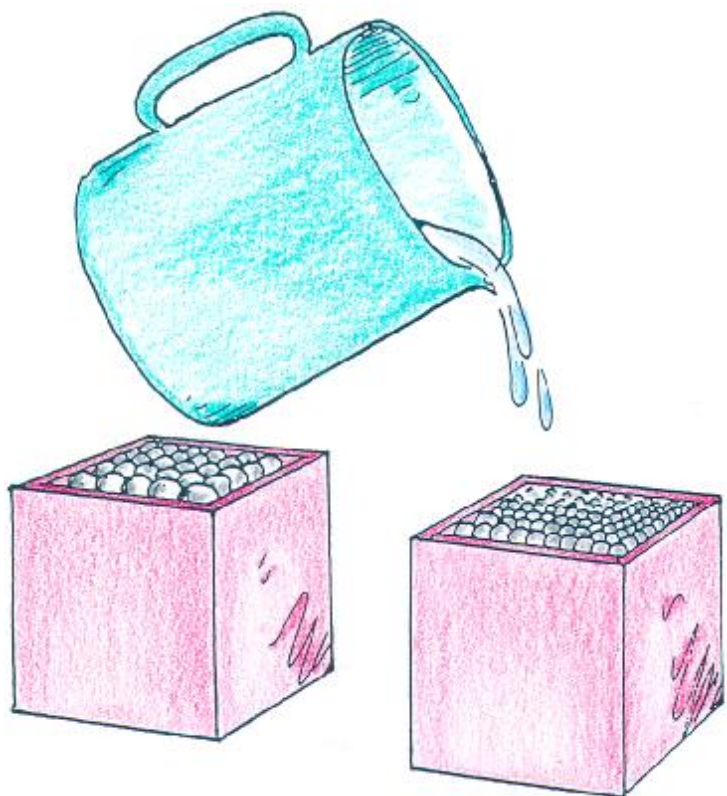CONCEPTUAL Physics

Two identical boxes are brim filled with spherical steel ball bearings—one with uniform big-diameter bearings and the other with half-size ones. If you pour water and fill each box, which will take more water?

a) The box of big bearings.
b) The box of small bearings.
c) Both the same.

Which box weighs more?

thanx to Tom Humphrey

Next-Time Question

Two identical boxes are brim filled with spherical steel ball bearings—one with uniform big-diameter bearings and the other with half-size ones. If you pour water and fill each box, which will take more water?

a) The box of big bearings.
b) The box of small bearings.
c) Both the same.

Answer: c, both the same

The volume of empty space in both boxes is the same, so the volume of water to fill them is the same. Although there's more space between the larger bearings, they're fewer in number. There's less space between the smaller bearings but there are more of them. It's a wash.

And since the volume of open space in each box is the same, the volume of steel is the same. That means both weigh the same—whether filled with water or not.

Let's exaggerate: Consider a cubical box containing a single sphere of diameter D equal to the length of the box. A simple calculation shows the volume of the sphere is 52% that of the cube, which means 48% open space. Now consider spheres of half size. Rectangularly packed, 8 spheres of diameter $D/2$ will fill the same cube—like 8 smaller cubes, each with 48% open space. Same total open space. Likewise for smaller spheres, rectangularly packed, where the volume of open space is the same. That means a box full of uniform small spheres weighs the same as the box with the single sphere of diameter D!

$D = \ell$

$\dfrac{D}{2} = \dfrac{\ell}{2}$

Hewitt Drewit!