



NSDL/NSTA Web Seminar:
Chemistry Comes Alive III: Water



Tuesday, December 9, 2008



Today's NSDL Experts



Dr. John Moore, W. T. Lippincott Professor,
University of Wisconsin-Madison and
Director of the Institute for Chemical Education



Dr. Lynn Diener, Assistant Professor,
Mount Mary College, Milwaukee, Wisconsin



Dr. James Skinner, J. O. Hirschfelder Professor,
and Director of the Theoretical Chemistry Institute,
University of Wisconsin-Madison



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Special Guest



Jon Holmes, Editor of Journal of Chemical Education Online, University of Wisconsin at Madison



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Let's explore the chemistry and properties of water using resources from the ChemEd DL and NSDL



- Molecules 360
- ACS Education Division
- Periodic Table Live!
- Multimedia problems
- *J. Chemical Education*
- CSERD
- Middle School Portal
- Teachers Domain



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Poll Question:

How much of the earth's water is suitable for drinking?



- A. 0.1%
- B. 1%
- C. 10%
- D. 15%



NSDL resource: http://www.epa.gov/safewater/kids/water_trivia_facts.html



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H₂O facts

- Made of hydrogen and oxygen
- Exists in 3 phases of matter on earth.
- Approximately 70% of a human's mass is water.



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In which phase of matter does water exist most frequently on earth? Stamp your answer.



Gas	Liquid
Plasma	Solid

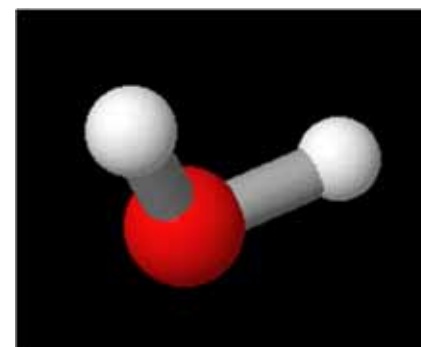


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Molecules 360



- Water
- Water has a large dipole moment.
 - Partial positive charge on the hydrogen atoms
 - Partial negative charge on the oxygen atom
- The interaction between dipole moments on two different molecules is an important contribution to the hydrogen bond
- Hydrogen bonding is at the heart of the way that water behaves.

<http://www.chemeddl.org/collections/molecules/index.php?molecule=66>



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Water is adhesive, meaning...

- A. It is attracted to itself.
- B. It forms droplets on wax paper.
- C. It is attracted to other things, making it easy for water to travel upwards in a plant by adhering to cell walls.
- D. Water bugs can walk on water.



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Water properties

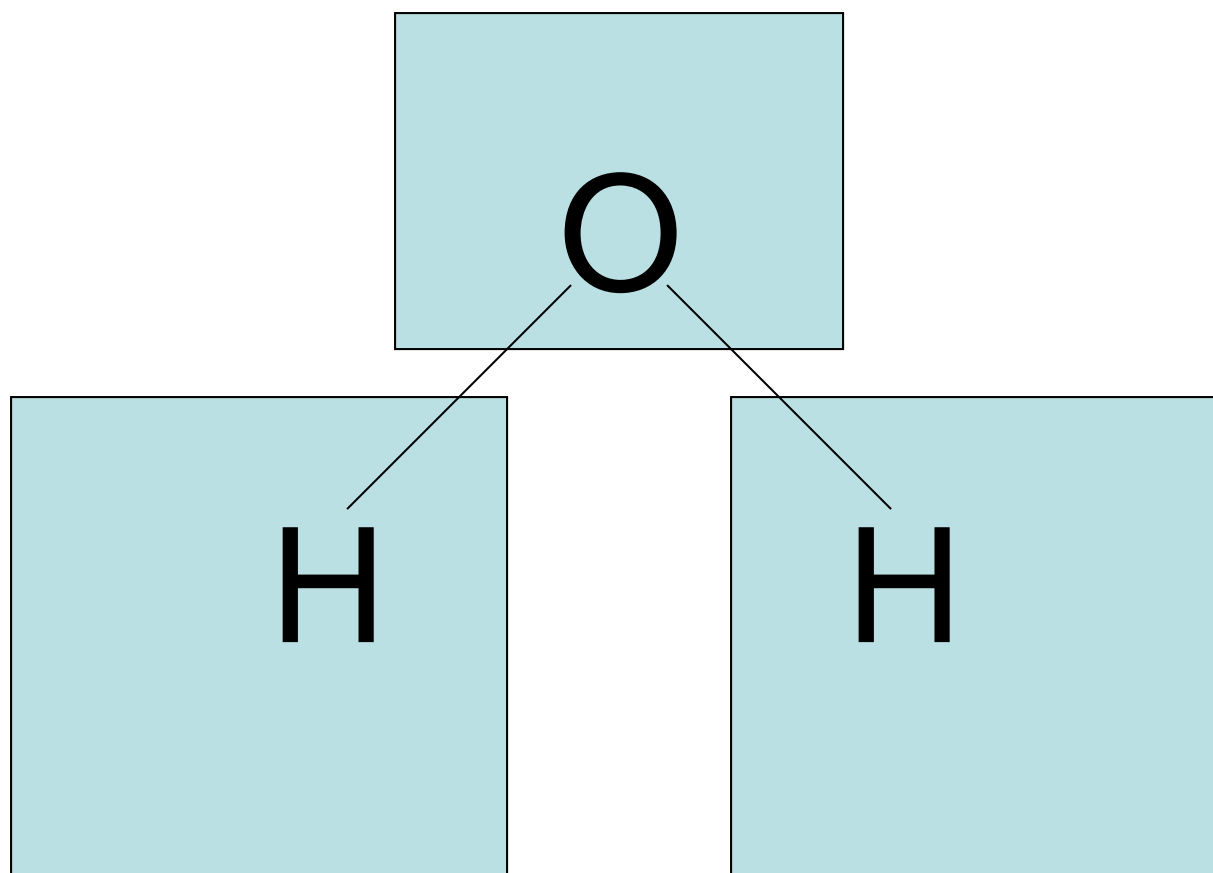
- Cohesion and adhesion
- “Universal” solvent
- Solid less dense than liquid near melting point
- High specific heat capacity, heats of melting and vaporization, thermal conductivity, and surface tension
- A valuable online resource from ACS:
[Water activities for kids online](#)



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Stamp where the charge is partially negative





Let's pause for
questions from
the audience....



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Explore the [Periodic Table Live!](http://chemeddl.org/collections/ptl/index.html) to learn more about hydrogen and oxygen






Periodic Table Live!

Chart/Sort... Glossary...

Start!
Download
Required
Components
Charting & Sorting
Documentation
Acknowledgements

Periodic Table Live! allows you to explore a broad range of information about the elements, their reactions, their properties, their structures and their histories.



by
Alton J. Banks, Evan M. Davis, Jon L. Holmes, Jerrold J. Jacobsen, John C. Kotz, John W. Moore,
Paul F. Schatz, William R. Robinson, Jaclyn Tweedale, and Susan Young

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<http://chemeddl.org/collections/ptl/index.html>



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Learn useful information about hydrogen and oxygen by clicking on their symbols in the table



Periodic Table Live!

Chart/Sort... Glossary...

Hydrogen

1
H
1.00794

$1s^1$

Description Physical Atomic

H Hydrogen Media Characteristics | Discovery | Found | Name | Preparation | Reactions | Uses

Crystal
Images
Element
Use 1
Use 2
Use 3
Video

Click thumbnail image to view image of element.

Hydrogen, the lightest element, exists as diatomic molecules. In the solid state the element has a hexagonal closest packed structure.

Hydrogen was prepared many years before it was recognized as a distinct substance by [Cavendish](#) in 1766. It was given its name by [Lavoisier](#) in 1783.

The name is derived from the Greek words, *hydro* and *genes*, meaning water forming, the symbol H is derived from the name.

Hydrogen is the most [abundant element in the universe](#).

The element has three isotopes:
H = hydrogen (H, protium), 1.0078 amu
D = deuterium, D, 2.0141 amu
T = tritium, T, 3.0160 amu (radioactive)

Hydrogen is the most [abundant of all elements in the universe](#). It has been estimated that hydrogen makes up more than 90% of all the atoms or three-quarters of the mass of the universe. It is found in the sun and most stars, and plays an important part in the proton-proton reaction and carbon-nitrogen cycle, which accounts for the energy of the sun and stars.

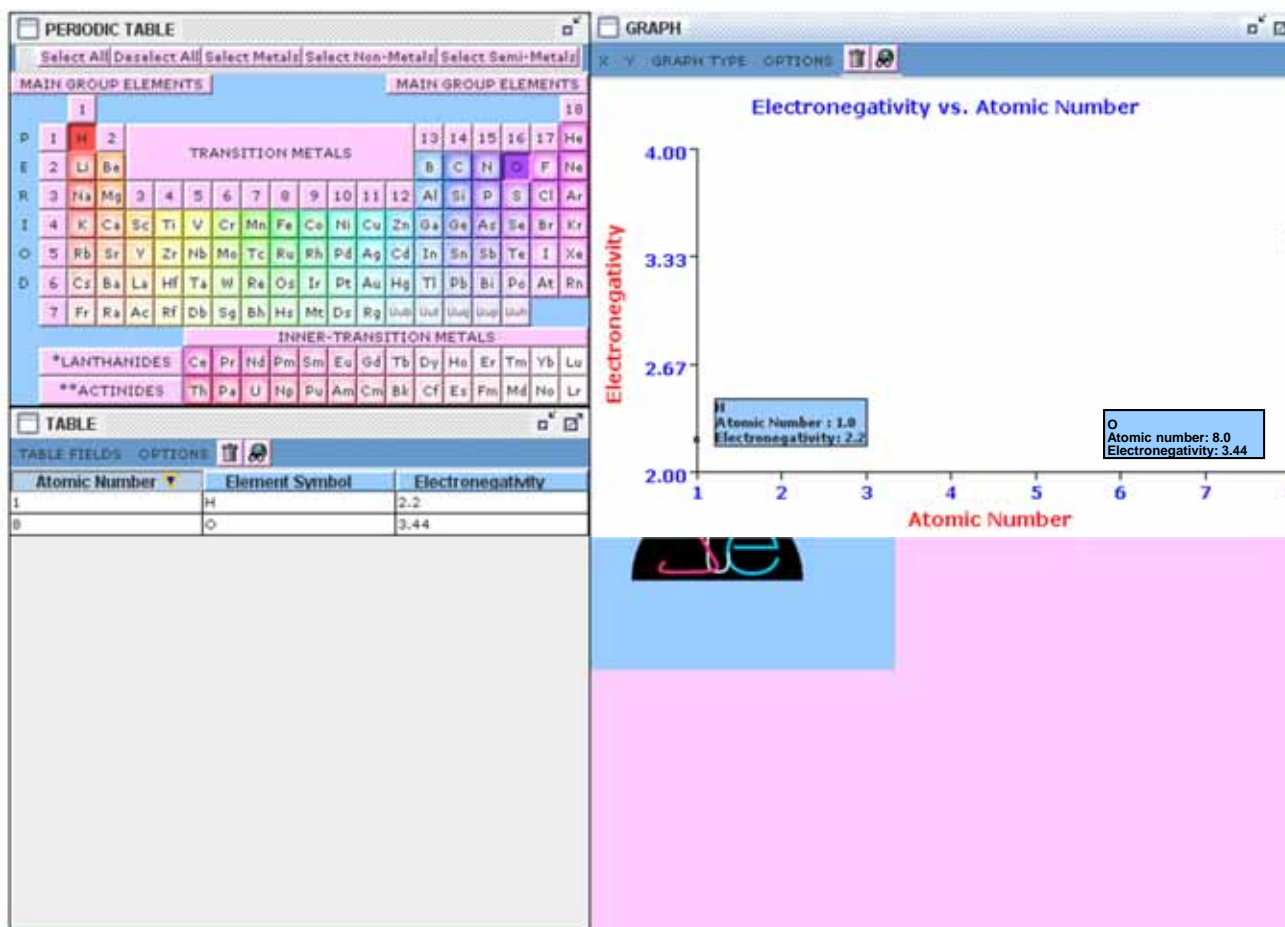
Hydrogen is a major constituent of some planets, such as Jupiter, the core of this planet may consist of solid hydrogen, at least in part, and liquid hydrogen may be present elsewhere on the planet.

On [earth](#), hydrogen occurs chiefly in combination with oxygen in water, but it is also present in organic matter, such as [living plants](#), [petroleum](#), coal, etc. It is the lightest of all gases, and combines with other elements, sometimes explosively, to form compounds ([reaction of hydrogen with oxygen](#)).

Hydrogen is prepared by the action of steam on heated carbon.

$C(s) + H_2O(g) \rightarrow H_2(g) + CO(g)$

Chart and Sort



Multimedia problems can help your students learn about water properties.



Choose a problem

1. [Directions](#)
2. [Acids](#)
3. [Acids and Salts](#)
4. [Ammonia](#)
5. [Burning Magnesium](#)
6. [Cannon](#)
7. [Chromate/Dichromate](#)
8. [Disorder](#)
9. [Drinking Bird](#)
10. [Electrostatic Attraction](#)
11. [Electrolysis #1](#)
12. [Electrolysis #2](#)
13. [Electrolysis #3](#)
14. [Fireworks](#)
15. [Floating Squares](#)
16. [Halogens and Halides](#)
17. [Hexane #1](#)
18. [Hexane #2](#)
19. [Metals #1](#)
20. [Metals #2](#)
21. [Nitrogen Oxides](#)
22. [NO and O₂ #1](#)
23. [NO and O₂ #2](#)
24. [NO and O₂ #3](#)
25. [Oxides](#)
26. [Paramagnetism](#)
27. [Phlogiston](#)
28. [Steam](#)
29. [Strong Acids](#)
30. [Two Balloons](#)
31. [Two Solids](#)
32. [Water #1](#)

General Chemistry

Multimedia Problems

Problems:

David Whisnant

Video and Digitization:

Renee Cole
Jerrold Jacobsen
Kelly Houston Jetzer
Trevor Peace
Tony Tautges
David Whisnant
Randall Wildman



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What does the video tell you about the density of liquid water compared to solid water?



- A. Ice is more dense than liquid water.
- B. Ice is less dense than liquid water
- C. Ice and liquid water have the same density.





Let's pause for
questions from
the audience....



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DigiDemos



Chemistry for Everyone

JCE DigiDemos: Tested Demonstrations

edited by

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Stilling Waves with Ordered Molecular Monolayers

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This is hardly a new demonstration. It was first done by Lord Rayleigh around 1900 in a public lecture at the Royal Institution (1) in which he used an electric fan (replacing the organ bellows used in his research) and a six foot trough. The demonstration was based on Benjamin Franklin's¹ observation in 1770 that a teaspoon of vegetable oil stilled waves on half an acre of pond surface (2). Observation of the behavior of oil droplets on the surface of water dates back to Babylonian lecanomaney (divination by observation of the shapes taken by oil on water) in the 18th century B.C.E. (3)! It is probably time to bring this demonstration up-to-date.

There have been several attempts to develop a practical application for stilling waves in this manner. Franklin supervised a hurricane trial to see whether it could be used to calm violent

proceeds as new technology allows more sophisticated experiments. The same investigation, with essentially the same simple apparatus, was repeated by three Nobel laureates (Rayleigh, Langmuir, and Roentgen) and one amateur scientist Agnes Pockels (8), who may have made the most important experimental contribution (9) after Ben Franklin's original report. Lord Rayleigh (10) used the data to deduce the size of a molecule, while Langmuir (11) related the effect to molecular properties. Franklin did neither, although he is sometimes credited with these insights when the "dimensions of a molecule" experiment (12-15) is repeated in countless educational laboratories.

Demonstration



ChemEd DL



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Vegetable oil spreads quickly over the water surface stilling the waves, mineral oil does not.



The mineral oil doesn't spread quickly because its molecules are (stamp your answer):

Entirely hydrophobic	Entirely hydrophilic	Too small



Other NSDL pathways also have wonderful resources to teach your students about water!



<http://nsdl.org>



Solubility from CSERD



An Introduction to Chemistry **Shockwave Animations**

Home Textbook Animations Tutorials Checklists PowerPoint Chapter Maps Glossaries Molecules

Shockwave Animations

The Atoms First version chapter numbers are in parentheses.

Chapter 2 (3)
[Structure of Matter](#)
[Element Properties](#)

Chapter 3 (7)
[The Structure of Water](#)

Chapter 4 (7)
[Animation of Dissolving NaCl](#)
[Animation of a Precipitation Reaction](#)

Chapter 5 (8)
[Acid Animation](#)

Restart

Back Next

What type of attraction holds water molecules together in liquid water? Click on the appropriate button on the right or click **Next** to be given the answer.

Covalent Bonds
Ionic Bonds
Metallic Bonds
Hydrogen Bonds
Dipole-Dipole Attractions
London Forces

Copyright 2004 Mark Bishop

http://preparatorychemistry.com/Bishop_Solubility_frames.htm



Which property of water is displayed in this [video](#) from the Middle School Portal?



- A. Density of solid water
- B. “Universal” solvent
- C. Cohesion
- D. High specific heat capacity



http://www.visionlearning.com/library/module_viewer.php?mid=57



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Teachers Domain video about oceans and climate



<http://www.teachersdomain.org/resources/ess05/sci/ess/watcyc/oceancur/index.html>



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How much water must a dairy cow drink to produce one gallon of milk? Stamp your answer.



1 gallon	2 gallons	4 gallons	10 gallons

NSDL resource: http://www.epa.gov/safewater/kids/water_trivia_facts.html



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On average, which uses less water? Stamp your answer.

Hand washing dishes	Automatic dishwasher

http://www.epa.gov/safewater/kids/water_trivia_facts.html



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Let's pause for
questions from
the audience....



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Current research into water

- Surprisingly, there is still much we do not understand about water!
- Wall Street Journal, 3/10/06: “The structure of water isn’t certain after all.”
2 or 3.5 hydrogen bonds per molecule?
- Phillip Ball, Nature (2008)



NATURE|Vol 452|20 March 2008

WATER ESSAY

Water — an enduring mystery

Yet another theory of liquid water structure raises questions about interdisciplinarity, drug design, astrobiology, molecular biology, geochemistry and more.

Philip Ball

No one really understands water. It's embarrassing to admit it, but the stuff that covers two-thirds of our planet is still

Worse, the more we look, the



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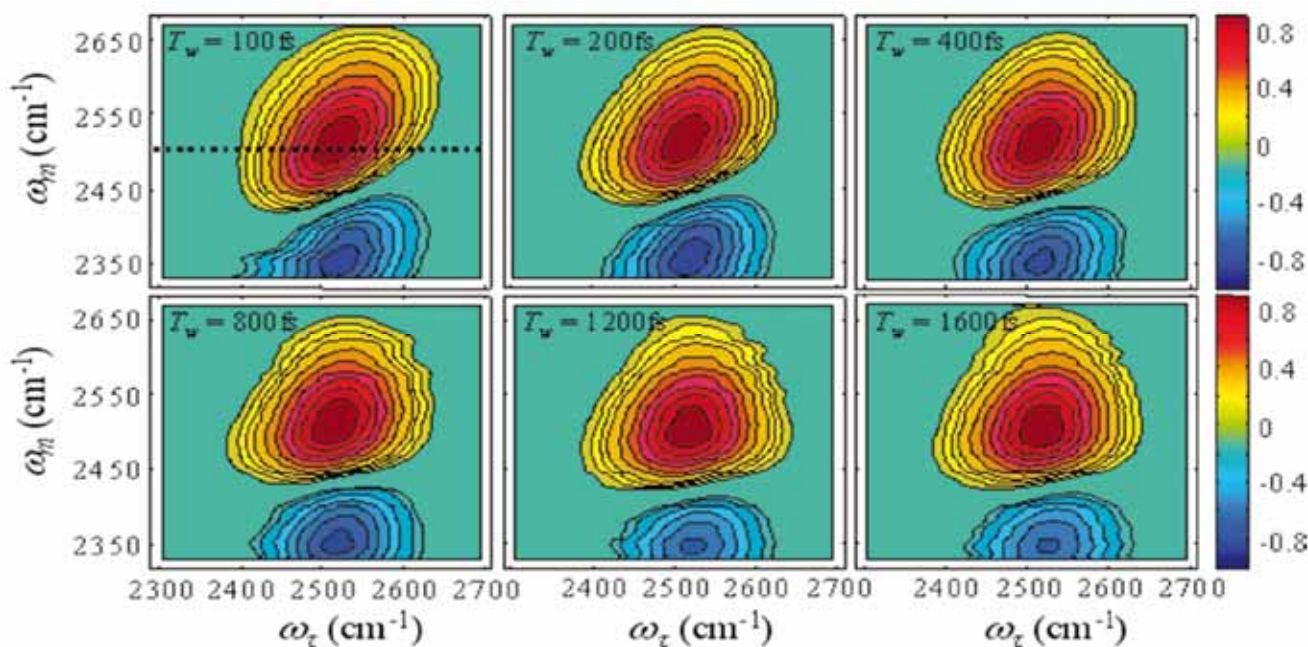
National Science Foundation
WHERE DISCOVERIES BEGIN



A new experimental technique



- 2D-IR spectroscopy shows that in liquid water hydrogen bonds make and break in about 1.5 ps (1.5×10^{-12} s).

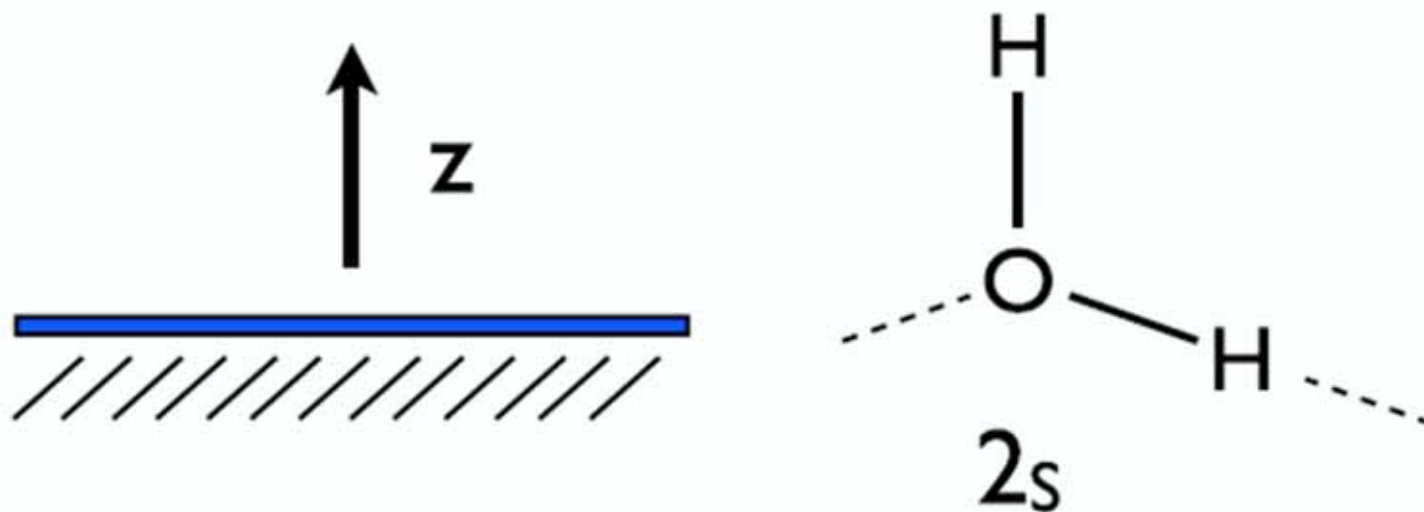


J. B. Asbury *et al.*, J. Chem. Phys. **121**, 12431 (2004)



Another new technique

Vibrational sum-frequency spectroscopy shows that most molecules at the liquid surface make 2 hydrogen bonds, one donor and one acceptor.



B. M. Auer and J. L. Skinner, J. Chem. Phys. **129**, 214705 (2008)



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An important theoretical technique

- Computer simulation. Solves Newton's equations of motion for several hundred molecules.
- Videos of:
 - a) motion in a liquid
 - b) freezing of a liquid



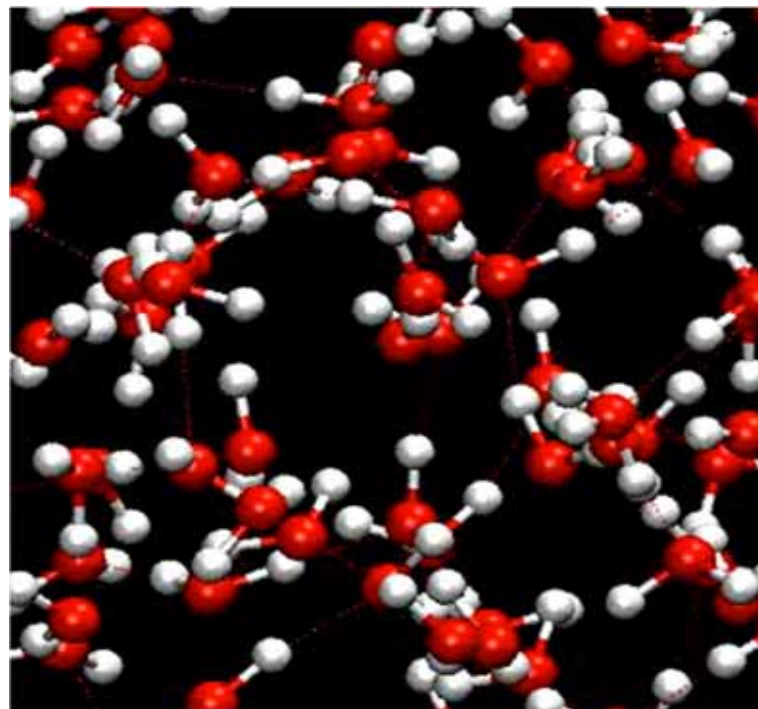
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About how long does it take a molecule to rotate substantially in liquid water?



- A. 2 fs (2×10^{-15} s)
- B. 2 ps (2×10^{-12} s)
- C. 2 ns (2×10^{-9} s)
- D. 2 μ s (2×10^{-6} s)
- E. 2 ms (2×10^{-3} s)



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Let's pause for
questions from
the audience....



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Chemical Education Digital Library (ChemEd DL)...



is ***the*** place on the Web to find chemistry resources. It is a collaboration of the *JCE*, the ACS Education Division and the ChemCollective project.





Everything we used today can be found in the ChemEd DL, the JCE Dlib, or NSDL.



<http://nsdl.org>





<http://chemeddl.org>



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**THANK
YOU!**



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Resources from this seminar:

<http://www.diigo.com/list/nsdlworkshops/web-seminar-chemistry-water>

Search for “diigo nsdl workshops water”

Learn about new tools and resources, discuss issues related to science education, find out about ways to enhance your teaching at:

<http://expertvoices.nsdl.org/learningdigitalK12>



<http://nsdl.org>





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<http://learningcenter.nsta.org>

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