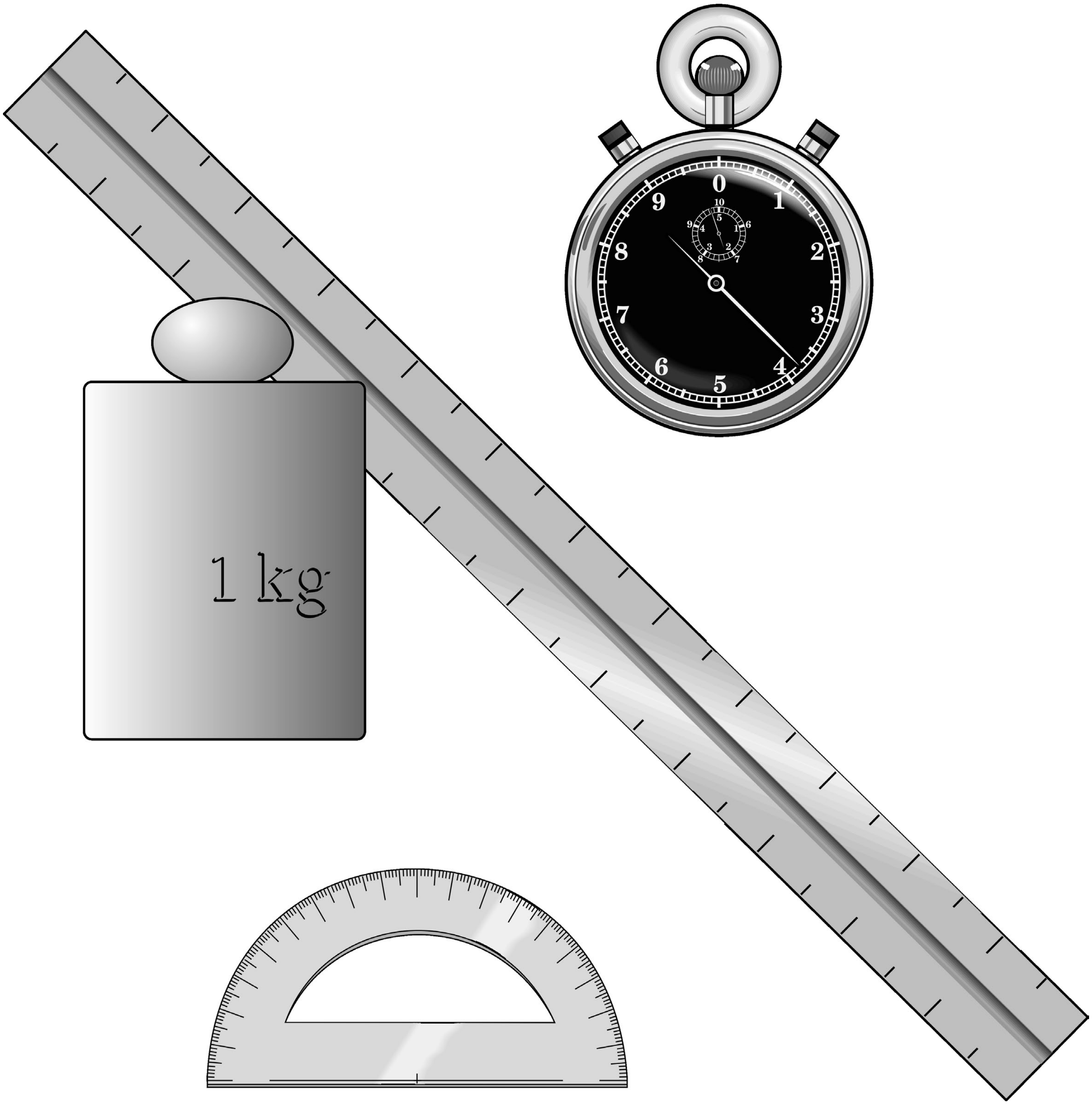
1 kg
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1. SI units of measurement

The basic units

The Laws of Physics are expressions of fundamental relationships between certain physical quantities.

There are many different quantities in physics. In order to simplify measurement and to comply with the theory of physics, some of them are taken as basic quantities, while all others are derived from those basic ones.

Measurements are made by comparing the magnitude of a quantity with that of a given unit of that quantity.

In physics, which Electronics and Television are a part of, the ***International system of units*****,** known as **SI** (from the French *Système Internationale*), is used.

The following are **the seven basic units**:

Unit	**Symbol**	**Measures**
Meter	[m]	length
Kilogram	[kg]	mass
Second	[s]	time
Ampere	[A]	electric current
Kelvin	[K]	temperature
Candela	[cd]	luminous intensity
Mole	[mol]	amount of substance

These basic units are defined by internationally recognized standards.

The standard for meter, for example, until 1983 was defined as a certain number of wavelengths of a specific radiation in the spectrum of krypton. In October 1983 it was redefined as the distance that light travels in vacuum during a time of 1/299,792,458 second.

The standard of kilogram, for example, is the mass of a particular piece of platinum-iridium alloy cylinder kept at the International Bureau of Weights and Measurements in Sèvres, France.

The basic unit of time, the second, was defined in 1967, as a "time required for a Cesium-133 atom to undergo 9,192,631,770 vibrations."

Kelvin degrees have the same scale division as Celsius degrees, only that the starting point of 0° K is equivalent to –273° C and this is called the ***absolute zero***.

All other units in physics are defined with some combination of the above-mentioned basic units. For example, an area of a block of land is defined by the equation:

$$P = a \times b$$

where a is the width of the block of land, and b is the length. If both a and b are expressed in meters [m], the product P will be expressed in [m^2]. We should mention that in mathematics the multiplication is not always represented with the × sign as above, but very often a dot · is used in between the factors being multiplied, or sometimes even without a symbol at all.

We all know that speed, for example, is defined as [m/s], although we quite often use [km/h]. We can easily convert [km/h] into [m/s] by knowing how many meters there are in a kilometer and how many seconds there are in an hour.

SI units are almost universally accepted in science and industry throughout the world, and we should all be aware that measurements like "inches" for length, "miles per hour" for speed and "pounds or stones" for weight should be used as little as possible. They often cause confusion in people from various professions and various parts of the world. If you use SI units, more people will understand you and your product. Also, it is easier to compare products from various parts of the world if they use the same units.

Another very important thing to clarify is that every symbol in the SI system has a precise meaning relative to the letter used (capital or small). So, a kilometer is written as [km], not [Km] or [klm]. A megabyte is written as [MB], not [mB]. A nanometer is written as [nm], not [Nm] and so on. As technical people involved in closed circuit television, we should stick to these principles.

Derived units

All other physical processes can be explained and measured using the basic units. We will not go into the details of how they are obtained, nor is it the purpose of this book to do so, but it is important to understand that there is always a fundamental relation between the basic and derived unit.

The following are some of the derived SI units, some of which will be used in this book:

Quantity	Unit	Symbol / Definition
Area	Square meter	m^2
Volume	Cubic meter	m^3
Velocity	Meters per second	m/s
Acceleration	Meters per second per second	m/s^2
Frequency	Hertz	Hz = 1/s
Density	Kilograms per cubic meter	kg/m^3
Force	Newton	$N = kg \cdot m/s^2$
Pressure	Pascal	$Pa = kg/m \cdot s^2$
Torque	Newton meter	$T = N \cdot m$
Energy, work	Joule	$J = N \cdot m$
Power	Watt	W = J/s
Electric charge	Coulomb	$C = A \cdot s$
Electric potential	Volt	$V = \Omega/A$
Electrical resistance	Ohm	$\Omega = V/A$
Electrical capacitance	Farad	F = C/V
Conductance	Siemens	S = A/V
Magnetic flux	Weber	$Wb = V \cdot s$
Magnetic field intensity	Tesla	$T = Wb/m^2$
Inductance	Henry	H = Wb/A
Illumination	Lux	$lx = lm/m^2$
Luminous flux	Lumen	lm = cd·steradian
Luminance	Nit	$nt = cd/m^2$

Metric prefixes

When the number of units (i.e., the value) for a particular measurement is very high or very small, there is a convention for using certain symbols before the basic unit and each has a specific meaning. The following are metric prefixes accepted by the international scientific and industrial community that you may find not only in CCTV but also in other technical area:

Prefix	Multiple	Symbol
exa-	10^{18}	E
peta-	10^{15}	P
tera-	10^{12}	T
giga-	10^{9}	G
mega-	10^{6}	M
kilo-	10^{3}	k
hecto-	10^{2}	h
deca-	10	D
unity	$10^{0} = 1$	
deci-	10^{-1}	d
centi-	10^{-2}	c
milli-	10^{-3}	m
micro-	10^{-6}	μ
nano-	10^{-9}	n
pico-	10^{-12}	p
femto-	10^{-15}	f
atto-	10^{-18}	a

By using these prefixes, we can say 2 km, referring to 2000 meters. If we say 1.44 MB, we are thinking of 1,440,000 bytes. A very common measurement of data transmission speed over networks is expressed in megabits per second (Mb/s), which is different from megabytes per second (MB/s). One byte is equal to 8 bits, and they are denoted with lower case “b” for bits and capital “B” for bytes. A nanometer will be

0.000000001 meters. The frequency of 12 GHz would be $12 \cdot 10^9$ = 12,000,000,000 Hz and so on.

A very common unit used these days in CCTV when handling hard disk drives is gigabytes (GB). One gigabyte is equal to thousand of megabytes, or a million of kilobytes. The correct value for binary 1 GB megabytes is 1024 MB (which is 2^{10}), and the correct binary value for 1 MB is 1024 kB. When hard disk manufacturers write 300 GB on their disks, this represents a decadic 300,000,000,000 bytes. So when such a hard disk is installed in the computer, the operating system reports 279 GB. This is the real binary value, and it is obtained by dividing 300,000,000,000 with 1024 to get kB, then with 1024 again to get MB, and finally with 1024 again to get GB.

Now that we have established the basics of a technically correct discussion that is, introduced the basic units of measurement, we can start with the fundamentals of all visions, including photography, cinematography, and television – ***light***.