Constants

Physical constants

Speed of light in vacuum or air	c	$= 3.00 \times 10^{8}$ m s^{-1}
Electron charge	e	$= -1.60 \times 10^{-19}$ C
Electron volt	1 eV	$= 1.60 \times 10^{-19}$ J
Unified atomic mass unit	1 u	$= 1.66 \times 10^{-27}$ kg
Mass of electron	m_e	$= 9.11 \times 10^{-31}$ kg
Mass of proton	m_p	$= 1.67 \times 10^{-27}$ kg
Mass of neutron	m_n	$= 1.68 \times 10^{-27}$ kg
Mass of alpha particle	m_α	$= 6.65 \times 10^{-27}$ kg
Mass–energy equivalent	1 u	= 931 MeV
Tonne	1 tonne	$= 10^{3}$ kg $= 10^{6}$ g
Absolute zero	0 K	= -273 °C

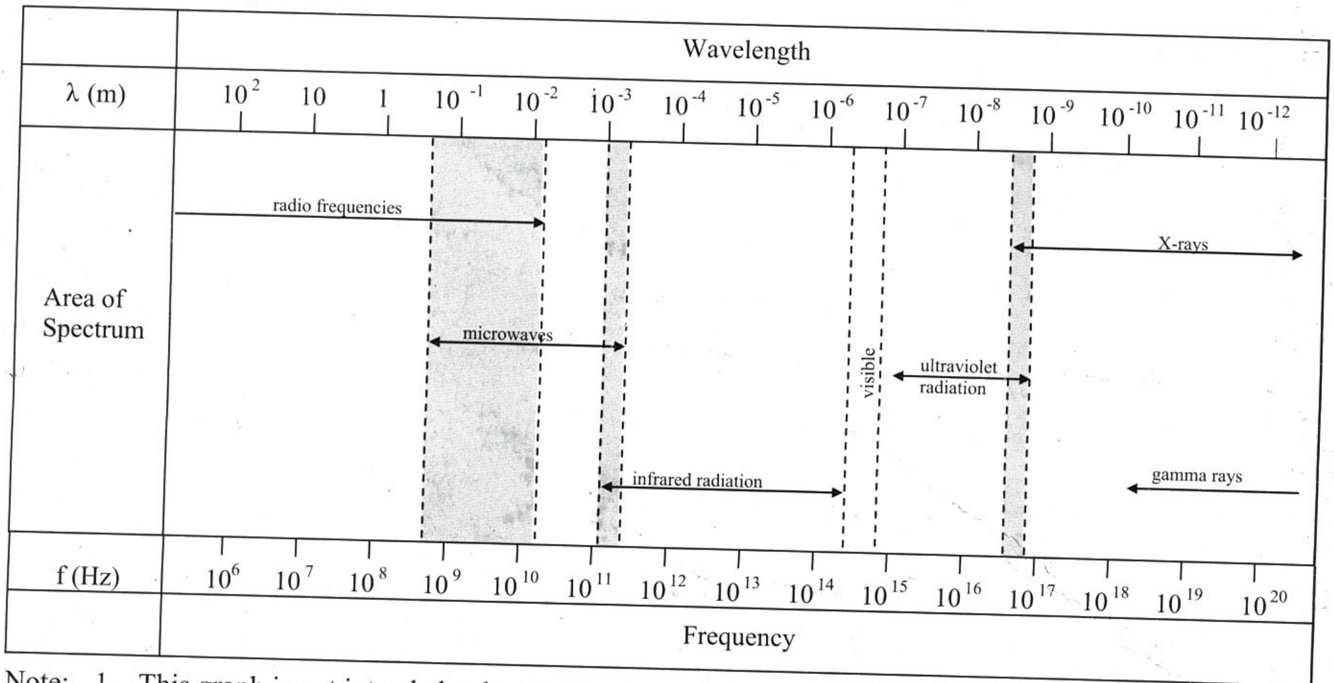
Physical data

Mean acceleration due to gravity on Earth	g	$= 9.80$ m s^{-2}
Specific heat capacity of water	c_w	$= 4.18 \times 10^{3}$ J kg^{-1} K^{-1}
Specific heat capacity of ice	c_i	$= 2.10 \times 10^{3}$ J kg^{-1} K^{-1}
Specific heat capacity of steam	c_s	$= 2.00 \times 10^{3}$ J kg^{-1} K^{-1}
Latent heat of fusion for H_2O	L_f	$= 3.34 \times 10^{5}$ J kg^{-1}
Latent heat of vaporisation for H_2O	L_v	$= 2.26 \times 10^{6}$ J kg^{-1}
Speed of sound in air at 25 °C	V_s	= 346 ms^{-1}

Quality factors

Approximate quality factor for alpha radiation	QF_α	= 20
Approximate quality factor for beta radiation	QF_β	= 1
Approximate quality factor for gamma radiation	QF_γ	= 1
Approximate quality factor for slow neutrons	QF_{sn}	= 3
Approximate quality factor for fast neutrons	QF_{fn}	= 10

Electromagnetic spectrum



Note:
1. This graph is not intended to be used for accurate measurement.
2. Shaded areas represent regions of overlap.
3. Gamma rays and X-rays occupy a common region.

Chapter 3

Specific Heat Capacity

Notes

The specific heat capacity of a pure substance is the ratio of the heat energy added to (or removed from) a sample of that substance to the resulting temperature change, per kilogram of the substance.
We express specific heat capacity mathematically as

$$c = \frac{Q}{m\,(T_{final} - T_{initial})} \qquad \text{or} \qquad c = \frac{Q}{m\Delta T}$$

where **Q** is the quantity of energy absorbed or released, in J
m is the mass of substance in kg
(T_{final} - $T_{initial}$) or **ΔT** is the change in temperature in either K or °C.
c is the specific heat capacity of the substance in J kg^{-1} K^{-1} or J kg^{-1} $°C^{-1}$

The units that we use to measure specific heat capacity in the SI (international system) are joules per kilogram per degree. As long as T_{final} and $T_{initial}$ are both expressed in the same unit it does not matter whether T is measured in degrees Celsius (°C) or in kelvins (K).

The expression above can also be written as

$$Q = m\,c\,(T_{final} - T_{initial}) \quad \text{or} \quad Q = m\,c\,\Delta T$$

For example, if 4.18×10^3 J of energy is added to 1.00 kg of water, the temperature of the water rises by 1.00 °C (or 1.00 K). The specific heat capacity of water is therefore 4.18×10^3 J kg^{-1} K^{-1}, or 4.18×10^3 J kg^{-1} $°C^{-1}$.

Where appropriate, use the following data in the problems in this chapter:
Density of water = 1.00×10^3 kg m^{-3}

Substance	Specific Heat Capacity	Substance	Specific Heat Capacity
air	1000	ice	2100
alcohol (ethanol)	2430	lead (solid)	130
aluminium	900	lead (liquid)	105
brass	380	olive oil	1650
copper	390	cast iron	460
ethelene glycol	2400	stainless steel	445
glass	670	steam (at 110 °C)	2010
human body (average)	3500	water	4180

Table of Specific Heat Capacities (J kg^{-1} K^{-1})

Principle of Mixtures
When two substances with different temperatures mix, the cooler substance will gain heat whilst the hotter substance will lose heat. In an isolated system, this heat exchange will continue until they reach thermal equilibrium, at which time both substances have the same temperature.
If the mixture does not lose heat to or gain heat from its surroundings, then the heat lost by one substance will equal the heat gained by the other substance. This is what we mean by an 'isolated system'.
This works even if the two substances are the same; for example, when we mix hot and cold water. The end result can be predicted by treating the hot water and the cold water as separate items even though they mix completely.