



**CEN4415  
PROCESS DESIGN I**

## 2.2 Predicting Trends

In this method, there are four possible modifiers to a term in an equation.

1.  $\zeta$ : value remains constant.
2.  $\uparrow$ : value increases.
3.  $\downarrow$ : value decreases.
4.  $?$ : value change not known.

Each variable in an expression has one of these identifiers appended.

If  $x$  is a constant then  $x \rightarrow x(\zeta)$ .

# Example

For a bimolecular, elementary, gas-phase reaction, the rate expression is known to be  $-r_A = kC_A C_B$ .

- a. What is the effect on the reaction rate of increasing the reaction pressure by 10% while maintaining constant temperature?
- b. What is the effect on the reaction rate of increasing the reaction temperature by 10% while maintaining constant pressure?

## **SOLUTION :**

The goal is to determine the effect of increasing pressure on the reaction rate. The equation containing the unknown value, which is the reaction rate,  $r_A$ , is given. We need a relationship between pressure and at least one variable in the equation.

We have information, from the ideal gas law, that tells us that

$$C_i = P_i/RT,$$

where  $i$  is A or B.

Now that we have the necessary relationships, an intuitive understanding can be obtained by predicting trends.

a)

$$C_i(\uparrow) = y_i(\zeta)P(\uparrow)/R(\zeta)T(\zeta) = P_i(\uparrow)/R(\zeta)T(\zeta)$$

Moving to the rate expression, the resulting trend is predicted by

$$r_A(\uparrow) = k(\zeta)C_A(\uparrow)C_B(\uparrow)$$

which means that the reaction rate increases.

b)

$$C_i(\downarrow) = y_i(\uparrow)P(\uparrow)/R(\uparrow)T(\downarrow) = P_i(\uparrow)/R(\uparrow)T(\downarrow)$$

From the rate expression,

$$r_A(?) = k(\uparrow)C_A(\downarrow)C_B(\downarrow)$$

## REFERENCES

1. Sinnott, R.K. 1999, *Coulson's & Richardson's Chemical Engineering, Volume 6, Chemical Engineering Design*, ButterWorth Heinemann, Oxford.
2. Turton R., Bailie R.C., Whitin W.C., Shaeiwitz J.A. 1998, *Analysis, Synthesis and Design of Chemical Processes*, Prentice Hall, New Jersey.