# Chemistry 130, Final Exam

Instructor: Bergdahl

***Spring 2019***

Name:_____

Be prepared to show ID upon request.

****Any use of any electronic devices is prohibited during the test** ****

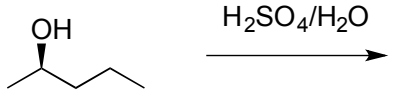
Be prepared to show ID upon request.

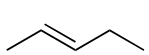
My student I.D. (red I.D.) number is:

Good Luck!!

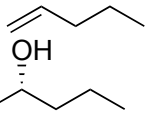
**Part A. 1-50 Questions. Each correct is 3 points. (Part 1 max 150 points)**

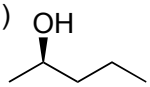
1) The major product of the below reaction will be



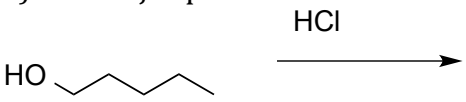

A) 

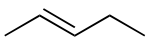
B)

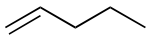
C) 

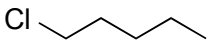

D) 


2) The major product of the below reaction will be



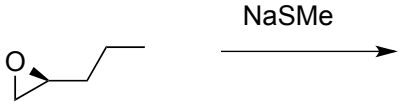

A) 

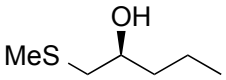
B) 

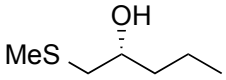
C) 

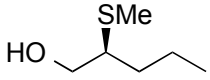

D) no reaction

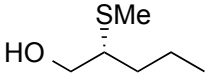
3) The product of the reaction below is




A) 


B) 


C) 

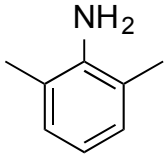

D) 

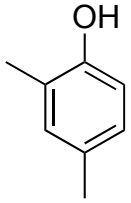
4) Epoxides are good electrophiles because

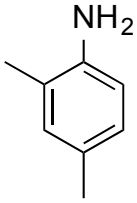
A) RO- is a good leaving group
B) Epoxide opening after nucleophilic attach relieves a lot of ring strain
C) They are not good electrophiles.
D) There are no sterics because of the small 3 membered ring

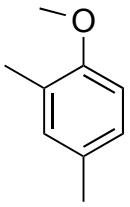
5) An alkaloid is
A) An opioid from nature
B) A complex molecule found in nature with a bunch of heteroatoms in it
C) A basic molecule found in nature with nitrogen atoms in the structure
D) A neutral molecule found in nature with oxygen atoms in the structure

6) Which of the below compounds is 2,4-dimethylaniline

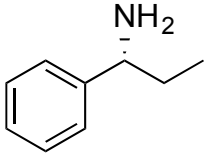
A) 

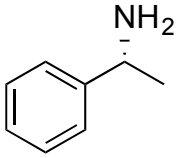

C) 

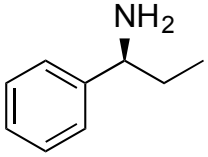

B) 

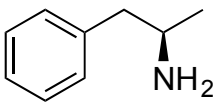

D) 


7) Which of the molecules below is (R)-1-phenyl-1-propanamine

A) 


C) 


B) 


D) 

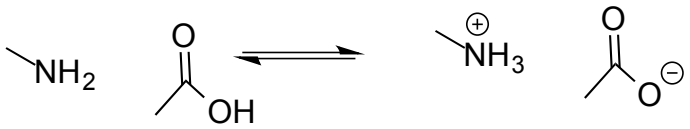

8) Which compound will have the highest boiling point.
A) $C_2H_6$ B) $CH_3NH_2$ C) $CH_3OH$ D) $CH_3OCH_3$

9) Which compound is the better base.
A) $C_2H_6$ B) $CH_3NH_2$ C) $CH_3OH$ D) $CH_3OCH_3$

10) Why are alcohols worse bases than amines?

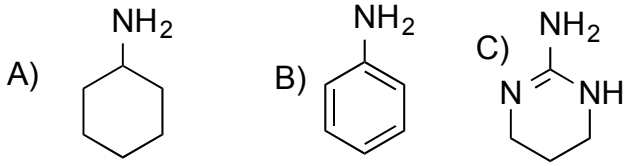
A) Because nitrogen is more electronegative, the lone pair of electrons is more easily shared
B) Because nitrogen is less electronegative, the positive charge in the conjugate acid is more stable with amines
C) Actually, alcohols are always stronger bases than amines.

11) The Keq for the below reaction is




A) 1
B) greater than 1
C) less than 1

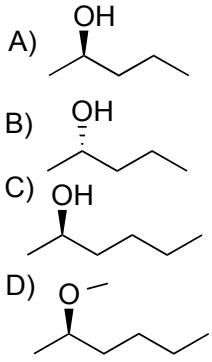
12) Which of the following amines is the strongest base?




13) Why?
A) Resonance stabilizes the lone pair of electrons on the basic nitrogen
B) Electronegativity
C) Resonance destabilizes the lone pair of electrons on the basic nitrogen
D) The inductive effect

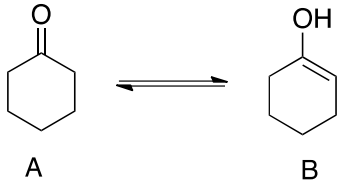
14) The oxygen in a hydroxyl group is____hybridized and has bond angles of ____
A) sp, 180
B) $sp^3$, 120
C) $sp^2$, 120
D) $sp^3$, 109.5

15) Which molecule below is *R*-2-pentanol



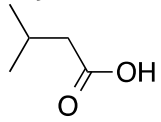
16) What is the electron configuration of a neutral Nitrogen atom?
A) $1s^2 2s^2 2p^5$
B) $1s^2 2s^2 2p^3$
C) $1s^2 2s^2 2p^4$
D) $1s^2 2s^2 2p^2$

17) Molecule _____is enol taoutomer and the Keq of this reaction is___



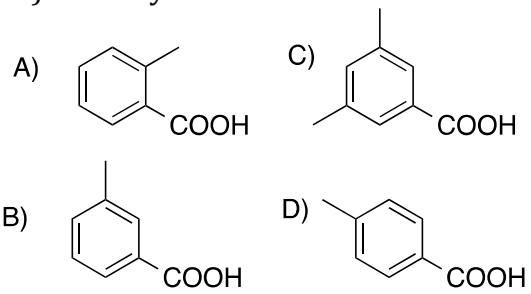

A) A, greater than 1
B) B, greater than 1
C) A, less than 1
D) B, less than 1

18) The name of the following molecule is

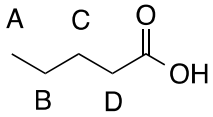



A) 2-methyl butanoic acid
B) 3-methyl butanoic acid
C) 2-methyl propanoic acid
D) isovaleric acid

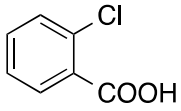
19) 3-methyl benzoic acid is

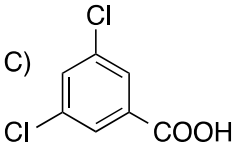


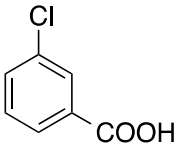

20) Which carbon refers to the alpha carbon?

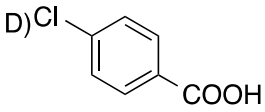


21) Which Acid is the most acidic

A) 

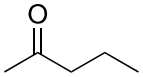

C) 

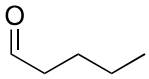

B) 


D) 

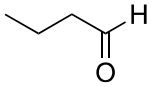

22) The carbon in a carbonyl group is____hybridized and has a partial ____
A) sp, positive charge
B) $sp^2$, positive charge
C) $sp^2$, negative charge
D) $sp^3$, positive charge

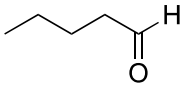
23) which molecule below is pentanal

A) 


B) 


C)

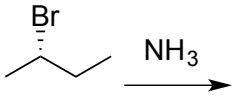
D) 

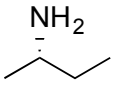




24) aldehydes are generally _____polar than ketones
A) Less
B) More
C) similarly

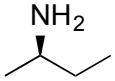
25) Alcohols have _____boiling points than comparably sized aldehydes/ketones
A) Higher
B) Lower

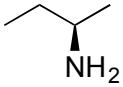
26) Predict the major product from the below reaction



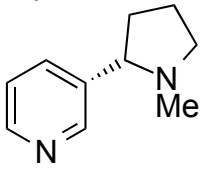

A) 


C) 

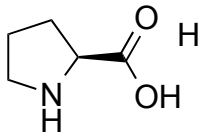

B) 


D) 

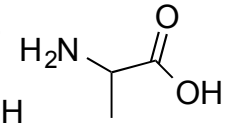

27) Which of the following amines is primary aliphatic




A




B

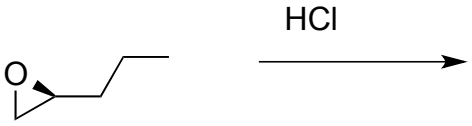


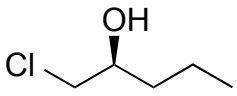

C

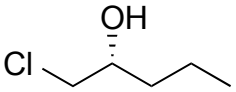
$NH_3$

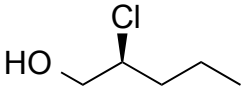
D

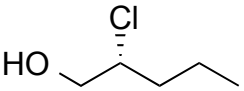
28) The product of the reaction below is




A) 

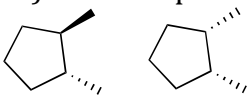

B) 


C) 


D) 

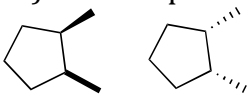

29) alcohols are _____ acidic than thiols
A) more
B) Less

30) The compounds below are



A) Constitutional Isomers
B) Enantiomers
C) Diastereomers
D) Geometric Isomers
E ) the same molecule

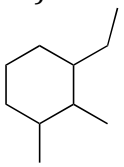
31) The compounds below are



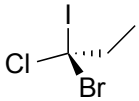
A) Constitutional Isomers
B) Enantiomers
C) Diastereomers
D) Geometric Isomers
E ) the same molecule

32) Enantiomers are
A) Superposable mirror images
B) Non-superposable mirror images
C) Molecules that have the same connectivity but a different orientation of atoms in 3-dimensional space
D) Molecules that have the same molecular formula but a different connectivity.

33) How many possible stereoisomers does the compound below have?

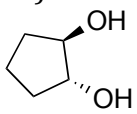


A) 2
B) 6
C) 8
D)12

34) 

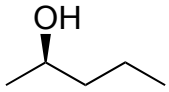
Is in the ____configuration
A) S
B) R

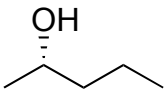
35) The stereocenters in the below molecule are in the _____configuration

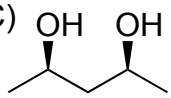


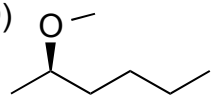

A) S,S
B) R,R
C) R,S
D) S.R
E) none of the above because molecule is not chiral

36) Which of the compounds below will have the lowest boiling point

A) 

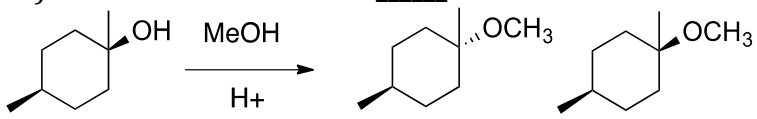

B) 


C) 


D) 

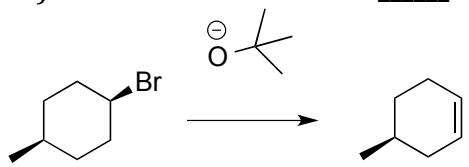

37) How many steps are there in the mechanism of a SN1 nucleophilic displacement reaction?
A) 1
B) 2
C) 3
D) 4

38) The reaction below is a _____



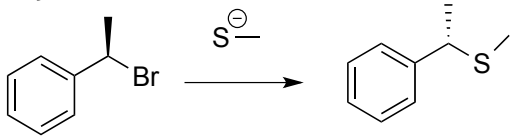

A) SN1 B) E1 C) SN2 D) E2

39) The reaction below is a _____




A) SN1 B) E1 C) SN2 D) E2

40) The reaction below is a _____

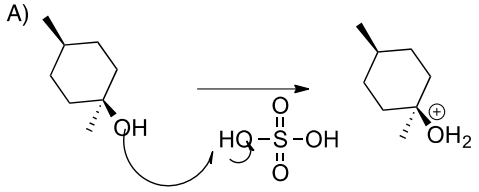



A) SN1 B) E1 C) SN2 D) E2

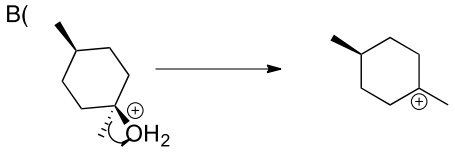
41) Which of the below anions is the best leaving group
A) I- B) Br- C) Cl- D) F-

42) Which of the following steps is the rate determining step of an SN1 reaction is

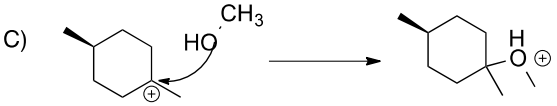
A)



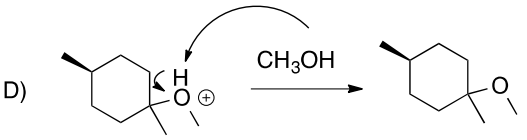

B(



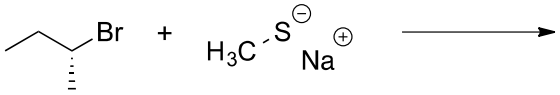

C)




D)

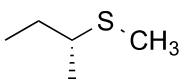


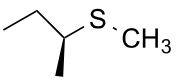

43) Please predict the major product form the below reaction



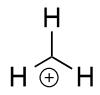
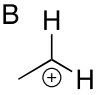

A) 

B) 

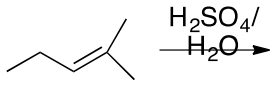

C) 

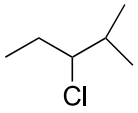

D) 

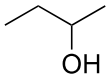
44) The most stable carbocation below is

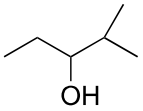
A  B  C  D 

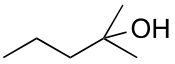
45) Predict the product of the below reaction



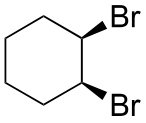

A) 

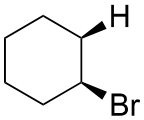

C) 

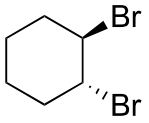

B) 

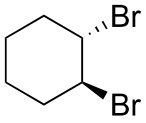

D) 


46) Predict the product of the below reaction

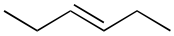

**A** 

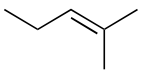

**C** 

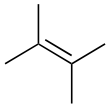

**B** 


**D** 

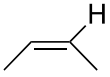

47) Which of the below alkenes will have the highest boiling point?

A) 

B) 

C) 

48) Which of the following hydrocarbons is least acidic?

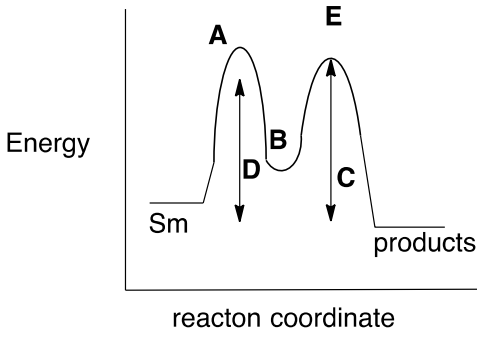
A) 


B) 

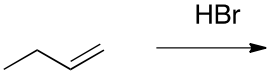

C) 

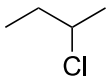
49) The Intermediate in the reaction profile below corresponds to _____

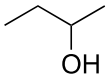
Sm=Starting materials

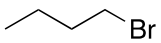


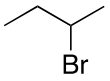

50) Predict the product of the below reaction




A) 


C) 

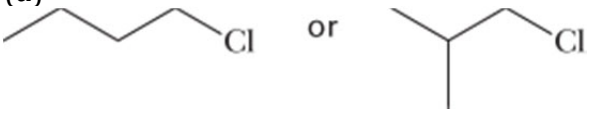

B) 


D) 

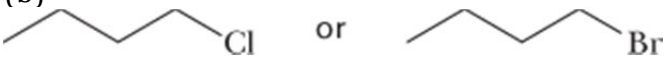
**Part B. Short answer questions, 51-60, each problem is worth 8-15 points (total 100 points)**

Problem 51. Select the member of each pair that shows the greater rate of $S_N2$ reaction with KI in acetone. (8p)

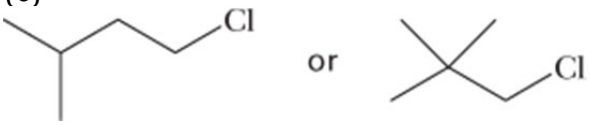
(a)



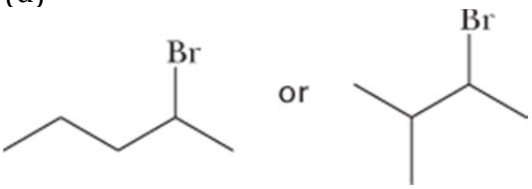

(b)




(c)




(d)




Problem 52. Predict the position of equilibrium for each acid-base reaction; that is, does each lie considerably to the **left**, does each lie considerably to the **right**, or are the concentrations **evenly** balanced? (Use letters **L**, **R** or **E** above the equilibrium arrows for a-d) (8p)

(a) $CH_3CH_2OH + Na^+OH^- \rightleftharpoons CH_3CH_2O^-Na^+ + H_2O$

(b) $CH_3CH_2SH + Na^+OH^- \rightleftharpoons CH_3CH_2S^-Na^+ + H_2O$

(c) $CH_3CH_2OH + CH_3CH_2S^-Na^+ \rightleftharpoons CH_3CH_2O^-Na^+ + CH_3CH_2SH$

(d) $CH_3CH_2S^- Na^+ + CH_3\overset{\overset{O}{\|}}{C}OH \rightleftharpoons CH_3CH_2SH + CH_3\overset{\overset{O}{\|}}{C}O^- Na^+$

Problem 53. Draw a structural formula for each compound (given are IUPAC names). (9p)

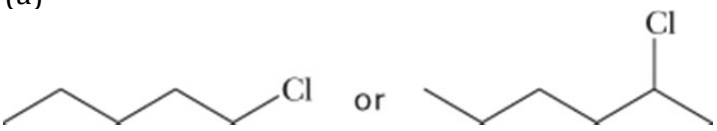
(a) 3-Aminopropene

(b) (R)-2-pentanol

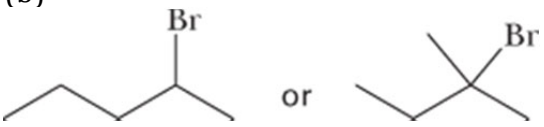
(c) meso-1,2-Dibromocyclopentane

Problem 54. Select the member of each pair that undergoes nucleophilic substitution in aqueous ethanol more rapidly. (9p)

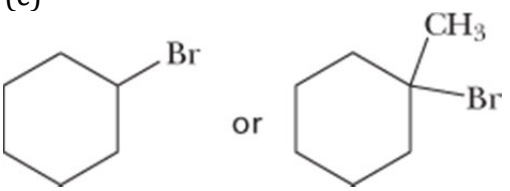
(a)




(b)




(c)



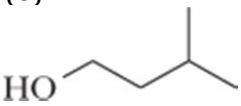
Problem 55. Provide an IUPAC or common name for the molecules below (15p)

(a)

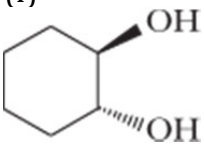

(b)


(c)

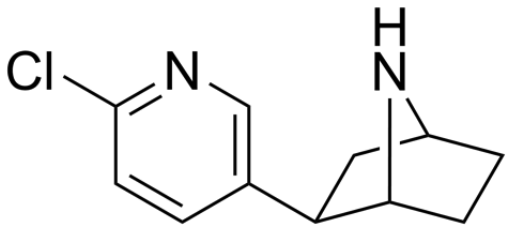

(e)




(f)



Problem 56. Epibatidine (below), a colorless oil isolated from the skin of the Ecuadorian poison frog *Epipedobates tricolor*, has several times the analgesic potency of morphine. It is the first nonopioid (nonmorphine-like in structure) analgesic ever isolated from a natural source. (8p)

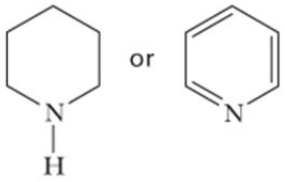



(a) Which of the two nitrogen atoms of epibatidine is the more basic?

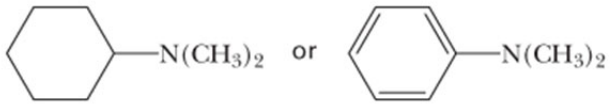
(b) Mark all stereocenters in this molecule.

Problem 57. From each pair of compounds, select the stronger base. (12p)

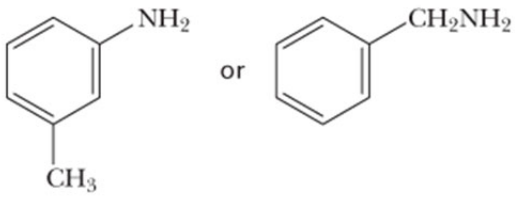
(a)



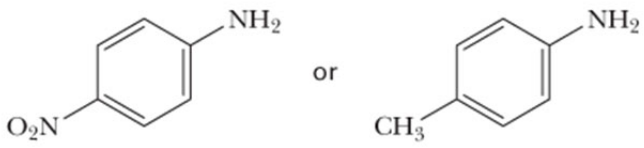

(b)



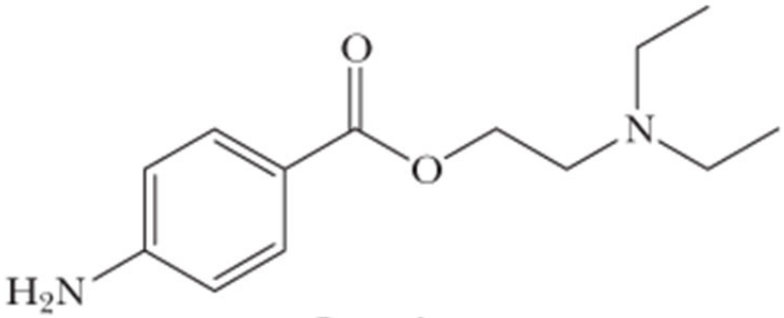

(c)




(d)



Problem 58. Procaine was one of the first local anesthetics for infiltration and regional anesthesia. The hydrochloride salt of procaine is marketed as Novocaine®. (6p)




Procaine

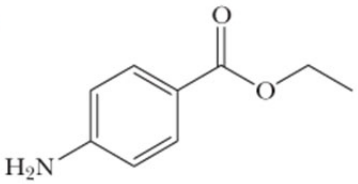
(a) Which nitrogen atom of procaine is the stronger base?

(b) Draw the formula of the salt formed by treating procaine with one mole of HCl.

(c) Is procaine chiral? Would a solution of Novocaine® in water be optically active or optically inactive?

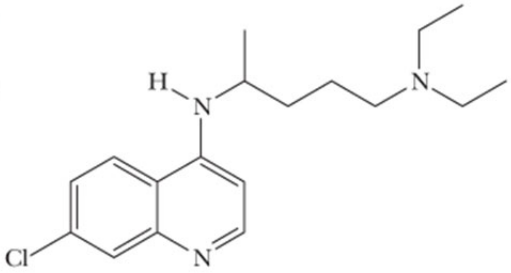
Problem 59. Classify each amino group as primary, secondary, or tertiary and as aliphatic or aromatic. (10p)

(a)




Benzocaine
(a topical anesthetic)

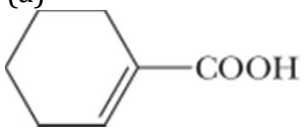
(b)



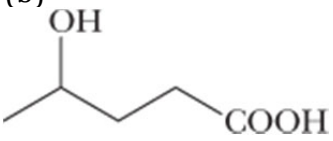

Chloroquine
(a drug for the
treatment of malaria)

Problem 60. Write the IUPAC name for each compound below. (15p)

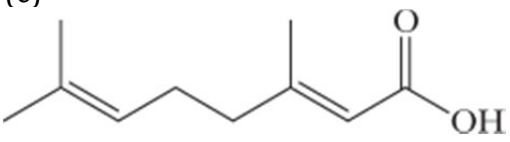
(a)



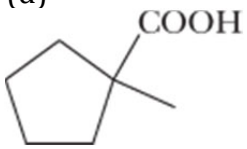

(b)



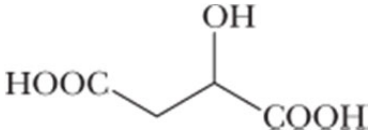

(c)



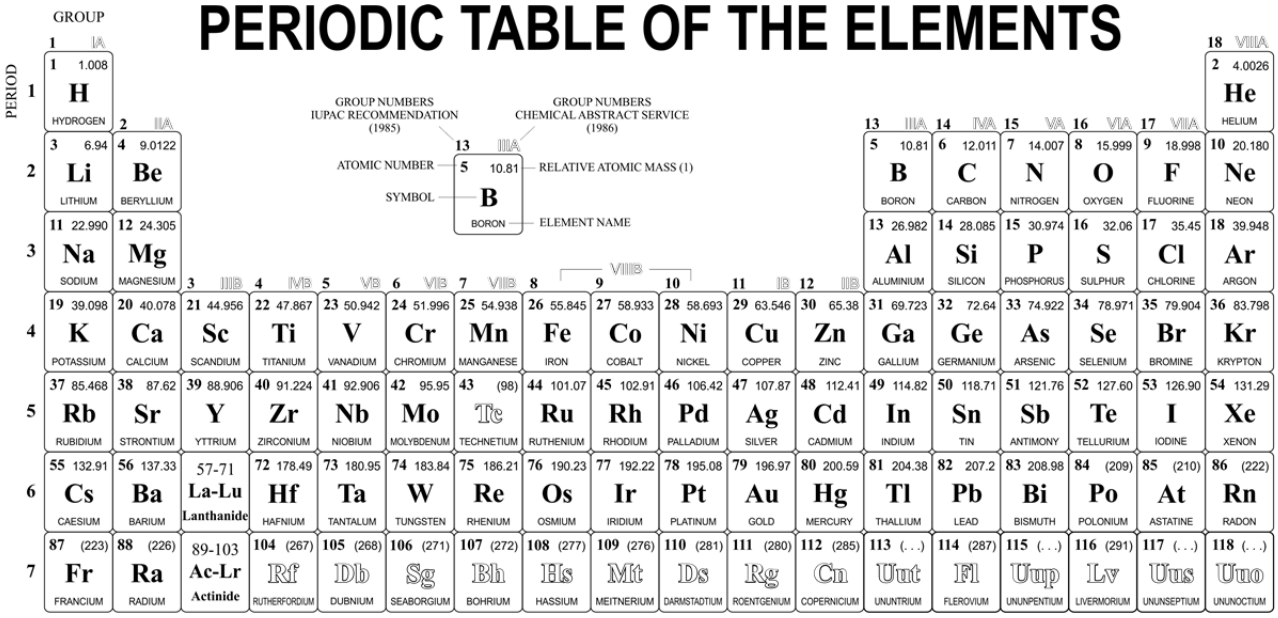

(d)




(e)



# PERIODIC TABLE OF THE ELEMENTS






LANTHANIDE

| 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 173.05 | 174.97 |
| La | Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu |
| LANTHANUM | CERIUM | PRASEODYMIUM | NEODYMIUM | PROMETHIUM | SAMARIUM | EUROPIUM | GADOLINIUM | TERBIUM | DYSPROSIUM | HOLMIUM | ERBIUM | THULIUM | YTTERBIUM | LUTETIUM |

ACTINIDE

| 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (227) | 232.04 | 231.04 | 238.03 | (237) | (244) | (243) | (247) | (247) | (251) | (252) | (257) | (258) | (259) | (262) |
| Ac | Th | Pa | U | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr |
| ACTINIUM | THORIUM | PROTACTINIUM | URANIUM | NEPTUNIUM | PLUTONIUM | AMERICIUM | CURIUM | BERKELIUM | CALIFORNIUM | EINSTEINIUM | FERMIUM | MENDELEVIUM | NOBELIUM | LAWRENCIUM |

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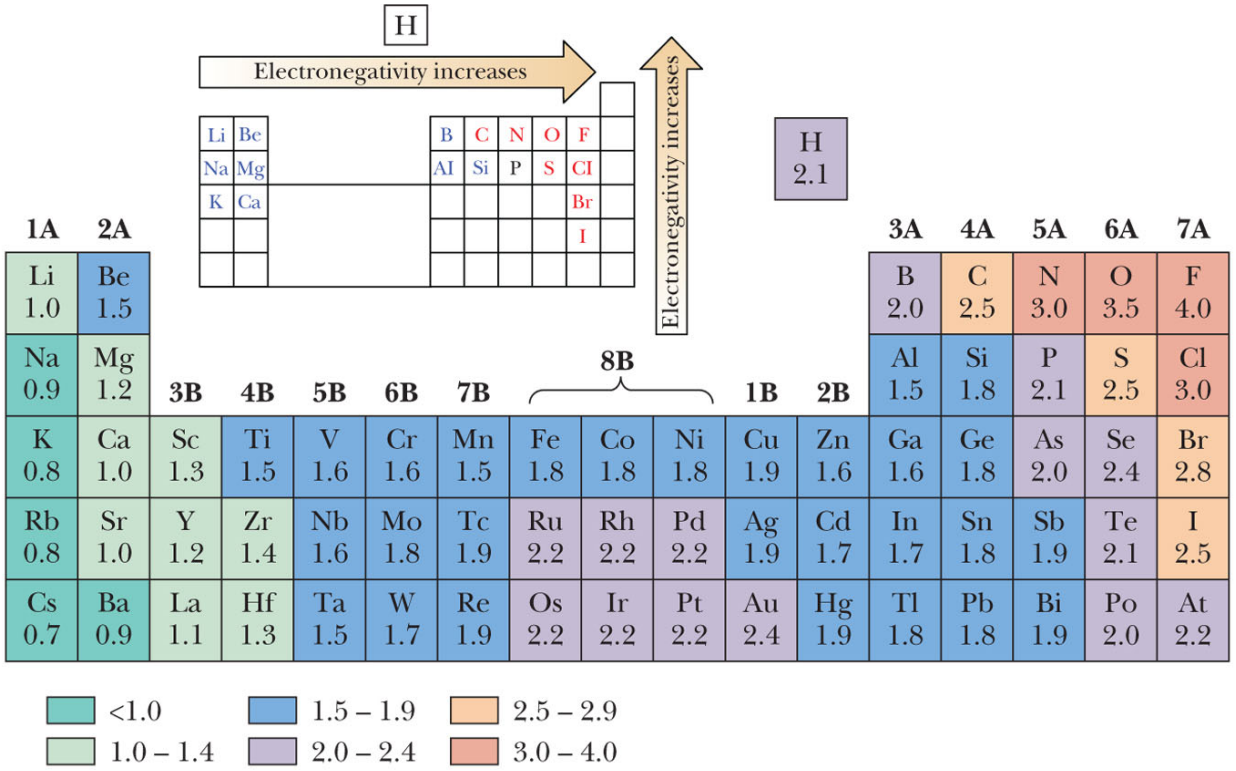
(1) Pure Appl. Chem., **88**, 265-291 (2016)

## TABLE 1.4 Electronegativity Values and Trends for Some Atoms (Pauling Scale)




## TABLE 2.2 $pK_a$ Values for Some Organic and Inorganic Acids

the weaker the acid, the stronger is its conjugate base

the stronger the acid, the weaker is its conjugate base

| | Acid | Formula | $pK_a$ | Conjugate Base | |
|---|---|---|---|---|---|
| Weaker acid | ethane | $CH_3CH_3$ | 51 | $CH_3CH_2^-$ | Stronger base |
| | ammonia | $NH_3$ | 38 | $NH_2^-$ | |
| | ethanol | $CH_3CH_2OH$ | 15.9 | $CH_3CH_2O^-$ | |
| | water | $H_2O$ | 15.7 | $HO^-$ | |
| | methylammonium ion | $CH_3NH_3^+$ | 10.64 | $CH_3NH_2$ | |
| | bicarbonate ion | $HCO_3^-$ | 10.33 | $CO_3^{2-}$ | |
| | phenol | $C_6H_5OH$ | 9.95 | $C_6H_5O^-$ | |
| | ammonium ion | $NH_4^+$ | 9.24 | $NH_3$ | |
| | hydrogen cyanide | HCN | 9.21 | $CN^-$ | |
| | carbonic acid | $H_2CO_3$ | 6.36 | $HCO_3^-$ | |
| | acetic acid | $CH_3COOH$ | 4.76 | $CH_3COO^-$ | |
| | benzoic acid | $C_6H_5COOH$ | 4.19 | $C_6H_5COO^-$ | |
| | phosphoric acid | $H_3PO_4$ | 2.1 | $H_2PO_4^-$ | |
| | hydronium ion | $H_3O^+$ | −1.74 | $H_2O$ | |
| | sulfuric acid | $H_2SO_4$ | −5.2 | $HSO_4^-$ | |
| Stronger acid | hydrogen chloride | HCl | −7 | $Cl^-$ | Weaker base |
| | hydrogen bromide | HBr | −8 | $Br^-$ | |
| | hydrogen iodide | HI | −9 | $I^-$ | |

**Grading:** **Part A _____/150 points**

**Part B_____/100 points**

**Total_____/250 points**