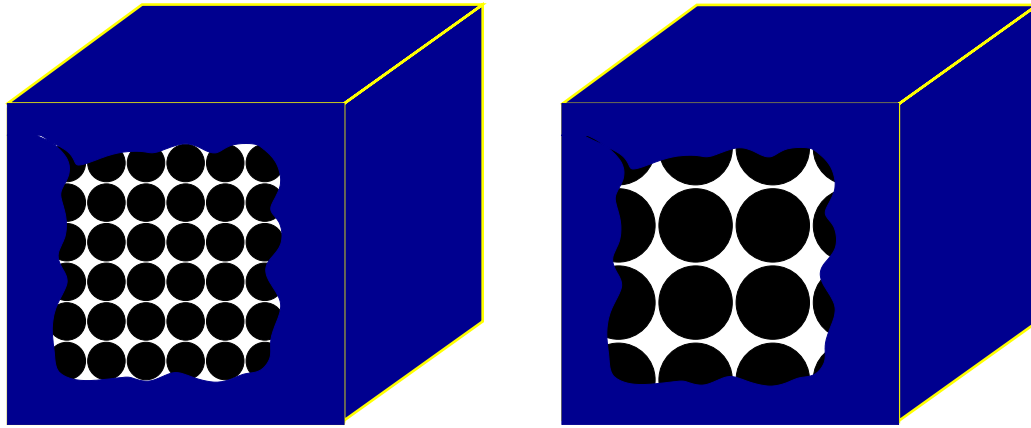


Making space

Into a big container one puts many spherical marbles all of the same size. The marbels are in the most close-packing configuration. Then one fills the empty space between the marbles with water, volume V . Now we replace the small marbles with marbles twice the size (in volume), but still in the most close-packing configuration. We also can still assume that the container holds many marbles of the new size.

How much more water will the empty space between the bigger marbles hold?



Answer of problem **Making space**

Exactly the same. The volume of empty space does not change.

One can do a dimensional estimate. Say we have container with volume $V = L^3$, and marbles of diameter d . The number of marbles that will fit in the container is of the order

$$N = a \frac{L}{d} \frac{L}{d} \frac{L}{d} = a \frac{V}{d^3}$$

where a is some constant that characterizes the packing pattern independent of the marble size.

The volume taken by marbles is

$$V_{\text{marbles}} = N \frac{4\pi}{24} d^3 = \text{const} * V \quad - \text{ independent of the marble size!}$$