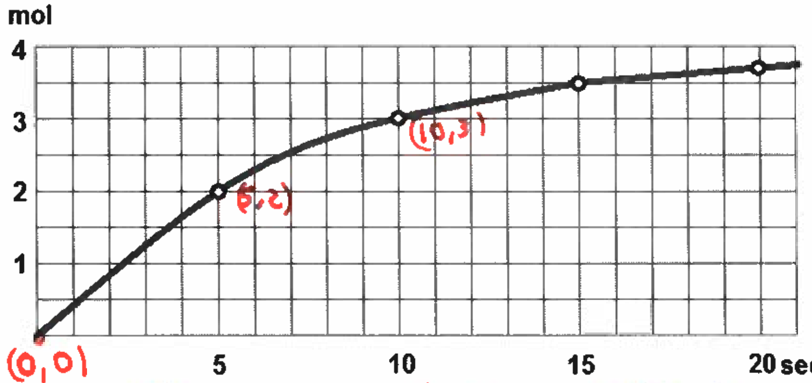
Rates **In-class practice** Name: Answers.

1. From the data in the following graph, calculate (a) the average rate of reaction for the first 5s.
(b) the average rate of reaction between 5s & 10s.



(a) $rate = \frac{2-0}{5-0} = \frac{2}{5} = 0.4\ mol/s$ (b) $rate = \frac{3-2}{10-5} = \frac{1}{5} = 0.2\ mol/s$

2. Write the predicted rate law for each reaction below.
What would happen if the 1st reactant concentration were to double?

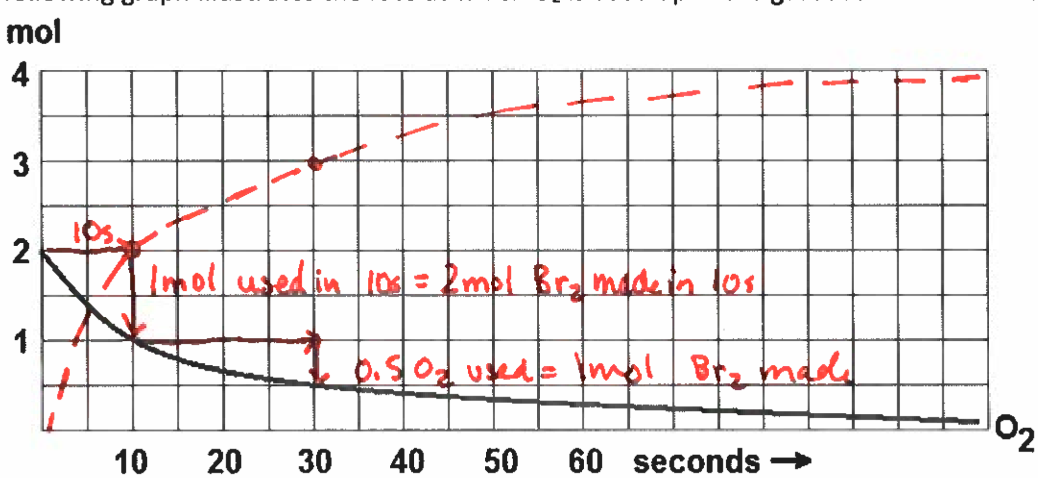
a. $4\,NH_3 + 5\,O_2 \rightarrow 4\,NO + 6\,H_2O$ $rate = k[NH_3]^4[O_2]^5$ ×16

b. $NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$ $rate = k[NaOH][HCl]$ ×2

c. $H_2SO_{4(aq)} + 2KOH_{(aq)} \rightarrow K_2SO_{4(aq)} + H_2O_{(l)}$ $rate = k[H_2SO_4][KOH]^2$ ×2

d. $4HBr_{(g)} + O_{2(g)} \rightarrow 2Br_{2(g)} + 2H_2O_{(g)}$ $rate = k[HBr]^4[O_2]$ ×16

3. The following graph illustrates the rate at which O_2 is used up in the gaseous reaction $\mathbf{4HBr + O_2 \rightarrow 2Br_2 + 2H_2O}$



a. Draw the curve illustrating the rate of appearance of Br_2.
b. Calculate the average rate of disappearance of O_2 over the first 10 seconds $rate = \frac{1mol}{10} = -0.1\ mol/s$
c. Calculate the average rate of production of Br_2 during the same time $0.1 \times 2 = 0.2\ mol/s$
d. Calculate the average rate of disappearance of HBr during this time $-0.1 \times 4 = -0.4\ mol/s$
e. Calculate the rate of appearance of H_2O during this time $0.1 \times 2 = 0.2\ mol/s$

4. Find the rate expression using the data below. You must show calculations to justify your answer.

[A] mol/L	[B] mol/L	Rate (mole/L•s)
1.50	1.50	3.20×10^{-1}
1.50	4.50	2.88
3.00	1.50	6.40×10^{-1}

Rate = k $[A]^{x?}$ $[B]^{y?}$

$$\frac{\text{rate 3}}{\text{rate 1}} = \frac{0.640}{0.320} = \frac{\cancel{k}(3.00)^x \cancel{(1.50)^y}}{\cancel{k}(1.50)^x \cancel{(1.50)^y}} \qquad \frac{\text{rate 2}}{\text{rate 1}} = \frac{2.88}{0.32} = \frac{\cancel{k}\cancel{(1.50)^x}(4.50)^y}{\cancel{k}\cancel{(1.50)^x}(1.50)^y}$$

$2 = 2^x$ $\qquad$ $9 = 3^y$

$x = 1$ $\qquad$ $\boxed{\text{rate} = k[A]^1[B]^2}$ $\qquad$ $y = 2$

$2.88 = k(1.50)(4.50)^2$

$k = 0.0948 \frac{L^2}{mol^2 s}$ or $9.48 \times 10^{-2} \frac{1}{M^2 s}$

5. Given the reaction $3H_2 + N_2 \rightarrow 2 NH_3$.

The graph below shows the amount of nitrogen (in mols) present over a period of time.

On the same graph, draw a curve showing the amount of ammonia (NH_3) present (in mols) during the same time period. You must show at least 4 data points.

You may assume that there was no ammonia present in the container before the reaction began.