IMPORTANT QUESTIONS WITH ANSWERS

Q # 1. Define Physics? Describe its main areas of research.

Ans. Physics is the branch of science that deals with matter, energy and the relationship between them. The study of physics involves laws of motion, the structure of space and time, the nature and types of forces, the interaction between different particles, the interaction of radiation with matter etc.

Q # 2. What do you know about the natural philosophy?

Ans. Initially, the observations of man about the world around him give birth to the single discipline of science, called natural philosophy.

Q # 3. Differentiate among the physical and biological sciences.

Physical Sciences	Biological Sciences
i) Physical sciences deal with non-living things. ii) Examples: Physics, Chemistry, Astronomy	i) Biological sciences deal with living things. ii) Examples: Zoology, Botany etc.

Q # 4. Define the following branches of modern physics.
(i) Nuclear Physics (ii) Particle Physics (iii) Relativistic Mechanics (iv) Solid State Physics

Ans. **(i) Nuclear Physics:** The nuclear physics deals with the atomic nuclei.

(ii) Particle Physics: It deals with the ultimate particles with which the matter is composed.

(iii) Relativistic Mechanics: It deals with motion of bodies which moves with very large velocities (approaching that of light).

(iv) Solid State Physics: The solid state physics deals with structure and properties of matter.

Q # 5. Write down the significance of science and technology. Also describe the role of physics in the development of science and technology?

Ans. Modern tools of science and technology have brought all parts of world in close contact. The information media and fast means of communications have made the world a global village. The computer networks play pivotal role in the development of science and technology. The computer networks are the products of chips developed from basic ideas of physics.

Q # 6. What do you know about physical quantities? Also describe their significance.

Ans. The quantities that can be measured and are used to describe the properties of matter are called physical quantities.

Significance: The foundation of physics rest upon physical quantities in terms of which the laws of physics are expressed.

Q # 7. Differentiate among the base and derived quantities.

Base Quantities	Derived Quantities
(i) The base quantities are those physical quantities in terms of which other physical quantities are defined. (ii) Examples: Mass, length, time	(i) The quantities that are derived from the base quantities are called derived quantities. (ii) Examples: Velocity, acceleration, force

Q # 8. How the base quantities are measured?

Ans. The measurement of base quantity involves two steps:

(i) The choice of a standard.

(ii) The establishment of a procedure for comparing the quantity to be measure with standard.

Q # 9. What are the characteristics of an ideal standard?

Ans. An ideal standard has two principle characteristics.

(i) It is accessible

(ii) It is invariable

Q # 10. What do you know about international system of units? Describe its significance.

Ans. In 1960, an international committee agreed on a set of definitions and standards to describe the physical quantities. The system that was established is called System International of units.

Significance: Due to simplicity and convenience with which the units in this system are amenable to arithmetic manipulation, it is in universal use by the world's scientific community.

Q # 11. Define following?

(i) Base Units (ii) Derived Units (iii) Supplementary Units (iv) Radian (v) Steradian

Ans. **(i) Base Units:** The units associated with the base quantities are called base units.

(ii) Derived Units: The units associated with the derived quantities are called derived units.

(iii) Supplementary Units: The General Conference on Weights and Measures has not yet classified certain unit of SI under either base or derived units. These SI units are called derived supplementary units. Radian and steradian are supplementary units.

(iv) Radian: The angle between two radii of a circle corresponding to the arc length of one radius on its circumference is called radian.

(v) Steradian: The 3D angle subtended at the center of the sphere corresponding to the surface area of one square radius is called steradian.

Q # 12. What do you mean by scientific notation? Describe the following numbers in scientific notation.

(i) $\mathbf{134.7}$ **(ii)** $\mathbf{0.0023}$ **(iii)** $\mathbf{43.94 \times 10^{-2}}$

Ans. The standard form to represent numbers using power of ten is called scientific notation. In scientific notation of any measurement, there should be only one non-zero digit at the left of the decimal point. The measurements expressed in scientific notation are as follows:

(i) The scientific notation of measurement 134.7 is 1.347×10^2

(ii) The scientific notation of measurement 0.0023 is 2.3×10^{-3}

(iii) The scientific notation of measurement 43.94×10^{-2} is 4.394×10^{-1}

Q # 13. Define error. Also describe possible causes of error.

Ans. The difference between the observed and calculated value of any measurement is called error. The errors may occur due to following reasons.

(i) Negligence or inexperience of a person

(ii) The faulty apparatus

(iii) Inappropriate method or technique

Q # 14. What types of errors are possible in measuring the time period of pendulum by stop watch? [BISE Sargodha 2008, 2009]

Ans. The possible errors that might occur are the personal error and systematic error. The personal error occurs due to negligence or inexperience of a person, while the systematic error may be due to the poor calibration of equipment or incorrect marking etc.

Q # 15. Differentiate among the random and systematic error.

Random Error	Systematic Error
(i) If the repeated measurements of a quantity give different values under same conditions, then the error is called random error.	(i) Systematic error refers to the effect that influences all measurement of a particular quantity equally.
(ii) The random error occurs due to some unknown causes	(ii) It may occur due to zero error of the instrument, poor calibration or incorrect marking etc.
(iii) Repeating the measurement several times and taking an average can reduce the effect of random error.	(iii) The systematic error can be reduced by comparing the instrument with another which is known to be more accurate.

Q # 16. What are the significant figures? Describe their significance.

Ans. In any measurement, the accurately known digits and the first doubtful digit are called the significant figures. The uncertainty or accuracy in the value of a measured quantity is indicated by significant figures.

Q # 17. How many significant figures are there in following measurements?

(i) **1007** **(ii)** **0.00467** **(iii)** **02.59** **(iv)** **7.4000**

(v) **3.570** **(vi)** $\mathbf{8.70 \times 10^3}$ **(vii)** **8000 with least count of 10**

(viii) **8000 with least count of 1000**

Ans. (i) The number of significant figures in the measurement 1007 are 4.

(ii) The number of significant figures in the measurement 0.00467 are 3.

(iii) The number of significant figures in the measurement 02.59 are 3.

(iv) The number of significant figures in the measurement 7.4000 are 5.

(v) The number of significant figures in the measurement 3.570 are 4.

(vi) The number of significant figures in the measurement 8.70×10^3 are 3.

(vii) The number of significant figures in the measurement 8000, with least count of 10, are 3.

(viii) The number of significant figures in the measurement 8000, with least count of 1000, is 1.

Q # 18. Write down the final result of following computation up to appropriate precision.

(i) $\frac{5.348\times10^{-2}\times3.64\times10^{4}}{1.336} = 1.45768982 \times 10^3$

(ii)
$$\begin{array}{r} 72.1 \\ 3.42 \\ \underline{0.003} \\ 75.523 \end{array}$$

(iii)
$$\begin{array}{r} 2.7543 \\ 4.10 \\ \underline{1.2373} \\ 8.1273 \end{array}$$

Ans. **(i)** The final result up to appropriate precision is 1.46×10^3. It is because of the reason that the factor 3.64×10^4 , is the least accurate measurement which has three significant figures. Therefore the answer should be written to the three significant figures.

(ii) The final result up to appropriate precision is 75.5. It is because of the reason that the factor 72.1 has smallest number of decimal places. Thus, the answer should be rounded off to one decimal place.

(iii) The final result up to appropriate precision is 8.13. It is because of the reason that the factor 4.10 has smallest number of decimal places. Thus, the answer should be rounded off to two decimal places.

Q # 19. Differentiate among precision and accuracy.

Precision	**Accuracy**
(i) The precise measurement is one which has least absolute uncertainty.	(i) An accurate measurement is one which has less fractional or percentage uncertainty.
(ii) The precision of measurement depends on the instrument or device being used.	(ii) The accuracy in any measurement not only depends on instrument being used, but also on the total measurement taken.

Q # 20. Which of the following measurement is more precise and which of them is mare accurate.

(i) Length of object is recorded as 25.5 cm using meter rod.

(ii) The length of object is measured as 0.45cm using vernier calipers.

Solution.

(i) Length of object is recorded as 25.5 cm using meter rod.

$Absolute\ Uncertainty\ =\ Least\ count\ of\ meter\ rod\ \ =\ 0.1\ cm$

$Percentage\ Uncertainty\ =\frac{Absolute\ Uncertainity}{Total\ Measurement}\times 100=\frac{0.1}{25.5}\times 100=0.4\ \%$

(ii) The length of object is measured as 0.45 cm using vernier calipers.

$Absolute\ Uncertainty\ =\ Least\ count\ of\ vernier\ callipers\ \ =\ 0.01\ cm$

$Percentage\ Uncertainty\ =\frac{Absolute\ Uncertainity}{Total\ Measurement}\times 100=\frac{0.01}{0.45}\times 100=2\ \%$

Result: The measurement (ii) is more precise because it has less absolute uncertainty. The measurement (i) is more accurate as it has less percentage uncertainty.

Q # 21. Assess the total uncertainty in the final result for following cases

(i) Find out displacement between points $x_1=10.5\pm 0.1$ and $x_2=26.8\pm 0.1$

(ii) If the potential difference of $V=5.2\pm 0.1$ volt applied across the ends of conductor, and as the result the current $I=0.84\pm 0.05$ pass through conductor. Determine the resistance of conductor.

(iii) Find out volume of sphere whose radius $r=2.25\pm 0.01\ cm$.

(iv) The six measurements were taken of the diameter of wire using screw gauge which are 1.20, 1.22, 1.23, 1.19, 1.22, 1.21. Determine the uncertainty in final result.

(v) The simple pendulum completes 30 vibrations 50.6 s. the least count of the stop watch is 0.01 s. Find out uncertainty in the time period of simple pendulum.

Ans. (i) Given points are

$x_1=10.5\pm 0.1,\ x_2=26.8\pm 0.1$

Displacement $x=?$

$x=x_2-x_1$

$=(26.8\pm 0.1)-(10.5\pm 0.1)$

$=16.3\pm 0.2\ cm$

(ii) Resistance $R=?$

Given quantities are

Potential Difference $V=5.2\pm 0.1$ volt

Current $I=0.84\pm 0.05$

By Ohm's law,

$R = \frac{V}{I} = \frac{5.2}{0.84} = 6.2\ \Omega$ ----------------------**(1)**

Uncertainty = ?

$$\%\ Uncertainty\ in\ V = \frac{0.1}{5.2} \times 100 = 2\ \%$$

$$\%\ Uncertainty\ in\ I = \frac{0.05}{0.84} \times 100 = 6\ \%$$

Therefore,

$R = 6.2\ \Omega$ with 8 % uncertainty

or

$R = 6.2 \pm 0.5\ \Omega$

(iii) Volume of sphere $V = ?$

Given

Radius $r = 2.25 \pm 0.01\ cm$

As Volume of sphere $V = \frac{4}{3}\pi r^3$

$= \frac{4}{3}\pi(2.25)^3 = 47.7\ cm^3$ ---------------------- **(1)**

Uncertainty = ?

$$\%\ Uncertainty\ in\ r = \frac{0.01}{2.25} \times 100 = 0.4\ \%$$

$$Total\ Uncertainty\ in\ r = 3 \times 0.4\ \% = 1.2\ \%$$

Hence

Volume of sphere $V = 47.7\ cm^3$ with 1.2 % uncertainty

or $V = 47.7 \pm 0.6 cm^3$

(iv) The measurements of diameter of wire are 1.20, 1.22, 1.23, 1.19, 1.22, 1.21

Average diameter of wire = $\frac{1.20+1.22+1.23+1.19+1.22+1.21}{6} = 1.21$

Deviation of each measurement from average value are 0.01, 0.01, 0.02, 0.02, 0.1,0

Mean Deviation = $\frac{0.01+0.01+0.02+0.02+0.1+0}{6} = 0.01$

Thus uncertainty in mean value of diameter = 0.01

Hence Diameter of wire =$1.21 \pm 0.01\ mm$

(v) Given that

Time for 30 Vibrations = 54.6 s

Time Period = Time for 1 Vibration = $\frac{54.6}{30} = 1.82$ s

Uncertainty = ?

$$Uncertainty = \frac{Least\ Count}{Total\ Number\ of\ Vibratios} = \frac{0.1}{30} = 0.003\ s$$

Thus time period is expressed as

$$T = 1.82 \pm 0.003\ \text{s}$$

Q # 22. What do you know about the dimension analysis?

Ans. To express any physical quantity in by scientific symbols of corresponding base quantities, written within the square brackets, called the dimensions. The scientific symbols used to express the dimensions of different physical quantities are as follows

$$\text{Dimension of Mass} = [\,\text{M}\,]$$

$$\text{Dimension of Length} = [\,\text{L}\,]$$

$$\text{Dimension of Time} = [\,\text{T}\,]$$

Q # 23. Write down the dimensions of velocity, acceleration and force?

$$\text{Dimension of Velocity} = \frac{\text{Dimensions of Displacement}}{\text{Dimensions of Time}} \Rightarrow [\,\text{v}\,] = \frac{[\,\text{L}\,]}{[\,\text{T}\,]} = [\,\text{LT}^{-1}\,]$$

$$\text{Dimension of acceleration} = \frac{\text{Dimensions of Velocity}}{\text{Dimensions of Time}} \Rightarrow [\,\text{a}\,] = \frac{[\,\text{LT}^{-1}\,]}{[\,\text{T}\,]} = [\,\text{LT}^{-2}\,]$$

$$\text{Dimension of Force} = (\text{Dimensions of Mass})(\text{Dimensions of acceleration})$$

$$\Rightarrow [\,\text{F}\,] = [\,\text{m}\,][\,\text{a}\,] = [\,\text{M}\,][\,\text{LT}^{-2}\,] = [\,\text{MLT}^{-2}\,]$$

Q # 24. What are the advantages of dimension analysis?

Ans. The dimension analysis may be used for

(i) Checking the correctness of a physical equation

(ii) Deriving a possible formula of a physical quantity

Q # 25. What is homogeneity principle?

Ans. According to homogeneity principle "If the dimensions of a physical quantity on both sides of equation are the same, then the equation will be dimensionally correct".

Q # 26. Write down any two drawbacks of dimension analysis?

Ans. The major drawbacks of dimension analysis are

(i) The dimension analysis is unable to find the values of various constant in physical equations.

(ii) The dimension analysis cannot be applied to the physical quantities involving trigonometric and logarithmic functions.

Q # 27. Determine the dimension of following physical quantities?

(i) Nuclear Energy (ii) Angle (θ)

Ans. (i)

$$Dimensions\ of\ Energy = Dimension\ of\ Work$$

$$[Energy] = [W] = [F.d]$$

$$[Energy] = [F].[d] = [MLT^{-2}][L] = [ML^2T^{-2}]$$

(ii) We know that

$$S = r\theta$$

$$\Rightarrow \theta = \frac{S}{r} \Rightarrow [\theta] = \frac{[S]}{[r]} = \frac{[L]}{[L]} = 1$$

Therefore, angle is a dimensionless quantity.

EXERCISE SHORT QUESTIONS

Q # 1. Name several repetitive phenomenon occurring in nature which can serve as reasonable time standards.

Ans. Any natural phenomenon that repeats itself after exactly same time interval can be used as time standard. The following natural phenomenon can be used as time standard.

- The rotation of earth around the sun and about its own axis
- The rotation of moon around earth
- Atomic vibrations in solids

Q # 2. Give the drawbacks to use the time period of a pendulum as a time standard.

Ans. The time period of the simple pendulum depends upon its length and value of 'g' (gravitational acceleration) at any place. Therefore, the drawbacks to use the time period of a pendulum as a time standard are

- The value of 'g' changes at different places
- The variation in the length of simple pendulum due to change in temperature in different seasons
- Air resistance may affect the time period of simple pendulum

Q # 3. Why we use it useful to have two units for the amount of substance, the kilogram and the mole?

Ans. The kilogram and mole are the units to determine the amount of a substance. Both units are useful in different cases describe below

- The unit kilogram is useful when we want to describe the macroscopic behavior of an object without considering the interaction between the atoms present in it
- The unit mole is useful when we want consider a fix number of atoms of a system. It is used to determine the microscopic behavior of any object.

Q # 4. Three students measured the length of a needle with a scale on which minimum division is 1 mm and recorded as (i) 0.2145 (ii) 0.21 (iii) 0.214. Which record is correct and why?

Ans. The record (iii) is correct.

Reason: As the scale used for measurement has the least count of 1 mm = 0.001 m. So the reading must be taken up to three decimal places. Therefore, the reading 0.214 m is correct.

Q # 5. An old saying is that "A chain is only as strong as its weakest link". What analogous statement can you make regarding experimental data used in computation?

Ans. The analogous statement for experimental data used in computation will be

"*A result obtained by mathematical computation of experimental data is only as much accurate as its least accurate reading in measurements*".

Q # 6. The time period of the simple pendulum is measured by a stop watch. What type of errors are possible in the time period?

Ans. The possible errors that might occur are the personal error and systematic error. The personal error occurs due to negligence or inexperience of a person, while the systematic error may be due to the poor calibration of equipment or incorrect marking etc.

Q # 7. Does the dimensional analysis gives any information on constant of proportionality that may appear in an algebraic expression. Explain?

Ans. Dimension analysis does not give any information about constant of proportionality in any expression. This constant can be determined experimentally of theoretically.

Example: In the expression of time period of simple pendulum, the constant of proportionality cannot be determined from dimension analysis.

Q # 8. What are the dimensions of (i) Pressure (ii) Density

(i) By definition, Pressure $=\frac{\text{Force}}{\text{Area}}$

$$\text{Dimension of Pressure} = \frac{\text{Dimensions of Force}}{\text{Dimensions of Area}} \Rightarrow [\,P\,] = \frac{[\,F\,]}{[\,A\,]}$$

$$\because [\,F\,] = [\,m\,][\,a\,] = [\,M\,][\,LT^{-2}\,] = [\,MLT^{-2}\,]$$

$$\Rightarrow [\,P\,] = \frac{[\,F\,]}{[\,A\,]} = \frac{[\,MLT^{-2}\,]}{[\,L^2\,]}$$

$$\Rightarrow [\,P\,] = [\,ML^{-1}T^{-2}\,]$$

(ii) By definition, Density $=\frac{\text{Mass}}{\text{Volume}}$

$$\text{Dimension of Density} = \frac{\text{Dimensions of Mass}}{\text{Dimensions of Volume}} \Rightarrow [\,\rho\,] = \frac{[\,\text{mass}\,]}{[\,\text{volume}\,]}$$

$$\because [\,\text{mass}\,] = [\,M\,]$$

$$\because [\,\text{volume}\,] = [\,L^3\,]$$

$$\Rightarrow [\,\rho\,] = \frac{[\,M\,]}{[\,L^3\,]} = [\,ML^{-3}]$$

Q # 9. The wavelength λ of a wave depends on the speed v of the wave and its frequency f. Decide which of the following is correct, $f = v\lambda$ or (ii) $f = \frac{v}{\lambda}$

(i) $f = v\lambda$ Dimension of LHS $= [f] = [T^{-1}]$ Dimension of RHS $= [v\lambda] = [v][\lambda]$ $\because [v] = [LT^{-1}]$ $\because [\lambda] = [L]$ Dimension of RHS $= [v\lambda] = [LT^{-1}][L]$ $= [L^2T^{-1}]$ As Dimension of LHS $\neq$ Dimension of RHS Hence, the equation $f = v\lambda$ is not dimensionally correct.	**(ii)** $f = \frac{v}{\lambda}$ Dimension of LHS $= [f] = [T^{-1}]$ Dimension of RHS $= \left[\frac{v}{\lambda}\right] = \frac{[v]}{[\lambda]} = \frac{[LT^{-1}]}{[L]}$ $= [T^{-1}]$ As Dimension of LHS $=$ Dimension of RHS Hence, the equation $f = \frac{v}{\lambda}$ is dimensionally correct.