Second	Midterm	Fxam

Thursday, February 27, 2014

Name

You may use model kits but no other material with chemical information without instructor approval.

Please do not use ipods or other music players.

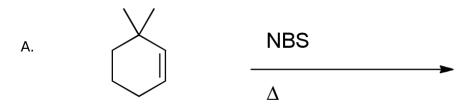
hydrogen 1	1999																2002 10	helium 2 He
1.0079 lithium	beryllium											i	boron	carbon	nitrogen	oxygen	fluorine	4.0026 neon
3	4												5	6	7	8	9	10
Li	Be												В	C	N	0	F	Ne
6.941	9.0122												10.811	12.011	14.007	15.999	18.998	20.180
sodium 11	magnesium 12												aluminium 13	silicon 14	phosphorus 15	sulfur 16	chlorine 17	argon 18
Na	Mg												ΑI	Si	P	S	CI	Ar
22.990	24.305												26.982	28.086	30.974	32.065	35.453	39.948
potassium 19	calcium 20		scandium 21	titanium 22	vanadium 23	chromium 24	manganese 25	iron 26	cobalt 27	nickel 28	copper 29	zinc 30	gallium 31	germanium 32	arsenic 33	selenium 34	bromine 35	krypton 36
K	Ca		Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
39.098	40.078		44.956	47.867	50.942	51.996	54.938	55.845	58.933	58.693	63,546	65.39	69.723	72.61	74.922	78.96	79.904	83.80
39.098 rubidium	40.078 strontium		44.956 yttrium	47.867 zirconium	50.942 niobium	51.996 molybdenum	54.938 technetium	55,845 ruthenium	58.933 rhodium	58,693 palladium	63,546 silver	65,39 cadmium	69.723 indium	72.61 tin	74.922 antimony	78.96 tellurium	79,904 lodine	83.80 xenon
39.098 rubidium 37	40.078 strontium 38		44.956 yttrium 39	47,867 zirconium 40	50.942 niobium 41	51.996 molybdenum 42	54.938 technetium 43	55.845 ruthenium 44	58.933 rhodium 45	58.693 palladium 46	63,546	65.39 cadmium 48	69.723 Indium 49	72.61 tin 50	74.922 antimony 51	78.96 tellurium 52	79.904	83.80 xenon 54
39.098 rubidium 37	40.078 strontium 38		44.956 yttrium	47,867 zirconium 40	50.942 niobium 41	51.996 molybdenum 42	54.938 technetium 43	55.845 ruthenium 44	58.933 rhodium 45	58.693 palladium 46	63,546 silver 47	65.39 cadmium 48	69.723 Indium 49	72.61 tin 50	74.922 antimony 51	78.96 tellurium 52	79,904 lodine	83.80 xenon 54
39,098 rubidium 37 Rb	40.078 strontium		44.956 yttrium 39	47.867 zirconium	50.942 niobium	51.996 molybdenum	54.938 technetium	55,845 ruthenium	58.933 rhodium	58,693 palladium	63,546 silver	65,39 cadmium	69.723 indium	72.61 tin	74.922 antimony	78.96 tellurium	79,904 lodine	83.80 xenon
39.098 rubidium 37 Rb 85.468 caesium	strontium 38 Sr 87.62 barium	22723	44.956 yttrium 39 Y 88.906 lutetium	47.867 zirconium 40 Zr 91.224 hafnium	50.942 niobium 41 Nb 92.906 tantalum	51,996 molybdenum 42 Mo 95,94 tungsten	54.938 technetium 43 TC [98] rhenium	ruthenium 44 Ru 101.07 osmium	58.933 rhodium 45 Rh 102.91 iridium	palladium 46 Pd 106.42 platinum	63,546 silver 47 Ag 107,87 gold	cadmium 48 Cd 112.41 mercury	69.723 Indium 49 In 114.82 thallium	72.61 tin 50 Sn 118.71 lead	74.922 antimony 51 Sb 121.76 bismuth	78.96 tellurium 52 Te 127.60 polonium	79.904 lodine 53 126.90 astatine	83.80 xenon 54 Xe 131.29 radon
39,098 rubidium 37 Rb 85,468 caesium 55	40.078 strontium 38 Sr 87.62 barium 56	57-70	44.956 yttrium 39 Y 88.906	47.867 zirconium 40 Zr 91.224 hafnium 72	50.942 niobium 41 Nb 92.906 tantalum 73	51,996 molybdenum 42 Mo 95,94 tungsten 74	54.938 technetium 43 TC [98] thenium 75	55.845 ruthenium 44 Ru 101.07	58,933 rhodium 45 Rh 102,91	58.693 palladium 46 Pd 106.42 platinum 78	63,546 silver 47 Ag 107.87	65,39 cadmium 48 Cd 112,41 mercury 80	69.723 indium 49 In 114.82 thallium 81	72.61 tin 50 Sn 118.71 lead 82	74.922 antimony 51 Sb 121.76 bismuth 83	78.96 tellurium 52 Te 127.60 polonium 84	79.904 lodine 53 126.90 astatine 85	83.80 xenon 54 Xe 131.29 radon 86
39,098 rubidium 37 Rb 85,468 caesium 55 Cs	40.078 strontium 38 Sr 87.62 barlum 56 Ba	57-70 X	44.956 yttrium 39 Y 88.906 lutetium 71 Lu	47.867 zirconium 40 Zr 91.224 hafnium 72 Hf	50.942 nioblum 41 Nb 92.906 tantalum 73 Ta	51.996 molybdenum 42 Mo 95.94 tungsten 74	54.938 technetium 43 TC [98] rhenium 75 Re	ruthenium 44 Ru 101.07 osmium 76 Os	58,933 rhodium 45 Rh 102,91 iridium 77 Ir	palladium 46 Pd 106.42 platinum 78 Pt	63.546 silver 47 Ag 107.87 gold 79 Au	cadmium 48 Cd 112.41 mercury 80 Hg	69,723 Indium 49 In 114,82 thallium 81	72.61 tin 50 Sn 118.71 lead 82 Pb	74.922 antimony 51 Sb 121.76 bismuth 83 Bi	78.96 tellurium 52 Te 127.60 polonium 84 Po	79,904 lodine 53	83.80 xenon 54 Xe 131.29 radon 86 Rn
39,098 rubidium 37 Rb 85,468 caesium 55 Cs 132,91	40.078 strontium 38 Sr 87.62 barium 56 Ba 137.33		44.956 yttrium 39 Y 88.906 lutetium 71 Lu 174.97	47.867 zirconium 40 Zr 91.224 hafnium 72 Hf 178.49	50.942 niobium 41 Nb 92.906 tantalum 73 Ta 180.95	51,996 molybdenum 42 Mo 95,94 tungsten 74 W	54.938 technetium 43 TC [98] thenium 75 Re 186.21	55,845 ruthenium 44 Ru 101.07 osmium 76 Os 190.23	58,933 rhodium 45 Rh 102,91 iridium 77 Ir 192,22	58,693 palladium 46 Pd 106.42 platinum 78 Pt 195.08	63,546 silver 47 Ag 107,87 gold 79 Au 196,97	65,39 cadmium 48 Cd 112,41 mercury 80 Hg 200,59	69.723 indium 49 In 114.82 thallium 81	72.61 tin 50 Sn 118.71 lead 82 Pb 207.2	74.922 antimony 51 Sb 121.76 bismuth 83	78.96 tellurium 52 Te 127.60 polonium 84	79.904 lodine 53 126.90 astatine 85	83.80 xenon 54 Xe 131.29 radon 86
39.098 rubidium 37 Rb 85.468 caesium 55 Cs 132.91 francium	40.078 strontium 38 Sr 87.62 barlum 56 Ba 137.33 radium	*	44,956 yttrium 39 Y 88,906 lutetium 71 Lu 174,97 lawrencium	47.867 zirconium 40 Zr 91.224 hafnium 72 Hf 178.49 rutherfordium	50.942 niobium 41 Nb 92.906 tantalum 73 Ta 180.95 dubnium	51,996 molybdenum 42 Mo 95,94 tungsten 74 W 183,84 seaborgium	54,938 technetium 43 TC [98] thenium 75 Re 186,21 bohrium	55,845 ruthenium 44 Ru 101.07 osmium 76 Os 190.23 hassium	58,933 rhodium 45 Rh 102.91 iridium 77 Ir 192.22 meitnenium	58,693 palladium 46 Pd 106.42 platinum 78 Pt 195.08 ununnilium	63,546 silver 47 Ag 107.87 gold 79 Au 196.97 unununium	cadmium 48 Cd 112.41 mercury 80 Hg 200.59 ununbium	69,723 Indium 49 In 114,82 thallium 81	72.61 tin 50 Sn 118.71 lead 82 Pb 207.2 ununquadium	74.922 antimony 51 Sb 121.76 bismuth 83 Bi	78.96 tellurium 52 Te 127.60 polonium 84 Po	79,904 lodine 53	83.80 xenon 54 Xe 131.29 radon 86 Rn
39,098 rubidium 37 Rb 85,468 caesium 55 Cs 132,91 francium 87	40.078 strontium 38 Sr 87.62 barlum 56 Ba 137.33 radium 88	89-102	44,956 yttrium 39 Y 88,906 lutetium 71 Lu 174,97 lawrencium 103	47.867 zirconium 40 Zr 91.224 hafnium 72 Hf 178.49 rutherfordium 104	50.942 niobium 41 Nb 92.906 tantalum 73 Ta 180.95 dubnium 105	51.996 molybdenum 42 Mo 95.94 tungsten 74 W 183.84 seaborgium 106	54,938 technetium 43 TC [98] thenium 75 Re 186.21 bohrium 107	55,845 ruthenium 44 Ru 101,07 osmium 76 OS 190,23 hassium 108	58,933 rhodium 45 Rh 102.91 iridium 77 Ir 192.22 meitnerium 109	58,693 palladium 46 Pd 106.42 platinum 78 Pt 195.08 ununnilium 110	63,546 silver 47 Ag 107.87 gold 79 Au 196.97 unununium 111	65.39 cadmium 48 Cd 112.41 mercury 80 Hg 200.59 ununbium 112	69,723 Indium 49 In 114,82 thallium 81	72.61 tin 50 Sn 118.71 lead 82 Pb 207.2 ununquadium 114	74.922 antimony 51 Sb 121.76 bismuth 83 Bi	78.96 tellurium 52 Te 127.60 polonium 84 Po	79,904 lodine 53	83.80 xenon 54 Xe 131.29 radon 86 Rn
39.098 rubidium 37 Rb 85.468 caesium 55 Cs 132.91 francium	40.078 strontium 38 Sr 87.62 barlum 56 Ba 137.33 radium	*	44,956 yttrium 39 Y 88,906 lutetium 71 Lu 174,97 lawrencium	47.867 zirconium 40 Zr 91.224 hafnium 72 Hf 178.49 rutherfordium	50.942 niobium 41 Nb 92.906 tantalum 73 Ta 180.95 dubnium	51,996 molybdenum 42 Mo 95,94 tungsten 74 W 183,84 seaborgium	54,938 technetium 43 TC [98] thenium 75 Re 186,21 bohrium	55,845 ruthenium 44 Ru 101.07 osmium 76 Os 190.23 hassium	58,933 rhodium 45 Rh 102.91 iridium 77 Ir 192.22 meitnenium	58,693 palladium 46 Pd 106.42 platinum 78 Pt 195.08 ununnilium 110	63,546 silver 47 Ag 107.87 gold 79 Au 196.97 unununium	65.39 cadmium 48 Cd 112.41 mercury 80 Hg 200.59 ununbium 112	69,723 Indium 49 In 114,82 thallium 81	72.61 tin 50 Sn 118.71 lead 82 Pb 207.2 ununquadium	74.922 antimony 51 Sb 121.76 bismuth 83 Bi	78.96 tellurium 52 Te 127.60 polonium 84 Po	79,904 lodine 53	83.80 xenon 54 Xe 131.29 radon 86 Rn

*	La	nt	ha	ın	id	е	se	ri	е	S

^{* *} Actinide series

s	lanthanum 57	cerium 58	praseodymium 59	neodymium 60	promethium 61	samarium 62	europium 63	gadolinium 64	terbium 65	dysprosium 66	holmium 67	erbium 68	thulium 69	ytterbium 70
0	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Но	Er	Tm	Yb
	138.91	140.12	140.91	144.24	[145]	150.36	151.96	157.25	158.93	162.50	164.93	167.26	168.93	173.04
	actinium	thorium	protactinium	uranium	neptunium	plutonium	americium	curium	berkelium	californium	einsteinium	fermium 400	mendelevium 4.04	nobelium
	89	90	91	92	93	94	95	96	97	98	99	100	101	102
	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No
	[227]	232.04	231.04	238.03	[237]	[244]	[243]	[247]	[247]	[251]	[252]	[257]	[258]	[259]

1. (30 points) Write the expected product(s) for each of the following reactions. Specify stereochemistry where appropriate, and include all expected products.



C.
$$H_3$$
CO CO_2CH_3

2. (25 points) Write (over the arrow) the reagents and/or conditions needed to accomplish the following transformations.

A. CO₂CH₃

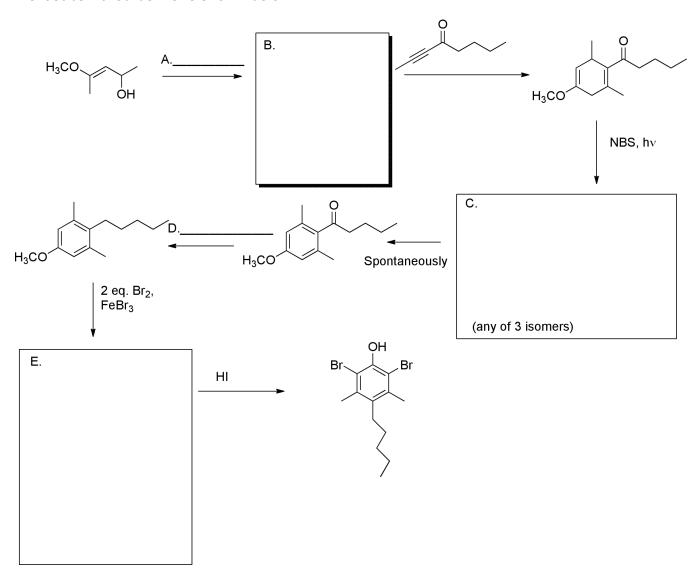
C. NO₂

E. $\begin{array}{c} \text{CI} \\ \text{NO}_2 \end{array}$

3. (20 points) Write multistep mechanisms (using the correct electron-pushing formalism, and as many steps as needed) for each of the following transformations. Be sure to draw resonance structures for any intermediate so stabilized.

A.
$$H_2O$$
, Δ H_2O Both racemic

 $4. \ (15 \ points)$ Fill in the reagents or the boxed structures for A-E in the synthesis of the hexasubstituted benzene shown below.



- 5. (10 points) As we know, nitration of anisole is directed to the ortho and para sites. The usual conditions (HNO_3/H_2SO_4) gives a 31:2:67 mixture of ortho:meta:para nitroanisole.
- A. Using the very reactive salt $NO_2^+BF4^-$ by itself in a polar solvent gives a 72:0:27 ortho:meta:para mixture at the same temperature. Explain why. (Hint: look at the intermediate(s) formed; think about reversibility in different parts of the mechanism.)

B. The nitrogen-containing 5-member ring N-methylpyrrole (shown) can be selectively nitrated with $NO_2^+BF_4^-$ to give predominantly one of two possible products. Which one would you expect to predominate and why?

N-methylpyrrole

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 ₃ CH ₂ -H	101
(CH ₃) ₂ CH-H	98.5
$(CH_3)_3C-H$	96.5
CH₃-F	110
CH₃-Cl	85
CH₃-Br	70
CH₃-I	57
CH₃CH₂-F	111
CH₃CH₂-Cl	84
CH₃CH₂-Br	70
CH₃CH₂-I	56
(CH3)2CH-F	111
(CH₃)₂CH-Cl	84
(CH₃)₂CH-Br	71
$(CH_3)_2CH-I$	56
$(CH_3)_3C-F$	110
(CH₃)₃C-Cl	85
(CH₃)₃C-Br	71
(CH₃)₃C-I	55

Typical Heats of Hydrogenation