EXAMPLE 2: At a temperature of 4°C, water is at its greatest density. What is the degree of Fahrenheit?

Solution:

$$
\begin{aligned}
{}^{\circ}F &= ({}^{\circ}C) \times \frac{9}{5} + 32 \\
&= 4 \times \frac{9}{5} + 32 \\
&= 7.2 + 32 \\
&= 39.2
\end{aligned}
$$

2 PREFIXES FOR SI UNITS

The prefixes commonly used in the SI system are based on the power 10. For example, a kilogram means 1000 grams, and a centimeter means one-hundredth of 1 meter. The most used prefixes are listed in Table 1.2, together with their abbreviations, meanings, and examples.

3 MATHEMATICS

Most calculations required by the water and wastewater plants operators and managers are depended on ordinary addition, subtraction, multiplication, and division. Calculations are by hand, by calculator, or by a computer. Engineers should master the formation of problems: daily operations require calculations of simple ratio, percentage, significant figures, transformation of units, flow rate, area and volume computations, density and specific gravity, chemical solution, and mixing of solutions.

Miscellaneous Constants and Identities

$$
\begin{aligned}
\pi &= 3.14 \text{ (pi)} \\
e &= 2.7183 \text{ (Napierian)} \\
x^{0} &= 1 (x > 0) \\
0^{x} &= 0 \ (x > 0)
\end{aligned}
$$

TABLE 1.2 Prefixes for SI Units

Prefix	Abbreviation	Multiplication factor	Example
tera	T	$1000000000000 = 10^{12}$	
giga	G	$1000000000 = 10^{9}$	
mega	M	$1000000 = 10^{6}$	
myria	my	$10000 = 10^{4}$	
kilo	k	$1000 = 10^{3}$	km, kg
hecto	h	$100 = 10^{2}$	
deka	da	$10 = 10^{1}$	
		$1 = 10^{0}$	meter (m), gram (g)
deci	d	$0.1 = 10^{-1}$	
centi	c	$0.01 = 10^{-2}$	cm
milli-	m	$0.001 = 10^{-3}$	mm, mg
micro	μ	$0.000001 = 10^{-6}$	μm, μg
nano	n	$0.000000001 = 10^{-9}$	
pico	p	$0.000000000001 = 10^{-12}$	
femto	f	$0.000000000000001 = 10^{-15}$	
atto	a	$0.000000000000000001 = 10^{-18}$	

3.1 Logarithms

Every positive number x can be expressed as a base b raised to a power y:

$$x = b^y$$

y is called the logarithm of x to the base b and is symbolized as

$$y = \log_b x$$

The logarithm of a number is the power to which the base must be raised to equal that number. Logarithms and exponential functions have numerous uses in engineering. Logarithms simplify arithmetic and algebraic computations according to the following rules:

$$\log_b(xy) = \log_b x + \log_b y$$

$$\log_b \frac{x}{y} = \log_b x - \log_b y$$

$$\log_b x^y = y\log_b x$$

The two most common bases are 10 and e. The exponential e is an irrational number resulting from an infinite series and is approximately equal to 2.71828.

Definitions:

$$\text{log base } 10 = \log_{10} = \log$$

$$\text{log base } e = \log_e = \ln$$

$$\text{log base } q = \log_q$$

where q is any positive number except 0 or 1.

Antilog$_q$, or $\log_q^{-1}$, is the number whose log value being stated for $\log_q x = m$.

EXAMPLE 1:

$$\log x = a \rightarrow x = 10^a$$

$$\text{since } 1000 = 10^3, \quad \text{i.e. } \log 1000 = 3$$

$$0.001 = 10^{-3}, \quad \text{i.e. } \log 0.001 = -3$$

$$\ln y = b \rightarrow y = e^b$$

$$\log_q z = c \rightarrow z = q^c$$

Given m, find

$$x = \log_q^{-1} m$$

EXAMPLE 2: Find log 3.46 and log 346.

Solution: The answer can be found in $\log_{10}$ tables or using a calculator or computer. We can obtain

$$\log 3.46 = 0.539, \quad \text{i.e. } 3.46 = 10^{0.539}$$

$$\log 346 = 2.539, \quad \text{i.e. } 346 = 10^{2.539}$$

If a positive number N is expressed as a power of e, we can write it as $N = e^p$. In this case, p is the logarithm of N to the base e (2.7183) or the natural logarithm of N and can be written as $p = \ln N$ or $p = \ln_e N$. More examples are as follows:

$$\ln 2 = 0.6931$$

$$\ln 10 = 2.3026$$