Stefan's Law.

According to it the radiant energy emitted by a perfectly black body per unit area per sec (i.e. emissive power of black body) is directly proportional to the fourth power of its absolute temperature,

i.e. $E \propto T^4$ or $E = \sigma T^4$

Where σ a constant is called Stefan's constant having dimension $[MT^{-3}\theta^{-4}]$ and value $5.67 \times 10^{-8} W/m^2K^4$.

(i) If e is the emissivity of the body then $E = e\sigma T^4$

(ii) If Q is the total energy radiated by the body then $E = \frac{Q}{A \times t} = e\sigma T^4 \Rightarrow Q = A\,t\,e\sigma T^4$

(iii) If a body at temperature T is surrounded by a body at temperature T0, then Stefan's law may be put as

$$E = e\sigma(T^4 - T_0^4)$$

(iv) Cooling by radiation: If a body at temperature T is in an environment of temperature T0(< T), the body is loosing as well as receiving so net rate of loss of energy

$$\frac{dQ}{dt} = eA\,\sigma(T^4 - T_0^4) \qquad \text{.....(i)}$$

Now if m is the mass of body and c its specific heat, the rate of loss of heat at temperature T must be

$$\frac{dQ}{dt} = mc\frac{dT}{dt} \qquad \text{.....(ii)}$$

From equation (i) and (ii) $mc\frac{dT}{dt} = eA\,\sigma(T^4 - T_0^4)$

∴ Rate of fall of temperature or rate of cooling, $\frac{dT}{dt} = \frac{eA\,\sigma}{mc}(T^4 - T_0^4)$ .....(iii)

i.e. when a body cools by radiation the rate of cooling depends on

(a) Nature of radiating surface i.e. greater the emissivity, faster will be the cooling.

(b) Area of radiating surface, i.e. greater the area of radiating surface, faster will be the cooling.

(c) Mass of radiating body i.e. greater the mass of radiating body slower will be the cooling.

(d) Specific heat of radiating body i.e. greater the specific heat of radiating body slower will be cooling.

(e) Temperature of radiating body i.e. greater the temperature of body faster will be cooling.

(f) Temperature of surrounding i.e. greater the temperature of surrounding slower will be cooling.