

# Contents

Why Metric? .....	3
Building Blocks .....	6
A Brief History of Timekeeping .....	8
How to Build a Derby Winner .....	10
Moving Right Along .....	12
Fire! .....	14
Elements and Compounds .....	16
Light Drawing .....	18
Energy at Rest, Energy in Motion.....	20
First Link on the Food Chain .....	22
Muscle Power .....	24
The Amazing Chemical Factory .....	26
Nature's Balancing Act .....	28
How Many Kingdoms Are There? .....	30
Lynn Margulis .....	32
When Cells Divide.....	34
Mendel's Pea Patch .....	36
The Double Helix .....	38
The Genetic Switchboard.....	40
Designer Genes .....	42
Internal Security .....	44
Medical Technology .....	46
Why Save the Rain Forest? .....	48
Mollusks, Arthropods, Echinoderms, and Chordates.....	50
A Little Backbone .....	52
Spider Webs and Food Webs .....	54
Survive! .....	56
Wetlands .....	58
Endless Summer.....	60
The End of the World Is Coming! .....	62
Glossary.....	64



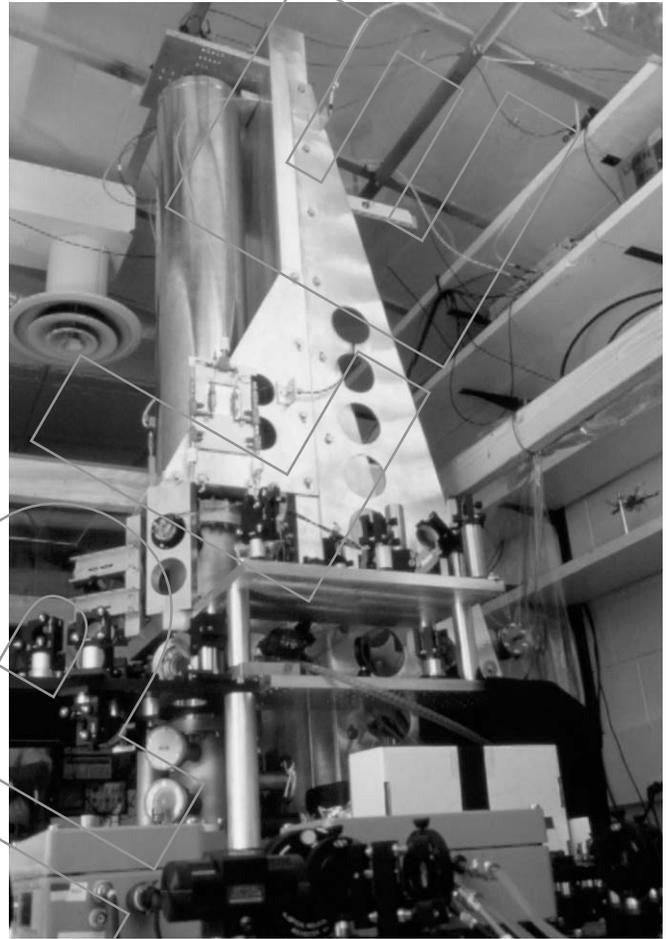
# A Brief History of Timekeeping

**T**here's a clock in a laboratory in Maryland that looks like no clock you've ever seen. It's an atomic clock. What's special about an atomic clock? Well, this one, called NIST-F1, is the most accurate clock ever built. It will not gain or lose a second in 30 billion years. In fact, atomic clocks keep better time than Earth itself! Earth wobbles in its rotation—not so you'd notice, but enough that NIST-F1 must be adjusted now and then to correct for tiny differences in the length of a day.

You only need a clock *that* accurate for special purposes, such as regulating global-positioning system (GPS) satellites. But people have always sought greater precision in keeping time. For early humans, measuring months and seasons was good enough. The first timekeeping devices were the sun and moon. The Egyptians, over 6,000 years ago, were probably the first to determine that a year equaled 365 days.

The idea of a clock came later. The Sumerians, about 5,000 years ago, divided a day into 12 periods, and each period into 30 parts. But they had no way of measuring them. You need two things to make a clock. You need a regular, repeating process to mark equal measures of time. And you need a way to keep track of these measurements and to show them. The first clocks, around 3,500 years ago, marked time by the passage of the sun or by dripping water. But the sun doesn't always shine, and it's hard to control flowing water. Other early clocks measured time by falling sand or marked candles, but they were not very accurate either.

The first mechanical clocks came along about 700 years ago. They used weights to drive the machinery that made the clock "tick." They weren't much more accurate than water clocks. Then about 500 years ago, spring-powered clocks were invented. They ran more slowly as the spring unwound, but could be made accurate to a few minutes a day. Later, that was improved to less than a second. The big advance in mechanical timekeeping was the invention of the pendulum



Cesium Frequency Clock  
National Institute of Standards and Technology

clock in 1656. By 1900, the best pendulum clocks were accurate to within 0.01 second a day.

Electronic clocks came along in the 1920s. They measure time by vibrations in a mineral called quartz. Most clocks and watches today are quartz regulated.

Atomic clocks keep far more accurate time than any other type of clock. They measure time by a process inside atoms. No friction or mechanical vibration disturbs their regular operation. NIST-F1 measures the process in atoms of a metal called cesium—exactly 9,192,631,770 times per second. In fact, that's how scientists now define a second. It's 9,192,631,770 "ticks" of a cesium atom.

**Put an X in the square beside the best answer.**

1. NIST-F1 keeps time by measuring a process in an atom of the element \_\_\_\_\_.  
 sodium                       cesium                       cerium                       calcium
2. Which of these sentences best expresses what the article is mostly about?  
 Today's clocks have greater accuracy than people really need.  
 Atomic clocks keep better time than Earth itself.  
 People have always sought greater precision in keeping time.  
 You need a regular, repeating process to mark equal measures of time.
3. You can conclude that \_\_\_\_\_ lowers the accuracy of a mechanical clock.  
 Earth's wobble                       the length of a pendulum  
 falling sand                       vibration
4. Which of these kinds of clocks was invented *second*?  
 weight-driven clocks                       water clocks  
 electronic clocks                       spring-powered clocks
5. Water clocks were *not* accurate because \_\_\_\_\_.  
 measuring months was good enough                       they used weights to drive machinery  
 water evaporates on a sunny day                       it is hard to control the flow of water
6. In paragraph 2, the word precision means \_\_\_\_\_.  
 exactness                       mystery                       profit                       difference



**Write your answer to the following question on the lines below.**

Why do we need accurate timekeeping to within a minute a day? Why do we need accurate timekeeping to within less than 0.01 second a day?

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