Solution to the osmium density challenge

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What would the atomic weight of osmium have to change to in order for iridium to become the densest metal [1]? Iridium becomes denser than osmium when $\rho(\text{Ir}) > \rho(\text{Os})$. The density of iridium is $\rho(\text{Ir}) = 22.562 \pm 0.011 \text{ g/cm}^3$ and the density of osmium is $\rho(\text{Os}) = 22.589 \pm 0.005 \text{ g/cm}^3$. Comparing two numbers that have associated uncertainties is not a trivial task, but in the most simplistic approach the density of osmium has to be less than 22.562 g/cm^3 in order for iridium to become the “densest metal” at normal conditions. The density and the atomic weight are directly related:

$$\rho(\text{Os})_{\text{new}} / \rho(\text{Os})_{\text{old}} = A_{\text{r}}(\text{Os})_{\text{new}} / A_{\text{r}}(\text{Os})_{\text{old}}.$$

The value $\rho(\text{Os}) = 22.589 \text{ g/cm}^3$ derives from the atomic weight $A_{\text{r}}(\text{Os}) = 190.23(3)$. Consequently,

$$A_{\text{r}}(\text{Os})_{\text{new}} = 190.23 \times (22.562 \text{ g/cm}^3) / (22.589 \text{ g/cm}^3) = 190.00.$$

Hence, iridium becomes denser than osmium at normal conditions when $A_{\text{r}}(\text{Os}) < 190.00$. Is it likely that the standard atomic weight of osmium might be revised down from 190.23 to 190.00? Although wide variations in the atomic weight of osmium were originally obtained with chemical determinations, experience with modern mass spectrometric determinations of atomic weight indicates that it is unlikely that a revised value would differ from the current value by more than a very small amount.

References

1. Arblaster JW (2014) *Platin Met Rev* 39:164

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