Part I. Multiple Choice:

1. The bonding in which of the following compounds is the most covalent?
   __ A. CaO
   __ B. NaF
   __ C. CO
   __ D. F₂
   __ E. HCl

2. Which subshell contains the orbital with quantum numbers n=3, l=2, m_l=0?
   __ A. 2s
   __ B. 3s
   __ C. 3p
   __ D. 3d
   __ E. 4d

3. Which of the following pairs of atoms/ions is isoelectronic?
   __ A. O⁻², S⁻²
   __ B. Na, Na⁺¹
   __ C. Br⁻¹, Kr
   __ D. Cu, Zn
   __ E. none of these

4. Which of the following electronic transitions in the hydrogen atom requires absorption of the highest energy light?
   __ A. n = 1 to n = 2
   __ B. n = 2 to n = 3
   __ C. n = 3 to n = 4
   __ D. n = 4 to n = 5
   __ E. n = 5 to n = 6

5. Which of the following numbers describes the number of valence electrons in all halogens?
   __ A. 2
   __ B. 3
   __ C. 5
   __ D. 7
   __ E. none of these

6. Order the elements S, Cl, and F in terms of increasing atomic radii.
   __ A. S, Cl, F
   __ B. Cl, F, S
   __ C. F, S, Cl
   __ D. F, Cl, S
   __ E. S, F, Cl
7. 550 nm electromagnetic radiation is in what region of the electromagnetic spectrum?
   ___ A. Ultraviolet
   ___ B. Visible
   ___ C. Infrared
   ___ D. Microwave
   ___ E. X-ray

8. Circle the correct answer for each of the following:
   a) The _____ 1st ionization energy:  Li,  Na,  Mg
   b) The _____ (most exothermic) electron affinity:  As,  Se,  Br

**Part II. Short Answers: To get full credit you must show all your work!**

9. In one sentence, clearly explain why the 3p orbital in an atom of argon is higher energy than the 3s orbital.

10. In one sentence, clearly explain why MgO has a much higher lattice energy than NaF.

11. Give the electron configuration for the following atoms and ions (condensed notation is OK).

   P

   \[ \text{Ti}^{12} \]
12. It requires \(3.86 \times 10^5\) kJ/mol of energy to eject electrons from the surface of a certain metal. What is the maximum wavelength of electromagnetic radiation that can supply this amount of energy?

13. What is the energy of one mole of radio wave photons with a wavelength of 95.6 meters?

14. For laughing gas, \(\text{N}_2\text{O}\)

   a) Draw a valid Lewis structure below (connectivity N–N–O). **Assign formal charges to all atoms.**

   b) Draw two additional resonance structures of the structure you drew in part (a). **Assign formal charges to all atoms.**

   c) Circle the single structure above (from the three structures in parts (a) and (b)) that most closely represents the true structure of \(\text{N}_2\text{O}\) and **briefly** explain your choice.
15. Complete the Lewis structure for the compound nitromethane (CH₃NO₂) as shown below. Assign formal charges to all non-hydrogen atoms. To the right of the structure, draw a resonance structure of what you drew on the left.

![Lewis structure of nitromethane]

your resonance structure

16. Under the right conditions, methane (CH₄) reacts with chlorine gas to produce methylene chloride (CH₂Cl₂), a common organic solvent. Use the table of bond dissociation energies to calculate the enthalpy change (ΔH°) for this reaction.

\[
\text{CH}_4 + 2 \text{Cl}_2 \rightarrow \text{CH}_2\text{Cl}_2 + 2 \text{HCl}
\]

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### Formulas and Constants

\[
N_A = 6.022 \times 10^{23} \text{ mol}^{-1} \quad h = 6.626 \times 10^{-34} \text{ J s} \quad c = 2.998 \times 10^8 \text{ m s}^{-1}
\]

\[
e^* = 1.602 \times 10^{-19} \text{ C} \quad m_e = 9.109 \times 10^{-31} \text{ kg} \quad 1 \text{ Å} = 1 \times 10^{-10} \text{ m}
\]

\[
\Delta E = h\nu = \frac{hc}{\lambda} \quad v\lambda = c \quad \lambda = \frac{h}{mv}
\]

\[
V = \frac{\kappa Q_1 Q_2}{d} \quad \kappa = 8.99 \times 10^9 \text{ J m}^2\text{C}^2
\]

\[
\mu = Qr \quad 1 \text{ D} = 3.336 \times 10^{-30} \text{ C m} \quad \Delta x \Delta p \geq \frac{h}{4\pi}
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