

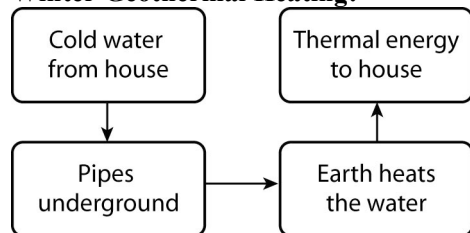
## Section 6.5: Heating and Cooling Systems

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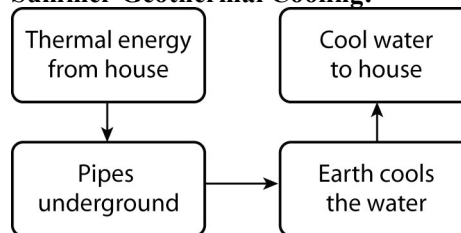
- Answers may vary. Sample answer:  
Forced-air heating systems are popular for a number of reasons: Their duct work can accommodate air conditioning, a humidifier and a filter, they are cheaper to replace than a boiler, they respond quickly to programmable thermostats, and the homeowner does not have to worry about the water pipes causing water damage.
- Answers may vary. Sample answer:  
CFCs are also used as solvents to clean electronic components and as blowing agents in the production of plastic foams.
- Programmable thermostats work by turning off the furnace or air conditioner when the homeowner does not need them. For example, in the winter at night or when he/she is at work, the homeowner can set the thermostat to a lower temperature. Therefore it will not turn the furnace on until temperatures have really dipped. A smart thermostat gives the homeowner control of the thermostat through a computer. The system sends information about whether a furnace, boiler, or air conditioner is on or off, functioning well, or needs attention. The homeowner can monitor the system from a distance to adjust the temperature. This is especially useful for second homes where the homeowner lives far away.
- Geothermal systems can be used as both a heating system and a cooling system because they use Earth's natural thermal energy for heating and cooling. In the winter, thermal energy is transferred from below Earth's surface into a building to heat it. In the summer, thermal energy is transferred from the building into Earth's surface to cool it.

5.

#### Winter Geothermal Heating:



#### Summer Geothermal Cooling:



6. (a) The specific heat capacity value for air is  $1.0 \times 10^3 \text{ J}/(\text{kg} \cdot ^\circ\text{C})$ .

(b) Answers may vary. Sample answer:

Furnaces and hot water boilers come in different levels of efficiency. As of December 31, 2009, all furnaces in Canada must have an efficiency of at least 90 %. This means low- and mid-efficiency furnaces should no longer be available.

The annual fuel utilization efficiency (AFUE) rating is the ratio of heat output of the unit to the total energy used by the unit in a year. An AFUE of 90 % means that 90 % of the fuel's energy is used for the home, while the other 10 % is lost through the chimney or other vents.

High-efficiency forced-air furnaces and hot water boilers will be compared.

Forced-air furnaces have improved efficiency with the addition of a second heat exchanger. The thermal energy exchanger condenses any gases and uses the thermal energy from this condensation. Hot water boilers also have a second thermal energy exchanger that condenses any water vapour and uses the thermal energy from the condensation. Furnaces usually have a chimney and duct work as part of their thermal energy transport system. Hot water boilers usually have radiators or baseboards to transport heat. Hot water boilers can have higher efficiency ratings than high-efficiency furnaces. More thermal energy is retained because there is no chimney. However, most hot water boilers run on electricity, which currently can be more expensive than fuels for furnaces such as natural gas.

(c) Answers may vary. Sample answer:

Based on cost alone, I would choose a forced-air furnace that uses natural gas. Electricity rates are steadily increasing while natural gas rates will vary depending on demand. The rates will increase during high demand periods and decrease during low demand periods.