NAME \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ UNIT 2: BASIC ATOMIC STRUCTURE and

BASICS OF REDOX **(Part 1)**

➊ <http://www.chemguide.co.uk/atoms/properties/gcse.html#top> (very good)

➋ <https://www.youtube.com/watch?v=h6LPAwAmnCQ> (not bad!)

➌ <https://www.youtube.com/watch?v=P-wDdFyeLpM> (not bad)

➍ <https://www.youtube.com/watch?v=EMDrb2LqL7E&t=596s> (Goes more deeply into electron configuration which is

not really the focus of this packet …. but the first part is fairly good)

➎ <https://opentextbc.ca/chemistry/chapter/2-3-atomic-structure-and-symbolism/> (very good)

**Learning Goals**: The expected outcomes of your work, are listed. Goal 1 lists important vocabulary terms. You want to know each term's definition. The packet or other sources will help you find reasonable definitions for the terms listed in Goal 1.

Goal 1) You must be able to **define / compare / contrast / interpret** the vocabulary terms:

atom \* the smallest representative, neutral unit of an element (in which the number of protons equals the

number of electrons) capable of participating in chemical reactions

isotope \*a representative atom (species) of an element, having the same atomic number as all other atoms of

the element, but having a different mass number, due to a different number of neutrons.

subatomic particle \*any species that comprises the nucleus or electron cloud of an atom or ion.

mass number \* the unitless, whole number sum of the protons and neturons of a nucleus. The number of

nucleons (mass number) of a specific isotope

nucleons \* subatomic particles comprising the nucleus (generally the protons and neutrons)

atomic number \*the number of protons of a nucleus

nuclear charge \*a positive value equivalent to the total number of protons (the atomic number) of a nucleus

ion \* any species in which the number of protons does not equal the number of electrons

Goal 2) **explain**: why all **atoms** may be said to be **neutral** particles (or 0) in overall charge,

and how an atom of an element compares/contrasts to (an) ion(s) of that element.

\*Atoms are neutral, because the number of positive protons are equal to the number of the negative

electrons. The ion of an atom has lost or gained electron(s), and thus the proton number does not equal the

electron number.

Goal 3) list facts of an atom's 3 major subatomic particles with respect to the :

* + - name
    - physical characteristics (mass, charge)
    - location within the atom

Goal 4) interpret an isotopic notation:

Note: **There is no “official”** system of isotopic notation. (I know! …odd!) Different websites/texts may use slightly different formats to impart the exact same information, regarding atomic number, mass number etc. You must rise above this issue and learn how to integrate other formats with the format in this packet. I find the following, however, quite valuable for learning.

The four corners of an element’s symbol may be used to designate different information.

Mass Number

Oxidation State

Atomic Number

Subscript

X

This goal 4 focuses only upon the upper left and lower left corners of a symbol.

( #p + #n) = Mass number or # of nucleons (the upper left corner)

Atomic number = # p = nuclear charge ∴# e- X

(the lower left corner)

**For example:**

Given the isotopic notation for an atom of: you will need to identify:

the # of nucleons is 63 or rather, the atom has a mass # of 63 ... due to 30 protons  **+** 33 neutrons

the atomic # = 30 which means there are 30 protons and thus a nuclear charge of +30

and **since this is an atom, one may infer** that there are also 30 electrons

And, using the periodic table you can tell that the above represents an atom of

zinc and its specific name is zinc-63 (pronounced as: ***zinc sixty three***)

Goal 5) write the isotopic notation (as in Goal 4) for any atom or ion using information provided in a

a question and/or information.

Goal 6) interpret the charge of simple positive ions (cations) and negative ions (anions) relative to the

ion's atom (or neutral, in charge, form).

e.g) Ca**2+** is an ion. It has an unequal number of protons and electrons. The charge of +2 indicates

that it has 2 more protons (or 2 more + charges) relative to its atom (Ca0) because 2 electrons

(or 2 negative charges) have been removed/lost [Ca**2+** is the oxidized form of the element

calcium]

**Summary of the subatomic particles you must know**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Subatomic  Particle | Symbol | Charge | Location | Comments |
| Proton | + | +1 | Nucleus | +1 charge  1μ in mass  Total number of protons = **atomic number.**  Total charge due to protons **= nuclear charge.**  In reaction chemistry (non-nuclear), the number of protons of an atom is a constant. It does NOT change. |
| Neutron | n | 0 | Nucleus | 0 charge  1μ in mass  Part of the mass of an atom. |
|  |  |  |  | The sum (#p +#n) = mass number |
| Electron | - | -1 | electron cloud | -1 charge  0 μ  In an atom, the #protons = #of electrons. This is not true for a species called an ion.  The number of electrons may change, as electrons may be shared, lost or gained during a chemical reaction. |
|  |  |  |  | The arithmetic difference between the number of protons and the number of electrons is equivalent to charge of an ion |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Subatomic  Particle | Symbol | Charge | Location | Comments |
| Proton | +, or | +1 | Nucleus: The proton is in general termed to be a nucleon | The proton is the fundamental unit of positive charge, for our course.  A free (unbounded) proton has a mass of 1.67262 × 10−24 grams or approximately 1 atomic mass unit (1μ).  The presence of protons of the nucleus causes the nucleus to have an overall positive charge (the nuclear charge).  The proton is slightly smaller than the neutron.  The number of protons of an atom or of an ion is called the **atomic number.** |
| Neutron | n or | 0 | Nucleus: The proton is in general termed to be a nucleon | The neutron has no charge. It is assigned a 0 in overall charge, thus it does not contribute at all to the charge of any atom or ion. However, the neutron is slightly larger than a proton, at  1.67493 x 10-24 grams. Despite this difference in mass, a neutron is also considered to be approximately 1μ.  The neutron has no charge, but it adds to the mass of the atom.  The neutron appears to help stabilize or reduce the repulsive forces between protons. |
| Electron | -, or e- or β- | -1 | the electron cloud of an atom, beyond or surrounding the nucleus. | The electron is the fundamental unit of negative charge, for our course.  The electron has a mass of 9.1 x 10-28 grams or 0.00055μ. The mass of an electron is deemed to be essentially 0.  The presence of electrons in what we shall term as the electron cloud area surrounding a nucleus, causes the electron cloud to have an overall negative charge.  The electron is incredibly smaller than the proton. It would require approximately 1,800 electrons to equal the mass of a single proton. Despite this incredible difference in mass, the negative charge of an electron is equal in heft or in magnitude to the magnitude of a proton.  Thus, in an atom with one proton and one electron, the overall charge of the *ATOM* equals 0. The charge of the proton is cancelled completely by the opposite but equal charge of the electron. |

Before we get into this, I would like to offer you a metaphor for the structure of an atom, in light of our work on reaction chemistry.

I would like you to consider an atom, like a feudal kingdom. Think of a castle on a hill, surrounded by a village.



Give me a metaphor!

**An atom is like a feudal kingdom**

Diagram

Description automatically generated

The protons of the nucleus are like a feudal castle ... the last to be attacked. The electrons (the farms and outlying town) are the first to be lost and that area in which growth occurs in times of prosperity ... \* This metaphor implies that the atomic number is stable (in terms of reaction chemistry) while all the chemical activity is happening ***in or to*** the e- cloud

In case of attack, the village is affected first …. The castle walls don’t really change. (So, in the case of a chemical reaction, outer electrons (the village) get lost). OR…. In case of serious economic growth, the village is what grows… The castle walls stay the same. (So, in the case of some chemical reactions, the electron cloud can “grow” by having electrons from another source, added on) … The castle (the protons of the nucleus), stay(s) the same no matter what. I mean, once you build a castle wall, you don’t go around, changing it! Right?

**TAKE HOME MESSAGE: ALL CHANGE HAPPENING TO THE ATOM OCCURS IN THE ELECTRON CLOUD (THE VILLAGE). IN MANY CHEMICAL REACTIONS, NEGATIVE CHARGE (ELECTRONS) IS/ARE EITHER BEING LOST OR GAINED. THE NUCLEUS (THE CASTLE) REMAINS UNTOUCHED.**

I) Organization of the atom

Fact1: Atoms of the same element must have the same \*number of protons (called the atomic number).

Most atoms also have neutrons. However, the number of neutrons may be different from atom to atom.

This leads us to the idea of ISOTOPES.

Isotopes of a specific element

* have the same number of protons. They are atoms of the same element.
* ***but isotopes of an element have a different number of neutrons, thus, a different mass number***
* have the same number of electrons, thus they undergo the exact same chemical reactions, since chemical reactions are primarily concerned with electrons.

Diagram, schematic

Description automatically generated

vs.

p =\*8 p =\*8

n = \*8 n =\*10

mass# = \*16 mass # =18

but! e- = \*8 e- = \*8

written as: O-16 written as O-18

Fact2: Under normal chemical circumstances the ONLY subatomic particle that can change in quantity is

the electron!!!! The \*atomic number of an element (the number of protons)

DOES NOT CHANGE under normal chemical circumstances. Thus a species takes on a charge

(becomes an ion, **it is because \***electrons were lost or electrons were gained.

One way you may help yourself learn the above is to consider the letter symbol of an element.

If there is no change in the letter symbol, then chemists are trying to imply that **then the number of**

**protons is the same ... so just electrons changed in number.**

Consider: 2 Na + Cl2 → 2 NaCl Notice the Na on the reactant side and the Na on the

product side. We may assume that each symbol

represents a species with only 11 protons, as they are

the same symbol.

Fact3: The charge tells you which subatomic particle (proton or electron) is \*in EXCESS and by how

many.

Fact4: When the charge is "+" there are more protons than electrons, BECAUSE electrons (or negative

charges) have been lost.

Fact5: When the charge is "- " there are more electrons than protons, BECAUSE electrons (or negative

charge) has been GAINED.

II) **IONS;** As a rule, the number of protons does not change ... only the number of electrons changes. (I am

picking up on Fact2).

A) Any species with an UNEQUAL number of protons and electrons is called an \*ion

1) \*Cation = positive ion … Such an ion has more protons than electrons, due to a loss of

electrons

2) \*Anion = negative ion …Such an ion has more electrons than protons, due to a gain of

electrons.

3) Ions may be monatomic (a single species with a charge) OR polyatomic (multiple species in

which the charge represents an overall charge. e.g.) (PO4)-3

4) So, compare an ***atom*** of Na0 with an ***ion*** of Na+1

Each has the same number of protons (the **letter symbol is the same**!!!!)

Na+1 however has one MORE proton. BUT since the number of protons did not change,

the number of electrons must have changed. It must be that an electron was lost.

Na0 has 11 protons and 11 electrons

Na+1 has 11 protons but only 10 electrons (so there is one more proton than electron)

5) Compare an atom of S0 with the ion S-2

Each has the same number of protons (the letter symbol is the same: S vs. S) You may

infer that they have the same number of protons or atomic number, when the letter symbol is the same)

S-2 however has two MORE electrons ... since the number of protons did not change,

thus, the number of electrons must have changed. It seems two electrons were gained

S0 has 16 protons and 16 electrons

S-2 anion has 16 protons and 2 extra electrons making 18 electrons

Don't worry *yet*, from where the extra 2 electrons came. Just concern yourself

with being able to interpret the meaning of the symbolism.

B) The key is to remember that **the charge tells you which subatomic particle is in EXCESS.** You

must then realize that the proton number IS NOT CHANGING in a regular “reaction chemistry”

reaction.... Thus **the charge must be due to lost or gained electrons.**

Compare F0 to F-1 Check your periodic table. You will note that fluorine has 9 protons.

9 protons vs. 9 protons

9 electrons vs. 10 electrons (The charge tells you that there is one more electron)

Compare Cu0 to Cu+2 Check your periodic table. You will note that copper has 29 protons

29 protons vs. 29 protons

29 electrons vs. 27 electrons (The charge tells you that there are two more protons than electrons and

since the protons can't change in number, two electrons must have

been lost)

**So some students like to think of it this way.... When the ion is negative, you must add the number to the number of electrons. When the ion is positive you must subtract the number from the number of electrons.**

**Try This...** Take out your periodic table. Note that the periodic table only lists ATOMS. So, this is a good starting point.

1) Consider the calcium ion, Ca+2 How many protons and electrons does the ion have?

step 1: Look up Ca on the Periodic Table. Do you understand that the periodic table lists ONLY

atoms? Thus Ca0 . An ATOM of calcium has 20 p and (thus) 20 e-

step 2: Now, look at the charge of the calcium ion, Ca+2. Do you see that it is a +2?

This means there are 2 more protons than electrons ... and since protons numbers don't change

you can assume that:

2 of the 20 original electrons were lost. Remember, that + is a symbol for protons, so +2 literally

translates into “ 2 more protons (+) vs. electrons”.

So if the atom had 20 protons, and the ion STILL has 20 protons, but is a +2, then that means,

two electrons were lost…..

Thus Ca+2 has 20 protons and only 18 e- …. The +2 means there are two more protons than

electrons, because 2 electrons were lost from Ca0

2) Consider the aluminum ion, Al+3 How many protons and electrons doe the ion have?

Step 1: How many protons does and atom of Al0 have? How many electrons then? (13 and 13)

Step 2: Notice the charge is +3 which means that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ there are 3 fewer electrons

or 3 electrons were lost

So... Al+3 has 13 protons and 10 electrons

3) Consider the iodide ion , I-1 How many protons and electrons does it have?

Step 1: How many protons does and atom of I0 have? How many electrons then? (53 and 53)

Step 2: Notice the charge is -1 which means that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ there is 1 more electron

So... I-1 has 53 protons and 54 electrons

**Check your understanding:**

**\_\_\_**1) When an **atom** has an atomic number of 10, then how many electrons must the atom have in the electron cloud?

\_\_\_2) When an atom has a nuclear charge of +7, then how many electrons must the atom have?

\_\_\_3) When an atom has 29 electrons, how many protons must the atom possess?

\_\_\_4) What is the overall charge of any atom?

5) In what ways does an ion differ from an atom? List at least two differences. These differences will be related to each

other. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Ans: 1. 10 e- 2. 7 e- 3. 29 p 4. 0 or neutral 5 Ions have a charge of + or -. Ions have an unequal number of

protons and electrons resulting in an overall charge.

PRACTICE PROBLEMS

Complete each practice problem. The following may be of help to you. All answers are given at the end. Check your work.

(#p + #n) = mass number  # of nucleons ⮱ upper left number

X

Atomic number = # p = nuclear charge  # e- ⮳lower left number

1) Example: Given the isotopic notation of Cr you can tell that the atom has:

Cr

a mass # of 52 OR the # p + # n = 52

24 + 28 = 52

an atomic number of 24 OR 24 protons OR a nuclear charge of +24

and since it has 24 protons and is an atom, it has 24 electrons

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

2) According to the isotopic notation: Ge, the number of **nucleons** (not neutrons), is equal to \_\_\_\_\_\_\_\_

Complete each practice problem. The following may be of help to you. All answers are given at the end. Check your work.

(#p + #n) = mass number  # of nucleons ⮱ upper left number

X

Atomic number = # p = nuclear charge  # e- ⮳lower left number

3) Given: the following : Na

a) \_\_\_\_\_ What is the mass number of this atom? How do you know? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) \_\_\_\_\_ What is the atomic number of this atom? How do you know? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4) Given the following : Zr

a) \_\_\_\_\_ What is the mass number of this atom ?

b) \_\_\_\_\_ What is the atomic number of this atom ?

c) \_\_\_\_\_ How many **neutrons** (not nucleons) comprise this atom's nucleus? How do you know?

5) An atom has an atomic number of 13 and a mass number of 27.

Hint: Use the information to first write out the isotopic notation,

as was given in problems 1-4

a) \_\_\_\_\_ How many protons comprise the nucleus of this atom ?

b) \_\_\_\_\_ How many **nucleons**  (not neutrons) comprise the nucleus of this atom ?

c) \_\_\_\_\_ How many neutrons comprise the nucleus of this atom ?

d) \_\_\_\_\_ To what is the nuclear charge equal ? (include a + sign) How do you know? \_\_\_\_\_\_\_\_\_\_\_\_

e) \_\_\_\_\_ How many electrons surround the nucleus of this atom ?

f) \_\_\_\_\_ What is the overall charge of this atom (the charge of the atom)?

(#p + #n = mass number)  # of nucleons ⮱ upper left number

X

Atomic number = # p = nuclear charge  # e- ⮳lower left number

6) An atom has 76 electrons and a mass number of 190

Hint: Use the information to first write out the isotopic notation, 4

as was given in problems 1-

a) \_\_\_\_\_ How many protons comprise the nucleus of this atom?

b) \_\_\_\_\_ How many nucleons (not neutrons) comprise the nucleus of this atom ?

c) \_\_\_\_\_ How many neutrons comprise the nucleus of this atom ?

d) \_\_\_\_\_ To what is the nuclear charge equal ?

e) \_\_\_\_\_ What is the atomic number of this atom ?

f) \_\_\_\_\_ What must be the overall charge of this atom? How do you know? \_\_\_\_\_\_\_\_

g) \_\_\_\_\_\_\_\_ This is an atom of which element? Just give the letter symbol (use the periodic table)

h) What is the relationship between the terms atomic number and number of protons in any atom? \_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7). An atom has a nuclear charge of +12 and 14 neutrons.

a) \_\_\_\_\_ How many protons comprise the nucleus of this atom?

b) \_\_\_\_\_ How many nucleons comprise the nucleus of this atom?

c) \_\_\_\_\_ How many electrons surround the nucleus?

d) \_\_\_\_\_ What is the mass number of this atom?

e) \_\_\_\_\_ What is the atomic number of this atom?

f) \_\_\_\_\_ What must be the overall charge of this atom (atomic charge)?

g) \_\_\_\_\_\_\_\_\_\_\_\_\_ What is the isotopic notation of this element?

h) \_\_\_\_\_ What is the nuclear charge of this atom?

(#p + #n = mass number)  # of nucleons ⮱ upper left number

X

Atomic number = # p = nuclear charge  # e- ⮳lower left number

8) An atom has a mass number of 30 and 16 neutrons in the nucleus.

a) \_\_\_\_\_ How many protons comprise the nucleus of this atom?

b) \_\_\_\_\_ How many nucleons comprise the nucleus of this atom?

c) \_\_\_\_\_ How many electrons surround the nucleus?

d) \_\_\_\_\_What is the nuclear charge of this atom?

e) \_\_\_\_\_What is the atomic number of this atom?

f) \_\_\_\_\_ What is the overall charge of this atom?

g) \_\_\_\_\_\_\_\_\_ What is the isotopic notation of this atom?

9) The nucleus of an atom has 58 nucleons and there are 28 electrons surrounding the nucleus.

a) \_\_\_\_\_ How many protons comprise the nucleus of this atom?

b) \_\_\_\_\_ How many neutrons comprise the nucleus of this atom?

c) \_\_\_\_\_ What is the mass number of this atom?

d) \_\_\_\_\_ What is the nuclear charge of this atom? How do you know ? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e) \_\_\_\_\_ What is the atomic number of this atom ?

\_\_\_\_10. The unit of mass called an "atomic mass unit" is based upon a fraction of the mass of isotopes of

which element?

a) C-14 c) Na-11

b) O-16 d) C-12

\_\_\_\_\_11. Study a copy of the periodic table thoroughly. Based upon this study, the elements are organized:

a) according to increasing mass c) according to increasing atomic number

b) alphabetically d) by the dates of discovery

\_\_\_\_\_12. Which of the following is the least in mass?

a) a proton b) an electron c) a neutron d) an atom of H-2

\_\_\_\_\_13. Which of these subatomic particles is described as having a charge of +1 ?

a) proton b) neutron c) electron

\_\_\_\_\_14. Which subatomic particle is described as the fundamental unit of negative charge?

a) proton b) neutron c) electron

15. The following is an answer from a student on a test. The underlined part has something wrong. She would

get 0 of 1 point. What should it read?

"If an atom had 30 protons and 35 neutrons it would have a mass number of 35."

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

16. The following is an answer from a student on a test. The underlined part has something wrong.

He would get 0 out of 1 point. What should it read, when corrected?

"Given 20 protons and 20 electrons, it is clear that the ion must have an overall charge of 0."

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

17. The following is an answer from a student on a test. The underlined part has something wrong. She would

get 0 out of 1 point. What should be written?

"An atom has a mass number of 31 and a proton number of 16. The number of electrons must be 31."

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

18) Why are electrons not included in the mass number of an isotope, in our course? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

19) Define the term: isotopes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

20) Which choice is an example of the isotopes of an element?

a) and c) and

b) and d) and

21) Use a periodic table to help you with this:

Given the ion: F-1 How many protons are in the nucleus? \_\_\_\_

How many electrons surround the nucleus? \_\_\_\_\_\_

22)  is an isotope of the element sodium, while 1+ is a second isotope of sodium, but also a cation.

Compare and contrast the two species in terms of: atomic number, overall charge, number of electrons,

and number of neutrons.

|  |  |  |
| --- | --- | --- |
|  | an atom of Na-23 | a +1 cation of Na-22 |
| atomic number |  |  |
| overall charge |  |  |
| number of electrons |  |  |
| number of neutrons |  |  |

Answers to Questions 1-21

1. 24 and 52. The atomic number is in the lower left corner and the mass number is in the upper left

2. 73 The term "nucleons" may be considered to be a synonym for mass number

3. a) 23 b) 11 4. a) 91 b) 40 c) 51

5. a) 13 b) 27 c) 14 d) +13 e) 13 f) 0

6. a) 76 b) 190 c) 114 d) +76 e) 76 f) 0 g) Os (osmium) h) They are synonyms

7. a) 12 b) 26 c) 12 d) 26 e) 12 f) 0 g) Mg h) +12

8. a) 14 b) 30 c) 14 d) +14 e) 14 f) 0 g) Si

9. a) 28 b) 30 c) 58 d) +28 e) 28

10. d This fact is in your reading as well as noted on your periodic table (Top-center "key" using Carbon)

11. c The PT is organized by ascending atomic number (number of protons). While it may SEEM to be organized by what is

called the atomic mass … it is not … there are some glaring exceptions … check out elements 52Te and 53I

12. b 13. a 14. c

15) The mass number is the sum of the number of protons and neutrons. Therefore, the mass number should be 65 (no unit!)

16) 20 protons and 20 electrons make a neutral ATOM, not ion. IONS are charged. The term ion should not have been used.

17) The number of electrons of an atom equals the number of protons, **not** the mass number.

18) Electrons have so little mass, that no atom has a sufficient number of electrons to alter the mass. They are, for our course,

effectively 0 atomic mass units.

19) Isotopes are atoms with the same atomic number (of the same element), but with a different number of neutrons (or different

mass number due to a difference in the number of neutrons)

20) d same symbol, same atomic number, different mass number (due to a different number of protons)

21) 9 protons, 10 electrons (the -1 indicates one more electron than in the atom)

|  |  |  |
| --- | --- | --- |
|  | an atom of Na-23 | a +1 cation of Na-22 |
| atomic number | 11 | 11 |
| overall charge | 0 | +1 or 1+ or just + |
| number of electrons | 11 | 10 |
| number of neutrons | 12 | 11 |

22)

PRE-QUIZ 1: BASIC ATOMIC STRUCTURE

*Since this is a pre-quiz you may, of course, use your notes. Do try however, to "wean " yourself away from them. Learn the material.*

DIRECTIONS: For questions in this section, one or more of the responses given are correct. Using your notes and understanding of the periodic table, decide which of the responses is (are) correct. Then choose :

a) when only choice I is correct

b) when only choice II is correct

c) when only choices I and II are both correct

d) when only choices II and III are both correct

e) when I, II, and III are each correct

\_\_\_\_\_1) Which of the following applies to an atom of Mg-25 ? (Hint .. look up Mg on the periodic table to find determine the

atomic number. Then, re-write the symbol like the atoms in

question 2, and then answer)

I) 24 protons II) 13 neutrons III) 12 electrons

\_\_\_\_\_2) Which of the following is true for these two different atoms of phosphorous? P and P

I) The have different mass numbers

II) They have the same number of protons

III) They have a different number of neutrons

\_\_\_\_\_3) The symbol : X most probably represents an isotope of

I) gold II) silver III) tin

\_\_\_\_\_4) It requires approximately 1,836 \_\_\_\_\_\_\_\_\_\_\_ to equal the mass of 1 proton.

I) neutrons II) electrons III) nucleons

\_\_\_\_\_5) The term "nucleons" refers to

I) electrons II) protons III) neutrons

\_\_\_\_\_6) Ultimately, the nuclear charge of an atom is

I) the number of neutrons

II) the atomic number

III) equivalent in magnitude to the charge of the electron cloud

\_\_\_\_\_7) Which of the following applies to an atom of Al-28?

I) 13 protons II) 28 neutrons III) 15 electrons

\_\_\_\_\_8) Assume each following symbol represents an atom. Which has (have) a zero number of neutrons?

I)  II)  III) 

DIRECTIONS : For questions 9 – 12 use the following choices :

ASSERTION REASON

a) True True statement and correctly explains (or predicts) the assertion

b) True True statement but does NOT correctly explain the assertion

c) True False

d) False True

e) False False

For example:

Assertion Reason

Tom is a science teacher . because Tom wears glasses and is a p.i.t.a.!

*ANSWER: Both statements are true. However, the wearing of glasses or being a pain in the ass, has*

*NOTHING TO DO the fact that Tom is a science teacher.* *So*,  *the BEST answer is ‘b”.*

|  |  |  |  |
| --- | --- | --- | --- |
|  | ASSERTION |  | REASON |
| 9.\_\_\_\_ | Based on the Periodic Table, you know that each atom of potassium (K) has 19 protons in its nucleus | Because | According to the Periodic Table, potassium is atomic number 19 and the atomic number is a synonym for the number of protons. |
| 10.\_\_\_ | The mass of an atom is generally attributed to the number of protons and neutrons. | Because | The magnitude of an electron's negative charge is equal to the magnitude of a proton's positive charge. |
| 11.\_\_\_ | Atoms are the smallest unit of matter | Because | Atoms are made of subatomic particles |
| 12.\_\_\_ | The *nuclear* charge of an atom is related to the number of protons in the nucleus | Because | By definition, an atom’s charge must be neutral. The number of positive charges must equal the number of negative charges |

13 Correct this statement so that the underlined portion is correct.

An atom with 12 protons, 14 neutrons and 12 electrons has a mass number of 38.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

14) The terms atomic mass and mass number both deal with the protons and the neutrons of atoms of an

in some way. But, how do the two terms differ from each other?

Identify 2 ways the terms (or representative values) are different from each other:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

15) How many protons and how many electrons does the ion Fe+3 have? (are you using your periodic table?)

16) How many electrons are in an ion of Cl-1

Answers to Pre-Quiz:

1. d 2. e 3. b 4. b 5. d 6. d 7. a 8) a

9. a The reason is an excellent explanation as why you, as a student, may assert that K has 19 protons in each atom.

10. b Both statements are pretty accurate ...but the reason does not explain, predict or account for the truth value of the

assertion

11. d Please !! Atoms are not the smallest matter and they're mostly empty space . An atom can’t be the smallest unit

of matter if it is made of smaller pieces of matter … An atom IS the smallest unit of an element that can react

chemically ... but not the smallest unit of matter.

12. a In order to be called an atom, the assertion must be true. The Reason clearly recognizes this.

13 An atom with 12 protons, 14 neutrons and 12 electrons has a mass number of 26.

The mass number is just #p + #n

14) The atomic mass is an average mass based on frequency and isotopic mass ... while the mass number is just a

counted value of the nucleons

OR The atomic mass has a unit of mass (atomic mass unit), the mass number has no unit

OR The atomic mass value is representative of all the naturally occurring forms of the atoms of an element,

while the mass number represents only one isotopic form of the element

15) 26 protons and 23 electrons

16) 18 electrons

PRE-QUIZ 2: BASIC ATOMIC STRUCTURE

DIRECTIONS: For questions in this section, one or more of the responses given are correct. Using your knowledge of chemistry and understanding of the periodic table, decide which of the responses is (are) correct. Then choose:

a) when only choice I is correct

b) when only choice II is correct

c) when only choices I and II are both correct

d) when only choices II and III are both correct

e) when I, II, and III are each correct

\_\_\_\_\_1) Which of the following applies to an atom of C-14? (hint...use your Periodic Table)

I) 14 nucleons II) 8 neutrons III) 6 protons

\_\_\_\_\_2) Which of the following is true of the atoms: O-18 and F-19 ? (hint...use your Periodic Table)

I) They have different atomic numbers

II) They have the same number of neutrons

III) They have the same mass numbers

\_\_\_\_\_3) The symbol :  is at atom of

I) iron II) zinc III) barium

\_\_\_\_\_4) It requires approximately 1 proton to equal the mass of \_\_\_\_\_\_\_\_\_\_\_

I) 1 neutron II) 1,836 electrons III) 1 atom of tritium

\_\_\_\_\_5) The term "atomic number" refers to

I) protons II) nucleons III) neutrons

\_\_\_\_\_6) Regarding the overall charge of any atom,

I) The number of protons must equal the number of neutrons

II) the number of electrons must equal the number of protons

III) that charge must be equal to zero

\_\_\_\_\_7) The current value of 1 μ is based upon the mass of an atom of

I) Oxygen-16

II) Carbon-12

III) Carbon-14

DIRECTIONS : For questions 8- 11 use the following choices :

ASSERTION REASON

a) True True statement and correctly explains (or predicts) the assertion

b) True True statement but does NOT correctly explain the assertion

c) True False

d) False True

e) False False

For example:

Assertion Reason

Tom is a science teacher . because Tom wears glasses and is a p.i.t.a.!

*ANSWER: Both statements are true. However, the wearing of glasses or being a pain in the ass, has*

*NOTHING TO DO the fact that Tom is a science teacher.* *So*,  *the BEST answer is ‘b”.*

ASSERTION REASON

\_\_\_\_\_8. The magnitude of 1 electron's charge because A proton is much larger than an electron.

is equal to the magnitude of a It takes almost 1,836 electrons to equal

single proton's charge the mass of 1 proton.

\_\_\_\_\_9. Na-23 has the same number of because Atoms of Na-23 and Mg-24 have the

neutrons as an atom of Mg-24 same number of electrons

\_\_\_\_\_10 The number of neutrons must be because A neutron has no overall charge and is

equal to the number of protons in therefore considered to be a neutral

every nucleus subatomic particle

\_\_\_\_\_11 By definition, an atom must be neutral. because The nuclear charge of any atom is equal

in overall charge in magnitude but opposite in charge to the

total charge due to the atom's electrons

of the electron cloud

12) Define: Nuclear Charge: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

13) Define: Atom: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_14) What is the one value every ion as well as every atom of an element must have in common?

a) number of electrons c) number of neutrons

b) charge d) number of protons

\_\_\_\_\_15) How many neutrons are in an atom of Zn-65 ?

Answers to Pre-Quiz:

1. e 2. c 3. a 4. c 5. a 6. d 7. b

8. b The facts regarding the sizes of these subatomic particles has no direct application to the reason why

their charges are equal in magnitude. Both statements are true... but not really related.

9. c The assertion is true. If you use Mass # = # p + # n, you can prove that each nucleus has 12 neutrons. However, they do NOT

have the same number of electrons (they are atoms of different elements or the number of electrons for an atom is equal to the

number of protons. These are atoms of different elements… and have different numbers of protons, thus different numbers of

electrons.

10 d The assertion is just false. The number of neutrons and protons MAY NOT equal each other. But, a neutron is neutral and

therefore 0 in charge.

11 a

12 the number of protons of a nucleus OR the total charge of an atom's nucleus, which is equal to the atomic number

13 The smallest neutral (in charge) species of an element that can take part in a chemical reaction.

14 d

15 35

PRE-QUIZ 3: BASIC ATOMIC STRUCTURE

\_\_\_1) The atomic number of an atom is always equal to the number of its

(1) protons, only (2) neutrons, only (3) protons plus neutrons (4) protons plus electrons

2) In the reading, the following statement is made: “When an atom loses electrons, it becomes a positive ion.

When an atom gains electrons, it becomes a negative ion.”

a) Using an atom of N-16 how many protons are in the nucleus of the atom? \_\_\_\_\_\_\_\_

b) How many electrons must be in the same atom of N-14? \_\_\_\_\_\_

c) If the atom gains three more electrons from some other source, what is the probable charge on the ion? \_\_\_\_

d) If the atom of N-16 lost two electrons, what is the probable charge of the ion? \_\_\_\_\_\_

\

\_\_\_3)



\_\_\_4)



\_\_\_5)



\_\_\_6)



\_\_\_7)



\_\_\_8)

\_\_\_9) An oxide ion (O2-) formed from an oxygen-18 atom, contains exactly:

1) 8 protons, 8 neutrons, 10 electrons

2) 8 protons, 10 neutrons, 8 electrons

3) 8 protons, 10 neutrons, 10 electrons

4) 10 protons, 8 neutrons, 8 electrons

10) Using the following table, compare the subatomic particles of the isotopes O-16 and O-18

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | mass  number | atomic  number | number  of neutrons | number  of electrons |
| O-16 |  |  |  |  |
| O-18 |  |  |  |  |

11) The chemical reactions of an atom depend on the number of electrons. Make a prediction about the

reactions atoms of oxygen-16 and oxygen -18 undergo.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

12) Account for the slightly different mass, in grams, between a proton and a neutron. \_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

13) What is the difference between an atom (such as Na0) and its ion (such as Na+1) ? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

14) An atom has 9 protons, 10 neutrons and 9 electrons. The atom gains one more electron. What is the

charge of the resulting ion? \_\_\_\_\_\_\_\_\_\_

15) An atom has 12 protons, 11 neutrons and 12 electrons. The atom loses two of its electrons. What is the

charge of the resulting ion? \_\_\_\_\_\_\_\_\_

16) Using the following table, compare the subatomic particles of the atom 56Fe0 to its ion, 55Fe+3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | mass  number | atomic  number | number  of neutrons | number  of electrons |
| 56Fe0 |  |  |  |  |
| 55Fe+3 |  |  |  |  |

17) List one major conclusion of the Rutherford Gold Foil experiment. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Answers:

1) 1 definition

2) a) 7 you need to use the periodic table

b) 7 they must be equal in an **atom**

c) -3 there would be three more electrons than protons or: 10 e- vs. 7 p for a difference of -3

d) +2 there would be two more p than e- or: 5 e- vs. 7 p for a difference of +2

3) 1 4) 4 When an atom loses e- (loses negative charge), the resulting ion is positive.

5) 1 same element (same atomic number or # of protons) but a different mass number (therefore a different

number of neutrons)

6) 2 7) 4 8) 2 mass # = #p + #n

9) 3 choice 1 is a close answer … but the mass is 18 for the atom in question, not 16.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | mass  number | atomic  number | number  of neutrons | number  of electrons |
| O-16 | 16 | 8 | 8 | 8 |
| O-18 | 18 | 8 | 10 | 8 |

10)

11) Since the number of electrons is equal, it is reasonable to assume that the isotopes undergo the same chemical reactions.

12) A neutron is slightly heavier due, to the fact that it is made, in part from a proton and an electron.

13) The atom has an equal number of protons and neutrons. The ion has lost 1 electron hence the atom has 11 protons &

11 electrons, and the ion has 11 protons and only 10 electrons; There is one more electron in the atom (one fewer electron in

the ion)

14) -1 15) +2

16)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | mass  number | atomic  number | number  of neutrons | number  of electrons |
| 56Fe0 | 56 | 26 | 30 | 26 |
| 55Fe+3 | 55 | 26 | 29 | 23 |

17) The atom is mostly empty space ...or... The mass of an atom is found primarily making up the nucleus ....or.... The positive

charge of the atom is concentrated in the nucleus while the negative charge is in the electron cloud outside of the nucleus