Dougherty Valley HS Chemistry - AP
Atomic Structure – Atomic Structure FRQs

Worksheet #9

Name: **Period:** **Seat#:**

Directions: Show all work in a way that would earn you credit on the AP Test! This is always the rule! Grading rubrics posted in the Google Answer Key Drive. Check your work, correct in green pen after you try them yourself in an honest way! Don't peek at rubrics while you work! **USE BINDER PAPER, STAPLE TO YOUR WORKSHEET**. Clearly label work.

LONG ASSIGNMENT! DON'T WAIT UNTIL THE LAST MINUTE! BREAK IT INTO CHUNKS!
SET A TIMER FOR 1.5 MIN PER FRQ PART AND SEE IF YOU FINISH ON TIME!

1999

2. Answer the following questions regarding light and its interactions with molecules, atoms, and ions.

(a) The longest wavelength of light with enough energy to break the Cl–Cl bond in $Cl_2(g)$ is 495 nm.

(i) Calculate the frequency, in s^{-1}, of the light.

(ii) Calculate the energy, in J, of a photon of the light.

(iii) Calculate the minimum energy, in kJ mol^{-1}, of the Cl–Cl bond.

(b) A certain line in the spectrum of atomic hydrogen is associated with the electronic transition in the H atom from the sixth energy level (n = 6) to the second energy level (n = 2).

(i) Indicate whether the H atom emits energy or whether it absorbs energy during the transition. Justify your answer.

(ii) Calculate the wavelength, in nm, of the radiation associated with the spectral line.

(iii) Account for the observation that the amount of energy associated with the same electronic transition (n = 6 to n = 2) in the He+ ion is greater than that associated with the corresponding transition in the H atom.

2006

8. Suppose that a stable element with atomic number 119, symbol Q , has been discovered.

(a) Write the ground-state electron configuration for Q , showing only the valence-shell electrons.

(b) Would Q be a metal or a nonmetal? Explain in terms of electron configuration.

(c) On the basis of periodic trends, would Q have the largest atomic radius in its group or would it have the smallest? Explain in terms of electronic structure.

(d) What would be the most likely charge of the Q ion in stable ionic compounds?

(e) Write a balanced equation that would represent the reaction of Q with water.

(f) Assume that Q reacts to form a carbonate compound.

(i) Write the formula for the compound formed between Q and the carbonate ion, CO_3^{2-} .

(ii) Predict whether or not the compound would be soluble in water. Explain your reasoning.

2006B

7. Account for each of the following observations in terms of atomic theory and/or quantum theory.

(a) Atomic size decreases from Na to Cl in the periodic table.

(b) Boron commonly forms molecules of the type BX3 . These molecules have a trigonal planar structure.

(c) The first ionization energy of K is less than that of Na.

(d) Each element displays a unique gas-phase emission spectrum.

2007B

2. Answer the following problems about gases.

(a) The average atomic mass of naturally occurring neon is 20.18 amu. There are two common isotopes of naturally occurring neon as indicated in the table below.

Isotope	Mass (amu)
Ne-20	19.99
Ne-22	21.99

(i) Using the information above, calculate the percent abundance of each isotope.

(ii) Calculate the number of Ne-22 atoms in a 12.55 g sample of naturally occurring neon.

(b) A major line in the emission spectrum of neon corresponds to a frequency of $4.34 \times 10^{14}\ s^{-1}$. Calculate the wavelength, in nanometers, of light that corresponds to this line.

2007B cont.

(c) In the upper atmosphere, ozone molecules decompose as they absorb ultraviolet (UV) radiation, as shown by the equation below. Ozone serves to block harmful ultraviolet radiation that comes from the Sun.

$$O_3(g) \xrightarrow{UV} O_2(g) + O(g)$$

A molecule of $O_3(g)$ absorbs a photon with a frequency of $1.00 \times 10^{15}\ s^{-1}$.

(i) How much energy, in joules, does the $O_3(g)$ molecule absorb per photon?

(ii) The minimum energy needed to break an oxygen-oxygen bond in ozone is 387 kJ mol^{-1}. Does a photon with a frequency of $1.00 \times 10^{15}\ s^{-1}$ have enough energy to break this bond? Support your answer with a calculation.

2008

5. Using principles of atomic and molecular structure and the information in the table below, answer the following questions about atomic fluorine, oxygen, and xenon, as well as some of their compounds.

Atom	First Ionization Energy (kJ mol^{-1})
F	1,681.0
O	1,313.9
Xe	?

(a) Write the equation for the ionization of atomic fluorine that requires 1,681.0 kJ mol^{-1}

(b) Account for the fact that the first ionization energy of atomic fluorine is greater than that of atomic oxygen. (You must discuss <u>both</u> atoms in your response.)

(c) Predict whether the first ionization energy of atomic xenon is greater than, less than, or equal to the first ionization energy of atomic fluorine. Justify your prediction

2005

7. As shown in the table below, the first ionization energies of Si, P, and Cl show a trend.

Element	First Ionization Energy (kJ mol^{-1})
Si	786
P	1,012
Cl	1,251

(i) For each of the three elements, identify the quantum level (e.g., n = 1, n = 2, etc.) of the valence electrons in the atom

(ii) Explain the reasons for the trend in first ionization energies.

2003B

7. Account for the following observations using principles of atomic structure and/or chemical bonding. In each part, your answer must include specific information about both substances.

(a) The Ca^{2+} and Cl^- ions are isoelectronic, but their radii are not the same. Which ion has the larger radius? Explain.

(b) Carbon and lead are in the same group of elements, but carbon is classified as a nonmetal and lead is classified as a metal.

(c) Compounds containing Kr have been synthesized, but there are no known compounds that contain He .

(d) The first ionization energy of Be is 900 kJ mol^{-1}, but the first ionization energy of B is 800 kJ mol^{-1}

2007B

	1st I.E (kJ mol^{-1})	2nd I.E (kJ mol^{-1})	3rd I.E (kJ mol^{-1})
Element 1	1,251	2,300	3,820
Element 2	496	4,560	6,910
Element 3	738	1,450	7,730
Element 4	1,000	2,250	3,360

6. The table above shows the first three ionization energies for atoms of four elements from the third period of the periodic table. The elements are numbered randomly. Use the info. in the table to answer the following Qs

(a) Which element is most metallic in character? Explain your reasoning.

(b) Identify element 3. Explain your reasoning.

(c) Write the complete electron configuration for an atom of element 3.

(d) What is the expected oxidation state for the most common ion of element 2 ?

(e) What is the chemical symbol for element 2 ?

(f) A neutral atom of which of the four elements has the smallest radius?

Reflection: Think about the types of mistakes you made, things you need to restudy, things that tricked you, etc. One of the most important skills to develop in AP Chem is self reflection and not making the same mistakes. The joke is – you should always make NEW mistakes, not the SAME mistakes ☺