Mapping Atomic Structure

Drawing a Scale Model

Introduction

The mass of an atom is concentrated in its nucleus—a small, dense region with a diameter about 1/100,000 that of the atom. Most of the size of an atom is apparently empty space! How can we translate the dimensions of the nucleus and the atom to things we can see and understand? In this activity, we will use basketballs and a map of the city to draw a scale model of the atom.

Concepts

- Atomic nucleus
- Atomic radius

Materials

Basketball
Map of city
Metric ruler
Tape measure

Safety Precautions

Although the materials used in this activity are considered nonhazardous, please observe all laboratory safety guidelines.

Procedure

1. Using a tape measure, measure the circumference of a basketball in *centimeters* to three significant figures.
2. Rearrange the formula for the circumference of a sphere (circumference $= 2\pi r$) to solve for the radius *(r)*. Use this equation to calculate the radius of the basketball in cm to three significant figures.
3. Imagine that the basketball represents the nucleus of an atom. Assuming that the radius of an atom is about 100,000 times *larger* than that of the nucleus, calculate the radius of an atom that would have a basketball as its nucleus. Record the radius in *kilometers* to three significant figures.
4. Obtain a map of your city and draw a circle on the map to illustrate the size of a city "atom" compared to its basketball "nucleus," assuming that the basketball is located in your school building.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
MS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter
Disciplinary Core Ideas: High School
HS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter

Science and Engineering Practices
Asking questions and defining problems
Developing and using models
Using mathematics and computational thinking

Crosscutting Concepts
Scale, proportion and quantity
Systems and system models

Tips

- Most textbooks use the ratio 1/100,000 to describe the relative sizes of the nucleus and the atom. This is an approximation. The radius of a carbon nucleus, for example, is 2.7×10^{-15} m, while the radius of a carbon atom is 7.0×10^{-11} m—the carbon atom is 26,000 times larger than its nucleus.
- The map below shows how big an atom would have to be if it had a basketball-sized nucleus located in downtown Chicago, Illinois.

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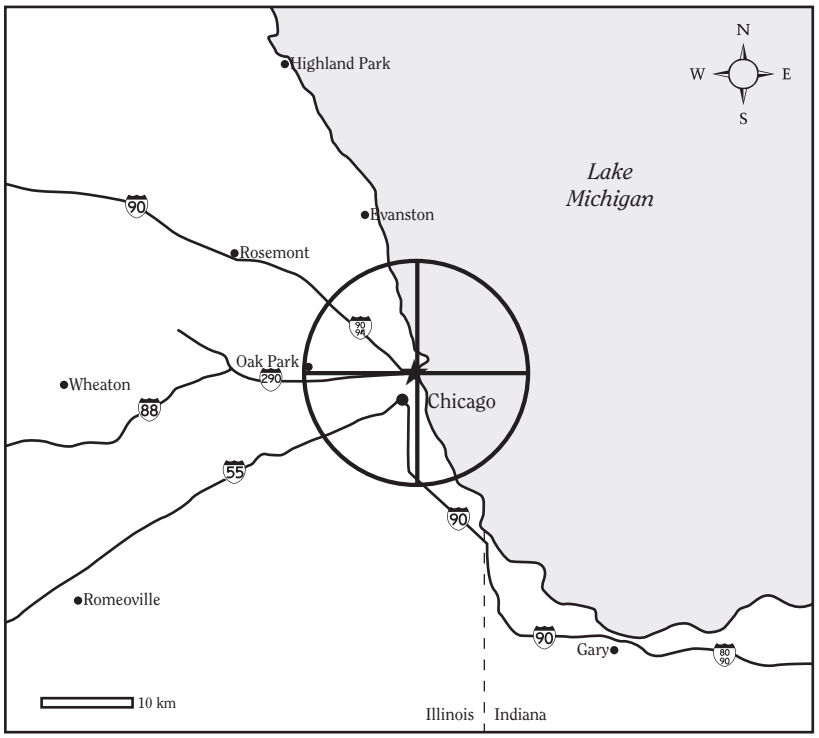
- The standard circumference of a basketball is 750 mm. Radius = 120 mm.



Map Scale 1.2 cm = 10 km

1.0 cm = 8.3 km

Radius of basketball "nucleus" = 120 mm = 0.120 m

Radius of city "atom" = 100,000 × 0.120 m = 12,000 m = 12 km

$$\text{Radius of atom on map scale} = 12\ \text{km} \times \frac{1.0\ \text{cm}}{8.3\ \text{km}} = 1.5\ \text{cm}$$

Reference

This activity was adapted from *Flinn ChemTopic™ Labs*, Volume 3, *Atomic and Electron Structure;* Cesa, I., Editor; Flinn Scientific: Batavia, IL (2003).

Materials for *Mapping Atomic Structure—Drawing a Scale Model* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP6365	Atomic and Electron Structure, Flinn ChemTopic™ Labs, Volume 3
AP5386	Ruler, Metric, Clear
FB0524	Tape Measure, Metric, Pkg. 10

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.