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Otava
Learning

Physics and chemistry materials from Finland

Titanium Physics and Chemistry

The Titanium series for lower secondary school physics and chemistry inspires learning. The series covers a variety of different topics and the exercises are suitable for different kinds of learners. Pupils are motivated through experiential and functional learning. The series encourages personal thinking and insight. Informative videos, pictures, illustrations and infographics promote multiliteracy. Titanium takes advantage of ICT, and simulations are also used in studying the different phenomena.

Textbooks

The textbook contains the whole theory of physics or chemistry and the exercises for the whole lower secondary school.

Each year has a book of its own. The language in the books is student friendly. In addition, special attention has been paid to placing the images and the texts on the pages in a manner that makes learning easier.

The sections can be learned in a convenient order according to the school's curriculum and distribution of lessons. The clear structure offers natural opportunities for differentiation.

Different learners are taken into account in the diverse exercises. The exercises proceed from the easiest to the most difficult ones, so the books are also well suited for differentiation. There are practical experiments for pupils as well as tests and simulations to be carried out with digital tools. The answers can be found in the digital teaching material.

The Titanium product family for lower secondary school physics and chemistry

- Textbook
- Digital book
- Digital teaching material



2 The achievements of chemistry

- > What materials are used to make your phone's battery?
- > What materials are new ice hockey sticks made of?
- > What inventions of chemistry do you know?

Experiments

Do you know substances?

Your teacher will give you samples of different substances. What substances do you recognise? Write the name of the substance and one of its characteristics in the table.

Sample	Substance	Characteristics
1		
2		
3		
4		
5		

The experiments help to understand the topic discussed.

Each section starts with an introductory page with a brief presentation of the main topics and a table of contents.

The initial questions in each chapter determine pupils' starting level and help to start a discussion.

3 Working safely in the laboratory

- > How do you protect your eyes in chemistry class?
- > What do you measure in millilitres?
- > What corrosive substances do you know?

Experiments

Lighting up the laboratory burner

Equipment and substances: laboratory burner, matches

Practise using the laboratory burner with your partner. Light and switch off the burner exactly as instructed below.

- a) Lighting up the laboratory burner.
 1. Shut the air hole.
 2. Light a match and move it onto the burner.
 3. Open the gas valve slowly. A flame is lit.
 4. Put out the match.
 What colour is the flame now?



5. Open the air hole. What colour is the flame now?

- b) Shutting off the laboratory burner.
 1. Turn the valve until it is completely closed.
 2. Make sure there is no smell of gas coming from the gas cylinder.

Making a solution

Equipment and substances: scales, a 100 millilitre beaker, a 100 millilitre measuring cylinder, water, table salt

Your teacher will first demonstrate how the scales work. To tare scales means resetting the scales to zero when an empty container is on it.

1. Place a beaker on the scales and tare the scales.
2. Weigh 10 grams of salt in the beaker.
3. Pour 90 millilitres of water in the measuring cylinder.
4. Pour the water into the beaker and mix. What is the mass of the solution?



Heating up water in a test tube

Equipment and substances: laboratory burner, matches, test tube, test tube rack, test tube tongs, water

Your teacher will first show you how to heat up water safely in a test tube.

1. Add around 3 centimetres of water into the test tube.
2. Put the test tube into the rack.
3. Carefully light the laboratory burner.
4. Take hold of the test tube with the test tube tongs.
5. Bring the test tube above the flame. The part of the tube filled with water should be in the flame.
6. Keep moving the test tube the way your teacher showed you.
7. Heat up the water until it boils.
8. Put the test tube into the test tube rack and let it cool down.



Lighting up the laboratory burner
Exact weighing
Exactly 10 ml

Multiliteracy is promoted by presenting information in a variety of ways.

> In a centrifuge, the test tubes rotate very fast.

Distillation separates substances using different boiling points
Distillation is a separation technique that can be used to separate out the different substances in a solution.
When you heat a solution, the substances in it start to boil. The substances boil at different temperatures. The first substance to boil is the one with the lowest boiling point.
When a substance boils, its state changes from liquid to gas. This gas then goes into the condenser, where it condenses into a liquid. We can then collect this liquid.
People use distillation for things like oil refining and making strong alcoholic drinks.

Purifying water by distillation
Water evaporates and condenses in the container.
Water vapour condenses.
Pure water is collected.

> Water is purified by distillation.

Distillation makes water clean
In many countries, there is a shortage of clean drinking water. Distillation can be used to make drinking water. When you heat seawater, the water is the first thing that starts to boil, and it changes into pure water vapour. In the condenser, the water vapour condenses into water. You can then collect this water. Salt and other substances in the seawater remain in the container.
When we distil water, we are repeating the water cycle that takes place in nature. Every day huge amounts of water evaporate from the sea and lakes into the air. In the air, the water condenses into clouds and then falls either as rain or snow.

> Black ink contains different colours. We can separate out these colours using paper chromatography.

Chromatography is a separation technique for small quantities of substances
Make a dot on the filter paper. Use a pen that has soluble ink. Next, put the edge of the paper in some water. The water will start to rise up the paper. When the water reaches the ink dot, the dot starts to move with the water.
Gradually, different colours separate from each other as the water moves upwards. This separation happens because different colours dissolve in the water in different ways. The colours that do not dissolve well get stuck on the paper. It means that they move more slowly in the water. The name of this separation technique is **paper chromatography**.
In chemistry laboratories, people use chromatography to separate out small quantities of substances.

Exercises

5. We can get drinking water from seawater using
 - a) filtration
 - b) extraction
 - c) distillation
6. We use distillation when we make
 - a) coffee
 - b) strong alcoholic drinks
 - c) tea.
7. Chromatography works because different substances have different
 - a) solubility
 - b) melting points
 - c) boiling points.
8. Distillation equipment includes
 - a) a Petri dish
 - b) a measuring cylinder
 - c) a condenser.
9. Distillation works because of a particular property of different substances. What is this property?
10. Why are the two changes of state that take place in distillation?

The videos inspire natural curiosity and prompt pupils to look for explanations for different phenomena.

The key concepts are printed in bold letters and explained in the glossary at the end of the book. The glossary also provides the concepts in English.

The exercises promote scientific thinking as well as problem-solving and information searching skills. They proceed from easier exercises to more challenging ones.

Simple diagrams and illustrative infographics explain the topics.

Exercises

9. What are the three different states of a substance?
 - a) a pure substance
 - b) a mixture
 - c) a compound
 - d) an element?
10. Which of the following are pure substances and which are mixtures?
toothpaste, milk, tea, sand, iron, sugar, cocoa, a gold ring
Pure substances: _____
Mixtures: _____
11. Brass and stainless steel are alloys.
 - a) What metals does brass contain?
 - b) What metals does stainless steel contain?

12. Which of the following pictures show
 - a) a pure substance
 - b) a mixture
 - c) a compound
 - d) an element?

13. What are the properties of pure substances?
14. a) What is oxygen's state of matter at $-200\text{ }^{\circ}\text{C}$?
b) What is carbon dioxide's state of matter at $-40\text{ }^{\circ}\text{C}$?
c) What is ethanol's state of matter at $0\text{ }^{\circ}\text{C}$?
15. a) What kind of mixture is smoke?
b) What kind of mixture is mud?

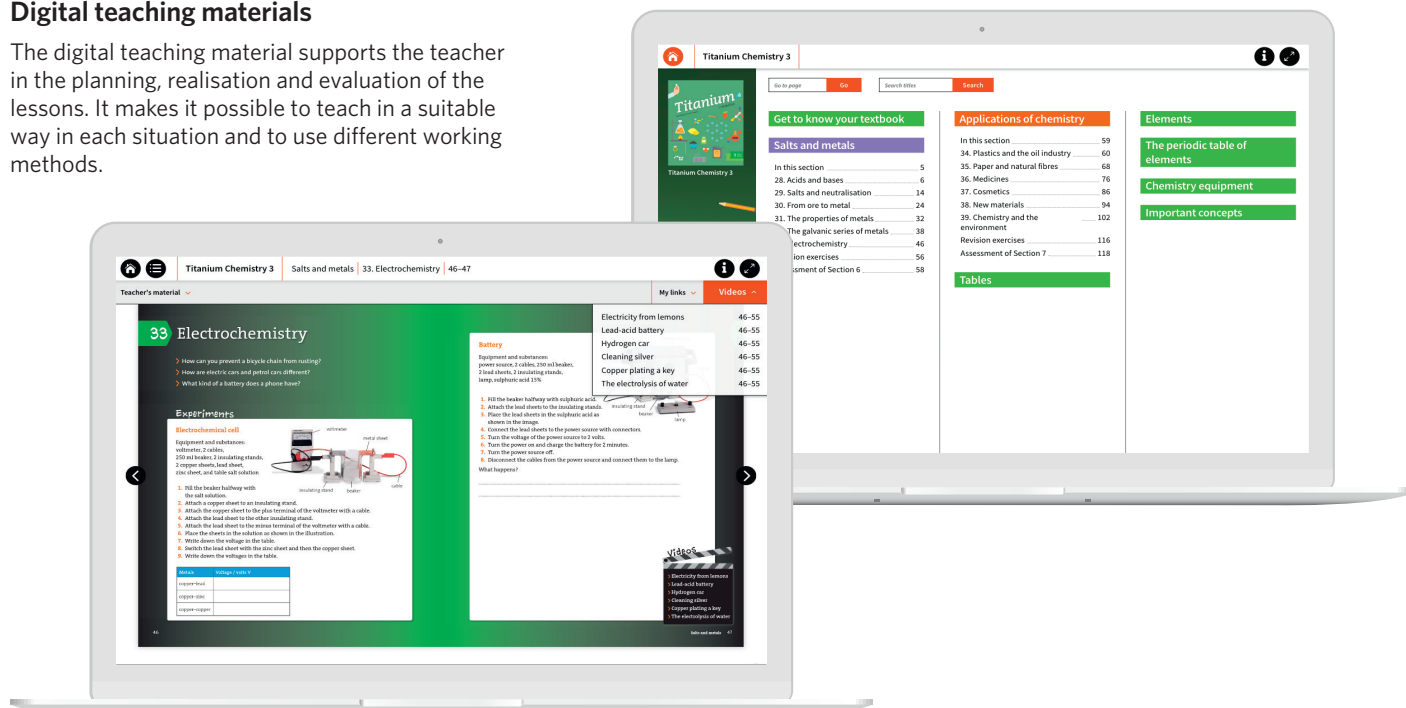
Summary

- > Substances are either pure substances or mixtures.
- > Pure substances are either elements or compounds.
- > Mixtures are either homogenous or heterogenous.
- > Some examples of homogenous mixtures are alloys, gas mixtures and solutions.
- > Some examples of heterogenous mixtures are smoke, mud, foam, mist, gel and emulsions.
- > A pure substance has a precise melting point and boiling point.

A summary at the end of each chapter concludes the most important points.

Digital teaching materials

The digital teaching material supports the teacher in the planning, realisation and evaluation of the lessons. It makes it possible to teach in a suitable way in each situation and to use different working methods.



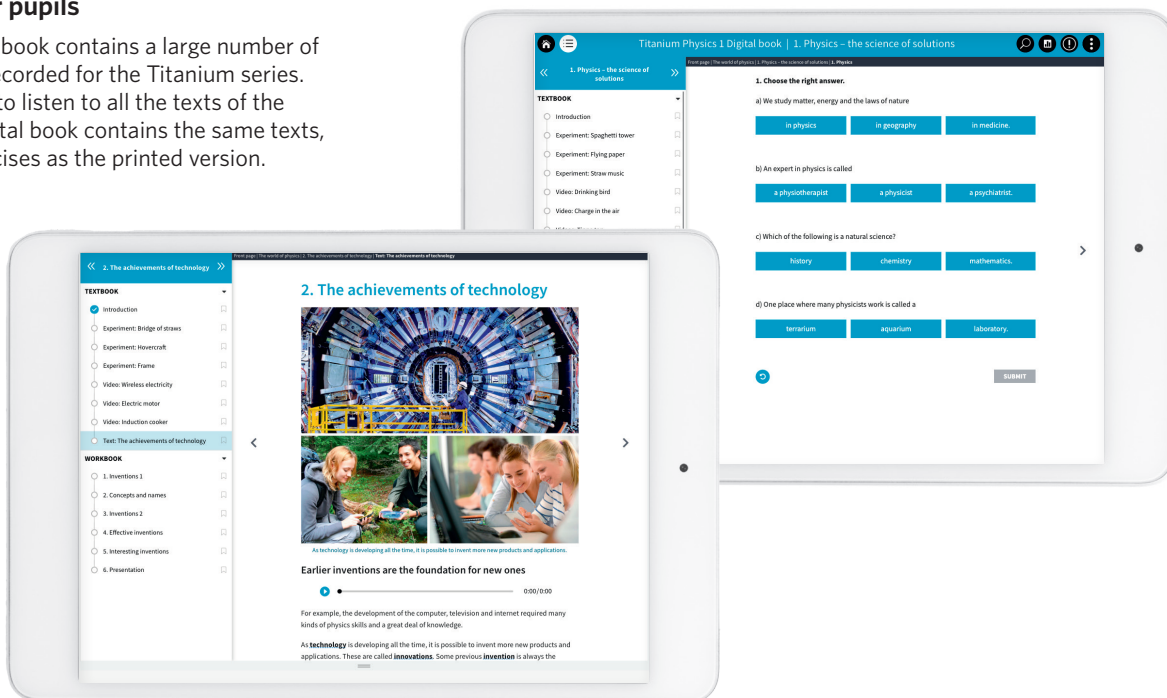
The material includes:

- The videos, including the commentaries
- Background information about the experiments in the textbook for the teacher
- The equipment and substances required for the experiments
- Safety instructions
- Pupil's book (including the texts of the chapters read aloud)
- Answers to all exercises
- Model tests and modifiable test questions



Digital book for pupils

The pupil's digital book contains a large number of teaching videos recorded for the Titanium series. It is also possible to listen to all the texts of the textbook. The digital book contains the same texts, pictures and exercises as the printed version.



Experienced award-winning authors

Titanium Physics authors:

PhD. Martti Heinonen

- Has worked as a head master (principal) in upper secondary school
- Has written several best-selling physics, chemistry and mathematics text books
- Has received several significant awards in teaching and writing non-fiction books

M.Sc. Jukka Kohtamäki

- Teacher in Hakkari lower secondary school
- Member of the National Physics Curriculum Team organized by Finnish National Board of Education
- Received the Distinguished Science Teacher Award in 2013 from the Technology Industries of Finland Centennial Foundation

M.Sc. Mikko Korhonen

- Teacher in Mikkeli upper secondary school
- Received the Fulbright Distinguished Award in Teaching 2010
- Received the Distinguished Science Teacher Award in 2013 from the Technology Industries of Finland Centennial Foundation

Titanium Chemistry authors:

Lic.Phil. Helena Muilu

- Teacher in The University of Jyväskylä Teacher Training School
- Has written several best-selling chemistry and physics textbooks
- Has guided students for several years to become physics and chemistry teachers

M.Sc. Tommi Virtanen

- Teacher in Karakallio lower secondary school
- Mathematics, chemistry and physics teacher and a chemist
- Chemistry and physics Advisory teacher in Espoo

Titanium Physics

Sections and Chapters

The World of Physics

1. Physics – the Science of Solutions
2. Achievements of Technology
3. About Physical Science
4. Quantities and Units
5. Formulas and Graphs
6. Energy

Sound and Light

7. Sound
8. Noise, Echo and Resonance
9. Light
10. Lenses
11. Mirrors
12. Wave Motion

Power and Motion

13. Interactions
14. Forces
15. Velocity
16. Acceleration
17. Pressure
18. Balance and Leverage
19. Work and Force

Heat

20. Temperature and Heat
21. Heat transfer
22. Thermal Expansion
23. Changes in Physical State
24. Storage of Thermal Energy
25. Heaters at Home
26. Energy Production and Energy Sources

Electricity and Magnetism

27. Electromagnetic Interaction
28. Electric Current and Voltage
29. Resistance and Ohm's Law
30. Household Appliances
31. Electromagnetic Induction
32. Generation and Transmission of Electricity

Universe

33. Electromagnetic Radiation
34. Radioactivity
35. Nuclear Reactions
36. Sun and Solar System
37. Earth and Moon
38. Stars and Star Systems



Titanium Chemistry

Sections and Chapters

The World of Chemistry

1. Chemistry – the Science of Studying Substances
2. Achievements of Chemistry
3. Laboratory Work Safety
4. Substances Around Us
5. Separating the Components of Mixtures
6. Elements and Compounds

Water and Air

7. Water – the Source of Life
8. Water as a Solvent
9. Acidity and Basicity
10. Slow and Fast Reactions
11. Characteristics of Air
12. Combustion and Fire Safety

From Atoms to Compounds

13. Atom Structure Model
14. The Periodic System
15. Ionic Bonding and Metallic Bonding
16. Covalent Bonding and Molecules

The Chemistry of Carbon

17. Carbon – a Diverse Element
18. Hydrocarbons
19. Alcohols
20. Carboxylic Acids

Chemistry at Home

21. Nutrients
22. Proteins
23. Carbohydrates
24. Fats
25. Chemistry of Cooking
26. Detergents
27. Waste Processing and Recycling

Salts and Metals

28. Acids and Bases
29. Salts and Neutralisation
30. From Ores to Metals
31. Properties of Metals
32. Galvanic Series of Metals
33. Electrochemistry

Applications of Chemistry

34. Plastics and the Petroleum Industry
35. Paper and Natural Fibres
36. Medicines
37. Cosmetic Substances
38. New Materials
39. Chemistry and the Environment



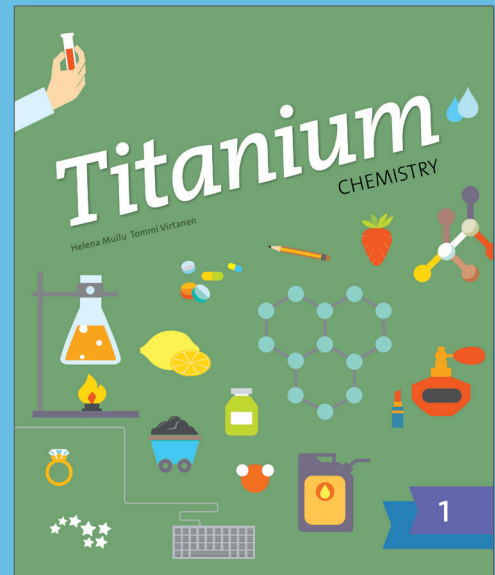
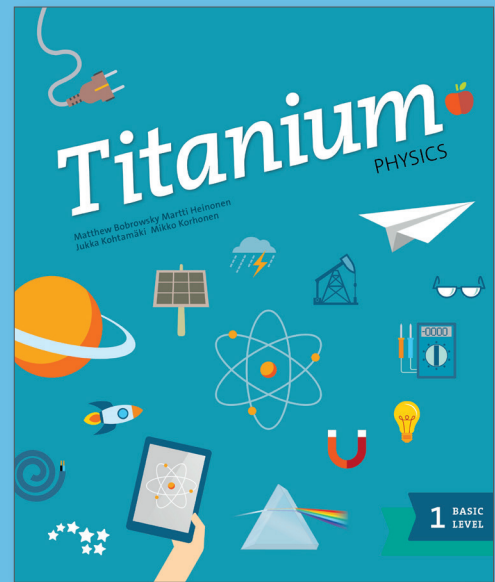


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