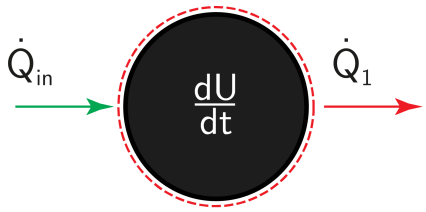
EB - Rad. - Outer 10

Set up the outer energy balance for the sphere that describes the change of its homogeneous temperature T_1 over the course of time. Use view factors and surface brightness whenever possible.



Energy balance:

$$\frac{\partial U}{\partial t} = \sum \dot{Q}_{\text{in}} - \sum \dot{Q}_{\text{out}}$$

$$\frac{dU}{dt} = \dot{Q}_{\text{amb}} - \dot{Q}_{\text{conv}} - \dot{Q}_1$$

Change of internal energy over time:

$$\frac{dU}{dt} = m_1 c_1 \frac{dT_1}{dt}$$

Heat fluxes:

Ambient radiation:

$$\dot{Q}_{\text{amb}} = \sigma A_1 T_\infty^4$$

Rate of heat loss by convection:

$$\dot{Q}_{\text{conv}} = \alpha_{\text{conv}} A_1 \left(T_1 - T_\infty\right)$$

The surface brightness of body 1 will be determined in a separate task and can be stated as $\dot{Q}_1$.

Substituting and rewriting:

$$\Rightarrow m_1 c_1 \frac{dT_1}{dt} = \sigma A_1 T_\infty^4 - \alpha_{\text{conv}} A_1 \left(T_1 - T_\infty\right) - \dot{Q}_1$$