CH 334 Form A

Second Midterm Exam Monday, November 6, 2017

Name_____

You may use model kits but no other material with chemical information without instructor approval. Tables of possibly useful data are included on the last page.

Please do not use any electronic gadgets (calculators, music players, phones, etc.).

IUPAC Periodic Table of the Elements

1																	18
1 H hydrogen 1.008 [1.0078, 1.0082]	2		Key: atomic number Symbol name conventional atomic weight standard atomic weight									13	14	15	16	17	2 He helium 4.0026
3 Li lithium 6.94 [6.938, 6.997]	4 Be beryllium 9.0122											5 B boron 10.81 [10.806, 10.821]	6 C carbon 12.011 [12.009, 12.012]	7 N nitrogen 14.007 [14.006, 14.008]	8 O oxygen 15.999 [15.999, 16.000]	9 F fluorine 18.998	10 Ne neon 20.180
11 Na sodium 22.990	12 Mg magnesium 24.305 [24.304, 24.307]	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 26.982	14 Si silicon 28.085 [28.084, 28.086]	15 P phosphorus 30.974	16 S sulfur 32.06 [32.059, 32.076]	17 Cl chlorine 35.45 [35.446, 35.457]	18 Ar argon 39.948
19 K potassium 39.098	20 Ca calcium 40.078(4)	21 Sc scandium 44.956	22 Ti titanium 47.867	23 V vanadium 50.942	24 Cr chromium 51.996	25 Mn manganese 54.938	26 Fe iron 55.845(2)	27 Co cobalt 58.933	28 Ni nickel 58.693	29 Cu copper 63.546(3)	30 Zn zinc 65.38(2)	31 Ga gallium 69.723	32 Ge germanium 72.630(8)	33 As arsenic 74.922	34 Se selenium 78.971(8)	35 Br bromine 79.904 [79.901, 79.907]	36 Kr krypton 83.798(2)
37 Rb rubidium 85.468	38 Sr strontium 87.62	39 Y yttrium 88.906	40 Zr zirconium 91.224(2)	41 Nb niobium 92.906	42 Mo molybdenum 95.95	43 Tc technetium	44 Ru ruthenium 101.07(2)	45 Rh rhodium 102.91	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60(3)	53 I iodine 126.90	54 Xe xenon 131.29
55 Cs caesium 132.91	56 Ba barium 137.33	57-71 lanthanoids	72 Hf hafnium 178.49(2)	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23(3)	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38 [204.38, 204.39]	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganesson

57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium	62 Sm samarium 150.36(2)	63 Eu europium 151.96	64 Gd gadolinium 157.25(3)	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.97
89 Ac actinium	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

For notes and updates to this table, see www.iupac.org. This version is dated 28 November 2016.

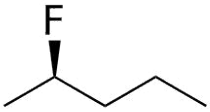
1. (15 points) Draw correct structures for the following compounds.

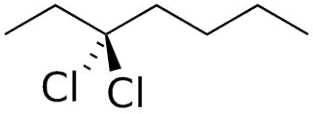
a. *trans*-1,3-dichlorocyclopentane

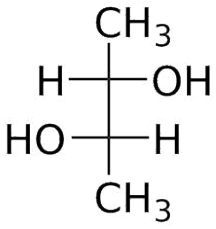
b. *cis*-4-methyl-*iso*-propylcyclohexane

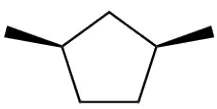
c. S-3-bromooctane

2. (20 points) Identify each molecule shown below as chiral (C) or achiral (A). Circle every stereocenter and assign the configuration as R or S.

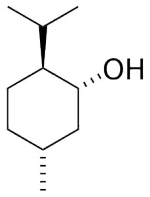








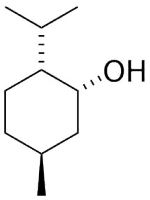
3. (20 points) Menthol, the major flavoring component in peppermint, has the following structure (right). The specific rotation, $[\alpha]_D = -50.2°$.



(-)-menthol

A. The enantiomer of (-)-menthol (we call it (+)-menthol) can be prepared synthetically. State what specific rotation it should show, and explain your reasoning.

B. The synthesis of this enantiomer also results in a third compound, (-)neomenthol, with the structure at the right. The amount produced varies with reaction conditions but is typically 2-15%. Its specific rotation, $[\alpha]_D = -20.8°$.



(-)-neomenthol

Predict the approximate specific rotation that would be observed for the synthetic mixture of (+)-menthol and (-)-neomenthol. Explain your reasoning. (A quantitative calculation is not necessary.)

C. Which of the following mixtures could be separated by recrystallization (relying on different solubilities)?

-A 1:1 mixture of (+)-menthol and (-)-menthol
-A 1:1 mixture of (+)-menthol and (-)-neomenthol

Explain your choice(s) based on the nature of the stereochemical relationship between each pair of isomers.

4. (25 points) This question deals with *cis*-1,3-dimethylcyclohexane.

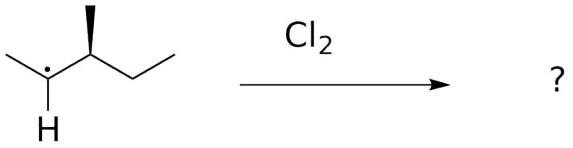
A. Draw the two ring-flip isomers of the chair conformation of cis-1,3-dimethylcyclohexane.

B. Which of these is more stable, and by how much? Explain your reasoning.

C. How would placing an oxygen at atom 5 in the ring (in place of CH_2) change the equilibrium between the two ring flip isomers? Explain (Hint: consider why one ring flip isomer is disfavored).

5. (20 points) Draw each product expected from monochlorination of 3-methylpentane using Cl_2 and hν. Include all distinct stereoisomers.

If the following free radical intermediate could be generated selectively (a challenging task!), would its reaction with Cl_2 generate a racemic or a nonracemic mixture of products? Explain.



Bond strengths (kcal/mol):

F-F	38
Cl-Cl	58
Br-Br	46
I-I	36
H-F	136
H-Cl	103
H-Br	87
H-I	71
CH_3-H	105
CH_3CH_2-H	101
$(CH_3)_2CH$-H	98.5
$(CH_3)_3C$-H	96.5
CH_3-F	110
CH_3-Cl	85
CH_3-Br	70
CH_3-I	57
CH_3CH_2-F	111
CH_3CH_2-Cl	84
CH_3CH_2-Br	70
CH_3CH_2-I	56
$(CH_3)_2CH$-F	111
$(CH_3)_2CH$-Cl	84
$(CH_3)_2CH$-Br	71
$(CH_3)_2CH$-I	56
$(CH_3)_3C$-F	110
$(CH_3)_3C$-Cl	85
$(CH_3)_3C$-Br	71
$(CH_3)_3C$-I	55

A values (kcal/mol)

Substituent	A
Me	1.8
Et	1.8
^{i}Pr	2.1
^{t}Bu	4.5
O-Me	0.75
Cl	0.52
Br	0.55
I	0.46
Methyl-Methyl 1,3 interaction	3.7