CHEM3900 **Name: _____**
Practice EXAM #1 **Summer 2023** **200 pts**
10:00 am

A- Multiple Choice.

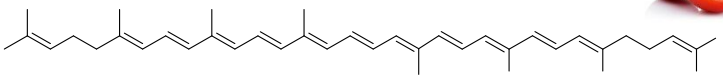
Circle the correct answer to the following questions (100 pts = 10 pts/each).

Lect. 1 – Worksheet 2

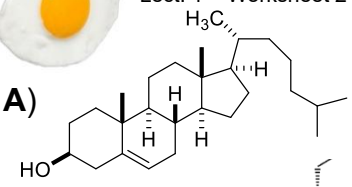
1) Which of the following structures has no conjugation?

A)
B)
C)
D)
E) None of the above

B)

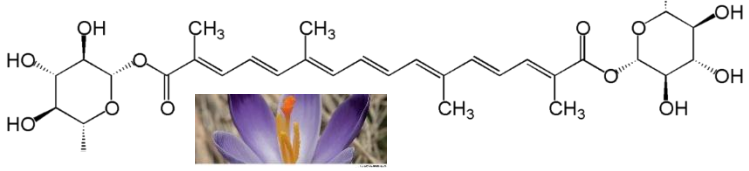


A)



C)

D)

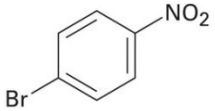


2) Of the following structures, which is *meta* substituted?

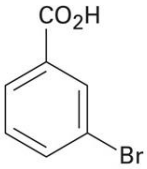
HW 15.1

A) A only
B) B only
C) C only
D) A and B only
E) B and C only

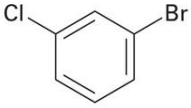
A)



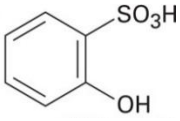
B)



C)



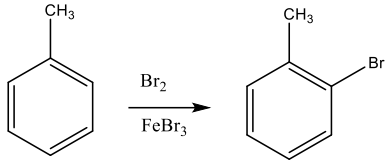
D)



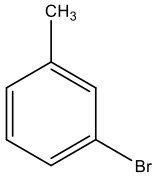
3) Monobromination of toluene gives which compound(s)?

HW 16.1

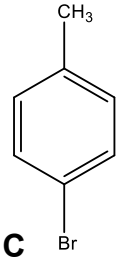
A) A only
B) B only
C) C only
D) All of the above
E) None of the above



A



B



C

4) Rank the compounds below in order of increasing reactivity to electrophilic substitution:

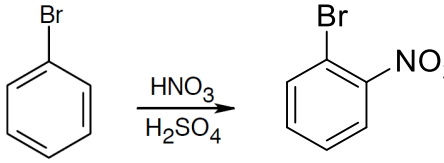
HW16.8

A) phenol, benzene, chlorobenzene, benzoic acid
B) benzene, chlorobenzene, phenol, benzoic acid
C) benzoic acid, chlorobenzene, benzene, phenol
D) benzene, chlorbenzene, benzoic acid, phenol
E) benzoic acid, chlorobenzene, phenol, benzene

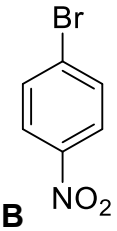
5) The major product(s) in the nitration (HNO_3) of bromobenzene is/are?

Lect. 4 – Worksheet 2

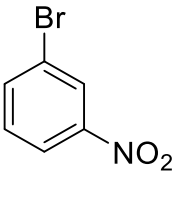
A) A only
B) B only
C) A and B only
D) A and C only
E) A, B and C



A



B

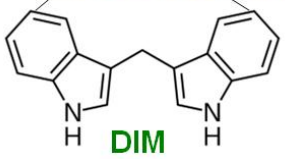


C

6) Indoles are often biologically active. One of the most famous is di-indole methane (**DIM**) due its anti-cancer activity. How many π electrons does DIM have?

Lect. 2 – Worksheet 3

A) 2
B) 6
C) 10
D) 14
E) 20

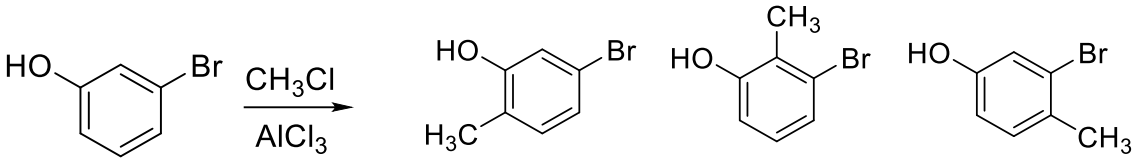


DIM

7) Predict the monoalkalation product(s) you would expect to obtain from the following reaction.

HW 16.49b

A) A only
B) B only
C) A and B only
D) A and C only
E) A, B and C

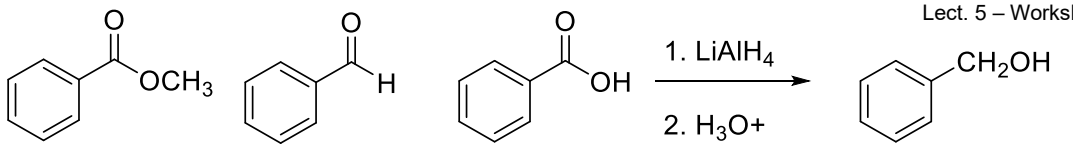


A **B** **C**

8) What carbonyl compound gives the following alcohol on reduction with LiAlH4 and H_3O^+?

Lect. 5 – Worksheet 4

A) A only
B) B only
C) C only
D) All of the above
E) None of the above

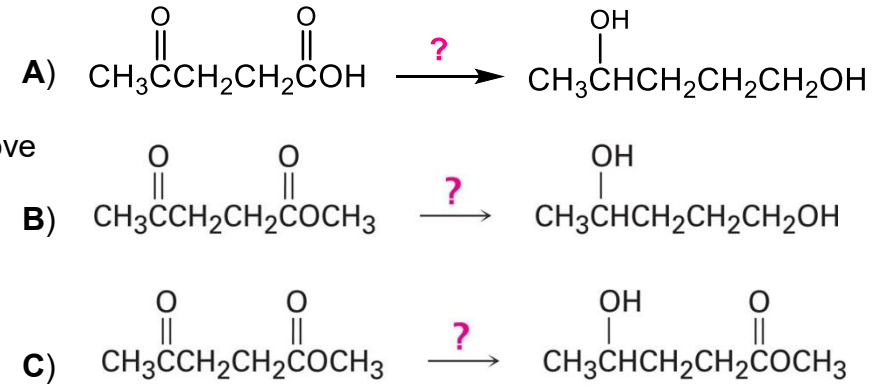


A **B** **C**

9) Which reaction(s) would not go to completion using the reagent $NaBH_4$ / H_3O^+?

HW 17.7

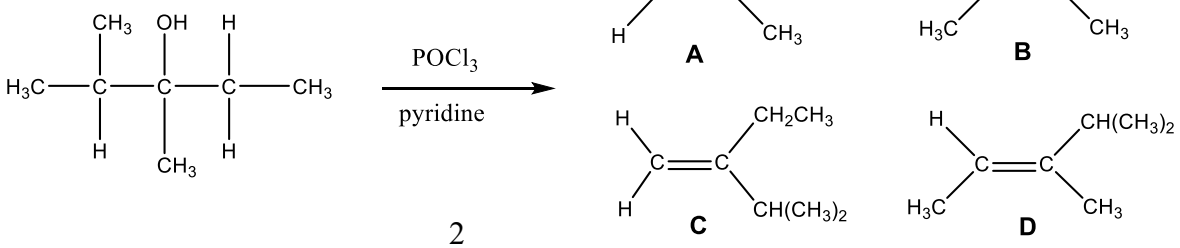
A) A only
B) A and B
C) B and C
D) A, B and C
E) None of the above



10) What products would you expect from the dehydration of the following alcohol and which is the major product (in **bold**)?

Lect. 6 – Worksheet 3

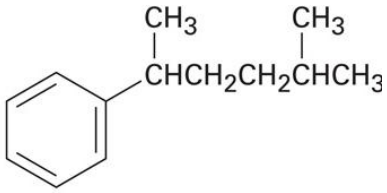
A) **A**, B and C only
B) **A**, B, C and D
C) A, **B**, C and D
D) A, B, **C** and D
E) A, B, C and **D**

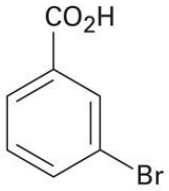


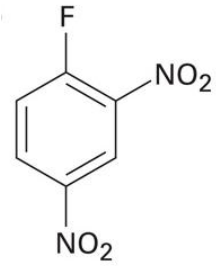
A **B** **C** **D**

B - Short answer. Correctly answer the following questions. PLEASE SHOW YOUR WORK. (100 pts).

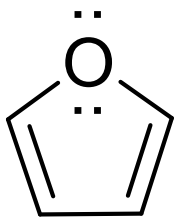
11a) What are the IUPAC names for the following compounds? (12 pts) HW 15.18



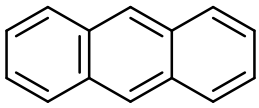




11b) Draw an orbital picture of furan to show how the molecule is aromatic. (10 pts) HW 15.9



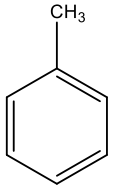
12) *Anthracene* has four resonance structures, one of which is shown. What are the other three? (15 pts) HW 15.25



/35

13) What is the major monosubstitution product from the Friedel-Crafts reaction of: Benzene with 1–chloro-2-methylpropane in the presence of $AlCl_3$? (12 pts)
Please show the mechanism (with arrows pushing).

14) Propose a syntheses to carry out the following conversion. Assume *ortho* and *para* isomers can be separated (i.e. don't worry about the ortho product). (18 pts) new/related

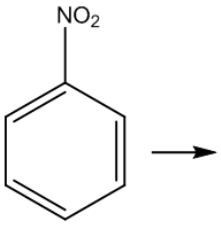


para-amino benzoic acid (PABA)
a naturally occurring active ingredient used in some suncreens

/30

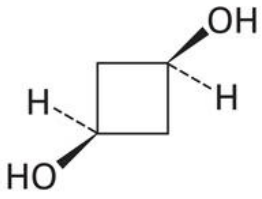
15) Draw resonance structures for the intermediates from the reaction of an electrophile (E^+) being attached from the "***Para"*** position of ***nitrobenzene*** and circle the least stable intermediate. (12 pts)

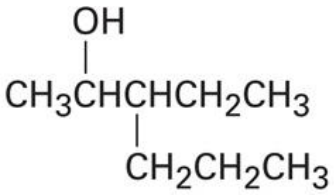
Lect. 4 – Worksheet 3



16) What are the IUPAC names for the following alcohols (6 pts).

HW 17.37

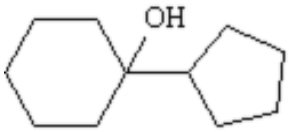




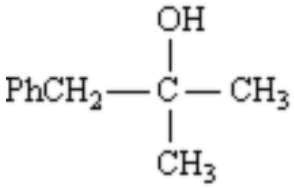
17) A highly useful and general method for the synthesis of alcohols is the addition of Grignard reagents to carbonyl compounds. Show what Grignard reagent and what carbonyl compound you would start with to prepare these alcohols. (8 pts)

New/related

a)



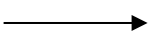
b)

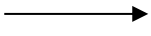


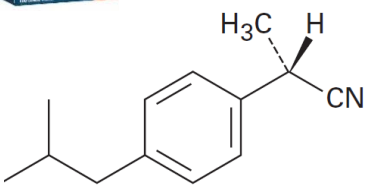
(Ph = Phenyl)

18) In the commercial synthesis of (*S*)-ibuprofen (**Advil®**) what reagent(s) would you use to carry out the following reaction and what intermediate would you generate? (9 pts)

Lect. 6 – Worksheet 2



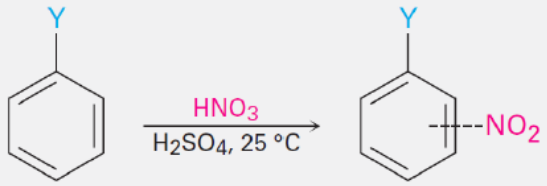




(*S*)-ibuprofen (Advil®)

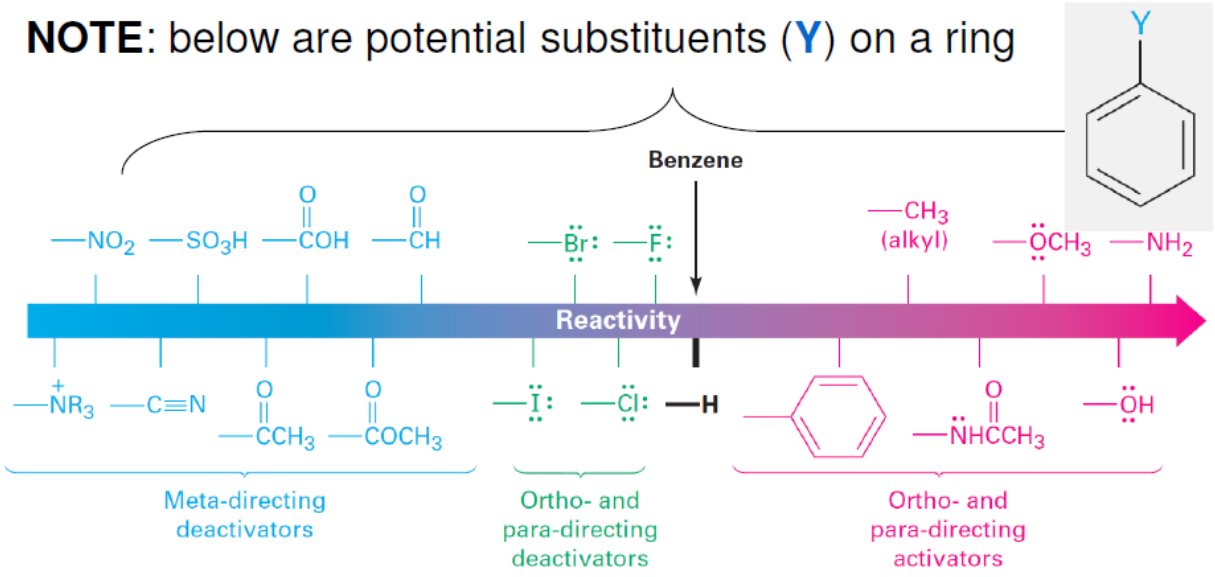
Chem 3900
Handout 2
Lecture 4
Chap 16

Table 16.1 Orientation of Nitration in Substituted Benzenes



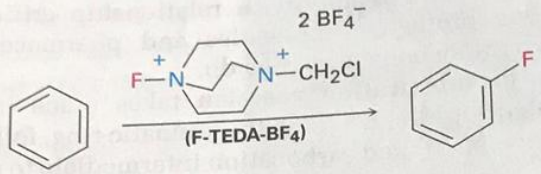
	Product (%)				Product (%)		
	Ortho	Meta	Para		Ortho	Meta	Para
Meta-directing deactivators				**Ortho- and para-directing deactivators**			
$-\overset{+}{N}(CH_3)_3$	2	87	11	–F	13	1	86
$-NO_2$	7	91	2	–Cl	35	1	64
$-CO_2H$	22	76	2	–Br	43	1	56
–CN	17	81	2	–I	45	1	54
$-CO_2CH_3$	28	66	6	**Ortho- and para-directing activators**			
$-COCH_3$	26	72	2	$-CH_3$	63	3	34
–CHO	19	72	9	–OH	50	0	50
				$-NHCOCH_3$	19	2	79

NOTE: below are potential substituents (**Y**) on a ring

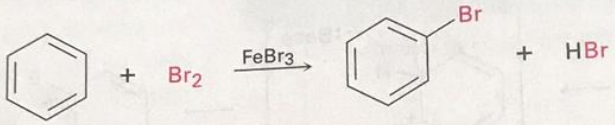


SUMMARY OF REACTIONS

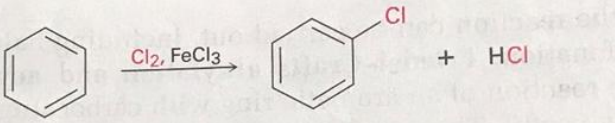
1. Electrophilic aromatic substitution
   (a) Fluorination (Section 16-2)



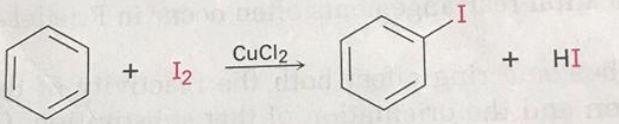
(b) Bromination (Section 16-1)



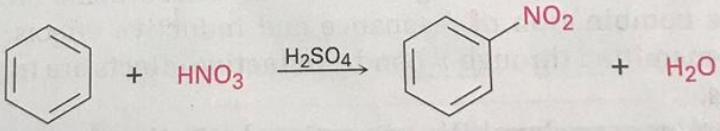
(c) Chlorination (Section 16-2)



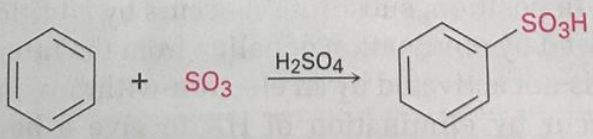
(d) Iodination (Section 16-2)



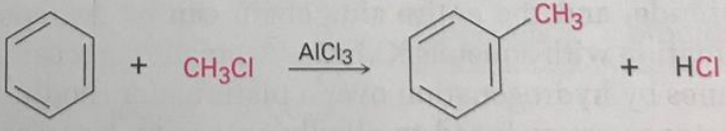
(e) Nitration (Section 16-2)



(f) Sulfonation (Section 16-2)

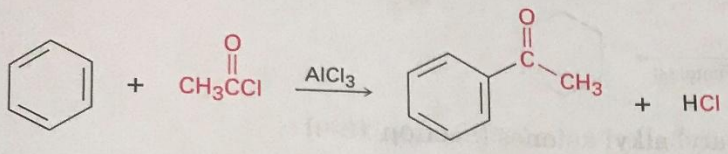


(g) Friedel–Crafts alkylation (Section 16-3)

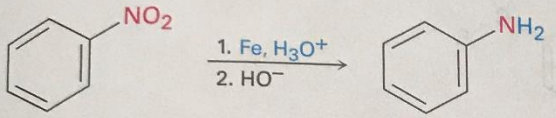


Aromatic ring.	Must be at least as reactive as a halobenzene.
Alkyl halide.	Primary alkyl halides undergo carbocation rearrangement.

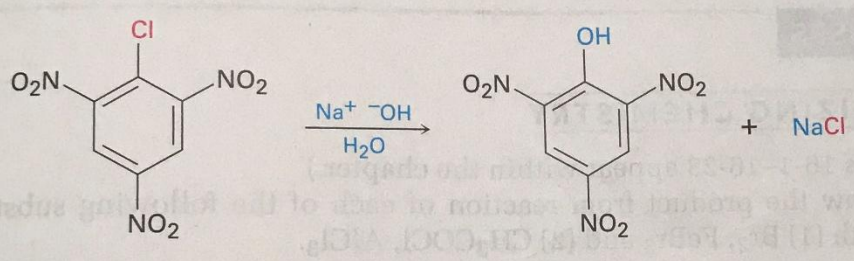
(h) Friedel–Crafts acylation (Section 16-3)



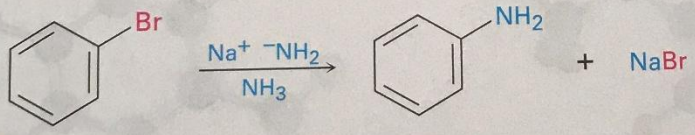
2. Reduction of aromatic nitro groups (Section 16-2)



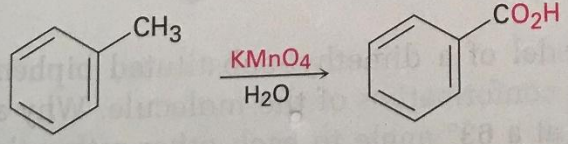
3. Nucleophilic aromatic substitution
   (a) By addition to activated aryl halides (Section 16-6)



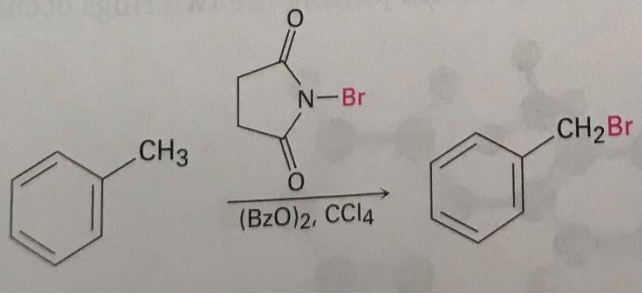
   (b) By formation of benzyne intermediate from unactivated aryl halide (Section 16-7)



4. Oxidation of alkylbenzene side chain (Section 16-8)



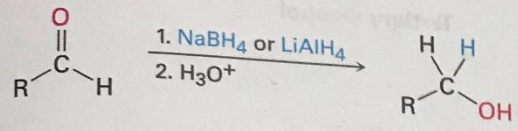
5. Benzylic bromination of alkylbenzene side chain (Section 16-8)



1. Synthesis of alcohols

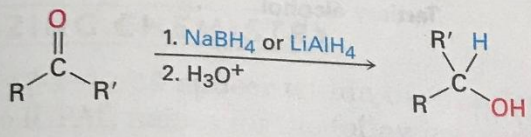
(a) Reduction of carbonyl compounds (Section 17-4)

(1) Aldehydes



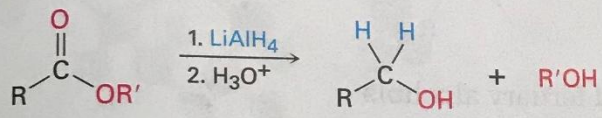
Primary alcohol

(2) Ketones



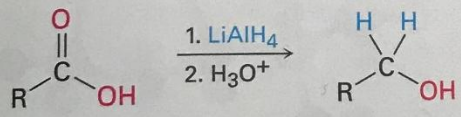
Secondary alcohol

(3) Esters



Primary alcohol

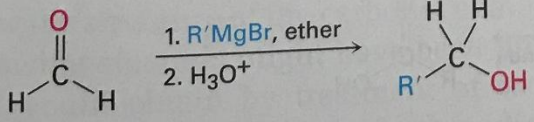
(4) Carboxylic acids



Primary alcohol

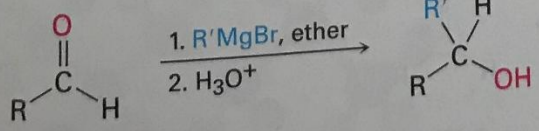
(b) Grignard addition to carbonyl compounds (Section 17-5)

(1) Formaldehyde



Primary alcohol

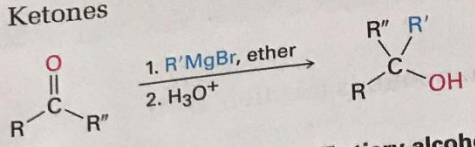
(2) Aldehydes



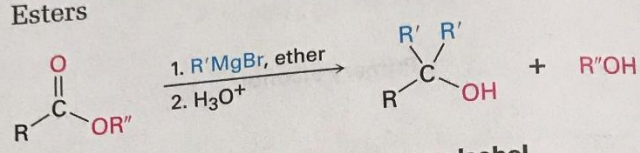
Secondary alcohol

(continued)

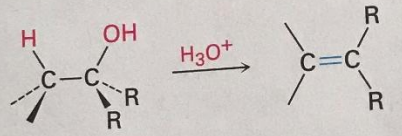
(3) Ketones



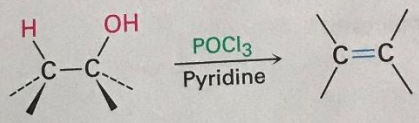
(4) Esters



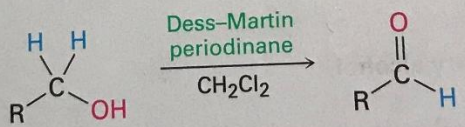
2. Reactions of alcohols
   (a) Dehydration (Section 17-6)
      (1) Tertiary alcohols

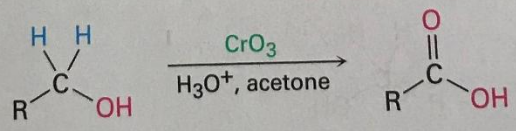


(2) Secondary and tertiary alcohols

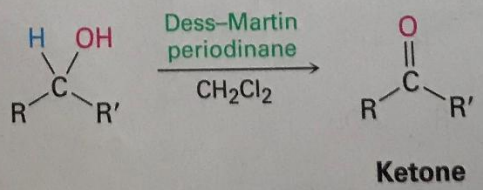


(b) Oxidation (Section 17-7)
   (1) Primary alcohols





(2) Secondary alcohols



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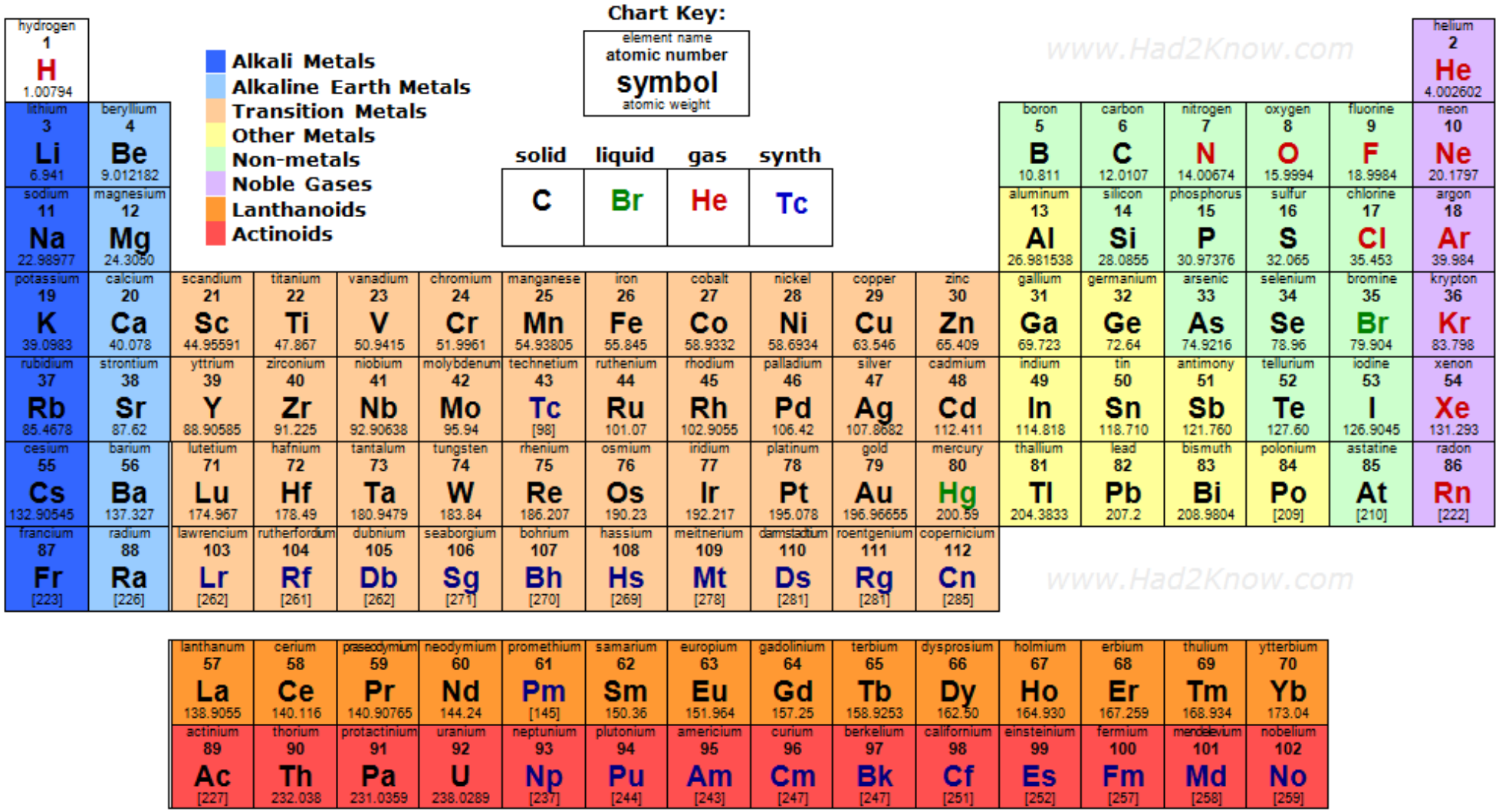
Chart Key:
element name
atomic number
symbol
atomic weight
Alkali Metals
Alkaline Earth Metals
Transition Metals
Other Metals
Non-metals
Noble Gases
Lanthanoids
Actinoids
solid
liquid
gas
synth
C
Br
He
Tc
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hydrogen 1 H 1.00794
helium 2 He 4.002602
lithium 3 Li 6.941
beryllium 4 Be 9.012182
boron 5 B 10.811
carbon 6 C 12.0107
nitrogen 7 N 14.00674
oxygen 8 O 15.9994
fluorine 9 F 18.9984
neon 10 Ne 20.1797
sodium 11 Na 22.98977
magnesium 12 Mg 24.3050
aluminum 13 Al 26.981538
silicon 14 Si 28.0855
phosphorus 15 P 30.97376
sulfur 16 S 32.065
chlorine 17 Cl 35.453
argon 18 Ar 39.984
potassium 19 K 39.0983
calcium 20 Ca 40.078
scandium 21 Sc 44.95591
titanium 22 Ti 47.867
vanadium 23 V 50.9415
chromium 24 Cr 51.9961
manganese 25 Mn 54.93805
iron 26 Fe 55.845
cobalt 27 Co 58.9332
nickel 28 Ni 58.6934
copper 29 Cu 63.546
zinc 30 Zn 65.409
gallium 31 Ga 69.723
germanium 32 Ge 72.64
arsenic 33 As 74.9216
selenium 34 Se 78.96
bromine 35 Br 79.904
krypton 36 Kr 83.798
rubidium 37 Rb 85.4678
strontium 38 Sr 87.62
yttrium 39 Y 88.90585
zirconium 40 Zr 91.225
niobium 41 Nb 92.90638
molybdenum 42 Mo 95.94
technetium 43 Tc [98]
ruthenium 44 Ru 101.07
rhodium 45 Rh 102.9055
palladium 46 Pd 106.42
silver 47 Ag 107.8682
cadmium 48 Cd 112.411
indium 49 In 114.818
tin 50 Sn 118.710
antimony 51 Sb 121.760
tellurium 52 Te 127.60
iodine 53 I 126.9045
xenon 54 Xe 131.293
cesium 55 Cs 132.90545
barium 56 Ba 137.327
lutetium 71 Lu 174.967
hafnium 72 Hf 178.49
tantalum 73 Ta 180.9479
tungsten 74 W 183.84
rhenium 75 Re 186.207
osmium 76 Os 190.23
iridium 77 Ir 192.217
platinum 78 Pt 195.078
gold 79 Au 196.96655
mercury 80 Hg 200.59
thallium 81 Tl 204.3833
lead 82 Pb 207.2
bismuth 83 Bi 208.9804
polonium 84 [209]
astatine 85 [210]
radon 86 [222]
francium 87 Fr [223]
radium 88 Ra [226]
lawrencium 103 Lr [262]
rutherfordium 104 Rf [261]
dubnium 105 Db [262]
seaborgium 106 Sg [271]
bohrium 107 Bh [270]
hassium 108 Hs [269]
meitnerium 109 Mt [278]
damstadtium 110 Ds [281]
roentgenium 111 Rg [281]
copernicium 112 Cn [285]
lanthanum 57 La 138.9055
cerium 58 Ce 140.116
praseodymium 59 Pr 140.90765
neodymium 60 Nd 144.24
promethium 61 Pm [145]
samarium 62 Sm 150.36
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gadolinium 64 Gd 157.25
terbium 65 Tb 158.9253
dysprosium 66 Dy 162.50
holmium 67 Ho 164.930
erbium 68 Er 167.259
thulium 69 Tm 168.934
ytterbium 70 Yb 173.04
actinium 89 Ac [227]
thorium 90 Th 232.038
protactinium 91 Pa 231.0359
uranium 92 U 238.0289
neptunium 93 Np [237]
plutonium 94 Pu [244]
americium 95 Am [243]
curium 96 Cm [247]
berkelium 97 Bk [247]
californium 98 Cf [251]
einsteinium 99 Es [252]
fermium 100 Fm [257]
mendelevium 101 Md [258]
nobelium 102 No [259]