

# Living with a Volcano in Your Backyard

## An Educator's Guide with Emphasis on Mount Rainier

General Information Product 19

U.S. Department of the Interior  
U.S. Geological Survey and the National Park Service



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# **Living with a Volcano in Your Backyard**

## **An Educator's Guide with Emphasis on Mount Rainier**

### **Project Coordinators**

**Carolyn Driedger, Anne Doherty, Cheryl Dixon**

U.S. Geological Survey General Information Product 19

**U.S. Department of Interior**

**U.S. Geological Survey and National Park Service**

**U.S. DEPARTMENT OF INTERIOR**  
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# Living with a Volcano in Your Backyard— An Educator’s Guide with Emphasis on Mount Rainier

Project Coordinators: Carolyn Driedger<sup>1</sup>, Anne Doherty<sup>2</sup>, and Cheryl Dixon<sup>2</sup>

## INTRODUCTION

Today’s residents, as well as residents of centuries past consider Mount Rainier “the spiritual and cultural icon of the Pacific Northwest.” As a backdrop for many of the state’s residents, Mount Rainier offers beauty, solace, inspiration, and challenge. The mountain sets the daily mood for thousands of people who gaze at and respect it. There is no mistaking this object of admiration when people smile and remark that, “the mountain is out!”

Yet, the origin of Mount Rainier, formed by volcanic processes and now heavily laden with snow and ice, remains an enigma to many admirers. During the 1980s, volcanologists from around the world voted Mount Rainier as one of 17 volcanoes most worthy of additional study because of the hazard potential to large population centers nearby. Subsequent research indicates that Mount Rainier, though quiet since the nineteenth century, is very much an “active volcano” with potential to erupt again and disrupt the life of Pacific Northwest residents. Following days to months or more of warning, Mount Rainier could erupt lava and ash and melt snow and ice to form lahars (volcanic mudflows). Or, Mount Rainier could simply warm up briefly, jolt us from our apathy, and then return to slumber for many more years.

Until such time, the mountain is ours to explore. **Living with a Volcano in Your Backyard—An Educator’s Guide with Emphasis on Mount Rainier** invites educators to learn what scientists are discovering about Mount Rainier’s past; to explore its slopes during this period of quiescence; and to plan future responses to volcanic unrest.

Mount Rainier National Park is a unique classroom, rich in resources for observing geologic change. The park staff encourages safe and knowledgeable use by educators, and students and their families.

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<sup>1</sup> U.S. Geological Survey; <sup>2</sup> National Park Service

## 2 Living with a Volcano in Your Backyard—An Educator’s Guide

The National Park Service and the U.S. Geological Survey’s Volcano Hazards Program (USGS-VHP) support development and publication of this educator guide as part of their mission to educate the public about volcanoes. The USGS-VHP studies the dynamics of volcanoes, investigates eruption histories, develops hazard assessments, monitors volcano-related activity, and collaborates with local officials to lower the risk of disruption when volcanoes become restless.

### CREDITS

#### Project Coordinators

Carolyn Driedger, Anne Doherty and Cheryl Dixon

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#### Contributing Agencies

U.S. Geological Survey	Orting School District	National Park Service
Mount Rainier Volcano	Eatonville School District	Yelm School District
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Management Division	Management Division	

#### Primary Activity Developers and Writers

Brit Argow	Cheryl Dixon	Colleen Riley
Anne Doherty	Carolyn Driedger	

#### Contributing Activity Developers and Writers

Jenny Anderson	Chris Maun	Bob Smith
Lisa Anjozian	Jane Poole	Marianne Smith
Julie Benkovich	Mike Roylance	Kim Strassburg
Mary Henterly	Tom Sisson	Debra Wood
Kathy Johnstone	Nina Shields	

#### Graphics and Design

Lisa M. Faust (U.S. Geological Survey)

**Reviewers**

**Activity Technical Reviewers**

Cynthia Gardner	Tom Sisson	James Vallance
Larry Mastin	Kevin Scott	Jody Woodcock
Bobbie Myers	Willie Scott	
Tom Pierson	Robert Tilling	

**Educator Reviewers**

Jenny Anderson	Annette Heffron	Richard Muse
Britt Argow	Mary Henterly	Jane Poole
Bonnie Beaudoin	Steven Hoden	Shirley Reboin
Julie Benkovich	Jeff Houck	Richard Schroedel
Barry Bloch	David Jacobson	Marianne Smith
Ellen Bratcovich	Kathy Johnstone	Ted Stout
Penny Davis	Laura Kraig	Kim Strassburg
Dawn Ellis	Mathew Kwartin	Eric Temple
Ken Fidler	Jim Lazzarni	Brett Thomsen
Olga Haider	Chris Maun	Debra Wood
Rick Haughee	Katie Mettler	Kristy Worley

**Editorial Reviews**

Jaelyn Richardson LaRue (National Park Service)  
Robert Tilling (U.S. Geological Survey)  
Christine Janda (U.S. Geological Survey)

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The Mount Rainier Volcano Hazards Work Group is a coalition of emergency and land-use managers, educators, public officials, community leaders, and scientists dedicated to mitigating the effects of volcanic activity at Mount Rainier. Since 1996, the workgroup has met regularly to plan responses to future volcanic unrest at Mount Rainier. These measures include developing a Volcano Response Plan that defines the role of each contributing agency during volcanic unrest, practicing the plan, training emergency management staff about volcano matters, and supporting development of a lahar detection system and accompanying notification system. Member agencies provide grass roots community outreach regarding volcanic hazards. Their effort encouraged the writing of **Living with a Volcano in your Backyard—An Educator’s Guide with Emphasis on Mount Rainier**.

## HOW TO USE THIS GUIDE

**Living with a Volcano in Your Backyard—An Educator’s Guide with Emphasis on Mount Rainier** is a three-unit guide that provides science content and inquiry-based activities about volcanoes of the Cascade Range, with emphasis placed on Mount Rainier. Activities are designed for middle school students. Adaptations and extensions offer opportunities for students in higher and lower grade levels. Background sections provide more in-depth information. This guide includes more than 30 activities, a field guide to geological sites of interest in Mount Rainier National Park, glossary, list of Internet resources, and supplementary information.

The principal purpose of this guide is to familiarize students with the geologic and hydrologic processes that shaped Mount Rainier. The authors wish to show how present populations can enjoy the mountain safely and responsibly while recognizing these natural processes as hazards. Materials in the guide enable broad instruction about volcanoes of the Cascade Range, and focused instruction about Mount Rainier volcano. Science content and activities are usable alone or as augmentation for other curricula.

**Note:** All graphics associated with this guide can be downloaded individually at:

<http://vulcan.wr.usgs.gov/Outreach/Publications/GIP19/framework.html>

## KEY CONCEPTS

### Many Volcanoes of the Cascade Range are Historically and Presently Active

- ◆ Mount Rainier is one of thousands of volcanoes located in a circum-Pacific zone of volcanism known as the Ring of Fire
- ◆ Volcanoes of the Cascade Range erupted recently in geologic time; seven volcanoes have erupted since the signing of the Declaration of Independence in 1776
- ◆ Layers of lava and volcanic ash remain as evidence of a volcano's eruptive history
- ◆ People of the Pacific Northwest witnessed volcanic eruptions repeatedly after entering the region approximately 9,000 years ago; people recorded their observations in oral and written stories
- ◆ Each Cascade volcano possesses a unique history and eruption style
- ◆ Plate tectonics processes that produced the Cascade Volcanoes remain unchanged. Future eruptions will occur.

### Diverse and Dynamic Processes Shaped Volcanoes of the Cascade Range

- ◆ The Cascadia Subduction Zone is the foundation for volcanoes of the Cascade Range
- ◆ Water plays a principal role in the development of eruptions; first, it lowers the melting point of mantle rock enough to transform solid rock to magma, and later it expands and propels magma up the conduit causing a volcanic eruption
- ◆ Water also plays a principal role in destruction of a volcano because it reduces rock stability; stream water and glacial ice erode the volcano; water mobilizes loose volcanic rock and forms debris flows and lahars (volcanic mudflows)
- ◆ When Ice-Age glaciers enveloped Mount Rainier, they influenced the movement of lava flows and thus, the location of today's ridges and valleys
- ◆ Lava flows and domes, volcanic ash, pyroclastic flows and lahars built the existing landscapes at volcanoes of the Cascade Range
- ◆ Mount Rainier consists of overlapping layers of lava flows and rock rubble
- ◆ Volcanic ash, tiny fragments of erupted magma, are blown by the wind and distributed thousands of miles distant
- ◆ Landslides and lahars have covered valley floors for tens of kilometers (miles) distant from some Cascade volcanoes
- ◆ Chemical composition and cooling conditions determine the appearance of volcanic rocks
- ◆ The geologic processes that built Cascade volcanoes pose hazards for the future

### **Studying a Volcano's Past and Present Behavior Provides Important Clues about Future Eruptions**

- ◆ Geologists examine rock layers at each volcano to determine past eruptive behavior and thus the most likely type of volcanic activity to happen in the future
- ◆ Scientists consider Mount Rainier “active” (although it is not currently erupting) because of recurring earthquake activity, the presence of geothermal heat and gas release and the volcano's location in an active tectonic setting
- ◆ Volcanologists are on continual watch for changes that could indicate the onset of volcanic unrest; they watch for variations in earthquake activity, gas release and slope stability
- ◆ Magma, rising in the Earth, causes rock breakage and earthquakes that precede an eruption
- ◆ Earthquakes are a reliable tool for volcano forecasting because they occur weeks to months or more in advance of an eruption
- ◆ Lahars (volcanic mudflows) are the most significant hazard to people who live in the vicinity of Mount Rainier because they are known to have traveled more than one hundred kilometers (sixty miles) or more distant
- ◆ While most lahars form by snow and ice-melt during an eruption, landslides can also initiate lahars during non-eruptive times with little or no warning

### **We Can Prepare for the Next Eruption of Mount Rainier**

- ◆ Mount Rainier has the potential to erupt during our lifetime
- ◆ Reviewing Mount Rainier's history can help us identify the lowland communities that could be adversely impacted by the mountain's power
- ◆ When people understand the risks presented by volcanic eruptions, they can take steps to prevent disasters
- ◆ Preparing and understanding hazard maps help us prepare for future volcanic activity
- ◆ Reducing volcano risk requires societal debate, tough choices, and the ability to view issues from a variety of perspectives
- ◆ Multiple career opportunities exist in the monitoring, planning and preparation for the next eruption of Mount Rainier
- ◆ Observing and learning about Mount Rainier will help you be ready for renewed volcanic activity and associated hazards

### **Mount Rainier is Culturally Significant**

- ◆ Mount Rainier is a principal cultural icon of the Pacific Northwest
- ◆ Volcanoes can be community assets, bringing aesthetic and economic benefit
- ◆ Interest in volcanoes is nearly universal, and unites people globally as they address volcanic risk
- ◆ Mount Rainier inspires artistic and cultural traditions
- ◆ Mount Rainier offers a fascinating opportunity to learn about volcanoes and local ecology

## ACTIVITY OVERVIEW

### Chapter 1—What the Past Tells Us

*This chapter provides a general overview of the volcanoes of the Cascade Range. The chapter begins with a pre-assessment activity entitled “Eruption!” and then addresses the plate tectonics responsible for Cascades volcanism. It ends with activities regarding how volcanoes work.*

#### Overview

##### Blast from the Past

- ◆ **Eruption!** — In this pre-assessment activity, students describe their perceptions of a volcanic eruption in a personal journal entry. Then they read an actual eyewitness account of the 79 A.D. eruption of Mount Vesuvius in Italy and compare those events to the eruption events depicted in their journal entries.
- ◆ **Fire, Flood, and Fury** — Native American oral traditions chronicle geologic events in the history of Mount Rainier. These stories are read, interpreted, and illustrated by students with the use of storyboards.
- ◆ **Nineteenth-Century News** — Read nineteenth-century newspaper accounts of recent eruptions at Mount Rainier. The minor eruptive activity at Mount Rainier illustrates that not all eruptions are large or destructive.
- ◆ **Cascade Volcano Timeline** — Cascade volcanoes are young in relation to the geologic events that have shaped the Earth. A timeline illustrates the high incidence of Cascade volcano activity in comparison to geologic and human events since the signing of the Declaration of Independence. A hypothetical genealogy of one family’s history illustrates the collective and individual activity of the Cascade volcanoes.
- ◆ **A String of Volcanoes** — Students research information about Cascade volcanoes and write the information on cards used to construct a mobile.
- ◆ **Volcano Hall of Fame** — This is a game where students use fun facts to try to identify a specific Cascade volcano.

##### Forces Responsible for Cascade Volcanism

- ◆ **Surrounded by Volcanoes** — Explore geographical information to learn about tectonic boundaries, origin of the “Ring of Fire,” and volcanoes in the Pacific Northwest. Identify and label Cascade volcanoes on a satellite image.
- ◆ **Magma Mash** — Students take on the role of minerals cooling at different rates in an exploration of magma behavior, and then examine samples of rocks cooled at different rates.

- ◆ **Riding the Magma Elevator** — Examine the process of magma formation from mantle melting in the subduction zone, rising to the magma chamber, and erupting from the magma conduit. During this activity, the class will ride an imaginary elevator from the subduction zone and out the volcano crater.
- ◆ **Soda Bottle Volcano** — Examine how gases energize explosive volcanic eruptions by making comparisons to gases in a soda bottle and performing a carefully controlled “eruption” of baking soda/vinegar or soda water.

## Chapter 2—Today’s Discoveries Unlock the Past

*Volcanic processes are the principal focus of Chapter 2, and are the natural progression from the Chapter 1 overview about how volcanoes work. Activities invite inquiry about volcanic processes at Cascade volcanoes, and about how researchers conduct their research.*

### Overview

#### Lava, Rock Rubble, and Mud, Oh My!

- ◆ **Understanding Volcanic Hazards Video/DVD** — Introduces students to the vocabulary and character of volcanic processes and how volcano hazards impact people living near and far from a volcano. This video/DVD is intended for older students only.
- ◆ **Volcanic Processes** — This activity is an alternative to the **Understanding Volcanic Hazards video**. Students view graphics of volcanic processes, then answer questions on a worksheet. As an optional activity, they can prepare a booklet or computer presentation about each process with an emphasis on the interaction of these processes during a volcanic eruption.
- ◆ **Tephra Popcorn** — Students study physical characteristics of tephra using samples and make mass and volume measurements of popcorn to understand the role gases play in tephra formation.
- ◆ **Lava Building Blocks of Mount Rainier** — Students explore the nature and motion of lava flows and learn their importance as the building blocks of Mount Rainier. Students learn how the composition and texture of lava differs between volcanoes and affects the ultimate shape of a volcano.
- ◆ **Rock Stars** — Using photos and rock samples, students identify the characteristics that tell a story about where and how each rock was formed.
- ◆ **Fire and Ice** — Students conduct or observe an experiment simulating glacier/lava flow interactions, then answer questions about how glacier and lava interactions shaped specific features on Mount Rainier.
- ◆ **Lahar in a Jar** — Using experimental and scientific methods, explore how loose rock is mobilized by small amounts of water to form lahars.

- ◆ **Rock Rubble Review** — This is a physically active game that tests the students’ knowledge of volcano terminology, processes, and impacts on communities.

### Interpreting Volcanic History

- ◆ **Earth Blocks** — Learn about the “Law of Superposition” and how to interpret rock and sediment layers by reading a short story and arranging “Earth Blocks.”
- ◆ **Volcano Fan Club** — Students learn that tephra layers at Mount Rainier originated from several volcanoes by looking at tephra dispersal patterns and thickness contours on maps.
- ◆ **Tephra Explorer** — Students view distributions of tephra layers found around Mount Rainier and discover the source.
- ◆ **Shoobox Geologist** — Make a model of layers emplaced by processes of deposition and erosion in a volcanically active landscape. Students interpret geologic events from layers in a classmate’s model using stratigraphic columns and the Law of Superposition.
- ◆ **Perilous Beauty video** — The “Perilous Beauty” video introduces students to the types of hazards common to Mount Rainier, specifically mudflows and the types of mechanisms that produce them.

### Chapter 3—Don’t be Scared – Be Prepared!

*Chapter 3 contains information about volcanic hazards and suggestions for preparedness. Several activities suggest how students can appreciate the benefits of living near a Cascade volcano, and can enjoy them, most often from their own communities.*

#### Overview

##### Mapping Your Way to Mount Rainier

- ◆ **Play-Dough Topo** — Students make a clay model volcano, complete with glacial and fluvial valleys, and then create a topographic map of their volcano.
- ◆ **Topographic Maps and Mount Rainier** — Students explore how lines on a topographic map represent the real landscape by comparing features on photographs and topographic maps. Later, students analyze and answer questions about a Mount Rainier National Park map.
- ◆ **Planning Your Trip to Mount Rainier National Park** — Students will plan a trip to Mount Rainier National Park using topographic, highway, and official Park maps.

### Living with a Volcano in Your Backyard

- ◆ **The Next Eruption of Mount Rainier** — Through a series of activities, students will examine the hazards associated with Mount Rainier by making a timeline of Mount Rainier events, interpreting hazard maps, investigating the potential effects of volcanic events on their community, and becoming acquainted with how scientists watch for signs of volcanic unrest.
- ◆ **Reducing Volcanic Risk video/DVD** — Familiarizes students with the steps they can take to reduce volcanic risk.

### Home and Community Preparedness Plans

- ◆ **Don’t be Scared—Be Prepared!** — Students learn simple steps to preparedness by conducting basic preparedness tasks with their class and family.
- ◆ **A Volcano Tussle—How Much Do We Risk?** — Students play the roles of persons with interest in maintaining visitation facilities at Mount Rainier National Park while faced with the prospect of geologic hazards. They write position papers and later defend them within in group.
- ◆ **Living Well with a Volcano in Your Backyard!—Prepare, Then Enjoy It!** — This activity provides a variety of options for students to explore and appreciate the many ways that volcanoes are beneficial to their community. It includes the Mount Rainier paper model. Students color, cut, fold and paste a simple cone-shaped volcano, and in the process become familiar with many geographic features within Mount Rainier National Park.

*NOTE:* Teachers should consult “Recommended Activity Sequencing” to determine the most appropriate activities based on time and teaching goals.

## EXPLANATION OF ACTIVITY FORMAT AND FONTS

- **Overview:** The overview provides a summary of concepts and general procedures addressed in the activity
- **Grade Level:** Authors based grade designation upon the level that best fit Skills and Benchmark activity
- **Learner Objectives:** Students should meet the listed objectives of each activity
- **Setting:** Authors chose the most practical location for completion of an activity
- **Timeframe:** Authors used classroom reviews to determine time frame required for completion of each activity
- **Materials:** A list of materials required for each section of the activity
- **Skills:** Skills are based on criteria established for Washington State teaching standards
- **Benchmarks:** Up-to-date benchmarks for each activity are posted at:  
<http://www.nps.gov/mora/forteachers/curriculummaterials.htm>
- **Vocabulary:** First usage of a vocabulary word in an activity is designated in *bold italics*, and is included in the **Glossary**
- **Teacher Tips:** Teacher Tips highlight additional information and specific recommendations to increase added value to the activity
- **Teacher Background:** Provides the teacher with the content information required to complete the activity
- **Procedures:** Recommends course of action for conducting the activity
  - ◆ **Assessment**
  - ◆ **References**
  - ◆ **Credits**
- **Adaptations:** Alternate procedures for this activity
- **Extensions:** Ideas for expanding the study of concepts in this activity
- **Assessments:** Recommendations for student assessment
- **References:** Suggested references for additional information
- **Student and Teacher Pages:** Activity pages designed for student and teacher use

## FONT KEY

- References to section titles within an activity are indicated by “*bold italics.*”
- References to other activities and units within the educator guide are indicated by “**Scrawlin.**”

## RECOMMENDED ACTIVITY SEQUENCING

### One week of classes 50-minutes each

- **Eruption! or Fire, Flood and Fury, or Nineteenth Century News** (1 class)
- **Cascade Volcano Timeline** (2 classes)
- **Eruption!** (1 class)
- **Soda Bottle Volcano** (1 class)
- **Understanding Volcanic Hazards video/DVD or Volcanic Processes** (1 class)
- **Lahar in a Jar** (1 class)
- **The Next Eruption of Mount Rainier** (1 class)

### Two weeks of classes 50-minutes each

- Use all of the recommendations above, and add one additional activity from Chapter 2 or 3

### Three weeks of classes 50-minutes each

- Conduct the above two weeks and add the following three activities
  - ◆ **Earth Blocks** (1 class)
  - ◆ **Tephra Explorer** (2 classes)
  - ◆ **Shoebox Geologist** (2 classes)

### Six weeks of classes 50-minutes each

- Conduct all of Chapter 1 and Chapter 2 activities in order
- **Play-Dough Topo** (1 class)
- **Topo Scavenger Hunt** (1 class)
- **Planning Your Trip to Mount Rainier National Park**, or other Chapter 3 activities (2 classes)

### Schools located in any volcano hazard zone

- **Eruption!** (1 class)
- **Perilous Beauty video** (1 class)
- **The Next Eruption of Mount Rainier** (1 class)
- **Don’t be Scared—Be Prepared** (1 class)
- **A Volcano Tussle** (1 class)
- **Living Well with a Volcano in Your Backyard—Prepare, Then Enjoy It!** (1 class)

### Schools in a lahar hazard zone

- **Lahar in a Jar** (1 class)
- **Understanding Volcanic Hazards video/DVD** [older students only] (1 class)
- **Perilous Beauty video** (1 class)
- **Reducing Volcanic Risk video/DVD** (1 class)
- **Don’t Be Scared—Be Prepared!** (1 class)
- **The Next Eruption of Mount Rainier** (1 class)

- **A Volcano Tussle** (1 class)
- **Living Well with a Volcano in Your Backyard—Prepare, Then Enjoy It!** (1 class)

**Schools in vicinity of volcanoes of the Cascade Range, but not in a hazard zone**

- All of Chapter One
- All of Chapter Two

**Teachers with plans for class field trip to Mount Rainier National Park**

- **Surrounded by Volcanoes** (2 classes)
- **Volcanic Processes** or **Understanding Volcanic Hazards video/DVD** (1 class)
- **Play-Dough Topo** (1 class)
- **Topographic Maps and Mount Rainier** (2 classes)
- **Planning Your Trip to Mount Rainier National Park** (1 class)

**Community and school safety**

- **Perilous Beauty video** (1 class)
- **Reducing Volcanic Risk video/DVD** ( class 1)
- **Don't Be Scared—Be Prepared!** (1 class)
- **Living Well with a Volcano in Your Backyard—Prepare, Then Enjoy It!** (1 class)

**Social studies and English**

- **Eruption!** (1 class)
- **Fire, Flood and Fury** (1 class)
- **Nineteenth Century News** (1 class)

**Note to teachers downloading files:** In addition to downloading activity files, teachers are encouraged to download chapter overviews, Glossary, and Internet Resources.

**EDUCATOR STANDARDS MATRIX**

**Washington State and National Education Standards**

This interdisciplinary curriculum is aligned with middle school level Washington State Essential Academic Learning Requirements (EALRs) and Grade Level Expectations (GLEs) as well as National Education Standards. See the complete, detailed alignment matrices at the website below.

Please note that as of the publication date of this curriculum guide, only the GLEs for Science, Communications, Reading, and Writing subject areas have been completed; the matrix will be modified after GLEs have been published for other subject areas. For the most current standards alignment, please see the linked document located on the Mount Rainier National Park Education Program website at:

<http://www.nps.gov/mora/forteachers/curriculummaterials.htm>

## CONVERSION FACTORS

### SI to Inch/Pound

For readers who wish to convert measurements from the metric system of units to the inch-pound system, the conversion factors are listed below.

<b>Multiply</b>	<b>By</b>	<b>To obtain</b>
Length		
kilometer (km)	0.6214	mile (mi)
meter (m)	3.281	foot (ft)
Area		
hectacre (ha)	2.471	acre
square meter (m <sup>2</sup> )	10.76	square foot (ft <sup>2</sup> )
Volume		
cubic kilometer (km <sup>3</sup> )	0.2399	cubic mile (mi <sup>3</sup> )
Flow rate		
liter per second (L/s)	15.85	gallon per minute (gal/min)
metric ton (t)	1.102	short ton (2,000 pounds)
metric ton (t)	0.9842	long ton (2,240 pounds)
kilogram per second (kg/s)	27.273	pound per minute (lb/s)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows: °F = (1.8 x °C) + 32

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