$$\mathbf{N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)}$$

Part A

$-1/3\ \Delta[H_2]/\Delta t = 1/2\ (\Delta[NH_3]/\Delta t)$

$-\Delta[H_2]/\Delta t = 3/2\ (\Delta[NH_3]/\Delta t) = 3/2\ (1.15\ \text{mmol}\ NH_3 \cdot L^{-1} \cdot h^{-1}) = 1.73\ \text{mmol}\ H_2 \cdot L^{-1} \cdot s^{-1}$

(**B**)

Part B

Unique average rate = $-(\Delta[N]/\Delta t) = -1/3\ (\Delta[H_2]/\Delta t) = ½\ (\Delta[NH_3]/\Delta t)$

$= 1/2\ (1.15\ \text{mmol}\ NH_3 \cdot L^{-1} \cdot h^{-1}) = 0.58\ \text{mmol} \cdot L^{-1} \cdot s^{-1}$

(**A**)

1s

Reaction rate order of SO_2 = 1^{st} order
Reaction rate order of SO_3 = $-1/2^{th}$ order
Overall reaction rate order $1-1/2 = 1/2^{th}$ order

(**A**)

Part 1

Original Rate = $k[NO]^x = 1$

Doubled Rate = $k[2(NO)]^x = 4$

Therefore the reaction order must be 2nd order **C**

Part 2

Original Rate = $k[NO]^2[O_2]^x = 1$

Doubled Rate = $k(4)[2(O_2)]^x = 8$

Therefore the reaction order must be 1st order **B**

Part 3

Rate = $k[NO]^2[O_2]$

Overall Rate = 2 +1 **D**

Rate = $k[CO]^x[Cl_2]^y$

Determine reaction order for CO by using equations 1 and 2

$$0.121 = k[0.12]^x[0.20]^y$$

$$0.241 = k[0.24]^x[0.20]^y$$

$$\frac{0.121 = k[0.12]^x[0.24]^y}{0.241 = k[0.24]^x[0.24]^y}$$

$$0.50 = \frac{[0.12]^x}{[0.24]^x} = [0.50]^x$$

$$\log(0.50) = x\log(0.50)$$

x = 1.00 therefore the reaction order of CO is first order

Determine reaction order for Cl_2 by using equations 2 and 3

$$0.241 = k[0.24][0.20]^y$$

$$0.682 = k[0.24][0.40]^y$$

$$\frac{0.241 = k[0.24][0.20]^y}{0.682 = k[0.24][0.40]^y}$$

$$0.353 = \frac{[0.20]^y}{[0.40]^y} = [0.50]^y$$

$$\log(0.353) = y\log(0.50)$$

y = 3/2 therefore the reaction order of Cl_2 is 3/2 order

Resulting Rate = $k[CO][Cl_2]^{3/2}$ the reaction order overall is 5/2 order

Determine k

Overall Rate = $k[CO][Cl_2]^{3/2}$

= $k[0.12\ mol\cdot L^{-1}][0.20\ mol\cdot L^{-1}]^{3/2} = 0.121\ mol\cdot L^{-1}\cdot s^{-1}$

k = 11.27 $L^{3/2}\cdot mol^{-3/2}\cdot s^{-1}$ **D**

4s

$[A]_t = [A]_o e^{-kt}$

$[A]_o = 0.20\ mol \cdot L^{-1}$

$t = 100\ ms = 0.1\ s$

$k = 3.4\ s^{-1}$

$[A]_t = [A]_o e^{-kt} = (0.20\ mol \cdot L^{-1}) e^{(-(2.4\ s-1)(0.1\ s-1))} = 0.14\ mol \cdot L^{-1}$

B