Unit 1 Physical Quantities and Measurements

1.1 Calculate the number of second in a (a) day (b) week (c) month and state your answers using SI prefixes.

Given Data

(a) $t = 1\ day$
(b) $t = 1\ week$
(c) $t = 1\ month$

To Find

$$No.\ of\ seconds\ in\ SI\ prefixes = ?$$

Solution

(a)
$$t = 1\ day$$
$$t = 1 \times 24 \times 60 \times 60\ s$$
$$t = 86400\ s$$
$$t = 8.64 \times 10^4\ s$$
$$t = 86.4 \times 10^{-1} \times 10^4\ s$$
$$t = 86.4 \times 10^{-1+4}\ s$$
$$t = 86.4 \times 10^3\ s$$
$$\boldsymbol{t = 86.4\ ks} \qquad \because k = 10^3$$

(b)
$$t = 1\ week$$
$$t = 1 \times 7 \times 24 \times 60 \times 60\ s$$
$$t = 604800\ s$$
$$t = 6.048 \times 10^5\ s$$
$$t = 604.8 \times 10^{-2} \times 10^5\ s$$
$$t = 604.8 \times 10^{-2+5}\ s$$
$$t = 604.8 \times 10^3\ s$$
$$\boldsymbol{t = 604.8\ ks} \qquad \because k = 10^3$$

(c)
$$t = 1\ month$$
$$t = 1 \times 30 \times 24 \times 60 \times 60\ s$$
$$t = 2592000\ s$$
$$t = 2.592 \times 10^6\ s$$
$$\boldsymbol{t = 2.592\ Ms} \qquad \because M = 10^6$$

1.2 State the answers of problem 1.1 in scientific notation.

Given Data

(a) $86.4\ ks$
(b) $604.8\ ks$
(c) $2.592\ Ms$

To Find

$$Answers\ in\ scientific\ notation = ?$$

Solution

(a)
$$86.4\ ks$$
$$= 86.4 \times 10^3\ s$$
$$= 8.64 \times 10^1 \times 10^3\ s$$
$$= 8.64 \times 10^{1+3}\ s$$
$$= \boldsymbol{8.64 \times 10^4\ s}$$

(b)
$$604.8\ ks$$
$$= 604.8 \times 10^3\ s$$
$$= 6.048 \times 10^2 \times 10^3\ s$$
$$= 6.048 \times 10^{2+3}\ s$$
$$= \boldsymbol{6.048 \times 10^5\ s}$$

(c)
$$2.592\ Ms$$
$$= \boldsymbol{2.592 \times 10^6\ s}$$

1.3 Solve the following addition or subtraction. State your answers in scientific notation.

(a) $\boldsymbol{4 \times 10^{-4}\ kg\ +\ 3 \times 10^{-5}\ kg}$
(b) $\boldsymbol{5.4\ \times 10^{-6}\ m - \ 3.2\ \times 10^{-5}\ m}$

Given Data

(a) $4 \times 10^{-4}\ kg\ +\ 3 \times 10^{-5}\ kg$
(b) $5.4\ \times 10^{-6}\ m - \ 3.2\ \times 10^{-5}\ m$

To Find

$$Answers\ in\ scientific\ notation = ?$$

Solution

(a)
$$4 \times 10^{-4}\ kg\ +\ 3 \times 10^{-5}\ kg$$
$$= 4 \times 10^{-4}\ kg\ +\ 0.3 \times 10^1 \times 10^{-5}\ kg$$
$$= 4 \times 10^{-4}\ kg\ +\ 0.3 \times 10^{1-5}\ kg$$
$$= 4 \times 10^{-4}\ kg\ +\ 0.3 \times 10^{-4}\ kg$$
$$= (4 + \ 0.3) \times 10^{-4}\ kg$$
$$= \boldsymbol{4.03 \times 10^{-4}\ kg}$$

(b)
$$5.4\ \times 10^{-6}\ m - \ 3.2\ \times 10^{-5}\ m$$
$$= 0.54\ \times 10^1 \times 10^{-6}\ m - \ 3.2\ \times 10^{-5}\ m$$
$$= 0.54\ \times 10^{1-6}\ m - \ 3.2\ \times 10^{-5}\ m$$
$$= 0.54\ \times 10^{-5}\ m - \ 3.2\ \times 10^{-5}\ m$$
$$= (0.54\ - 3.2) \times 10^{-5}\ m$$
$$= \boldsymbol{-2.66 \times 10^{-5}\ m}$$

1.4 Solve the following multiplication or division. State your answers in scientific notation.

(a) $\boldsymbol{(5\ \times 10^4\ m) \times (3 \times 10^{-2}\ m)}$
(b) $\boldsymbol{\frac{6 \times 10^8\ kg}{3 \times 10^4\ m^3}}$

Given Data

(a) $(5\ \times\ 10^4 m) \times (3 \times 10^{-2}\ m)$
(b) $\frac{6 \times 10^8\ kg}{3 \times 10^4\ m^3}$

To Find

$$Answers\ in\ scientific\ notation = ?$$

Solution

(a)
$$(5\ \times\ 10^4\ m) \times (3 \times 10^{-2}\ m)$$
$$= 5 \times 3 \times 10^{4-2}\ m^2$$
$$= 15 \times 10^2\ m^2$$
$$= 1.5 \times 10^1 \times 10^2\ m^2$$
$$= 1.5 \times 10^{1+2}\ m^2$$
$$= \boldsymbol{1.5 \times 10^3\ m^2}$$

(b)
$$\frac{6 \times 10^8\ kg}{3\ \times\ 10^4\ m^3}$$
$$= \frac{6}{3} \times 10^{8-4}\ kgm^{-3}$$
$$= \boldsymbol{2.0 \times 10^4\ kgm^{-3}}$$

1.5 Calculate the following and state your answer in scientific notation. $\boldsymbol{\frac{(3 \times 10^2\ kg) \times (4.0\ km)}{5 \times 10^2\ s^2}}$

Given Data

$$\frac{(3 \times 10^2\ kg)\ \times\ (4.0\ km)}{5 \times 10^2\ s^2}$$

To Find

$$Answers\ in\ scientific\ notation = ?$$

Solution

$$\frac{(3 \times 10^2\ kg)\ \times\ (4.0\ km)}{5 \times 10^2\ s^2}$$
$$= \frac{(3 \times 10^2\ kg)\ \times\ (4.0 \times 10^3\ m)}{5 \times 10^2\ s^2}$$

$$= \frac{3 \times 4.0}{5} \times 10^{2+3-2}\ kgms^{-2}$$
$$= \mathbf{2.4 \times 10^{3}\ kgms^{-2}}$$

1.6 State the number of significant digits in each measurement. (a) $0.0045\ m$ (b) $2.047\ m$ (c) $3.40\ m$ (d) $3.420 \times 10^{4}\ m$

Given Data

(a) $0.0045\ m$
(b) $2.047\ m$
(c) $3.40\ m$
(d) $3.420 \times 10^{4}\ m$

To Find

$$Significant\ digits = ?$$

Solution

(a) $0.0045\ m$ **2** $(Significant\ digits)$
(b) $2.047\ m$ **4** $(Significant\ digits)$
(c) $3.40\ m$ **3** $(Significant\ digits)$
(d) $3.420 \times 10^{4}\ m$ **4** $(Significant\ digits)$

1.7 Write in scientific notation: (a) $0.0035\ m$ (b) $206.4 \times 10^{2}\ m$

Given Data

(a) $0.0035\ m$
(b) $206.4 \times 10^{2}\ m$

To Find

$$Answers\ in\ scientific\ notation = ?$$

Solution

(a)
$$0.0035\ m$$
$$= \mathbf{3.5 \times 10^{-3}\ m}$$

(b)
$$206.4 \times 10^{2}\ m$$
$$= 2.064 \times 10^{2} \times 10^{2}\ m$$
$$= 2.064 \times 10^{2+2}\ m$$
$$= 2.064 \times 10^{4}\ m$$

1.8 Write using correct prefixes: (a) $5.0 \times 10^{4}\ cm$ (b) $580 \times 10^{2}\ g$ (c) $45 \times 10^{-4}\ s$

Given Data

(a) $5.0 \times 10^{4}\ cm$
(b) $580 \times 10^{2}\ g$
(c) $45 \times 10^{-4}\ s$

To Find

$$Correct\ prefixes = ?$$

Solution

(a)
$$5.0 \times 10^{4}\ cm$$
$$= 5.0 \times 10^{4} \times 10^{-2}\ m$$
$$= 5.0 \times 10^{4-2}\ m$$
$$= 5.0 \times 10^{2}\ m$$
$$= 0.5 \times 10^{1} \times 10^{2}\ m$$
$$= 0.5 \times 10^{1+2}\ m$$
$$= 0.5 \times 10^{3}\ m$$
$$= \mathbf{0.5\ km} \qquad (\boldsymbol{kilometer})$$

(b)
$$580 \times 10^{2}\ g$$
$$= 58.0 \times 10^{1} \times 10^{2}\ g$$
$$= 58.0 \times 10^{1+2}\ g$$
$$= 58.0 \times 10^{3}\ g$$
$$= \mathbf{58.0\ kg} \qquad (\boldsymbol{kilogram})$$

(c)
$$45 \times 10^{-4}\ s$$
$$= 4.5 \times 10^{1} \times 10^{-4}\ s$$
$$= 4.5 \times 10^{1-4}\ s$$
$$= 4.5 \times 10^{-3}\ s$$
$$= \mathbf{4.5\ ms} \qquad (\boldsymbol{millisecond})$$

1.9 Light year is a unit of distance used in Astronomy. It is the distance covered by light in one year. Taking the speed of light as $3.0 \times 10^{8}\ ms^{-1}$, calculate the distance.

Given Data

$$Speed\ of\ light = c = 3.0 \times 10^{8} ms^{-1}$$
$$Time = t = 1\ year$$
$$t = 1 \times 365 \times 24 \times 60 \times 60\ s$$
$$t = 31536000\ s$$
$$t = 3.1536 \times 10^{7}\ s$$

To Find

$$Distance\ covered = S = ?$$

Solution

By using formula of distance

$$S = vt$$
$$S = ct \qquad \because c = v$$
$$S = (3.0 \times 10^{8})(3.1536 \times 10^{7})$$
$$\boldsymbol{S = 9.5 \times 10^{15}\ m}$$

1.10 Express the density of mercury given as $13.6\ gcm^{-3}$ in kgm^{-3}.

Given Data

$$Density\ of\ mercury = 13.6\ gcm^{-3}$$

To Find

$$Density\ of\ mercury\ in\ kgm^{-3} = ?$$

Solution

$$13.6\ gcm^{-3}$$
$$= 13.6 \times \frac{1\ g}{1\ cm^{3}}$$
$$= 13.6 \times \frac{10^{-3} kg}{10^{-6} m^{3}} \quad \because 1\ g = 10^{-3} kg\ \&\ 1\ cm^{3} = 10^{-6} m^{3}$$
$$= 13.6 \times 10^{-3+6}\ kgm^{-3}$$
$$= 13.6 \times 10^{3}\ kgm^{-3}$$
$$= 1.36 \times 10^{1} \times 10^{3}\ kgm^{-3}$$
$$= 1.36 \times 10^{1+3}\ kgm^{-3}$$
$$= \mathbf{1.36 \times 10^{4}\ kgm^{-3}}$$