1.2 Measuring molecules

Problem 1.2 *Benjamin Franklin dropped oil on a lake's surface and noticed that a given amount of oil could not spread out beyond a certain area. If the number of drops of oil was doubled, then so was the maximum area to which it would spread. His measurements revealed that 0.1 cm^3 of oil spread to a maximum area of 40 m^2. How thick is such an oil layer?*

1.2.1 Notes

1.2.2 Related problems

1. Franklin actually showed that 1 teaspoon of oil would spread to cover about 0.5 acre (Note: 10^4 m^2 = 2.47 acres). Determine how many cubic centimeters there are in a teaspoon.
2. Estimate the average spacing between H_2O molecules in liquid water by making use of two pieces of information: (a) liquid water has a density of 1 g/cm^3, and (b) every 18 g of water contains Avogadro's number (6.02×10^{23}) of H_2O molecules.
3. You hire a car that has 6/8 of a tank of fuel. The car hire agent asks for you to return the car with 6/8 of a tank of fuel otherwise it will charge for fuel at a premium rate. After using the car for a week the car has 1/4 tank of fuel. You look up that the capacity of the tank is 35 litres, how much should you spend on refilling the car so that you fill it just enough so that the car hire company doesn't charge you for extra fuel, but not so much that you are paying for more fuel than required? (assume the cost of fuel is £1.30 per litre.)
4. Sirs Andre Geim and Konstantin Novoselov were awarded the Nobel Prize in Physics (2010) for ground greaking experiments using graphene. Graphene is one of the crystalline forms of carbon in which carbon atoms are arranged in a regular hexagonal pattern. Given the information that each milli-gram of graphene has an area 1.299 m^2 and that carbon atoms have an atomic mass of 12 g mol^{-1}, what is the distance between carbon atoms in the 2-d material graphene? (hint: you will need to consider the area of an array of hexagons)
5. How many molecules of air are there in Earth's atmophere? (take the depth of the atmosphere to be 10 km; radius of Earth, $Re = 6.4 \times 10^6$ m; molecular weight of air $\sim$ 29 g mole^{-1}; density of air $\sim$ 1 kg m^{-3})

1.2.3 Notes on related problems

1.2.4 Homework and reading

Background reading:

- Review the periodic table handout.
- Optional: Hewitt et al. (2009, Chapters 9.1 and 11.7);
- Croft and Davison (2006, chapter on 'Indices') OR 2.1, 2.2, 2.3, 2.4 and 2.5 of the *Foundation Maths Support Pack*.

Do this weeks assessment on Blackboard:

- 'Indices and removing brackets'.
- 'Measuring molecules'.
- If you are struggling with unit conversion and geometry, do the supplementary material and bring to next class to discuss with us.