# EXERCISE

**Select the correct answer of the following questions.**

**1) Which of the following quantities has not been expressed in proper units?**

a. $\dfrac{stress}{strain}$ = newton metre$^{-2}$                      b. Force = kg ms$^{-2}$

c. Energy = kg ms$^{-2}$                                     d. Pressure – Newton ms$^{-2}$

**2) Which of the following correctly represent the S.I. unit of pressure?**

a. Newton metre$^{-2}$        b. Newton$^2$ metre$^{-1}$        c. Newton        d. Newton$^{-1}$

**3) Which of the following may be used as a valid formula to calculate speed of ocean? v = speed, g = acceleration due to gravity, γ = wave length, ρ = density, h=depth**

a. $\sqrt{\gamma gb}$              b. ρgh              c. v =hr              d. none

**4) What is the SI unit of constant k in the following equation? where F = 6πηrv, where F = force v = velocity r = radius.**

a Kg m$^1$s$^1$              b. kg ms              c. kg$^{-1}$ m$^2$s              d. kg m$^2$s$^2$

**5) Which of the following is a smallest value?**

a. 1 mm x 1 pm    b. 1 cm x 1 km    c. 1 Gm x 1 Em    d. a nm x 1m

**6)** $\dfrac{1\,Km}{1\,Gm}$ = ..........?

a. 10$^{-6}$m              b. μ              c. 10$^6$              d. 10 μ

7) In a cricket match, 500 spectators are counted one by one. How many significant figures will be there in the final result?

a. 3                    b. 1                    c. 2                    d. 0

8) The equation relating pressure and density is p = pgh. How can both sides of this equation be written in terms of base units?

a. $[Nm^{-1}] = [kgm^{-3}] [ms^{-1}] [m]$          b. $[Nm^{-2}] = [kgm^{-3}] [ms^{-2}][m]$

c. $[kgm^{1}s^{-2}] = [kgm^{-3}] [ms^{-2}] [m]$         d. $[kgm^{-1}s^{-1}] = [kgm^{-1}] [ms^{-2}][m]$

9) A series of measurements of the acceleration of free fall g is shown in the table which set of results is precise but not accurate?

| g/ms$^{-2}$ | | | | | |
|:---:|:---:|:---:|:---:|:---:|:---:|
| a | 9.81 | 9.79 | 9.84 | 9.83 | 9.79 |
| b | 9.81 | 10.12 | 9.89 | 8.94 | 9.42 |
| c | 9.45 | 9.21 | 8.99 | 8.76 | 8.51 |
| d | 8.45 | 8.46 | 8.5 | 8.41 | 8.47 |

10) A mass m has acceleration a. it moves through a distance s in time t. The power used in accelerating the mass is equal to the product of force and velocity. The percentage uncertainties are 0.1% in m, 1% in a, 1.5% in s, 0.5 in t.

a. 2.1 %                b. 2. 6 %                c. 3.1 %                d. 4.1 %

11) Which one is a pair of SI base units?

a. ampere, joule                    b. coulomb, second

c. kilogram, Kelvin                    d. meter, Newton

12) What is the ratio $\frac{1\,\mu m}{1\,Gm}$ ?

a. $10^{3}$              b. $10^{-9}$              c. $10^{-12}$              d. $10^{-15}$

**13) A student measured the diameter of wire using a screw gauge with least count 0.001 cm. The correct measurement is**

a. 5.3 cm                b. 5.32 cm                c. 5.320 cm                d. 5.3200 cm

**14) The dimensions of frequency f are**

a. $[T^2]$                b. $[LT^{-1}]$                c. $[T^{-1}]$                d. $[MT^{-1}]$

**15) Which one is the least sub multiple?**

a. pico                b. femto                c. Atto                d. neno

**16) One femto is equal to**

a. $10^{15}$ s                b. $10^{-15}$ s                c. $10^{-16}$ s                d. $10^{-9}$ s

**17) The scientific notation of a number 0.0023 is expressed as**

a. $2.3 \times 10^{-3}$                b. $0.023 \times 10^{-2}$                c. $2.3 \times 10^{-4}$                d. $0.23 \times 10^{3}$

**Answers:**

| 1. | (c) | 2. | (d) | 3. | (a) | 4. | (a) | 5. | (a) |
|---|---|---|---|---|---|---|---|---|---|
| 6. | (b) | 7. | (a) | 8. | (c) | 9. | (a) | 10. | (b) |
| 11. | (c) | 12. | (d) | 13. | (c) | 14. | (c) | 15. | (c) |
| 16. | (b) | 17. | (a) | | | | | | | | |

**Write the short answer of the following:**

**Q.1    Define the number π and show that 2 π radian is equal to 360°.**

**Answer**

The number Pi, denoted by the Greek letter π - pronounced 'pie', is one of the most common constants in all of mathematics.

It is the circumference of any circle, divided by its diameter. Nobody knows its exact value, because no matter how many digits you calculate it to, the number never ends. For most practical uses, you can assume it is 3.142. It is the ratio of circumference of a circle to the diameter of the same circle.

**Mathematically**

$$\pi = \frac{\text{Circumference of circle}}{\text{Diameter of the circle}}$$

$$= c/d$$

Since 1 Radian = 57.3°

2 $\pi$ Radian = 57.3° × 2 × 3.14

2 $\pi$ Radian = 360°

**Q.2    Define the terms error, uncertainty, precision and accuracy in measurement?**

**Answer**

**Errors and Uncertainties**

All physical measurements are uncertain and imprecise to some limit. There are three sources of errors.

**Sources of errors**

(i)     Negligence or inexperience of a person

(ii)    Faulty apparatus

(iii)   Inappropriate method or technique

The uncertainty is usually described as an error in measurement.

**Type of Errors**

There are two major types of errors.

(1) Random error     (2) Systematic error

**Precision**

Precision means how close the measured values are to each other. The precision of a measurement depends upon the least count of measuring

instrument. The smaller the unit, the more precise the measurement. The precision of a measurement describes the units you used to measure something. For example, you might describe your height as 'about 6 feet'. That wouldn't be very precise. If, however, you said that you were '74 inches tall' that would be more precise.

A precise measurement is the one which has less absolute uncertainty.

The precision of a measurement is determined by the instrument or device being used.

## Accuracy

Accuracy means how close a measured value (result) is to the actual (true) value. The accuracy of a measurement is the difference between your measurement and the accepted correct answer. The bigger the difference, the less accurate your measurement. An accurate measurement is one which has less fractional or percentage error. The accuracy of measurement depends on the fractional or percentage uncertainty in that measurement.

## Example

When the object is recorded as 25.5 cm by using a meter rod having smallest division in millimeter. It is the difference of two reading of the initial and position. The uncertainty in the single reading as discussed before is taken as 0.05 cm which is now double and called absolute uncertainty equal to 0.1 cm (i.e 0.051± 0.05=±0.1). Absolute uncertainty, in effect, is equal to the least count of the measuring instrument. This is called precision.

## Q.3   Explain several repetitive phenomena occurring naturally which could serve reasonable time standard.

## Answer

There are many natural processes, which could be used as time standard in nature some of them are:

a)   Rotation of moon around the earth.

**b)**    Rotation of earth about its own axis, and around the sun.

**c)**    Crystal lattice vibration.

**d)**    Radioactive decay of radioactive elements.

**e)**    Pulse rate of human beings.

**f)**    Change of season.

## Q.4    Why do we find it useful to have two units for the amount of substance i.e. kilogram and mole?

**Answer**

The amount of substance is measured in kilogram when microscopic properties of a substance are not required i.e. number of particles, atoms, molecules ions etc. The term kilogram is used only at macroscopic level.

The mole is concerned to the microscopic properties of a substance i.e. when we are concerned with number of particles, we use mole as the unit of amount of substance because one mole of substance contains equal number of particles i.e. NA $6.022 \times 10^{23}$

## Q.5    Show that the famous Einstein equation E = mc² is dimensionally consistent. Answer

L.H.S. = 'E'

Since the unit of energy is joule and

$1J = kg\ m^2S^{-2}$

$= [ML^2R^{-2}]$          ............... (1)

R.H.S $= mc^2$

$= kgm^2S^{-2}$

$= [ML^2R^{-2}]$          ............... (2)

From Equation (1) & (2) it is clear that E = mc² is dimensionally consistent.

### Q.6  Deduce the dimension of gravitational constant.

**Answer**

As   $F = \dfrac{GMm}{r^2}$

$G = \dfrac{mm_2}{r^2}$

$G = FR^2\, Me^1\, m^{-1}$              ............... (1)

The dimension of Force is $[MLT^{-1}]$

The dimension of R is $[L]$

The dimension of Me & m is $[M]$

So, equation (1) becomes

$G = [MLT^{-2} \times L^2 \times M^{-1} \times M^{-1}]$

$G = [L^3\, M^{-1}\, T^{-2}]$

### Q.7  Find the dimension of K.E.

**Answer**

As K.E $= 1/2\, mv^2$

The dimension of mass is $[M]$

The dimension of velocity of $\left[LT^{-1}\right]$

So, equation (1) becomes

$= 1/2\, [M \times (LT^{-1})^2]$

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

Which is the required dimension.

### Q.8 Give the draw backs to use the period of a pendulum as time standards?

**Answer**

The time period of a simple pendulum is given as

$$T = 2\pi\sqrt{\frac{l}{g}} \qquad\qquad ........(1)$$

It is clear from Equation (1) that time period of pendulum is directly proportional to the square root of length of pendulum and inversely proportional to the square root of acceleration due to gravity i.e.,

$$T \propto \sqrt{l}$$

$$T \propto \frac{1}{\sqrt{g}}$$

- Since length of pendulum is temperature dependent, that is in summer and winter it changes.
- Similarly, acceleration due to gravity varies with altitude, also its value at poles and at equator is different. That is why period of a pendulum cannot be used as time standard.

## Q.9    Are radian & steradians the basic units of system international? Justify your answer.

### Answer

Radian & steradians both are not considered as basic units of system international. These are supplementary units. Plane angle is measured in radians & solid angle is measured in steradians. Although both plane & solid angles are pure quantities (dimensionless). Yet these are measured in radian & steradian. That is why they are called supplementary units.

## Q.10   What does the word 'micro' signify in the word microwave oven?

### Answer

The prefix 'micro' represented by symbol `μ' (mew) in the word 'microwave oven' signifies that electromagnetic waves produced in microwave oven have wave lengths of the order of $10^{-6}$ m.

i.e.        $10^{-6}$ m 1 μ m

The thermal radiations whose wave lengths are of the order of $10^{-6}$ m is called microwaves.

## Q.11   Density of air is 1.2 kg/m³. Change it into g/cm³.

**Answer:**

$$d = 1.2 \text{ kg} / \text{m}^3$$

$$= \frac{1.2 \times 1000 \, g}{(100 \, cm)^3} \qquad 1 kg = 1000 \, g$$

$$= \frac{1.2 \times 10^3 g}{(100)^3 \, cm^3}$$

$$= 1.2 \times 10^{-3} \text{ g/cm}^3$$

## Q.12   An old saying is that A chain is only as strong as its weakest link, what analogous statement can you make regarding measurement.

**Answer**

Its analogous statement in measurement is a result of experimental data is only as much accurate as possible if it has least fractional uncertainly in the data.

## Q.13   Differentiate between the light year and year?

**Answer**

- **Light year:** It is the distance travelled by light in one year between any two points in space is called light year

1 light year = $9.45 \times 10^{15}$ m

- **Year:** The time period in which earth completes one revolution around the sun is called a year. 1 year = $3.1536 \times 10^{7}$ Sec