Heat and Thermal Energy

Heat - an energy transfer that occurs because of a difference in temperature.

Internal Energy - the energy a substance has because of its temperature.

Energy may be transferred between two objects without heat flow.

Example: rubbing two coins together. Both internal energies are increased due to mechanical work but both remain in thermal equilibrium throughout.

Units of Heat

- Calorie - the amount of heat energy required to raise the temperature of 1 gram of H_2O from 14.5°C to 15.5°C. *A 'food' calorie is 10^3 "physics" calories.*
- BTU - the amount of heat energy required to raise the temperature of 1 lb. of H_2O from 63°F to 64°F.
- Joule - the S.I. unit of heat and work.

1 calorie = 4.186 Joules = 3.9×10^{-3} Btu

Example: A student eats a 1000 food calorie meal consisting of pizza, soda, and snacks. How many 100kg clean & jerks (225 lbs.) must they do to work off this meal just by lifting weights (neglecting metabolism)?

Work required is:

1000 food cal $\times 10^3$ cal = 1×10^6 calories = 4.186×10^6 J

The work done lifting weights is against gravity $\therefore$ $W = mg\delta$. For n repetitions through some height δ, $W = nmg\delta$. Assume $\delta = 2.0$ meters.

$$n = \frac{4.186 \times 10^6 J}{(100kg)(9.8m \cdot s^{-2})(2.0m)} = 2136 reps!$$

How far would you have to run uphill to burn off these calories (neglecting metabolism)?

4271 meters!