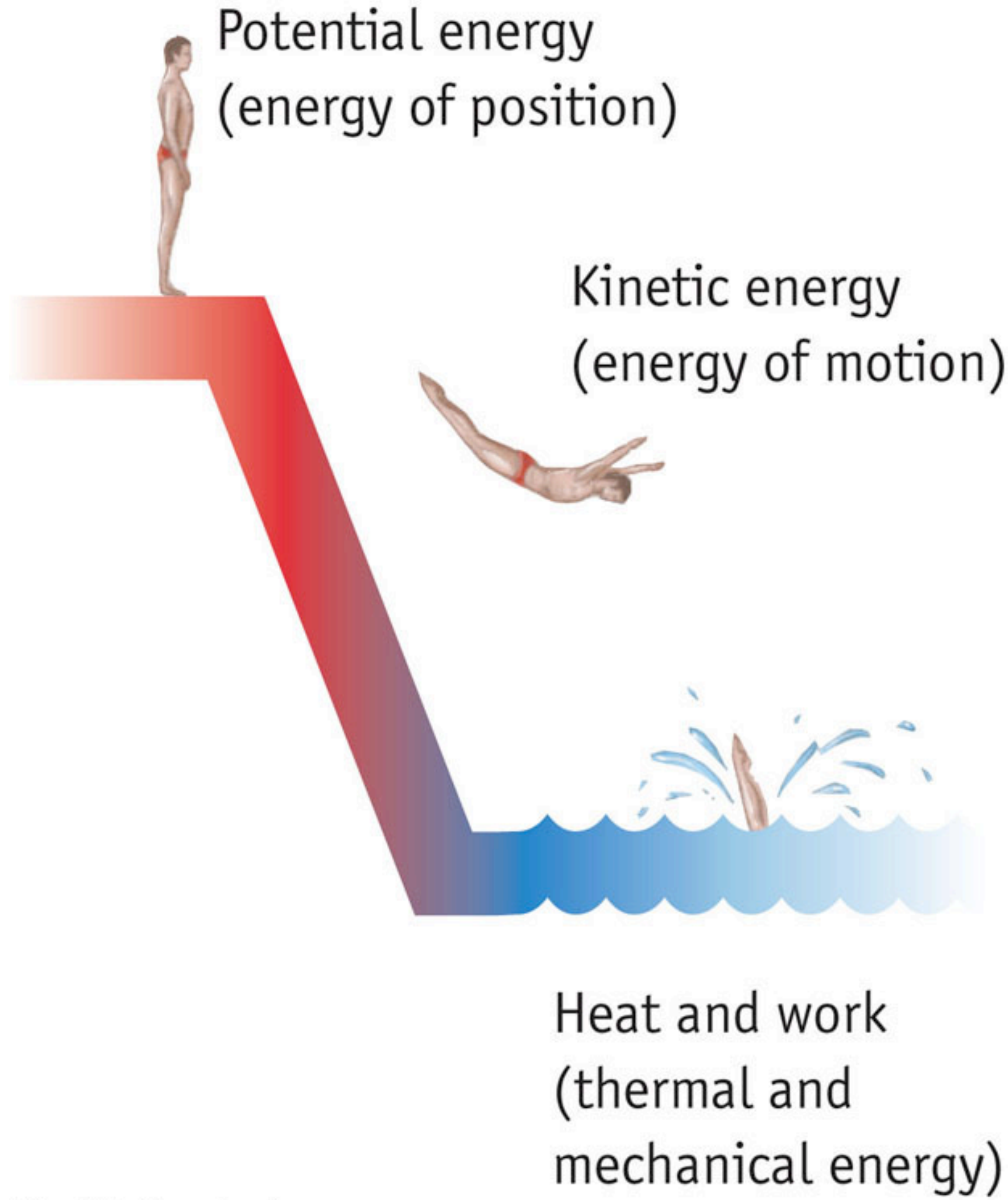

Potential energy
(energy of position)
Kinetic energy
(energy of motion)
Heat and work
(thermal and
mechanical energy)

Fig. 5-2, p. 211

Energy

Energy

Kinetic:

Energy

Kinetic: Mechanical – moving car

Energy

Kinetic:	Mechanical – moving car Thermal – moving molecules

Energy

Kinetic:	Mechanical – moving car Thermal – moving molecules Electrical – moving charge

Energy

Kinetic: Mechanical – moving car
Thermal – moving molecules
Electrical – moving charge
Sound – moving waves of gas compression and expansion

Energy

Kinetic: Mechanical – moving car
Thermal – moving molecules
Electrical – moving charge
Sound – moving waves of gas
compression and expansion

Potential:

Energy

Kinetic:	Mechanical – moving car Thermal – moving molecules Electrical – moving charge Sound – moving waves of gas compression and expansion
Potential:	Gravitational – the eraser

Energy

Kinetic:

Mechanical – moving car
Thermal – moving molecules
Electrical – moving charge
Sound – moving waves of gas compression and expansion

Potential:

Gravitational – the eraser
Chemical – gasoline

Energy

Kinetic:

Mechanical – moving car
Thermal – moving molecules
Electrical – moving charge
Sound – moving waves of gas compression and expansion

Potential:

Gravitational – the eraser
Chemical – gasoline
Electrostatic – +..- attraction (static E)

Temperature reflects molecular kinetic energy (thermal)

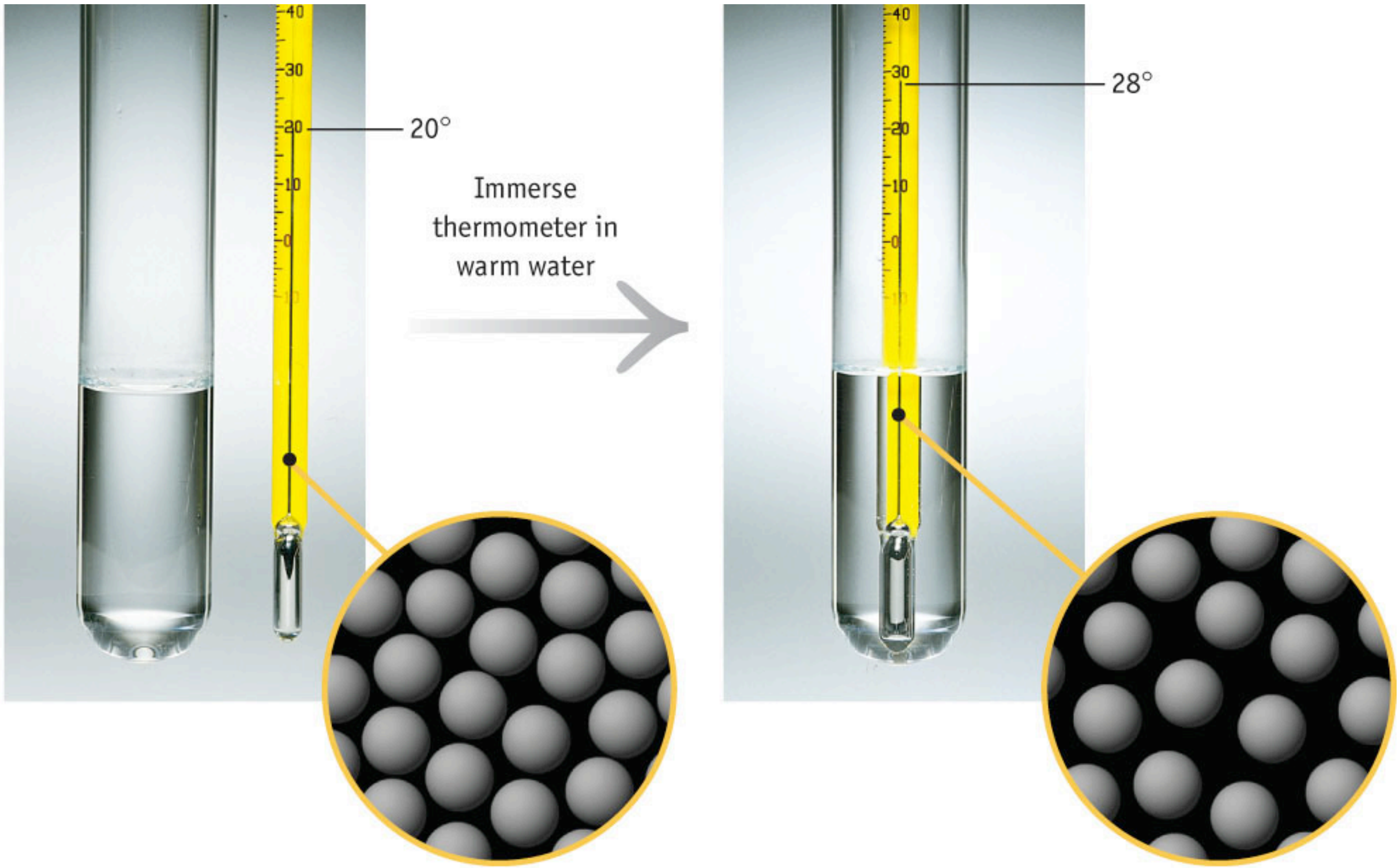


Fig. 5-3, p. 211

Law of Conservation of Energy

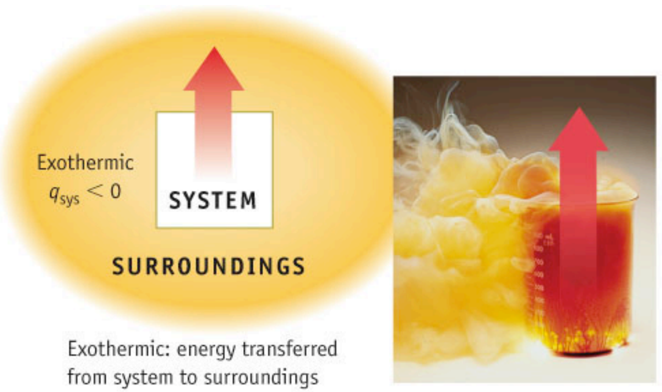
Law of Conservation of Energy

The total energy of the universe is constant

Law of Conservation of Energy

The total energy of the universe is constant

System: define carefully



Exothermic: energy transferred from system to surroundings

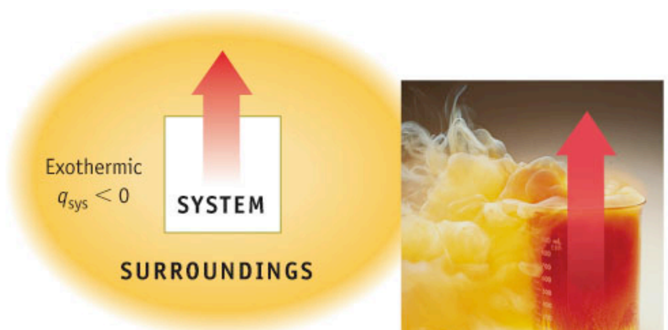
Law of Conservation of Energy

The total energy of the universe is constant

System: define carefully

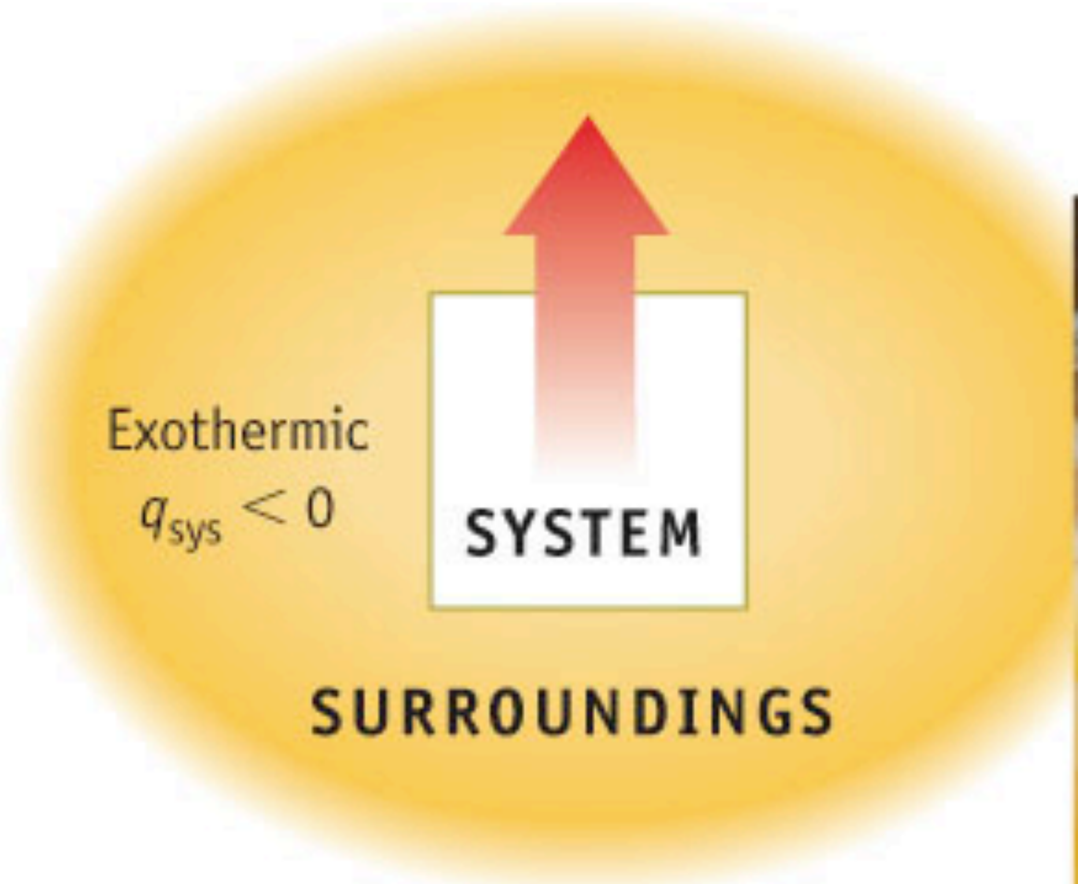
System + Surroundings = Universe

All nomenclature is from the point of view of the system



Exothermic: energy transferred from system to surroundings

Exothermic: energy transfer **from** system
(out of)



Exothermic: energy transferred from system to surroundings

Fig. 5-6, p. 214

Exothermic: energy transfer **from** system
(out of)

All nomenclature is from the point of view of the *system*

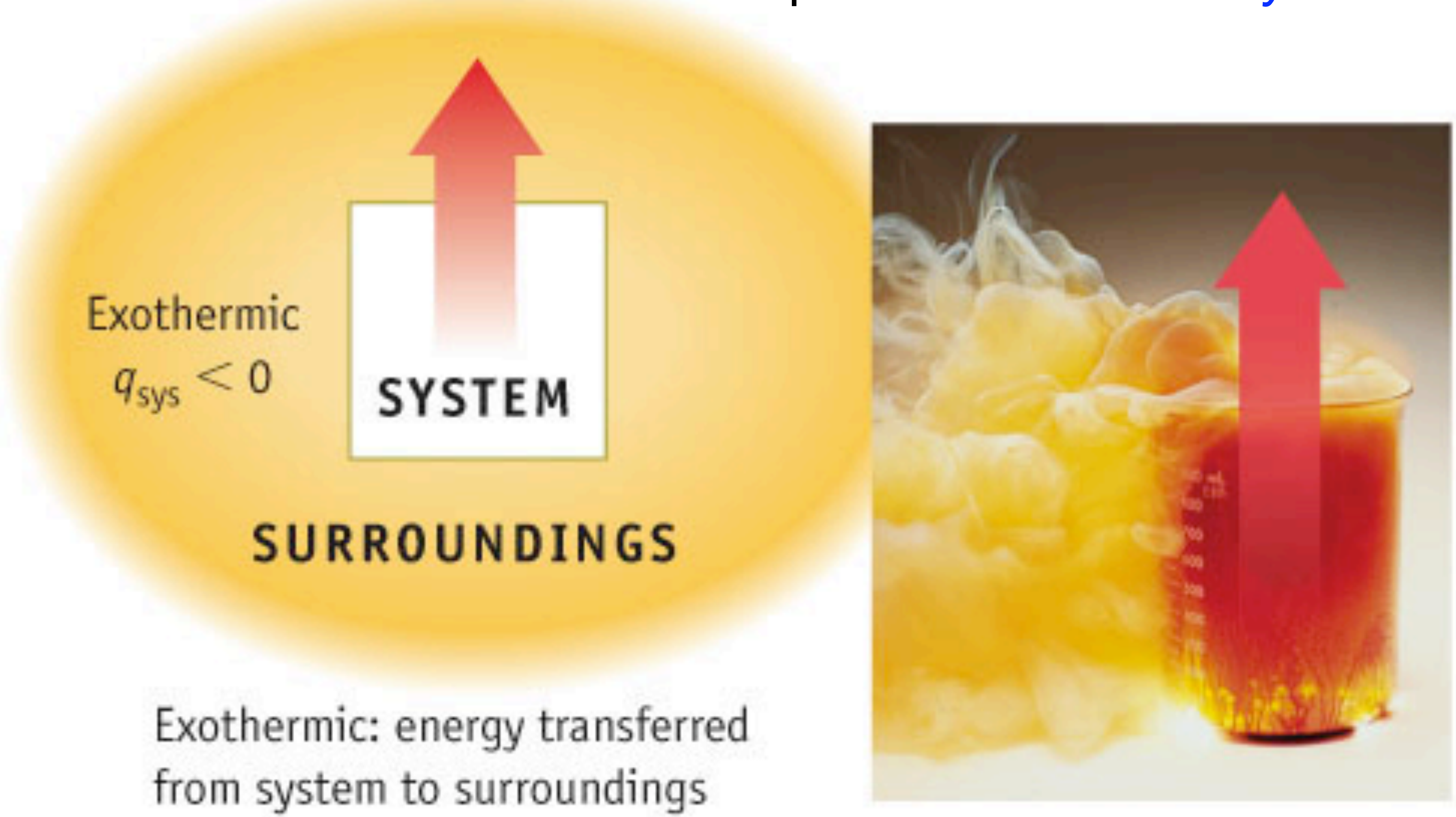
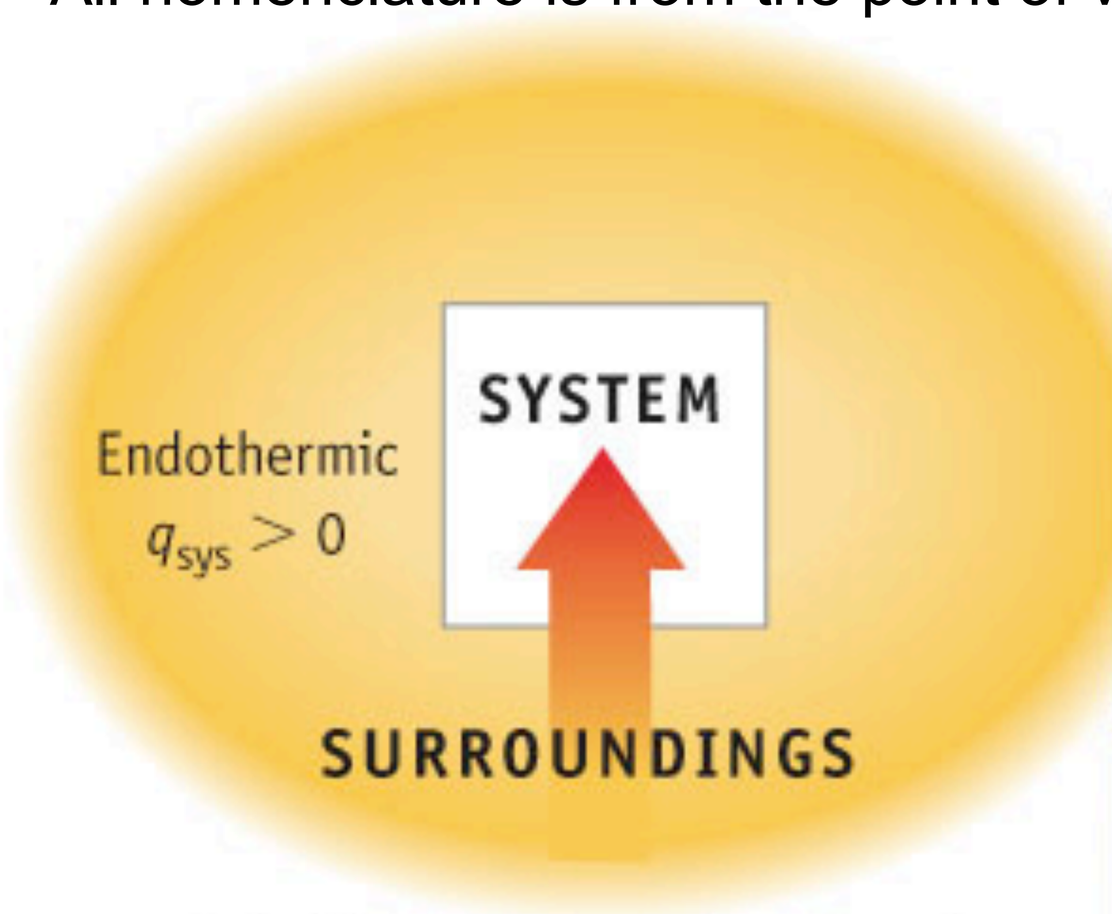


Fig. 5-6, p. 214

Endothermic: energy transfer **into** system

All nomenclature is from the point of view of the *system*



Endothermic: energy transferred from surroundings to system

Fig. 5-6, p. 214

Temperature reflects molecular kinetic energy (thermal)

T = 21°C	T = 55°C

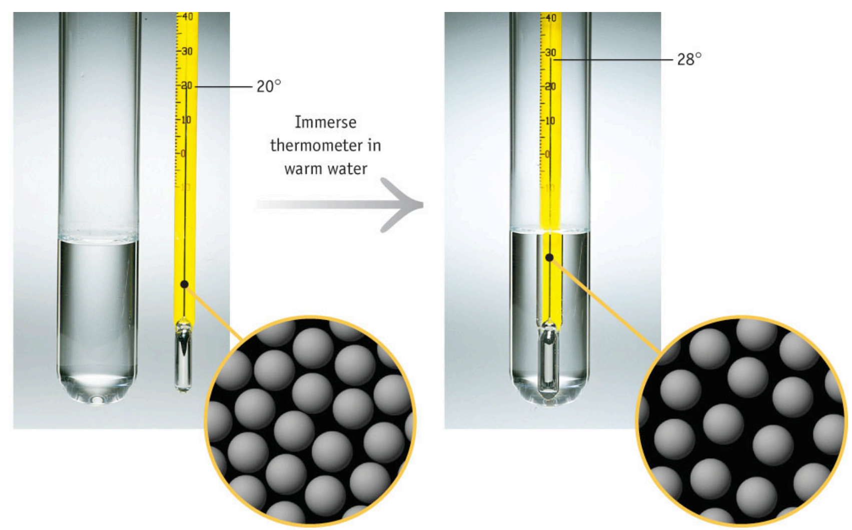


Fig. 5-3, p. 211

Temperature reflects molecular kinetic energy (thermal)

T = 21°C	T = 55°C

Transfer of thermal energy is *spontaneous*

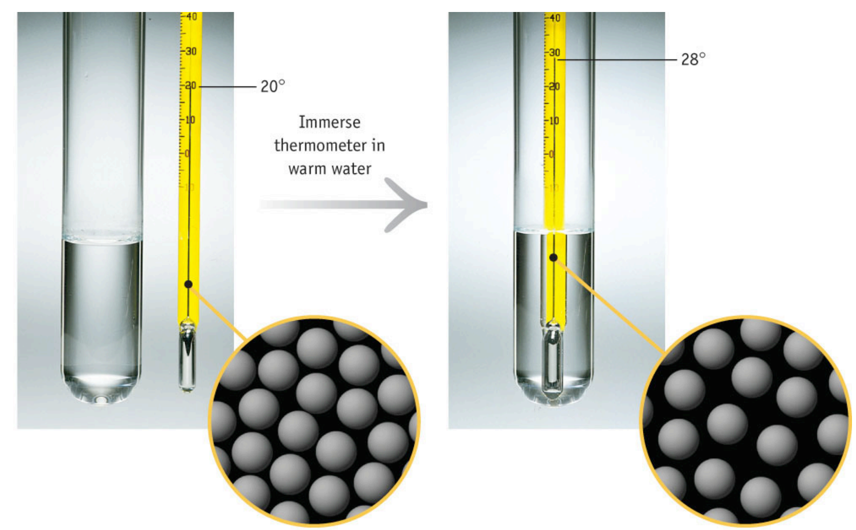
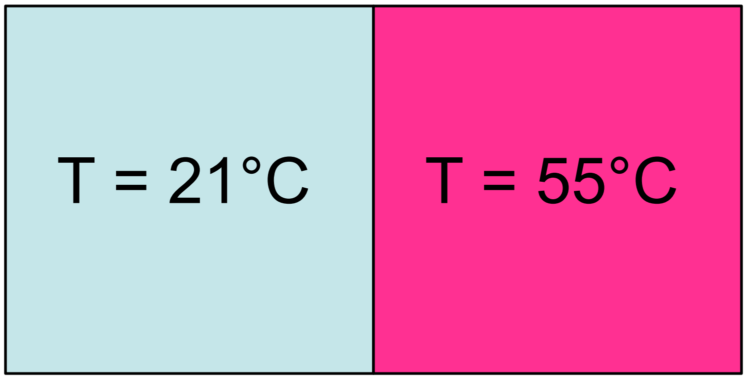
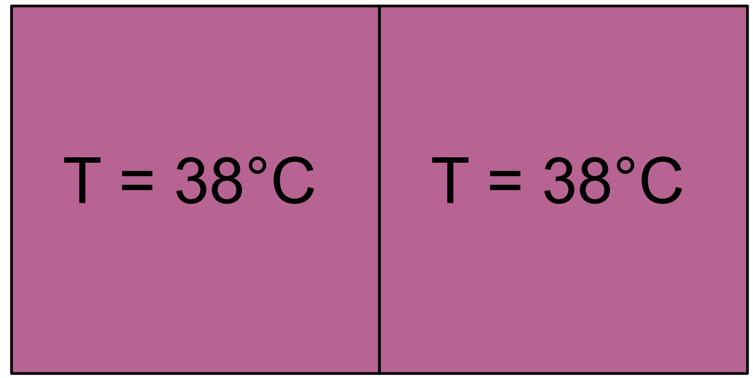


Fig. 5-3, p. 211

Temperature reflects molecular kinetic energy (thermal)





Thermal Equilibrium

Transfer of thermal energy is *spontaneous*

Continues until the system reaches thermal equilibrium

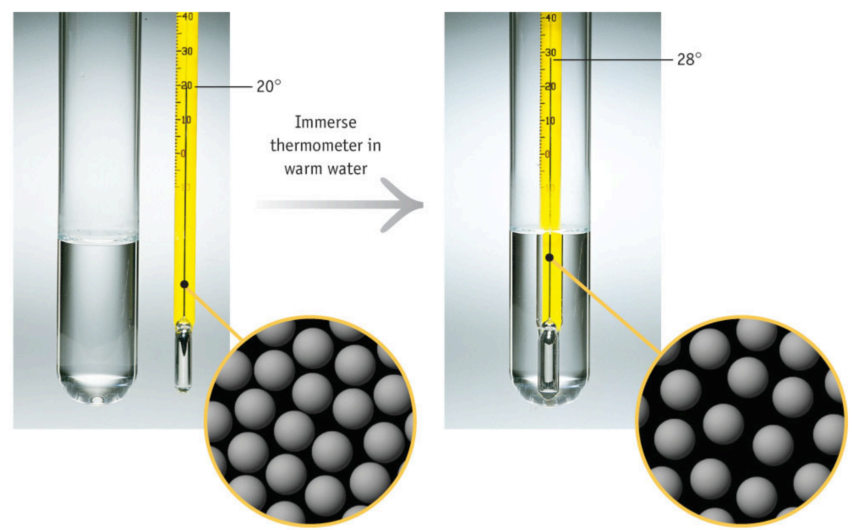
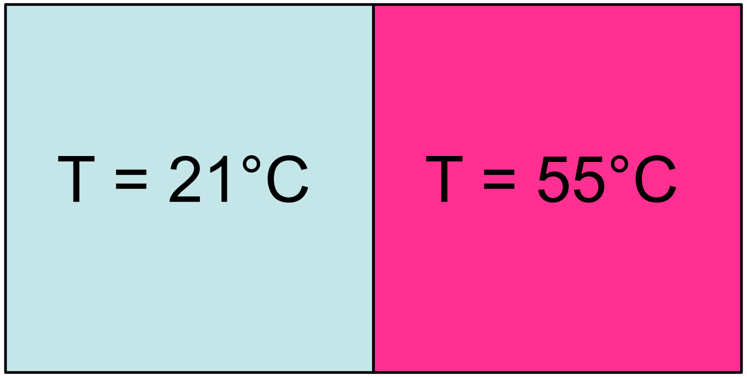
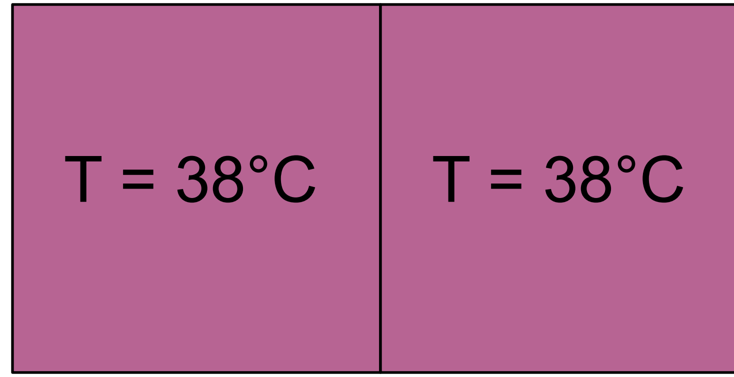


Fig. 5-3, p. 211

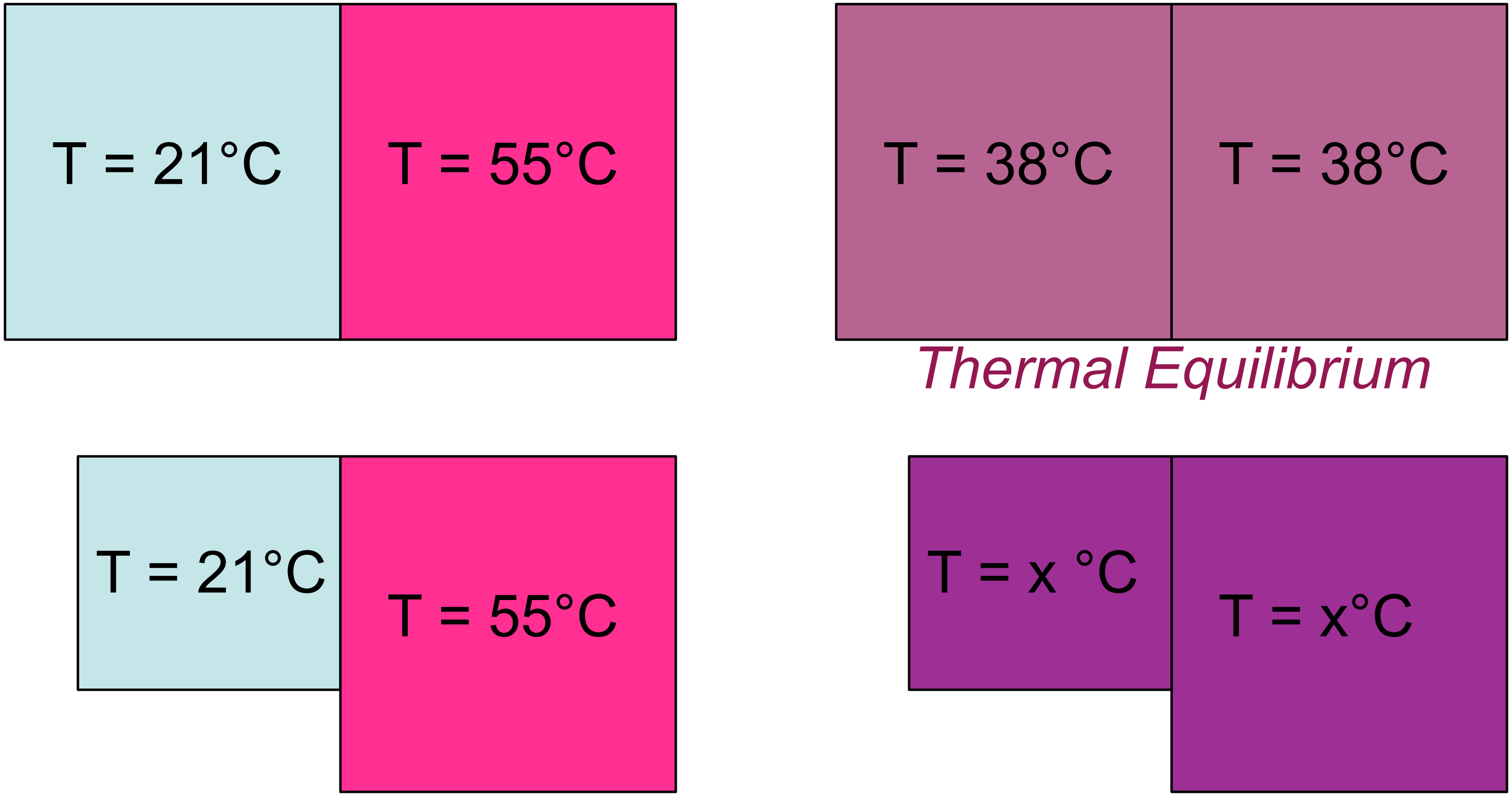
Temperature reflects molecular kinetic energy



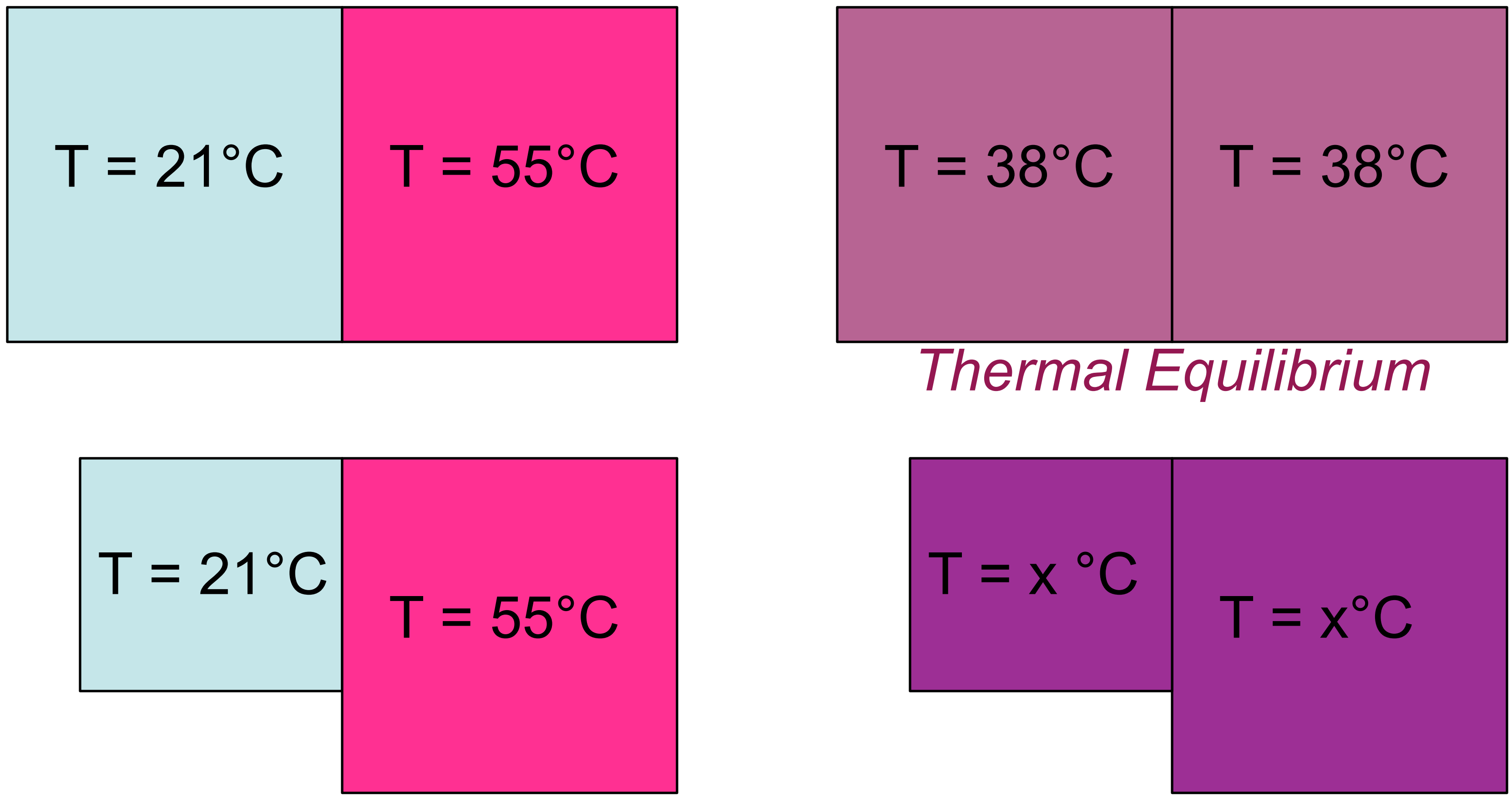


Thermal Equilibrium

Temperature reflects molecular kinetic energy



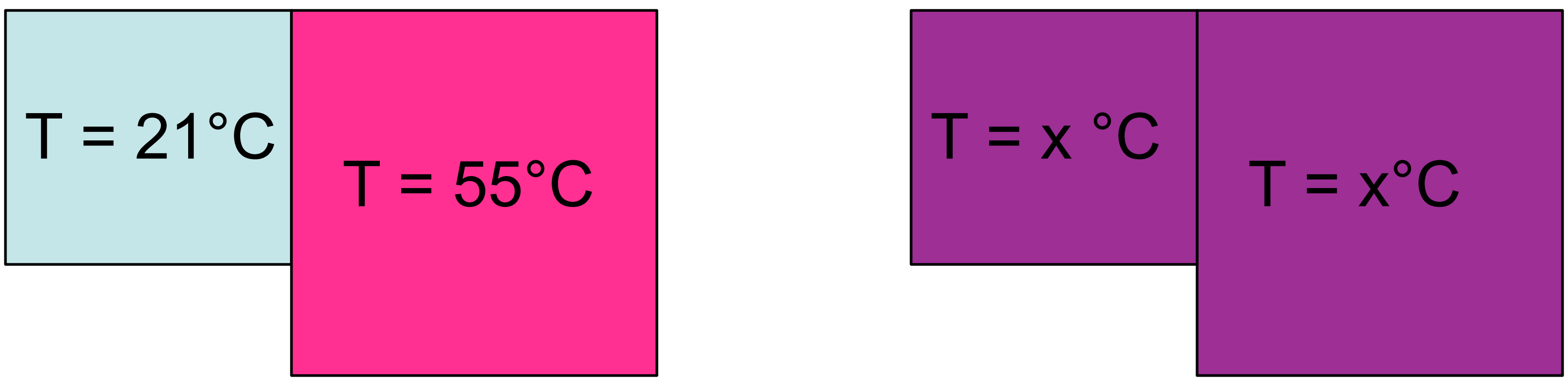
Temperature reflects molecular kinetic energy



Is x **(1) less** than 38°C or **(2) greater** than 38°C?

Temperature reflects molecular kinetic energy

Mass matters

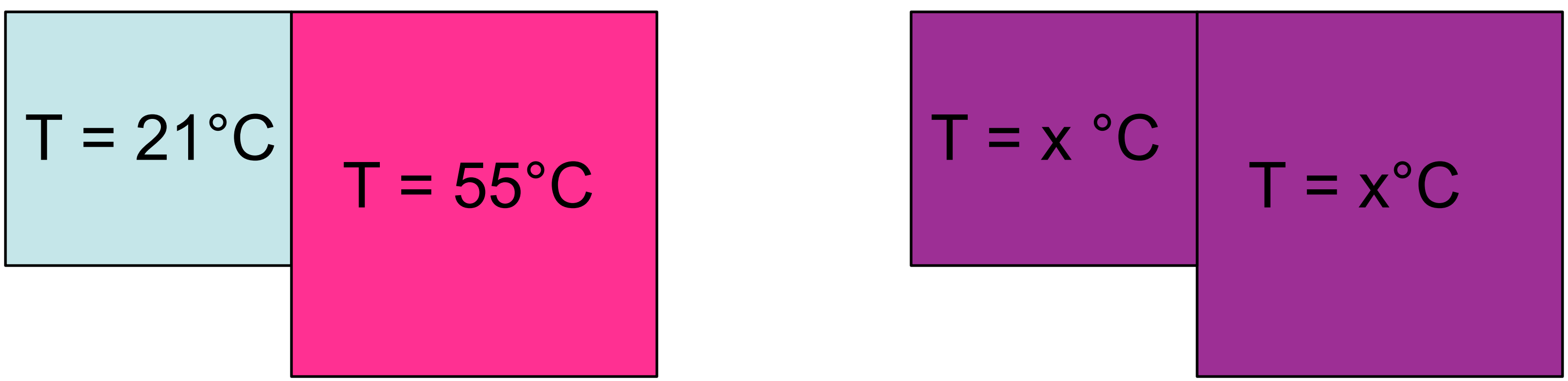


Is x **(1) less** than 38°C or **(2) greater** than 38°C?

Temperature reflects molecular kinetic energy

Mass matters

Heat Capacity matters



Is x **(1) less** than 38°C or **(2) greater** than 38°C?

$$q = Cm\Delta T$$

Energy (q) required to change the temperature (ΔT) of a given mass (m) of a substance with a specific heat capacity (C)

p. 216

$$q = Cm\Delta T$$

Energy (q) required to change the temperature (ΔT) of a given mass (m) of a substance with a specific heat capacity (C)

$$q = \left(0.385\ \frac{\text{J}}{\text{g}\cdot\text{K}}\right)(10.0\ \text{g})(\underset{\substack{\uparrow \\ T_{\text{final}} \\ \text{Final temp.}}}{598\ \text{K}} - \underset{\substack{\uparrow \\ T_{\text{initial}} \\ \text{Initial temp.}}}{298\ \text{K}}) = +1160\ \text{J}$$

$$q = Cm\Delta T$$

Energy (q) required to change the temperature (ΔT) of a given mass (m) of a substance with a specific heat capacity (C)

$$q = \underbrace{\left(0.385\ \frac{\text{J}}{\text{g} \cdot \text{K}}\right)}_{\text{C}} (10.0\ \text{g})(\underbrace{598\ \text{K}}_{\substack{T_{\text{final}} \\ \text{Final temp.}}} - \underbrace{298\ \text{K}}_{\substack{T_{\text{initial}} \\ \text{Initial temp.}}}) = +1160\ \text{J}$$

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$$q = \underbrace{\left(0.385\ \frac{\text{J}}{\text{g}\cdot\text{K}}\right)}_{C}\underbrace{(10.0\ \text{g})}_{m}\underbrace{(598\ \text{K} - 298\ \text{K})}_{\Delta T} = +1160\ \text{J}$$

T_{final} Final temp.

$T_{initial}$ Initial temp.

$$q = Cm\Delta T$$

Energy (q) required to change the temperature (ΔT) of a given mass (m) of a substance with a specific heat capacity (C)

$$q = \overset{C}{\overline{\left(0.385\ \frac{\text{J}}{\cancel{\text{g}}\cdot\text{K}}\right)}}\ \overset{m}{\overline{(10.0\ \cancel{\text{g}})}}\ \overset{\Delta T}{\overline{(\underset{\substack{\uparrow \\ T_{\text{final}} \\ \text{Final temp.}}}{598\ \text{K}} - \underset{\substack{\uparrow \\ T_{\text{initial}} \\ \text{Initial temp.}}}{298\ \text{K}})}} = +1160\ \text{J}$$

p. 216

$$q = Cm\Delta T$$

Energy (q) required to change the temperature (ΔT) of a given mass (m) of a substance with a specific heat capacity (C)

$$q = \overbrace{\left(0.385\ \frac{\text{J}}{\cancel{\text{g}}\cdot\cancel{\text{K}}}\right)}^{\text{C}}\overbrace{(10.0\ \cancel{\text{g}})}^{\text{m}}\overbrace{(\underset{\substack{\uparrow\\ T_{\text{final}}\\ \text{Final temp.}}}{598\ \cancel{\text{K}}} - \underset{\substack{\uparrow\\ T_{\text{initial}}\\ \text{Initial temp.}}}{298\ \cancel{\text{K}}})}^{\Delta\text{T}} = +1160\ \text{J}$$

p. 216

$$q = Cm\Delta T$$

$$q = \underbrace{\left(0.385\ \frac{\text{J}}{\text{g}\cdot\text{K}}\right)}_{C}\underbrace{(10.0\ \text{g})}_{m}\underbrace{(\underbrace{598\ \text{K}}_{\substack{T_{\text{final}}\\ \text{Final temp.}}} - \underbrace{298\ \text{K}}_{\substack{T_{\text{initial}}\\ \text{Initial temp.}}})}_{\Delta T} = +1160\ \text{J}$$

$$q = Cm\Delta T$$

Specific heat capacity
(per gram)

$$q = \underbrace{\left(0.385 \frac{\mathrm{J}}{\mathrm{g \cdot K}}\right)}_{}^{C} \overbrace{(10.0\ \mathrm{g})}^{m} \overbrace{(\underset{\substack{\uparrow \\ T_{\text{final}} \\ \text{Final temp.}}}{598\ \mathrm{K}} - \underset{\substack{\uparrow \\ T_{\text{initial}} \\ \text{Initial temp.}}}{298\ \mathrm{K}})}^{\Delta T} = +1160\ \mathrm{J}$$

$$q = Cm\Delta T$$

Specific heat capacity
(per gram)

mass

$$q = \underbrace{\left(0.385\ \frac{\text{J}}{\text{g}\cdot\text{K}}\right)}_{C}\underbrace{(10.0\ \text{g})}_{m}\underbrace{(598\ \text{K} - 298\ \text{K})}_{\Delta T} = +1160\ \text{J}$$

T_{final} Final temp.

$T_{initial}$ Initial temp.

$$q = Cm\Delta T$$

Specific heat capacity
(per gram)

mass

Temperature
(in Kelvin)

$$\underbrace{C}\quad\underbrace{m}\quad\underbrace{\Delta T}$$

$$q = \left(0.385\ \frac{\text{J}}{\text{g}\cdot\text{K}}\right)(10.0\ \text{g})(598\ \text{K} - 298\ \text{K}) = +1160\ \text{J}$$

T_{final}
Final temp.

$T_{initial}$
Initial temp.

The absolute temperature scale (Kelvin)

$$T_K = T_C + 273 \qquad\qquad T_C = \frac{5}{9}\left(T_F - 32\right)$$

What's special about Kelvin?

1) He copyrighted the name
2) The scale reflects molecular motion (0=no motion)
3) Larger numbers reflect better precision

The absolute temperature scale (Kelvin)

$$T_K = T_C + 273 \qquad\qquad T_C = \frac{5}{9}\left(T_F - 32\right)$$

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Always (always, always) use Kelvin

Always (always, always) use Kelvin

OK, there's one place you can cheat: ΔT

Always (always, always) use Kelvin

OK, there's one place you can cheat: ΔT

Why can you cheat?

Always (always, always) use Kelvin

OK, there's one place you can cheat: ΔT

Why can you cheat?

$$\Delta T = T_K^{final} - T_K^{initial}$$

$$\Delta T = \left(T_C^{final} + 273\right) - \left(T_C^{initial} + 273\right)$$

$$\Delta T = T_C^{final} + \cancel{273} - T_C^{initial} - \cancel{273}$$

$$\Delta T = T_C^{final} - T_C^{initial}$$

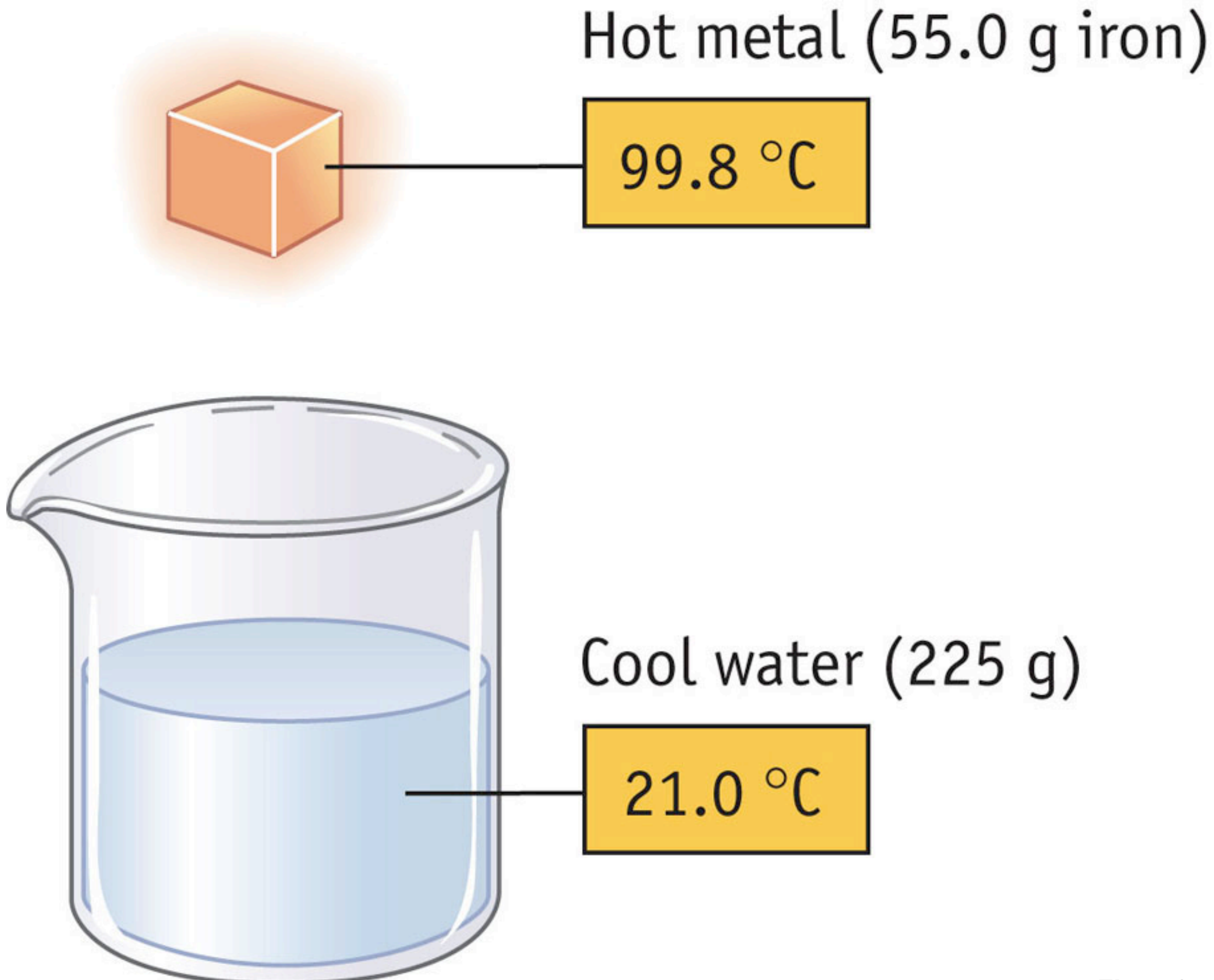

Fig. 5-8, p. 217