

# Bulk Properties of Copper: Introduction

## Answers

1. Let's say a current of one ampere flows through the circuit in Figure 1. This means that a charge of one coulomb passes through the lamp every second. Research to find out how many electrons there are in one coulomb of charge.

One coulomb of charge is  $6.24 \times 10^{18}$  electrons. We can write this number as 6,240,000,000,000,000,000.

2. What is the purpose of the pins on the heat sink in Figures 2 and 3?

The pins provide a huge surface area to transfer heat into the airflow from the fan.



Figure 1

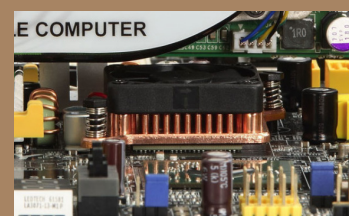


Figure 2

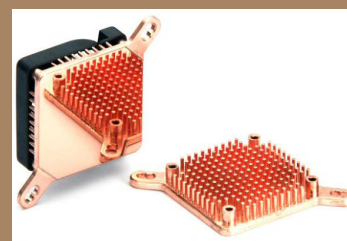


Figure 3

3. In the thermal conductivity chart, the difference in conductivity between sandstone and lead looks about the same as the difference in conductivity between lead and copper. Is this really the case?

There are about 43 x-axis units between sandstone and lead. As we move right on the log scale the divisions get larger. From lead to copper is about 360 units. The log scale allows the whole chart to be drawn on one page, but it needs careful reading.

4. Copper is used in pans because it conducts heat well. Why does the stainless steel layer have very little effect on the conductivity?

The conductance of the pan is hardly affected because the steel layer is very thin: only 0.2 mm. The word *conductance* is the thermal equivalent of electrical resistance. Although the conductivity of stainless steel is low compared to copper, the conductance of a very thin layer is high. In this case the steel is designed to provide a harder durable surface. Bare copper would be too soft to withstand the wear and tear in the kitchen.

## 5. Why is stainless steel used for the handle?

The stainless steel handle is a poor enough thermal conductor to allow the pan to be picked up with bare hands.

6. In the counter-current heat exchanger below, is the heat energy transferred from the clockwise flow to the anticlockwise flow or the other way around? How is the counter-current heat exchanger different from the heat exchanger in a whale's flipper?

The inner, clockwise flow starts hot and loses heat to the outer, anticlockwise flow. Heat is transferred from the clockwise to the anticlockwise flow. It is important to understand that the inner, clockwise tube runs inside the outer, anticlockwise tube. This is not the case in the whale flipper, where the artery and vein are just close together.

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