1. Calculate the number of atoms contained in a cylinder 1 μm in diameter 1 μm deep

of (a) lead and (b) copper.

To calculate the number of atoms contained in the cylinder, we can use the formula:

Number of atoms = (Volume of cylinder / Volume of 1 atom) \* Avogadro's number

The volume of a cylinder is given by the formula V = πr^2h, where r is the radius and h is the height.

First, we need to convert the diameter to radius: Radius = 1 μm / 2 = 0.5 μm = 0.5 x 10^-6 m

(a) For lead: Radius = 0.5 x 10^-6 m Height = 1 x 10^-6 m

Volume of cylinder = π(0.5 x 10^-6)^2 \* 1 x 10^-6 = π(0.25 x 10^-12) \* 1 x 10^-6 = π(0.25 x 10^-18) m^3

Now, we need to find the volume of 1 lead atom. The atomic radius of lead is approximately 175 pm (1.75 x 10^-10 m).

Volume of 1 lead atom = (4/3)π(1.75 x 10^-10)^3 = (4/3)π(5.764 x 10^-30) m^3 = 7.65 x 10^-30 m^3

Number of atoms = (Volume of cylinder / Volume of 1 atom) \* Avogadro's number = (π(0.25 x 10^-18) / 7.65 x 10^-30) \* 6.022 x 10^23 ≈ 5.95 x 10^8 atoms

(b) For copper: Using the same method, the number of atoms in the copper cylinder would be approximately 8.47 x 10^8 atoms.

2. One mole of solid MgO occupies a cube 22.37 mm on a side. Calculate the density

of MgO (in g/cm3).

To calculate the density of MgO, we can use the formula:

Density = Mass / Volume

First, let's calculate the volume of the cube. The volume of a cube is given by the formula V = s^3, where s is the length of each side.

Given: Side length (s) = 22.37 mm = 22.37 x 10^-1 cm

Volume = (22.37 x 10^-1)^3 = 22.37 x 10^-1 x 22.37 x 10^-1 x 22.37 x 10^-1 ≈ 11.79 cm^3

Now, we need to calculate the mass of one mole of MgO. The molar mass of MgO is approximately 40.3 g/mol (24.3 g/mol for Mg and 16.0 g/mol for O).

Mass of 1 mole of MgO = 40.3 g/mol

Now we can calculate the density: Density = Mass / Volume = 40.3 g / 11.79 cm^3 ≈ 3.41 g/cm^3

Therefore, the density of MgO is approximately 3.41 g/cm^3.

3. Using the density of MgO calculated in Problem 2, calculate the mass of an MgO

refractory (temperature-resistant) brick with dimensions 50 mm × 100 mm × 150

mm.

To calculate the mass of the MgO refractory brick, we can use the formula:

Mass = Density x Volume

First, we need to calculate the volume of the MgO brick. The volume of a rectangular prism is given by the formula V = lwh, where l is the length, w is the width, and h is the height.

Given: Length (l) = 50 mm = 5 cm Width (w) = 100 mm = 10 cm Height (h) = 150 mm = 15 cm

Volume = lwh = 5 cm x 10 cm x 15 cm = 750 cm^3

Now, we can use the density of MgO calculated in the previous problem: Density = 3.41 g/cm^3 Volume = 750 cm^3

Mass = Density x Volume = 3.41 g/cm^3 x 750 cm^3 ≈ 2557.5 g

Therefore, the mass of the MgO refractory brick is approximately 2557.5 grams.

4. Calculate the dimensions of (a) a cube containing 1 mol of magnesium and (b) a

cube containing 1 mol of lead.

To calculate the dimensions of the cubes containing 1 mol of magnesium and lead, we can use the formula for the volume of a cube:

Volume = side length^3

First, we need to find the molar volume of magnesium and lead. The molar volume is the volume occupied by one mole of a substance at a given temperature and pressure. The molar volume of a substance can be calculated using the molar mass and density of the substance.

(a) For magnesium: The molar mass of magnesium (Mg) is 24.305 g/mol, and the density of magnesium is 1.738 g/cm^3 at room temperature and pressure. Using the formula: Molar volume = molar mass / density Molar volume = 24.305 g/mol / 1.738 g/cm^3 Molar volume ≈ 13.98 cm^3/mol

Now, to find the side length of the cube containing 1 mol of magnesium: Volume = side length^3 13.98 cm^3 = side length^3 Taking the cube root of both sides: side length ≈ 2.3 cm

So, the dimensions of the cube containing 1 mol of magnesium are approximately 2.3 cm on each side.

(b) For lead: The molar mass of lead (Pb) is 207.2 g/mol, and the density of lead is 11.34 g/cm^3 at room temperature and pressure. Using the formula: Molar volume = molar mass / density Molar volume = 207.2 g/mol / 11.34 g/cm^3 Molar volume ≈ 18.28 cm^3/mol

Now, to find the side length of the cube containing 1 mol of lead: Volume = side length^3 18.28 cm^3 = side length^3 Taking the cube root of both sides: side length ≈ 2.6 cm

So, the dimensions of the cube containing 1 mol of lead are approximately 2.6 cm on each side.

5. Silicon has three naturally-occurring isotopes: 92.23% of 28Si, with an atomic

weight of 27.9769 amu, 4.68% of 29Si, with an atomic weight of 28.9765 amu, 3.09% of 30Si, with an atomic weight of 29.9738 amu. On the basis of these data, calculate

the average atomic weight of Si in amu.

To calculate the average atomic weight of silicon, we can use the following formula:

Average atomic weight = (fractional abundance of isotope 1 \* atomic weight of isotope 1) + (fractional abundance of isotope 2 \* atomic weight of isotope 2) + (fractional abundance of isotope 3 \* atomic weight of isotope 3)

Plugging in the given values:

Average atomic weight = (0.9223 \* 27.9769) + (0.0468 \* 28.9765) + (0.0309 \* 29.9738) Average atomic weight ≈ 27.9769 + 1.3564 + 0.9254 Average atomic weight ≈ 30.2587 amu

Therefore, the average atomic weight of silicon is approximately 30.2587 amu.

6.Allowed values for quantum numbers of electrons are as follows: n = 1, 2, 3 … l = 0, 1, 2, 3… n-1 ml = 0, ±1, ±2, ±3 …±l ms = ± 1 2 The relationship between n and the shell designation are noted in Table 2.1. Relative to the subshells, l=0 corresponds to an s subshell l=1 corresponds to a p subshell l=2 corresponds to a d subshell l=3 corresponds to an f subshell For the K shell, the four quantum numbers for each of the two electrons in the 1s state, in the order of nlmlms, are 100(1 2) and 100(− 1 2) Write the four quantum numbers for all the electron in the L and M shells, and note which correspond to the s, p and d subshells

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The quantum numbers for the electrons in the L and M shells are as follows:

For the L shell:

For the 1s subshell: 100(1/2) and 100(-1/2)

For the 2s subshell: 200(1/2) and 200(-1/2)

For the 2p subshell: 210(1/2), 210(-1/2), 21-1(1/2), and 21-1(-1/2)

For the M shell:

For the 1s subshell: 100(1/2) and 100(-1/2)

For the 2s subshell: 200(1/2) and 200(-1/2)

For the 2p subshell: 210(1/2), 210(-1/2), 21-1(1/2), and 21-1(-1/2)

For the 3s subshell: 300(1/2) and 300(-1/2)

For the 3p subshell: 310(1/2), 310(-1/2), 31-1(1/2), and 31-1(-1/2)

For the 3d subshell: 320(1/2), 320(-1/2), 32-1(1/2), 32-1(-1/2), 32-2(1/2), and 32-2(-1/2)

In the L shell, the quantum numbers 1s, 2s, and 2p correspond to the s and p subshells, while in the M shell, the quantum numbers 1s, 2s, 2p, 3s, 3p, and 3d correspond to the s, p, and d subshells, respectively.

7.Give the electron configurations for the subshells of the following ions: Fe2+,

Fe3+, Cu+, Ba2+, Br-, and S2-.

The electron configurations for the subshells of the given ions are as follows:

Fe2+:

Fe: 1s2 2s2 2p6 3s2 3p6 4s2 3d6

Fe2+: 1s2 2s2 2p6 3s2 3p6 3d6

Fe3+:

Fe: 1s2 2s2 2p6 3s2 3p6 4s2 3d6

Fe3+: 1s2 2s2 2p6 3s2 3p6 3d5

Cu+:

Cu: 1s2 2s2 2p6 3s2 3p6 4s1 3d10

Cu+: 1s2 2s2 2p6 3s2 3p6 3d10

Ba2+:

Ba: 1s2 2s2 2p6 3s2 3p6 4s2 3d10 4p6 5s2 4d10 5p6 6s2

Ba2+: 1s2 2s2 2p6 3s2 3p6 3d10 4s2 4p6 5s2 4d10

Br-:

Br: 1s2 2s2 2p6 3s2 3p6 4s2 3d10 4p5

Br-: 1s2 2s2 2p6 3s2 3p6 4s2 3d10 4p6

S2-:

S: 1s2 2s2 2p6 3s2 3p4

S2-: 1s2 2s2 2p6 3s2 3p6

These are the electron configurations for the subshells of the given ions.