Temperature

Molecular level: measure of average kinetic energy.

Existence of molecules from Brownian motion.

1 a.m.u. is 1.66×10^{-27} kg.

1

(**1**) If $1\,\text{m}^3$ of CU has a mass of 63 amu and $\rho = 8.9 \times 10^3 \,\text{kg/m}^3$, how many atoms does it have?

(**2**) Roughly how far apart are they?

2

Temperature Scales

$$°C = \frac{5}{9}\left[°F - 32\right]$$

$$°C = °K - 273.15$$

(**3**) Water boils at $100°$ C. What's it in $°$F and $°$K?

3

Thermal Equilibrium: No heat flow: same temperature.

If A is in thermal equilibrium with B and B with C, then A is in thermal equilibrium with C.

Thermal conductivity: Capacity of an object to conduct heat.

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Heat flows from high temperature to low.

Heat is transferred in one (or more) of three ways: energy transfer by direct contact (_____), by actual movement of molecules (_____), or carried through space (_____).

(**4**) How does heat get to us from the sun?

_____

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Thermal Expansion

Linear:
$$\Delta \ell = \alpha \ell_0 \Delta T$$

α: coefficient of linear expansion.

Volume:
$$\Delta V = \beta V_0 \Delta T$$

β: coefficient of volume expansion.

6 Units of both are inverse temperature.

ADDITIONAL NOTES

(**5**) Steel has $\alpha = 12 \times 10^{-6}$ per $°$. If a steel bridge has length $\ell_0 = 200$ m at $20°$ C, what are the range of lengths it can have between $-30°$ C and $40°$ C?

1)

2)

Positive is expansion, negative is contraction.

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Heat usually causes expansion, and cooling causes contraction.

But there are anomalies: e.g., water contracts a bit as it cools, till $4°$ C. After that it expands again to the point that when it turns to ice, the volume is greater than that of the orginal water.

(**6**) Why did you already know that? _____

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Gas laws
$$PV \propto T$$
Historically:

1) $V \propto \dfrac{1}{P}$, Boyle's Law (T constant)

2) $V \propto T$, Charle's Law (P constant)

2) $P \propto T$, Gay-Lussac's Law (V constant)

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Moles

A mole is the amount of substance whose mass in grams equals its molecular mass.

It contains 6.02×10^{23} molecules. (Avogadro's number.)

10

(**7**) How many moles in 132 g of 44 amu of a substance?

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Gas law
$$PV = nRT$$

where n is the number of moles, and $R = 8.314$ J/(moles·$°$K).

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ADDITIONAL NOTES

Other units of heat:

One calorie (cal) is 4.186 J.

One kilo-calorie is 4.186 kJ.

A dietary calorie (Cal) is a kilo-calorie.

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Specific and Latent Heats

Specific heat: Amount of heat needed to raise the temperature of a unit mass by $1°$ C.

$$Q = mc\Delta T$$

where c is the specific heat of the substance.

Latent heat (for phase transitions): $Q = mL$.

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ADDITIONAL NOTES

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