Rutherford's atom

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1. An ångström (Å) is 10×10^{-10} m; it is a very useful unit because atomic radii are of the order of 1 ångström. Work out the following:
   (a) The relationship between an ångström and a nanometer?
   (b) How many ångströms are there in a millimetre?
   (c) How many ångströms are there in a micrometre?
2. The radius of an olive oil drop is measured at 0.45 mm using a travelling microscope. The drop is put on a dusted water surface and spreads out to a circular disc of radius 23.8 cm.
   (a) Calculate the thickness of the disc
   (b) The olive oil molecules stack like wheat in a field, i.e. longest way up. Use this information to give some estimate of the size of an atom. The chemical name of olive oil is propane 1,2,3-trioctadec-9-enoate!!
3. (a) An atom has a diameter of 0.2 nm. How many such atoms would cover an area of 1 cm^2?
   (b) How many such atoms would be needed to fill a space of 1 cm^3?
4. A hydrogen atom has a mass of 1.661×10^{-27} kg. How many atoms are in 1 kg of hydrogen?
5. Read about Rutherford's experiment and find out how big a nucleus is relative to the whole of the atom. What are the units called which are used to express the size of nuclei? Define this unit.
6. If the radius r of a nucleus is taken to be half the distance from the centre of the nucleus to a point where the density of the nuclear material has fallen to half the value at the centre, the radius in metres of a nucleus is given approximately by the relationship:

$$r = 1.4 \times 10^{-15} A^{1/3},$$

   where A is the mass (nucleon) number of the nucleus.

   Starting with this relationship, calculate:
   (a) the radius of a gold nucleus ($A = 197$)
   (b) the volume of the gold nucleus.
   (c) the density of gold is 18 880 kg m^{-3}. Calculate the approximate volume of the gold atom. Compare this with your previous answer for (b).

   [This question from *Heinemann Advanced Science: Chemistry*, Ann and Patrick Fullick, p.30]