to indicate the movement of electrons to give the structures you drew.** 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.

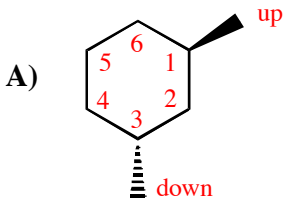


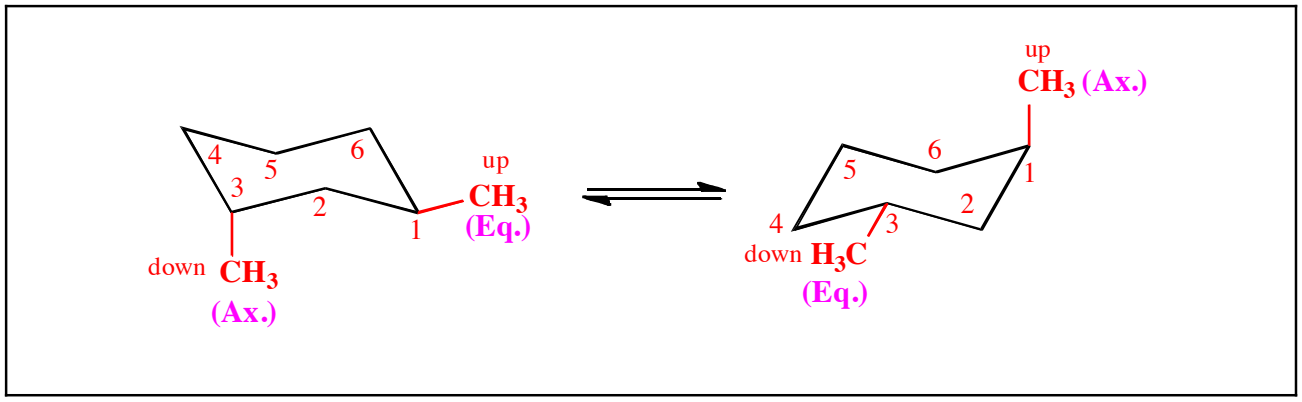
13. (4 pts each) For each pair of molecules, circle the one that has LESS STRAIN, then put an "X" in the box under all the types of strain that explain(s) your answer:

			Angle strain	Torsional strain	Steric strain
	vs.	☐	X	X	☐
	vs.		☐	X	☐
	vs.		☐	☐	X
	vs.		☐	☐	X
	vs.		☐	☐	X

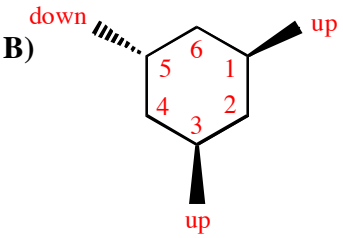
14. (7 pts each) For the following cyclohexane derivatives, draw the two alternative chair conformations. IF there is a difference in stability, draw a circle around the more stable conformation. If there is not any difference in stability, do not circle either chair form.

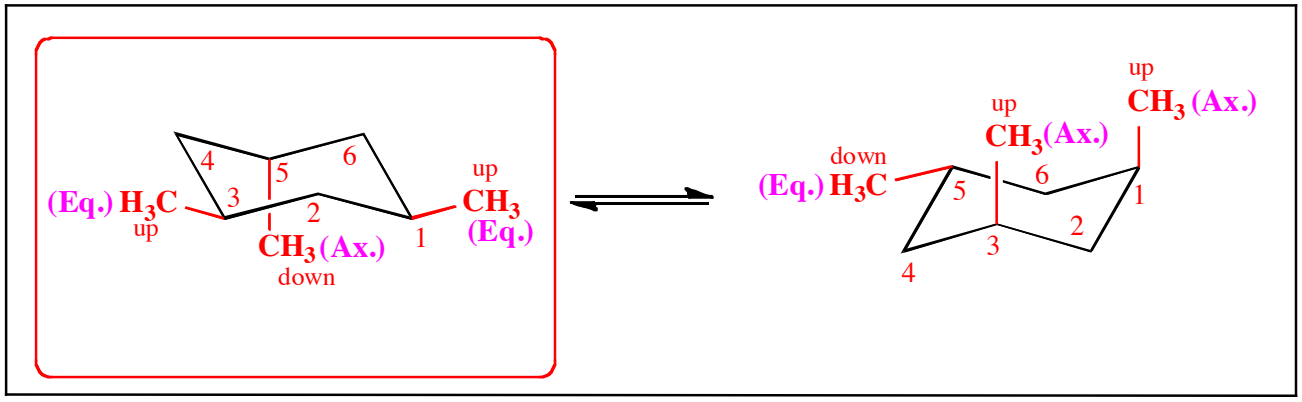
A)



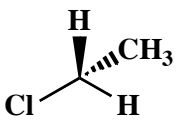


B)





15. (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, leave the box blank.



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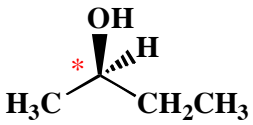
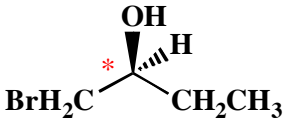
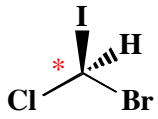


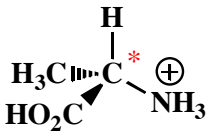
R



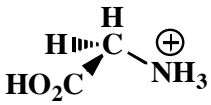
S



R



S



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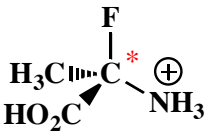
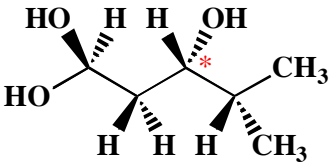


R



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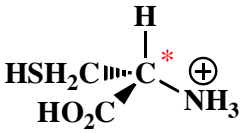
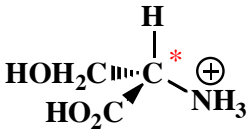
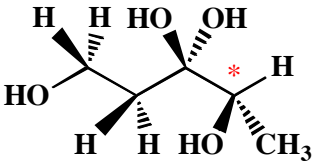


R

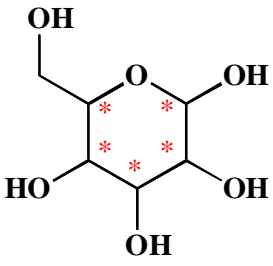


S

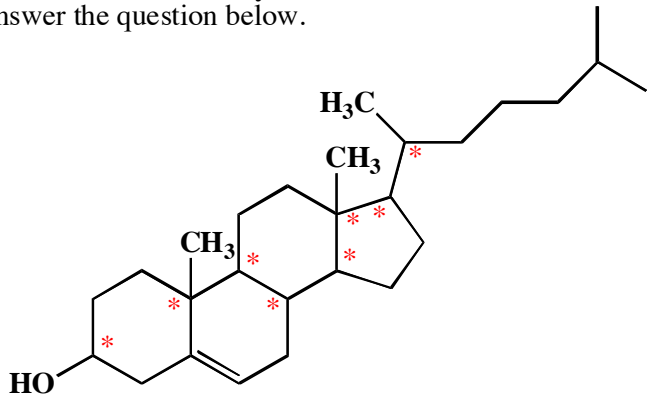


S

16. (13 pts) Most students find it difficult to identify chiral centers in ringed structures so take you time on this one. For the following important biological molecules, identify all the chiral centers. Put an asterisk next to all chiral centers you find then answer the question below.



D-Glucose

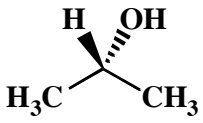


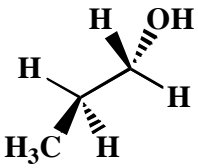
Cholesterol

(2 pts) How many stereoisomers are possible for this molecule? $2^5 = 32$

(2 pts) How many stereoisomers are possible for this molecule? $2^8 = 256!$

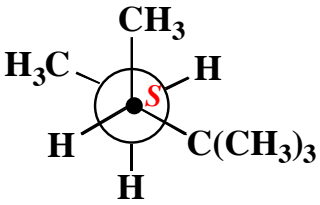
17. (4 pts each) For each pair of molecules, on the line provided state the relationship between the two structures. Possible answers could be **enantiomers**, **consitutional isomers**, or **same molecule.**

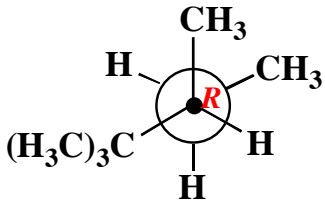




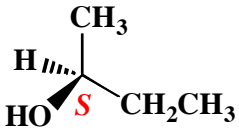
Relationship:

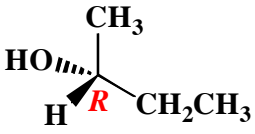
constitutional isomers



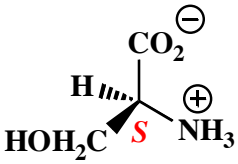


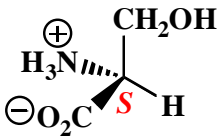
enantiomers



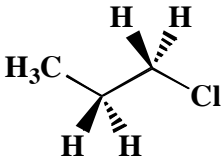


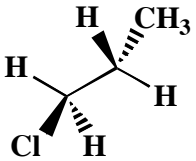
enantiomers





same molecule





same molecule

18. (16 points total) Here is an "apply what you know" problem in the format of an MCAT style passage. Circle the correct answers.

Most people are familiar with the idea that oil and water do not mix. Crude oil is a complex mixture of mostly very long chain alkanes. During the refining process, the long alkane chains of crude oil are broken into shorter chains using heat and catalysts, then purified by distillation at refineries on the basis of boiling point into fractions such as gasoline (boiling point fraction between 100°C and 400°C) or diesel fuel (boiling point fraction between 180°C and 360°C). During the Deepwater Horizon oil rig disaster a little over two years ago, between 17 and 39 million gallons of crude oil spilled into the Gulf of Mexico. Thousands of birds, turtles and sea mammals died because they were covered by oil. Well over 125 miles of coastline were affected. The major cause of the destruction is that the oil was not simply diluted by sea water, but rather, it floated on the surface in large slicks that were blown by prevailing winds until they reached a shore. What is worse, animals that need to breath air such as turtles and sea mammals (dolphins, whales, manatees) became trapped under the oil slick and had to surface into it to breathe, sealing their doom. Unsuspecting birds landed on the surface of the oil slick, becoming covered in sticky oil that prevented them from flying away.

1. (4 pts) Why does oil float on the surface of sea water rather than sink to the bottom.

A. Oil is less dense than water primarily because crude oil is mostly -CH_2- chains while water is H_2O and O has a higher atomic number than C.
B. Oil is less dense than water primarily because crude oil is mostly -CH_2- chains while water is H_2O and O has a lower atomic number than C.
C. Oil is less dense than water primarily because water molecules cannot pack together as well as the crude oil molecules pack together.
D. All of the above.

2. (4 pts) The long chain alkanes of crude oil stick to each other largely through interactions that can be described as the following:

A. London dispersion forces.
B. Attraction between induced transient dipoles associated with temporary fluctuations in electron clouds around the molecules.
C. Hydrogen bonding
D. Both A and B

3. (4 pts) Recall that hydrogen bonds are significantly stronger than London dispersion forces. The reason that crude oil and water do not mix is primarily because:

A. The water molecules are so strongly attracted to each other through hydrogen bonds that the crude oil molecules cannot break the water molecules apart well enough to dissolve.
B. The crude oil alkane molecules are so strongly attracted to each other through hydrogen bonds that the water molecules cannot break them apart enough to dissolve.
C. The crude oil molecules are too large to fit between water molecules.
D. It is primarily the salt in salt water that prevents the crude oil from dissolving in the ocean.

18. (cont.)

4. (4 pts) As mentioned in the passage, when crude oil is refined, heat and catalysts break the long carbon chains into much shorter ones. The resulting mixture is distilled and fractions with specific boiling point ranges are collected together and sold according to their intended use such as jet fuel, gasoline, heating oil, etc. Based upon what you know about the boiling points of branched vs. straight chain alkanes, which statement do you think will NOT be true as you analyze what actual molecules are in each fraction isolated based on similar boiling points.

A. The fractions with higher boiling points will generally have larger alkane molecules (higher molecular weights).
B. In a given fraction, the branched molecules will on average have a higher molecular weight compared to the straight chain molecules.
C. In a given fraction, the branched molecules will on average have a lower molecular weight compared to the straight chain molecules.
D. The fractions with lower boiling points will generally have smaller alkane molecules (lower molecular weights).

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 (Luke's Locker is a great running store for this). 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!!!