

Matter and relativity

Background

These SPICE resources are intended to assist teachers when teaching aspects of physics that have not previously been included in Western Australian syllabuses. This includes concepts related to the standard model of fundamental particles and force, and Einstein's special and general theories of relativity.

Where possible, the resources include elements of the constructivist learning approach based on the 5-E model — **Engage, Explore, Explain, Elaborate and Evaluate**. However, it is not feasible to align each learning activity with all five elements of the model, within the teaching time available.

Purpose

These learning resources enable students to:

- extend their understanding of subatomic particles to include neutrinos and quarks;
- describe qualitative aspects of special relativity, such as reference frames and the equivalence of mass and energy; and
- describe qualitative aspects of general relativity, such as effect of gravity on time.

Learning resources

Matter and relativity 1: Quarks

Quarks consists of a teachers guide, fact sheet and presentation.

The presentation contains images, facts and questions to enable students to understand and explain the structure of matter. The fact sheet provides students with information about the Large Hadron Collider: what it is; where it is located; what it does; and what physicists hope to learn from using it. See the teachers guide for detailed information on the purpose and use of this resource.

Matter and relativity 2: Introduction to relativity

Introduction to relativity consists of a teachers guide, two presentations and a student worksheet.

Students use the presentations and worksheet to explore and explain aspects of Einstein's special and general theories of relativity. See the teachers guide for detailed information on the purpose and use of this resource.

Matter and relativity 3: Satellite clocks

Satellite clocks consists of a teachers guide, interactive learning object and student worksheet.

Students use an interactive learning object to explore effects of speed on time (special relativity) and effects of gravity on time (general relativity) for an Earth-orbiting satellite. See the teachers guide for detailed information on the purpose and use of this resource.

Matter and relativity 4: Measuring time

Measuring time consists of a teachers guide, background sheet and three minute video.

The video, *Measuring time*, draws together many concepts of modern physics, including special and general relativity, quarks, and some interesting aspects of cosmology. It features Professor Andre Luitjen's research at The University of Western Australia to construct the world's most accurate clock. See the teachers guide for detailed information on the purpose and use of this resource.

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Banner image: Composite image of the Crab Nebula (X-ray: NASA/CXC/SAO/F.Seward; Optical: NASA/ESA/ASU/J.Hester & A.Loll; Infrared: NASA/JPL-Caltech/Univ. Minn./R.Gehrz)

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Web: spice.wa.edu.au

Email: spice@uwa.edu.au

Phone: (08) 6488 3917

Centre for Learning Technology (M016)
The University of Western Australia
35 Stirling Highway
Crawley WA 6009