Trying to weigh air?

What's really happening

(Ireland)

Background

The principle of Archimedes applies to the weight of objects immersed in fluids, i.e. in liquids or gases.

You will need...

- ✓ Electronic balance
- ✓ a light plastic bag
- ✓ a clothes peg

Follow these steps

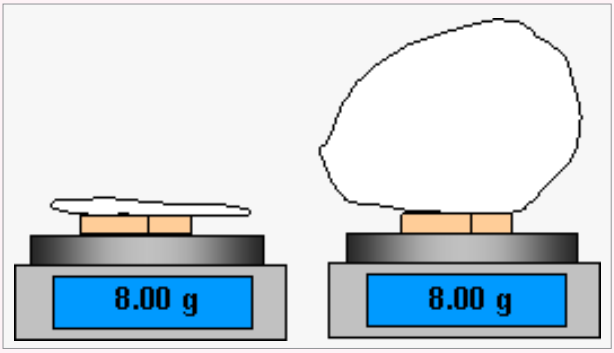
1. Weigh an empty plastic bag and a clothes peg.
2. Then inflate the bag without blowing into it and seal it with the clothes peg.
3. Weight it again.
4. Explain why the weight is the same.

So what happened?

The density of air is about 1.2 g cm^{-3} (i.e. 1.2 kg m^{-3}).

Any object that is weighed in air will appear lighter by an amount that is exactly equal to the weight of air it has displaced. (Archimedes' Principle)

If the plastic bag has a volume of, for instance, 1 litre then when it if full of air it should be about 1.2 grams weight heavier. However, it will be lighter by the weight of air that the bag of air has displaced — which is also about 1.2 grams weight.



Extension: hot air balloons

The table below shows the density of air at various temperatures.

Temp. (°C)	Density (kg m^{-3})
0	1.29
10	1.25
20	1.20
80	1.00
100	0.95

1. A commonly used size for a hot air balloon is 2800 cubic metres. What mass of air does it contain at 10°C? (See table left)
2. What mass of air does it contain at 100°C?
3. If the contained air is at 100°C and the outside air temperature is 10°C, what is the maximum total mass the balloon can lift (i.e. the balloon material, burner, fuel tanks, basket and passengers)?

Image: Wikimedia Commons (by Kropsoq)

Answers

1. 3500 kg (i.e. 2800 ×1.25)
2. 2660 kg (i.e. 2800 ×0.95)
3. 840 kg (i.e. 3500 - 2660)