Answers.

Chemistry 12 Rates of Reaction Worksheet #1

1. Consider: $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

   If the rate of formation of NH_3 is 9.0×10^{-4} mol/s, then what is the rate of consumption of N_2?

   4.5×10^{-4} mol/s

2. Suggest 2 specific changes that would increase the rate of rusting of a piece of iron.

   increase temperature, increase surface area of iron, increase O_2 concentration, add a catalyst

3. Consider:

   (I) concentration of reactants
   (II) temperature of reactants
   III surface area of reactants — not between 2 gases.

   Which factor(s) affect the rate of a chemical reaction between 2 gases?

4. Consider: $2NO_{2(g)} \longrightarrow 2NO_{(g)} + O_{2(g)}$

   What is the rate of formation of O_2 if, under certain conditions, the rate of decomposition of NO_2 is 3.2×10^{-3} mol/sec? 1.6×10^{-3} mol/sec

5. Consider:

   I $N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$ Homogeneous reaction
   (II) $2Mg_{(s)} + O_{2(g)} \longrightarrow 2MgO_{(s)}$
   (III) $CaCO_{3(s)} + 2H^+_{(aq)} \longrightarrow Ca^{2+}_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

   Which reaction rate(s) will increase if the surface area is increased?

6. Consider:

   (I) frequency of successful collisions
   II volume of reaction vessel
   III pressure of the system
   IV mass of system

   Which condition(s) must increase to increase the rate of the reaction?

7. Consider:

   I pressure per mole
   II energy consumed per mole
   (III) volume of gas per unit time
   IV moles formed per litre of solution

   Which is(are) an expression of the rate of a chemical reaction?

8. Give an example of a heterogeneous reaction and list four different factors that affect the rate of this reaction.

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

   1. Temperature
   2. Concentration of HCl
   3. Surface area of Mg

9. Consider the reaction:

$$C_2H_{4(g)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 2H_2O$$

At certain conditions, 0.15 mol CO_2 is produced in 2.0 minutes. What is the rate of consumption C_2H_4 of in g/s? $0.15\ mol\ CO_2 \times \frac{1\ mol\ C_2H_4}{2\ mol\ CO_2} = 0.075\ mol\ C_2H_4$ in 2.0 min.

10. Consider the following reaction: $0.075\ mol \times \frac{28.0\ g}{1\ mol} = 2.1\ g$ in $120\ s = 0.018\ g/s$

$$C_{12}H_{22}O_{11(s)} \longrightarrow 11\ H_2O_{(g)} + 12C_{(s)}$$

The rate of decomposition of $C_{12}H_{22}O_{11(s)}$ is 0.75 mol/min. What mass of C is produced in 10.0 seconds? $0.75\ mol/min \times \frac{12\ mol\ C}{1\ mol\ C_{12}H_{22}O_{11}} = 9.0\ mol/60\ s = 9.0\ mol \times \frac{12.0\ g}{1\ mol} = 108/60. = 18\ g$ in 10.0 s

11. The mass of a burning candle is monitored to determine the rate of combustion of paraffin. An accepted reaction for the combustion of paraffin is:

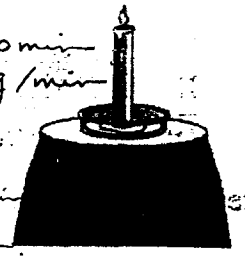
$$2C_{28}H_{58(s)} + 85O_{2(g)} \longrightarrow 58\ H_2O_{(g)} + 56CO_{2(s)}$$

a) Calculate the average rate of consumption of paraffin in g/min for the time interval 12.0 to 24.0 minutes. $24.5 - 23.4\ g = 1.1\ g / 12.0\ min = 0.092\ g/min$

FW $C_{28}H_{58} = 394.0\ g/mol$

b) Calculate to rate of CO_2 production in mol/min for the time interval 12.0 to 24.0 minutes. $0.092\ g \times \frac{1\ mol}{394.0\ g} = 2.34 \times 10^{-4}\ mol/min$

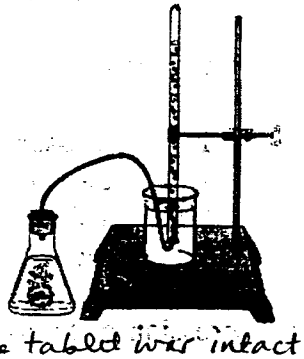
$2.34 \times 10^{-4}\ mol \times \frac{56\ mol\ CO_2}{2\ mol\ C_{28}H_{58}} = 6.5 \times 10^{-3}\ mol/min$



The following data is observed:

Time (min)	Mass (g)
0.0	25.6
6.0	25.1
12.0	24.5
18.0	23.9
24.0	23.4
30.0	22.8

12. An Alka-seltzer tablet is added to water to produce carbon dioxide gas. The gas was collected using water displacement.



The following data is recorded:

Time (s)	Volume of CO_2 (mL)
0.0	0
10.0	3.0
20.0	20.0
30.0	33.5
40.0	43.0
50.0	43.0
60.0	43.0

a) Calculate the average rate of reaction for the formation of CO_2 gas for the times:

i) 0-10 seconds $\frac{3.0\ mL}{10.0\ s} = 0.30\ mL/s$

ii) 10-20 seconds $\frac{20.0 - 3.0}{10.0\ s} = 1.70\ mL/s$

b) Suggest a reason why the rate of reaction from 0-10 seconds is slower than the rate from 10.0-20.0 seconds. The tablet was intact (whole) from 0-10 s meaning a smaller surface area and thus a slower rate, whereas from 10-20 s the tablet broke apart, increasing SA and thus increasing collision frequency and rate.

c) The rate of reaction is not constant during the entire interval from 10.0 s to 40.0 s. Describe the change in rate and explain a reason for the change.

Time interval	Rate
10.0 – 20.0 s	1.70 mL/s
20.0 – 30.0 s	1.35 mL/s
30.0 – 40.0 s	0.95 mL/s

The rate decreases from 10.0 – 40.0 s. The [reactant] decreased as the tablet was consumed, resulting in decreased collision frequency & thus decreased rate.