Worksheet 1-1
- Measuring Reaction Rates

Name - Key
Due Date - _____

Answer the questions in the space provided. You must show all of your work to receive full marks. All answers MUST be rounded to the correct number of Sig. Figures.

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1. A chemist wishes to determine the rate of reaction of zinc with hydrochloric acid. The equation for the reaction is:

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + ZnCl_{2(aq)}$$

A piece of zinc is dropped into 1.00 L of 0.100 M HCl and the following data were obtained:

Time	Mass of Zinc
0 s	0.016 g
4 s	0.014 g
8 s	0.012 g
12 s	0.010 g
16 s	0.008 g
20 s	0.006 g

a) Calculate the ***Rate of Reaction*** in *grams of Zn consumed per second.*

$\frac{\Delta \text{mass Zn}}{\Delta \text{time}} = \frac{0.016 - 0.006}{20\text{s}} = \frac{0.01}{20}$

Answer 5.0×10^{-4} g/s

b) Calculate the ***Rate of Reaction*** in *moles of Zn consumed per second.*

$5.0 \times 10^{-4}\ \frac{\text{g}}{\text{s}} \times \frac{1\ \text{mol}}{65.4\ \text{g}} = 7.6 \times 10^{-6}$

Answer 7.6×10^{-6} mol/s

c) Write out the complete ionic equation for the reaction.

$Zn(s) + 2H^+(aq) + 2Cl^-(aq) \rightarrow H_2(g) + Zn^{2+}(aq) + 2Cl^-(aq)$

d) What will happen to the $[H^+]$ as the reaction proceeds? decrease

e) What will happen to the $[Cl^-]$ as the reaction proceeds? nothing, it is a spectator ion.

2. When magnesium is reacted with dilute hydrochloric acid (HCl), a reaction occurs in which hydrogen gas and magnesium chloride is formed.

   a) Write a ***balanced formula equation*** for this reaction.

   $Mg_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + MgCl_2$

   b) If the rate of consumption of magnesium is 5.0×10^{-9} mol/s, find the *mass of Mg consumed in 5.0 minutes.*

   $x\,g\,Mg = 5.0\times10^{-9}\,\frac{mol}{s} \times \frac{24.3\,g}{1\,mol} \times \frac{60\,s}{1\,min} \times 5\,min$

   Answer $3.6\times10^{-5}\,g$

3. Given the reaction:

   $CO_{2(g)}$ (colourless) + $NO_{(g)}$ (colourless) → $CO_{(g)}$ (colourless) + $NO_{2(g)}$ (brown)

   Suggest a method which could be used to *monitor* the rate of this reaction.

   Change in colour. Colourless → brown

   Why wouldn't total pressure be a good way to monitor the rate of this reaction?

   Same moles of gas produced as consumed ie. pressure will not change

4. Equal volumes of $Fe^{2+}_{(aq)}$ and $C_2O_4^{2-}_{(aq)}$ are individually reacted with 0.10 M $MnO_4^-{}_{(aq)}$, and the following data were obtained:

Reactant	Concentration	Temperature	Time for complete reaction
Fe^{2+}	0.20 M	25°C	1.6 s
$C_2O_4^{2-}$	0.40 M	35°C	17.0 s

   Explain in detail why these results are obtained.

   Fe^{2+} is an aqueous ion & no bonds need to be broken in it. ∴ it will react faster even though it is at a lower conc. and temp.

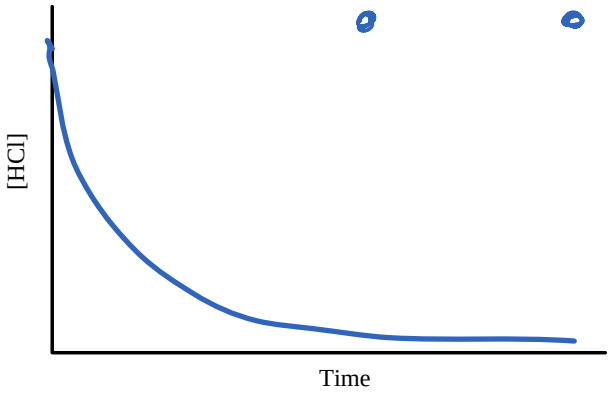
5. Given the $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(\ell)}$ reaction:

explain why this reaction is very slow at room temperature. (1 mark)

The gases are diatomic and have covalent bonds which are strong and hard to break.

6. On the following set of axes, draw the shape of the curve you would expect if you plotted the ***[HCl]*** *vs.* ***Time***, starting immediately after the two reactants are mixed. The equation for the reaction is:

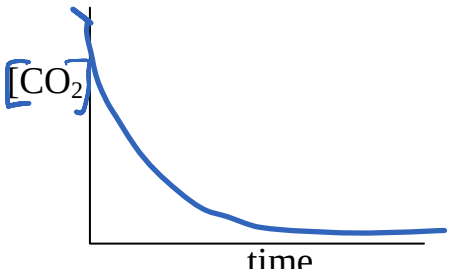
$$Mg_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + MgCl_{2(aq)}$$

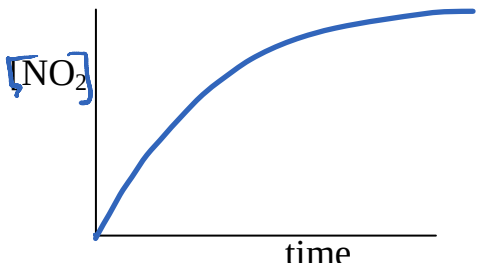


Explain how you got that particular shape. Be detailed.

- Starting with HCl and as rxn proceeds it gets used ∴ lowering the conc.
As the [HCl] lowers the rxn will go slower

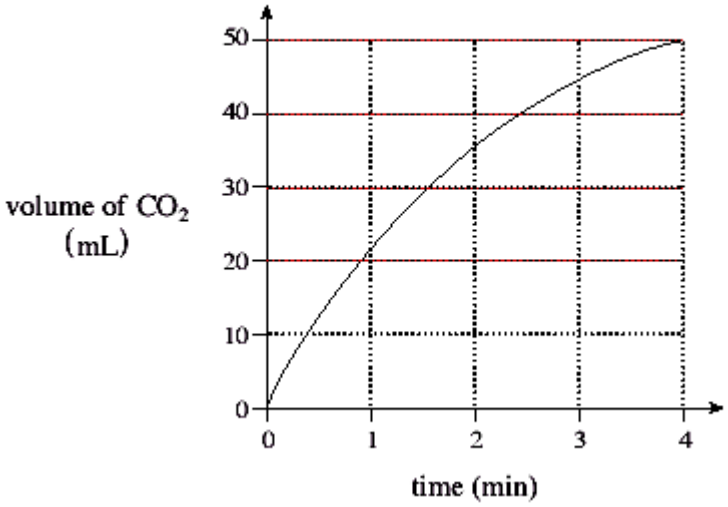
7. Given the reaction: $CO_{2(g)} + NO_{(g)} \rightarrow CO_{(g)} + NO_{2(g)}$, sketch the shapes of the curves on the following graphs assuming that some CO_2 and NO is placed in a closed container and left to react. (2 marks)





8. Given the following reaction and graph:

$$CaCO_{3(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(\ell)}$$



a) Calculate the average rate of reaction in mL CO_2 /min for the time interval 0 – 2 min. (2 marks)

$\frac{\Delta vol}{\Delta time} = \frac{35-0}{2} \rightarrow 17.5\ mL/min$

Answer 17.5 mL/min

b) Calculate the average rate of reaction in mL CO_2 /min for the time interval 2 – 4 min. (2 marks)

$\frac{\Delta vol}{\Delta time} = \frac{30-35}{2} = 7.5$

Answer 7.5 mL/min

c) Explain why the rate in (b) is less than the rate in (a) (1 mark)

the [HCl] is decreasing, as [reactants]↓, rxn rate↓

9. Given the reaction: **$Sn_{(s)} + 2\ HCl_{(aq)} \rightarrow H_{2(g)} + SnCl_{2(aq)}$**
Give 4 methods by which the rate of this reaction could be increased (4 marks)

↑ SA of Sn

↑ [HCl]

↑ temp of rxn

↑ add a catalyst.

10. The following table relates the ***time*** and the ***mass of Zn*** during the reaction between Zn and 0.5M HNO_3 :

$$Zn_{(s)} + 2HNO_{3\,(aq)} \rightarrow H_{2(g)} + Zn(NO_3)_{2(aq)}$$

Time	Mass of Zn (g)
0.0 s	*36.2 g*
60.0 s	*29.6 g*
120.0 s	*25.0 g*
180.0 s	*22.0 g*

a) Calculate the reaction rate, in g/s, from time 0 to 60 s.

$\frac{36.2-29.6}{60} = 0.11\ g/s$

b) Calculate the reaction rate, in g/s, from time 120s to 180 s.

$\frac{25.0-22}{60} = 0.050\ g/s$

c) Explain why the rate in calculation "b" is less than that of calculation "a".

As [aHNO3] goes down the reaction rate will decrease

11. Give ***two*** reasons why *water* is effective at putting out fires. Use concepts learned in this unit so far.

Water can decrease temp of the rxn

Water removes O_2 as a reactant

12. Consider the *rate* of the following reaction:

$$Fe_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + FeCl_{2(aq)}$$

a) Is rate dependent on *temperature*? Yes. Explain your answer.

As temp ↑, rate ↑ in all rxns

b) Is rate dependent on *pressure*? No. Explain your answer.

none of the reactants are gas

c) Is rate dependent on *surface area*? yes. Explain your answer.

heterogeneous

13. Consider the *rate* of the following reaction:

$$2NaOCl_{(aq)} \rightarrow 2NaCl_{(aq)} + O_{2(g)}$$

a) Is rate dependent on *temperature*? yes. Explain your answer.

all rxns are dep. on temp.

b) Is rate dependent on *pressure*? no. Explain your answer.

no gas reactants

c) Is rate dependent on *surface area*? no. Explain your answer.

homogeneous

c) Is rate dependent on *[NaOCl]*? yes. Explain your answer.

↑ [NaOCl] will ↑ rxn rate