

## Problem Set 6 - Solutions

1. The second law of thermodynamics states that heat flows from high to low temperatures. An example that supports this law is the fact that hot coffee, if left to stand in a cup, will cool off.
2. A heat engine takes in thermal energy and outputs thermal energy and work. An example of a heat engine is an automobile.
3. The difference between a heat pump and a refrigerator is that a heat pump takes in heat from a high-temperature object and outputs heat and work, while a refrigerator takes in work and heat from an outside source and pumps heat from a low-temperature object to a high-temperature object, (the arrows on the diagram are reversed).
4. The second law of thermodynamics us that a heat engine can never be 100% efficient. Some energy will always be lost as it flows to a lower-temperature object.
5. Ice melts because the energy from the higher-temperature liquid surrounding the ice is transferred to the lower-temperature ice, causing the molecules to move more and melt the ice (converting the ice from a solid to a liquid state).  
A room with a poorly insulated window gets colder because the heat inside the room is allowed to travel outside, to the lower-temperature air.
6. The following are not heat engines:  
electric locomotive  
wind turbine  
solar hot water heater

(If you said that a solar hot water heater was a heat engine, you did not lose points. It uses radiant energy, not thermal energy).