

5. This question is about the combining proportions of the elements



Understanding the proportions in which the elements combine was a crucial step in developing the atomic theory of matter. The picture above shows an experiment performed in the 1660s in which antimony was heated using the sun's rays to form an oxide.

In the experiment, 'ye Artist' reported that '12 *grains* of antimony increased to 15 *grains* of calx', (a *grain* is an old measure of mass). Given the crudeness of the experiment, this value is remarkably close to the theoretical yield of 14.4 '*grains*'.

(a) Calculate the formula of the oxide formed.

In another experiment published in 1673, Robert Boyle measured the increase in mass when zinc metal is heated in air. He describes the experiment thus:

*We took a Drachm of filings of Zink and kept it in a Cupelling-fire about three Hours. Then it look'd as if the filings had been calcin'd. This being weigh'd in the same scales gain'd full six grains.*

(b) Given that there are 60 grains in a Drachm, calculate the mass of product (in grains) that would have been produced assuming a yield of 100%.

Assuming that Boyle's measurements are accurate, only a fraction,  $\alpha$ , of the zinc must have been converted to the oxide. ( $\alpha$  is a fraction between 0 and 1; 0 meaning none of the zinc reacted and 1 meaning all reacted).

(c) Calculate the value of  $\alpha$  and hence the masses of zinc oxide and unreacted zinc metal at the end of the experiment.