CH 222 Sample Final Exam Name: _____ Lab Section: _____

Multiple Choice Questions (160 Points) There is *only* one best answer for each question. Good luck!

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1. Atomic number describes the number of _____ in an atom.

   a. protons
   b. neutrons
   c. electrons
   d. a and b
   e. all of the above

2. Which of the following symbols represents an alpha particle?

   a. $^{4}_{2}\mathrm{He}$
   b. $^{2}_{4}\mathrm{He}$
   c. $^{0}_{+1}\mathrm{e}$
   d. $^{0}_{-1}\mathrm{e}$
   e. $^{1}_{0}\mathrm{n}$

3. The most penetrating type of radiation is a(n)

   a. alpha particle
   b. beta particle
   c. gamma ray
   d. positron
   e. cathode ray

4. If plutonium-244 decays by successive **α, β, β, α** emissions, what nucleus is produced?

   a. $^{236}_{88}\mathrm{Ra}$
   b. $^{236}_{89}\mathrm{Ac}$
   c. $^{236}_{90}\mathrm{Th}$
   d. $^{240}_{90}\mathrm{Th}$
   e. $^{236}_{92}\mathrm{U}$

5. If Ag-106 decays by electron capture, what is the product?

   a. $^{105}_{46}\mathrm{Pd}$
   b. $^{106}_{46}\mathrm{Pd}$
   c. $^{105}_{47}\mathrm{Ag}$
   d. $^{106}_{48}\mathrm{Cd}$
   e. $^{107}_{47}\mathrm{Ag}$

6. By what (single step) process does polonium-211 decay to lead-207?

   a. α particle emission
   b. β particle emission
   c. positron emission
   d. electron capture
   e. neutron capture

7. The decay of radioactive elements is a first-order process. The half-life of carbon-14 is 5730 years. How many years will it take for 5.0 g of carbon-14 to decay to 1.0 mg?

   a. 5730 years
   b. 17,200 years
   c. 24,900 years
   d. 57,300 years
   e. 70,400 years

8. Given the initial rate data for the reaction A + B → C, determine the rate expression for the reaction.

[A], M	[B], M	Δ[C]/Δ*t* (initial) M/s
0.334	0.134	4.11×10^{-9}
0.334	0.187	8.00×10^{-9}
0.668	0.134	4.11×10^{-9}

   a. $\frac{\Delta[C]}{\Delta t} = 2.75 \times 10^{-7}\ M^{-2}s^{-1}[A]^2[B]$
   b. $\frac{\Delta[C]}{\Delta t} = 3.07 \times 10^{-8}\ s^{-1}[B]$
   c. $\frac{\Delta[C]}{\Delta t} = 2.29 \times 10^{-7}\ M^{-1}s^{-1}[B]^2$
   d. $\frac{\Delta[C]}{\Delta t} = 6.85 \times 10^{-7}\ M^{-2}s^{-1}[A][B]^2$
   e. $\frac{\Delta[C]}{\Delta t} = 1.23 \times 10^{-8}\ s^{-1}[A]$

9. For a zero order reaction, which of the following (if plotted versus time) should give a straight line?

   a. ln [A]
   b. ln k
   c. ln [1/A]
   d. 1/[A]
   e. [A]

10. In basic solution, $(CH_3)_3CCl$ reacts according to the equation:

$$(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$$

The accepted mechanism for the reaction is

$$(CH_3)_3CCl \rightarrow (CH_3)_3C^+ + Cl^- \quad \text{(slow)}$$
$$(CH_3)_3C^+ + OH^- \rightarrow (CH_3)_3COH \quad \text{(fast)}$$

What is a rate law that is consistent with the mechanism for this reaction?

a. rate = $k[(CH_3)_3CCl]$
b. rate = $k[(CH_3)_3CCl][OH^-]$
c. rate = $k[(CH_3)_3C^+][OH^-]$
d. rate = $k[(CH_3)_3CCl][OH^-]/[Cl^-]$
e. rate = $k[(CH_3)_3CCl][OH^-]/[Cl^-]$

11. The elementary steps for the catalyzed decomposition of dinitrogen monoxide are shown below.

$$2\ N_2O(g) + 2\ NO(g) \rightarrow 2\ N_2(g) + 2\ NO_2(g)$$
$$2\ NO_2(g) \rightarrow 2\ NO(g) + O_2(g)$$

Which of the following statement(s) is/are CORRECT?

1. The overall balanced reaction is $2\ N_2O(g) \rightarrow 2\ N_2(g) + O_2(g)$.
2. NO(g) is a catalyst for the reaction.
3. $N_2(g)$ is a reaction intermediate.

a. 1 only
b. 2 only
c. 3 only
d. 1 and 2
e. 1, 2, and 3

12. What is the half-life for a first-order reaction with a rate constant of 0.291 s^{-1}?

a. 0.420 s
b. 1.93 s
c. 2.38 s
d. 6.87 s
e. 13.1 s

13. The effect of adding a catalyst to a reaction is to

a. increase the number of collisions between reactants
b. increase the energy of the products
c. increase the equilibrium constant of a reaction
d. lower the activation energy of a reaction
e. decrease the enthalpy change of a reaction

14. Which of the following elements is most likely to form compounds with an expanded valence shell?

a. P
b. Ne
c. F
d. Li
e. N

15. Which of the following combinations is most likely to produce an ionic bond?

a. Cl and Br
b. P and S
c. N and O
d. B and O
e. Li and F

16. Which of the following aqueous solutions would have the highest vapor pressure at 25 °C?

    a. pure water
    b. 1 m glucose ($C_6H_{12}O_6$)
    c. 1 m $NaNO_3$
    d. 1 m $MgCl_2$
    e. 1 M $(NH_4)_2SO_4$

17. What is the formal charge on each atom in a hypobromite ion, OBr^{-1}?

    a. O = -2, Br = -1
    b. O = -2, Br = +1
    c. O = -1, Br = +1
    d. O = -1, Br = 0
    e. O = 0, Br = -1

18. Use VSEPR theory to predict the molecular geometry of HCN.

    a. bent
    b. linear
    c. trigonal planar
    d. tetrahedral
    e. octahedral

19. How many sigma (σ) bonds and pi (π) bonds are in acetylene, C_2H_2?

    a. one σ, one π
    b. two σ, two π
    c. three σ, one π
    d. three σ, two π
    e. four σ, one π

20. One product of the combustion of ethylene, C_2H_4, is carbon dioxide. What change in hybridization of the carbon occurs in this reaction?

    a. sp^3 to sp^2
    b. sp^2 to sp
    c. sp^3 to sp^3d
    d. sp^2 to sp^3d^2
    e. sp^2 to sp

21. Use molecular orbital theory to predict which ion is paramagnetic.

    a. C_2^{2-}
    b. O_2^{2-}
    c. O_2^{2+}
    d. N_2^{2-}
    e. B_2^{2-}

22. Which of the following molecules may be a cycloalkane?

    a. C_3H_8
    b. C_4H_6
    c. C_5H_{12}
    d. C_6H_{12}
    e. C_7H_{16}

23. The empirical formula of a certain hydrocarbon is CH_2. When 0.120 mole of the hydrocarbon is completely combusted with excess oxygen, 17.7 L CO_2 gas is produced at 27 °C and 1.00 atm. What is the molecular formula of the hydrocarbon?

    a. C_2H_2
    b. C_2H_4
    c. C_3H_6
    d. C_5H_{10}
    e. C_6H_{12}

24. An unknown gaseous hydrocarbon contains 85.63 % C. Its density is 0.426 g/L at 0.465 atm and 373 K. What is the molecular formula of the gas?

    a. C_2H_4
    b. C_3H_6
    c. C_4H_8
    d. C_5H_{10}
    e. C_6H_{12}

25. What intermolecular force or bond is primarily responsible for the solubility of H_2S in water?

    a. ion-dipole force
    b. dipole-dipole force
    c. ionic bonding
    d. covalent bonding
    e. hydrogen bonding

26. What is the solute mole fraction of 1.98 m $Fe(NO_3)_3$(aq)? The molar mass of $Fe(NO_3)_3$ is 241.9 g/mol and the molar mass of water is 18.02 g/mol.

    a. 0.0345
    b. 0.0641
    c. 0.324
    d. 0.479
    e. 0.863

27. Concentrated hydrofluoric acid is 28.9 M and has a density of 1.18 g/mL. What is the weight percent of concentrated HF?

    a. 24.5%
    b. 49.0%
    c. 51.0%
    d. 68.2%
    e. 75.5%

28. The Henry's law constant for N_2 in water at 37 °C is 8.2×10^{-7} M/mm Hg. What is the equilibrium concentration of N_2 in water when the partial pressure of N_2 is 634 mm Hg?

    a. 1.3×10^{-9} M
    b. 5.2×10^{-4} M
    c. 1.9×10^{-2} M
    d. 1.9×10^{3} M
    e. 7.7×10^{8} M

29. Which of the following species will have a Lewis structure most like that of a sulfate ion, SO_4^{2-}? Assume that the Lewis structure has no double bonds.
    a. NH_3
    b. CBr_4
    c. SO_3
    d. H_2CO
    e. H_2O

30. Use Lewis structures to predict the bond order for a nitrogen-oxygen bond in the nitrite ion, NO_2^{1-}.

    a. 1/2
    b. 1
    c. 4/3
    d. 3/2
    e. 3

31. For $NH_4NO_3(aq)$, the solvent is

    a. NH_4NO_3
    b. NH_4^+
    c. NO_3^{1-}
    d. water
    e. Duff beer

32. Determine which of the following species is paramagnetic.

    a. NO^{+1}
    b. CO
    c. CN^{-1}
    d. OF^{-1}
    e. NO