

Exam 1—1

10<sup>th</sup> Grade

Chemistry

*Read every question carefully and answer the questions based on what you are asked.*

*Do not leave any question blank and show your work.*

*You may not leave the exam early; even if you are finished, review the test until the end of the designated time.*

*Show your work on the paper and make sure you write units.*

*Please do not ask any unnecessary questions during the test.*

***Alireza Shirazian***

1) Complete the following operation using significant figures:

$$0.00015 \times 54.6 + 1.002 =$$

2) Vanadium has a density of  $5.96 \frac{\text{g}}{\text{dm}^3}$ ;

A) Convert this density to  $\frac{\text{kg}}{\text{m}^3}$

B) Calculate, in  $\frac{\text{g}}{\text{dm}^3}$ , the volume of a sample of Vanadium with mass of 7.57g.

3) Suppose atoms are spheres and the volume of a sphere is found by the formula  $\frac{4}{3} \pi r^3$ . The

barium atom has a radius of 216.9pm and the copper atom has a radius of 127.7pm.

A) Convert the radius of each element to cm.

B) Using the formula provided in the question, find the volume of each of the above elements in cubic centimeters.

4) Complete the following:

A) Define the law of conservation of mass and the law of conservation of energy and explain how the formula  $E = mc^2$  relates mass to energy:

B) Suppose a 15.9g sample of sodium is added to a solution of acetic acid weighing 20.0g. The two substances react, releasing carbon dioxide gas to the atmosphere. After reaction, the contents of the vessel weigh 29.3g. What is the mass of carbon dioxide given off during the reaction? (consider the law of conservation of mass when solving this problem)

5) Suppose 123kJ of heat is transferred to a sample of Aluminum with mass of 0.110 kg. If the specific heat of aluminum is  $0.897 \frac{\text{J}}{\text{g} \cdot \text{K}}$  and the final temperature of aluminum sample is  $100^\circ \text{C}$ , then find the initial temperature:

6) Suppose we have an unknown element with three isotopes. The isotopic mass and percent abundance of each is as follows: 93.26% of the isotopes weigh 38.964g, 0.01% weigh 39.964g and 6.73% weigh 40.962g.

A) Define isotope (what are isotopes and how are they different from each other?):

B) Calculate the atomic weight of this element.

C) Using the periodic table, find out which group and period does this element belong to:

7) Complete the following:

A) Describe the gold foil experiment of Rutherford and state the important conclusion that resulted from it:

B) What experiment did J.J. Thomson perform and what was the most important thing he discovered?

8) Give one example of each:

A) A main group element in the second period

B) An alkali metal

C) A halogen

D) A lanthanide element

E) A transition metal in the fourth period

- 9) Suppose the energy levels in eV for an element are given as: -0.38, -0.54, -0.85, -1.5, -3.4, and -13.6.
- Which of the mentioned numbers give the energy at the ground state of the element?
  - Suppose an electron jumps from the ground state ( $n=1$ ) to the third energy level ( $n=3$ ), How much energy will the electron release/absorb?
  - Suppose an electron jumps from the ground state ( $n=4$ ) to the third energy level ( $n=2$ ), How much energy will the electron release/absorb?
  - Blue light has a wavelength of about 300nm and red light has a wavelength of about 700nm. Which light has a higher frequency? Which light has a higher energy?
- 10) Suppose an element has 54 neutrons and a mass of about 96 amu;
- What is the atomic number of the element?
  - How many electrons, protons and neutrons does the element have in neutral state?
  - Draw the orbital system for this element.
  - Write the electron configuration for this element.
  - Which quantum number determines an electron's energy level in this element? How about the shape?
- 11) Periodic trends:
- Order the following elements by increasing atomic radius: Se, S, As.
  - Which of the following elements form ions that are larger than the neutral state atom: K, Mg, Li, C, Cl? Why is that the case? (you must explain)
  - Order the following elements by increasing electron affinity: As, Be, F, Li
  - Arrange the following elements by increasing ionization energy: Ar, Na, Cl, Al
  - Draw the valence orbitals for both Mg and Al. Use your drawings to explain why Al has a lower ionization energy than Mg.
- 12) Iron(III) nitrate has the formula  $Fe(NO_3)_3$ .
- What is the ratio of iron atoms to oxygen atoms in this compound?
  - Write the electron configuration of the  $Fe^{3+}$  cations:
- 13) Name the following ionic compounds:
- $Na_2SO_4$
  - $CaO$
  - $CuCl$
  - $Cr_2O_3$
  - $LiBr$
- 14) Write the formulas of the following compounds:
- Lead(II) cyanide
  - Iron(II) sulfate
  - Copper(II) hydroxide
  - Cesium oxide
  - Lithium phosphate

- 15) Consider the element represented by the atomic number 34:
- A) Write the electron configuration of this element
  - B) Assuming that the mass number of this element is 79, How much do 3 moles of this element weigh?
  - C) How many atoms are there in a 1g sample of this element?
  - D) How many atoms are there in 2 moles of this element?
  - E) Do atoms of this element form cations or anions? Why?

(EC) Answer the following questions:

- A) Define law of absolute proportions and the law of multiple proportions:
- B) Write 3 important properties of metals
- C) Write 3 important properties of ionic compounds.

(EC) Consider the compound  $Fe_2(CO_3)_3$ .

- A) Name it
- B) A 23g sample of this compound contains how many atoms of iron?
- C) How many moles of iron is that?

(EC) Write the electron configuration of Ti (which has an atomic number of 81)