The problems in this review are designed to help prepare you for your upcoming exam. Questions pertain to material covered in the course and are intended to reflect the topics likely to appear in the exam. Keep in mind that this worksheet was created by CARE tutors, and while it is thorough, it is not comprehensive. In addition to exam review sessions, CARE also hosts regularly scheduled tutoring hours.

Tutors are available to answer questions, review problems, and help you feel prepared for your exam during these times:

Session 1: Sunday, September 18th 5p-7p: Ankit, Greg, and Sera

Session 2: Monday, September 19th 5:30p-7:30p: Olivia, Jonathan, and Sera

Can’t make it to a session? Here’s our schedule by course:

https://care.grainger.illinois.edu/tutoring/schedule-by-subject

Solutions will be available on our website after the last review session that we host.

Step-by-step login for exam review session:

1. Log into Queue @ Illinois: https://queue.illinois.edu/q/queue/902
2. Click “New Question”
3. Add your NetID and Name
4. Press “Add to Queue”

Please be sure to follow the above steps to add yourself to the Queue.

Good luck with your exam!
1. Calculate the following equations using the correct significant figure rules.

(a) \(0.008 + 0.42 - 0.041\)
(b) \(100.0 \times 47.830\)

(a) \(= 0.39\)
(b) \(= 4783\)

2. Write the corresponding name/chemical formula for the following compounds:

(a) \(\text{H}_2\text{SO}_4\)
(b) \(\text{Ca}_3\text{P}_2\)
(c) Ammonium Chlorate
(d) Copper (II) Acetate
(e) Tetraphosphorus Hexoxide

(a) Sulfuric Acid(Di-hydrogen Sulfate)
(b) Calcium Phosphide
(c) \(\text{NH}_3\text{ClO}_3\)
(d) \(\text{Cu(CH}_3\text{COO})_2\)
(e) \(\text{P}_4\text{O}_6\)

3. Draw the corresponding Lewis structures for the following compounds:

I. HCN
II. \(\text{CO}_2\)
III. \(\text{AsF}_5\)

I. \(\text{H} \equiv \text{C} \equiv \text{N} :\)

II. \(\overset{\cdot}{\text{O}} = \text{C} = \overset{\cdot}{\text{O}}\)

III.
4. Which of the following statements regarding the Lewis structure below are FALSE?

\[
\begin{array}{c}
\text{O} \\
\left| \right| \\
\text{H} \quad \text{C} \quad \text{C} = \text{C} \quad \text{C} \quad \text{N} \quad \text{H} \\
1 \quad 2 \quad 3 \\
\text{H} \quad \text{H}
\end{array}
\]

A) An sp\(^2\) hybrid orbital from C-1 overlaps with an sp hybrid orbital from C-2 to form the sigma bond between C-1 and C-2.
B) This molecule has three \(\pi\) bonds.
C) Two of the atoms in this compound are sp\(^3\) hybridized.
D) The \(\pi\) bonds between C-2 and C-3 are formed from overlap of sp hybrid orbitals.
E) There are 10 sigma bonds in this molecule.

The answer is D because \(\pi\) bonds are formed from two unhybridized P-orbitals, not the sp hybrid orbitals. The hybridized orbitals form \(\sigma\) bonds. A tricky option for this question is option (B). There are three \(\pi\) bonds in this molecule. Two of them comes from the triple bond between C2 and C3, and the third one comes from the double bonds between C1 and O. There are two \(\pi\) bonds in a triple bond because there are two unhybridized P-orbitals for each of the carbon C2 and C3 due to their sp-hybridization.

5. Write the electron configuration for the following elements in shorthand notation:

(a) O 
(b) Pb 
(c) K 
(d) Ce 
(e) Rn 
(f) Cu 
(g) Mn

(a) \([\text{He}]2s^22p^6\)
(b) \([\text{Xe}]6s^24f^{14}5d^{10}6p^2\)
(c) \([\text{Ar}]4s^1\)
(d) \([\text{Xe}]6s^24f^15d^1\)
(e) \([\text{Xe}]6s^24f^{14}5d^{10}6p^6\)
(f) \([\text{Ar}]4s^13d^{10} \quad (*\text{EXCEPTION}*)\)
(g) \([\text{Ar}]4s^23d^5\)

6. Answer the following questions about periodic trends.

(a) Rank from smallest to largest atomic radii: Li, O, Fr, Rb, He
(b) Which has a higher ionization energy, Boron or Beryllium?
(c) Rank from most to least ionization energy: P, As, Te, O
(d) Rank from smallest to largest atomic radii: Na\(^+\), O\(^2-\), F\(^-\), Mg\(^+\)

(a) He < O < Li < Rb < Fr
(b) Beryllium. *Trick Question* because it goes against the trend. Look at the electron configurations of each. Notice that Boron has one unpaired electron whereas Beryllium does not.
(c) O > P > As > Te
(d) Na\(^+\) < Mg\(^+\) <F\(^-\) <O\(^2-\). All the ions have the same number of electrons, but the number of protons are different. With more protons, the electrical attraction force between the protons and electrons is stronger, which results in a smaller radius.

7. Balance the following equation.

\[
\text{C}_8\text{H}_{18} + \underline{\text{O}_2} \rightarrow \underline{\text{CO}_2} + \underline{\text{H}_2\text{O}}
\]

\[
2 \text{C}_8\text{H}_{18} + 25 \text{O}_2 \rightarrow 16 \text{CO}_2 + 18 \text{H}_2\text{O}
\]

8. Circle the following ions that have 2 unpaired electrons in ground state.

\[
\text{Cu}^+ \quad \text{Ni}^{2+} \quad \text{Zn}^{2+} \quad \text{Cr}^{2+} \quad \text{Ti}^{2+}
\]

The electron configurations of these ions are shown below.
Cu\(^+\): [Ar]4s\(^0\)3d\(^{10}\)
Ni\(^{2+}\): [Ar]4s\(^0\)3d\(^8\)
Zn\(^{2+}\): [Ar]4s\(^0\)3d\(^{10}\)
Cr\(^{2+}\): [Ar]4s\(^0\)3d\(^4\)
Ti\(^{2+}\): [Ar]4s\(^0\)3d\(^2\)

The only two ions with 2 unpaired electrons are Ni\(^{2+}\) and Ti\(^{2+}\).

9. Which bond has the shortest bond length and give an explanation as to why?

A) Single
B) Double Bond
C) Triple Bond

The answer is **triple bond**. Triple bonds are stronger than double bonds, which are stronger than single bonds. The increased number of shared electrons results in more attraction between the atoms.
10. How many of the following processes are examples of a chemical change?

(I) \( H_2O \) (l) \( \rightarrow \) \( H_2O \) (g)

(II) \( I_2 \) (s) \( \rightarrow \) \( I_2 \) (g)

(III) \( CH_4 \) (g) + 2\( O_2 \) (g) \( \rightarrow \) \( CO_2 \) (g) + 2\( H_2O \) (l)

(IV) \( C_6H_{12}O_6\) (s) \( \rightarrow \) \( C_6H_{12}O_6\) (aq)

(V) 2\( H_2O_2\) (aq) \( \rightarrow \) 2\( H_2O\) (l) + \( O_2\) (g)

A) 1 B) 2 C) 3 D) 4 E) 5

Chemical change occurs when one molecule is transformed into different chemical substances. In this case, only (III) and (V) exhibit chemical changes. Therefore, the answer is (B).
11. For a hydrogen atom, how many of the following three electronic transitions are exothermic? Circle them.

A) n = 6 to n = 1  
B) n = 2 to n = 3  
C) n = 3 to n = 5

The answer is (A). Going from a higher energy state (n=6) to a lower energy state (n=1) results in releasing energy, which is an exothermic process.

12. When an electron in a 2p orbital of a lithium atom makes a transition to the 2s orbital, a photon of wavelength 670.8 nm is emitted. Calculate the energy difference between the 2p and 2s orbitals in lithium.

Calculate the frequency and then multiply by Plank’s Constant to solve for the energy difference

\[ c = \nu \lambda \]
\[ \nu = 4.437 \times 10^{14} \text{ Hz} \]
\[ E = h\nu = \frac{c}{\lambda} \]

\[ E = 2.96 \times 10^{-19} \text{ J} \]

13. Calculate the change in energy for the n = 4 to the n = 2 transition in hydrogen.

\[ E = -R_1 Z^2 \left( \frac{1}{n_2^2} - \frac{1}{n_1^2} \right) \]

where \( Z = 1 \), \( n_2 = 2 \), and \( n_1 = 4 \)

Plug in the values so \( E = -(2.178 \times 10^{-18})(1^2)\left( \frac{1}{2^2} - \frac{1}{4^2} \right) \)

\[ -4.084 \times 10^{-19} \text{ J} \]

14. Does a visible light (\( \lambda = 400 - 700 \text{ nm} \)) photon have enough energy to excite a H electron from n=1 energy to n = 6 energy state?

Need to find maximum amount of energy from visible light. Lowest wavelength provides highest energy.

\[ E = \frac{hc}{\lambda} \rightarrow E = \frac{hc}{400\text{nm}} = 4.966 \times 10^{-19} \text{ J} \]

Same equation as 3, but with \( Z = 1 \), \( n_2 = 6 \) and \( n_1 = 1 \)

Plug in values and solve to find \( E = 2.1775 \times 10^{-18} \text{ J} \) which is the energy required to move an electron from energy level 1 to energy level 6.

The energy from visible light \( (4.966 \times 10^{-19} \text{ J}) \) is less than the required amount.

Therefore, the answer is visible light does NOT have enough energy to excite a H electron from energy level 1 to 6.
15. Calculate the mass percent composition of the following compound

\[ \text{C}_3\text{H}_4\text{O}_2 \]

C: \[ \frac{(12.01 \times 3)}{72.062} \times 100 \% = 50\% \]

H: \[ \frac{(1.008 \times 4)}{72.062} \times 100 \% = 5.6\% \]

O: \[ \frac{(16 \times 2)}{72.062} \times 100 \% = 44.4\% \]