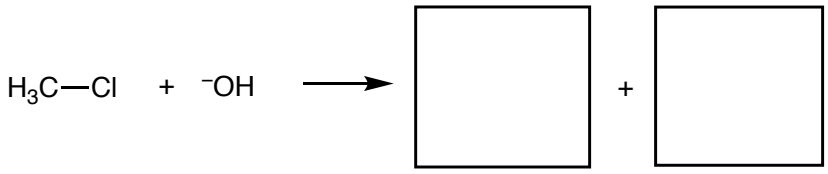
Kinetics

1. Complete the reaction by providing the missing products.



2. Consider the kinetic data, collected at 25 °C, for the reaction in problem 1.

Experiment	$[CH_3Cl]_0$ (M)	$[OH^-]_0$ (M)	Initial Rate (M/s)
1	0.0010	1.0	4.9×10^{-7}
2	0.0020	1.0	9.8×10^{-7}
3	0.0010	2.0	9.8×10^{-7}
4	0.0020	2.0	2.0×10^{-6}

A) Determine the rate law for this reaction.

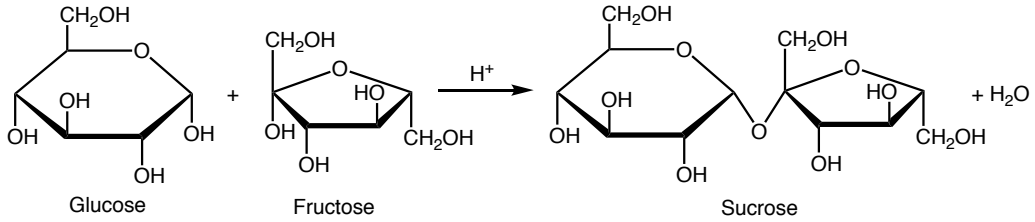
B) Determine the value and units of the rate constant (k).

C) Calculate the activation energy (E_a) for this reaction if $A = 5.18 \times 10^{-2}$ s^{-1}.

$$k = Ae^{\frac{-E_a}{RT}}$$

Chemical Equilibrium

3. D-glucose and D-fructose can react via condensation to form the dipeptide sucrose.

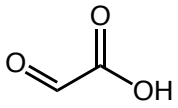


If the initial concentrations of [glucose] = [fructose] = 0.150 M and the $K_c = 7.35 \times 10^{-6}$ for this reaction at 27 °C, calculate the concentrations of glucose, fructose, and sucrose at equilibrium.

Acid-Base Equilibria

4. Glyoxylic acid (HOCCOOH) has a pK_a = 3.18 at 25 °C.

   A) Write/Draw a balanced chemical equation for the dissociation of glyoxylic acid (drawn below).

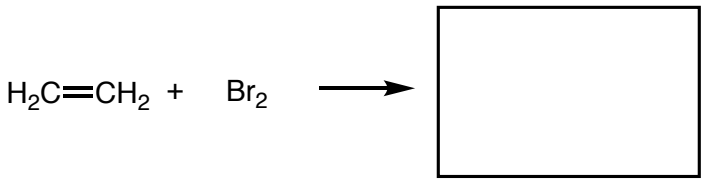


   B) Draw a resonance structure for the conjugate-base, the glyoxylate anion.

   C) If 2.0 mL of 1.0 M sodium hydroxide are added to 8.0 mL of a 1.4 M glyoxylic acid solution, what is the pH of the resulting solution?

Thermodynamics

5. Complete the reaction by providing the missing products.



6. Consider the following thermodynamic data collected at 25 °C.

	C_2H_4	Br_2	$C_2H_4Br_2$
$\Delta H_f° \left(\frac{kJ}{mol}\right)$	226.7	30.9	−1240.3
$\Delta S° \left(\frac{J}{mol \cdot K}\right)$	200.8	245.5	223.3

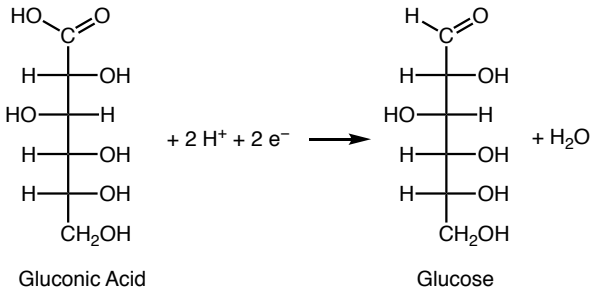
A) Calculate the Gibbs free energy change for this reaction.

B) Is this reaction driven by enthalpy or entropy?

C) Calculate the temperature at which this reaction will be nonspontaneous.

Electrochemistry

7. Glucose is a reducing sugar that can be oxidized by the Tollens' reagent. Consider the two reduction processes and their standard reduction potentials ($E°$).



Gluconic Acid Glucose

; $E°$ = +0.050 V

$$Ag^+ + 1\ e^- \rightarrow Ag \qquad ; E° = +0.800\ V$$

A) Which is the reducing agent and which is the oxidizing agent?

B) Write the net ionic equation for a Galvanic/voltaic cell based on these reactions.

C) Determine the value of the $E°_{cell}$.

D) Determine the value of the initial potential if an electrochemical cell is made with [glucose] = [gluconic acid] = 0.200 M glucose and 0.400 M silver nitrate solutions at 25 °C.