H.W.

2) The diameter of a wire measured in an experiment was 0.022 cm, 0.023 cm, 0.026 cm, 0.025 cm, 0.024 cm and 0.025 cm find

i) The mean value of diameter.

ii) absolute error in a each measurement

iii) Percentage error

i) Let $a_1 = 0.022$ cm $a_2 = 0.023$ cm

$a_3 = 0.026$ cm $a_4 = 0.025$ cm

$a_5 = 0.024$ cm $a_6 = 0.025$ cm

$$\therefore \text{mean value} = \frac{0.022 + 0.023 + 0.026 + 0.025 + 0.024 + 0.025}{6}$$

$$= \frac{0.145}{6}$$

$$= 0.024$$

ii) absolute error $\Delta a_1 = a_m - a_1 = 0.024 - 0.022$

$= 0.002$

similarly $\Delta a_2 = \pm 0.001$

$\Delta a_3 = -0.002$

$\Delta a_4 = -0.001$

$\Delta a_5 = 0$ $\Delta a_6 = 0.001$

iii) mean absolute error $\overline{\Delta a} = \frac{0.005}{6}$

$= 0.0008$

≈ 0.001

$\therefore$ Percentage error $= \frac{0.001}{0.024} \times 100$

$= \frac{1 \times 1000}{0}$

$= \frac{0.001 \times 1000}{0.024 \times 1000} \times 100$

$= \frac{100}{24}$

$= 4.16$

2) Refractive index of a flint glass (μ) was measured in an experiment and was found to be 1.655, 1.667, 2.666, 1.659, 2.669 and 1.654. Find i) the mean value of μ

ii) mean absolute error

iii) Relative error

iv) Percentage error

Ans:-

Let $R_1 = 1.655$

$R_2 = 1.661$

$R_3 = 2.666$

$R_4 = 1.659$

$R_5 = 2.669$

i) mean value $= \frac{1.655 + 2.667 + 2.666 + 1.659 + 2.669 + 1.654}{5}$

$= \frac{8.326}{5}$

$= 1.663$

ii) Absolute error $\Delta R_1 = R_m - R_1 = 1.663 - 1.655$

$\Delta R_2 = -0.004$

$\Delta R_3 = -0.003$

$\Delta R_4 = 0.004$

$\Delta R_5 = -0.003$

$\therefore$ mean absolute error $= \frac{0.022}{5}$

$= 0.004$

iii) Relative error $= 1.663 \pm 0.004$

iv) Percentage error $= \frac{0.004}{1.663} \times 100$

$= \frac{0.4}{1.663}$

3) while determining the time period of oscillation of a simple pendulum, the readings from various measurements are 1.73 s, 1.62 s, 1.52 s, 1.45 s and 1.83 s. Calculate the values of mean value of time period, absolute error, mean absolute error and relative error.

Ans:- Let, $a_1 = 1.73$

$a_2 = 1.62$

$a_3 = 1.52$

$a_4 = 1.45$

$a_5 = 1.83$

$\therefore$ mean value, $a_m = \frac{1.73 + 1.62 + 1.52 + 1.45 + 1.83}{5}$

$= \frac{8.75}{5}$

$= 1.63$

$\therefore$ absolute error, $\Delta R_1 = a_m - a_1 = -0.10$

$\Delta R_2 = 0.01$

$\Delta R_3 = 0.11$

$\Delta R_4 = 0.18$

$\Delta R_5 = -0.20$

∴ mean absolute error = $\frac{0.20 + 0.02 + 0.22 + 0.18 + 0.20}{5}$

$= \frac{0.60}{5}$

$= 0.12$

∴ relative error $= 2.63 \pm 0.12$

4) while determining the density of a sea water, the readings from various measurements are 1.03 g/cc, 1.12 g/cc, 0.92 g/cc, 1.05 g/cc and 1.13 g/cc. Calculate the values of mean density, absolute error, mean absolute error and relative error.

Ans:- Let $r_1 = 1.03$

$r_2 = 1.12$

$r_3 = 0.92$

$r_4 = 1.05$

$r_5 = 1.13$

∴ mean value $= \frac{1.03 + 1.12 + 0.92 + 1.05 + 1.13}{5}$

$= \frac{5.25}{5}$

$= 1.05$

absolute error, ΔR_1 $\Delta r_1 = r_m - r_1 = 1.05 - 1.03$
$= 0.02$

$\Delta r_2 = -0.07$

$\Delta r_3 = 0.13$

$\Delta r_4 = 0$

$\Delta r_5 = -0.05$

$\therefore$ mean absolute error $= \frac{0.02 + 0.07 + 0.13 + 0.05}{5}$

$= \frac{0.30}{5}$

$= 0.06$

$\therefore$ relative error $= 1.05 \pm 0.06$

5) The resistance of a wire as measured in an experiment was found to be 10.3Ω, 10.7Ω, 9.8Ω, 10.4Ω and 9.6Ω
Calculate i) Mean value of resistance

ii) absolute error in each measurement

iii) mean absolute error

iv) Fractional error

v) Percentage error.

Ans:-

Let $R_1 = 10.3$

$R_2 = 10.7$

$R_3 = 9.8$

$R_4 = 10.4$

$R_5 = 9.6$

i) mean value, $R_m = \frac{10.3 + 10.7 + 9.8 + 10.4 + 9.6}{5}$

$= \frac{50.8}{5}$

$= 10.16$

≈ 10.2

ii) absolute error, $\Delta R_1 = -0.1$

$\Delta R_2 = -0.5$

$\Delta R_3 = 0.04$

$\Delta R_4 = -0.2$

$\Delta R_5 = 0.8$

iii) mean absolute error, $\Delta \bar{R}_m = \frac{0.2 + 0.5 + 0.04 + 0.2 + 0.8}{5}$

$= \frac{2.0}{5}$

$= 0.4$

iv) Percentage error $= \frac{0.04}{10.2} \times 100$

$= \frac{400}{10.2} \times 3.92$

iii) mean absolute error, $\Delta \bar{A} = \frac{0.002 + 0 + 0.005 + 0.004 + 0.006}{5}$

$= \frac{0.017}{5}$

$= 0.03$

iv) Percentage error $= \frac{0.03}{1.33} \times 100$

$= \frac{3}{1.33}$

$= \frac{300}{133}$

$= 2.25$

7) Using a screw gauge, the diameter of a metal rod was measured. The observations are given as follows: 0.39 mm, 0.38 mm, 0.37 mm, 0.41 mm, 0.38 mm, 0.38 mm, 0.40 mm, 0.39 mm, Calculate

i) the most accurate value of the diameter,

ii) the relative error, and

iii) the percentage error in the measurement of the diameter.

6) The diameter of a wire as measured by a screw gauge was found to be 1.328 mm, 1.330 mm, 1.325 mm, 1.334 mm and 1.336 mm. Calculate

i) mean value of diameter

ii) absolute error in each measurement by ~~a screw~~.

iii) mean absolute error

iv) Fractional error

v) percentage error

Ans:- Let $A_1 = 1.328$ mm $\quad A_2 = 1.330$ mm

$A_3 = 1.325$ mm $\quad A_4 = 1.334$ mm

$A_5 = 1.336$ mm

i) mean value $A_m = \dfrac{1.328 + 1.330 + 1.325 + 1.334 + 1.336}{5}$

$= \dfrac{6.653}{5}$

$= 1.330$

~~≈ 1.33~~

ii) absolute error, $\Delta A_1 = A_m - A_1 = 1.330 - 1.328$

$= 0.002$

$\Delta A_2 = 0$

$\Delta A_3 = 0.005$

$\Delta A_4 = 0.004$ $\quad \Delta A_5 = 0.006$

Sol^n:

Let $l_1 = 0.39$ $l_2 = 0.38$ $l_3 = 0.37$

$l_4 = 0.40$ $l_5 = 0.39$

$\therefore$ mean value $l_m = \dfrac{0.39 + 0.38 + 0.37 + 0.40 + 0.39}{5}$

$= \dfrac{1.93}{5}$

$= 0.38$

$\therefore$ absolute error $\Delta l_1 = l_m - l_1 = 0.38 - 0.39$

$= -0.01$

Similarly $\Delta l_2 = 0$

$\Delta l_3 = 0.02$

$\Delta l_4 = -0.02$

$\Delta l_5 = -0.01$

$\therefore$ mean absolute error, $\Delta \bar{l} = \dfrac{0.01 + 0 + 0.02 + 0.02 + 0.01}{5}$

$= \dfrac{0.05}{0.01}$

$\therefore$ relative error $= l_m \pm \Delta \bar{l}$

$= (0.38 \pm 0.01)$ mm

$\therefore$ Percentage error $= \frac{0.07}{0.38} \times 100$

$= \frac{1 \times 100}{38}$

≈ 2.63

Q) 8) A student performs an experiment and found following values of the refractive index of 1.29, 1.33, 1.34, 1.35, 1.32, 1.36, 1.30, 1.33

Find the mean value of refractive index, the mean ~~value of refrac~~ absolute error, The relative error and percentage error.

Ans:- Let $a_1 = 1.29$, $a_2 = 1.33$, $a_3 = 1.34$

$a_4 = 1.35$, $a_5 = 1.32$, $a_6 = 1.36$

$a_7 = 1.30$, $a_8 = 1.33$

$\therefore$ mean value, $a_m = \frac{1.29 + 1.33 + 1.34 + 1.35 + 1.32 + 1.36 + 1.30 + 1.33}{8}$

$= \frac{10.62}{1.32}$

absolute error $\Delta a_1 = 0.03$

$\Delta a_2 = -0.01$

$\Delta a_3 = -0.03$

$\Delta a_4 = -0.03$

$\Delta a_5 = 0$

$\Delta a_6 = -0.04$

$\Delta a_7 = 0.02$

$\Delta a_8 = -0.01$

mean absolute error, $\Delta \bar{a}$

$$= \frac{0.03 + 0.01 + 0.02 + 0.03 + 0.04 + 0.02 + 0.01}{8}$$

$$= \frac{0.16}{8}$$

$$= 0.02$$

$\therefore$ relative error $= (a_m + \Delta \bar{a})$

$$= (1.32 \pm 0.02)$$

$\therefore$ Percentage error $= \frac{0.02}{1.32} \times 100$

$$= \frac{200}{132}$$

$$= 1.51$$