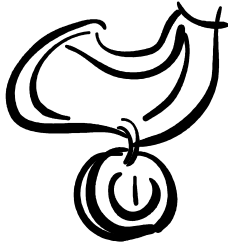


## Physics and France

France and French-speaking countries have played an important role in the development of physics, from the eighteenth century with Ampère and Coulomb through Marie and Pierre Curie's important work with radioactivity. Cutting-edge research in the field of physics continues today in French national labs and at the CERN laboratory located in France and Switzerland. See how much you know—and perhaps add to your knowledge—with the following items.



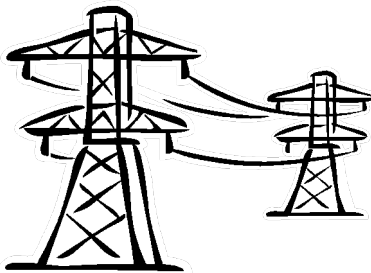
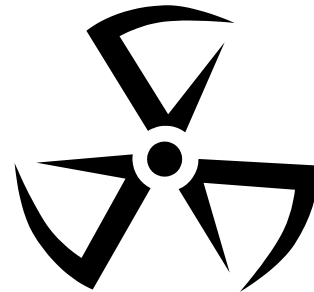
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  - b. 6
  - c. 10
  - d. 18

2. Henri Becquerel and Marie and Pierre Curie won the Nobel Prize in Physics in 1903. What phenomenon did they discover and research?
  - a. relativity
  - b. the nature of light
  - c. the wave nature of electrons
  - d. radioactivity



3. A common unit indicating a rate of radioactive decay is \_\_\_\_
  - a. the descartes
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  - c. the carnot
  - d. the curie

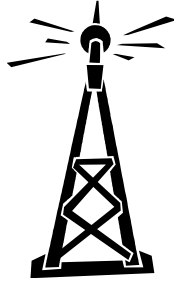
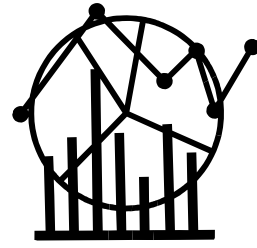
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5. Charles Augustin de Coulomb (1736-1806) studied the interactions between charged particles. His discovery is formulated as
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  - d. Coulomb’s Amplitude

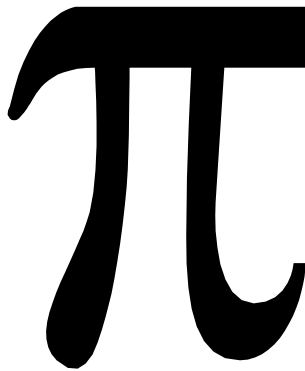
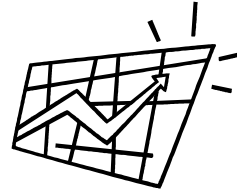
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6. In 1924, Louis-Victor de Broglie (pron. "duh broy") made a crucially important proposition: electrons and protons can act like both particles and \_\_\_\_\_.  
 a. molecules  
 b. heat  
 c. waves  
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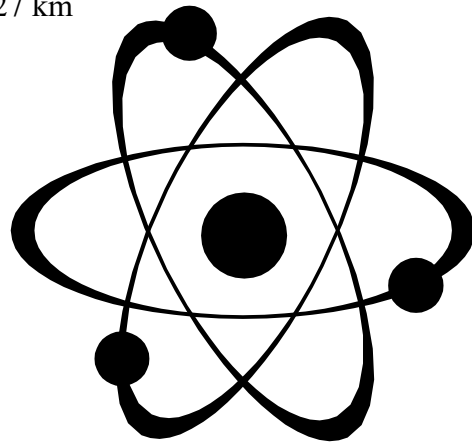
7. Some of the most cutting-edge research in particle physics takes place at the laboratory called CERN. What is this institution's name in English?  
 a. Center for Energy and Neutron Research  
 b. Center for Energy and Nuclear Research  
 c. Council for European Energy Research  
 d. European Organization for Nuclear Research

8. Where is CERN located?  
 a. in Germany and France  
 b. in France and Switzerland  
 c. in Switzerland alone  
 d. in France alone



9. In 1985, excavation began on the tunnel to house what would be the largest accelerator at CERN: the LEP (Large Electron-Positron) collider. In 2008, the LHC or Large Hadron Collider began using this tunnel. What is the circumference of the tunnel?  
 a. 5 km  
 b. 8 km  
 c. 13 km  
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10. While working at CERN in 1980, physicist Tim Berners-Lee had an idea. He developed this over the next ten years, and it was first put into use at CERN.  
 a. the World Wide Web  
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 d. the particle accelerator



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The questions can be used as a "bell-ringer" activity—a short activity usually done at the beginning of class to help students focus on the subject of that class.

Correct answers are indicated by an asterisk. Brief explanations for some items, as well as complete source information, are given at the end of the document.

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## Answers:

1. People working in French institutions have won Nobel Prizes in Physics in ten different years. (Source: <http://nobelprize.org>) They are:

### 1903

**Antoine Henri Becquerel** (1852-1908)

*Ecole polytechnique*

Awarded half of the prize, "in recognition of the extraordinary services he has rendered by his discovery of spontaneous radioactivity"

**Pierre Curie** (1859-1902) and **Marie Curie** (1867 in Warsaw, Poland - 1934), née Slodowska

*Ecole municipale de physique et de chimie industrielles*

Each received one quarter of the prize, "in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel"

### 1908

**Gabriel Lippman** (1845 in Luxembourg-1921)

*Sorbonne*

Awarded "for his method of reproducing colors photographically based on the phenomenon of interference"

### 1926

**Jean Baptiste Perrin** (1870-1942)

*Sorbonne*

Awarded "for his work on the discontinuous structure of matter, and especially for his discovery of sedimentation equilibrium"

### 1929

**Prince Louis-Victor Pierre Raymond de Broglie** (1892-1987)

(pronounced "duh broy")

*Sorbonne; Institut de France*

Awarded "for his discovery of the wave nature of electrons"

### 1966

**Alfred Kastler** (1902-1984)

*Ecole normale supérieure*

Awarded "for the discovery and development of optical methods for studying Hertzian resonances in atoms"

### 1970

**Louis Eugène Félix Néel** (1904-2000)

*University of Grenoble*

Awarded half of the prize "for fundamental work and discoveries concerning antiferromagnetism and ferromagnetism which have led to important applications in solid state physics"

**1991**

**Pierre-Gilles de Gennes** (1932-2007)

*Collège de France*

Awarded "for discovering that methods developed for studying order phenomena in simple systems can be generalized to more complex forms of matter, in particular to liquid crystals and polymers"

**1992**

**Georges Charpak** (b. 1924 in Dabrovica, Poland)

*Ecole supérieure de physique et de chimie; CERN, Geneva, Switzerland*

Awarded "for his invention and development of particle detectors, in particular the multiwire proportional chamber"

**1997**

**Claude Cohen-Tannoudji** (b. 1933)

*Collège de France; Ecole normale supérieure*

Awarded one third of the prize "for development of methods to cool and trap atoms with laser light"

**2007**

**Albert Fert** (b. 1938)

*Université de Paris-Sud; Unité mixte de physique CNRS/THALES, Orsay*

Awarded half of the prize "for the discovery of Giant Magnetoresistance"

2. Source: <http://nobelprize.org>

"The study of natural radioactivity began in 1896.... Henri Becquerel discovered a radiation from uranium salts that seemed similar to x-rays. Intensive investigation in the following two decades by Marie and Pierre Curie, Ernest Rutherford, and many others revealed that the emissions consist of positively and negatively charged particles and neutral rays...." (Hugh D. Young and Roger A. Freedman. (2008). *Sears and Zemansky's University Physics*, 12th edition. San Francisco: Pearson Addison Wesley, p. 1484.)

3. Source: Young and Freedman , p. 1487.

4. Source: Young and Freedman, p. 848.

He lived from 1775-1846. "One ampere is defined to be *one coulomb* per second [1 A = 1 C/s]." (p. 848)

5. Source: Young and Freedman, p. 716.

Coulomb's Law is as follows: "The magnitude of the electric force between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them." (p. 716)

6. Source: Young and Freedman, p. 1350.

7. Source: <http://public.web.cern.ch/Public/Welcome.html>.

"Founded in 1954, the CERN Laboratory sits astride the Franco–Swiss border near Geneva. It was one of Europe's first joint ventures and now has 20 Member States." (Source: <http://public.web.cern.ch/Public/en/About/About-en.html>)

The acronym CERN comes from the French "Conseil Européen pour la Recherche Nucléaire," or European Council for Nuclear Research. Today, "the laboratory operated by CERN is commonly referred to as the European Laboratory for Particle Physics." (Source: <http://public.web.cern.ch/Public/en/About/Name-en.html>)

8. Source: <http://public.web.cern.ch/Public/Welcome.html>

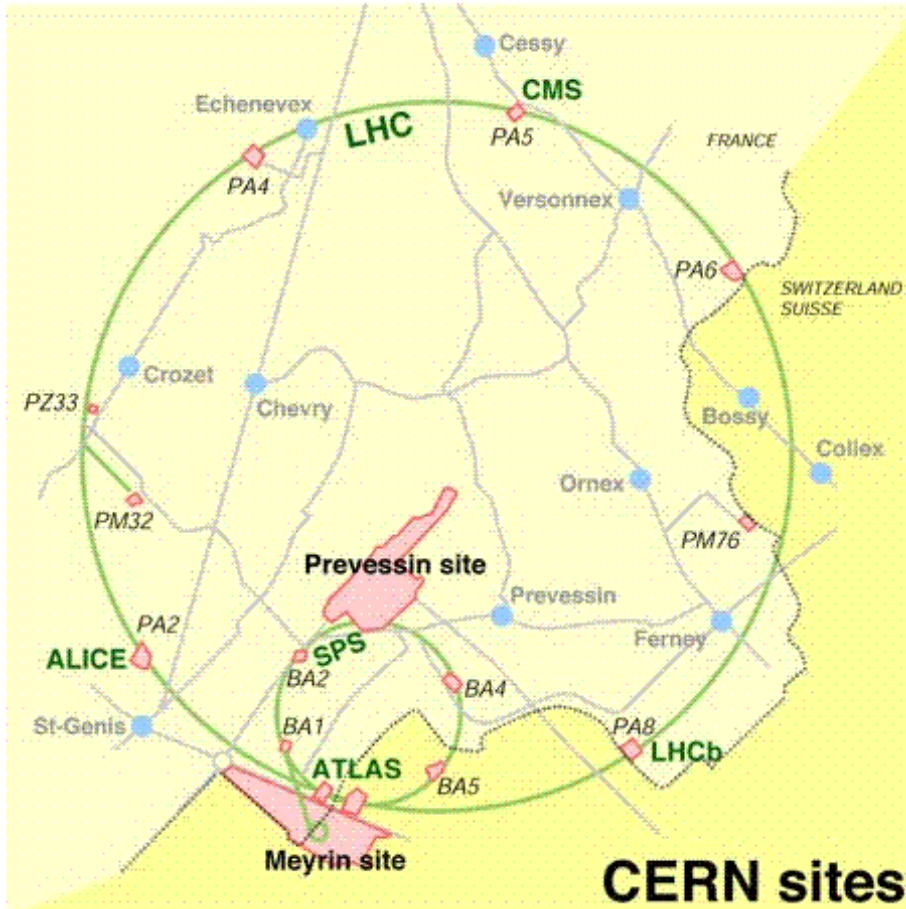
9. Source: <http://public.web.cern.ch/Public/en/About/History89-en.html>

"With its 27 km circumference, the Large Electron-Positron (LEP) collider was – and still is - the largest electron-positron accelerator ever built. The excavation of the LEP tunnel was Europe's largest civil-engineering project prior to the Channel Tunnel. Three tunnel-boring machines started excavating the tunnel in February 1985 and the ring was completed three years later."

In 2008, the LHC—Large Hadron Collider—was set to start functioning. "The LHC, the world's largest and most powerful particle accelerator is the latest addition to CERN's accelerator complex. It mainly consists of a 27 km ring of superconducting magnets with a number of accelerating structures to boost the energy of the particles along the way." (Source: <http://public.web.cern.ch/Public/en/LHC/HowLHC-en.html>)

"The Large Hadron Collider (LHC) is a gigantic scientific instrument near Geneva, where it spans the border between Switzerland and France about 100 m underground. It is a particle accelerator used by physicists to study the smallest known particles – the fundamental building blocks of all things. It will revolutionize our understanding, from the miniscule world deep within atoms to the vastness of the Universe."

(Source: <http://public.web.cern.ch/Public/en/LHC/LHC-en.html>)



Map from <http://building.web.cern.ch/building/>

10. Physicists, who work in large international collaborations, need to share complex data among researchers at different institutions and on different continents. While working at CERN, Berners-Lee developed the idea of "a global hypertext system." It would allow scientists at CERN and all over the world to share their data—to "link information systems"—in a relatively straightforward and non-hierarchical way, using a "graphical user interface" or GUI.

He first called this network a "Mesh"—but in 1990, when writing code for the project, he named it the "World Wide Web." The first-ever web server was at CERN.

(Sources: <http://www.w3.org/History.html> and <http://www.w3.org/History/1989/proposal.html>)

See also <http://public.web.cern.ch/Public/en/About/Web-en.html> for the history of the Web, as well as <http://info.cern.ch/>, for the "website of the world's first-ever web server."