

BIOLOGICAL & CHEMICAL KINETICS

A. INTRODUCTION AND DEFINITIONS (CHAPTER 2)

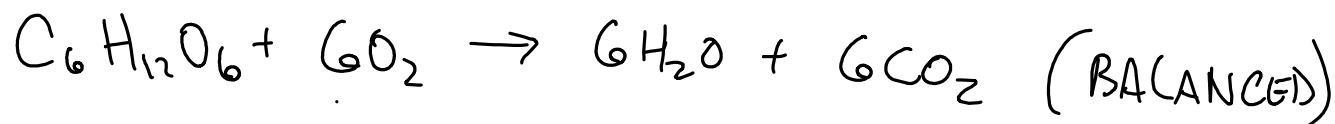
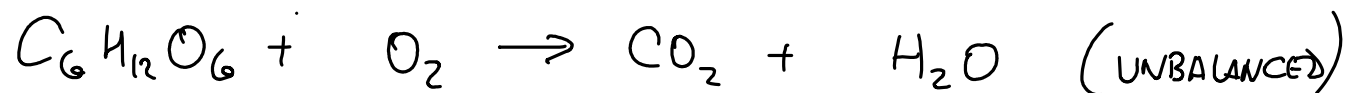
STOICHIOMETRY — THE PRINCIPLE THAT CHEMICALS COMBINE IN SPECIFIC PROPORTIONS WHEN THEY REACT WITH EACH OTHER.

THIS PRINCIPLE CAN BE STATED MATHEMATICALLY BY "BALANCING" AN EQUATION.

EXAMPLE

GLUCOSE REACTS WITH OXYGEN
TO FORM CARBON DIOXIDE AND WATER
(BIOLOGICAL)

GLUCOSE + OXYGEN →
CARBON DIOXIDE + WATER



STOICHIOMETRY

WHAT WE HAVE REALLY DONE IS PERFORM AN ATOM BALANCE
(MORE LATER)

- FOR CONVENIENCE THIS EQUATION IS WRITTEN SO THAT THE COEFFICIENTS ARE WHOLE NUMBERS.
- IMPLICATION IS THAT IF 1 MOLE OF GLUCOSE REACTS COMPLETELY WITH 6 MOLES OF O_2 , THEN NO GLUCOSE NOR O_2 WILL REMAIN. IF 1 MOLE OF GLUCOSE IS AVAILABLE TO REACT WITH 7 MOLES OF O_2 , AND REACTION GOES TO COMPLETION THEN 1 MOLE OF O_2 WILL REMAIN.

Limiting Reactant — THE REACTANT WHICH WOULD DISAPPEAR FIRST IF THE REACTION PROCEEDED TO COMPLETION.

Excess Reactant — THE REACTANT WHICH WOULD REMAIN IF THE REACTION PROCEEDED TO COMPLETION.

PERCENTAGE EXCESS
(BASED ON EXCESS
REACTANT WHICH COULD
BE CONSUMED)

FRACTIONAL CONVERSION
(USUALLY BASED ON
LIMITING REACTANT)

$$Z = \frac{\text{MOLES FED} - \text{MOLES CONSUMED}}{\text{MOLES CONSUMED}}$$

$$X_i = \frac{\text{MOLES OF LIMITING REACTANT CONS}}{\text{MOLES OF LIMITING REACTANT FED}}$$

$$X_i = \frac{\text{MOLES FED} - \text{MOLES REMAINING}}{\text{MOLES FED}}$$

YIELD -

A MEASURE OF THE DEGREE TO WHICH
THE REACTION HAS PRODUCED THE
"DESIRED PRODUCT".

$$\underline{YIELD_{FED}} = \frac{\text{MOLES OF DESIRED PRODUCT FORMED}}{\text{MOLES OF LIMITING REACTANT FED}}$$

$$\underline{YIELD_{CONS}} = \frac{\text{MOLES OF DESIRED PRODUCT FORMED}}{\text{MOLES OF LIMITING REACTANT CONSUMED}}$$

$$\underline{YIELD_{FED} \leq YIELD_{CONS}}$$

SELECTIVITY - A MEASURE OF THE FRACTION
OF THE TOTAL PRODUCT WHICH IS
THE DESIRED PRODUCT.

$$\text{SELECTIVITY} = \frac{\text{MOLES OF DESIRED PRODUCT}}{\text{MOLES OF UNDESIRE PRODUCTS}}$$

THIS EQUATION HAS A RATIO... ONE
COULD ALSO DEFINE SELECTIVITY
AS A FRACTION

WHERE "UNDESIRED PRODUCTS" CAN MEAN

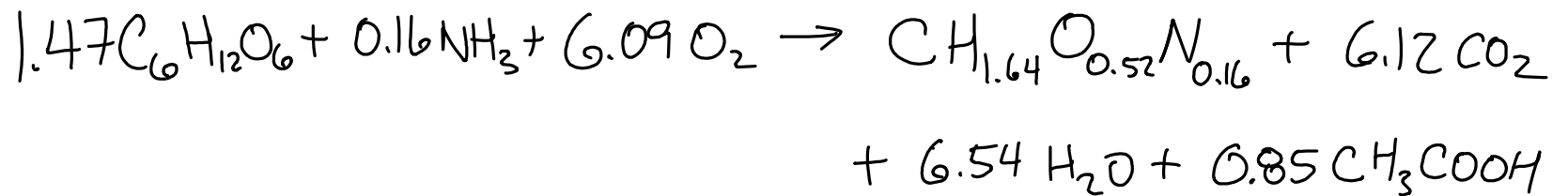
- ALL PRODUCTS $\neq$ REACTANTS REMAINING AT END
- SELECTED PRODUCTS $\neq$ REACTANTS REMAINING AT END
- ALL PRODUCTS REMAINING AT END
- SELECT PRODUCTS REMAINING AT END
- ETC

EXAMPLE 1

ONLY 2 REACTIONS OCCUR

RXN #1

GLUCOSE + AMMONIA + OXYGEN $\rightarrow$ CELLS + CO_2 + H_2O + ACETIC ACID



- NOTE:
- 1) CELLS HAVE A THEORETICAL CHEMICAL FORMULA, DEFINED SO THAT SUBSCRIPT FOR CARBON IS 1.
 - 2) STOICHIOMETRIC COEFFICIENTS ARE NON-INTEGERS. BY CONVENTION COEFFICIENT SO CELLS IS ONE.