HEAT

In the case of the earth, because we are in a very high vacuum, convective heat transfer = 0, conductive heat transfer = 0. Heat transfer is primarily radiative

$$\left(\frac{dQ}{dt}\right)_{\substack{\text{radiative}\\ \text{in}}} = 1.7 \times 10^{17}\ W$$ from sunlight in visible regio

This is just about exactly balanced by reflected sunlight and thermal emission in the infrared

$$\left(\frac{dQ}{dt}\right)_{\substack{\text{radiative}\\ \text{out}}} = 1.7 \times 10^{17}\ W$$

There is a miniscule increase in internal energy due to population growth etc - how is this fueled by heat transfer from radiation?

A more important increase in internal energy may be caused by a shift in the earth's radiative equilibrium - GLOBAL WARMING due to the GREEN HOUSE EFFECT.

WORK

How is work done on the earth setting here

Remember definition

$$W = \int \vec{F} \cdot d\vec{s}$$

What EXTERNAL forces are acting on the earth?

Gravity due to Sun, Moon + to a lesser extent other planets... As far as the earth's bulk motion around the sun no net work is done (over an orbit)

But

Tidal forces produce friction between oceans + earth:

Slowing Earth's Rotation

$\Delta U = I(\Delta\omega)^2$ - What about conservation of Earth momentum

Heating up Oceans

There are again minimal but important over the 4½ billion year terrestrial history

The simplicity of the first law hides alot of complicated stuff

Differential form

$$\boxed{dU = dQ - dW}$$

You Can't Win

Because the internal energy of a system is necessarily finite you cannot extract more energy from an object than you put into it indefinitely - Perpetual Motion of the 1st Type violates First Law