October 2023 Problem Set

1) Which atom does not fit this electron configuration? $[Ne]3s^23p^6$
    a. Ar
    b. Cl^-
    c. P^{2+}
    d. Ca^{2+}
   e. S^{2-}

2) How many photons are contained in a flash of violet light (440 nm) that contains 185 kJ of energy?
    a. 5.27×10^{23} photons
    b. 6.35×10^{35} photons
    c. 4.09×10^{23} photons
    d. 4.52×10^{19} photons
    e. 4.20×10^{10} photons

3) Assume that the electron of a hydrogen atom has been excited to n = 5. As this excited atom relaxes back to ground state, how many different wavelengths of light emission are possible?
    a. 1
    b. 5
    c. 8
    d. 10
    e. 4

4) Which of the following transitions of an electron (in a hydrogen atom) represents the longest emission wavelength photon?
    a. n = 5 to n = 4
    b. n = 3 to n = 1
    c. n = 2 to n = 1
    d. n = 3 to n = 4
    e. n = 4 to n = 1

5) $1s^22s^22p^63s^23p^64s^23d^54p^1$ is the electron configuration of an excited state of an element. What is its ground state configuration and what element is it?
    a. $1s^22s^22p^63s^23p^64s^23d^54p^2$, Co
    b. $1s^22s^22p^63s^23p^64s^23d^5$, Mn
    c. $1s^22s^22p^63s^23p^64s^23d^6$, Fe
   d. $1s^22s^22p^63s^23p^64s^33d^4$, Fe
    e. None of the above

Question 6 – 9 refer to the following compound below, streptonigrin. Streptonigrin is a natural product from *Streptomyces flocculus*.
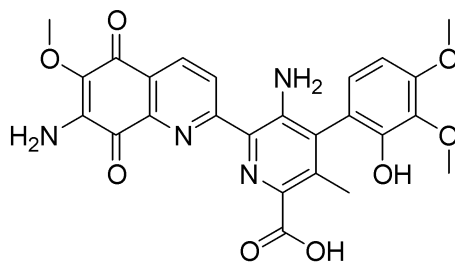
6) How many **hydrogens** are capable of hydrogen bond donation?
   a. 1
   b. None
   c. 3
   d. 6
   e. 4

7) How many **atoms** are capable of hydrogen bond acceptance?
   a. 6
   b. 9
   c. 10
   d. 3
   e. 12

8) Which of the following statements are true?
   a. There are 3 CH_3 groups
   b. There are 4 sp^3 hybridized carbons
   c. All carbons possess 120 ° bond angles
   d. The ethers are capable of hydrogen bond donation
   e. The compound has an ester

9) Which functional group is not present?
   a. Ketone
   b. Amine
   c. Alcohol
   d. Carboxylic acid
   e. Amide

10) Which of the following species would **not** possess a net dipole moment vector?
    a. ClF_4^-
    b. ClF_3
    c. ClF_5
    d. ClF_2^-
    e. All of the above

11) BCl_3 possess no dipole moment, while PCl_3 does. What is the 3D geometry of PCl_3 centered around P?
    a. Trigonal pyramid
    b. Trigonal planar
    c. T-shape
    d. L-shape
    e. Tetrahedral

12) CaO is less soluble than KCl. Which of the following statements is true describing the reasoning behind this observation? Refer to Coulomb's law
    a. The force of attraction between CaO and KCl is the same because they are both neutral in charge
    b. The force of attraction between Ca^{2+} and O^{2-} is much stronger than the force of attraction between K^+ and Cl^- because of the larger charges
    c. The distance between atoms in CaO is much shorter than KCl because Cl^- has more electrons
    d. The distance between atoms in CaO is longer than KCl because Ca^{2+} radius is much larger than K^+
    e. None of the above

13) Na_3PO_4 and $Pb(NO_3)_2$ are both soluble salts, but $Pb_3(PO_4)_2$ is insoluble. Given 100 mL of a 0.200 M solution of $Pb(NO_3)_2$, what volume of 0.150 M Na_3PO_4 is required to precipitate Pb^{2+} as lead phosphate?
    a. 44.5 mL
    b. 50.0 mL
    c. 88.9 mL
    d. 26.6 mL
    e. 13.3 mL

14) Food first begins being digested by saliva, then upon swallowing reaches the stomach fluid. If the pH of saliva is 6.000 while the pH of the stomach is 3.500, what is the change in hydronium concentration that the food experiences?
    a. 3.152×10^{-3} M
    b. 3.883×10^{-8} M
    c. 3.883×10^{-4} M
    d. 3.152×10^{-4} M
    e. 3.883×10^{-5} M

15) For the following system, how could the reaction be shifted to the left in order to decrease the concentration of $Cl_{2\,(g)}$? The forward reaction is endothermic

$$SO_2Cl_{2\,(g)} \rightleftharpoons SO_{2\,(g)} + Cl_{2\,(g)}$$
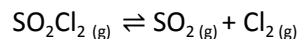
   a. Decrease concentration of $SO_{2\,(g)}$
   b. Decrease the temperature
   c. Decrease pressure
   d. Increase volume
   e. None of the above

16) Which is true for the following forward redox reaction?

$$2ClO_3^- + Mn^{2+} \rightleftharpoons 2\,ClO_2 + MnO_2$$
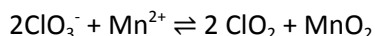
   a. Mn^{2+} loses 2 electrons to become Mn^{4+}
   b. ClO_3^- is the reducing agent
   c. The oxidation state of Cl in ClO_2 is higher than in ClO_3^-
   d. The manganese undergoes reduction
   e. None of the above

17) The pK_a for weak acid HF is 3.17. If you want to prepare a buffer solution that is pH 4.00 using HF and its conjugate base salt, NaF, what is the concentration ratio for $[F^-]/[HF]$ that you should use?
   a. $[F^-]/[HF] = 0.14$
   b. $[F^-]/[HF] = 6.76$
   c. $[F^-]/[HF] = 5.0$
   d. $[F^-]/[HF] = 0.78$
   e. $[F^-]/[HF] = 7.17$

18) For the following pairs of 0.5 M solutions, which will produce a buffer solution when mixed?
   a. 100 mL of aqueous NaOH and 100 mL of aqueous HCl
   b. 100 mL of aqueous CH_3COOH and 200 mL of aqueous NaOH
   c. 100 mL of aqueous CH_3COONa and 100 mL of aqueous NaOH
   d. 100 mL of aqueous NaCl and 100 mL of aqueous HCl
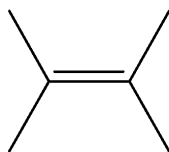   e. 100 mL of aqueous CH_3COOH and 75 mL of CH_3COONa

19) Which is the following not true regarding intermolecular forces between I_2 and Br_2?
   a. I_2 is more polarizable
   b. I_2 has a higher boiling point
   c. I_2 possess a stronger permanent dipole than Br_2
   d. Both possess London dispersion forces
   e. All of the above are true
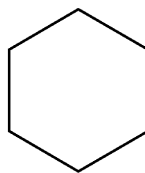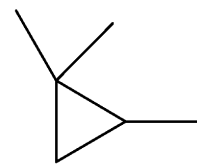
20) Which structure is not an isomer of C_6H_{12}?
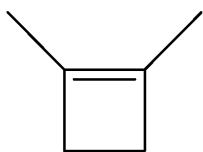
1   **2**   **3**   **4**

   a. 1
   b. 2
   c. 3
   d. 4
   e. All of the above are isomers of C_6H_{12}

21) In reality, many gases deviate from the ideal gas law. Strong intermolecular forces of a gas will cause gas molecules to interact with each other rather than the container, making the actual pressure of the gas lower than the calculated ideal. Which gas would have the largest deviation from its ideal pressure?
   a. Ne
   b. NH_3
   c. Br_2
   d. CH_4
   e. Cl_2

22) The average atomic mass of nitrogen that is listed on the periodic table is 14.007 amu. There are two isotopes of N. ^{14}N = 14.003 amu, and ^{15}N = 15.000 amu. What is the percent abundance of ^{14}N to 3 decimal places?
   a. 99.018%
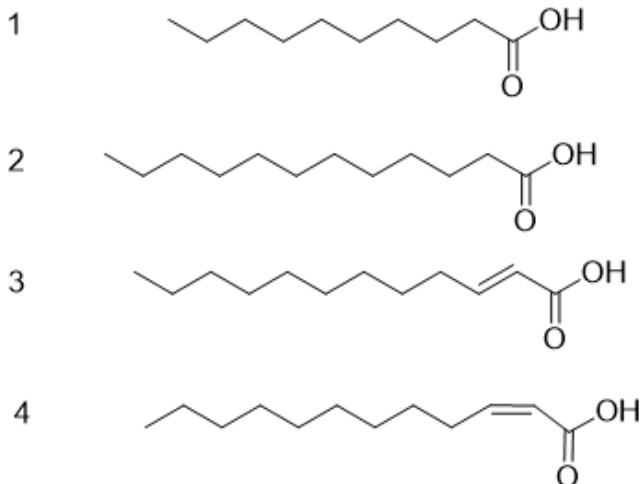   b. 50%
   c. 99.599%
   d. 95.469%
   e. 90.145%

23) Use the information in the table below. What is the P-Cl bond energy PCl_3?

Species	ΔH_f° (kJ/mol)
$PCl_{3\ (g)}$	-306.1
$P_{(g)}$	314.5
$Cl_{(g)}$	121.4

   a. 328.3

b. 264.1
c. 193.1
d. 102.1
e. 129.5

24) Rank the melting point of the following fatty acids from lowest to highest

1

2

3

4

a. $2 < 1 < 4 < 3$
b. $1 < 3 < 4 < 2$
c. $1 < 2 < 3 < 4$
d. $1 < 4 < 3 < 2$
e. $3 < 1 < 2 < 4$

25) If 4.50 g of oxalic acid, $C_2H_2O_4$, is combusted under excess oxygen, 0.90 g of H_2O is produced. How many grams of CO_2 is produced?
   a. 4.38 g
   b. 1.80 g
   c. 2.19 g
   d. 5.40 g
   e. None of the above