Winnie the Pooh—Buoyancy

In this creative animated short, Winnie the Pooh and Piglet are soaring above the treetops with just a few balloons. This scenario is quite common in cartoons and other fantasy movies (e.g. Up, Mickey Mouse Clubhouse, etc.). However, the buoyant force required to cause Pooh and Piglet to accelerate upwards is not nearly satisfied with just a few balloons.

First, ask your students to estimate a few physical parameters:

Volume of balloon: The balloons can be approximated as spheres with a radius of 20 cm. Then, the volume is $V = \frac{4}{3}\pi r^3 = 0.034\ m^3$.

Mass of Pooh and Piglet: Let's say Pooh is 1 kg (about 2 lbs.) and Piglet is about 0.5 kg (about 1 lb.).

Density of Helium: Have the students find this in their text or on the internet and convert it to SI units. $\left(\rho_{He} = 0.164\frac{kg}{m^3}\right)$

Now, recognize that the buoyant force must be, at least, equal to the combined weight of Piglet and Pooh (though, of course, it must be larger than this to accelerate upwards).

Now, we can calculate the number of balloons required to balance the buoyant and gravitational forces

$$F_B = F_w$$

$$N\rho_{He}V_{balloon}g = \left(m_{Pooh} + m_{Piglet}\right)g$$

$$N = \frac{\left(m_{Pooh} + m_{Piglet}\right)g}{\rho_{He}V_{balloon}g}$$

$$N = \frac{(1\ kg + 0.5\ kg)9.8\frac{m}{s^2}}{0.164\frac{kg}{m^3}(0.034m^3)9.8\frac{m}{s^2}} = 270\ balloons$$

Just for fun, have them calculate the number of helium filled balloons required to lift them, sitting in a lawn chair.