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

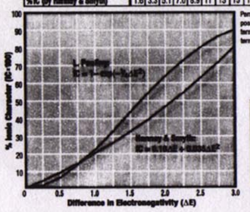
▼ Elementary Subatomic Particles

	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)	5.48579903(13) x 10^{-7}	1.007276470(12) x 10^{-3}	1.008664904(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)	−1.75881962(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)	2.42631058(22) x 10^{-12}	1.32141002(12) x 10^{-15}	1.31959110(12) x 10^{-15}	–	–
Magnetic moment (J/T); μ	928.47701(31) x 10^{-26}	1.41060761(47) x 10^{-26}	0.96623707(40) x 10^{-26}	0	0
In Bohr magnetons; μ/μ_B	1.001159652193(10)	1.521032202(15) x 10^{-3}	1.04187563(25) x 10^{-3}	0	0
In nuclear magnetons; μ/μ_N	1838.282000(37)	2.792847386(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 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 (μ) 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 = 5.0507866(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	69	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.

Elements

Groups: 1 IA IA; 2 IIA 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

Atomic No.	Symbol	Name	Atomic Weight	Melting Point, °C	Boiling Point, °C	Density	Electronegativity	First Ionization Potential, eV	Oxidation States	Electronic Configuration
1	H	Hydrogen	1.00794	−259.34	−252.87	0.0899	2.20	13.598	1	$1s^1$
2	He	Helium	4.002602	−272.2 (26 atm)	−268.93	0.1785	–	24.587		$1s^2$
3	Li	Lithium	6.941	180.5	1342	0.534	0.98	5.392	1	$[He]2s^1$
4	Be	Beryllium	9.012182	1287	2471	1.8477	1.57	9.322	2	$[He]2s^2$
5	B	Boron	10.811	2075	4000	2.31	2.04	8.298	3	$[He]2s^22p^1$
6	C	Carbon	12.011	4492*	3825*	2.25	2.55	11.260	2,±4	$[He]2s^22p^2$
7	N	Nitrogen	14.00674	−210.00	−195.79	1.25046	3.04	14.534	2,±3,4,5	$[He]2s^22p^3$
8	O	Oxygen	15.9994	−218.79	−182.95	1.429	3.44	13.618	−2	$[He]2s^22p^4$
9	F	Fluorine	18.9984032	−219.62	−188.12	1.69	3.98	17.422	−1	$[He]2s^22p^5$
10	Ne	Neon	20.1797	−248.59	−246.08	0.9002	–	21.564		$[He]2s^22p^6$
11	Na	Sodium	22.989768	97.72	883	0.97	0.93	5.139	1	$[Ne]3s^1$
12	Mg	Magnesium	24.3050	650	1090	1.74	1.31	7.646	2	$[Ne]3s^2$
13	Al	Aluminum	26.981539	660.32	2519	2.702	1.61	5.986	3	$[Ne]3s^23p^1$
14	Si	Silicon	28.0855	1414	3265	2.33	1.90	8.151	4	$[Ne]3s^23p^2$
15	P	Phosphorus	30.973762	44.15	277	1.82	2.19	10.486	±3,4,5	$[Ne]3s^23p^3$
16	S	Sulfur	32.066	115.21	444.60	2.07	2.58	10.360	±2,4,6	$[Ne]3s^23p^4$
17	Cl	Chlorine	35.4527	−101.5	−34.04	3.214	3.16	12.967	±1,3,5,7	$[Ne]3s^23p^5$
18	Ar	Argon	39.948	−189.35	−185.85	1.784	–	15.759		$[Ne]3s^23p^6$
19	K	Potassium	39.0983	63.38	759	0.86	0.82	4.341	1	$[Ar]4s^1$
20	Ca	Calcium	40.078	842	1484	1.54	1.00	6.113	2	$[Ar]4s^2$
21	Sc	Scandium	44.955910	1541	2830	2.989	1.36	6.54	3	$[Ar]3d^14s^2$
22	Ti	Titanium	47.88	1668	3287	4.5	1.54	6.82	3,4	$[Ar]3d^24s^2$
23	V	Vanadium	50.9415	1910	3407	5.96	1.63	6.74	2,3,4,5	$[Ar]3d^34s^2$
24	Cr	Chromium	51.9961	1907	2671	7.20	1.66	6.766	2,3,6	$[Ar]3d^54s^1$
25	Mn	Manganese	54.93805	1246	2061	7.47	1.55	7.435	2,3,4,6,7	$[Ar]3d^54s^2$
26	Fe	Iron	55.847	1538	2861	7.86	1.83	7.870	2,3	$[Ar]3d^64s^2$
27	Co	Cobalt	58.93320	1495	2927	8.92	1.88	7.86	2,3	$[Ar]3d^74s^2$
28	Ni	Nickel	58.6934	1455	2913	8.90	1.91	7.635	2,3	$[Ar]3d^84s^2$
29	Cu	Copper	63.546	1084.62	2562	8.94	1.90	7.726	1,2	$[Ar]3d^{10}4s^1$
30	Zn	Zinc	65.39	419.53	907	7.14 (25°C)	1.65	9.394	2	$[Ar]3d^{10}4s^2$
31	Ga	Gallium	69.723	29.76	2204	6.095	1.81	5.999	3	$[Ar]3d^{10}4s^24p^1$
32	Ge	Germanium	72.61	938.25	2833	5.35	2.01	7.899	4	$[Ar]3d^{10}4s^24p^2$
33	As	Arsenic	74.92159	817*	614*	5.727 (25°C)	2.18	9.81	±3,5	$[Ar]3d^{10}4s^24p^3$
34	Se	Selenium	78.96	221	685	4.81	2.55	9.752	−2,4,6	$[Ar]3d^{10}4s^24p^4$
35	Br	Bromine	79.904	−7.2	58.8	3.119	2.96	11.814	±1,5	$[Ar]3d^{10}4s^24p^5$
36	Kr	Krypton	83.80	−157.36	−153.22	3.74	–	13.999		$[Ar]3d^{10}4s^24p^6$
37	Rb	Rubidium	85.4678	39.31	688	1.532	0.82	4.177	1	$[Kr]5s^1$
38	Sr	Strontium	87.62	777	1382	2.6	0.95	5.695	2	$[Kr]5s^2$
39	Y	Yttrium	88.90585	1526	3336	4.469	1.22	6.38	3	$[Kr]4d^15s^2$
40	Zr	Zirconium	91.224	1855	4409	6.49	1.33	6.84	4	$[Kr]4d^25s^2$
41	Nb	Niobium	92.90638	2477	4744	8.57	1.6	6.9	3,5	$[Kr]4d^45s^1$
42	Mo	Molybdenum	95.94	2623	4639	10.2	2.16	7.099	2,3,4,5,6	$[Kr]4d^55s^1$
43	Tc	Technetium	(97.9072)	2157	4265	11.5	1.9	7.28	7	$[Kr]4d^55s^2$
44	Ru	Ruthenium	101.07	2334	4150	12.3	2.2	7.37	2,3,4,6,8	$[Kr]4d^75s^1$
45	Rh	Rhodium	102.90550	1964	3695	12.4	2.28	7.46	2,3,4	$[Kr]4d^85s^1$
46	Pd	Palladium	106.42	1554.9	2963	12.02	2.20	8.34	2,4	$[Kr]4d^{10}$
47	Ag	Silver	107.8682	961.78	2162	10.5	1.93	7.576	1	$[Kr]4d^{10}5s^1$
48	Cd	Cadmium	112.411	321.07	767	8.642	1.69	8.993	2	$[Kr]4d^{10}5s^2$
49	In	Indium	114.818	156.60	2072	7.30	1.78	5.786	3	$[Kr]4d^{10}5s^25p^1$
50	Sn	Tin	118.710	231.93	2602	7.28	1.96	7.344	2,4	$[Kr]4d^{10}5s^25p^2$
51	Sb	Antimony	121.757	630.63	1587	6.684 (25°C)	2.05	8.641	±3,5	$[Kr]4d^{10}5s^25p^3$
52	Te	Tellurium	127.60	449.51	988	6.25	2.1	9.009	−2,4,6	$[Kr]4d^{10}5s^25p^4$
53	I	Iodine	126.90447	113.7	184.4	4.93	2.66	10.451	±1,5,7	$[Kr]4d^{10}5s^25p^5$
54	Xe	Xenon	131.29	−111.75	−108.04	5.89	–	12.130		$[Kr]4d^{10}5s^25p^6$
55	Cs	Cesium	132.90543	28.44	671	1.879	0.79	3.894	1	$[Xe]6s^1$
56	Ba	Barium	137.327	727	1897	3.594	0.89	5.212	2	$[Xe]6s^2$
57	La	Lanthanum	138.9055	920	3455	6.146	1.10	5.577	3	$[Xe]5d^16s^2$
72	Hf	Hafnium	178.49	2233	4603	13.31	1.3	7.0	4	$[Xe]4f^{14}5d^26s^2$
73	Ta	Tantalum	180.9479	3017	5458	16.6	1.5	7.89	5	$[Xe]4f^{14}5d^36s^2$
74	W	Tungsten	183.84	3422	5555	19.35	2.36	7.98	2,3,4,5,6	$[Xe]4f^{14}5d^46s^2$
75	Re	Rhenium	186.207	3186	5596	20.5	1.9	7.88	−1,2,4,6,7	$[Xe]4f^{14}5d^56s^2$
76	Os	Osmium	190.23	3033	5012	22.61	2.2	8.7	2,3,4,6,8	$[Xe]4f^{14}5d^66s^2$
77	Ir	Iridium	192.22	2446	4428	22.65	2.20	9.1	2,3,4,6	$[Xe]4f^{14}5d^76s^2$
78	Pt	Platinum	195.08	1768.4	3825	21.45	2.28	9.0	2,4	$[Xe]4f^{14}5d^96s^1$
79	Au	Gold	196.96654	1064.18	2856	19.31	2.54	9.225	1,3	$[Xe]4f^{14}5d^{10}6s^1$
80	Hg	Mercury	200.59	−38.83	356.73	13.546	2.00	10.437	1,2	$[Xe]4f^{14}5d^{10}6s^2$
81	Tl	Thallium	204.3833	304	1473	11.85	2.04	6.108	1,3	$[Xe]4f^{14}5d^{10}6s^26p^1$
82	Pb	Lead	207.2	327.46	1749	11.34	2.33	7.416	2,4	$[Xe]4f^{14}5d^{10}6s^26p^2$
83	Bi	Bismuth	208.98037	271.40	1564	9.78	2.02	7.289	3,5	$[Xe]4f^{14}5d^{10}6s^26p^3$
84	Po	Polonium	(208.9824)	254	962	9.196	2.0	8.42	2,4	$[Xe]4f^{14}5d^{10}6s^26p^4$
85	At	Astatine	(209.9871)	302	337	–	2.2	–	±1,3,5,7	$[Xe]4f^{14}5d^{10}6s^26p^5$
86	Rn	Radon	(222.0176)	−71	−61.7	9.73	–	10.748		$[Xe]4f^{14}5d^{10}6s^26p^6$
87	Fr	Francium	(223.0197)	27	677	–	0.7	–	1	$[Rn]7s^1$
88	Ra	Radium	(226.0254)	700	<1140	5.8	0.9	5.279	2	$[Rn]7s^2$
89	Ac	Actinium	(227.0278)	1051	3198	10.07	1.1	6.9	3	$[Rn]6d^17s^2$
104	Unq	Unnilquadium	(261.11)	–	–	–	–	–	4	$[Rn]5f^{14}6d^27s^2$
105	Unp	Unnilpentium	(262.114)	–	–	–	–	–		$[Rn]5f^{14}6d^37s^2$
106	Unh	Unnilhexium	(263.118)	–	–	–	–	–		$[Rn]5f^{14}6d^47s^2$
107	Uns	Unnilseptium	(262.12)	–	–	–	–	–		$[Rn]5f^{14}6d^57s^2$
108	Uno	Unniloctium	(265)	–	–	–	–	–		$[Rn]5f^{14}6d^67s^2$
109	Une	Unnilennium	(266)	–	–	–	–	–		$[Rn]5f^{14}6d^77s^2$
110	Uun	Ununnilium	(272)	–	–	–	–	–		

*indicates approximate values and/or inconsistent literature data.

● Lanthanides

Atomic No.	Symbol	Name	Atomic Weight	Melting Point, °C	Boiling Point, °C	Density	Electronegativity	First Ionization Potential, eV	Oxidation States	Electronic Configuration
58	Ce	Cerium	140.115	799	3424	6.770	1.12	5.466	3,4	$[Xe]4f^15d^16s^2$
59	Pr	Praseodymium	140.90765	931	3510	6.773	1.13	5.422	3,4	$[Xe]4f^36s^2$
60	Nd	Neodymium	144.24	1016	3066	7.00	1.14	5.489	3	$[Xe]4f^46s^2$
61	Pm	Promethium	(144.9127)	1042	3000	7.264	1.13	5.554	3	$[Xe]4f^56s^2$
62	Sm	Samarium	150.36	1072	1790	7.536	1.17	5.631	2,3	$[Xe]4f^66s^2$
63	Eu	Europium	151.965	822	1596	5.244	1.2	5.666	2,3	$[Xe]4f^76s^2$
64	Gd	Gadolinium	157.25	1314	3264	7.901	1.20	6.141	3	$[Xe]4f^75d^16s^2$
65	Tb	Terbium	158.92534	1359	3221	8.230	1.2	5.842	3,4	$[Xe]4f^96s^2$
66	Dy	Dysprosium	162.50	1411	2561	8.551	1.22	5.927	3	$[Xe]4f^{10}6s^2$
67	Ho	Holmium	164.93032	1472	2694	8.80	1.23	6.018	3	$[Xe]4f^{11}6s^2$
68	Er	Erbium	167.26	1529	2862	9.066	1.24	6.101	3	$[Xe]4f^{12}6s^2$
69	Tm	Thulium	168.93421	1545	1946	9.321	1.25	6.18436	2,3	$[Xe]4f^{13}6s^2$
70	Yb	Ytterbium	173.04	824	1194	6.966	1.1	6.25394	2,3	$[Xe]4f^{14}6s^2$
71	Lu	Lutetium	174.967	1663	3393	9.84	1.27	5.42589	3	$[Xe]4f^{14}5d^16s^2$

●● Actinides

Atomic No.	Symbol	Name	Atomic Weight	Melting Point, °C	Boiling Point, °C	Density	Electronegativity	First Ionization Potential, eV	Oxidation States	Electronic Configuration
90	Th	Thorium	232.0381	1750	4788	11.72	1.3	6.08	4	$[Rn]6d^27s^2$
91	Pa	Protactinium	231.03588	1572	–	15.37	1.5	5.89	4,5	$[Rn]5f^26d^17s^2$
92	U	Uranium	238.0289	1135	4131	19.05±0.02	1.38	6.05	3,4,5,6	$[Rn]5f^36d^17s^2$
93	Np	Neptunium	(237.0482)	644	–	20.45	1.36	6.19	3,4,5,6	$[Rn]5f^46d^17s^2$
94	Pu	Plutonium	(244.0642)	640	3228	19.816	1.28	5.8	3,4,5,6	$[Rn]5f^67s^2$
95	Am	Americium	(243.0614)	1176	2607	13.67	1.3	5.993	3,4,5,6	$[Rn]5f^77s^2$
96	Cm	Curium	(247.0703)	1345	–	13.51	1.3	6.02	3	$[Rn]5f^76d^17s^2$
97	Bk	Berkelium	(247.0703)	1050	–	14.78	1.3	6.23	3,4	$[Rn]5f^97s^2$
98	Cf	Californium	(251.0796)	900	–	–	1.3	6.30	3	$[Rn]5f^{10}7s^2$
99	Es	Einsteinium	(252.083)	860	–	–	1.3	6.42	3	$[Rn]5f^{11}7s^2$
100	Fm	Fermium	(257.0951)	1527	–	–	1.3	6.50	3	$[Rn]5f^{12}7s^2$
101	Md	Mendelevium	(258.10)	827	–	–	1.3	6.58	2,3	$[Rn]5f^{13}7s^2$
102	No	Nobelium	(259.1009)	827	–	–	1.3	6.65	2,3	$[Rn]5f^{14}7s^2$
103	Lr	Lawrencium	(262.11)	1627	–	–	–	–	3	$[Rn]5f^{14}6d^17s^2$

Key

7 VIIA VIIB — Group Classifications[6]

54.93805 — Atomic Weight[1] () indicates most stable or best known isotope
25 — Atomic Number[2]
1246 — Melting Point[7], °C
2,3,4,6,7 — Oxidation States[3] bold indicates most stable state
2061 — Boiling Point[7], °C
7.47 — Density[8], g/cm³ (gases: g/L at 0°C, 1 atm)
Mn — Symbol[4] black = solid, red = gas, blue = liquid, outline = synthetically prepared
1.55 — Electronegativity[9]
7.435 — First Ionization Potential[10], eV
$[Ar]3d^54s^2$ — Electronic Configuration[5]
Manganese — Name[4]

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 coding scheme to categorize periodic properties. Because of the potential for confusion between these two systems (i.e., VIIA in one scheme is equal to VIIB 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; SP = 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.
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Signature_____ Pg 1 _____(20)

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

2. (8 pts each) For the following two molecular formulas, 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.

A) $(CH_3)_3CCH_2OCH_2CH_2NH_2$

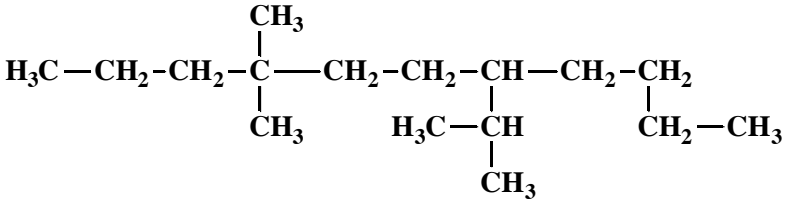
How many different stereoisomers are there for the above molecule? _____

B) $H_3NCHOHCO_2H$

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

3. Provide an acceptable IUPAC name for the following three molecules. **Do not designate R or S for these but you need to indicate *cis* or *trans* if appropriate.**

A) (6 pts)



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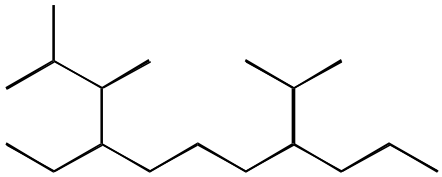
Although stereochemistry is not indicated on the above structure, how many stereoisomers are possible? _____

B) (6 pts)



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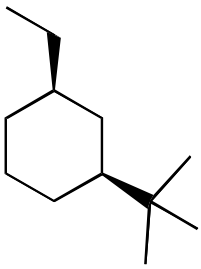
Although stereochemistry is not indicated on the above structure, how many stereoisomers are possible? _____

C) (10 pts)

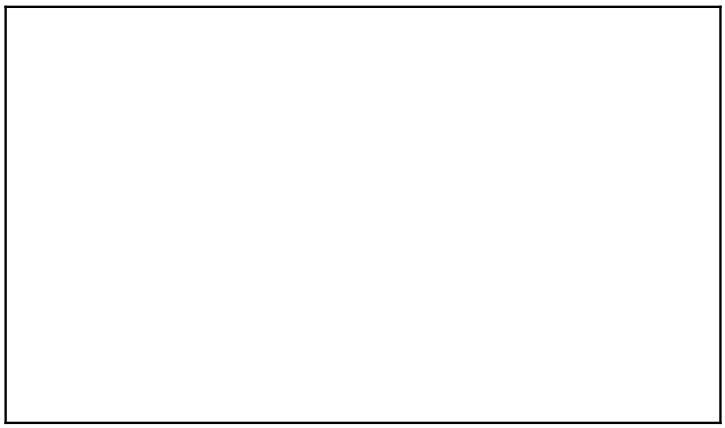


_____

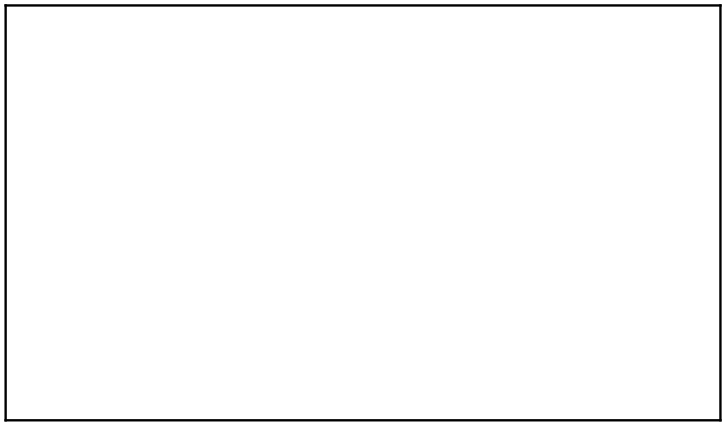
Is the molecule chiral? _____ **If you answered yes, then in the box provided, draw the enantiomer of the above structure.**

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).

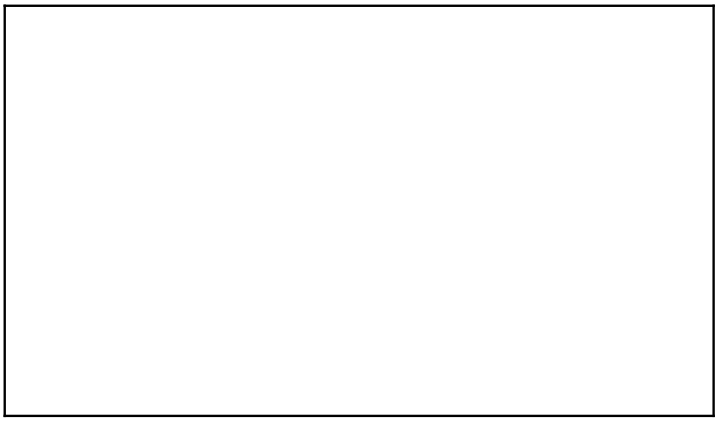
A) 4-*tert*-Butyl-5-ethyl-2-methylheptane



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

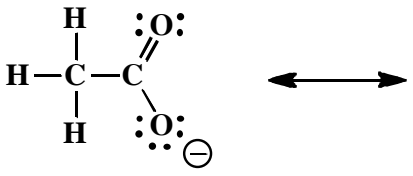


C) *(R)*-5-Isobutyl-2-methylnonane (Use wedges and dashes to indicate the appropriate stereochemistry at all chiral centers)



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.



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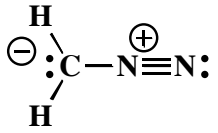
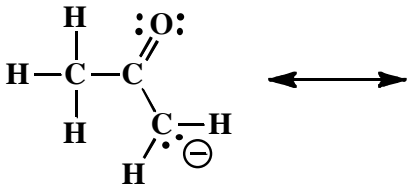
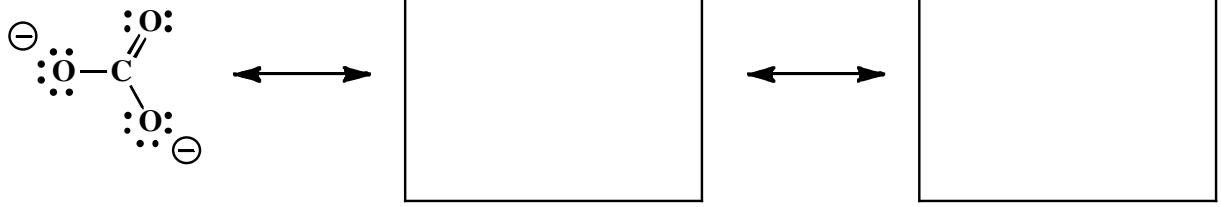


C.



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.



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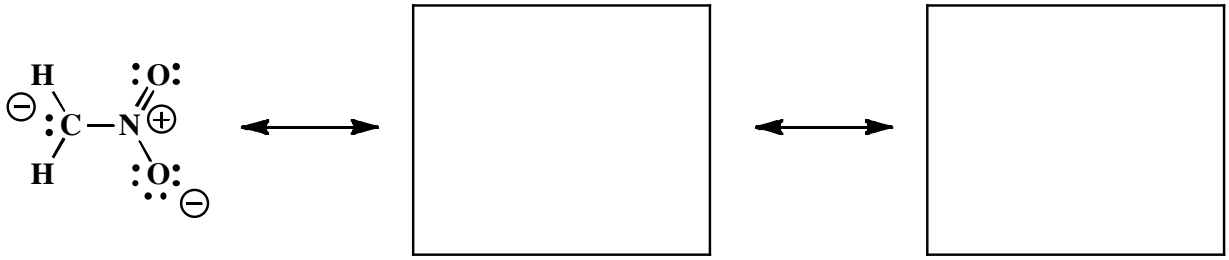
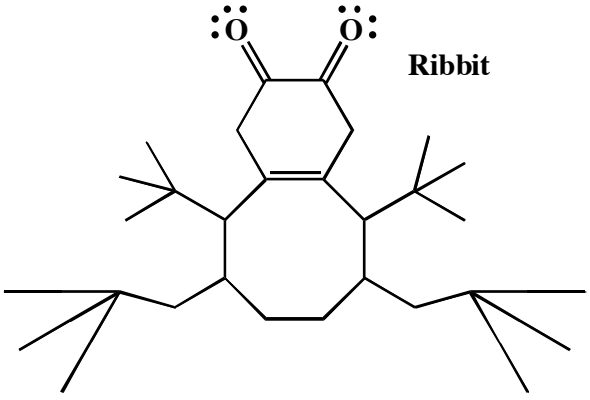




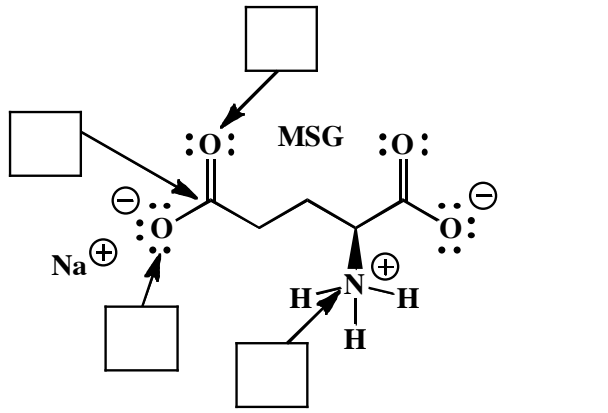
8. (2 pts each) Fill in each blank with the word or words that best completes the sentences.

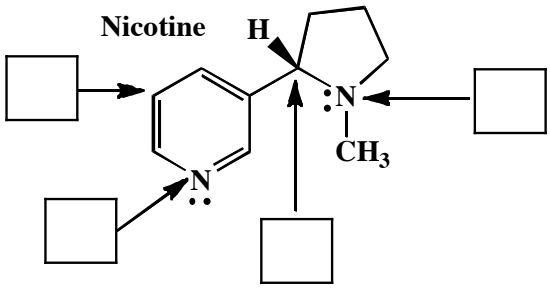
For organic chemistry, it is best to think of _____ as waves.

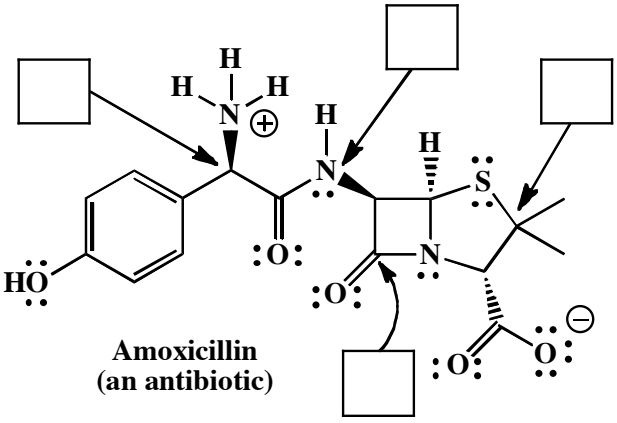
According to the valence bond approach, the atomic orbitals on each atom are combined first to create _____ orbitals, that overlap to create _____ bonds.

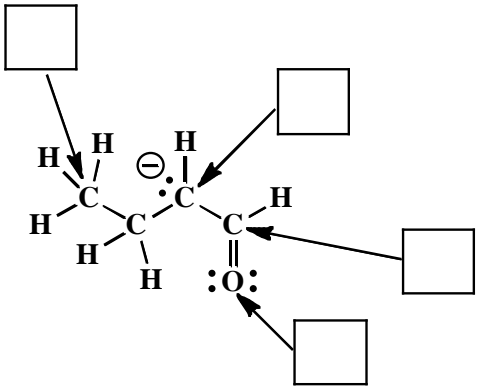
Three (or more) atom "pi-ways" are the situation resonance _____ structures are usually trying to describe. For pi bonding and therefore pi delocalization to occur over more than two atoms (i.e. pi-ways), parallel and overlapping _____ orbitals are needed on ALL of the adjacent atoms involved. As a result,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

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



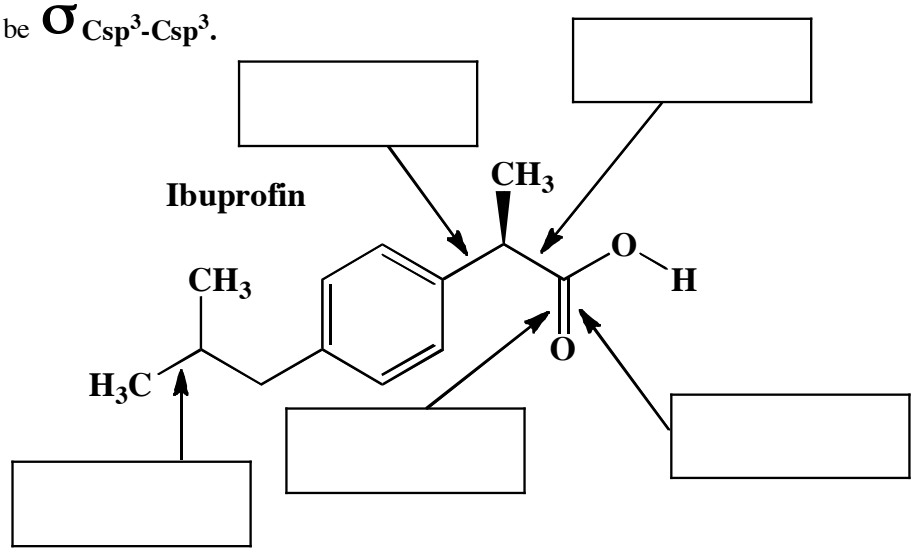




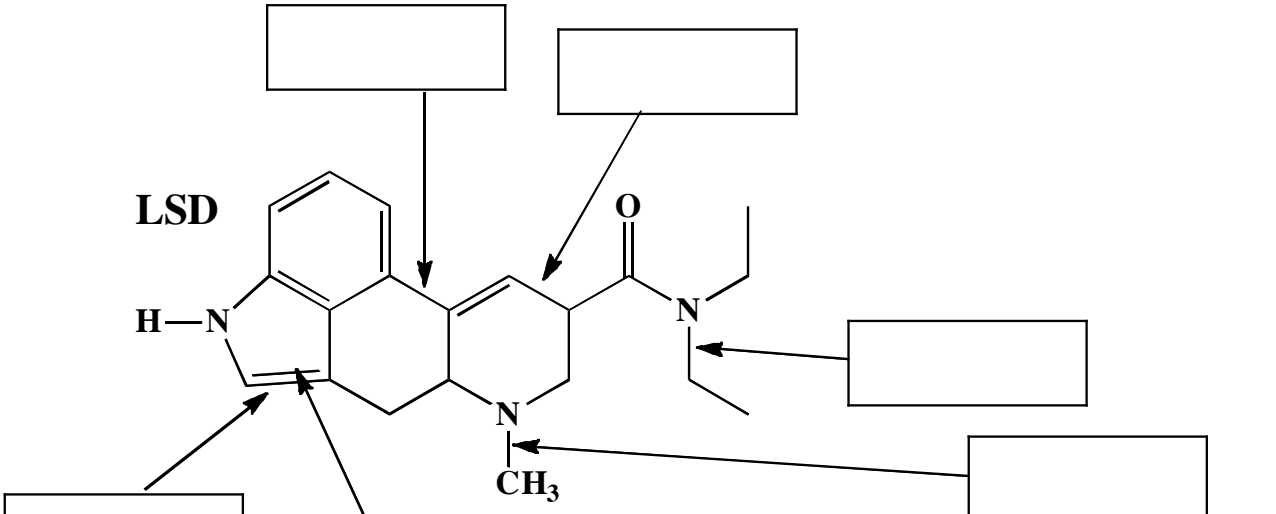


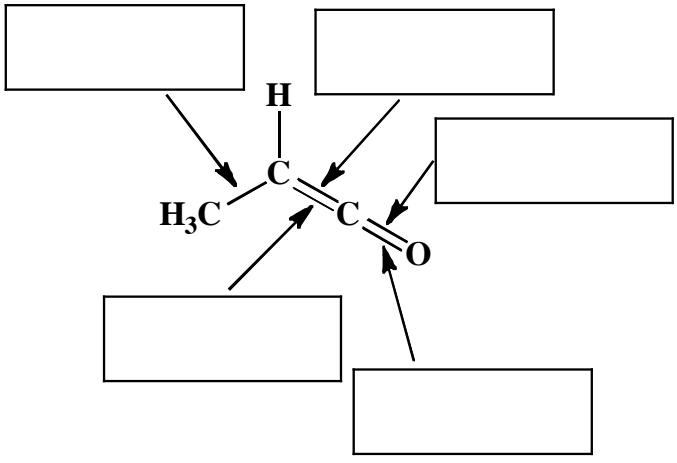
10. (2 pts each) Describe each bond indicated with an arrow as the overlap of orbitals. For example, an answer might be $\sigma_{Csp^3\text{-}Csp^3}$.

Ibuprofin

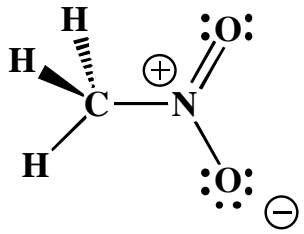


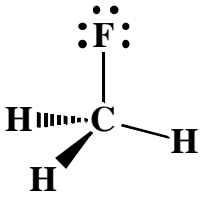
LSD

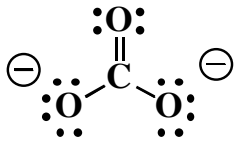




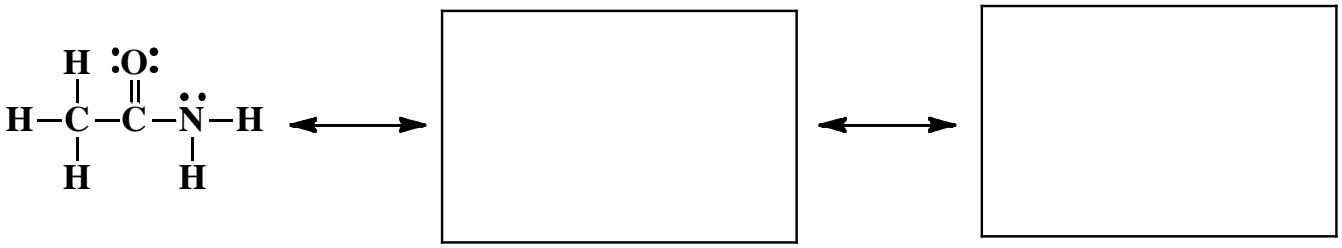
11. (2 pts each) For the following molecules, use the dipole moment symbol ⟶ to show the direction of the molecular dipole moment in all molecules that have an overall molecular dipole. Note for this one you do NOT need to draw the individual bond dipole moments, just the overall molecular dipole moment,



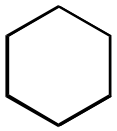
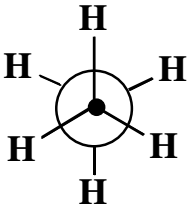
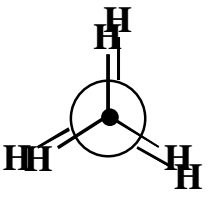
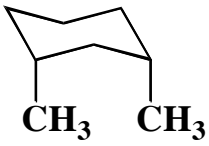
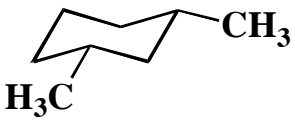
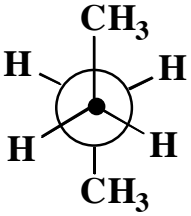
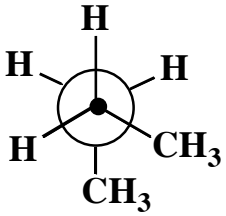
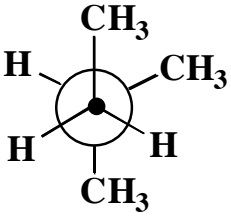
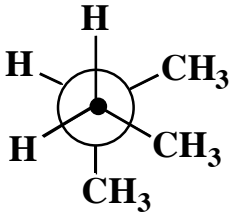




12. (10 pts) The following molecule is best represented as the hybrid of three contributing structures. **Draw the second and third important contributing structures** in the spaces provided, including all lone pairs and formal charges. **For the two structures on the left use arrows to indicate the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

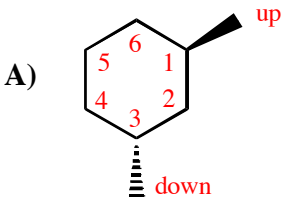


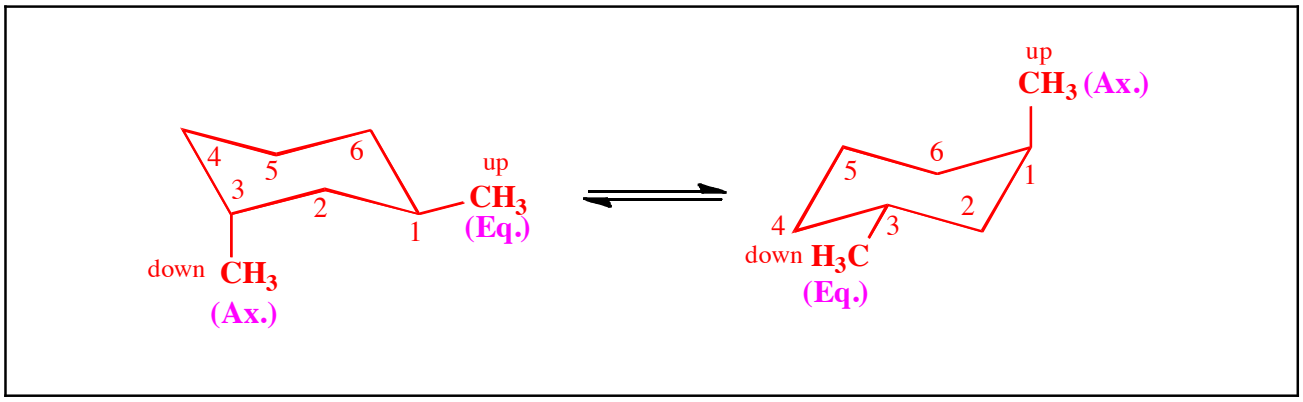
13. (4 pts each) For each pair of molecules, circle the one that has LESS STRAIN, then put an "X" in the box under all the types of strain that explain(s) your answer:

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

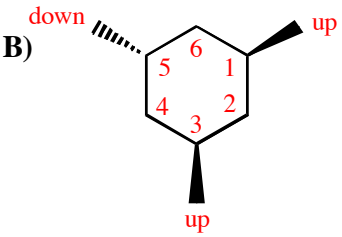
14. (7 pts each) For the following cyclohexane derivatives, **draw the substituent groups on the two alternative chair conformations to indicate axial vs. equatorial positions**. Be as careful as you can to clearly distinguish axial from equatorial in your drawing. If there is a difference in stability, **draw a circle around the more stable conformation.** If there is not any difference in stability, do not circle either chair for

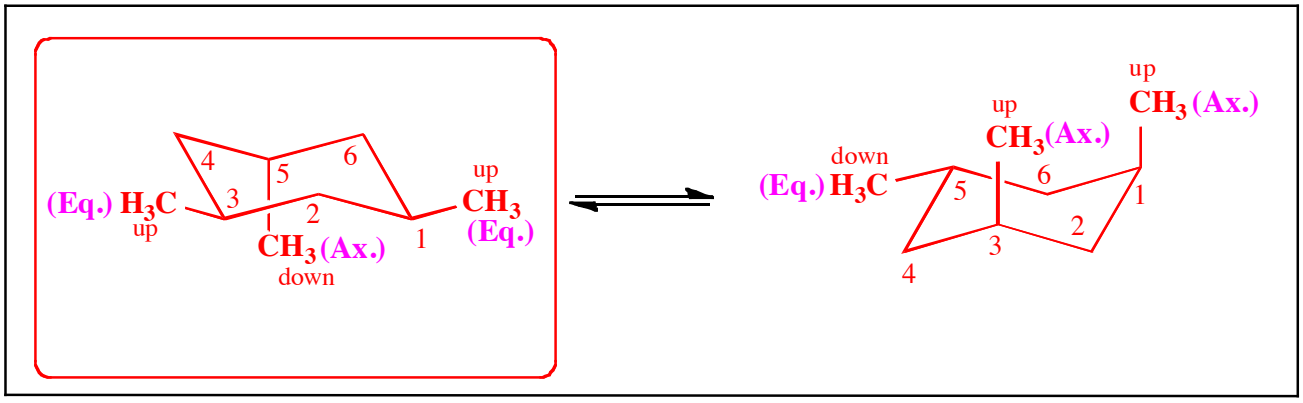
A)



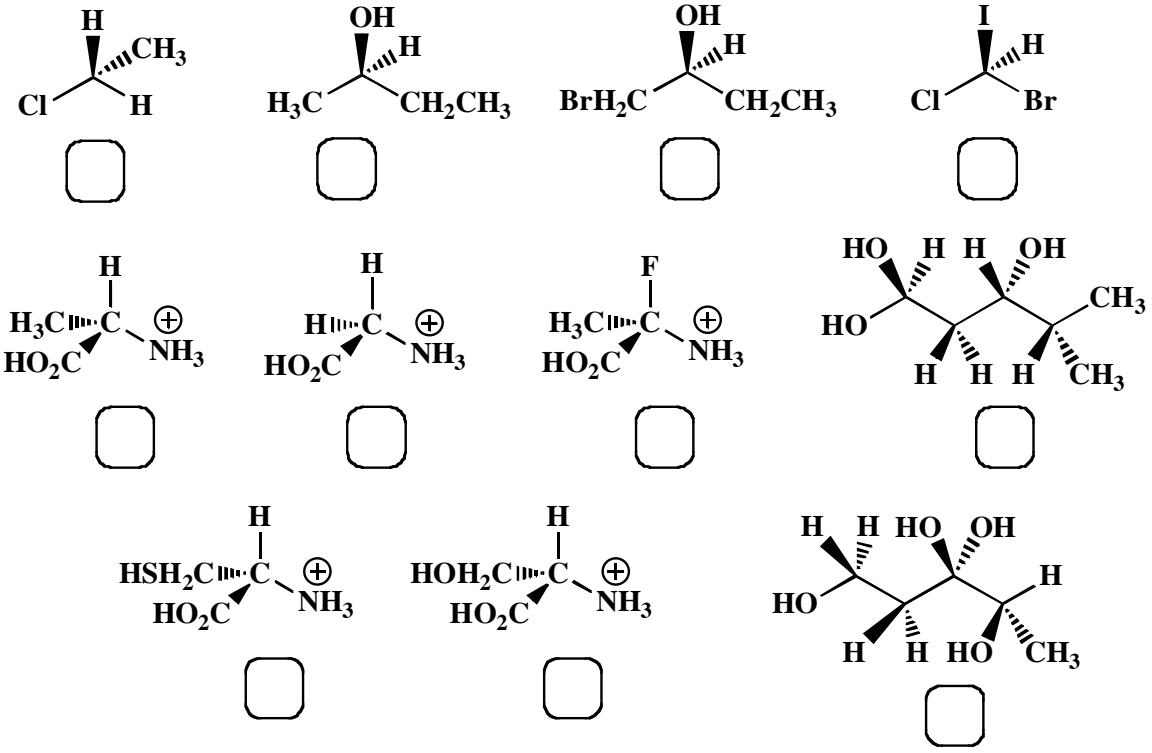


B)

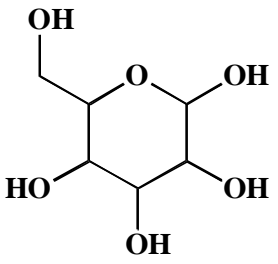




15. (2 pts each) Examine the following structures. For each molecule with a chiral center, assign the stereochemistry then write "R" or "S" as appropriate in the box provided below each structure. For all molecules that have no chiral centers, leave the box blank.

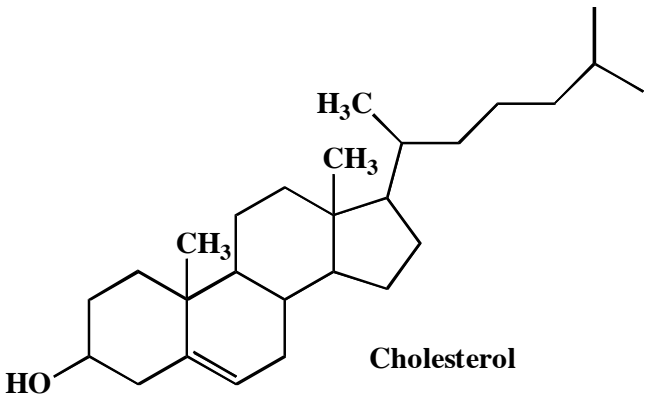


16. (17 pts) Most students find it difficult to identify chiral centers in ringed structures so take your time on this one. For the following important biological molecules, we have not indicated stereochemistry. We want you to identify all the chiral centers. **Put an asterisk next to all chiral centers you find then answer the questions below.**



D-Glucose

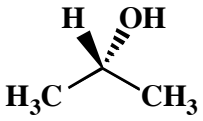
How many stereoisomers are possible for this structure? _____

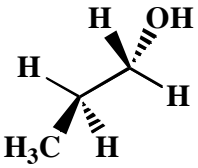


Cholesterol

How many stereoisomers are possible for this structure? _____

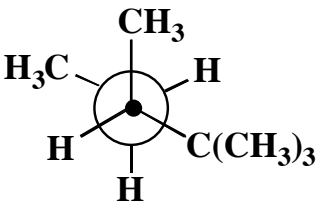
17. (4 pts each) For each pair of molecules, on the line provided state the relationship between the two structures. Possible answers could be **enantiomers**, **consitutional isomers**, or **same molecule.**

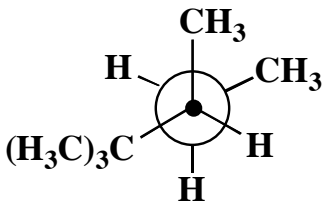




Relationship:

_____





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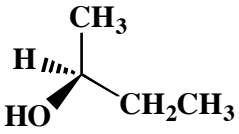

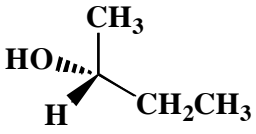

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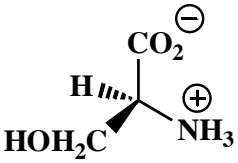

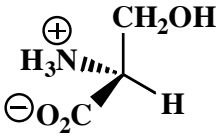

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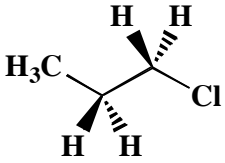

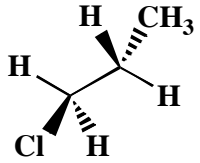

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18. (16 points total) Here is an "apply what you know" problem in the format of an MCAT style passage. Circle the correct answers.

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!!!