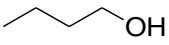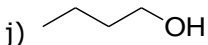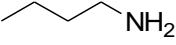**3A. Predict relative acidity and basicity of molecules or based on element effects, inductive effects, resonance effects and hybridization effects.**

OCSL: 3.1 – 3.33

3A.1 Circle the stronger acid in each pair.

a) HCl / HBr   b) HCF_3 / $HCBr_3$ c) NH_3 / H_2O d) $ClCH_2CH_2OH$ / CH_3CH_2OH

e) HF / H_2O f) HI / HBr   g) H_2O / H_2S h) CBr_3OH / CCl_3OH

i) $\sim\sim OH$ j) $\sim\sim OH$ $\sim\sim NH_2$ k) CH_3CO_2H / CH_2ClCO_2H

3A.2 Circle the stronger base in each pair.

a) H_2O / H_2S b) Br^- / F^- c) CH_3^- / OH^- d) CH_3NH^- / CH_3O^-

e) $H_2C=CH^-$ / $H-C\equiv C^-$ f) F^- / OH^- g) $CH_3CH_2^-$ / CH_3O^- h) H_2O / NH_3

i) $CFH_2CH_2O^-$ / CH_3CFHO^- j) $CH_2BrCO_2^-$ / $CH_2ClCO_2^-$

3A.3 Briefly explain the acidity difference between the two molecules below.

acetic acid   ethanol
pKa = 4.9   pKa = 16
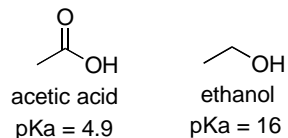
3B. Identify the acid and base in a Brønsted-Lowry acid-base reactions, draw the products and predict the direction based on pK$_a$ values or structure.
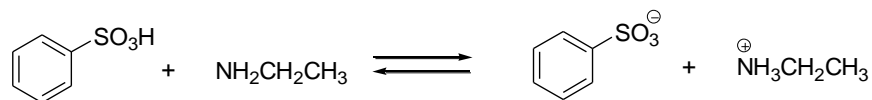
OCSL: 3.34 – 3.45

3B.1 Identify the acids and bases in each equilibrium then predict the direction of equilibrium based on the given pK$_a$ information.
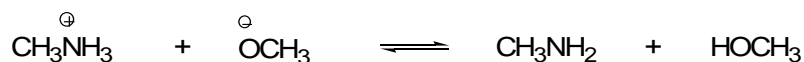
a) pKa of the carbon acid is 25, pKa of the nitrogen acid is 38.

$HC\equiv C^{\ominus}$ NH_3 ⇌ $^{\ominus}NH_2$ $HC\equiv CH$
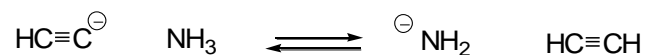
b) The nitrogen acid pKa of 10.6 and the sulfur based acid has a pKa of -7

SO_3H (on benzene ring) $+$ $NH_2CH_2CH_3$ $\rightleftharpoons$ $SO_3^{\ominus}$ (on benzene ring) $+$ $\overset{\oplus}{N}H_3CH_2CH_3$
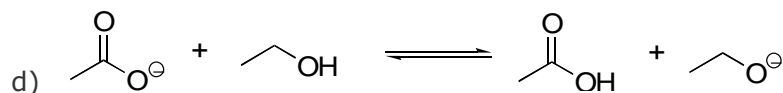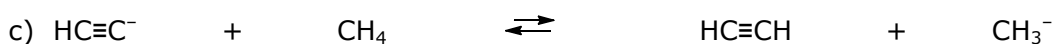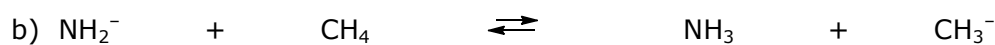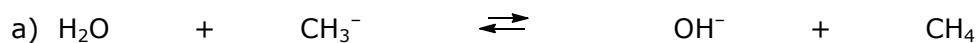
c) The pKa of the nitrogen based acid is 10.66, pKa of the oxygen based acid is 16.02.

$\overset{\oplus}{C}H_3NH_3$ $+$ $\overset{\ominus}{O}CH_3$ $\rightleftharpoons$ CH_3NH_2 $+$ $HOCH_3$

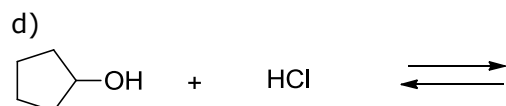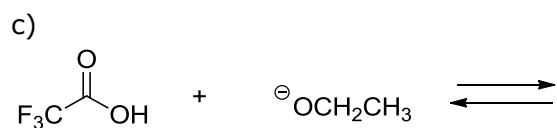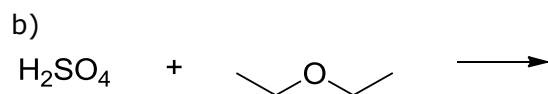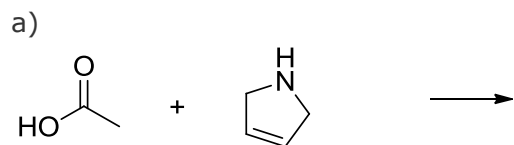3B.2 Sodium amide ($NaNH_2$) can be used to deprotonate acetylene according to the reaction below. Which has a lower pK_a, acetylene or ammonia?
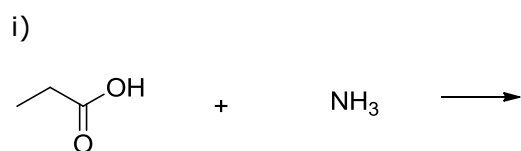
$H-C{\equiv}C-H$ $+$ $NaNH_2$ $\longrightarrow$ $H-C{\equiv}C^{\ominus}$ $\overset{\oplus}{Na}$ $+$ NH_3
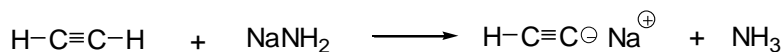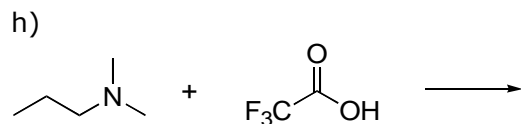
3B.3 Predict the direction of equilibrium for the following acid-base reactions based on your knowledge of acidity trends.

a) H_2O $+$ CH_3^- $\rightleftharpoons$ OH^- $+$ CH_4

b) NH_2^- $+$ CH_4 $\rightleftharpoons$ NH_3 $+$ CH_3^-

c) $HC{\equiv}C^-$ $+$ CH_4 $\rightleftharpoons$ $HC{\equiv}CH$ $+$ CH_3^-

d)

3B.4 Predict the products of the following acid-base reactions.

a)

b)

H_2SO_4 $+$ $\longrightarrow$

c)

 $+$ $^{\ominus}OCH_2CH_3$ $\rightleftharpoons$

d)

 $-OH$ $+$ HCl $\rightleftharpoons$

e)

H−C≡C−H   + $^{\ominus}CH_2CH_3$ ⇌

f)

−NH₂   +   H₂SO₄   ⟶

g)

CH₃OH   +   HCl   →

h)

   +   ⟶

i)

        +   NH₃   ⟶

3B.5

acetic acid   malonic acid
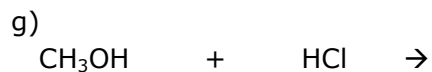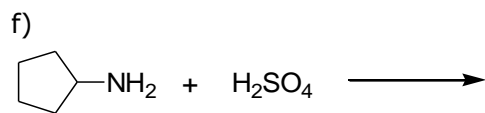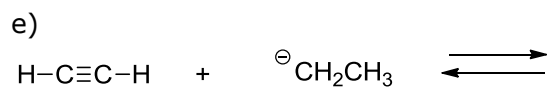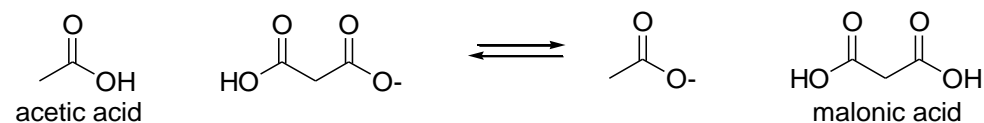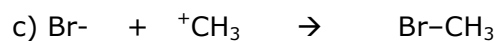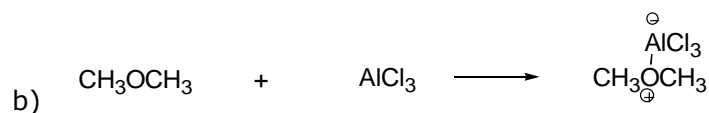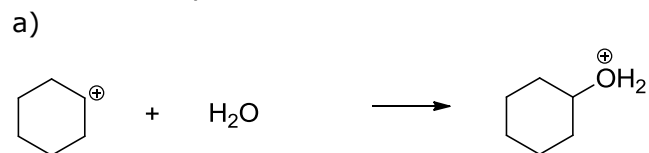
a) Malonic acid is more acidic than acetic acid. Explain.
b) Indicate the direction of the equilibrium.

3C. Identify the acid and base in a Lewis acid-base reaction, draw the products of a Lewis acid-base reaction.

3C.1   Identify the Lewis acid and base in the reactions below.

a)

   +   H₂O   ⟶

b)   CH₃OCH₃   +   AlCl₃   ⟶   CH₃$\overset{\ominus}{\underset{\oplus}{O}}$CH₃ (with AlCl₃)

c) Br-   + $^{+}CH_3$ →   Br−CH₃

d) FeCl₃   +   H₂O   →   H₂O^{+}−$^{-}$FeCl₃

3C.2 Predict the products of the following Lewis acid-base reactions.

a) BH_3 + ^-OH →

b) NH_3 + BF_3 →

c) $AlCl_3$ + $HOCH_3$ →

d) $^+CH_3$ + SH_2 →

e) Cl^- + $FeCl_3$ →