

Green Chemistry Workshop

August 21-22, 2008

Energy Comparison Activity Teacher Supplemental Information

Calculations

Given:

200 g water, $\Delta T = 50.5^{\circ}\text{C}$ (16°C to 66.5°C)

Combustion of 4.86 L of methane, $\Delta H = -802.3 \text{ kJ/mol CH}_4$

698 watt electric hot plate

1000 watt microwave

Electricity – 10.56¢ per kilowatt hour

Natural Gas – \$11.80 per thousand cubic feet

Heat Source	Energy (kJ)	Time (sec)	Efficiency	Cost (¢)	Savings
Bunsen Burner	174.63	245	24.2%	0.203	0.571¢
Hot Plate	263.86	378	16.0%	0.774	-
Microwave	61.81	62	68.3%	0.181	0.593 ¢

Given:

50 gallons water, $\Delta T = 50.5^{\circ}\text{C}$ (16°C to 66.5°C)

Combustion of methane, $\Delta H = -802.3 \text{ kJ/mol CH}_4$

698 watt electric hot plate

1000 watt microwave

Electricity – 10.56¢ per kilowatt hour

Natural Gas – \$11.80 per thousand cubic feet

Heat Source	Energy (kJ)	Time (hr)	Efficiency	Cost (\$)	Savings
Bunsen Burner	165,096	64.3	24.2%	\$1.92	\$6.22
Hot Plate	277,541	111	16.0%	\$8.14	-
Microwave	58,496	16.3	68.3%	\$1.72	\$6.43

Notes:

- Based on the above data, if you were to lower the temperature of your 50 gallon hot water tank from 99°F to 90°F you would save approximately 20% on the cost of heating your water.
- Heating of larger volumes of water (1 L) with a microwave has been found to be more efficient, about 80% compared to the 68% found for 200 ml of water.
- Heating 1 L volumes with a source that submerses the heating coils in the water, like an electric kettle, has about 90% efficiency.
- The extremely low efficiency of the hot plate is most likely due to the difference in area of the hot plate and the beaker of water. A large percentage of the heat provided by the hot plate is released into the air rather than absorbed by the water.