Tier 3.1 Thermal Physics… Part 1 Latent and Specific Heat Part 2 Heat Engines
Name: Period:

Part 1

1. Fort Saint Vrain Power plant was first a nuclear power plant that was later converted to use a carbon based fuel (propane). The main water tank is 100,000 liters which is draws from the Platte river. Consider the water to be at room temperature (293 K). Use the listed energy densities to determine the amount fuel need to boil off the water.

1. Coal 24 MJ/kg 2. Propane 50 MJ/kg

3. Crude oil 46 MJ/kg 4. Refined Uranium 3,456,000 MJ/kg

2. Blood can carry excess energy from the interior to the surface of the body, where the energy is dispersed in a number of ways. While a person is exercising, 0.6 kg of blood flows to the surface of the body and releases 2000 J of energy. The blood arriving at the surface has the temperature of the body interior, 37.0°C. Assuming that blood has the same specific heat capacity as water, determine the temperature of the blood that leaves the surface and returns to the interior.

3. When resting, a person has a metabolic rate of about $4.2 \times 10^5$ joules per hour. The person is submerged neck-deep into a tub containing $1.0 \times 10^3$ kg of water at 27.00 °C. If the heat from the person goes only into the water, find the water temperature after half an hour.

4. An electric hot water heater takes in cold water at 13.0 °C and delivers hot water. The hot water has a constant temperature of 45.0 °C, when the "hot" faucet is left open all the time and the volume flow rate is 5.0 X 10^-6 $m^3/s$. What is the minimum power rating of the hot water heater?

5. In order to extract the maximum flavor in the shortest amount of time, your local fast food purveyor has decided to brew its coffee at 90 ℃ and serve it quickly so that it has only cooled down to 85 ℃. While this may be economically sensible, it is negligent and dangerous from a health and safety standpoint. Water (which is what coffee mostly is) at 85 ℃ is hot enough to cause third-degree burns (the worst kind) in two to seven seconds. You decide to add ice cubes to your coffee to cool it down to a more reasonable 55 ℃ so you will be able to drink it sooner. (Watery brew be damned. You need your caffeine now.) How many 23.5 g ice cubes at −18.5 ℃ should you add to your 355 ml cup of coffee to accomplish your thermal goal?

6. Suppose we have 50kg of ice at 200K. We want to heat the material until it all turns to steam at 400K. How much heat is required?

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Part 2

1. Mr. McNeill spends four minutes in a light saber duel and does 1090 J of work. In the process, his internal energy is decreased by 2990 J. Determine the value of Q, include the algebraic sign

2. When a gas is enclosed beneath a piston receives 1930 J of heat, Q, from its surroundings, it performs 2250 J of work in raising the piston. What is the change in the internal energy of the gas?

3. A gas is compressed under isobaric conditions, and it's volume changes from $7.0 \times 10^{-3}$ to $2.0 \times 10^{-3}$ $m^3$. The pressure of the gas is $1.5 \times 10^5$ Pa. Determine the work done.

4. Sketch a PV diagram of the following process: 2.0L of ideal gas at atmosphere pressure is cooled at a constant pressure to a volume of 1.0L and then expanded isothermally back to 2.0L, whereupon the pressure is increased at a constant volume until the original pressure is reached.

5. A refrigerator works buy compressing then expanding fluorocarbons. The gas starts at room temperature (25K) and is compressed from 2.00L to a volume of 0.50L. This volume is held when the gas is exposed to a large heat sink (the outside air) bring it back to room temperature 25K. 13000 joules of work is then done on the gas to expand it under an adiabatic process. What is the final temperature of the gas ($KE = 5/2\ nR\Delta T$)?