NO PREP

Ice, Floods, and Thaw

Winter Weathering and Erosion

Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

Ice, Floods, and Thaw: Winter Weathering and Erosion

Cracks in the Sidewalk: How Freeze–Thaw Weathering Works

On a cold winter morning, you might notice cracks in the sidewalk, chunks missing from curbs, or new potholes in the road. It can feel like the ground just "broke" over the winter—but what's really happening is a powerful form of mechanical weathering called freeze-thaw. When liquid water seeps into small cracks in rock, asphalt, or concrete and then freezes, it expands by about 9%. That expansion pushes outward on the sides of the crack like a tiny hydraulic jack. If this happened once, the crack might not change very much. But winter rarely gives you just one freeze. In many climates, temperatures bounce above and below 0°C (32°F) repeatedly. Each cycle of freezing and thawing allows more water to enter the crack, freeze, expand,

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From Melting Snow to Muddy Streets: Runoff, Infiltration, and Flood Risk

When winter storms hit, snow and ice accumulate on roofs, sidewalks, and frozen ground. As temperatures warm, this stored water must go somewhere. It can infiltrate into the soil, evaporate back into the air, or run off across the surface

into storm drains, streams, and rivers. In late winter and early spring, the balance between infiltration and runoff can shift rapidly, sometimes causing flooding even when there's no heavy rain. One key factor is the condition of the soil. If the ground is frozen, water has a hard time soaking in. Instead, meltwater flows over the surface like water on a paved parking lot. Ice-covered storm drains can back up, forming large puddles at street corners. In rural areas, meltwater races across fields and down hillsides, picking up sediment and carrying it into ditches and creeks. If warming is slow and gradual, rivers may handle the extra water without much trouble. But when a sudden warm spell or rain-on-snow event hits—rain falling on top of snowpack—melt can be rapid, and streams can rise dangerously fast. Here is a simplified look at how different conditions change the risk of flooding and erosion: For Earth science, it's important to see winter not as a "quiet" time, but as a setup for powerful erosion when melting begins. The same meltwater that cleans salt off the roads can carve small channels in soil, undercut stream banks, and carry pollutants (like road salt, oil, and litter) into waterways.

Ice Jams, River Erosion, and Long-Term Change

Winter also changes how rivers behave. As temperatures drop, rivers can develop ice cover. Later, when warming begins, chunks of ice break loose and move downstream. In some cases, these floating blocks build up behind a narrow bridge opening or bend in the river, forming an ice jam. Water can back up behind the jam, flooding nearby land even if there hasn't been heavy rain. When the jam finally breaks, a sudden surge of water and ice can scour riverbanks and damage bridges. Over many seasons, freeze–thaw cycles and seasonal floods reshape landscapes. River channels may migrate, banks erode, and new bars of gravel and sand form downstream. Human structures—roads, culverts, levees, and parking lots—can either help manage these flows or unintentionally make problems worse by blocking natural drainage paths. The same processes that create a pothole in your street are at work on larger scales, carving valleys, widening streams, and redistributing sediment. Seeing these connections is part of thinking like an Earth scientist: the small, annoying pothole and the big, dramatic flood are both expressions of water, gravity, and temperature working over time.

Key Information

Condition	Infiltration	Runoff / Flood Risk	Erosion Potential
Frozen ground, rapid thaw	Very low	High	High (water flows over land surface)
Slow warming, unfrozen ground	Moderate to high	Low to moderate	Moderate
Rain-on-snow event on frozen soil	Very low	Very high	Very high (fast-moving meltwater)
Bare soil on steep slopes during thaw	Low to moderate	Moderate	High (soil easily washed away)

Case Study Excerpt – The Vanishing Parking Lot

At the start of January, the student parking lot behind Ridgeview High was smooth, with only a few hairline cracks. By March, students were dodging new potholes and muddy puddles. Curious, their Earth science teacher asked the class to investigate. They noted that snowplows pushed snow into tall piles along the edges of the lot. Whenever a warm spell hit, meltwater flowed across the asphalt toward the drains. But some drains were blocked by ice and trash, so water pooled in low spots and seeped into tiny cracks. Overnight, the water froze and expanded, widening the cracks. After dozens of freeze–thaw cycles, pieces of asphalt loosened and broke away under the weight of cars, leaving deep potholes and loose gravel. The same process sent salty, gritty runoff into the nearby creek, which turned cloudy after every big melt.

1. Which specific freeze–thaw and drainage factors helped turn small cracks into large potholes in the Ridgeview parking lot?

2. How did the way snow and meltwater were managed (plow piles, blocked drains) affect both the parking lot surface and the nearby creek?

Multiple Choice

1. Freeze–thaw weathering breaks pavement and rock mainly because:

    a) Snow always melts evenly without entering cracks

    b) Ice chemically dissolves asphalt in a single storm

    c) Water expands when it freezes, pushing outward on cracks over many cycles

    d) Water shrinks when it freezes, pulling cracks closed instead of widening

2. During a rapid thaw on frozen ground, meltwater is more likely to:

    a) Stay in place and never move

    b) Flow over the surface, increasing flood and erosion risk

    c) Turn directly into water vapor without soaking into the soil

    d) Soak deeply into the soil and reduce runoff

3. An ice jam forms when:

    a) River ice pieces pile up and block flow at a narrow point, causing water to back up

    b) Snowplows push ice into piles in a parking lot

    c) Groundwater freezes in underground aquifers

    d) Rivers freeze completely solid from bottom to top all winter, creating an ice cap

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ Mechanical weathering	A) Process of water soaking into the soil
2. ___ Freeze–thaw cycle	B) Water flowing over land into streams and storm drains
3. ___ Runoff	C) Repeated freezing and melting of water in cracks
4. ___ Ice jam	D) Physical breakdown of rock without changing its chemical composition
5. ___ Infiltration	E) Flooding caused when ice blocks river flow

Fill-in-the-Blank

1. When meltwater cannot soak into frozen soil, it becomes surface _____, which can carry sediment and pollutants into streams.

2. Breaking rock and pavement into smaller pieces by freezing and thawing water is an example of mechanical _____.

3. When chunks of river ice pile up at a narrow bridge or bend, they can form an ice _____ that raises water levels upstream.

Short Answer

Answer each question in 2-4 complete sentences.

1. Using ideas from the reading, explain how freeze–thaw cycles can turn a tiny crack in a road into a full pothole by the end of winter.

_____

_____

_____

2. Describe one situation in which a winter thaw or warm spell could increase flood risk in your community, even without heavy rain.

3. How can better snow and meltwater management (for example, clearing drains or changing where snow piles are placed) reduce both pothole formation and stream pollution?