



This road is covered with ice. Ice-covered roads are slippery and dangerous.

Icy Heat

Ice-covered roads are a major problem in cold areas, causing accidents and costly delays. Engineers are working on new ways to melt ice and clear it off roads. To make ice change phase from solid to liquid, you have to transfer energy to it. The engineers are testing out a system that runs electric currents through the surface of a road, raising its temperature and transferring energy to the ice above it. In science and engineering, energy transferred this way is called “heat.”

It might sound dangerous to use heat to keep roads clear of ice. Maybe a hot road would melt the tires of passing cars, or even burn the shoes

of crossing pedestrians! However, this new type of road surface would not feel hot to the touch. In fact, it would probably feel very cool if you put your hand on it. Even when it’s melting the ice, the temperature of the new road surface barely rises above 10°C .

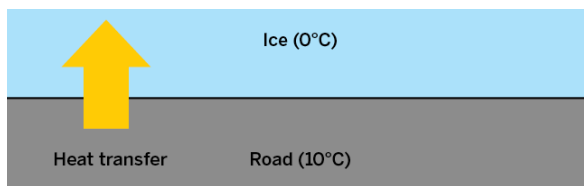
How can something that cool give off heat? In everyday language, the word *heat* can mean all kinds of things, but in science, it has a very specific meaning that has to do with something called thermal energy. Thermal energy is the energy that an object has because its molecules are moving. When you touch something with a higher temperature than your hand, that

object feels warm to you because thermal energy is transferred from the object to your hand. Scientists call the thermal energy that is transferred “heat.” Whenever two objects with different temperatures touch, heat transfers from the object with a higher temperature to the object with a lower temperature.

That’s why the ice-melting road surface feels cold to the touch: it has a lower temperature than your hand, so heat is transferred from your hand to the road surface if you touch it. However, even objects that feel cold to us still have thermal energy, because the molecules are still moving. The road surface is colder than your hand, but it’s warmer than ice, so heat will transfer from the road surface to any ice that is touching it. The road surface doesn’t have to feel hot to us to transfer heat and melt ice.

What about the ice? Could it ever give off heat? We think of ice as cold. Water freezes at 0°C , much colder than our hands ever are, so an ice cube will always feel cold to the touch. When you touch ice, heat will transfer from the warmer object (your hand) to the cooler object (the ice cube). However, the water molecules that make up the ice cube are still moving, even though they are moving more slowly than the molecules in liquid water. The ice cube still has thermal energy.

Now imagine something even colder than the ice cube: a piece of dry ice. Dry ice is solid carbon dioxide and has a temperature of -78.5°C . If the ice cube came into contact with a piece of dry ice, what would happen? Heat always transfers from the warmer object (in this case, the ice cube) to the colder object (the dry ice). The ice cube would give off heat!



The road is warmer than the ice, so heat transfers from the road to the ice.



An ice cube will always feel cold to the touch. That’s because heat transfers from our hands to the ice.



This is carbon dioxide that has frozen solid, forming dry ice. Frozen carbon dioxide is much colder than frozen water.