

# **Teacher's Guide For**

## **Glaciers and Ice Caps – The Melting**

For grade 7 - College

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## **MATERIALS IN THE PROGRAM**

Teacher's Guide -This Teacher's Guide has been prepared to aid the teacher in utilizing materials contained within this program. In addition to this introductory material, the guide contains the following:

- Suggested Instructional Notes
- Student Learning Goals
- Test Questions on Blackline Masters Quiz 1A for duplication and handout to students

## **INSTRUCTIONAL NOTES**

It is suggested that you preview the program and read the related Student Goals and Teacher Points. By doing so, you will become familiar with the materials and be better prepared to adapt the program to the needs of your class. You will probably find it best to follow the program in the order in which it is presented in this Teacher's Guide, but this is not necessary. The program can be divided into chapters accessed through the DVD's Menu Screen under Chapter Selects. It is also suggested that the program presentation take place before the entire class and under your direction. As you review the instructional program outlined in this Teacher's Guide, you may find it necessary to make some changes, deletions, or additions to fit the specific needs of your students. After viewing the program you may wish to copy the Test Questions on Blackline Master 1A and distribute to your class to measure their comprehension of the events.

## **INTRODUCTION AND SUMMARY OF PROGRAM**

*Glaciers and Ice Caps – The Melting* is a unique approach to presenting in a logical way the scientific study of glaciers, ice caps and their impact on climate and climate change. Presented in an effective format designed to promote successful student learning, *Glaciers and Ice Caps – The Melting* examines the key elements of the Arctic and Antarctica ice sheets, glaciers, and permafrost and their role in global warming. The greatest portion of Earth's fresh water is locked up in glaciers. For the past 10,000 years, Earth has been in an interglacial period allowing humankind to flourish. *Glaciers and Ice Caps – The Melting* shows how only a small change in temperature can change ice from its solid state to a liquid with profound impacts on climates and sea levels, hence on ecosystems, agriculture and human populations. In addition, the program uses interviews with leading cryosphere experts to present the latest discoveries regarding the melting of glaciers and ice caps.

Below is a list of the program and its chapters. Using this program, teachers can create a lesson plan to cover the specific concepts and themes discussed.

### ***Glaciers and Ice Caps – The Melting***

- Introduction
- The Arctic and Antarctica
- The Warming of the Arctic

- The Melting Ice Caps
- Thawing of the Permafrost
- Melting of Glaciers and Ice sheets

### **LINKS TO CURRICULUM STANDARDS**

The design for this program includes the following curriculum correlations: National Science Educations Standards, Content Standard Grades (6-12) California State Board of Education Content Standards for Earth Sciences (Grades 6-12); and the State of New Jersey Department of Education Core Curriculum Content Standards for 5.8 Earth Science, section B, (Grades 7 – 12); and 5.10, Environmental Studies, Sections A and B, (Grades 7 – 12). In addition, the National Science Educations Standards, Content Standard B - Properties and changes of properties in matter, motions and forces, transfer of energy: Content Standard D – Structure of the Earth system, Earth’s history, Earth in the solar system and the McRel K-12 Science Standards and Benchmarks, Level III (Grades 6-8) and Level IV (Grades 9-12.)

### **SUMMARY OF PROGRAM**

#### ***Glaciers and Ice Caps – The Melting***

This program on *Glaciers and Ice Caps – The Melting* presents the key concepts of glaciers and ice caps, their interactions with global warming and their impact on climate change.

Chapter one introduces viewers to the world of snow and ice, known as the cryosphere, and how in the 21<sup>st</sup> century, it is impacted by global warming.

Chapter two describes the Arctic and Antarctica and the importance of their ice sheets. It also points out the importance of the change of snow and ice from a solid state to a liquid state – water.

Chapter three discusses the dynamics of an Arctic warm up – how and why it happens and the consequences of a warm up; and it introduces the concept of positive feedback loops.

The effects of melting ice caps are described in chapter four.

Chapter five describes the importance of permafrost to the Arctic and how it is affected by global warming. The impact of melting permafrost on human populations is also discussed.

Chapter six explains how glaciers work and what melting glaciers and ice caps has meant for the Earth in the past and what it could mean for the Earth in the future.

## **Chapter 1 *Glaciers and Ice Caps – The Melting: Introduction***

**Student Goals - In this *Glaciers and Ice Caps – The Melting* chapter the students will learn:**

- The world of snow and ice is known as the cryosphere
- How an increase in temperature makes glaciers retreat and sea ice melt
  - In 2004 Alaska's Mendenhall Glacier retreated 656 feet
  - There's been a 20 percent decrease in the summertime Arctic sea ice cover over the last 25 years
  - Early snow melts affect wildlife, such as seal pups who are freezing to death without snow as an insulator as a result of global warming
- The melting of glaciers will raise ocean levels dramatically

## **Chapter 2 *Glaciers and Ice Caps – The Melting: The Arctic and Antarctica***

**Student Goals - In this *Glaciers and Ice Caps – The Melting* chapter the students will learn:**

- How the Arctic and Antarctic are subject to great changes with only a small shift in temperature from below freezing to above freezing or from a solid system to a liquid system
- Greenland is over three times the size of Texas
  - It is almost completely covered by glaciers and ice fields
  - If Greenland's ice sheet were to melt, it would raise the ocean sea level across the planet by 20 feet
- Antarctica contains 70 percent of the planet's freshwater and 90% of the world's ice
  - Antarctica actually consists of two distinct ice sheets: the larger East Antarctica Ice Sheet and the smaller West Antarctica Ice Sheet
- The dynamics of Greenland and Antarctic ice sheets are changing rapidly as the climate warms

## **Chapter 3 *Glaciers and Ice Caps – The Melting: The Warming of the Arctic***

**Student Goals - In this *Glaciers and Ice Caps – The Melting* chapter the students will learn:**

- The world of frozen water, occurs in four forms
  - Frozen soil known as permafrost
  - Icecaps, frozen sea water and to a lesser extent frozen fresh water
  - Glaciers, which are highly compressed snow
  - Snow itself, which is mostly air
- Frozen water is constantly interacting with the atmospheric and oceanic systems
  - All three systems are tightly joined in a network of interconnected feedbacks loops
  - Many are positive feedback loops that drive change in all three planetary systems faster than anyone expected 30 years ago

- The addition of greenhouse gases into the atmosphere, caused by burning fossil fuels, has started present day climate change
- But the resulting melting of ice and snow will speed the transition to a different world
- There will be destructive impacts on human populations
- Changes can already be seen in the Arctic, where warming and its impacts have already accelerated
  - The Arctic is experiencing a big thaw
  - This big thaw is happening because less of the sun's radiation in the Arctic is being reflected back into space as sea and land ice melt
  - Warming in the Arctic pushes weather extremes
  - More precipitation occurs in the form of rain rather than snow
  - The number of frost days is reduced
  - Shorter winters directly impact permafrost, glaciers and ice fields and sea ice

#### **Chapter 4 *Glaciers and Ice Caps – The Melting: The Melting Ice Caps***

**Student Goals - In this *Glaciers and Ice Caps – The Melting* chapter the students will learn:**

- When Robert Peary and Matthew Henson were the first to reach the North Pole, they stood on sea ice
- The sea ice in the Arctic is now shrinking
  - As the ice cap melts, it breaks up into giant icebergs
  - When icebergs melt, they do not raise the sea level
  - They do expose more of the Arctic Ocean and the ocean transfers heat more readily to the atmosphere than sea ice can
- As the ice cap retreats from the Arctic's continental regions, new shipping lanes will undoubtedly open

#### **Chapter 5 *Glaciers and Ice Caps – The Melting: Thawing of the Permafrost***

**Student Goals - In this *Glaciers and Ice Caps – The Melting* chapter the students will learn:**

- Permafrost is organic rich soil that has been frozen for thousands of years
  - More carbon is trapped in permafrost than in all fossil fuels combined
  - As the permafrost melts, carbon and methane are released, adding more of these greenhouse gases to the atmosphere
  - This causes a positive feedback loop which thaws more permafrost releasing more carbon and methane
- The immediate effect of melting permafrost is on those who live on it
- An example is Shishmaref, an Inuit village in Northwest Alaska
- As the polar regions thaw and continental glaciers and ice fields melt, they will bring about different and devastating impacts more quickly than anyone expected

## **Chapter 6 *Glaciers and Ice Caps – The Melting: Melting of Glaciers and Ice sheets***

**Student Goals - In this *Glaciers and Ice Caps – The Melting* chapter the students will learn:**

- During the time when T. Rexes roamed North America, the planet was entirely ice free
  - Temperatures varied little from pole to pole
  - Ocean levels were so high that they flooded what is now the Great Plains
- After the dinosaurs died off 65 million years ago, CO<sub>2</sub> levels dropped, and the Earth began cooling
  - The planet entered a series of ice ages over the last 3 million years
  - 12,000 years ago, massive ice sheets covered much of the continents of North America, Europe and Asia
  - Then, in a mere 10 years, the temperatures in the Arctic rose dramatically, and the planet emerged from the last ice age
- Human civilization developed and grew into what it is today
- However, during this time, glaciers did not entirely disappear
  - Vast amounts of fresh water remained frozen on the Antarctic continent, Greenland, Alaska and in many high mountain systems
- But then in the last part of the 20th-century, glaciers worldwide began a new dramatic retreat
  - Each glacier expands and contracts from a central ice field
  - The Mendenhall Glacier in Alaska is typical
  - As the weight of more snow builds up the glacier, the snow is compacted into super dense ice
  - The super dense ice begins to act like a liquid and flows through internal deformation and the pull of gravity
  - In the 21<sup>st</sup> century, glaciers have been retreating so fast that scientists began to wonder if other factors might be involved
  - Beneath some glaciers such as Greenland's ice cap; the super dense ice has melted very fast and become a raging river
  - Both the west Antarctic and Greenland ice sheets are sliding and dumping their water rapidly into the oceans
- How much this process can accelerate is a great unknown
  - A big fear is that dumping so much cold, fresh water into the ocean around southern Greenland will change the large-scale flow of oceanic currents around the planet
- The impact of this melting could be devastating
  - Sea levels rise by as much as 60 feet, affecting hundreds of millions of people living along the world's coasts
  - Earth's climates will be making sudden and dramatic shifts

### **Answers to Blackline Master 1A Quiz**

1-c; 2-b; 3-d; 4-b,e,f; 5-a; 6-a; 7-c; 8-a; 9-b; 10-c; 11-a,b,d; 12-c