Name: _____ Date: _____

CHE-112 – CHAPTER 13 – PRACTICE QUESTIONS

1. Express the rate of the following reaction equation in terms of the rate of concentration change of NO_2Cl:

   $2\ NO_2\ (g) + Cl_2\ (g) \longrightarrow 2\ NO_2Cl\ (g)$

   A) rate of reaction = $\Delta[Cl_2]/\Delta t$
   B) rate of reaction = $-\ ½\ (\Delta[NO_2Cl]/\Delta t)$
   C) rate of reaction = $\ ½\ (\Delta[NO_2Cl]/\Delta t)$
   D) rate of reaction = $-\ ½\ (\Delta[NO_2]/\Delta t)$

2. Express the rate of the following reaction equation in terms of the rate of concentration change of $CHCl_3$:

   $CHCl_3\ (g) + Cl_2\ (g) \longrightarrow CCl_4\ (g) + HCl$

   A) rate of reaction = $\Delta[CCl_4]/\Delta t$
   B) rate of reaction = $2(\Delta[CHCl_3]/\Delta t)$
   C) rate of reaction = $\Delta[CHCl_3]/\Delta t$
   D) rate of reaction = $-\Delta[CHCl_3]/\Delta t$

3. Let the rate of the reaction described by the equation

   $$H_2\ (g) + Br_2\ (g) \longrightarrow 2\ HBr\ (g)$$

   be expressed as $-\Delta[Br_2]/\Delta t$. Express the rate of reaction in terms of the rate of concentration change of HBr.

   A) rate of reaction = $-\ ½\ \Delta[HBr]/\Delta t$
   B) rate of reaction = $-\Delta[H_2]/\Delta t$
   C) rate of reaction = $\ ½\ \Delta[HBr]/\Delta t$
   D) rate of reaction = $2\Delta[HBr]/\Delta t$

4. Let the rate of the reaction described by the equation

$$H_2\,(g) + 2\,ICl\,(g) \longrightarrow 2\,HCl\,(g) + I_2\,(g)$$

be expressed as $\Delta[I_2]/\Delta t$. Express the rate of reaction in terms of the rate of concentration change of ICl.

A) rate of reaction = $\Delta[ICl]/\Delta t$
B) rate of reaction = $-\frac{1}{2}\,\Delta[ICl]/\Delta t$
C) rate of reaction = $-\Delta[ICl]/\Delta t$
D) rate of reaction = $-2\Delta[ICl]/\Delta t$

5. The rate law for the reaction described by the equation

$$N_2O_5\,(g) \longrightarrow 2\,NO_2\,(g) + \tfrac{1}{2}\,O_2\,(g)$$

at 343 K is first order in $[N_2O_5]$ with a rate constant $k = 1.80\ h^{-1}$. Given that $[N_2O_5]_0 = 0.112$ M, calculate the rate of the reaction at $t = 0$.

A) $0.112\ M.h^{-1}$
B) $0.202\ M.h^{-1}$
C) $1.80\ M.h^{-1}$
D) $69.1\ M.h^{-1}$

6. The rate law for the reaction described by the equation

$$NO_2\,(g) \longrightarrow NO\,(g) + \tfrac{1}{2}\,O_2\,(g)$$

at 598 K is:

$$\text{rate of reaction} = (0.54\ M^{-1}.s^{-1})[NO_2]^2$$

Given that $[NO_2]_0 = 8.33 \cdot 10^{-2}$ M, calculate the rate of the reaction at $t = 0$ s.

A) $3.7 \cdot 10^{-2}\ M.s^{-1}$
B) $8.3 \cdot 10^{-2}\ M.s^{-1}$
C) $3.7 \cdot 10^{-3}\ M.s^{-1}$
D) $6.9 \cdot 10^{-3}\ M.s^{-1}$

7. The rate law for the reaction described by the equation

$$CHCl_3\ (g) + Cl_2\ (g) \longrightarrow CCl_4\ (g) + HCl\ (g)$$

is:

$$\text{rate of reaction} = k[CHCl_3][Cl_2]^{1/2}$$

What is the overall order of this reaction?

A) 1
B) 2
C) 3/2
D) 5/2

8. Nitrogen monoxide and oxygen react according to the reaction equation

$$2\ NO\ (g) + O_2\ (g) \longrightarrow 2\ NO_2\ (g)$$

Using the following initial rate data, determine the rate constant for the reaction.

Run	**$[NO]_0$/M**	**$[O_2]$/M**	**Initial rate of formation of NO_2 (g)/MDs^{-1}**
1	0.0228	0.0105	$1.35 \cdot 10^{-5}$
2	0.0456	0.0105	$5.40 \cdot 10^{-5}$
3	0.0228	0.0210	$2.70 \cdot 10^{-5}$

A) 2.47 $M^{-2}.s^{-1}$
B) 0.0564 $M^{-2}.s^{-1}$
C) $1.35 \cdot 10^{-3}$ $M^{-2}.s^{-1}$
D) 1.23 $M^{-2}.s^{-1}$

9. Hydrogen peroxide decomposes according to the reaction equation

$$2\ H_2O_2\ (aq) \longrightarrow 2\ H_2O\ (l) + O_2\ (g)$$

This reaction is first order in $[H_2O_2]$ at 70°C with a rate constant of $k = 0.0444\ \text{min}^{-1}$. If the initial concentration is $[H_2O_2]_0 = 0.25$ M, then what is the value of $[H_2O_2]$ 45.0 minutes after the solution is prepared?

A) 0.0043 M
B) 0.035 M
C) 0.055 M
D) 0.15 M

10. Argon-41 is a γ-emitter with a half-life of 109.2 minutes. What fraction of a sample of Ar-41 remains after 37.5 hours?

A) $6.29 \cdot 10^{-7}$
B) $7.70 \cdot 10^{-7}$
C) $4.09 \cdot 10^{-6}$
D) $6.92 \cdot 10^{-6}$

11. If a sample of sodium-24 chloride contains 0.075 mg of sodium-24, how much sodium-24 remains after 9.63 hours? The half-life of sodium-24 is 14.96 hours.

A) 0.027 mg
B) 0.048 mg
C) 0.072 mg
D) 0.084 mg

12. You order a sample of Na_3PO_4 containing the radioisotope phosphorus-32 ($t_{1/2}$ = 14.28 days) on Monday. You don't get to it until Thursday, 3.0 days after it was prepared and shipped. How much of the activity remains in your sample?

A) 15%
B) 32%
C) 69%
D) 87%

13. The gas-phase decomposition of CH_3CHO (g) occurs according to the equation

$$CH_3CHO\ (g) \longrightarrow CH_4\ (g) + CO\ (g)$$

The reaction is second order with $k = 0.105\ M^{-1}.s^{-1}$ at 490°C. If the concentration of CH_3CHO (g) is 0.022 M initially, what will its concentration be 4.3 minutes later?

A) 0.0013 M
B) 0.0089 M
C) 0.014 M
D) 0.020 M

14. The rate law for the reaction described by the equation

$$2\ N_2O\ (g) \longrightarrow 2\ N_2\ (g) + O_2\ (g)$$

is second order in N_2O (g). The reaction was carried out at 900 K with an initial concentration of N_2O (g) of $3.5 \cdot 10^{-2}$ M. If it took 91.3 minutes for $[N_2O]$ to fall to half it original value, what is the value of the rate constant for this reaction?

A) $3.5 \cdot 10^{-3}\ M^{-1}.s^{-1}$
B) $4.8 \cdot 10^{-3}\ M^{-1}.s^{-1}$
C) $5.2 \cdot 10^{-3}\ M^{-1}.s^{-1}$
D) $8.4 \cdot 10^{-3}\ M^{-1}.s^{-1}$

15. The rate law for the reaction described by the equation

$$A\ (g) \longrightarrow B\ (g) + C\ (g)$$

is second order in A (g) with an rate constant $k = 1.13 \cdot 10^{-2}\ M^{-1}.s^{-1}$ at 550 K. If the reaction is carried out at 550 K with an initial concentration of A (g) of $5.84 \cdot 10^{-2}$ M, how long will it take for [A] to fall to half it original value?

A) 1450 seconds
B) 1520 seconds
C) 1600 seconds
D) 1920 seconds

16. How does tripling the concentration of a reactant change the rate of a reaction that is second order in that reactant?
    A) The rate increases by a factor of three: $(3)^1$.
    B) The rate increases by a factor of six: (2)(3).
    C) The rate increases by a factor of eight: $(2)^3$.
    D) The rate increases by a factor of nine: $(3)^2$.

17. Cyclobutane, C_4H_8 (*g*), decomposes to ethylene, C_2H_4 (*g*), at 700 K:

$$C_4H_8\ (g) \longrightarrow 2\,C_2H_4\ (g)$$

    The reaction is first order in $[C_4H_8]$ with $k = 0.015\ \text{min}^{-1}$. If the initial concentration of C_4H_8 (*g*) is 1.33 M, what is its concentration after 5.5 minutes?
    A) 0.36 M
    B) 0.63 M
    C) 0.98 M
    D) 1.2 M

18. How long does it take for the concentration of a reactant to decrease by 25.6% of its initial value for a first-order reaction with $k = 1.35\ \text{min}^{-1}$?
    A) 13.1 s
    B) 0.200 min
    C) 1.01 min
    D) 21.9 s

19. If the half-life of uranium-238 is $4.47 \cdot 10^9$ years, then how long will it take for the amount of radioactivity in a sample to decrease to 0.050% of its original value?
    A) 5.74 half-lives
    B) 12.7 half-lives
    C) $1.93 \cdot 10^{10}$ years
    D) $4.90 \cdot 10^{10}$ years

20. Dinitrogen pentoxide decomposes according to the reaction equation

$$N_2O_5\ (g) \longrightarrow 2\ NO_2\ (g) + \tfrac{1}{2}\ O_2\ (g)$$

If the initial concentration of N_2O_5 (g) is $[N_2O_5]_0 = 0.832$ M, and if $[N_2O_5] = 0.166$ M at $t = 65.0$ min, then what is $[NO_2]$ at $t = 65.0$ min?

A) 0.525 M
B) 0.666 M
C) 1.05 M
D) 1.33 M

21. Incomplete initial rate data are given below for the reaction described by

$$2\ NO_2\ (g) \longrightarrow 2\ NO\ (g) + O_2\ (g)$$

Run	$[NO_2]_0$/M	(rate of reaction)$_0$/ MDs^{-1}
1	1.10	0.65
2	1.60	1.38
3	2.25	x

What is the rate of reaction, x, for Run 3?

A) 1.53 M.s^{-1}
B) 2.22 M.s^{-1}
C) 2.73 M.s^{-1}
D) 2.89 M.s^{-1}

22. How does halving the concentration of a reactant change the rate of a reaction that is first order in that reactant?

A) The rate decreases by a factor of two: $(1/2)^1$.
B) The rate does not change: $(1)^{1/2}$.
C) The rate increases by a factor of 1.4: $(2)^{1/2}$.
D) The rate increases by a factor of two: $(2)^1$.

23. If plotting your rate data as ln[A] vs. t results in a straight line, then which of the following represents the slope (m) of that line?
    A) $-k$
    B) $\ln[A]_0$
    C) $1/k$
    D) $1/[A]_0$

Answer Key - Chapter 13 Practice Problems

1. C
2. D
3. C
4. B
5. B
6. C
7. C
8. A
9. B
10. A
11. B
12. D
13. C
14. C
15. B
16. D
17. D
18. A
19. D
20. D
21. C
22. A
23. A