c) "UNDESIRED PRODUCTS" = ACETIC ACID

BY MOLES SELECTIVITY = $\frac{1.556}{0.193} = 8.06$

BY MASS SELECTIVITY = $\frac{140\text{g}}{11.58\text{g}} = 12.1$

"UNDESIRED PRODUCTS" = CELLS + CO_2 + ACETIC ACID (CARBON)

MOLES WOULD NOT TYPICALLY BE USED WITH CELLS

BY MASS

CELLS: $0.227\text{ mol} \times \frac{24.2\text{g}}{\text{mol}} = 5.49\text{g}$

CO_2 = $1.388\text{ mol} \times \frac{44.0\text{g}}{\text{mol}} = 61.07\text{g}$

$$\text{SELECTIVITY} = \frac{140\text{g}}{11.58\text{g} + 5.49\text{g} + 61.07\text{g}} = 1.79$$

d) NH_3 SUPPLIED 2.00 g

NH_3 CONSUMED

$$0.0363 \text{ mol} \times \frac{17.0 \text{ g}}{\text{mol}} = 0.62 \text{ g}$$

NH_3 REMAINING = $2.00 - 0.62 \text{ g} = \underline{1.38 \text{ g}}$

REACTION RATE IS (INSTANTANEOUS) CHANGE IN QUANTITY OF MATERIAL DUE TO A CHEMICAL REACTION PER UNIT TIME PER UNIT VOLUME.

ALMOST ALWAYS REACTION RATES ARE DESCRIBED IN MOLAR UNITS

$$R_i \equiv \frac{1}{V}\frac{dn_i}{dt}$$

NOTE $n_i = c_i V$

c_i: MOLAR CONCENTRATION OF COMPONENT i

n_i: NUMBER OF MOLES OF COMPONENT i

THUS,

$$R_i \equiv \frac{1}{V}\frac{d(c_i V)}{dt}$$

COMMON SIMPLIFICATION OCCURS IF THE VOLUME OF THE SYSTEM IS CONSTANT (NOT A FUNCTION OF TIME):

$$R_i = \frac{dc_i}{dt}$$

CONSTANT VOLUME

CONCENTRATION DEPENDENCE OF REACTION RATE

IN GENERAL $R_i = f(c_i)$

CLASSIFICATIONS:

i) NUMBER OF REACTIONS PARTICIPATING
   SINGLE VS. MULTIPLE

ii) WHETHER REACTION OCCURS APPRECIABLY IN BOTH DIRECTIONS
   IRREVERSIBLE VS. REVERSIBLE

iii) KINETICS OR MECHANISM OF REACTION

- ZEROTH ORDER
- FIRST ORDER
- SECOND ORDER
- HIGHER ORDER
- COMPLEX SCHEME

iv) STOICHIOMETRY OF REACTION

c) EXAMPLES OF REACTIONS

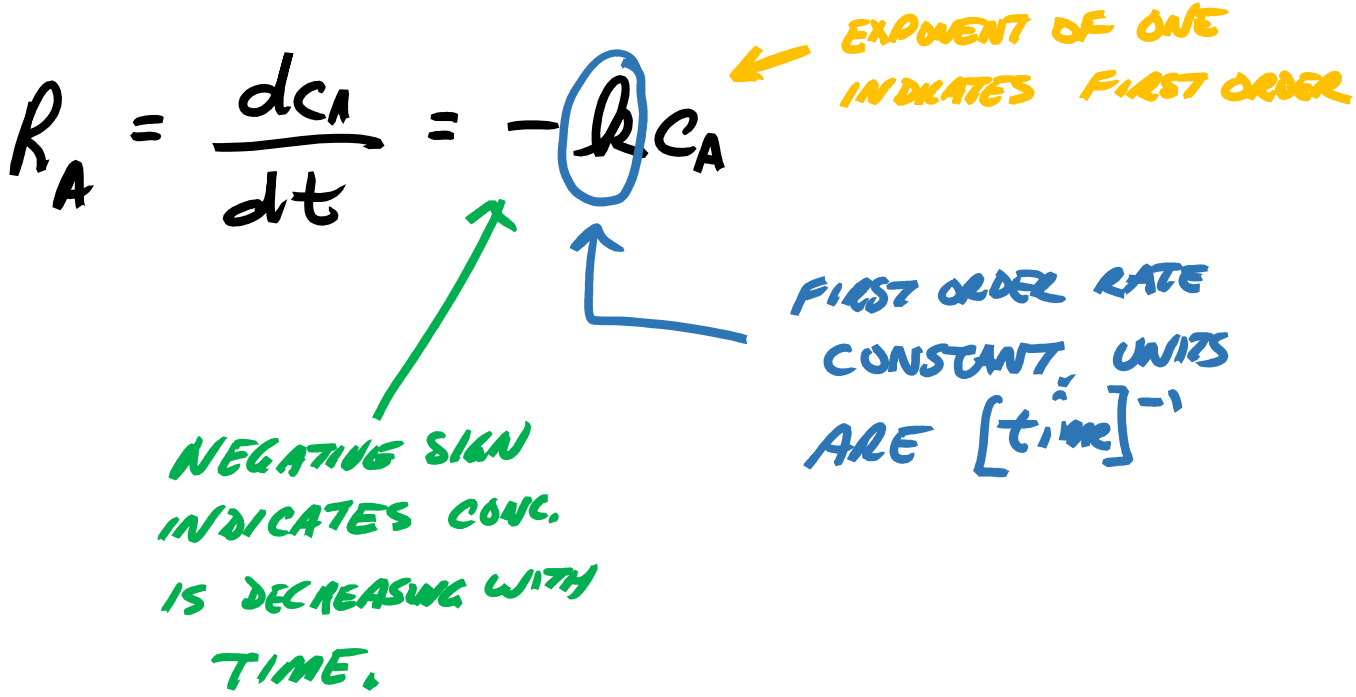
1) FIRST-ORDER IRREVERSIBLE SINGLE REACTION

$A \rightarrow B$

$A + B \rightarrow C$ WHERE "B" IS IN EXCESS

"FIRST ORDER" = THE RATE OF THE REACTION IS PROPORTIONAL TO THE CONC. OF ONE REACTANT

"IRREVERSIBLE" = ONLY FORWARD REACTION OCCURS APPRECIABLY


$R_A = \frac{dc_A}{dt} = -kc_A$
EXPONENT OF ONE INDICATES FIRST ORDER
FIRST ORDER RATE CONSTANT. UNITS ARE [time]$^{-1}$
NEGATIVE SIGN INDICATES CONC. IS DECREASING WITH TIME.

GOALS: DERIVE AN EQUATION FOR C_A AS A FUNCTION OF TIME IN ORDER TO:

1) CALCULATE CONCENTRATIONS AT SOME FUTURE TIME
2) CALCULATE TIME AT WHICH SOME CONC. WILL BE ACHIEVED

$$\frac{dc_A}{dt} = -kc_A$$

$$\frac{dc_A}{c_A} = -k\,dt$$

$$\int_{C_{A0}}^{C_A} \frac{dc_A}{c_A} = -k\int_0^t dt$$

@ $t=0$ C_A IS EQUAL TO A NON-ZERO NUMBER.

$$\ln C_A - \ln C_{A0} = -kt$$

$$\ln(C_A/C_{A0}) = -kt$$

$$C_A = C_{A0} e^{-kt}$$