V Rule : The trailing zeros (zeros to the right of the last non-zero digit) in a number with a decimal point are significant. e.g. 01.080 has 4 SF.

VI Rule : The trailing zeros in a number without a decimal point are not significant e.g. 010100 has 3 SF. But if the number comes from some actual measurement then the trailing zeros become significant. e.g. m = 100 kg has 3 SF.

VII Rule : When the number is expressed in exponential form, the exponential term does not affect the number of S.F. For example in $x = 12.3 = 1.23 \times 10^1 = .123 \times 10^2 = 0.0123 \times 10^3 = 123 \times 10^{-1}$ each term has 3 SF only.

V Rule : The trailing zeros (zeros to the right of the last non-zero digit) in a number with a decimal point are significant. e.g. 01.080 has 4 SF.

Trailing zero

10.250 S.F = 5

1.50 S.F = 3

Trailing zero

VI Rule : The trailing zeros in a number without a decimal point are not significant e.g. 010100 has 3 SF. But if the number comes from some actual measurement then the trailing zeros become significant. e.g. m = 100 kg has 3 SF.

80800 SF = 3

9000 SF = 1

100 cm S.F = 3

100 S.F = 1

200 m/s S.F = 3

200 S.F = 1

Ex

10,100

S.F = 3

10.100

S.F = 5

VII Rule : When the number is expressed in exponential form, the exponential term does not affect the number of S.F. For example in $x = 12.3 = 1.23 \times 10^{1} = .123 \times 10^{2} = 0.0123 \times 10^{3} = 123 \times 10^{-1}$ each term has 3 SF only.

1230×10^{-2}

8.0×10^{2}

1.2×10^{-3} , SF = 2

$900 = 9 \times 10^{2}$

a

S.F = 1

1.800000

$1 \times 10^{+2}$ S.F = 1

$10800 = 1.08 \times 10^{4}$

S.F = 3

GOLDEN KEY POINTS

- To avoid the confusion regarding the trailing zeros of the numbers without the decimal point the best way is to report every measurement in *scientific notation* (in the power of 10). In this notation every number is expressed in the form $a \times 10^{b}$, where a is the base number between 1 and 10 and b is any positive or negative exponent of 10. The base number (a) is written in decimal form with the decimal after the first digit. While counting the number of SF only base number is considered (Rule VII).
- The *change in the unit of measurement of a quantity does not affect the number of SF.* For example in 2.308 cm = 23.08 mm = 0.02308 m = 23080 μm each term has 4 SF.

Q 1. Write the following in scientific notation :

(a) 3256 g (b) .0010 g (c) 50000 g (5 SF) (d) 0.3204

Q 2. Give the number of significant figures in the following :

(a) 0.165 (b) 4.0026 (c) 0.0256 (d) 165

(e) 0.050 (f) 2.653×10^4 (g) 6.02×10^{23} (h) 0.0006032

Q-1

(a) 3256 gm

3.256×10^3 gm S.f = 4

(b) 0.0010 gm

1.0×10^{-3} gm S.f = 2

(c) 50000 gm

5.0000×10^4 gm $\boxed{S.f = 5}$

(d) 0.3204 S.f = 4

3.204×10^{-1}

Q.2

(a) 0.165 Sf = 3

(b) 4.0026 Sf = 5

(c) 0.0256 Sf = 3

(d) 165 Sf = 3

(e) 0.050 Sf = 2

(f) 2.653×10^4 S.f = 4

(g) 6.02×10^{23} S.f = 3

(h) 0.0006032 S.f = 4

ROUNDING OFF

To represent the result of any computation containing more than one uncertain digit, it is *rounded off* to appropriate number of significant figures.

Rules for rounding off the numbers :

I Rule : If the digit to be rounded off is more than 5, then the preceding digit is increased by one. e.g. $6.87 \approx 6.9$

II Rule : If the digit to be rounded off is less than 5, than the preceding digit is unaffected and is left unchanged. e.g. $3.94 \approx 3.9$

III Rule : If the digit to be rounded off is 5 then the preceding digit is increased by one if it is odd and is left unchanged if it is even. $\boxed{\text{e.g. } 14.35 \approx 14.4 \text{ and } 14.45 \approx 14.4}$

Imp

RULES FOR ARITHMETICAL OPERATIONS WITH SIGNIFICANT FIGURES :

I Rule : In addition or subtraction the number of decimal places in the result should be equal to the number of decimal places of that term in the operation which contain lesser number of decimal places.

$\boxed{\text{e.g. } 12.587 - 12.5 = 0.087 = 0.1}$ ($\because$ second term contain lesser i.e. one decimal place)

II Rule : In multiplication or division, the number of SF in the product or quotient is same as the smallest number of SF in any of the factors. e.g. $\boxed{5.0 \times 0.125 = 0.625 = 0.62}$

Ex $5 \times 0.125 = 0.625 = 0.6$ Ans

Ex-1 Four objects have masses 2.5 kg, 1.54 kg, 3.668 kg and 5.1278 kg. Find the total mass up to appropriate significant figures.

$m_1 = 2.5$ kg

$m_2 = 1.54$ kg

$m_3 = 3.668$ kg

$m_4 = 5.1278$ kg

$M_T = 2.5 + 1.54 + 3.668 + 5.1278$

$= 12.8358$

$= 12.8$ kg Ans

Ex-2 A man runs 100.2 m in 10.3 s. Find his average speed up to appropriate significant figure.

$$\text{Avg speed} = \frac{\text{total distance}}{\text{total time}}$$

$$= \frac{100.2}{10.3} = 9.7182 \simeq 9.72 \text{ m/s} \quad \text{Ans}$$

Q 3. Calculate area enclosed by a circle of diameter 1.06 m to correct number of significant figures.

$$\text{Area} = \pi r^2 \qquad r = \frac{d}{2}$$

$$= \frac{\pi d^2}{4}$$

$$\text{Area} = \frac{22}{28}\left(1.06 \times 1.06\right)$$

$$= 0.8828$$

$$\simeq 0.883 \ m^2$$

×

$r = 0.53$

s.f = 2

Q 4. Subtract 2.5×10^4 from 3.9×10^5 and give the answer to correct number of significant figures.

Q 5. The mass of a box measured by a grocer's balance is 2.3 kg. Two gold pieces of masses 20.15 g and 20.17 g are added to the box. What is (a) total mass of the box (b) the difference in masses of gold pieces to correct significant figures.

Q.4 $x_1 = 2.5 \times 10^4$

$x_2 = 3.9 \times 10^5 = 39 \times 10^4$

$x_2 - x_1 = 39 \times 10^4 - 2.5 \times 10^4$

$$\boxed{x_2 - x_1 = 36.5 \times 10^4}$$ Ans

$x_2 - x_1 = 3.65 \times 10^5$

$= 3.6 \times 10^5$

Q.5 $M = 2.3\ kg = 2300\ gm$

$m_1 = 20.15\ gm$

$m_2 = 20.17\ gm$

(a) $M_T = 2300 + 20.15 + 20.17$

$= 2340.32\ gm$ Ans

(b) $m_2 - m_1 = 20.17 - 20.15$

$= 00.02\ gm$ Ans

Errors

Errors can be expressed in the following ways :-

Absolute Error (Δa) : The difference between the true value and the individual measured value of the quantity is called the absolute error of the measurement.

Suppose a physical quantity is measured *n* times and the measured values are $a_1, a_2, a_3 \ldots\ldots\ldots a_n$. The arithmetic mean ($a_m$) of these values is

$$a_m = \frac{a_1 + a_2 + a_3 + \ldots\ldots\ldots\ldots a_n}{n} = \frac{1}{n}\sum_{i=1}^{n} a_i \qquad \ldots(1)$$

If the true value of the quantity is not given then mean value (a_m) *can be taken as the true value*. Then the absolute errors in the individual measured values are –

$$\Delta a_1 = a_m - a_1$$
$$\Delta a_2 = a_m - a_2$$
$$\ldots\ldots\ldots\ldots\ldots\ldots$$
$$\ldots\ldots\ldots\ldots\ldots\ldots$$
$$\Delta a_n = a_m - a_n$$

The arithmetic mean of all the absolute errors is defined as the final or mean absolute error $(\Delta a)_m$ or $\overline{\Delta a}$ of the value of the physical quantity a

$$(\Delta a)_m = \frac{|\Delta a_1| + |\Delta a_2| + \ldots\ldots\ldots + |\Delta a_n|}{n} = \frac{1}{n}\sum_{i=1}^{n} |\Delta a_i| \qquad \ldots(2)$$

So if the measured value of a quantity be 'a' and the error in measurement be Δa, then the true value (a_t) can be written as

$$a_t = a \pm \Delta a \qquad \ldots(3)$$