

Answer on the question #54215 – Chemistry – General chemistry

Question:

Calculate the expected mass of one mole of ^{31}P (phosphorus) atom given that the Avogadro constant equals 6.0225×10^{23} , the mass of one electron equals 9.1091×10^{-28} grams, the mass of the one proton equals 1.6725×10^{-24} grams and the mass of one neutron equals 1.6748×10^{-24} grams.

so far I have:

$$9.1091 \times 10^{-28} \times 15$$

$$1.6725 \times 10^{-24} \times 15$$

$$1.6748 \times 10^{-24} \times 16$$

is this correct.

Solution:

Phosphorus atom has 15 protons and, then 15 electrons. Thus, the number of neutrons is:

$$n = 31 - 15 = 16.$$

The expected mass of one ^{31}P atom is the sum of electrons', neutrons' and protons' masses:

$$m({}_{15}^{31}\text{P}) = 15 \times 1.6725 \times 10^{-24} + 16 \times 1.6748 \times 10^{-24} + 15 \times 9.1091 \times 10^{-28}.$$

Although the last term that corresponds to the electrons' contribution to the atom's mass is relatively small and can be neglected within the calculations, we take it into account to make the calculations more precise.

$$m({}_{15}^{31}\text{P}) = 51.8980 \times 10^{-24} \text{ g}$$

This is the mass of one ^{31}P atom (expected one). One mole contains the number of atoms that is equal to Avogadro's number. Thus:

$$m = 51.8980 \times 10^{-24} \times 6.0225 \times 10^{23} = 31.2556 \text{ g}$$

Answer: the mass of one mole of ^{31}P atoms is 31.2556 g.

