Dear students,

For work related to organic chemistry structures and nomenclature, the following link is a useful molecule drawing tool that will tell you the preferred IUPAC name for any molecule you can think of: http://www.chemaxon.com/marvin/sketch/index.jsp

And, it is kind of fun to play with. I used it to make the figures for problems 26-28.

Cheers,
Travis

1. Consider the reaction below:

$C_6H_{12}O_6(s) + 12\ O_2(g) \rightarrow 6\ CO_2(g) + 6\ H_2O(g)$

Which of the following is an incorrect expression of the rate?

1. rate = $(\Delta[H_2O] / 6 \cdot \Delta t)$
2. rate = $-(\Delta[O_2] / 12 \cdot \Delta t)$
3. rate = $(\Delta[CO_2] / 6 \cdot \Delta t)$
4. rate = $-(\Delta[C_6H_{12}O_6] / \Delta t)$

2. The overall reaction

$Br_2(g) + 2\ NO_2(g) \rightarrow 2\ BrNO(g) + O_2(g)$

Has an empirically determined rate law, rate = $k \cdot [NO_2]^2 \cdot [Br_2] \cdot [O_2]^{-1}$.

If k = $3.0 \times 10^4\ M^{-1} \cdot s^{-1}$, $[NO_2]$ = 0.01 M, $[Br_2]$ = 0.02 M and $[O_2]$ = 0.01 M, what is the observed rate?

1. $0.3\ M \cdot s^{-1}$
2. $0.0006\ M \cdot s^{-1}$
3. $300\ M \cdot s^{-1}$
4. $6.0\ M \cdot s^{-1}$

3. Consider the rate constants below:

I. k = 7.45 x 10-2 $M^{-2} \cdot s^{-1}$
II. k = 1.79 x 10-2 $M^{3} \cdot s^{-1}$
III. k = 4.77 x 10-2 $M^{1} \cdot s^{-1}$

Which response arranges them from lowest to highest order.

1. III, II, I
2. I, II, III
3. I, III, II
4. II, I, III
5. II, III, I
6. III, I, II

4. Consider the data below:

| Experiment number | [A] M | [B] M | [C] M | [D] M | initial rate $M \cdot s^{-1}$ |
|---|---|---|---|---|---|
| 1 | 0.42 | 0.5 | 1.12 | 2.01 | $1.06 \times 10^{-6}$ |
| 2 | 0.84 | 0.5 | 1.12 | 2.01 | $2.12 \times 10^{-6}$ |
| 3 | 0.75 | 0.25 | 1.12 | 2.01 | $1.89 \times 10^{-6}$ |
| 4 | 1.23 | 0.93 | 0.97 | 2.01 | $3.58 \times 10^{-6}$ |
| 5 | 0.21 | 1.35 | 0.56 | 5.53 | $8.02 \times 10^{-6}$ |

What is the overall order of this reaction?

1. 1
2. 2
3. 3
4. 4

5. Consider the elementary reaction:

$CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(g)$

If k = 9.7 x $10^6$ $M^{-1}\cdot hr^{-1}$, and there is initially 0.014 M $H_2O$, how long will it take for the $H_2O$ concentration to reach 7.95 M?

1. 36 ms
2. 22 ms
3. 13 ms
4. 5 ms

6. Consider the elementary reaction:

$SO_2(aq) + H_2O(l) \square H_2SO_3(aq)$

If k = 1.21 x $10^{-4}$ $M^{-1}\cdot s^{-1}$, and there is initially 2.3 M of $SO_2$, what is the half life of the reaction?

1. 1.0 hr
2. 1.6 hr
3. 2.6 hr
4. not enough information

7. A student studying the kinetics of a reaction finds that the natural log of some concentration data produces a straight line when plotted as a function of time. What is the order of the reaction?

1. 0th order
2. 1st order
3. 2nd order
4. not enough information

8. Collision theory predicts that

1. raising a system's temperature will accelerate any reactions.
2. reaction intermediates are short-lived.
3. activation energy has no effect on reaction rate.
4. all collisions are productive.

9. Transition state theory assumes that formation of the transition state is (reversible/irreversible) and (does/doesn't) require a minimum amount of energy.

1. irreversible, does
2. reversible, doesn't
3. reversible, does
4. reversible, doesn't

10. What is the activation energy for a reaction that has a rate constant (k) of magnitude 4.03 x $10^5$ and a pre-exponential factor (A) of $10^6$?

1. 2.25 $kJ\cdot mol^{-1}$
2. 2.25 $J\cdot mol^{-1}$
3. 2,251 $kJ\cdot mol^{-1}$
4. not enough information

11. What is a reaction's activation energy of raising the temperature from 100 °C to 1000 °C causes the rate to increase by a factor of 5?

1. $E_a$ = 1.2 $kJ\cdot mol^{-1}$
2. $E_a$ = 1.5 $kJ\cdot mol^{-1}$
3. $E_a$ = 3.9 $kJ\cdot mol^{-1}$
4. $E_a$ = 7.1 $kJ\cdot mol^{-1}$

12. Consider the reaction mechanism below:

step 1: $H_2O_2 \square H_2O\bullet + O\bullet$

step 2: $CO + O\bullet \square CO_2\bullet$

step 3: $CO_2\bullet + H_2O\bullet \square H_2O + CO_2$

overall: $H_2O_2 + CO \square H_2O + CO_2$

Which step must be the slow step if the reaction is experimentally determined to be 2nd order overall?

1. step 1

2. step 2
3. step 3
4. Any step.

13. Consider the reaction mechanism below:

step 1: $Cl + O_3 \rightarrow ClO + O_2$

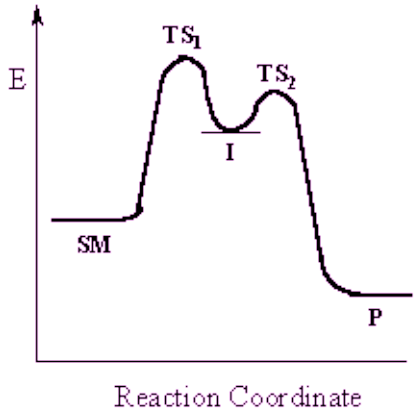
step 2: $ClO + O_3 \rightarrow Cl + 2\ O_2$

overall: $2\ O_3 \rightarrow 3\ O_2$

Which species is a catalyst and which is an intermediate, respectively?

1. Cl, ClO
2. ClO, Cl
3. $O_3$, $O_2$
4. $O_2$, $O_3$

14. Consider the diagram below:




How many steps does this reaction have? Which **reverse** step is the slowest?

1. 1, P→$TS_2$
2. 1, P→I
3. 2, P→I
4. 3, I→SM
5. 2, I→$TS_1$

15. The (chlorine radical/catalytic converter) is a heterogeneous catalyst and (chlorine radical/catalytic converter) acts on only one substrate.

1. catalytic converter, chlorine radical
2. catalytic converter, catalytic converter
3. chlorine radical, catalytic converter
4. chlorine radical, chlorine radical

16. Consider the balanced reaction below:

$2X\ (s) + 2H_2O\ (l) \rightarrow 2XOH\ (aq) + H_2\ (g)$

The species 'X' would be which of the following?

1. an alkali metal
2. an alkaline earth metal
3. a halogen
4. a chalcogen

17. Which of the following **is not** true of alkaline earth metals?

1. React with halogens to form salts
2. Tend to form a +2 charge
3. Somewhat reactive toward water
4. Gain electrons to achieve noble gas configuration
5. Have 2 electrons in their highest energy shell

18. Which member of the boron family is a deadly poison

1. Boron (B)
2. Aluminum (Al)
3. Gallium (Ga)
4. Indium (In)
5. Thallium (Tl)

19. The nitrogen group contains (1/2) non-metal(s), (1/2) metalloid(s) and (1/2) metal(s). Do not consider the synthetic superheavy element Ununpentium (Uup) in arriving at your answer.
1. 2, 1, 2
2. 1, 2, 2
3. 2, 2, 1
4. 1, 1, 1
5. 2, 2, 2

20. Which member of the carbon family is most abundant in Earth's crust?
1. Carbon (C)
2. Silicon (Si)
3. Germanium (Ge)
4. Tin (Sn)
5. Lead (Pb)

21. Which of the following statements **is not** true of the oxygen family?
1. They often have an oxidation number of -2
2. Are good reducing agents
3. Contains elements crucial to life
4. Are also called chalcogens

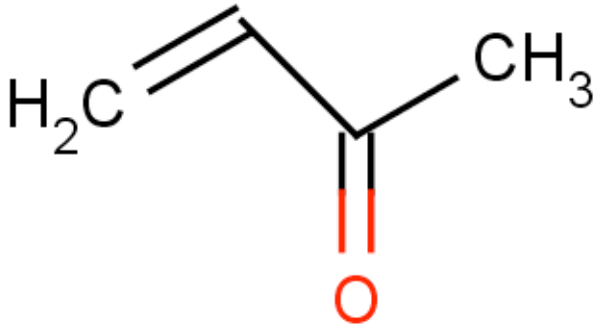
22. Which of the following **is not** true of the halogen family?
1. Its members are often found in their pure forms.
2. It contains the heaviest element required for life.
3. It contains most of the diatomic elements.
4. Its members are good oxidizing agents.
5. Its name mean salt-forming.

23. Alumina ($Al_2O_3$) is produced in which of the following processes?
1. Bayer process
2. *Contact* process
3. Hall process
4. Claus process

24. Which of the following gemstones is/are derived from aluminum oxides?
I. Diamond
II. Sapphire
III. Ruby
1. I
2. II
3. III
4. I and II
5. I and III
6. II and III
7. none

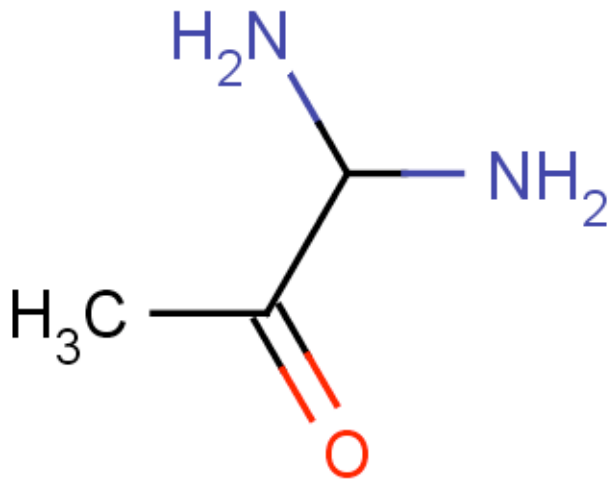
25. How many structural isomers would a hydrocarbon of formula $C_5H_{10}$ have? (Hint: this is an unsaturated hydrocarbon, so its isomers either have one double bond or are cyclical)
1. 8 isomers
2. 9 isomers
3. 10 isomers
4. 11 isomers
5. 12 isomers

26. What would be the name of the following molecule?



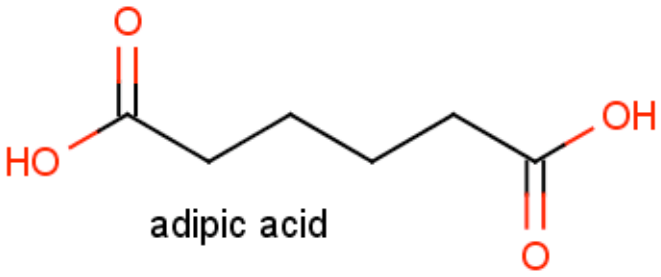

1. but-1-en-2-oic acid
2. but-1-en-2-one
3. but-3-en-2-one
4. prop-3-en-2-al
5. prop-1-en-2-oic acid

27. What would be the name of the following molecule?

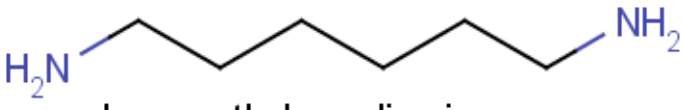



1. 1,1-diaminopropan-2-one
2. 3,3-diaminopropan-2-one
3. 1-amino-2-oxopropylamine
4. 2-oxopropanimidamide
5. 2-oxopropanamineamine

28. Condensation polymerization reactions between the following two species produces nylon. What type of bond is formed and what is produced aside from the polymer itself?



adipic acid



hexamethylene diamine

1. Ester bond, H+
2. Ester bond, nothing
3. Ether bond, H+
4. Amide bond, $NH_2OH$
5. Ether bond, water
6. Amide bond, water

29. Which of the following biopolymers is/are formed by condensation reactions?
    I. DNA
    II. Protein
    III. Starch
1. I
2. II
3. III
4. I and II
5. I and III
6. II and III
7. I, II and III

30.3 Which two monosaccharides are found in table suagr?
1. glucose and fructose
2. galactose and glucose
3. galactose and fructose
4. rhamnose and glucose