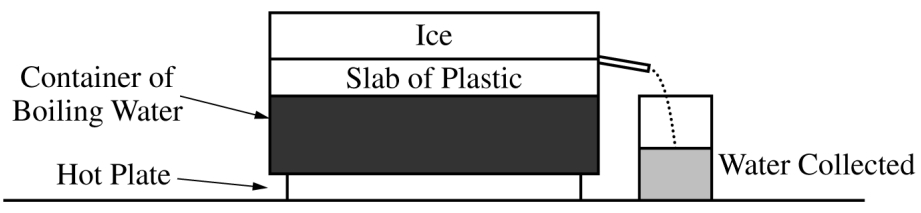


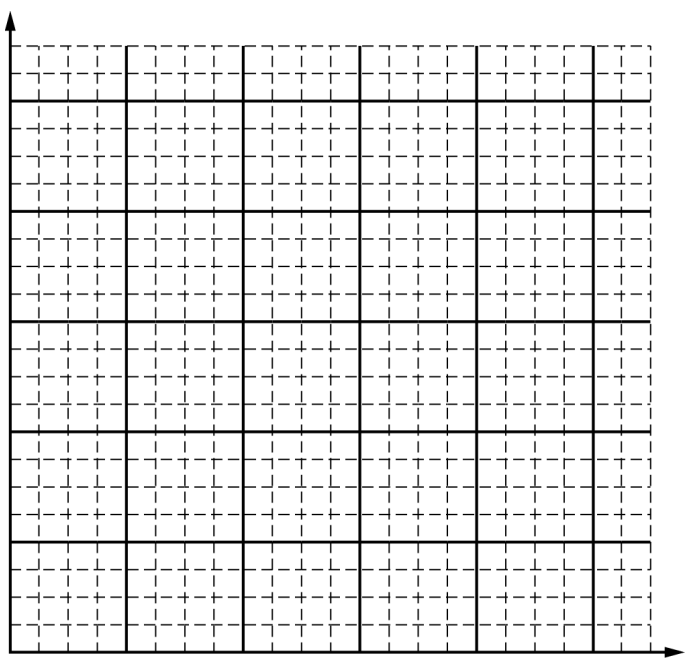
3. (12 points, suggested time 25 minutes)

A group of students use the apparatus shown above to determine the thermal conductivity of a certain type of plastic. A hot plate is used to keep water in a container boiling at a temperature of $100°C$. They place a slab of the plastic with area $0.025\ m^2$ and thickness 0.010 m above the container so that the bottom surface of the slab is at a temperature of $100°C$. They put a large block of ice with temperature $0°C$ on top of the plastic slab. Some of the ice melts, and the students measure the amount of water collected during a time Δt. The students correctly calculate the amount of energy Q delivered to the ice and thus determine $Q/\Delta t$. They repeat this experiment several times, each time adding an identical slab to increase the total thickness L of plastic. Their results are shown in the table below.

Energy flow rate $Q/\Delta t$ (J/s)	97	53	31	27	18
Total thickness of plastic L (m)	0.010	0.020	0.030	0.040	0.050

(a) The students want to create a graph to yield a straight line whose slope could be used to calculate the thermal conductivity of the plastic.

i. Label the axes below to indicate a pair of quantities that could be graphed to yield a straight line. Include units for the quantities.

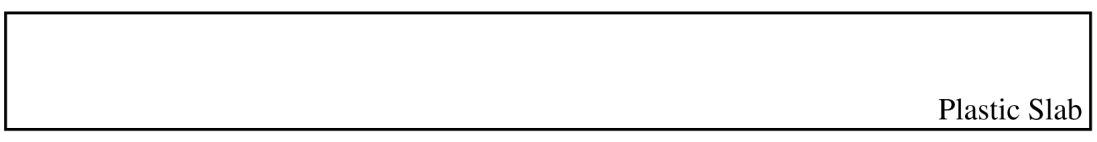


ii. On the grid on the previous page, create a linear graph using the values for the quantities indicated in part (a)(i). Be sure to do the following.
- Add to the data table the values of any quantities to be plotted that are not already given.
- Scale the axes.
- Plot the data from the table.
- Draw a line that best represents the data.

iii. Use the graph to calculate the thermal conductivity of the plastic.

(b) Indicate one potential problem with the setup that could lead to an experimental value for the thermal conductivity that is different from the actual value. Use physics principles to explain the effect this problem could have on the experimental value.

(c) The rectangle below represents a side view of the plastic slab. Draw a single arrow on the diagram representing the direction of the net flow of energy through the plastic.



(d) Describe what occurs in the plastic at the microscopic level that explains the energy flow you indicated in part (c).

(e) An extra plastic slab sits on a wood surface, with both the plastic slab and the wood surface at room temperature. A student touches each and finds that the plastic slab feels cooler than the wood surface. Explain what causes this observation.