CH 302 Spring 2007 Worksheet 15
Practice Exam 3

Constants:

$F = 96{,}485.3383\ C\ mol^{-1}$

$R = 8.314472\ J\ mol^{-1}K^{-1}$

1. Based on the half-cell potentials given below, what is K for the following reaction at 298 K? (For this reaction, n = 6)

$$3Ni^{2+}(aq) + 2Fe(s) \leftrightarrow 3Ni(s) + 2Fe^{3+}(aq)$$

Reaction	ΔE_r^0 (V)
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	-0.25
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	+0.77

   a. 3.17×10^{103}
   b. 3.15×10^{-104}
   c. 5.90×10^{5}
   d. 49.1

2. A battery made using the following reaction maintains a current of 0.73 amps (1 amp = 1 C/s) for 30 seconds. What is the change in the amount of lithium (solid) present in this amount of time?

$$Cu^{2+}(aq) + 2Li(s) \rightarrow Cu(s) + 2Li^{+}$$

   a. $+2.27 \times 10^{-4}$ mol
   b. -2.27×10^{-4} mol
   c. $+4.54 \times 10^{-4}$ mol
   d. -4.54×10^{-4} mol

3. Calculate the potential *E* for the following cell.

$$Cu \mid Cu^{2+}\ (7.3\ M) \parallel Au^{3+}(0.035\ M) \mid Au$$

   The balanced reaction is:

$$3Cu + 2Au^{3+} \rightarrow 3Cu^{2+} + 2Au\ (n = 6)$$

   The half-cell potentials are:

Reaction	ΔE_r^0 (V)
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	+0.34
$Au^{3+}(aq) + 3e^- \rightarrow Au(s)$	+1.52

   a. 1.18 V
   b. 0.855 V
   c. 1.13 V
   d. 1.04 V

4. Which type of battery uses the chemical manufactured in greatest quantity in the United States:
   a. metal hydride
   b. lead acid
   c. lithium ion
   d. alkaline

5. For the reaction

$$2NO + O_2 \rightarrow 2NO_2$$

Which of the following is equal to $d[O_2]/dt$?

a. $-d[NO]/2dt$
b. $d[NO_2]/2dt$
c. $-d[NO_2]/dt$
d. $-d[NO_2]/2dt$

6. A certain reaction is 2nd order in A, 0th order in B, and -3rd order in C. You have concentrations of [A] = 0.50 M, [B] = 3.2 M, and [C] = 0.95 M. The rate constant is $k = 4.7 \times 10^{-3}\ M^2\ S^{-1}$. What is the rate of the reaction?

a. $7.14 \times 10^{-3}\ M\ s^{-1}$
b. $1.37 \times 10^{-3}\ M\ s^{-1}$
c. $7.92 \times 10^{-3}\ M\ s^{-1}$
d. $2.47 \times 10^{-3}\ M\ s^{-1}$
e. $4.39 \times 10^{-3}\ M\ s^{-1}$

7. A reaction has a rate constant of $2.7 \times 10^{-4}\ M^2\ s^{-1}$. The order of the reaction is _____.

a. 0
b. 2
c. 3
d. -2
e. -1

8. The table below was constructed by using three different combinations of starting concentration and measuring the initial rate.

$[A]_0$ (M)	$[B]_0$ (M)	Initial rate (M/s)
0.3	0.3	2.70×10^{-5}
0.45	0.3	6.08×10^{-5}
0.45	0.6	1.22×10^{-4}

Find k for this reaction.

a. $3.00 \times 10^{-4}\ M^{-2}\ s^{-1}$
b. $1.00 \times 10^{-3}\ M^{-2}\ s^{-1}$
c. $3.33 \times 10^{-3}\ M^{-2}\ s^{-1}$
d. $1.11 \times 10^{-2}\ M^{-2}\ s^{-1}$

9. For the reaction

$$A \rightarrow B$$

$k = 2.43 \times 10^{-4}\ s^{-1}$. Assume the rate does not depend on any species besides A. If you begin with 0.750 M A, how much remains after 30 minutes?

a. 0.310 M
b. 0.484 M
c. 0.565 M
d. 0.725 M

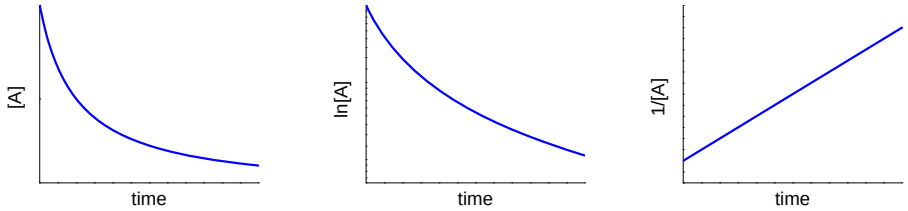
10. For the reaction

$$C \rightarrow D$$

$k = 6.25 \times 10^{-5}\ M^{-1}s^{-1}$. Assume the rate does not depend on any species besides C. If you begin with 1.33 M C, how much remains after 2 hours?

a. 0.880 M
b. 0.848 M
c. 0.832 M
d. 0.302 M

11. The following three plots relate the concentration of a species A and time in the reaction A → B. Based on these plots, the reaction is _____ order in A.



a. Zeroth
b. First
c. Second
d. Third
e. More information is needed.

12. Collision theory states that one of the major barrier to a reaction proceeding is:

a. There isn't enough energy to create the unfavorable transition complex.
b. The molecules are far apart and have to get close enough to collide and react.
c. The molecules must be in the proper orientation for a reaction to occur.
d. If molecules have too much energy, they will collide and "bounce off" of each other rather than reacting.

13. The activation energy E_a is the energy different between the _____ and the _____.

a. products; reactants
b. transition state; reactants
c. products; transition state

14. The reaction 2A + 3B → 5C has a rate constant k of $4.50 \times 10^{-4}\ M\ s^{-1}$ at 298 K and 2.50×10^{-2} at 373 K. What is the activation energy, E_a, for this reaction?

a. 49.5 kJ/mol
b. 595 kJ/mol
c. 21.1 kJ/mol
d. -49.5 kJ/mol
e. -595 kJ/mol

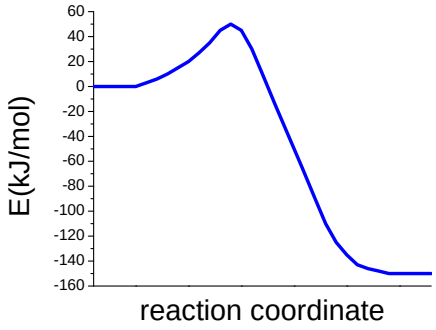
15. Given the reaction mechanism below, what is the rate expression for the reaction $NO_2 + CO \rightarrow NO + CO_2$?

$NO_2 + NO_2 \rightarrow NO_3 + NO$ slow

$NO_3 + CO \rightarrow NO_2 + CO_2$ fast

a. rate = $k[NO_2][CO]/[NO][CO_2]$
b. rate = $k[NO_2]^2[CO]/[NO]$
c. rate = $[NO_2]^2$
d. rate = $[NO_2]^2/[NO_3][NO]$

16. What is E_a for the exothermic reaction represented by the plot below?



a. 150 kJ/mol
b. 200 kJ/mol
c. -200 kJ/mol
d. 50 kJ/mol
e. -50 kJ/mol

17. Which of the following is NOT accomplished with an automobile's catalytic converters:
    a. Oxidation of toxic CO to the greenhouse gas CO_2
    b. Reduction of nitrogen oxides to N_2 and O_2
    c. Increased engine performance
    d. Oxidation of unburnt hydrocarbons

18. Which of these species is the most reactive with water?
    a. HCl(g)
    b. NaOH(s)
    c. Ca(s)
    d. H_2(g)
    e. Li(s)

19. Why is calcium so prevalent in structural materials such as concrete and tooth enamel?
    a. It's highly abundant in nature, so it's readily available for use in common materials.
    b. It forms strong covalent bonds, and because it has two electrons it can form strong double bonds.

c. Its cation has a small ionic radius and a double positive charge, so it has a high charge density and can form strong combinations with polyanions.
d. Its cation has a large ionic radius so it fills a lot of space in an ionic lattice.

20. Ruby, sapphire, and topaz are all gems made of _____ combined with trace metals.
    a. H_2O
    b. SiO_2
    c. Al_2O_3
    d. $Na_2B_4O_7$ (Borax)

21. Why is molecular nitrogen so very stable while molecular phosphorous is highly reactive with air?
    a. Nitrogen is more electronegative than phosphorous, so its bonds are stronger.
    b. Nitrogen forms triple bonds. Phosphorous is too large to form π bonds, so it must make a highly-strained P_4 structures.
    c. Phosphorous has empty d-orbitals, which make it much more reactive than nitrogen, which does not.

22. "_____ is everywhere because sand and rocks are everywhere."
    a. Carbon
    b. Aluminum
    c. Iron
    d. Silicon
    e. Nitrogen
    f. Boron

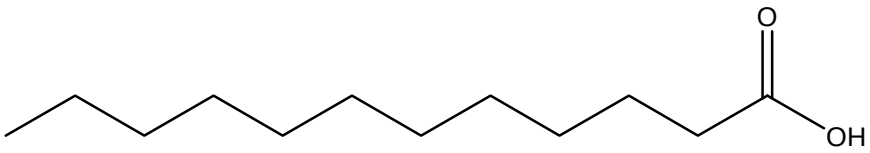
23. Which of the following has uses such as removing metals from the earth and making useful phosphates?
    a. Sulfuric acid
    b. Phosphoric acid
    c. Ammonia
    d. Chlorine

24. Why is Cl^- highly abundant in ocean water while F^- is almost completely absent?
    a. F^- ions in water rapidly undergo redox reactions to form F_2 gas, which is released into the atmosphere.
    b. HCl is a strong acid, so it dissolves completely, but HF isn't, so it sticks together in solution.
    c. Chlorine is more abundant in nature than fluorine is.
    d. F^- has a higher charge density, so it is less soluble in water and tends to stay in solid rocks and minerals.

25. Nylon is an example of a(n) _____.
    a. Block copolymer

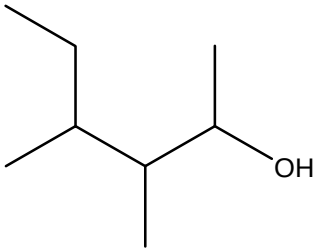
b. Protein
c. Polynucleotide
d. Alternating copolymer
e. Polysaccharide

26. The molecule below is an example of a _____.



a. Fatty acid
b. Sugar
c. Protein
d. Nucleic acid

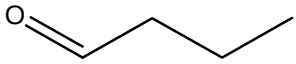
27. The *parent* in the name of the following molecule is _____.



a. –prop-
b. –but-
c. –pent-
d. –hex-
e. –hept-
f. –oct-

28. Which of the following is an example of an elimination reaction?
a. $CH_3OH + 3/2O_2 \rightarrow CO_2 + 2H_2O$
b. $CH_2{=}CH_2 + HBr \rightarrow CH_3\text{-}CH_2Br$
c. $CH_3\text{-}CH_2OH \rightarrow CH_2{=}CH_2 + H_2O$
d. $CH_3\text{-}CH_2OH + HBr \rightarrow CH_3\text{-}CH_2Br$

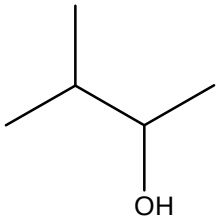
29. What is the name of the molecule below?



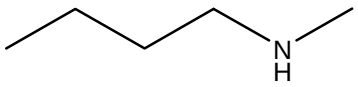
a. Propanol
b. Propanal
c. Propanone
d. Propanoic acid

30. The organic molecule 3-methylbut-2-amine has which of the following structures?

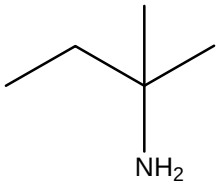
a.



b.



c.



d.