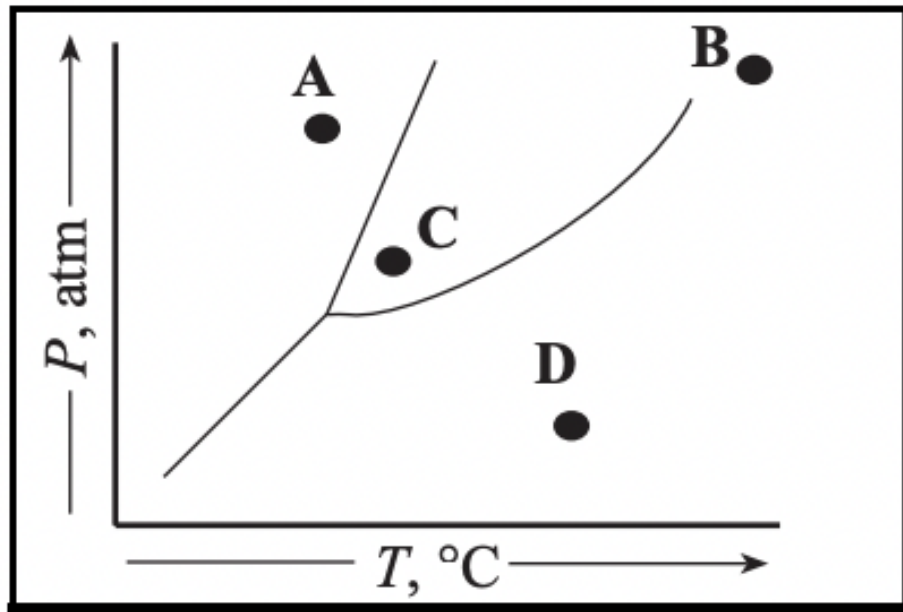




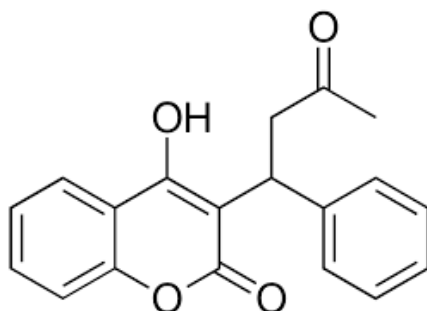
1. Which point in the phase diagram best represents supercritical conditions?



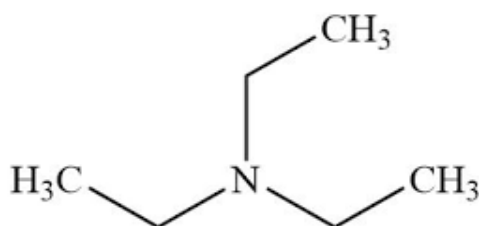
2. Consider a sample of  $O_2$  gas at 298 K. Calculate the  $v_{mp}$  (in  $\frac{m}{s}$ ) for this sample.  
Given: Ideal gas constant  $R = 8.314 J/mol \cdot K$ .
3. Water molecules undergo autoionization:  $2H_2O \rightleftharpoons H_3O^+ + OH^-$ . Similarly, liquid ammonia autoionizes:  $2NH_3 \rightleftharpoons NH_4^+ + NH_2^-$ . The natural log of the ion product constant for ammonia ( $pK_{NH_3}$ ) at  $-33^\circ C$  is 26.29. What is the concentration of  $NH_4^+$  and  $NH_2^-$  in liquid ammonia at 25 degree celsius? (round to 1 decimal place)

1. If at 100 degrees celsius, water has an autoionization constant  $K_w = 1.0 \times 10^{-12}$ . If an aqueous solution has a pH of 7 at 100 degree celsius, is it acidic, neutral or basic?
  - a. Acidic
  - b. Neutral
  - c. Basic
  
2. Water molecules undergo autoionization:  $2H_2O \rightleftharpoons H_3O^+ + OH^-$ . Similarly, liquid ammonia autoionizes:  $2NH_3 \rightleftharpoons NH_4^+ + NH_2^-$ . Guanidine is a weak base in water:  $C(NH_2)_2NH + H_2O \rightleftharpoons C(NH_2)_3^+ + OH^-$ . Assume it behaves similarly in liquid ammonia, write an equation for its dissociation in ammonia.
  
  
  
  
  
  
  
  
  
  
3.  $NH_3$  is converted to  $NO_2^-$  by nitrifying bacteria in natural waters. Is this an oxidation or reduction reaction?
  - a. Oxidation
  - b. Reduction
  - c. Not redox reaction

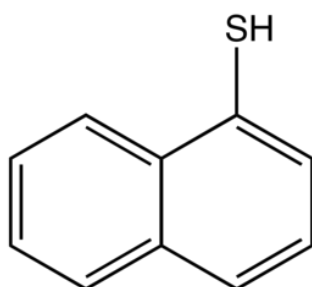
1. Arrange the following substances based on their melting points, from highest to lowest:  $N_2$ ,  $CO$ ,  $NH_3$ .
2. Arrange the following covalent compounds based on their melting points, from highest to lowest:  $SiC$ ,  $Si_3N_4$ ,  $SiO_2$ .
3. Which of the substances below cannot participate in hydrogen bonding?



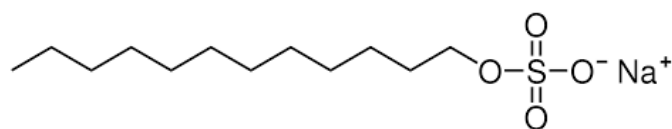
a.  
Warfarin



b.  
Triethylamine

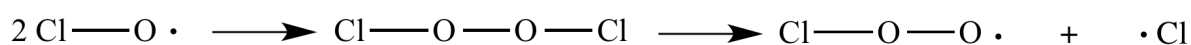
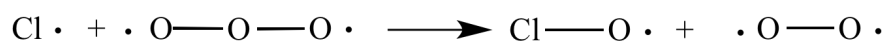
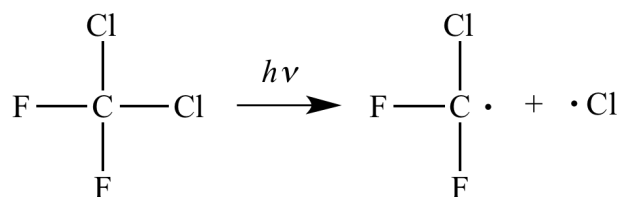


c.  
1-naphthalenethiol



d.  
Sodium dodecyl sulfate

1. Shown below is the mechanism of the destruction of the ozone layer by freon. Which species is most likely acting as a catalyst?



- $\text{Cl}\cdot$
  - $\text{ClO}_2$
  - $\text{CCl}_2\text{F}_2$
  - $\text{ClO}\cdot$
2. Which of the following groups of species can coexist in an aqueous solution in abundance?
- $\text{Ca}^{2+}, \text{NO}_3^-, \text{I}^-, \text{H}^+$
  - $\text{OH}^-, \text{Al}^{3+}, \text{Mg}^{2+}, \text{Cl}^-$
  - $\text{ClO}^-, \text{NH}_4^+, \text{Fe}^{3+}, \text{SO}_4^{2-}$
  - $\text{Na}^+, \text{Br}^-, \text{MnO}_4^-, \text{H}^+$
3. For the following reaction,  $\text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$ , the  $K_p$  at 300 K is 0.140 atm. What is the  $K_p$  of  $4\text{NO}_2 \rightleftharpoons 2\text{N}_2\text{O}_4$ ?



1. What is the molar mass of  $CH_3COOH$ ?
2. Draw the preferred Lewis structures for  $NO_3^-$ . Indicate any equivalent resonance structures if necessary.
3. What is the formal charge, if any, on the nitrogen atom in  $NO_2$ ?









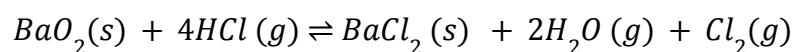


1. What direction does the dipole moment lie in  $CH_3Cl$ ?
  - a. Towards the carbon
  - b. Towards the hydrogens
  - c. Towards the chlorine
  - d. There is no dipole moment in the molecule
  
2. The auto-ionization of water, given by the equation  $2H_2O \rightleftharpoons H_3O^+ + OH^-$ , is known to be an endothermic process. If the temperature of the reaction was lowered, which way would the reaction proceed?
  - a. To the right
  - b. To the left
  - c. The reaction would not shift as it would still remain in equilibrium
  
3. The reaction between water and formic acid,  $HCOOH$ , has a  $K_a$  of  $1.77 \times 10^{-4}$ . When formic acid is titrated with sodium hydroxide,  $NaOH$ , which of the following listed indicators would be best used to detect the equivalence point?
  - a. Thymol blue: pH range 1.2-2.8
  - b. Methyl orange: pH range 3.2-4.4
  - c. Bromothymol blue: pH range 6.0-7.6
  - d. Phenolphthalein: pH range 8.2-10.0

1. A 10 g ice cube (specific heat =  $2.09 \frac{J}{g \cdot C}$ , enthalpy of fusion = 334 J/g) at  $-15^{\circ}C$  is added to 25 g of water (specific heat =  $4.184 \frac{J}{g \cdot C}$ ) at  $37^{\circ}C$ . What is the final temperature of the water?

2. Estimate the enthalpy of formation of 1 mol of HBr for the following reaction:  
 $H_2 + Br_2 \rightarrow 2HBr$ , given the following average bond dissociation energies: H-H = 436 kJ/mol, Br-Br = 193 kJ/mol, and H-Br = 366 kJ/mol.

3. Consider the following balanced, heterogeneous chemical reaction:



Using the Law of Mass Action, write the expression for the equilibrium constant, K, for this reaction.

1. Consider the following radial wavefunction for the H atom:

$$R_{n, \ell} = \frac{1}{2\sqrt{6}} \left[ \frac{Z}{a_0} \right] \sigma \text{ where } \sigma = \frac{Zr}{a_0}$$

Determine if there are any radial nodes. If there are, please indicate where they are.

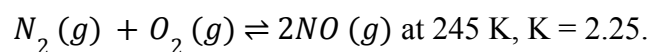
2. Consider the following radial wavefunction for the H atom:

$$R_{n, \ell} = \frac{1}{2\sqrt{6}} \left[ \frac{Z}{a_0} \right] \sigma \text{ where } \sigma = \frac{Zr}{a_0}$$

If the radial wavefunction given describes an electron in a hydrogen atom that has a total energy equal to  $-3.4$  eV, identify the quantum numbers  $n$  and  $\ell$  associated with this function. Hint: you can simplify using Bohr's model.

3. Write the balanced chemical equation for the combustion of liquid pentane ( $C_5H_{12}$ ).

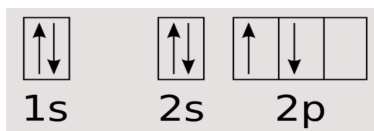
1. Consider the balanced reaction shown below to answer the following questions.



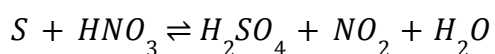
Determine if each of the initial conditions below will result in the reaction as written to proceed to the right in order to reach equilibrium.

- a.  $P(N_2) = 1.0 \text{ atm}$ ;  $P(O_2) = 1.5 \text{ atm}$ ;  $P(NO) = 1.5 \text{ atm}$
- b. The partial pressure of each gas is 0.45 atm
- c.  $P(N_2) = 0.20 \text{ atm}$ ;  $P(O_2) = 0.20 \text{ atm}$ ;  $P(NO) = 0.50 \text{ atm}$

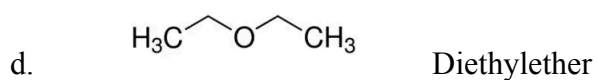
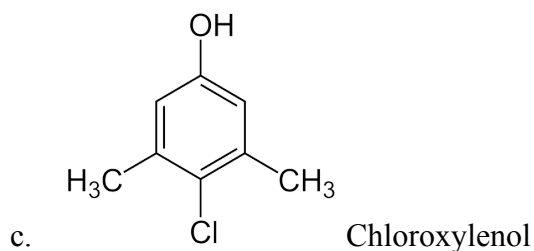
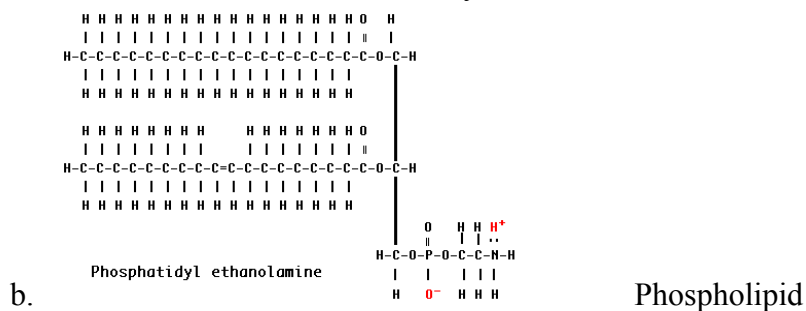
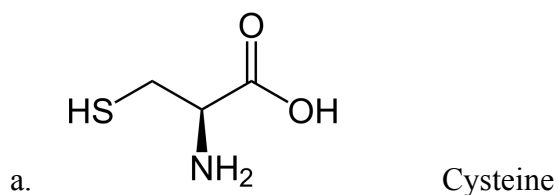
1. Which rule does the following configuration (of a ground state atom) violate?



2. Balance the reaction below:



3. Which of the following compounds **cannot** act as a hydrogen bond donor but **can** act as a hydrogen bond acceptor?

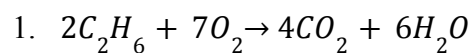






## EASY PACKET 18

Team ID: \_\_\_\_\_



You combine 20 g of  $C_2H_6$  and 30 g of  $O_2$ . Identify the limiting reagent of this reaction.

2. A sample of 1.23 mol of an ideal gas occupies a container volume of 0.04 m<sup>3</sup>. Calculate the pressure in the container.

3. True or False:  
 $CO_2$  contains bonds that are longer than those in  $O_3$ .

1. Draw the Lewis dot diagram for  $SO_4^{2-}$ . Write the formal charges on the four oxygen atoms. The order you write them in does not matter
  
  
  
  
  
  
  
  
  
  
2. Here is a list of elements: lithium, nitrogen, oxygen, fluorine, beryllium
  - a. Which one has the highest electronegativity?
  
  
  
  
  
  
  
  
  
  
  - b. Which one has the largest second ionization energy?
  
  
  
  
  
  
  
  
  
  
  - c. In the ground state, which element has only 1 electron in each of the three p orbitals?
  
  
  
  
  
  
  
  
  
  
3. What is the name of the VSEPR geometry of phosphorus pentafluoride?



1. Consider the following reaction:  $CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$ .  
Given  $\Delta H_{rxn}^{\circ} = -0.3 \text{ kJ/mol}$  for the reaction shown above, calculate the equilibrium constant ( $K_a$ ) at  $90^{\circ}\text{C}$ . You may assume that  $\Delta H_{rxn}^{\circ}$  and  $\Delta S_{rxn}^{\circ}$  are temperature independent over this temperature range.

2. What is the name of the process in which solid is converted directly into gas?

3. The pH of pure water at  $50^{\circ}\text{C}$  is 6.85. What is the value of  $K_w$  at  $50^{\circ}\text{C}$ ? Report your answer to the nearest 3 significant figures.