

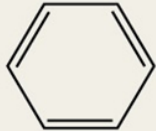
CHEM 244 INFORMATION PACKET:

Periodic Table, IR/NMR Tables

1	1 H 1.008 Hydrogen											2 He 4.003 Helium						
2	3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
3	11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminum	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
4	19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.88 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.39 Zinc	31 Ga 69.72 Gallium	32 Ge 72.61 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
5	37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.54 Molybdenum	43 Tc (99) Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
6	55 Cs 132.9 Cesium	56 Ba 137.3 Barium	*57 La 138.9 Lanthanum	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po (209) Polonium	85 At (210) Astatine	86 Rn (222) Radon
7	87 Fr (223) Francium	88 Ra 226.0 Radium	**89 Ac 227.0 Actinium	104 Rf (261) Rutherfordium	105 Db (262) Dubnium	106 Sg (263) Seaborgium	107 Bh (262) Bohrium	108 Hs (265) Hassium	109 Mt (268) Meitnerium	110 Uun (269) Ununnilium	111 Uuu (272) Ununium	112 Uub (277) Ununbium		114 Uuq (289) ?? Ununquadium		116 Uuh (289) Ununhexium		118 Uuo (293) Ununoctium

IR TABLE

The absorption bands of different functional groups absorb at different frequencies and intensities. Keep it simple!

Type of bond	Wavenumber (cm ⁻¹)	Intensity
C≡N	2260–2220	medium
C≡C	2260–2100 (~3300 if terminal)	medium to weak
C=C	1680–1600	medium
C=N	1650–1550	medium
	~1600 and “ripples” 1800-2000	strong to weak
C=O	1780–1650	strong
C—O	1250–1050	strong
C—N	1230–1020	medium
O—H (alcohol)	3650–3200	strong, broad
O—H (carboxylic acid)	3300–2500	strong, very broad

1H NMR TABLE

TABLE 9.1 Approximate Proton Chemical Shifts

Type of Proton	Chemical Shift (δ , ppm)	Type of Proton	Chemical Shift (δ , ppm)
1° Alkyl, RCH ₃	0.8–1.2	Alkyl bromide, RCH ₂ Br	3.4–3.6
2° Alkyl, RCH ₂ R	1.2–1.5	Alkyl chloride, RCH ₂ Cl	3.6–3.8
3° Alkyl, R ₃ CH	1.4–1.8	Vinylic, R ₂ C=CH ₂	4.6–5.0
Allylic, R ₂ C=C(CH ₃) R	1.6–1.9	Vinylic, R ₂ C=CH R	5.2–5.7
Ketone, RC(=O)CH ₃	2.1–2.6	Aromatic, ArH	6.0–8.5
Benzylic, ArCH ₃	2.2–2.5	Aldehyde, RCH(=O)	9.5–10.5
Acetylenic, RC≡CH	2.5–3.1	Alcohol hydroxyl, ROH	0.5–6.0 ^a
Alkyl iodide, RCH ₂ I	3.1–3.3	Amino, R—NH ₂	1.0–5.0 ^a
Ether, ROCH ₂ R	3.3–3.9	Phenolic, ArOH	4.5–7.7 ^a
Alcohol, HOCH ₂ R	3.3–4.0	Carboxylic, RCO(=O)H	10–13 ^a

^aThe chemical shifts of these protons vary in different solvents and with temperature and concentration.