Measurements and Errors

1. **In a measurement both positive and negative errors are found to occur with equal probability. The type of errors responsible for this is**

   1) Proportional errors 2) Random errors 3) Determinate errors 4) Systematic errors

2. **By repeating the same measurement several times, the error that can be reduced is**

   1) Determinate error 2) Instrumental error 3) Random errors 4) Systematic error

3. **The measured value of physical quantity expressed to infinite number of decimal places is called**

   1) Practical value 2) Ideal value 3) Absolute value 4) Real value

4. **Zero error of measuring instruments are called**

   1) Indeterminate error 2) Random error

   3) Disproportional error 4) Instrumental error

5. **What type of errors that can never be completely eliminated?**

   1) Determinate errors 2) Instrumental errors 3) Proportional errors 4) Random errors

6. **Which of the following error is not systematic error?**

   1) Least Count Error 2) Zero error

   3) Backlash error 4) Theoretical error due to approximate

7. **Of the following the dimensionless error is**

   1) Systematic error 2) Gross error 3) Random error 4) Relative error

8. **a) All zeros to the right of the last non-zero digit after the decimal point are significant.**

   b) If the number is less than one, all the zeros to the right of the decimal point but to the left of the first non-zero digit are not significant.

   1) Only a is correct 2) a, b are correct 3) Only b is correct 4) a, b are wrong

9. **If the immediate insignificant digit to be dropped is 5 then there will be two different cases**

   a) If the preceding digit is even, it is to be unchanged and 5 is dropped.

   b) If the preceding digit is odd, it is to be raised by 1.

   1) Only a is correct 2) a, b are correct 3) Only b is correct 4) a, b are wrong

10. If Y = a + b, the maximum percentage error in the measurement of Y will be

1) $\left(\frac{\Delta a}{a}+\frac{\Delta b}{b}\right)\times 100$ 2) $\left(\frac{\Delta a}{a+b}+\frac{\Delta b}{a+b}\right)\times 100$

3) $\left(\frac{\Delta a}{a}-\frac{\Delta b}{b}\right)\times 100$ 4) $\left(\frac{\Delta a}{a-b}-\frac{\Delta b}{a-b}\right)\times 100$

11. If Y = a - b, the maximum percentage error in the measurement of Y will be

1) $\left(\frac{\Delta a}{a}+\frac{\Delta b}{b}\right)\times 100$ 2) $\left(\frac{\Delta a}{a-b}+\frac{\Delta b}{a-b}\right)\times 100$

3) $\left(\frac{\Delta a}{a}-\frac{\Delta b}{b}\right)\times 100$ 4) $\left(\frac{\Delta a}{a-b}-\frac{\Delta b}{a-b}\right)\times 100$

12. A physical quantity is represented byx $=M^aL^bT^{-c}$. The percentage of errors in the measurements is then the maximum percentage error is

1) $\alpha a+\beta b-c\gamma$ 2) $\alpha a+\beta b-\gamma c$ 3) $\alpha a-\beta b-\gamma c$ 4) $\alpha a-\beta b+\gamma c$

13. Assertion : Parallax method cannot be used for measuring distances of stars more than 100 light years away.

Reason: Because parallel angle reduces so much that it cannot be measured accurately.

1) Both A and R is correct and R is the correct explanation of A.

2) Both A and R is correct but R is not the correct explanation of A.

3) A is true but R is False.

4) R is true but A is False.

14. Assertion: Number of significant figures in 0.005 is one of and that in 0.500 is three.

Reason: This is because zeros are not significant.

1) Both A and R is correct and R is the correct explanation of A.

2) Both A and R is correct but R is not the correct explanation of A.

3) A is true but R is False.

4) R is true but A is False.

15. Assertion: Out of these measurements $\ell=0.7m, \ell=0.70m$ and, $\ell=0.70m$ the last one is most accurate.

Reason: In every measurement, only the last significant digit is not accurately unknown.

1) Both A and R is correct and R is the correct explanation of A.

2) Both A and R is correct but R is not the correct explanation of A.

3) A is true but R is False.

4) R is true but A is False.

16. Assertion : Absolute error may be negative or positive.

Reason: Absolute error is the difference between the real value and the measured value of a physical quantity.

1) Both A and R are correct and R is the correct explanation of A.

2) Both A and R are correct but R is not the correct explanation of A.

3) A is true but R is False.

4) R is true but A is False.

17. 4.32 x 2.0 is equal to

1) 8.64 2) 8.6 3) 8.60 4) 8.640

18. The length and breadth of a plate are (6 ± 0.1) cm and (4 ± 0.2) cm respectively. The area of the plate is

1) $(24\pm1.6)cm^2$ 2) 24.4 cm^2 3) 23.6 cm^2 4) $(24\pm0.02)cm^2$

19. If the length of a cylinder is measured to be 50 cm with an error of 0.25 cm. The percentage error in the measured length is

1) 0.4% 2) 0.5% 3) 0.2% 4) 0.1%

20. The length of a cylinder is measured as 5cm using vernier calipers of least count 0.1 mm. The percentage error is

1) 0.5 % 2) 2 % 3) 20 % 4) 0.2 %

21. A body travels uniformly a distance of $(20.0\pm0.2)m$ in time $(4.0\pm0.04)s$. The velocity of the body is

1) $(5.0\pm0.4)ms^{-1}$ 2) $(5.0\pm0.2)ms^{-1}$ 3) $(5.0\pm0.6)ms^{-1}$ 4) $(5.0\pm0.1)ms^{-1}$

22. The distance travelled by a body is 107.25 m in time 1.5 s. The velocity with correct significant figures is

1) 71.5 2) 71 3) 71.50 4) 72.0

23. The length of a rectangular plate is measured as 10 cm by a vernier scale of least count 0.01 cm and its breadth as 5 cm by the same scale. The percentage error in area is

1) 0.1 % 2) 0.3% 3) 0.01% 4) 0.05%

24. The mass of a beaker is (10.1 ± 0.1) g when empty and (17.3 ± 0.1) g when filled with a liquid. The mass of the liquid with possible limits of accuracy is

1) $(7.2\pm0.2)g$ 2) $(7.2\pm0.1)g$ 3) $(7.1\pm0.2)g$ 4) $(7.2\pm0.3)g$

25. Force and area are measured as 20 N and 5 m^2 with errors 0.05 N and 0.0125 m^2. The maximum error in pressure is (SI units)

1) 4 ± 0.0625 2) 4 ± 0.05 3) 4 ± 0.125 4) 4 ± 0.02

26. Using a screw gauge the diameter of a wire is found to be, 1.51 mm, 1.53mm , 1.48 mm, 1.49 mm , 1.51mm , 1.54 mm. The true value of the diameter of the wire is (in mm)

1) 1.49 2) 1.52 3) 1.51 4) 0.151

27. Two resistors of $10K\Omega$ and $20K\Omega$ are connected in series. If tolerance of each resistor is 10% then tolerance of the combination will be

1) 5% 2) 10% 3) 15% 4) 20%

28. A student performs experiment with a simple pendulum and measure time period for 20 vibrations. If he measures time for 100 vibrations the error in the measurement of time period will be reduced by a factor of

1) 10 2) 20 3) 5 4) 80

29. In measuring 'g' using a simple pendulum a student makes a positive error of 1% in length of pendulum and a negative error of 3% in the value of time period. Percentage error in measurement of value of g is

1) 2% 2) 4% 3) 7% 4) 10%

30. The equivalent resistance of two resistors are $R_1=(200\pm3)\Omega$, $R_2=(300\pm6)\Omega$. The equivalent resistance when they are connected in parallel is

1) $(120\pm5.3)\ \Omega$ 2) $(120\pm6)\Omega$ 3) $(500\pm8)\Omega$ 4) $(120\pm4.6)\Omega$

31. The equivalent resistance of two resistors are $R_1=(50\pm2)\Omega$, $R_2=(150\pm3)\Omega$ and $R_3=(10\pm1)\ \Omega$. The equivalent resistance when they are connected in series is

1) $(210\pm6)\Omega$ 2) $(100\pm5)\Omega$ 3) $(200\pm12)\Omega$ 4) $(100\pm1)\Omega$

32. If $x=\frac{A^2B^3}{C\sqrt{D}}$ and percentage errors in a, B, C and D are 1%, 2%, 3% and 4% respectively, the percentage error in x is

1) 10% 2) 12% 3) 15% 4) 13%

33. The heat generated in a circuit depends on resistance (R), current (me) and time of flow (t). If maximum errors in above are 1%, 0.5% and 1% respectively. Error in measurement of power is

1) 2% 2) 6% 3) 3% 4) 1%

Key

1) 2	2) 3	3) 2	4) 4	5) 4	6) 3	7) 4	8) 2	9) 2
10) 2	11) 2	12) 2	13) 1	14) 3	15) 2	16) 1	17) 2	18)1
19) 2	20) 4	21) 4	22) 2	23) 2	24) 1	25) 4	26) 3	27)2
28) 3	29) 3	30) 2	31) 1	32) 4	33) 1			

Hints

18. A = *l*b

Area with absolute error = *l*b + absolute error in *l*b

$= lb + lb\left(\frac{\Delta l}{l}+\frac{\Delta b}{b}\right)$

$= 24 \pm 24\left(\frac{0.1}{6}+\frac{0.2}{4}\right)$

$= 24 \pm (0.4+1.2) = (24 \pm 1.6)\,cm^2$

19. % error in length $= \frac{\Delta l}{l} \text{ x } 100$

$= \frac{0.25}{50} \text{ x } 100 = 0.5\%$

20. % error in length = $\frac{\Delta l}{l} \text{x} 100$

$= \frac{0.02}{5} \text{x} 100 = 0.2\%$

21. $v = \frac{d}{t}$

Velocity with absolute error = $\frac{\text{d}}{\text{t}} \pm \left(\text{absolute error in} \frac{\text{d}}{\text{t}} \right)$

$= \frac{\text{d}}{\text{t}} \pm \frac{\text{d}}{\text{t}} \left(\frac{\Delta \text{d}}{\text{d}} + \frac{\Delta \text{t}}{\text{t}} \right)$

$= \frac{20}{4} \pm \frac{20}{4} \left(\frac{0.2}{20} + \frac{0.01}{4} \right)$

$= 5 \pm 5(0.01 + 0.01) = 5 \pm 0.1$

$= (5.0 \pm 0.1) m/s$

22. $v = \frac{d}{t} = \frac{107.5}{1.5} = 71.33 = 71$

23. % error in A = $(\%\text{ error in } l) + (\%\text{ error in } b)$

$= \left(\frac{\Delta l}{l} + \frac{\Delta b}{b} \right) 100$

$= \left(\frac{0.01}{10} + \frac{0.01}{5} \right) 100 = \left(\frac{1}{10} + \frac{1}{5} \right) = 0.3\%$

24. $(m_2 - m_1) \pm (\Delta m_2 + \Delta m_1)$

$= 7.2 \pm (0.1 + 0.1)$

$= (7.2 \pm 0.2) g$

25. Pressure with absolute error $= \frac{F}{A} + \frac{F}{A} \left(\frac{\Delta F}{F} + \frac{\Delta A}{A} \right)$

$= \frac{20}{5} + \frac{20}{5} \left(\frac{0.05}{20} + \frac{0.0125}{5} \right)$

$= 4 \pm 4 \left(\frac{0.01}{4} + 0.0025 \right)$

$= 4 \pm 4(0.0025 + 0.0025)$

$= 4 \pm 4(0.005) = (4 \pm 0.02) N/m^2$

26. $a_{mean} = \frac{a_1 + a_2 + a_3 + a_4 + a_5 + a_6}{6}$

$= \frac{1.51+1.53+1.48+1.49+1.51+1.54}{6} = \frac{9.06}{6}$

$= 1.51$

27. Tolerance is n nothing but error

$R = R_1 + R_2$

$\%$ error in R $= \frac{\Delta R_1 + \Delta R_2}{R_1 + R_2}$ x100

$\Delta R_1 = 10x\frac{10}{100} = 1k\Omega,\ \Delta R_2 = 20x\frac{10}{100} = 2k\Omega$

$\therefore \%$ error in R $= \left(\frac{1+2}{10+20}\right)100 = 10\%$

28. $\frac{e_1}{e_2} = \frac{N_2}{N_1} = \frac{100}{20} = 5 \therefore e_2 = \frac{e_1}{5}$

29. % change in g 1% + 2 x 3% = 7%

30. $R_1 = (200+3)\Omega = \left(200 + \frac{3}{200}\text{x}100\right) = (200+1.5\%)$

$R_2 = (300+6)\Omega = \left(300 + \frac{6}{300}\text{x}100\right) = (300+2\%)\Omega$

$R = \frac{R_1 R_2}{R_1 + R_2}$

R with % error $= \frac{R_1 R_2}{R_1 + R_2} \pm \%\ error\ in \frac{R_1 R_2}{R_1 + R_2}$

$= \frac{R_1 R_2}{R_1 + R_2} \pm (\%\ error\ in\ R_1 + \%\ error\ in\ R_2 + \%\ error\ in\ R_1 + R_2)$

$\frac{200\text{x}300}{500} \pm \left[1.5\% + 2\% + \frac{9}{500}\text{x}100\right]$

$(120 \pm 5.3\%)\ or \left(120 \pm 120\ \text{x}\ \frac{5.3}{100}\right)$

$(120 \pm 5.3\%)\ or\ (120 \pm 6.36)\Omega$

31. $R = R_1 + R_2 + R_3$

R with abs error

$= R_1 + R_2 + R_3 \pm (\Delta R_1 + \Delta R_2 + \Delta R_3)$

$= (210 \pm 6)\,\Omega$

32. $x = \dfrac{A^2B^3}{C\sqrt{D}}$

$\therefore$ % error in x = $2(\%\text{ change in A}) + 3(\%\text{ change in B}) + (\%\text{ change in C}) + \dfrac{1}{2}(\%\text{ change in D})$

$= 2(1\%) + 3(2\%) + (3\%) + \dfrac{1}{2}(4\%)$

$= 2\% + 6\% + 3\% + \dfrac{1}{2}(4\%)$

$= 2\% + 6\% + 3\% + 2\% = 13\%$

33. $P = i^2R$

% error in P = 2(% error in i) + (% error in R)

$2(0.5)\% + 1\% = 2\%$