Station 1

$$\Delta L = \alpha L_0 \Delta T$$
$$\Delta V = \beta V_0 \Delta T$$

1. Describe each of the above variables (with units)
2. You are selling apple cider for two dollars a gallon when the temperature is 4.0°C. The coefficient of volume expansion of cider is 280×10^{-6} $(^{o}C)^{-1}$. If the expansion of the container is ignored, how much more money (in pennies) would you make per gallon by refilling the container on a day when the temperature is 26 °C?

Station 2

$$Q = mc\Delta T$$
$$Q = mL_f$$
$$Q = mL_v$$

1. In what situations would you use $Q = mc\Delta T$?
2. In what situations would you use $Q = mL_f$? (two situations)
3. In what situations would you use $Q = mL_v$? (two situations)
4. Two grams of liquid water are at 0°C, and another two grams are at 100°C. Heat is removed from the water at 0°C completely freezing it at 0°C. This heat is then used to vaporize some of the water at 100°C. What is the mass (in grams) of the liquid water that remains? [$L_f = 33.5 \times 10^4$ J/kg, $L_v = 22.6 \times 10^5$ J/kg]

Station 3

$$Q = \frac{(kA\Delta T)t}{L}$$

1. Describe each of the above variables (with units)
2. Two rods, one of aluminum and the other of copper, are joined end to end. The cross-sectional area of each is 4.0×10^{-4} m^2, and the length of each is 0.040 m. The free end of the aluminum rod is kept at 302 °C, while the free end of the copper is kept at 25 °C. The loss of heat through the sides of the rods may be ignored. Both rods conduct the same amount of heat per second when in contact with each other. What is the temperature at the aluminum-copper interface? [k_{al} = 240 J/(s*m*°C) , k_{cu} = 390 J/(s*m*°C)]

Station 4

$$Q = e\sigma A\, T^4 t$$

1. Describe each of the above variables (with units)
2. How many days does it take for a cube with a side length of .100m and an emissivity of 0.700 maintained at a temperature of 30.0°C sitting in a room with a temperature of 25°C to radiate the same net amount of radiant energy that a one-hundred-watt lightbulb uses in one hour?

Station 5

$$\Delta U = Q - W$$
$$W = P\Delta V$$

1. Describe the 0^{th} law of thermodynamics.
2. Describe a situation in which the work would be positive (in terms of energy exchange and/or movement)?
3. Describe a situation in which the work would be negative (in terms of energy exchange and/or movement)?
4. A system gains 1500 J of heat, while the internal energy of the system increases by 4500 J and the volume decrease by 0.010 m^3. Assume the pressure is constant and find its value.

Station 6

1. Below will be four situations. Identify which thermodynamic process is best associated with each and explain your choice.
    a. A can of spray paint is activated and releases some of its content
    b. An enclosed, rigid helium container falls onto a fire
    c. A chunk of iron starts at 0^oC is heated and melts
    d. A balloon is allowed to float in a room and it maintains the same temperature as the room. Over time the balloon expands.

Station 7

$$Q_h = W + Q_c$$

1. Draw a heat engine, labelling the parts
2. The input heat for an engine is 14.5kJ. The engine rejects 7.8kJ of heat. How high can this engine lift a 150 kg person?

Station 8

$$eff = \frac{W_{net}}{Q_h}$$
$$eff = 1 - \frac{Q_c}{Q_h}$$
$$eff = 1 - \frac{T_c}{T_h}$$

1. When is it appropriate to use each of the above equations?
2. An engine has a hot reservoir temperature of 950 K and a cold reservoir temperature of 620 K. The engine operates at three-fifths maximum efficiency. What is the efficient of the engine?