Name _____ Date _____

Heat Transfer by Conduction, Convection and Radiation in a Cooling Cup Data Table

Directions: Read the lab notes and study the data table. In number questions, type only the number; the unit is shown next to the box.

The Cooling Cup Test

Use the lab notes and the data table to answer these questions.

Jamal's class poured 100 milliliters of hot water at 80 °C into each of four cups: a thin metal cup, a ceramic mug, a foam cup and a foam cup with a snug lid. The room was 20 °C. Every 10 minutes, they read a thermometer in each cup.

On its own, heat moves from a warmer place to a cooler one. Heat can travel in three ways. In conduction, heat passes through materials that touch, such as the water, the wall of the cup and the air against it. In convection, a moving liquid or gas carries heat along with it, as when warm air rises off a cup. In radiation, heat travels as waves, such as the invisible infrared waves that warm objects give off, and these waves can cross even empty space.

Within a minute, the outside of the metal cup felt hot, while the outside of the foam cups stayed barely warm. Steam rose from the three open cups but not from the cup with the lid.

Temperature of 100 mL of hot water in four cups in a 20 °C room

Cup	Start (°C)	After 10 minutes (°C)	After 20 minutes (°C)
Thin metal cup	80	60	46
Ceramic mug	80	65	54
Foam cup	80	70	62
Foam cup with lid	80	75	70

1. Temperature drop = starting temperature − later temperature. How many degrees did the water in the ceramic mug cool over the full 20 minutes?
   _____ °C

2. Average cooling rate = temperature drop ÷ time. What was the average cooling rate of the water in the thin metal cup during the first 10 minutes, in degrees Celsius per minute?
   _____ °C per minute

3. Jada says the water in the cups cooled because cold from the room flowed into them. Which statement best describes what really happened?
   A. Heat flowed out of the warmer water into the cooler cup and air; nothing called cold flowed in.
   B. Cold flowed in from the room until the water froze.
   C. Cold flowed into the water through the cup walls, which is why the metal cup cooled fastest.
   D. Cold and heat traded places, so the room got colder while the water warmed.

4. The lab notes say the outside of the metal cup felt hot within a minute, while the outside of the foam cups stayed barely warm. What does this observation, together with the table, suggest?
   A. The foam cups lost heat the fastest, but their outsides hid it.
   B. Foam lets cold into the water faster than metal does.
   C. The metal cup made heat of its own, which warmed its outside.
   D. Metal conducts heat quickly from the water to the cup's outer surface, where it passes into the room, so the water in the metal cup cooled fastest.

5. After 20 minutes, the foam cup with a lid held water 8 degrees warmer than the open foam cup. The lab notes say steam rose only from the open cups. Which kind of heat loss did the lid most likely reduce the most?
   A. Heat flowing into the water from the room
   B. Heat conducted through the foam sides of the cup
   C. Cold air sinking into the cup from above
   D. Heat carried off the open top by warm, moist air rising away from the water

6. The lab notes say radiation can cross even empty space. Which example shows heat moving mainly by radiation?
   A. Your face warming up while you sit beside a campfire
   B. Your hand warming up while you hold a mug of cocoa
   C. Warm air rising above a heater and spreading across the ceiling
   D. A metal spoon's handle getting hot while it sits in a pot of soup

7. The class repeats the test with cold water at 5 °C in the same four cups, still in the 20 °C room. Which cup would most likely keep its water coldest after 20 minutes, and why?
   A. The thin metal cup, because metal always feels cold
   B. The foam cup with a lid, because foam keeps the cold trapped inside
   C. All four would stay equally cold, because cold water cannot warm up
   D. The foam cup with a lid, because foam and the lid slow down the heat flowing in from the warmer room

8. A metal spoon and a wooden spoon have been lying side by side on a table in a 20 °C room for hours. When you pick them up, the metal spoon feels colder. Why?
   A. Both spoons are at 20 °C, but metal carries heat away from your warmer hand much faster than wood does.
   B. Metal lets cold flow into your hand.
   C. The metal spoon is at a lower temperature than the wooden spoon.
   D. Wood makes its own heat, so it feels warmer.