KEY

Review Sheet: UNIT TWO TEST

HISTORY OF ATOM, STRUCTURE OF ATOM, ATOMIC MASS

1. Know which isotope is the standard for the atomic mass unit. **CARBON-12**
2. Know what the difference in masses of isotopes of the same element is due to.
   DIFFERENT NUMBERS OF NEUTRONS
3. Know the charges and masses of protons, electrons, and neutrons

PARTICLE	**CHARGE**	**MASSES**
PROTON	**POSITIVE (p^+)**	**1 amu**
NEUTRON	**NEUTRAL (n^0)**	**1 amu**
ELECTRON	**NEGATIVE (e^-)**	**1/1840 amu**

4. Know how to calculate the number of protons, neutrons and electrons in an atom when given its isotope mass and atomic number.
   As an example: Lead (Pb) has an atomic number of 82. An isotope of lead has a mass of 206 amu. Calculate the number of protons, neutrons and electrons in an atom of this isotope. How would you write the isotope symbol for this isotope of lead?
   NUMBER OF PROTONS = ATOMIC NUMBER = NUMBER OF ELECTRONS = 82
   NUMBER OF NEUTRONS = MASS NUMBER – NUMBER OF PROTONS
   NUMBER OF NEUTRONS = 206 - 82 = 124 **ISOTOPE SYMBOL=** $^{206}_{82}Pb$
5. When given the isotope symbol for an element be able to give its number of protons, electrons and neutrons.
   As an example: Give the number of each of these particles for $^{70}_{30}Zn$.
   NUMBER OF PROTONS = NUMBER OF ELECTRONS = 30
   NUMBER OF NEUTRONS = 70-30 = 40
6. Assume the following three isotopes of element Z exist: *Z-123, Z-125,* and *Z-129*. If the atomic mass of Z is 128.66 amu, which of these isotopes is most abundant? (Hint: Think about the Mass Number)
   THE MOST ABUNDANT ISOTOPE IS THE ONE CLOSEST TO THE MASS OF 128.66 AMU AND THAT IS Z-129.
7. Use the following data table on the isotopes of element "X" to answer Questions A-C listed below:

Isotope	**Mass in amu**	**Percent Abundance**	**Mass × Abundance**
X-24	26.985	78.99	**26.985 × 0.7899 = 21.32**
X-25	24.986	10.00	**24.986 × 0.1000 = 2.499**
X-26	25.982	11.01	**25.982 × 0.1101 = 2.861**

   A. What is the average mass of element "X"? **21.32 + 2.499 + 2.861= 26.68 AMU**
   B. Using the periodic table what is the identity of element "X"? **ALUMINUM**
   C. Using the periodic table what is the atomic number of element "X"? **13**

8. Know how the relative number of protons, neutrons, and electrons compare in an atom.
   PROTONS AND NEUTRONS ARE IN THE NUCLEUS AND ELECTRONS ORBIT AROUND THE NUCLEUS. THE NUMBER OF PROTONS AND ELECTRONS IN A NEUTRAL ATOM ARE THE SAME. THE NUMBER OF NEUTRONS = MASS NUMBER – NUMBER OF PROTONS.
9. Know the relative size, charge, and mass of the nucleus compared to the rest of the atom.
   THE NUCLEUS IS EXTREMELY SMALL BUT IS VERY DENSE. MOST OF THE MASS OF AN ATOM IS INSIDE THE NUCLEUS. THE NUCLEUS IS POSITIVELY CHARGED WHILE AN ATOM HAS AN OVERALL NEUTRAL CHARGE.

10. Know the contributions of the following individuals according to you text and the video that we saw in class
    A. Bohr: **ELECTRONS ORBIT THE NUCLEUS AND CAN ONLY BE IN CERTAIN ORBITS OR ENERGY LEVELS**
    B. J.J. Thomson: **RAISIN BUN MODEL/PLUM PUDDING MODEL; DISCOVERED THE ELECTRON AND MEASURED THE RATIO OF ITS CHARGE TO MASS**
    C. Millikan: **DID AN OIL DROP EXPERIMENT TO DETERMINE THE CHARGE ON AN ELECTRON**
    D. Lavoisier: **CAME UP WITH THE LAW OF CONSERVATION OF MASS**
    E. Democritus: **GREEK PHILOSOPHER WHO CAME UP WITH ATOMISM**
    F. Planck: **MATTER EMITS OR ABSORBS ENERGY IN BUNDLES CALLED QUANTA**
    G. Rutherford: **GOLD FOIL EXPERIMENTS, NUCLEUS IS POSITIVELY CHARGED**
    H. Dalton: **CHEMICAL ATOMIC THEORY**
    I. Chadwick: **WAS OVERSHADOWED BY RUTHERFORD, DISCOVERED THE NEUTRON**

RADIOACTIVITY

11. Know that the forms of natural radioactivity are alpha, beta, and gamma. What are each of these? Which is the most dangerous of these?
    ALPHA - THESE ARE FAST MOVING HELIUM ATOMS (^4_2He)
    BETA - THESE ARE FAST MOVING ELECTRONS ($^{0}_{-1}e$)
    GAMMA - THESE ARE PHOTONS, JUST LIKE LIGHT, EXCEPT OF MUCH HIGHER ENERGY
    GAMMA RAYS ARE THE MOST DANGEROUS AND HAVE HIGH PENETRABILITY
12. Know why radioactivity occurs.
    BECAUSE OF SPONTANEOUS NUCLEAR DECAY
    AN UNSTABLE NUCLEUS WILL EJECT EITHER A PARTICLE AND/OR ENERGY UNTIL IT REACHES A MORE STABLE ARRANGEMENT
13. Know how to balance a nuclear reaction selecting the correct particle.
    As an example: What particles would you use to balance the following nuclear reactions?
    A. $^{27}_{12}Mg \rightarrow ^{27}_{13}Al + \_\_\_\_$ (a) ^4_2He (b) $^{0}_{-1}e$ (c) $^{0}_{+1}e$ (d) ^1_0n (e) gamma ray
    B. $^{231}_{90}Th \rightarrow ^{227}_{88}Ra + \_\_\_\_$ (a) ^4_2He (b) $^{0}_{-1}e$ (c) $^{0}_{+1}e$ (d) ^1_0n (e) gamma ray

ELEGANT UNIVERSE VIDEO QUESTIONS

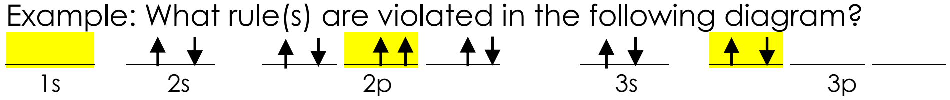
14. Know what the difference between gravity and electromagnetism is according to the "Elegant Universe" program we saw. **GRAVITY AND ELECTROMAGNETISM HAVE DIFFERENT STRENGTHS, ELECTROMAGNETISM IS STRONGER**
15. Know what the theory is that unifies all forces and particles but has not been test according to the "Elegant Universe" program we saw. **STRING THEORY IS THE THEORY THAT UNIFIES THE THEORY OF THE LARGE WITH THE THEORY OF THE SMALL. STATES THAT ALL THINGS ARE MADE FROM ONE SINGLE INGREDIENT (STRINGS)**
16. Know the differences between "General Relativity" and "Quantum Mechanics".
    GENERAL RELATIVITY IS USED TO EXPLAIN THINGS THAT ARE LARGE, WHILE QUANTUM MECHANICS SEEKS TO EXPLAIN THINGS THAT ARE VERY SMALL

QUANTUM MECHANICS, ELECTRON CONFIGURATION, ORBITAL DIAGRAMS

1. Know the four quantum numbers and what each corresponds to.
   FIRST QUANTUM NUMBER (n): PRINCIPLE ENERGY LEVEL
   SECOND QUANTUM NUMBER (ℓ): SUBSHELL/SUBLEVEL (s, p, d, f)
   THIRD QUANTUM NUMBER (m): ORBITAL AND ORIENTATION (s=1, p=3, d=5, f=7)
   FOURTH QUANTUM NUMBER (s): SPIN OF ELECTRON, IN AN ORBITAL MUST HAVE OPPOSING SPIN

2. Give the electron configurations for the following elements.
   A. Mg (z = 12) **$1s^2\,2s^2\,2p^6\,3s^2$**
   B. K (z = 19) **$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1$**
   C. Ge (z = 32) **$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^2$**
   D. Fe (z = 26) **$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^6$**
   E. O (z = 8) **$1s^2\,2s^2\,2p^4$**
   F. B (z = 5) **$1s^2\,2s^2\,2p^1$**
3. Give the orbital filling diagrams for the following elements.
   A. Mg (z = 12) ↑↓ (1s) ↑↓ (2s) ↑↓ ↑↓ ↑↓ (2p) ↑↓ (3s)
   B. K (z = 19) ↑↓ (1s) ↑↓ (2s) ↑↓ ↑↓ ↑↓ (2p) ↑↓ (3s) ↑↓ ↑↓ ↑↓ (3p) ↑ (4s)
   C. Ge (z = 32) ↑↓ (1s) ↑↓ (2s) ↑↓ ↑↓ ↑↓ (2p) ↑↓ (3s) ↑↓ ↑↓ ↑↓ (3p) ↑↓ (4s) ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ (3d) ↑ ↑ __ (4p)
   D. Fe (z = 26) ↑↓ (1s) ↑↓ (2s) ↑↓ ↑↓ ↑↓ (2p) ↑↓ (3s) ↑↓ ↑↓ ↑↓ (3p) ↑↓ (4s) ↑↓ ↑ ↑ ↑ ↑ (3d)
   E. O (z = 8) ↑↓ (1s) ↑↓ (2s) ↑↓ ↑ ↑ (2p)
   F. B (z = 5) ↑↓ (1s) ↑↓ (2s) ↑ __ __ (2p)
4. Give the electron dot diagrams for the following elements.
   A. Mg (z = 12) **Mg :**
   B. K (z = 19) **K •**
   C. Ge (z = 32) **•Ge:** (with one dot above)
   D. Fe (z = 26) **Fe :**
   E. O (z = 8) **•O:** (with two dots above and one below)
   F. B (z = 5) **B :** (with one dot above)
5. Give the number of orbitals there are in each of the sublevels
   A. s sublevel **1 orbital**
   B. p sublevel **3 orbitals**
   C. d sublevel **5 orbitals**
   D. f sublevel **7 orbitals**
6. How many sublevels are there in each of the energy levels?
   A. First **1**
   B. Second **2**
   C. Third **3**
   D. Fourth **4**
   E. Fifth **5**
   F. Sixth **6**
   G. Seventh **7**
   H. Eighth **8**
7. Give the maximum number of electrons that could be found in each of the sublevels.
   A. s sublevel **2 electrons**
   B. p sublevel **6 electrons**
   C. d sublevel **10 electrons**
   D. f sublevel **14 electrons**
8. How many electrons would be found in the indicated sublevels for each of the following elements?
   A. 2p sublevel for the element where z = 8 **$1s^22s^2\underline{2p^4}$ = 4 electrons**
   B. 3p sublevel for the element where z = 22 **$1s^22s^22p^63s^2\underline{3p^6}4s^23d^2$ = 6 electrons**
   C. 3d sublevel for the element where z = 25 **$1s^22s^22p^63s^23p^64s^2\underline{3d^5}$ = 5 electrons**
   D. 4f sublevel for the element where z = 62 **$1s^22s^22p^63s^23p^64s^23d^{10}4p^65s^24d^{10}5p^66s^2\underline{4f^6}$ = 6 e-**
9. Give the name of the element for each of the following electron configurations.
   A. $1s^2\,2s^2\,2p^3$ **Nitrogen**
   B. $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^8$ **Nickel**
   C. $1s^2\,2s^2\,2p^6\,3s^2\,3p^5$ **Chlorine**

10. Know the important idea or principle each of the following men contributed:
Schrodinger- Developed an equation using quantum numbers to explain electron arrangement
Pauli- Came up with the Pauli Exclusion Principle which stated that no two electrons in an atom have the same set of quantum numbers (if the other quantum numbers are the same, then the spin has to be different)
Heisenberg- Came up with the Heisenberg Uncertainty Principle which stated that you cannot know the momentum and position of an electron with equal certainty at the same time
11. When given an orbital filling diagram for an element, be able to determine which of the rules is violated: Aufbau Principle, Pauli Exclusion Principle or Hund's Rule.
Example: What rule(s) are violated in the following diagram?



Aufbau Principle is violated because 1s orbital should be filled before filling the 2s (lower energy levels fill up first)
Pauli Exclusion Principle is violated because in the 2p orbital, there are two electrons with the same spin. The two electrons should have opposite spins (one up arrow and one down arrow)
Hund's Rule is violated because in the 3p orbital there should not be two electrons. You should not give a single orbital two electrons if there is available space in that orbital (each orbital should get one electron before a single orbital gets two)
12. When given an electromagnetic spectrum be able to identify which of a pair of waves has a longer wavelength and a higher frequency. How do visible light waves compare in length and frequency to ultraviolet and infrared waves?
Radio Waves have a longer wavelength but a lower frequency. Gamma Rays have a shorter wavelength, but have a higher frequency. Radio Waves are lower energy waves and Gamma Rays have the highest energy. Visible light has a longer wavelength than UV waves, but a shorter wavelength than Infrared waves. Visible light has a higher frequency than Infrared waves, but lower frequency than UV waves.
13. What did de Broglie's equation conclude about particles of matter?
All particles behave as waves (Electrons have a wave-particle duality)
14. When given the predicted and actual configuration of an element explain the reason for the difference. As an example: Copper has a predicted configuration of $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^9$, but the actual configuration is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$. Why the difference?
Cu is able to obtain a more stable electron configuration when it takes an electron from the 4s and adds it to 3d. When it does this, it completes the d sublevel and this results in a more stable compound with lower energy. It only works if by removing one electron from the s subshell and adding to the d sublevel resulting in half full or full subshell. **Also know that it is more stable to have two partially filled orbitals than one fully filled and one partially filled**
15. When given the atomic emission spectra of unknown elements be able to identify which are the same.
They will have the same spectral lines- If you are given the atomic emissions spectra of many unknown elements, the two which have the identical spectra diagrams will be the same. Remember, each element has a unique atomic emission spectra.
16. Recognize the definitions of the following terms:
a. wavelength: **the shortest distance between equivalent points on a continuous wave**
b. photoelectric effect: **the emission of electrons from a metal's surface when light of a certain frequency shines on it**
c. atomic emission spectra: **the set of frequencies of the electromagnetic waves emitted by the atoms of an element**
d. principle quantum number: **indicates the relative sizes and energies of atomic orbitals**
e. ground state: **the lowest allowable energy state of an atom**

f. electromagnetic radiation: **a form of energy that exhibits wavelike behavior as it travels through space**

g. photon: **a particle of electromagnetic radiation with no mass that carries a quantum of energy**

h. quantum: **the minimum amount of energy that can be lost or gained by an atom**

i. atomic orbital: **a 3-D region around the nucleus of an atom that describes an electrons probable location**

17. Recognize Planck's equation for determining energy of a quantum of electromagnetic energy, de Broglie's equation for wavelength of a moving particle, and the equation for relating velocity of light, frequency and wavelength.

Planck's Energy Equation: $E=hv$

de Broglie's Equation: $\lambda=h/mv$

Equation relating velocity of light, frequency and wavelength: $c=\lambda v$

18. Be able to recognize the noble gas notation for an element. As an example give the noble gas notation for Na, F, N and Mg.

Na: [Ne] $3s^1$

F: [He] $2s^2\ 2p^5$

N: [He] $2s^2\ 2p^3$

Mg: [Ne] $3s^2$

19. Problem solving:

a. What is the wavelength of electromagnetic radiation having a frequency of 5.00×10^{12} Hz?

$c = \lambda v$ Where c is speed of light (3.00×10^8 m/s) and v is frequency (5.00×10^{12} Hz)

$$c = \lambda v$$

$$(3.00\times10^8\ \text{m/s}) = \lambda\ (5.00\times10^{12}\ 1/\text{s})$$

$$\lambda = 6.00\times10^{-5}\ \text{m}$$

b. What is the frequency of electromagnetic radiation having a wavelength of 3.33×10^{-8} m?

$c = \lambda v$ Where c is speed of light (3.00×10^8 m/s) and λ is wavelength (3.33×10^{-8} Hz)

$$c = \lambda v$$

$$(3.00\times10^8\ \text{m/s}) = (3.33\times10^{-8}\ \text{m})\ v$$

$$v = 9.00\times10^{15}\ \text{Hz or } 9.00\times10^{15}\ 1/\text{s}$$

c. Calculate the energy of a photon of violet light with a frequency of 6.8×10^{14} Hz.

$E=hv$ Where h is Planck's Constant 6.626×10^{-34} J•s and v is frequency (6.8×10^{14} Hz)

$$E = hv$$

$$E = (6.626\times10^{-34}\ \text{J}\cdot\text{s})\ (6.8\times10^{14}\ \text{Hz})$$

$$E = 4.5\times10^{-19}\ \text{J}$$

d. Calculate the energy of a photon of ultraviolet light that has a frequency of 5.02×10^{20} Hz.

$E=hv$ Where h is Planck's Constant 6.626×10^{-34} J•s and v is frequency (5.02×10^{20} Hz)

$$E = hv$$

$$E = (6.626\times10^{-34}\ \text{J}\cdot\text{s})\ (5.02\times10^{20}\ \text{Hz})$$

$$E = 3.3\times10^{-13}\ \text{J}$$