

14.1 A clogged fuel injector decreases car performance because the larger uneven drops created by a clogged injector have less surface area, decreasing the rate of combustion.

14.2 a) True. Since the concentration of x is increasing, it is a product.

b) False. As represented by the decreasing slope of the line, the rate of the reaction is decreasing over time.

c) True. The average rate of the reaction is greater between points 1 and 2 than points 1 and 3 because the reactants are continually being consumed so the reaction is continually slowing down.

d) False. A downward turn in the graph would indicate that product is being consumed.

14.3 Given the graph representing the concentration of reactants and products, we see that the concentration of product A is increasing more rapidly than the rate at which reactant B is consumed. As such, $B \Rightarrow 2A$ is the most likely equation for this reaction.

- 14.4 a) The reaction is occurring at a constant rate between time 0 and 15 min, as represented by the constant slope during this time.
- b) The reaction is complete after 15 minutes, as represented by the constant concentration of product after $T \approx 15$.

14.17 a) Reaction rate is speed of a chemical reaction measured in change in reactant or product per unit time.

b) Reaction rate is affected by concentration, temperature, surface area, and the presence of a catalyst.

c) The rate of disappearance of the reactants is not always equal to the rate of appearance of reactants. It depends on the stoichiometry of the reaction.

14.18 a) Reaction rate is typically measured in M/s .

b) In everyday experience we know that the cold temperatures found in a refrigerator cause the chemical rotting process to slow and the hotter an oven is the faster the food in it will cook...can you tell I was hungry when I wrote this?

c) Average rate is the speed of a reaction over a period of time; instantaneous rate is the speed of a reaction at any particular moment.

14.19 a & b)

Time (min)	0	10	20	30	40
Moles A	0.065	0.051	0.042	0.036	0.031
Moles B	0	0.014	0.023	0.029	0.034
[A]	0.65	0.51	0.42	0.36	0.31
rate = $\Delta[A]/\Delta t$		2.3×10^{-4}	1.5×10^{-4}	1.0×10^{-4}	0.8×10^{-4}

14.19 c)

$$\text{rate} = \Delta[A]/\Delta t = (0.36M - 0.51M)/20\text{min}(1200\text{sec}) = 1.25 \times 10^{-4} M/s$$

$$14.23 \text{ a) } \text{rate} = \frac{-\Delta[\text{H}_2\text{O}_2]}{\Delta t} = \frac{\Delta[\text{H}_2]}{\Delta t} = \frac{\Delta[\text{O}_2]}{\Delta t}$$

$$\text{c) } \text{rate} = \frac{-\Delta[\text{N}_2]}{\Delta t} = \frac{-\Delta[\text{H}_2]}{3\Delta t} = \frac{\Delta[\text{NH}_3]}{2\Delta t}$$

$$14.24 \text{ b) } \text{rate} = \frac{-\Delta[\text{SO}_2]}{2\Delta t} = \frac{-\Delta[\text{O}_2]}{\Delta t} = \frac{\Delta[\text{SO}_3]}{2\Delta t}$$

$$\text{d) } \text{rate} = \frac{-\Delta[\text{N}_2]}{\Delta t} = \frac{-\Delta[\text{H}_2]}{2\Delta t} = \frac{\Delta[\text{N}_2\text{H}_4]}{\Delta t}$$

14.25a)

$$\frac{-\Delta[\text{H}_2]}{2\Delta t} = \frac{-\Delta[\text{O}_2]}{\Delta t} = \frac{\Delta[\cancel{\text{H}_2\text{O}}]}{2\Delta t}$$

$$\frac{-(-0.48M)}{2s} = -x$$

$$x = -0.24M/s$$

$$\frac{-\Delta[\text{H}_2]}{2\Delta t} = \frac{-\Delta[\cancel{\text{O}_2}]}{\Delta t} = \frac{\Delta[\text{H}_2\text{O}]}{2\Delta t}$$

$$\frac{-(-0.48M)}{2s} = \frac{x}{2}$$

$$x = 0.48M/s$$

14.25b)

$$\frac{-\Delta[\text{NO}]}{2\Delta t} = \frac{-\Delta[\text{Cl}_2]}{\Delta t} = \frac{\Delta[\cancel{\text{NOCl}}]}{2\Delta t}$$

$$\frac{-(-56\text{torr})}{2\text{min}} = -x$$

$$x = -28 \text{ torr/min}$$

$$\frac{-\Delta[\text{NO}]}{2\Delta t} = \frac{-\Delta[\cancel{\text{Cl}_2}]}{\Delta t} = \frac{\Delta[\text{NOCl}]}{2\Delta t}$$

$$\frac{-(-56\text{torr})}{2\text{min}} = \frac{x}{2}$$

$$x = 56 \text{ torr/min}$$

The total change in pressure is the sum of the changes in partial pressures. Since NO is decreasing at 56 torr/min, Cl₂ is decreasing at 28 torr/min and NOCl is increasing at 56 torr/min the total change in pressure is a net decrease of 28 torr/min.