**Activity 1. Heating with a Bunsen burner**

1. Determine the amount of heat produced during the combustion of methane by using the balanced chemical equation for the reaction and standard enthalpies of formation.
2. Calculate the volume of natural gas that was consumed when you heated your mass of water through the temperature change that you recorded. Assume that the flow rate of natural gas through your Bunsen burner is 10 mL/s.
3. Calculate the amount of heat that was absorbed by your mass of water when its temperature changed by the amount that you recorded amount.
4. Assuming that natural gas is mostly methane, calculate the amount of heat released by the combustion of methane during the heating your mass of water.
5. By comparing the amount of heat absorbed by your mass of water to the amount of heat released during the combustion of methane, calculate the percent efficiency of heating with a Bunsen burner.

**Activity 2. Heating with an electric hot plate**

1. Calculate the amount of heat absorbed by your mass of water when you heated it through your recorded temperature change with an electric hot plate.
2. Use the power rating of your hot plate (usually listed on the underside of the device) and the period of time that you heated your mass of water to determine the energy expended by the hot plate. Recall that 1 watt = 1 J/s.
3. By comparing the amount of energy absorbed by the water to the energy expended by the hot plate, calculate the percent efficiency of heating with an electric hot plate.

**Acitivity 3. Heating with a microwave oven**

1. Calculate the amount of heat absorbed by the mass of water that was heated in the microwave oven.
2. Using the power rating of the microwave oven and the time period of heating the mass of water, calculate the amount of energy expended by the microwave during the heating of the water.
3. By comparing the amount of energy absorbed by the mass of water to the amount of energy expended by the microwave, calculate the percent efficiency of heating with a microwave.

**Activity 4. Comparing the environmental costs of heating**

When this lab was written, electricity cost about $0.08 per kilowatt-hour. A kilowatt-hour is 3.6 × 106 J. Natural gas cost about $12.00 per 1000 ft3. One liter is 0.0353 ft3.

1. Using the above information, calculate the economic cost of heating 250 mL of water by 10 °C using a Bunsen burner. Be sure to factor efficiency into your calculation.
2. Using the above information, calculate the economic cost of heating 250 mL of water by 10 °C using an electric hot plate. Be sure to factor efficiency into your calculation.
3. Using the above information, calculate the economic cost of heating 250 mL of water by 10 °C using a microwave. Be sure to factor efficiency into your calculation.
4. Which method of heating water uses the least total amount of energy?
5. In order to determine the environmental costs of the different methods of heating, determine the source of electricity in your local area and compare that to the combustion of natural gas.
6. Using the information you have collected regarding efficiency, dollar cost, and environmental cost, make a recommendation for how best to minimize energy used to heat substances in your school lab.