Q# 1–10 pg. 360

$A + 2B \rightarrow 3C + 4D$

$t = 14.7\,min \times 60 = 882\,s$

1. $r = \frac{\Delta A}{\Delta t} = \frac{0.0206\,mol/L - 0.0415\,mol/L}{882\,s}$

$= \frac{-0.0209\,mol/L}{882\,s}$

$= -2.3696 \times 10^{-5}\,\frac{mol/L}{s}$.

$r_B = -2.3696 \times 10^{-5}\,\frac{mol\,A}{L\,A\,s} \times \frac{2\,mol\,B}{1\,mol\,A}$

$= -4.74 \times 10^{-5}\,\frac{mol\,B}{L \cdot s}$

∴ the rate of consumption of B is $4.74 \times 10^{-5}\,\frac{mol}{L \cdot s}$.

2. $rate = \frac{\Delta c}{\Delta t}$

$= \frac{3.25 \times 10^{-2}\,mol/L - 5.00 \times 10^{-2}\,mol/L}{85\,s - 60\,s}$

$= \frac{-0.0175\,mol/L}{25\,s}$

$= -0.00070\,\frac{mol}{L \cdot s}$

∴ the average rate of reaction is $-7.0 \times 10^{-4}\,\frac{mol}{L \cdot S}$ or $-0.00070\,\frac{mol}{L \cdot S}$.

3. $Br_2\,(aq) + HCOOH\,(aq) \rightarrow 2Br^-\,(aq) + 2H^+\,(aq) + CO_2\,(g)$

$5.50 \times 10^{-4}\,mol/s$

a) $t = 5\,min \times \frac{60\,s}{min}$

$= 300\,s$

$n_{CO_2} = 5.50 \times 10^{-4}\,\frac{mol}{s} \times 300\,s$

$= 0.165\,mol$

b) $r_{Br_2} = 5.50 \times 10^{-4}\,\frac{mol\,CO_2}{s} \times \frac{1\,mol\,Br_2}{1\,mol\,CO_2}$

$= 5.50 \times 10^{-4}\,\frac{mol\,Br_2}{s}$

$n_{Br_2} = 0.165\,mol$

∴ 1:1 ratio it's the same

4. rate $= -\frac{\Delta c}{\Delta t}$

$\Delta c = -\text{rate} \cdot \Delta t$

$= -\left(0.045 \frac{mol}{L \cdot s}\right)\left(2.0 \min - 1.5 \min\right)$

$= -\left(0.045 \frac{mol}{L \cdot s}\right)\left(0.5 \min\right)$ → $0.5 \min \times 60$

$= -0.045 \frac{mol}{L \cdot s} \times 30 s$

$= -1.35 \frac{mol}{L}$

The change in concentration from 2min to 1.5min was $-1.35 \frac{mol}{L}$

but at 2min it was $4.0 \times 10^{-2} \frac{mol}{L}$

f - 2min
i - 1.5 min

$\Delta c = C_f - C_i$

$-1.35 \frac{mol}{L} = 4.0 \times 10^{-2} \frac{mol}{L} - C_i$

$C_i = 4.0 \times 10^{-2} \frac{mol}{L} + 1.35 \frac{mol}{L}$

$= 1.39 \frac{mol}{L}$

$= 1.4 \frac{mol}{L}$ (sf)

∴ the concentration at 1.5 min was $1.4 \frac{mol}{L}$.

5. $Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)}$

t = 1.0 min = 60 s
V = 30.0 mL = 0.03 L

t = 1.4 min = 84 s
V = 42.0 mL = 0.042 L

$\text{rate}_{H_2} = \frac{\Delta c}{\Delta t}$

$= \frac{(0.042 L - 0.03 L)}{84 s - 60 s}$

$= \frac{0.012 L}{24 s}$

$= 0.00050 \frac{L}{s}$ or $5.0 \times 10^{-4} \frac{L}{s}$

∴ the average rate of formation of H_2 is $5.0 \times 10^{-4} \frac{L}{s}$

6. $3BrO^-(aq) \rightarrow BrO_3^-(aq) + 2Br^-(aq)$

$r_{e\,2.0min} = 0.12 \frac{mol}{L \cdot s}$

$r_{BrO_3^-} = 0.12 \frac{mol}{L \cdot s} Br^- \times \frac{1 mol\ BrO_3^-}{2 mol\ Br^-}$

$= 0.060 \frac{mol}{L \cdot s} BrO_3^-$

∴ the rate of formation of BrO_3^- is $0.060 \frac{mol}{L \cdot s}$

$r_{BrO^-} = -0.12 \frac{mol}{L \cdot s} Br^- \times \frac{3 mol\ BrO^-}{2 mol\ Br^-}$

$= -0.18 \frac{mol}{L \cdot s} BrO^-$

∴ the rate of consumption of BrO^- is $0.18 \frac{mol}{L \cdot s}$

7. $4HBr(g) + O_2(g) \rightarrow 2Br_2(g) + 2H_2O(g)$

$t = 0s$: $0.42 \frac{mol}{L}$ ... $0 \frac{mol}{L}$

$t = 50.0s$: $0.26 \frac{mol}{L}$ ... ?

a) $r_{HBr} = \frac{\Delta c}{\Delta t}$

$= \frac{0.26 \frac{mol}{L} - 0.42 \frac{mol}{L}}{50.0s - 0s}$

$= \frac{-0.16 \frac{mol}{L}}{50.0s}$

$= -0.0032 \frac{mol}{L \cdot s}$ OR $-3.2 \times 10^{-3} \frac{mol}{L \cdot s}$

∴ the average rate of consumption of HBr is $3.2 \times 10^{-3} \frac{mol}{L \cdot s}$

b) $r_{Br_2} = 0.0032 \frac{mol\ HBr}{L \cdot s} \times \frac{2 mol\ Br_2}{4 mol\ HBr}$

$= 0.0016 \frac{mol\ Br_2}{L \cdot s}$.

$C_{at\ t=50.0s} = 0.0016 \frac{mol}{L \cdot s} \times 50.0s$

$= 0.080 \frac{mol}{L}$

∴ the concentration of Br_2 at 50.0s is $0.080 \frac{mol}{L}$

8. $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

$t = 1.80 min$

$r_{NO} = 1.04 \frac{mol}{L \cdot s}$

$t = 1.80 min \times 60$

$= 108 s$

$r_{O_2} = 1.04 \frac{mol}{L \cdot s} NO \times \frac{5 mol\ O_2}{4 mol\ NO}$

$= 1.30 \frac{mol}{}$

$C_{O_2} = 1.30 \frac{mol}{L \cdot s} \times 108 s$

$= 1.40 \times 10^2 \frac{mol}{}$

* can find concentration not moles (n)

$\therefore$ the concentration of oxygen consumed is $1.40 \times 10^{2} \frac{mol}{L}$

9. $2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$ + heat

$m = 0.50 g$
$t = 90.0 s$
$M = 22.990 \frac{g}{mol}$

$T = 30.0°C + 273.15$
$= 303.15 K$
$P = 102.4 kPa$

$$r_{Na} = 0.50 g \times \frac{1 mol}{22.990 g} \times \frac{}{90.0 s}$$

$$= 2.42 \times 10^{-4} \frac{mol}{s}$$

OR calculate r_{H_2} first and sub into $V = \frac{nRT}{P}$

b) $$n_{H_2} = 0.50 g\ Na \times \frac{1 mol\ Na}{22.990 g\ Na} \times \frac{1 mol\ H_2}{2 mol\ Na}$$

$$= 0.010874 mol$$

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$= \frac{(0.010874 mol)(8.314 \frac{L \cdot kPa}{mol \cdot K})(303.15 K)}{102.4 kPa}$$

$$= 0.26765 L$$

$$r_{H_2} = \frac{0.26765 L}{90.0 s}$$

$$= 2.97 \times 10^{-3} \frac{L}{s}$$

$\therefore$ the rate at which H_2 is generated is $2.97 \times 10^{-3} \frac{L}{s}$.

10. $2NO_{(g)} + Cl_{2(g)} \rightarrow 2NOCl_{(g)}$

$1.4 \frac{mol}{L \cdot s}$

$$r_{Cl_2} = 1.4 \frac{mol\ NO}{L \cdot s} \times \frac{1 mol\ Cl_2}{2 mol\ NO}$$

$$= 0.70 \frac{mol\ Cl_2}{L \cdot s}$$

$\therefore$ the rate of consumption of Cl_2 is $0.70 \frac{mol}{L \cdot s}$

$$r_{NOCl} = 1.4 \frac{mol\ NO}{L \cdot s} \times \frac{2 mol\ NOCl}{2 mol\ NO}$$

$$= 1.4 \frac{mol\ NOCl}{L \cdot s}$$

$\therefore$ the rate of formation of NOCl is $1.4 \frac{mol}{L \cdot s}$.