

## CHM2045 Exam 2 (Common Exam) Fall 2018

NAME\_\_\_\_\_

Section\_\_\_\_\_

**Directions:** *Identify the choice that best completes the statement or answers the question. Mark your answer on the SCANTRON SHEET*

- \_\_\_\_\_ 1. Express a pressure of 724 torr in atm.
- 0.724 atm
  - 0.853 atm
  - 0.953 atm
  - 1.05 atm
  - none of these
- \_\_\_\_\_ 2. A sample of oxygen occupies 47.2 liters under a pressure of 1240. torr at 25°C. What volume would it occupy at 25°C if the pressure were decreased to 730. torr?
- 27.8 L
  - 29.3 L
  - 32.3 L
  - 47.8 L
  - 80.2 L
- \_\_\_\_\_ 3. A sample of gaseous anesthetic cyclopropane, with a volume of 425 mL at a temperature of 27 °C is compressed to 415 mL at constant pressure by cooling the gas. What is the new temperature in degrees Celsius at this volume?
- 10 °C
  - 20 °C
  - 28 °C
  - 34 °C
  - 293 °C
- \_\_\_\_\_ 4. What is the molar mass of a gas if a 17.6 g sample exerts a pressure of 2.0 atm in a 4.0 L container at 27 °C?
- 54 g/mol
  - 42 g/mol
  - 66 g/mol
  - 28 g/mol
  - none of these
- \_\_\_\_\_ 5. What volume of H<sub>2</sub> gas will be produced at 1.0 atm and 28 °C if 10 g of Na are mixed with 100 g of H<sub>2</sub>O? The other product of the reaction is NaOH.
- 0.48 L
  - 5.4 L
  - 11 L
  - 2.7 L
  - none of these

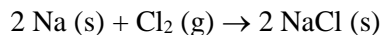
**Exhibit 1**

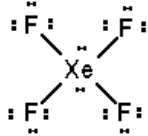
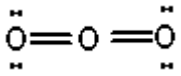
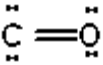
Consider a mixture of gases that includes 0.50 g of He, 5.0 g of Ne and 20 g of Ar contained in a 5.0 L vessel at 25 °C to answer the following question(s). Molar Mass(He) = 4.0 g/mol, Molar Mass(Ne) = 20 g/mol, and Molar Mass(Ar) = 40 g/mol

- \_\_\_\_\_ 6. Refer to Exhibit 1. What is the *mole fraction* of Ne in this mixture?
- 0.14
  - 0.20
  - 0.25
  - 0.28
  - 0.57
- \_\_\_\_\_ 7. Refer to Exhibit 1. What is the total pressure of this mixture of gases?
- 0.36 atm
  - 0.61 atm
  - 1.2 atm
  - 2.4 atm
  - 4.3 atm
- \_\_\_\_\_ 8. Calculate the pressure of 1.33 mol of Ar gas in a 6.33 L container at 200 °C using the van der Waals equation. ( $a = 1.34 \text{ atm}\cdot\text{L}^2/\text{mol}^2$ ,  $b = 0.0322 \text{ L/mol}$ )
- 3.22 atm
  - 1.23 atm
  - 8.15 atm
  - 6.33 atm
  - none of these
- \_\_\_\_\_ 9. A certain blue light has a wavelength of 453 nm ( $\lambda = 453 \text{ nm}$ ). What is the energy (in Joules) of one photon of this blue light with this wavelength?
- $9.97 \times 10^{-49} \text{ J}$
  - $2.99 \times 10^{-40} \text{ J}$
  - $1.46 \times 10^{-27} \text{ J}$
  - $4.37 \times 10^{-19} \text{ J}$
  - $6.86 \times 10^{26} \text{ J}$
- \_\_\_\_\_ 10. Calculate the frequency of light whose wavelength is  $5.0 \times 10^{-6}$  meters.
- $6.0 \times 10^{13} \text{ s}^{-1}$
  - $2.0 \times 10^5 \text{ s}^{-1}$
  - $3.0 \times 10^8 \text{ s}^{-1}$
  - $4.0 \times 10^{-20} \text{ s}^{-1}$
  - none of these

- \_\_\_\_ 11. Which of the following orbital diagrams for the ground state electronic configuration for a *phosphorus atom* is correct?
- a. [Ne]  $\begin{array}{|c|} \hline \uparrow \\ \hline \end{array} \begin{array}{|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow \\ \hline \end{array}$   
 $\begin{array}{c} 3s \quad \quad 3p \end{array}$
- b. [Ne]  $\begin{array}{|c|} \hline \uparrow\downarrow \\ \hline \end{array} \begin{array}{|c|c|c|} \hline \uparrow\downarrow & \uparrow & \\ \hline \end{array}$   
 $\begin{array}{c} 3s \quad \quad 3p \end{array}$
- c. [Ne]  $\begin{array}{|c|} \hline \uparrow \\ \hline \end{array} \begin{array}{|c|c|c|} \hline \uparrow\downarrow & \uparrow\downarrow & \\ \hline \end{array}$   
 $\begin{array}{c} 3s \quad \quad 3p \end{array}$
- d. [Ne]  $\begin{array}{|c|} \hline \\ \hline \end{array} \begin{array}{|c|c|c|} \hline \uparrow\downarrow & \uparrow\downarrow & \uparrow \\ \hline \end{array}$   
 $\begin{array}{c} 3s \quad \quad 3p \end{array}$
- e. [Ne]  $\begin{array}{|c|} \hline \uparrow\downarrow \\ \hline \end{array} \begin{array}{|c|c|c|} \hline \uparrow & \uparrow & \uparrow \\ \hline \end{array}$   
 $\begin{array}{c} 3s \quad \quad 3p \end{array}$
- \_\_\_\_ 12. What is the highest energy subshell that is occupied in the ground state of an atom of Bi (at. no. = 83)?
- a. 5p  
b. 5d  
c. 5f  
d. 6p  
e. none of these
- \_\_\_\_ 13. The ground state electron configuration of Ti is
- a.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$   
b.  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^3$   
c.  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$   
d.  $1s^2 2s^2 2p^6 3s^2 3p^6 4p^4$   
e. none of these
- \_\_\_\_ 14. Which of the following series of atoms are arranged in order of *decreasing* size?
- a.  $K > Ga > In$   
b.  $Cl > Br > Kr$   
c.  $Li > Mg > Ca$   
d.  $H > He > Li$   
e. none of these
- \_\_\_\_ 15. Which of the following is true?
- I. A neutral atom is larger than its corresponding cation. (for example:  $Na > Na^+$ )  
II. A neutral atom is larger than its corresponding anion. (for example:  $O > O^{2-}$ )  
III. Ionic radii increase down a group. (for example:  $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$ )
- a. I only  
b. I and II  
c. I and III  
d. II and III  
e. All of these
- \_\_\_\_ 16. Which element listed below has the most exothermic (energy released) electron affinity?
- a. Sn  
b. Sb  
c. Te  
d. I  
e. none of these

- \_\_\_\_\_ 17. Consider the reaction of sodium metal with chlorine gas to form NaCl as shown below. How does each element in the compound NaCl attain an octet of electrons?



- a. A sodium atom and a chlorine atom share two electrons.
  - b. A sodium atom loses an electron and the chlorine atom accepts the electron.
  - c. A chlorine atom loses an electron and the sodium atom accepts the electron.
  - d. A sodium atom loses an electron and the chlorine atom loses seven electrons.
  - e. A sodium atom gains seven electrons and the chlorine atom loses seven electrons.
- \_\_\_\_\_ 18. Which species listed below has the largest lattice energy?
- a.  $\text{CaCl}_2$
  - b.  $\text{LiCl}$
  - c.  $\text{MgF}_2$
  - d.  $\text{NaCl}$
  - e.  $\text{SrBr}_2$
- \_\_\_\_\_ 19. How many electrons (both lone and bond pairs) are used in the Lewis structure of  $\text{C}_2\text{O}_4^{2-}$ ?
- a. 30
  - b. 34
  - c. 32
  - d. 46
  - e. none of these
- \_\_\_\_\_ 20. Arrange the elements O, P, F in order of *increasing electronegativity*.
- a.  $\text{F} < \text{O} < \text{P}$
  - b.  $\text{O} < \text{F} < \text{P}$
  - c.  $\text{F} < \text{P} < \text{O}$
  - d.  $\text{P} < \text{O} < \text{F}$
  - e.  $\text{O} < \text{P} < \text{F}$
- \_\_\_\_\_ 21. Which molecule listed below has a total of 10 valence electrons around the central (first) atom?
- a.  $\text{XeF}_4$
  - b.  $\text{SeCl}_2$
  - c.  $\text{ClF}_3$
  - d.  $\text{AsF}_3$
  - e. none of these
- \_\_\_\_\_ 22. Pick the correct Lewis structure.
- a. 
  - b. 
  - c. 
  - d.  $\text{H} - \text{C} \equiv \text{N}$
  - e. all are correct

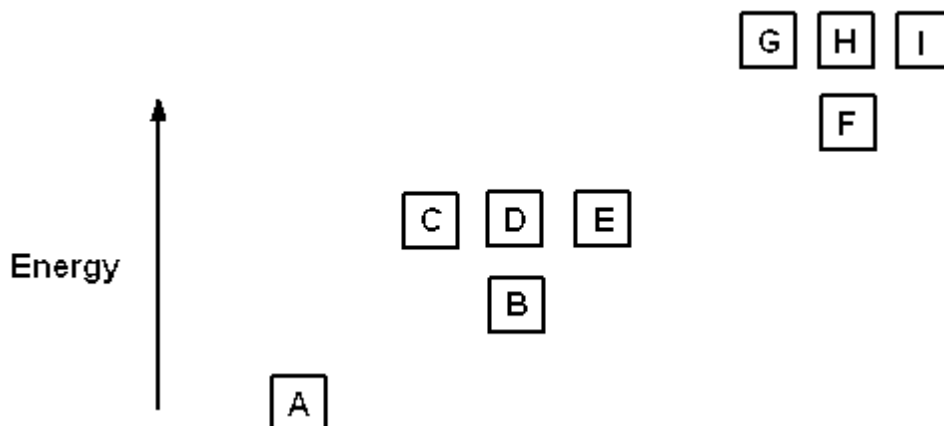
- \_\_\_\_ 23. Which of the following molecules has a central atom that has electron pairs (bonding and lone pairs) coordinated in a *tetrahedral* geometry?
- $\text{CCl}_4$
  - $\text{NF}_3$
  - $\text{H}_2\text{S}$
  - All of these
  - None of these
- \_\_\_\_ 24. What *molecular shape* is assumed by the three atoms in the molecule,  $\text{SO}_2$ ?
- Linear
  - Trigonal planar
  - Trigonal pyramidal
  - Tetrahedral
  - Bent
- \_\_\_\_ 25. What molecule listed below has a *square pyramidal* molecular shape?
- $\text{XeF}_4$
  - $\text{SF}_4$
  - $\text{SiF}_4$
  - $\text{CF}_4$
  - $\text{ClF}_5$
- \_\_\_\_ 26. How many pi ( $\pi$ ) bonds and how many sigma ( $\sigma$ ) bonds are present in the molecule,  $\text{HCN}$ ?
- 3  $\sigma$  bonds
  - 2  $\sigma$  bonds and 1  $\pi$  bond
  - 2  $\sigma$  bonds
  - 2  $\sigma$  bond and 2  $\pi$  bonds
  - 3  $\pi$  bonds
- \_\_\_\_ 27. How many possible orbital *orientations* are allowed when  $\ell = 3$ ?
- 1
  - 2
  - 3
  - 5
  - 7
- \_\_\_\_ 28. Which element listed below would most likely have the following series of ionization energies?

| $\text{IE}_1$ | $\text{IE}_2$ | $\text{IE}_3$ | $\text{IE}_4$ | $\text{IE}_5$ | $\text{IE}_6$ |
|---------------|---------------|---------------|---------------|---------------|---------------|
| 0.80 MJ/mol   | 2.43 MJ/mol   | 3.66 MJ/mol   | 6.22 MJ/mol   | 37.83 MJ/mol  | 47.28 MJ/mol  |

- Li
- B
- C
- O
- F

**Exhibit 2**

The following question(s) relate to the diagram below:



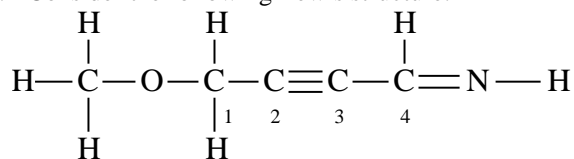
- \_\_\_\_ 29. Refer to Exhibit 2. What set of quantum numbers are acceptable for box C?
- a.  $n = 2, \ell = 2, m_\ell = -2$
  - b.  $n = 3, \ell = 2, m_\ell = -2$
  - c.  $n = 1, \ell = 1, m_\ell = -1$
  - d.  $n = 3, \ell = 0, m_\ell = -1$
  - e. none are acceptable

- \_\_\_\_ 30. Which one of the compounds below has the bonds that are the **most polar**?

(Electronegativities: H = 2.1, S = 2.5, P = 2.1, As = 2.1, Cl = 3.0, Si = 1.8, Sb = 1.9)

- a.  $\text{H}_2\text{S}$
- b.  $\text{PH}_3$
- c.  $\text{AsCl}_3$
- d.  $\text{SiH}_4$
- e.  $\text{SbCl}_3$

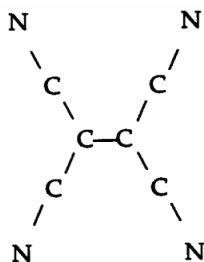
\*31. Consider the following Lewis structure:



What is the hybridization of the atoms O, C-1, C-2, and C-4, respectively?

- a)  $sp^3$        $sp^3$        $sp$        $sp^2$
- b)  $sp$        $sp^3$        $sp$        $sp$
- c)  $sp$        $sp^2$        $sp$        $sp^2$
- d)  $sp^2$        $sp^3$        $sp^2$        $sp^3$
- e)  $sp^3$        $sp$        $sp$        $sp^2$
- O                  C-1                  C-2                  C-4**

Tetracyanoethylene has the skeleton shown below:



Complete the Lewis structure and determine the following:

\*\*32. How many sigma and pi bonds are in the molecule?

- a) 4 sigma and 5 pi
- b) 6 sigma and 8 pi
- c) 9 sigma and 8 pi
- d) 9 sigma and 9 pi
- e) 5 sigma and 8 pi

\*\*33. Electrons occupying the theoretical  $7g$  orbitals all have a spin quantum number of  $m_s = +1/2$ . How many possible orbital *orientations* are allowed for  $7g$ ?

- a. 7
- b. 9
- c. 11
- d. 13
- e. 17