

Module 2.1

Introduction to S.I units

Learning Outcomes

- On successful completion of this module learners will be able to
 - Describe some of the S.I units relevant to energy use in buildings.

- S.I = The International System of Units abbreviated SI from the French name *le Système international d'unités*
- This is the modern form of the metric system.
- S.I is a system of units of measurement devised around seven base units and the convenience of the number ten.
- It is the world's most widely used system of measurement, both in everyday commerce and in science.

- Every day we use S.I. units.

Food is sold by the kilogram.



Drinks are sold by the litre.



Energy is sold by the kilowatt.



Distance are measured in metres or kilometres.

- People will use only the S.I. units that they need.
- Everyone does not need to understand the exact definition of each unit to be able to use those units.
- This module will only refer to a very small proportion of all possible S.I. units.

S.I base units (seven)

Quantity	Units	Symbol
Length	meter	M
Mass	Kilogram	Kg
Time	Second	S
Electric current	Ampere	A
Temperature	Kelvin	K
Amount of substance	Mole	mol
Luminous intensity	Candela	cd

- S.I. derived units

- Other quantities, called derived quantities, combine one or more of the seven base units to form derived units.
- Example using one base unit of length.

Base units of length = metre – m

Derived unit of area = square metre – m².

Derived unit of volume = cubic metre – m³.

- S.I. derived units - continued

- Examples using length and time.

Base units of length = metre – m

Base unit of time = second = s

Velocity or speed = distance
time

Derived units = metre (m)

second (s)

Derived units = m / s.

Units outside of the SI system

- Certain units are not part of the International System of units, but yet they are widely used.
- Often such units are multiples of the seven base units.
- Examples – time.

Base unit of time = second = s

Outside SI system, 1 minute = 60 s,

1 hour = 60 min = 3600 s.

1 day = 24 h = 86400 s.

Units outside of the SI system – continued.

- Examples – mass.

Base unit of mass = kilogram = kg

Outside SI system

1 metric ton = 1000 kg.

- Examples – area.

Base unit of area = metre = m

Outside SI system

1 hectare = 1 hecta m^2 = 10000 m^2

Units outside of the SI system – continued.

- Units not using simple multiples of base units.
- Take the unit of power, i.e. Watt or kilowatt.
- This is used to describe the amount of electrical energy being transferred or used,

or the amount of heat energy being transferred.

- Working backwards from this unit.

1 Watt = 1 Joule / second (1 W = 1 J/s)

Joule (symbol J) = the unit of energy.

Units outside of the SI system – continued.

Take the unit of energy = Joule (symbol J)

Definition -

(a) One joule is defined as the amount of work done by a force of one newton moving an object through a distance of one metre.

Or described in terms of electrical energy

(b) The work required to move an electric charge of one coulomb through an electrical potential difference of one volt.

Units outside of the SI system – continued.

- Working backwards from definition (a).

A Newton (symbol N) is defined as the force necessary to provide a mass of 1 kg with an acceleration of 1 m per second per second.

Thus

The unit of power = Watt, can be related back to base units of mass (kilogram - kg) and time (seconds – s)

Units outside of the SI system – continued.

- Working backwards from definition (b).

The coulomb (symbol C) is the SI derived unit of electric charge, and is the charge transferred by a constant current of one ampere in one second.

Thus

The unit of power = Watt, can be related back to base units of current (ampere - A) and time (seconds – s)

Units outside of the  continued.

- As said earlier, you do not need to understand the exact definition of each unit to be able to use those units.

Units related to building energy use.

- Some common units used in relation to building energy use –
- Area meter squared m^2
- Temperature Kelvin K

Degree celsius $^{\circ}C$

- Energy use kilowatt hour kW h
- Thermal transmittance (U-value)

watts per meter squared per degree kelvin

Units = $W / m^2 K$

References:

- <http://physics.nist.gov/cuu/Units/units.html>.

Appendix

Some commonly used prefixes for SI units.

Prefix	Symbol	10^n	Description
tera	T	10^{12}	Trillion
giga	G	10^9	Billion
mega	M	10^6	Million
kilo	k	10^3	Thousand
hecto	h	10^2	Hundred
deca	da	10^1	Ten
		10^0	One
deci	d	10^{-1}	Tenth
centi	c	10^{-2}	Hundreth
milli	m	10^{-3}	Thousandth
micro	μ	10^{-6}	Millionth
nano	n	10^{-9}	Billionth
pico	p	10^{-12}	Trillionth

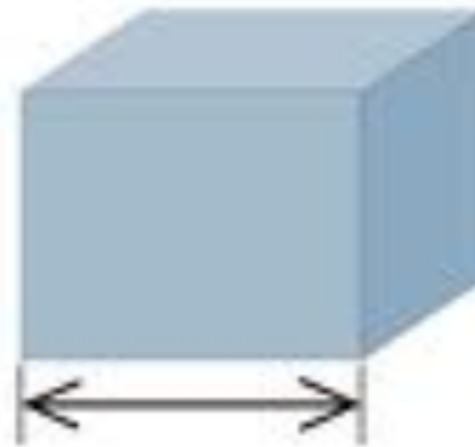
- Scientific Definition:

A unit is a particular physical quantity, defined and adopted by convention, with which other particular quantities of the same kind are compared to express their value.

- The definition of each of the seven base units of the SI is carefully drawn up so that it is unique and provides a sound theoretical basis upon which the most accurate and reproducible measurements can be made.

- Unit of length – meter.

Scientific Definition – The meter is the length of the path travelled by light in vacuum during a time interval of $1/299\,792\,458$ of a second.



- Unit of mass - kilogram.

Scientific Definition – The kilogram is equal to the mass of the international prototype of the kilogram as kept at the International Bureau of Weights and Measures .



- Unit of time – second.

Scientific Definition - The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom

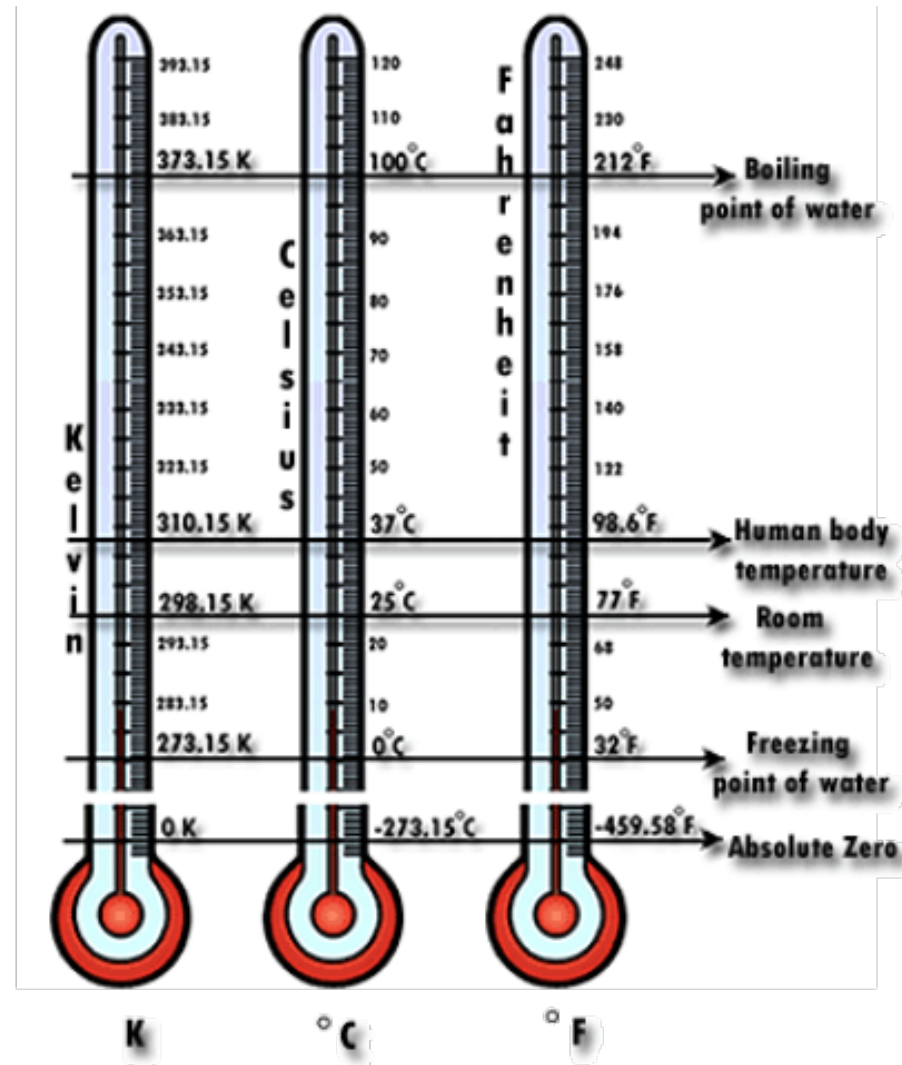


- Unit of electric current – ampere.

Scientific Definition - The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 meter apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per meter of length



- Unit of thermodynamic temperature – kelvin.
 Scientific Definition -
 The kelvin, unit of thermodynamic temperature, is the fraction $1/273.16$ of the thermodynamic temperature of the triple point of water.



- Unit of amount of substance – mole.

Scientific Definition - The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12; its symbol is "mol."



- Unit of luminous intensity - candela .

Definition - The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540×10^{12} hertz and that has a radiant intensity in that direction of $1/683$ watt per steradian.

