Thermal Energy and the Indian Tipi

Used as an IEFA addition to the Amplify 8th grade Thermal Energy Unit

NGSS Disciplinary Core Ideas

PS3.A: Definitions of Energy

MS-PS3-3, MS-PS3-4

PS3.B: Conservation of energy and energy transfer

MS-PS3-5

Materials:

Tipi
Heater or fire
Infrared Thermometer
Tipi Side Section Handout
Blue, Red, and Grey colored pencils

Review of Thermal Energy Vocabulary:

Molecule
Kinetic energy
Transfer
Collision
Equilibrium
Thermal energy
Temperature (average kinetic energy)

Additional vocabulary:

Convection heat
Radiant heat
Conduction heat

Mini Science Lesson before the Tipi Experience

Methods of Heat Transfer:

Radiant Heat: Radiation is a method of heat transfer that does not rely upon any contact between the heat source and the heated object. For example, we feel the heat from the sun even though we are not touching it. Heat can be transmitted through empty space by thermal radiation. In the tipi, the fireplace is the radiant heat. We can feel the heat from the fire even though we are not touching it.

Convection Heat: Convection is heat transfer of a fluid, such as air or water when the heated fluid is caused to move away from the source of the heat, carrying energy with it. Convection above a hot surface occurs because hot air expands, becomes less dense, and rises.

In the tipi, convection is the most efficient way to transfer heat. Convection occurs when warmer areas of air rise to cooler areas of air. As this happens, cooler air takes place of the warmer areas which have risen higher. This cycle results in a continuous circulation pattern and heat is transferred to cooler areas. Heat energy is transferred by the circulation of the air.

Conduction Heat: Conduction occurs when two objects at different temperatures are in contact with each other. Heat flows from the warmer to the cooler object until they are both at the same temperature. Conduction is the movement of heat through a substance by the collision of molecules. In our Thermal Energy Unit, the groundwater heater system for the school uses conduction heat. The water below the ground is warmed by the transfer of heat from the contact with the ground. When that water is pumped through the school, the warm water uses conduction heat to heat the school building by transferring energy until the school building and the water reach equilibrium.

Introduction of Tipi:
A small fire gives comfortable radiant heat, and as the hot air rises, much is trapped by the smaller top of the tipi's cone, giving all-round warmth. Air and temperature move naturally in a round space. Even though the tipi is cone-shaped, the thermal dynamics of the open-at-the-top design of the tipi uses no external energy to circulate temperature.

The smoke flaps act as a coat collar, keeping the wind from blowing down into the tipi and filling it with smoke. By directing the flaps, smoke is drawn out of the lodge. The smoke hole, being to some extent sheltered on the leeward side of the tipi and so not in the center, allows the fireplace to be closer to the door. This gives more living room at the back of the lodge, and because of the steeper angle of the poles at the back, there is more headroom. Areas close to the edge under the cover are for storage and sleeping.

Hand out Student Copies of Side Section of the Tipi - See attachment

Have students identify and color the fireplace red and label it with Radiant Heat.

Have students identify and color the base of the smoke flap pole blue to identify where cold air enters the Tipi.

Have students identify and color the smoke flap at the top of the tipi where smoke exits grey.

Have students use blue and red colored pencils to color blue and red arrows to demonstrate the warm air rising and cooler air, dropping, illustrating the convection heat inside a tipi.

Tipi Experience

The class will tour the tipi 15 students at a time. While in the tipi the teacher and students will use an infrared thermometer to take the temperature (average kinetic energy) of the radiant heat (propane fire pit) inside the tipi. The teacher and students will then use the infrared thermometer to take various temperature readings throughout the tipi focusing on the top, middle, and base of the tipi noting the differences in temperature and the convection of heat.

While in the tipi guest teachers and Native Nations students will share a few tipi origin stories.

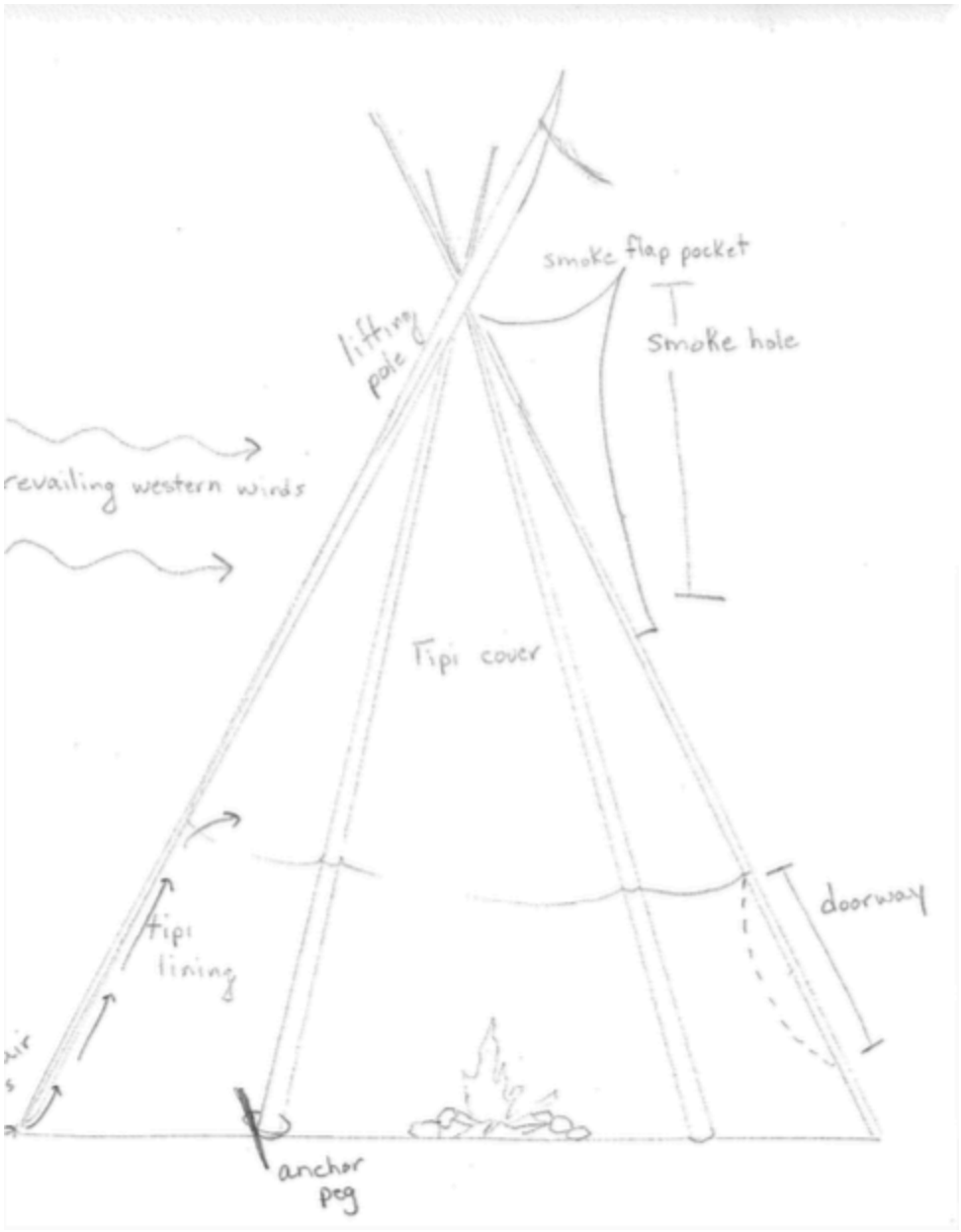
Optional Resource on the building of the Tipi
https://www.youtube.com/watch?v=6og_89w6bbU

Slide Show

Resources:
Worldwisdom.com
The Indian Tipi its history, construction, and use by Reginald and Gladys Laubin

http://coolcosmos.ipac.caltech.edu/cosmic_classroom/light_lessons/thermal/transfer.html

https://www.motherearthnews.com/nature-and-environment/living-in-a-tipi-zmaz79mjzraw


smoke flap pocket
lifting pole
Smoke hole
revailing western winds
Tipi cover
doorway
tipi lining
anchor peg