

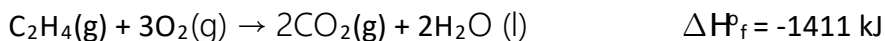


# Polytechnic Tutoring Center

## Midterm II REVIEW – CM 1003, Fall 2021

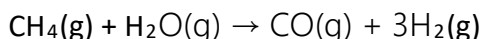
*Disclaimer: This mock exam is only for practice. It was made by tutors in the Polytechnic Tutoring Center and is not representative of the actual exam given by the Academic Department.*

- Which of the following processes is exothermic?
  - Dry ice sublimates into a higher temperature gas above the solid
  - Liquid water's boiling point is lowered by a decrease in pressure
  - Liquid sulfur solidifies when exposed to cool temperatures
  - Cellular machinery in plant cells use sunlight to synthesize sugars
  - Water transitions from liquid to vapor in a closed container
- Find the standard enthalpy of formation of ethylene,  $C_2H_4(g)$ , given the following data:



- 52.4 kJ
  - 57.8 kJ
  - 48.5 kJ
  - 51.3 kJ
  - 50.6 kJ
- An atom of chromium (Cr) has \_\_\_ unpaired electrons and is \_\_\_\_.
    - 3, diamagnetic
    - 5, diamagnetic
    - 3, paramagnetic
    - 5, paramagnetic
    - 6, paramagnetic

- Calculate  $\Delta H$  for this reaction (in kJ):



$$\Delta H_f^\circ(CH_4(g)) = -74.85 \text{ kJ/mol}$$

$$\Delta H_f^\circ(H_2O(g)) = -241.8 \text{ kJ/mol}$$

$$\Delta H_f^\circ(CO(g)) = -110.5 \text{ kJ/mol}$$

- 206.09 kJ
- 213.87 kJ
- 206.15 kJ
- 277.45 kJ
- 225.23 kJ

5. Copper metal has a specific heat of  $0.385 \text{ J/g}^\circ\text{C}$ . Calculate the amount of heat required to raise the temperature of  $0.358 \text{ moles}$  of Cu from  $20.0^\circ\text{C}$  to  $875^\circ\text{C}$
- $27.56 \text{ kJ}$
  - $7.49 \text{ kJ}$
  - $11.78 \text{ kJ}$
  - $15.82 \text{ kJ}$
6. Which atom has the electron configuration  $[\text{Kr}] 5s^2 4d^6$ ?
- Tc
  - Rh
  - Ru
  - Fe
  - Co
7. What is the ground state configuration for a W atom?
- $[\text{Xe}] 6s^1 4f^{15} 5d^4$
  - $[\text{Xe}] 6s^2 4f^{14} 5d^4$
  - $[\text{Xe}] 6s^2 4f^{10} 5d^8$
  - $[\text{Xe}] 6s^1 4f^{12} 5d^7$
  - $[\text{Xe}] 6s^2 4f^{12} 5d^6$
8. Which atom has the largest atomic radius?
- $\text{Rb}^+$
  - Kr
  - $\text{Fr}^+$
  - Co
  - $\text{At}^-$
9. Which of the following elements will have the largest first ionization energy?
- C, because carbon rarely forms  $\text{C}^+$  or  $\text{C}^-$  ions
  - He, because it is the most stable noble gas
  - Na, because it is easily oxidized
  - Al, because metals form strong metallic bonds
  - F, because it is electronegative enough to form polar covalent bonds
10. Which of the following is true about Lewis dot structures?
- Ionic bonds cannot be represented in Lewis dot structures due to electron exchange
  - All atoms in Lewis dot structures fill have a total of 8 electrons due to the octet rule
  - Lewis dot structure depends on the phase of the species in the molecule
  - Molecules can have multiple possible Lewis dot structures but the most plausible structure has the lowest formal charge
  - Lewis dot structures convey the geometry of the molecule modeled.

11. Which element has the highest electronegativity?
- Fr, because it is lowest and most left on the table
  - F, because it is highest and most right on the table
  - Ne, because noble gases have the most energetic valence electrons
  - H, because it is highest and most left on the table
  - Ag, because it is the most conductive metal
12. Carbon is hybridized  $sp^3$  in which of the following molecules?
- $C_6H_6$  because benzene has both single bond and double bond character
  - $CO_2$  because oxygen's electronegativity is more stability bonded to  $sp^3$
  - $CH_4$  because hydrogen is allowed to form only one single bond
  - $CN^-$  because  $sp^3$  satisfies both the octet rule for carbon and nitrogen
  - $CH_2$  because an  $sp^3$  lone pair exists on the central atom
13. What are the VSEPR geometries of  $CO_2$  and  $H_2O$ ?
- Both bent due to the lone electrons on central atom
  - Both linear because there are two groups around a central atom
  - Linear  $CO_2$  and bent  $H_2O$  because oxygen has two lone pairs
  - Seesaw  $CO_2$  and square planar  $H_2O$  because  $CO_2$  is nonpolar and  $H_2O$  is
  - Both T-shaped because there are two groups and one electron pair around the central atom
14. Consider a rare compound formed by Xenon,  $XeF_2$ . What is the hybridization of Xe in this molecule?
- $sp^3d$  because there are 5 orbitals in the bonding
  - $sp^2d$  because Xe has a filled valence shell in its ground state
  - $sp$  because Xe uses two orbitals to bond with both F
  - $sp^3d^2$  because two d orbitals are used to satisfy the octet rule
  - $sp^3sp$  because F hybridized  $sp$  to be able to form covalent bonds
15. What is the VSEPR geometry of  $XeF_2$ ?
- Tetrahedral pyramidal because there are 2 F and 2 electron pairs around Xe
  - Trapezoidal planar because F is dual hybridized as  $sp^2$  and there are 2 electron pairs
  - Conic bipyramidal because three electron pairs around Xe form a cone
  - Pentagonal planar because 5 electronegative groups form a pentagon on a constant plane
  - Trigonal Bipyramidal because 5 groups exist around the central atom

16. Consider a linear, a pyramidal branched and a ringed hydrocarbon of similar molecular mass. All are contained in a closed conduit under similar pressure and volume. Which would you expect to have a higher melting point? Do not assume ideal gases.
- Ringed hydrocarbon because ring structures occupy less volume in the liquid state and therefore have higher van der Waals forces of attraction
  - Linear hydrocarbon because alkanes have many possible conformations and are able to form van der Waals attractions with a greater number of nearby molecules
  - Pyramidal hydrocarbon because branches allow for conformational isomers and stronger dipole-dipole attractions between branches
  - All are similar in melting point because carbon in organic molecules behaves similarly under different physical conditions
  - Cannot be determined without the empirical formulas, chirality and bonding hybridizations for each molecular sample
17. Which element is oxidized in the following reaction?
- $$3\text{Cu} + 8\text{HNO}_3 \rightarrow 3\text{Cu}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$$
- Cu
  - H
  - N
  - NO<sub>3</sub>
  - HNO<sub>3</sub>

Long Response:

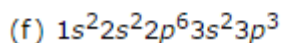
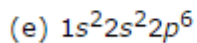
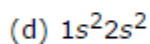
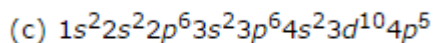
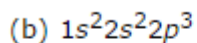
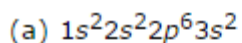
- 1) Draw and name the molecular geometry of NH<sub>3</sub> and NH<sub>4</sub><sup>+</sup>. Give the bond angles between each group.

- 2) Indicate which intermolecular forces are present in each of the compounds below:

	Ion-Ion	Dipole-Dipole	London	H- Bonding	Ion-Dipole
I <sub>2</sub>					
SO <sub>2</sub>					
CH <sub>3</sub> CH <sub>2</sub> OH					
CH <sub>3</sub> OCH <sub>3</sub>					
KBr					

3) A 10.00 kg hot iron ball bearing at is placed in a constant-pressure calorimeter containing 394. cubic centimeters of water at 10.75°C, raising the water temperature to 83.20°C. If the specific heat of the ball bearing is 0.450 J/g°C, calculate the initial temperature of the ball bearing. The specific heat of water is 4.184 J/g°C. Assume the calorimeter to have negligible heat capacity.

4) Consider the following sets of ground state electron configurations:



a) Identify the element in each set

b) Which set would you expect the highest atomic radius? Lowest?

c) Which set would you expect the highest electronegativity? Lowest?

d) Rewrite each set using noble gas core notation

5) Draw the lewis dot structure for  $\text{SO}_4^{2-}$  and  $\text{SO}_2$ , and any possible resonance structures. Would you expect them to have different bond lengths? If so, which would you expect to be longer?