Name: _____ Date: _____

1. Use Hess's Law to calculate the enthalpy change for the reaction
   $WO_{3(s)} + 3H_{2(g)} \rightarrow W_{(s)} + 3H_2O_{(g)}$
   from the following data:
   $2W(s) + 3O_2(g) \rightarrow 2WO_3(s)$ ΔH = -1685.4 kJ
   $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ ΔH = -477.84 kJ
   A) 125.9 kJ
   B) 252.9 kJ
   C) 364.9 kJ
   D) 1207.6 kJ
   E) 207.6 kJ

2. Choose the correct equation for the standard enthalpy of formation of $CO_{(g)}$ (gr indicates graphite).
   A) $C_{(gr)} + (1/2)O_{2(g)} \rightarrow CO_{(g)}$
   B) $2C_{(gr)} + O_{2(g)} \rightarrow 2CO_{(g)}$
   C) $C_{(gr)} + O_{(g)} \rightarrow CO_{(g)}$
   D) $C_{(gr)} + CO_{2(g)} \rightarrow 2CO_{(g)}$
   E) $CO_{(g)} \rightarrow C_{(gr)} + O_{(g)}$

3. For an orbital, a node is
   A) an area where there is no chance of finding the electron.
   B) the midpoint of the orbital.
   C) an area in which at least one electron is present.
   D) an area where there is a maximum probability of finding the electron.
   E) the size of the orbital.

4. Determine the end (final) value of *n* in a hydrogen atom transition, if the electron starts in *n* = 2 and the atom absorbs a photon of light with a frequency of 4.57×10^{14} Hz.
   A) 3
   B) 5
   C) 7
   D) 4
   E) 1

5. Which one of the following sets of quantum numbers is **correct**?
   A) $n = 4, l = 3, m_l = -2$
   B) $n = 2, l = 0, m_l = -1$
   C) $n = 2, l = 2, m_l = 0$
   D) $n = 3, l = 2, m_l = -3$
   E) $n = 4, l = 2, m_l = +4$

6. Calculate the frequency of the green light emitted by a hydrogen atom with a wavelength of 486.1 nm.
   A) $6.17 \times 10^{14}\ s^{-1}$
   B) $1.46 \times 10^{14}\ s^{-1}$
   C) $6.86 \times 10^{14}\ s^{-1}$
   D) $4.33 \times 10^{14}\ s^{-1}$
   E) $1.62 \times 10^{14}\ s^{-1}$

7. How many p electrons does Ga atom have?
   A) 13
   B) 1
   C) 5
   D) 10
   E) 31

8. Consider the following reaction: $3Li + Z \rightarrow Li_3Z$.
   What is the formula for the compound if we substitute magnesium for lithium?
   A) Mg_3Z_2
   B) MgZ
   C) Mg_2Z
   D) MgZ_2
   E) Mg_3Z

9. Elements with _____ first ionization energies and _____ electron affinities generally form cations.
   A) low, slightly positive
   B) high, very negative
   C) high, positive or slightly negative
   D) low, very negative
   E) very high, very positive

10. **The electron configuration of indium (In) is**
    A) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^1$
    B) **$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^1 5d^{10}$**
    C) **$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4d^{10} 4p^1$**
    D) **$1s^2 3s^2 2p^6 3s^2 3p^6 4s^2 4p^6 4d^{10} 5s^2 5d^{10} 5p^1$**
    E) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^2 5p^1$

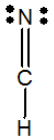
11. Choose the element with the highest first ionization energy (IE_1).
    A) P
    B) S
    C) Na
    D) Mg
    E) Al

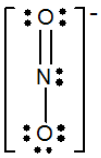
12. Place the following elements (As , O , Br) in order of increasing atomic radius.
    A) O < Br < As
    B) As < Br < O
    C) O < As < Br
    D) Br < As < O
    E) **As < O < Br**

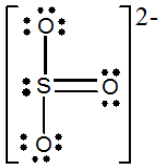
13. The lattice energy of $MgCl_2$ is the energy change for which one of the following processes?
    A) $Mg^{2+}(g) + 2Cl^-(g) \rightarrow MgCl_2(s)$
    B) $Mg(s) + Cl_2(g) \rightarrow MgCl_2(s)$
    C) $Mg(g) + 2Cl(g) \rightarrow MgCl_2(s)$
    D) $Mg^{2+}(s) + 2Cl^-(g) \rightarrow MgCl_2(g)$
    E) $MgCl_2(aq) \rightarrow MgCl_2(s)$

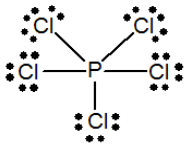
14. Which one of the following Lewis structures is definitely incorrect?

a. NO b. HCN c. NO_2^- d. SO_3^{2-} e. PCl_5









A) b
B) a
C) c
D) d
E) e

15. Given the following bond energies:

C–C347 kJ/mol

C=C614 kJ/mol

C–O358 kJ/mol

C=O799 kJ/mol

C–H413 kJ/mol

O–H463 kJ/mol

O–O146 kJ/mol

estimate ΔH for the reaction $H_2O_2 + CH_3OH \rightarrow H_2CO + 2H_2O$.

A) –345 kJ
B) –199 kJ
C) –105 kJ
D) +581 kJ
E) +299 kJ

16. The hybridization of I in IF_3 molecule is

A) dsp^3
B) d^2sp^3
C) sp^3
D) sp
E) sp^2

17. **Which of the following statements is TRUE?**
    A) When two atomic orbitals come together to form two molecular orbitals, bonding orbitals will be lower in energy compared to the anti-bonding orbitals.
    B) **Electrons placed in antibonding orbitals stabilize the ion/molecule.**
    C) The total number of molecular orbitals formed is not always equal to the number of atomic orbitals in the set.
    D) The total number of antibonding orbitals is always less than the number of bonding orbitals in a given ion/molecule.
    E) Electrons placed in antibonding orbitals will increase the bond order.

18. Use VSEPR theory to decide which one of the following molecules or ion will definitely have at least one 90° bond angle in it. (The central atom in each molecule is underlined).
    A) $\underline{P}Cl_5$
    B) $\underline{Al}Cl_4^-$
    C) $\underline{N}H_3$
    D) $\underline{C}O_2$
    E) $H_2\underline{O}$

19. Which one of the following molecules has a zero net dipole moment?
    A) SO_3
    B) CO
    C) CH_2Cl_2
    D) SO_2
    E) NH_3

20. The number of pi bonds in the oxalate ion ($C_2O_4^{2-}$) is
    A) 2
    B) 1
    C) 0
    D) 3
    E) 4

Answer Key

1. A
2. A
3. A
4. A
5. A
6. A
7. A
8. A
9. A
10. A
11. A
12. A
13. A
14. A
15. A
16. A
17. A
18. A
19. A
20. A