Chapter No: 1
PHYSICAL QUANTITIES AND MEASUREMENT
Comprehensive Questions

Q#1: Define Physics. How Physics play a crucial role in science, technology and society.

Ans: Physics:

Physics is the branch of science that involves the study of physical universe: energy, matter, and how they are related.

Explanation

The study of physics is to understand the world around us, the world inside us and the world beyond us. Physics covers a wide range of phenomena, from the smallest sub-atomic particles to the largest galaxies and universe.

Physics and Science

Physics is at the root of every field of science. Most of the major developments in Chemistry, Biology, Geology, Agricultural, Environmental science, Astronomy, Engineering and even in medicine have been made by physicists.

Physics, Technology and its impact on our Society:

Physics is concerned with gathering knowledge and organizing it. Technology lets humans use that knowledge for practical purposes. Physical phenomenon is there behind every technology and therefore physics has a key role in the progress of humankind and in the improvement of quality of living.

Example # 1:

Physics provide basic understanding for developing new instrumentation for medic al applications such as CT Scan, MRI and laser technology.

Example # 2:

The use of physics in information technology has improved the standard of communication. Mobile cell phones are commonly used even by illiterates. Hologram technology is a three-dimensional image.

Example # 3:

Physics investigate the motion of electrons and rockets, the energy in sound waves and electric circuits, the structure of the proton and of the universe.

Q#2: What is SI? Name SI base quantities and their units?

Ans: International System of Units:

In 1960, an international conference was held near Paris in France. In this conference, it was decided to introduce a system which could be used all over the world. It was given the name of system international. The international system of unit's is abbreviated as SI units. In this system seven quantities were chosen as basic quantities. The units of these quantities are defined and they are known as Base units, from which all other units are derived.

The seven basic physical quantities, their SI base units and symbols are given in table.

Base Quantity	SI Base Unit	Symbol of SI Unit
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Electric current	Ampere	A

Temperature	Kelvin	K
Amount of substance	Mole	mol
Luminous intensity	Candela	cd

Q#3: What are physical quantities? Distinguish between base and derived physical quantities.

Ans: Physical Quantities:

All those quantities which can be measured are called physical quantities.

Example:

Length, mass, time, density and temperature etc.

Difference between base and derived physical quantities:

Base Quantities	**Derived Quantities**
Minimum number of physical quantities selected and their units are defined and standardized such that in terms of these all other physical quantities can be expressed are called base quantities.	The physical quantities defined in term of base quantities are called derived quantities.
These are seven in number.	These are infinite, having no fix number.
Examples: Length, mass, time, electric current, temperature, amount of substance and intensity of light.	**Examples:** Speed, area, volume , density, work and momentum etc.

Q#4: What is standard form or scientific notation?

Ans: Scientific Notation:

Scientific notation is a way of writing numbers that are too big or too small to be easily written in decimal form.

Explanation:

A large or small number 'N' can be expressed in terms of a number 'M' and a power of 10 like

$$N = M \times 10^n$$

Where 'M' represents a number whose first digit is non-zero digit and 'n' represent the power of 10 which may be positive or negative.

Example:

The mass of moon is approximately 70,000,000,000,000,000,000,000kg, which in standard form or scientific notation is 7×10^{22} kg.

Similarly, the diameter of atomic nucleus is about 0.000000000000001m, which in standard form or scientific notation is 1×10^{-14} m.

Q#5: What are prefixes? Explain with examples.

Ans: Prefixes:

A mechanism through which a very small or very large number is expressed in terms of power of 10 by giving a proper name to it is called prefixes.

Explanation:

Prefixes are used before a standard unit to show how much larger or smaller the given physical quantity is as compared to the standard unit of that quantity.

Prefixes make standard form to be written even more easily. Large numbers are simply written in more convenient prefix with units.

Examples:

The thickness of a paper can be written conveniently in smaller units of millimeter instead of meter.

Similarly, the long distance between two cities may be expressed better in a bigger unit of distance, i.e. kilometer. A useful set of prefixes are given in table:

Decimal multiplier	Prefix	Symbol	Decimal multiplier	Prefix	Symbol
10^{18}	Exa	E	10^{-1}	deci	d
10^{15}	Peta	P	10^{-2}	centi	c
10^{12}	Tera	T	10^{-3}	milli	m
10^{9}	Giga	G	10^{-6}	micro	µ
10^{6}	Mega	M	10^{-9}	nano	n
10^{3}	Kilo	K	10^{-12}	pico	p
10^{2}	Hecto	H	10^{-15}	femto	f
10^{1}	Deca	Da	10^{-18}	atto	a

Q#6: Describe the construction and use for measurement of the following instruments:

a. Vernier Calliper

b. Screw Gauge

Ans(a): Vernier Calliper:

A device used to measure a fraction of smallest scale division by sliding another scale over it is called vernier calliper.

Construction:

There are two scales on vernier calipers.

1. **Main Scale:**

A main scale which has markings of usually of 1mm each and it contains jaw A on its left end.

2. **Vernier Scale:**

A vernier (Sliding) scale which has markings of some multiple of the marking on the main scale. The vernier scale usually has length of 9mm and is divided equally into 10 divisions. The separation between two lines on vernier scale is $\frac{9}{10}$ mm = 0.9mm. Vernier scale contains jaw B on its left end.

Vernier Constant or Least Count:

Minimum length which can be measured accurately with the help of a vernier callipers is called vernier constant or least count of vernier callipers. The least count of vernier callipers is calculated b:

$$\text{Least count}=\frac{\text{Smallest division on main scale}}{\text{Total no. of divisions on vernier scale}}.$$

If the smallest main scale division is 1mm and vernier scale division has 10 divisions on it then the least count is:

$$\text{Least count} = \frac{1\text{mm}}{10}$$
$$= 0.1\text{mm}$$
$$= 0.01\text{ cm}$$

Uses of Vernier Calliper:

Vernier calliper is an instrument used to measure small length accurately upto 0.1mm or 0.01 cm. It can be used to measure the thickness, diameter or width of an object and the internal, external diameter of hollow cylinder.

(b). Screw Gauge:

A device used to measure a fraction of smallest scale division by rotatory motion of circular scale over it is known as screw gauge.

Construction:

A screw gauge consists of a "U" shaped frame, which is attached to a hollow cylindrical tube on one end. The hollow tube has a uniformly threaded nut inside it. A long stud with a plane face is fitted into this nut. Exactly on the opposite side of this nut and on -the other end of "U" shaped frame, a smaller stud with a plane face is also attached. Faces of both the studs are exactly parallel to each other. The smaller stud is known as the anvil and the longer one is known as the spindle. The anvil is fixed part of device, whereas the spindle moves. The object to be measured is held between the anvil and the spindle.

Least Count of Screw Gauge:

The minimum length which can be measured accurately by a screw gauge is called least count of screw gauge. The least count of screw gauge is found by dividing its pitch (pitch is the distance travelled by the circular scale on linear scale in one rotation) by the total number of circular scale division.

$$\text{Least count}=\frac{\text{Pitch of Screw Gauge}}{\text{Total no.of division on circular scale}}$$

If the pitch of the screw gauge is 0.5mm and the number of divisions on circular scale is 50 then

Least Count = $\frac{0.5 \text{ mm}}{50}$

= 0.01 mm

or

= 0.001 cm

Uses of Screw Gauge:

The screw gauge is used to measure very short lengths such as the thickness of metal sheet or diameter of a wire up to 0.01 mm or 0.001cm.

Q#7: What is meant by the significant figures of measurement? What are the main points to be kept in mind while determining the significant figures of measurement?

Ans: Significant Figures:

The number of accurately known figures and the first doubtful figure are known as significant figures.

Explanation:

There are two types of values, exact and measured. Exact values are those that are counted clearly. For example, while reporting 3 pencils or 2 books, we can indicate the exact number of these items.

On the other hand, values associated with measurements of any kind are uncertain to some extent. For example, if we want to measure the length of a pencil with an ordinary meter ruler having least count of 1mm and we note that the length of the pencil is greater than 67 mm and less than 68 mm. We can estimate that the length of the pencil is 67.5 mm. This length is accurate in mm upto 67, but the last fraction of mm has been guessed. There is a chance of error in the last figure. It is known as the doubtful figure.

General Rules For Significant Figures:

1. Non-zero digits are always significant. That is all the digits from 1 to 9 are significant. For example, the number of significant figures in 47.73 is four.
2. Zero in between two significant digits is always significant. For example, the number of significant figures in 32.50063 is seven.
3. Zeros to the left of significant figures are not significant. For example, the number of significant figures in 0.00467 is three.
4. Zeros to the right of the significant figure may or may not be significant. In decimal fractions zero to the right of a decimal fraction are significant. For example, in 7.400 there are four significant figures. For example, in number 80,000 we may have 1, 2 or even 5 significant figures.
5. In scientific notation or standard form, the figures other than power of ten are all significant, for example mass of electrons is 9.11×10^{-31}kg. There are three significant figure in it.

Rules for Rounding Off Significant Figures:

a. If the last digit is less than 5 then it will be ignored. e.g. 2.6573 is rounded to 2.657.
b. When the dropping digit is greater than 5 then the last retained digit increased by 1. e.g. 2.6578 is rounded to 2.656.
c. When the dropping digit is 5 and the last retained digit is even then the last digit i.e. 5 will be dropped without affecting the next one e.g. 2.6585 is rounded to 2.658.
d. If the last digit is 5 and the 2^{nd} last is an odd digit then the 2^{nd} last digit is increased by 1 in order to round off 5. e.g. 2.6575 is rounded to 2.658.

TOPIC WISE QUESTIONS

Q.8 Discuss the contribution of Muslim scientists in the development of physics?
Ans. Scientists of the Islamic world contributed in the development of physics. Few of the notable scientists are;

YAQUB KINDI (800-873 AD)

He was born in Basra, Iraq. He had done valuable work in the field of meteorology, specific gravity and on tides. His most important work was done in the field of optics, especially on reflection of light.

IBNAL HAITHAM (965-1039 AD)

He was born in Basra, Iraq. He was great scholar of his time. His greatest work is the book on optics named Kitab-ul-Manazir. He is also considered as the inventor of the pin-hole camera.

AL-BERUNI (973-1048 AD)

He was an Afghan scholar and wrote 150 books on physics, cosmology, geography, culture, archeology and medicine. Al Beruni discussed the shape of earth the movement of the sun, moon and the phases of moon.

Q.9 **Discuss the work of famous Pakistani physicists?**
Ans:

Dr. Abdus Salam (1926-1996)

He was born in Jhang in 1926. He was a Pakistani theoretical physicist. He shared the 1979 Nobel prize in physics with Sheldon Glashow and Steven Weinberg for his contribution to the electroweak unification theory. He was the first Pakistani to receive a Nobel prize in Science.

Dr. Abdul Qadeer Khan

He was born in Bhopal, India in 1936. He is a Pakistani nuclear physicist and a metallurgical engineer, who founded the uranium enrichment program for Pakistan's atomic bomb project. He founded and established the Kahuta Research Laboratories (KRL) in 1976, and served as both its senior scientist and Director- General until he retired in 2001.

Q.10 **What is Physics? Describe main branches of physics.**
Ans. **Physics:**

Physics is the branch of science which deals with the properties of matter, energy and their mutual relationship.

Branches of Physics:

1. **Mechanics:**

The branch of physics which deals with the motion of material objects under the action of forces.

Examples:

Falling objects, friction, weight, spinning objects.

2. **Heat and Thermodynamics:**

The branch of physics which deals with the heat and temperature and their relation to energy. It also deals with the transformation of heat energy into other forms of energy.

Examples:

Melting and freezing processes, engines, refrigerators.

3. **Oscillations and Waves:**

The branch of physics which deals with the study of to and fro motion and various properties of waves.

Examples:

Mass-spring system, water waves, sound waves etc.

4. **Optics:**

The branch of physics which deals with the nature of light, its propagation, reflection, refraction, dispersion and the wave properties of light.

Examples:

Mirrors, lenses, telescopes, Eye.

5. **Electricity and Magnetism:**

The branch of physics which deals with the study of static as well as moving charges and associated physical phenomena.

Examples:

Electrical charge, circuitry, magnets, electromagnets.

6. **Atomic And Nuclear Physics:**

The branch of physics which deals with the structure and properties of individual atoms and nuclei of an atom.

Examples:

X-rays, lasers, nuclear reactor, MRI, CT scan, PET Scan.

7. **Relativity:**

The branch of physics which deals with the objects moving with very high speed and gravitation.

Examples:

Particle accelerators, Nuclear energy.

8. **Quantum Physics:**

Quantum Physics is that branch of physics which deals with discrete, indivisible units of energy called quanta as describe by quantum theory.

Examples: The atom and its parts.

9. **Particle Physics:**

It is the branch of physics in which we study the nature of the particles that constitute matter and radiation.

Examples:

Quarks, Leptons, photons, Bosons etc.

10. **Cosmology and Astrophysics:**

It deals with the study of the origin, evolution and eventual fate of the universe.

Examples:

Stars, galaxies and black holes.

11. **Biophysics and Medical Physics:**

It deals with the study of physical interactions of biological processes and application of physics health processes such as prevention, diagnosis and treatment.

Examples:

MRI, CT scan, Radiotracers and conduction in living cells.

Q11: What are physical quantities? Discuss its types.

Ans:

PHYSICAL QUANTITIES:

All those quantities which can be measured are called physical quantities.

Examples:

Length, mass, time, density and temperature etc.

TYPES OF PHYSICAL QUANTITIES:

There are two types of physical quantities which are given below;

1. Base physical quantities
2. Derived physical quantities

BASE PHYSICAL QUANTITIES:

Minimum number of physical quantities selected and their units are defined and standardized such that in terms of these all other physical quantities can be expressed are called base quantities.

There are seven base quantities which are mass, length, time, current, temperature, intensity and amount of substance.

BASE UNITS:

In **SI,** seven physical quantities are chosen as base and their units are defined, standardized and are called base units.

OR

The units of base quantities are known as base units.

The seven base physical quantities, their SI base units and symbols are given in table.

Base Quantity		SI Base Unit	
Name	**Symbol**	**Name**	**Symbol**
Length	L	Meter	m
Mass	m	Kilogram	kg
Time	T	Second	s
Electric charge	I	Ampere	A
Temperature	T	Kelvin	K
Luminous intensity	I	Candela	cd
Amount of substance	N	Mole	mol

DERIVED PHYSICAL QUANTITIES

The physical quantities defined in terms of base quantities are called derived physical quantities.

Examples:

work, area, volume, speed, power etc.

DERIVED UNITS

Units derived from multiplying and dividing base units are termed as derived units. In SI units for all other physical quantities can be derived from seven base units.

Some derived quantities with derived units are given in the table.

Derived Quantity		Derived Unit	
Name	**Symbol**	**Name**	**Symbol**
Area	A	Square meter	m^2
Speed	V	Meter per second	ms^{-1}
Force	F	Newton	$N=kgms^{-2}$
Energy	E,U	Joule	$J=kgm^2s^{-2}$
Pressure	P	Pascal	$Pa=kgm^{-1}s^{-2}$

Q.12 What is system of units?

Ans. SYSTEM OF UNITS:

A complete set of units for all physical quantities is called system of units.

There are several system of units.

For example;

Meter kilogram second system (MKS)

Foot pound second system (FPS)

But the system which is used internationally is system International (SI).

Q.13 What are measuring instruments?

Ans. MEASURING INSTRUMENTS:

Measuring instruments are devices to measure physical quantities.

Physicists use large number of measuring instruments. These range from simple objects such as rulers and stopwatches to Atomic Force Microscope (AFM) and Scanning Tunneling Electron microscope (STEM). All measuring instruments have some measuring limitations.

LEAST COUNT:

Least count is the minimum value that can be measured on the scale of a measuring instrument.

Q.14 What is meter rule?

Ans. Meter rule is used to measure the length of objects or the distance between two points.

Rulers are made from different materials and in a wide range of sizes.

Q.15 Describe the purpose, construction and use for measurement of vernier caliper?

Ans. VERNIER CALLIPERS:

A device used to measure a fraction of smallest scale division by sliding another scale over it is called vernier caliper.

PURPOSE:

Vernier calliper is used to measure the length, thickness, diameter or width of an object and the internal, external diameter of hollow cylinders and the depths.

CONSTRUCTION:

There are two scales on vernier calliper;

1. Main Scale
2. Vernier Scale

MAIN SCALE:

A main scale which has markings of usually 1mm each and it contains jaw A on its left end.

VERNIER SCALE:

A vernier scale (sliding) scale which has markings of some multiple of the markings on the main scale. The vernier scale usually has length of 9mm and is divided equally into 10 divisions. The separation between two lines on vernier scale is 9/10 mm=0.9mm. Vernier scale contains jaw B on its left end.

VERNIER CONSTANT OR LEAST COUNT:

Minimum length which can be measured accurately with the help of a vernier callipers is called vernier constant or least count of vernier calipers. The least count of vernier callipers is calculated by

$$\text{Least Count} = \frac{\text{smallest division on main scale}}{\text{total no.of divisions on vernier scale}}$$

If the smallest main scale division is 1mm and vernier scale division has 10 division on it then the least count i.e.

$$\text{Least count} = \frac{1\text{mm}}{10}$$

$$= 0.1 \text{ mm}$$

$$= 0.01 \text{ cm}$$

ZERO ERROR:

On closing the jaws of the callipers, the zero of the vernier scale may or may not coincide with the zero of the main scale. If their zero does not coincide, there is zero error in the instrument.

POSITIVE ZERO ERROR:

When the zero of the vernier scale remains right to the zero of the main scale, such error is called positive zero error.

NEGATIVE ZERO ERROR:

When the zero of the vernier scale is left of the zero of the main scale, such error is called negative zero error.

HOW TO FIND ZERO ERROR:

Bring the jaws of vernier calliper towards each other so that they touch each other. Now note the division of vernier scale which exactly coincides with any division of the main scale. Note it as "n" and multiply it with the least count.

ZERO CORRECTION:

If the error is positive this value (n×L.C) is subtracted from the actual reading. If the error is negative, the value is added to the actual reading.

MEASUREMENT WITH VERNIER CALLIPERS:

Suppose we want to measure the diameter of a small solid cylinder with the vernier calipers, we will use the following method;

1. First of all check the zero error of the vernier callipers.
2. Now place the object between the jaws of vernier calipers and tight them.
3. Now note the reading on main scale. Let this reading be represented by "x".
4. Now note a division on the vernier scale which coincides with any division of main scale. Now multiply this division of vernier scale with least count. Let this reading be "y".
5. Now add "x" and "y" (x+y) which is measurement of the given object.
6. In case of zero error, add negative error with (x+y) and in case of positive error subtract the error from (x+y).
   i.e Accurate Measurement= (x+y)± zero error.

Q.16 Describe the purpose, construction and use for measurement of screw gauge?

Ans. SCREW GAUGE:

A device used to measure a fraction of smallest scale division by rotatory motion of circular scale over it is known as screw gauge.

CONSTRUCTION:

A screw gauge consists of a "U" shaped frame, which is attached to a hollow cylindrical tube on one end. The hollow tube has a uniformly threaded nut inside it. A long stud with a plane face is fitted into this nut. Exactly on the opposite side of this nut and on the other end of

"U" shaped frame, a smaller stud with a plane is also attached. Faces of both the studs are exactly parallel to each other. The smaller stud is known as the anvil and the longer one is known as the spindle. The anvil is fixed part of device, whereas the spindle moves. The object to be measured is held between the anvil and the spindle.

PITCH OF SCREW GAUGE:

The distance travelled by the circular scale on linear scale in one rotation is called the pitch of screw gauge.

LEAST COUNT OF SCREW GAUGE:

The minimum length which can be measured accurately by a screw gauge is called least count of screw gauge. The least count of screw gauge is found by dividing its pitch by the total number of circular scale divisions.

$$\textbf{Least count} = \frac{\textbf{pitch of screw gauge}}{\textbf{total number of divisions on circular scale}}$$

If the pitch of the screw gauge is 0.5mm and the number of divisions on circular scale is 50 then

$$\text{Least count} = \frac{0.5\ \text{mm}}{50}$$

$$= 0.01\ \text{mm}$$

or $$= 0.001\ \text{cm}$$

ZERO ERROR:

Turn the thimble until the anvil and spindle meet. If the zero mark on the thimble scale does not lie directly opposite the datum line of the main scale, we say that there is zero error.

POSITIVE ZERO ERROR:

If the zero of the circular scale remains below the horizontal line then such zero error is called positive zero error.

NEGATIVE ZERO ERROR:

If the zero of the circular scale remains above the horizontal line of the linear scale then such zero error is called negative zero error.

HOW TO FIND ZERO ERROR:

Bring the bolt towards the stud by rotating cap of the screw, so that they touch each other. Note the division on the circular scale that exactly coincides with the horizontal line of the linear scale. Multiply this division "n" with the least count to get the zero error.

ZERO CORRECTION:

If there is zero error, then for correct measurement, we add the negative error or subtract the positive error from the actual reading.

MEASUREMENT WITH SCREW GAUGE:

Suppose we want to measure the diameter of a small sphere by using screw gauge we will use the following method;

1. First of all check the screw gauge for zero error.
2. Place the object between anvil and spindle and tight the sphere by rotating the thimble.
3. Now note the reading on linear scale and denote it by "x".

4. Now note a division on circular scale which coincides with the horizontal line of the linear scale. Now multiply this division with the least count. Let this reading be denoted by“y”.
5. Now add “x” and “y” (x+y) to get the result.
6. In case of zero error, to get the actual measurement, subtract positive zero error an add negative zero error to (x+y).
   i.e Accurate Measurement = (x+y)± zero error

Q.17 What is physical balance?
Ans. <u>PHYSICAL BALANCE:</u>

It is a device which is used for measuring the mass of a body.

<u>EXPLANATION:</u>

Physical balance is a common balance where there are two pans and we measure weight of an object by putting it in one pan and a known weight in the other.

A physical balance is a very sensitive common balance which can measure weight in milligram order. It is placed in a protective glass case so that even dust and wind can not affect the accuracy of the instrument.

Q.18 What is stop watch? Discuss its types and their working?
Ans. <u>STOP WATCH:</u>

It is a device which is used for measuring specific intervals of time.

There are two main types of stop watch;

1. Mechanical or Analogue Stop Watch
2. Digital Stop Watch

<u>MECHANICAL/ ANALOGUE STOP WATCH:</u>

It consists of two hands a small minute hand and a long second hand. Scales for each hand are marked on a circular dial.

<u>WORKING:</u>

To note the time both the hands are set at zero by pressing and releasing the knob. As the knob is pressed and released again, the watch starts.

When the second’s hand completes two rotations of 30 seconds each, the minute hand advances by one division. When it is required to be stopped, again the same knob is pushed, the watch stops, and time can be noted.

<u>DIGITAL STOP WATCH:</u>

A digital clock is a type of clock with a digital display.

OR

Digital Stopwatch shows the time in the form of digits.

<u>WORKING:</u>

The timing functions in digital stopwatch are usually controlled by two buttons on the case. Pressing the top button starts the timer running, and pressing the button a second time stops it, leaving the elapsed time displayed.

A press of the second button then resets the stopwatch to zero. The second button is also used to record split times or lap times. When the split time button is pressed while the watch is running, the display freezes, allowing the elapsed time to that point to be read, but the watch mechanism continues running to record total elapsed time. Pressing the split button a second time allows the watch to resume display of total time.

Q.19 Discuss the purpose, construction and working of measuring cylinder.

Ans. MEASURING CYLINDER:

Measuring cylinder is a device with the help of which we can determine the volume of a liquid as well as volume of irregular solid body such as key.

CONSTRUCTION:

It is made of transparent plastic or glass and it has a vertical scale in milliliter (ml) or cubic centimeter (cm^3).

WORKING:

Water is poured into a measuring cylinder until the cylinder is about half full. Note the volume of water.

Now an irregular shaped object is lowered gently into the cylinder such that it is immersed completely and note the volume of water again. The final volume is the sum of volume of water and volume of the object.

The volume of the object is found by subtracting the first reading from the second.

Conceptual Questions:

Q#1: How technology is shaped by physics?

Ans: Physics and technology are closely related. Physics is concerned with gathering knowledge and organizing it. So, Physical phenomenon is there behind every technology.

For example:

1. Buses, cars, motorcycles etc. are the important means of transport in modern technologies which are based on the principle of mechanics.
2. Heat engines work on the principle of thermodynamics.
3. Computer is used in the modern technology which works on the principle of physics.
4. The discovery of laws of electromagnetic induction enabled the engineers to develop electric generators.
5. The discovery of nuclear fission led to the development of nuclear power plant which produce huge amount of energy for use.
6. Physics helps in the development of new instruments for medical applications such as CT scan, MRI and LASER etc.

From the above discussion, it is clear that physics has played an important role in the development of various technologies.

Q#2: Physics and biology are considered different branches of science, how physics links with biology?

Ans: Physics helps biology to great extent for example:

i. Physics leads us to great invention like microscope, electron microscope, Computer Tomography (CT scan), Ultrasonic Machines, X-rays etc.
ii. Physics has invented concave and convex lenses which are widely used to correct short and long sightedness.
iii. The movement of muscles and bones are studied and followed by the principles of physics (lever and its types).
iv. Physics has helped a lot to understand photosynthesis by describing the nature of light.

Q#3: Why are measurements important?
Ans: Measurement is one of the most basic concepts in science. Physics deals with physical quantities which can be measured. So, measurement provides a standard for everyday things and processes.

Examples:

Some examples from daily life have shown the importance of measurement.

1. Without the ability to measure, it would be difficult for scientists to conduct experiments.
2. Without measurements, there would be no concept of freezing point, boiling point and density etc.
3. Without measurements, patients are unable to take correct dose of medicines.
4. Without measurements, buying and selling of things are impossible.
5. It is also essential in farming, engineering, construction, and manufacturing etc.
6. From weight, temperature, length, even time is a measurement and it does play a very important role in our lives.

Q#4: Why area is a derived quantity?
Ans: A derived quantity is the combination of various base quantities. Thus, area is a derived quantity because in area the same base quantity "length" occurs twice (in the form of length and breadth).

As we know that

Area = Length x breadth

Area = $\boldsymbol{\iota \times \iota}$

$= \boldsymbol{\iota^2}$

As unit of length is "m"

So,

Unit of area is **'m^2'.**

Q#5: Name any four derived units and write them as their base units?
Ans: Four derived units are newton, pascal, joule and ohm.

Derived units in term of base units are given below:

Derived Quantities	Derived Units	Derived unit in term of base unit
Volume	Cubic meter	m^3
Acceleration	Meter per second square	ms^{-2}
Force	Newton (N)	$kg\ ms^{-2}$
Pressure	Pascal (Pa)	$kg\ m^{-1}\ s^{-2}$

Q#6: Why in physics we need to write in scientific notation?
Ans: Scientific notation is an easy way of writing numbers that are very big or very small. In physics we need to write number in scientific notation because with the help of scientific notation we can express very large or very small number easily. A large or small number "N" can be expressed in term of a number "M" and a power of 10. e.g.;

$$\mathbf{N=Mx10^n}$$

Where "M" represents a number whose first digit is non-zero digit and "n" represent the power of 10 which may be positive or negative.

For example:

150, 000,000,000 m is expressed in terms of scientific notation as **$1.5x10^{11}$m.**

Q#7: What is least count? How least count for vernier caliper and screw gauge are defined?

Ans: Least Count:

Least Count is the minimum value that can be measured on the scale of measuring instrument.

Least Count of Vernier Calliper:

The minimum length which can be measured accurately with the help of vernier caliper is called least count of vernier calliper.

Least count can be obtained from dividing the value of smallest division on main scale by total number of divisions on vernier scale.

$$\text{Least Count} = \frac{\text{smallest division on main scale}}{\text{total no.of dividion on vernier scale}}$$

If smallest main scale division is 1mm and vernier scale division has 10 divisions then the least count is

$$\text{Least Count} = \frac{1\text{mm}}{10} = 0.1\text{mm}$$

Least Count of Screw Gauge: The minimum length which can be measured accurately by a screw gauge is called least count of the screw gauge.

The least count can be obtained by dividing its pitch by the total number of circular scale division:

$$\text{Least count} = \frac{\text{Pitch of the screw gauge}}{\text{total no.of divisions on circular scale}}$$

If the pitch of the screw gauge is 0.5mm and the number of divisions on circular scale is 50 then

$$\text{Least count} = \frac{0.5\text{mm}}{50} = 0.01\text{mm}$$

Q#8: How can we find the volume of a small pebble with the help of measuring cylinder?

Ans: Take a measuring cylinder and put some water into it about half full. Note the initial volume of water. i.e. Initial volume $=V_i$

Now a pebble is lowered gently into the cylinder such that it is immersed completely and note the final volume. The final volume is the sum of volume of water and volume of pebble which is V_f.

Now, find the difference "ΔV" in volume which is the volume of the pebble.

$$\textbf{Volume of the pebble} = \Delta V = V_f - V_i$$

ASSIGNMENTS

1.1 The mass of earth is 5,980,000,000,000,000,000,000,000 kg. Write this number in standard form/ scientific notation.

DATA:

Mass of earth = 5,980,000,000,000,000,000,000,000 kg

FIND:

Standard form=?

SOLUTION:

As we know that

$$N = M\times10^n$$

So,

$$5{,}980{,}000{,}000{,}000{,}000{,}000{,}000{,}000\text{kg} = 5.98\times10^{24}\text{kg}$$

Therefore, mass of earth in scientific notation is 5.98×10^{24}kg.

1.2 Calculate the number of seconds in a week. Express the number in power of 10 notation.

Data:

Number of seconds in a week=?

SOLUTION:

No. of days in1 week =7 days

No. of hours in 1 day =24 hours

No. of minutes in 1 hour =60 min

No. of seconds in 1 min=60 sec

So,

1 week=1×7×24×60×60

1 week= 604800 sec

In scientific notation,

$N=M\times10^{n}$

1 week = 6.048×10^{5} sec

1.3 Adult housefly (Musca domestica) is having a mass of only about 0.0000214kg. Express this number in standard form/ scientific notation.

DATA

Mass of housefly= 0.0000214 kg

SOLUTION

As we know that

$N=M\times10^{n}$

So,

$0.0000214kg=2.14\times10^{-5}kg$

Therefore, mass of housefly in scientific notation is 2.14×10^{-5}kg.

1.4 The smallest bird is the bee hummingbird. Males measure only 0.057m, convert this number to standard form and write this number in millimeters.

DATA:

Size of bee in meter= 0.057m

FIND:

a. Standard form=?

b. Size of bee in millimeter=?

SOLUTION:

a. In scientific notation, we know that

$\mathbf{N=M\times10^{n}}$

$0.057= 5.7x10^{-2}m$

b. Now, to convert in "mm"we also know that

$1m=10^{-3}mm$

So, Size of bee $=5.7x10^{-2}\ x10^{-3}mm$

$=5.7x10^{-2+3}m$

$=5.7x10^{1}mm$

$=57x10^{1-1}mm$

$=57x10^{0}\ mm$

Size of bee =57mm

So, the size of bee in millimeter is 57mm.

1.5 Calculate the distance from Peshawar to Lahore in millimeters.

DATA:

Distance from Peshawar to Lahore=489km

FIND:

Distance from Peshawar to Lahore in millimeter=?

SOLUTION:

Distance from Peshawar to Lahore=489km

$=489\text{x}10^3\text{m}$ (because kilo=10^3)

$=489\text{x}10^3\text{x}10^3\text{mm}$ (because 1m=10^3mm)

$=489\text{x}10^{3+3}\text{mm}$

$=489\text{x}10^6\text{mm}$

$=4.89\text{x}10^2\text{x}10^6\text{mm}$

$=4.89\text{x}10^{2+6}\text{mm}$

$\mathbf{=4.89x10^8mm}$

Therefore, distance from Peshawar to Lahore in millimeters is $4.89\text{x}10^8$mm.

1.6 Which of the following is the accurate device for measuring length;

a. A vernier calipers with main scale of 1mm marking and 50 divisions on sliding scale.

b. A screw gauge of pitch 1mm and 25 divisions on the circular scale.

DATA

Smallest division on main scale of vernier callipers= 1mm

Total no. of divisions on vernier scale= 50

Pitch of screw gauge= 1mm

Total no. of divisions on circular scale= 25

SOLUTION

a. Least count of vernier callipers is given by

$$\text{Least count} = \frac{\text{Smallest division on main scale}}{\text{total no.of divisions on vernier scale}}$$

$$= \frac{1\text{mm}}{50}$$

=0.02 mm

b. Least count of screw gauge is given by

$$\text{Least count} = \frac{\text{Pitch of screw gauge}}{\text{total no.of divisions on circular scale}}$$

$$\text{Least count} = \frac{1\text{mm}}{25}$$

=0.04 mm

As the least count of vernier calliper is smaller than that of screw gauge, so in this case vernier calipers will give more accurate result for measuring length.

1.7 A breaker contains 200ml of water, what is the volume of water in cm^3 and m^3.

DATA:

Volume of water in ml=200ml

FIND:

Volume of water in cm^3=?

Volume of water in m^3=?

SOLUTION:

Volume of water =v= 200ml

a. As V=200ml------------(1)

And we know that

$1\text{ml}=1\text{cm}^3$

So eq (1) becomes

$V=200x1ml$
$=200x1cm^3$
$V=200cm^3$--------------(2)

b. <u>Now find the volume of water in m^3</u>

As we know that
1m=100cm
Taking cube on both sides
$(1m)^3=(100cm)^3$
$1m^3=(100)^3\ cm^3$
$= 100x100x100\ cm^3$
$1m^3=1000000\ cm^3$
$\frac{1m^3}{1000000} = \frac{1000000}{1000000}cm^3$
$\frac{1}{10^6}m^3= 1cm^3$
$10^{-6}m^3 = 1cm^3$
Or
$1cm^3 = 10^{-6}m^3$
So eq (2) becomes
$V=200\ cm^3$
$=200x1\ cm^3$
$V=200x10^{-6}m^3$ (because $1cm^3= 10^{-6}m^3$)
$=2.0\ x\ 10^2x\ 10^{-6}\ m^3$
$=2.0x10^{2-6}m^3$
$V=2.0x10^{-4}m^3$

NUMERICAL QUESTIONS

1. Write the number in prefix to power of ten,

a. Mechanical nano-oscillators can detect a mass change as small as 10^{-21}kg.
b. The nearest neutron star (a collapsed star made primarily of neutrons) is about $3.00x10^{18}$m away from Earth.
c. Earth to sun distance is 149.6 million km.

SOLUTION;

a. Mass = 10^{-21}kg
Mass = 10^{-21}x 1kg $\because 1kg = 10^3\ g$
$=10^{-21}x\ 10^3g$
$=10^{-21+3}g$
$=10^{-18}g$
$=1x10^{-18}g$ ($\because 10^{-18}$ = atto)
Mass = 1 atto g
Or
Mass = 1 ag

b. Distance of nearest neutron from earth = $3.00x10^{18}$m
Distance = $3.00x10^{18}$m
=3.00 Exa. m (because 10^{18}= Exa)
Or Distance =3.00 Em

c. Earth to sun distance = 149.6 million km
$=149.6x10^6$km (because million=10^6)
$=149.6x10^6x10^3$m (because kilo= 10^3)

$=149.6x10^{6+3}m$
$=149.6x10^{9}m$
$=149.6$ Giga.m (because 10^9= Giga)

Earth to sun distance = 149.6 Gm

2. **An angstrom (symbol A*) is a unit of length (commonly used in atomic physics), defined as 10^{-10}m which is of the order of the diameter of an atom.**

a. **How many nanometers are in 1.0 angstrom?**

DATA:

1 angstrom = 10^{-10}m

SOLUTION:

1 angstrom = 10^{-10}m
$=10^{-1-9}m$ (because $a^{m+n}=a^m.a^n$)
$=10^{-1}x10^{-9}m$ ($\because 10^{-9}$ =1nano)
$=10^{-1}$nano. m
$=10^{-1}$nm
$=\frac{1}{10}$nm
=0.1 nm

1 angstrom= 0.1nm

b. **How many femtometers or fermis (the common unit of length in nuclear physics) are in 1.0 angstrom?**

SOLUTION:

1.0 angstrom= 10^{-10}m

Multiplying 10^{-5} on both sides:

$1.0x10^{-5}$ angstrom = 10^{-10}x 10^{-5}m
$1.0x10^{-5}$angstrom= 10^{-10-5}m (because $a^m.a^n= a^{m+n}$)
$1.0x10^{-5}$angstrom=10^{-15}m
$1.0x10^{-5}$angstrom= Femto.m (because 10^{-15}= 1 Femto)

Multiplying 10^5 on both sides:

1.0x 10^{-5} x 10^5angstrom= 10^5 femto m
$1.0x10^{-5+5}$ angstrom = 10^5 femto. m
1.0 x 10^0 angstrom= 10^5fm

So,

1.0 angstrom= 10^5fm

c. How many angstroms are in 1.0m?

SOLUTION:

1 angstrom=10^{-10}m
1 angstrom = $\frac{1}{10^{10}}$ m

Multiplying 10^{10} on both sides:

$1x10^{10}$angstrom=10^{10}x$\frac{1}{10^{10}}$m
10^{10}angstrom= 1m

Or

1m=10^{10} angstrom

3. **The speed of light is c= 299,792,458m/s.**
   a. **Write this value in scientific notation.**
   DATA:
   speed light is c= 299,792,458m/s
   FIND:
   Standard form=?
   SOLUTION:
   For scientific notation we have
   $N=Mx10^n$-----------(1)
   Then eq (1) becomes
   $299792458m/s= 2.99792458x10^8m/s$

So, the speed of light in scientific notation is $2.99792458x10^8m/s$.

   b. **Express the speed of light to**
      i. **Five significant figures**
      ii. **Three significant figures**

   SOLUTION

i. **As $c=2.99792458x10^8m/s$**
   Now, round off "c" upto five significant figures
   $c= 2.99792458 \, x10^8m/s$
   $c=2.9979246x10^8m/s$
   $c=2.997925x10^8m/s$
   $c=2.99793x10^8m/s$
   $c=2.9979x10^8m/s$

ii. **As $c=2.9979246x10^8$ m/s**
   Now, round off "c" upto three significant figures
   $c = 2.9979246x108m/s$
   $c = 2.997925x108m/s$
   $c = 2.99793x108m/s$
   $c = 2.9979x108m/s$
   $c = 2.998x108m/s$
   $c = 3.00x108m/s$

4. **Express the following in terms of power of 10**
   a. **7 nanometer**
   As nano $=10^{-9}$
   So 7 nanometer= $7x10^{-9}$ meter

   b. **96 megawatt**
   As mega = 10^6
   So 96 megawatt = $96x10^6$watt

   c. **2 gigabite**
   As giga = 10^9
   So 2 gigabites= $2x10^9$bite

   d. **43 picofarad**
   As pico = 10^{-12}
   So 43 picofarad = $43x10^{-12}$farad

e. **2 millimeter**
As milli=10^{-3}
So 2 millimeter = $2x10^{-3}$meter

5. **Write the following numbers in standard form;**

a. **Mass of Bacterial cell;0.000,000,000,005kg**
DATA:
Mass =0.000,000,000,005kg

FIND:
Standard form=?
SOLUTION:
As we know that
$N=Mx10^n$ -------(1)
then eq (1) becomes
0.000,000,000,005kg=$5x10^{-12}$kg
So, mass of the bacterial cell in standard form is $5x10^{-12}$kg.

b. **Diameter of sun; 1,390,000,000 m**
DATA:
Diameter of sun =1,390,000,000m
FIND:
Standard form=?
SOLUTION
As we know that
$N=Mx10^n$ -------(1)
Then, equation (1) becomes
1,390,000,000m=$1.39x10^9$m
So, diameter of Sun in standard form is $1.39x10^9$m.