PHYS 1110 Worksheet: Heat and work

1. The bridge of US 287 over the railroad tracks just south of town is 180.0 meters long. Its structure is steel, with a linear coefficient of thermal expansion of 11×10^{-6}/ºC. How much shorter is the bridge on a cold Winter day at –20°C than on a warm Summer day at +30°C?

2. USDA nutrition labels on food assume a daily energy intake of 2000 Calories. How many joules is this?

3. The 2004 Tour de France's Alpe d'Huez time trial was a climb with its finish 1200 m higher than the start. The winner, Lance Armstrong, and his gear had a combined mass of 84 kg. The work Lance had to do was (84 kg)(9.8 N/kg)(1200 m) = about 10^6 J.

   A. Muscle is about 20% efficient, so Lance had to deplete 5 times as much stored energy as the work he produced. How much energy did he burn?

   B. The specific heat of an average human body is calculated to be 2.98 kJ/(kg·K). If all the non-work energy he converted in the Alpe d'Huez climb stayed in his 75-kg body, how much would his body temperature have risen?

   C. How much sweat would Lance have needed to evaporate to keep his body temperature constant? The latent heat of evaporation of water is 2413 kJ/kg at 37 °C.