1. Nature of the physical world and measurement

Book back questions:

1. Distinguish between fundamental units and derived units.
   **Fundamental:**
   Fundamental quantities are quantities which cannot be expressed in terms of any other physical quantity. For example, quantities like length, mass, time, temperature are fundamental quantities.
   The units in which the fundamental quantities are measured are called fundamental units.

   **Derived:**
   Quantities that can be expressed in terms of fundamental quantities are called derived quantities. Area, volume, density etc. are examples for derived quantities. The units used to measure derived quantities are called derived units.

2. Give the SI standard for (i) length (ii) mass and (iii) time.
   - Length --- metre (m)
   - Mass ---- kilogram (kg)
   - Time ---- second (s)

3. Why SI system is considered superior to other systems?
   The SI system is logically far superior to all other systems. The SI units have certain special features which make them more convenient in practice. Permanence and reproduceability are the two important characteristics of any unit standard. The SI standards do not vary with time as they are based on the properties of atoms. Further SI system of units are coherent system of units, in which the units of derived quantities are obtained as multiples or submultiples of certain basic units.

4. What is the need for measurement of physical quantities?
   To deal and study the properties of materials measurement is in need and it is indeed. The measurement of physical quantities plays a significant role in the contribution of uniqueness to physics. The art of measuring physical quantities such as length, mass, time etc., helps us to understand the properties of materials. Measurement enriched the concept of dimensions that help us in verifying equations and deriving expressions for physical quantities.

5. You are given a wire and a metre scale. How will you estimate the diameter of the wire?
   Place the given wire at any division of the metre scale and make the turns of it side by side upto the next division that is upto a distance of 1mm. Let the number of turns within a distance of 1mm be n. Then the diameter of the thread will be 1/n (mm). For example if there are five turns within a distance of 1mm, then the diameter of the wire will be 1/5 mm i.e., 0.2mm. Thus the diameter of the wire can be estimated with the help of a metre scale.
7. Name four units to measure extremely small distances.

\[
\begin{align*}
10^{-15} & \text{ - femto - f} \\
10^{-12} & \text{ - pico - p} \\
10^{-9} & \text{ - nano - n} \\
10^{-6} & \text{ - micro - μ} \\
10^{-3} & \text{ - milli - m} \\
10^{-2} & \text{ - centi - c} \\
10^{-1} & \text{ - deci - d}
\end{align*}
\]

8. What are random errors? How can we minimise these errors?

Random errors:
It is very common that repeated measurements of a quantity give values which are slightly different from each other. These errors have no set pattern and occur in a random manner. Hence they are called random errors. They can be minimised by repeating the measurements many times and taking the arithmetic mean of all the values as the correct reading. The most common way of expressing an error is percentage error.
If the accuracy in measuring a quantity \( x \) is \( Δx \)

9. Show that \( \frac{1}{2} gt^2 \) has the same dimensions of distance.

For
\[
gt^2 = (MT^{-2})(T^2) = M T^{-2+2} = M
\]
So its same of dimensional of distance

10. What are the limitations of dimensional analysis?
(i) The value of dimensionless constants cannot be determined by this method.
(ii) This method cannot be applied to equations involving exponential and trigonometric functions.
(iii) It cannot be applied to an equation involving more than three physical quantities.
(iv) It can check only whether a physical relation is dimensionally correct or not. It cannot tell whether the relation is absolutely correct or not.

11. What are the uses of dimensional analysis?
(i) convert a physical quantity from one system of units to another.
(ii) check the dimensional correctness of a given equation.
(iii) establish a relationship between different physical quantities in an equation
2. Kinematics

1. Compute the (i) distance travelled and (ii) displacement made by the student when he travels a distance of 4km eastwards and then a further distance of 3 km northwards.

\[ \text{Solution :} \]

\[
\begin{array}{c}
\text{4m} \\
\downarrow \\
\text{3m}
\end{array}
\]

The total length of the path is the distance = 7 m
shortest distance between the initial and final position of the particle is the displacement = 1 m

2. What is the (i) distance travelled and (ii) displacement produced by a cyclist when he completes one revolution?

When a cyclist completes one revolution,
(i) Distance travelled is equal to the perimeter of circular path.
(ii) The displacement is zero since he has reached the starting point.

3. Differentiate between speed and velocity of a body.

**Speed**

It is the distance travelled in unit time. It is a scalar quantity.

**Velocity**

The velocity of a particle is defined as the rate of change of displacement of the particle. Its unit is m s\(^{-1}\) and its dimensional formula is LT\(^{-1}\)

4. What is meant by retardation?

Retardation or deceleration:

If the velocity decreases with time, the acceleration is negative. The negative acceleration is called retardation or deceleration.

5. What are scalar and vector quantities?

The scalar quantities have magnitude only. It is denoted by a number and unit. Examples: length, mass, time, speed, work, energy

The vector quantities have both magnitude and direction. Examples: displacement, velocity, acceleration, force, weight, momentum, etc.

6. What is the magnitude and direction of the resultant of two vectors acting along the same line in the same direction?

Consider two vectors P and Q acting along the same line in the same direction. To add these two vectors, join the tail of Q with the head of P. The resultant of P and Q is R= P+Q.
The length of the line gives the magnitude of R. R acts in the same direction as that of P and Q.

7. State: Parallelogram law of vectors and triangle law of vectors.

(i) **Triangle law of vectors** : If two vectors are represented in magnitude and direction by the two adjacent sides of a triangle taken in order, then their resultant is the closing side of the triangle taken in the reverse order.
(ii) **Parallelogram law of vectors**:
If two vectors acting at a point are represented in magnitude and direction by the two adjacent sides of a parallelogram, then their resultant is represented in magnitude and direction by the diagonal passing through the common tail of the two vectors.

8. **State Newton’s laws of motion.**

   **Newton’s first law of motion:**
   It states that every body continues in its state of rest or of uniform motion along a straight line unless it is compelled by an external force to change that state.

   **Newton’s second law of motion:**
   The rate of change of momentum of a body is directly proportional to the external force applied on it and the change in momentum takes place in the direction of the force.

   **Newton’s third Law of motion:**
   It states that for every action, there is an equal and opposite reaction.

9. **Define impulse of a force**

   **Impulse of a force:**
   The impulse J of a constant force F acting for a time t is defined as the product of the force and time. (i.e) Impulse = Force \times time
   \[ J = F \times t \]
   Impulse of a force is a vector quantity and its unit is N s.

10. **What is centrifugal reaction?**

    According to Newton’s third law of motion, for every action there is an equal and opposite reaction. The equal and opposite reaction to the centripetal force is called centrifugal reaction, because it tends to take the body away from the centre.

11. **What are the two types of collision?**

    A collision between two particles is said to occur if they physically strike against each other or if the path of the motion of one is influenced by the other. Collisions are divided into two types: (i) elastic collision and (ii) inelastic collision

3. **Dynamics of Rotational Motion**

1. **What are the different types of equilibrium?**

   (a) Stable equilibrium  (b) Unstable equilibrium  (c) Neutral equilibrium

2. **A cat is able to land on its feet after a fall. Which principle is being used? Explain.**

   Principle of conservation of angular momentum is being used here. Cat uses the conservation of angular momentum to change its orientation. When it falls, its centre of mass follows a parabolic path. When the cat is in the air, no net external torque acts on it, about its center of mass. So the angular momentum about the cat’s centre of mass cannot change. By pulling in its legs, it considerably reduces rotational inertia about the same axis and increases its angular speed.
4. Gravitation and Space Science

1. Why is the gravitational force of attraction between the two bodies of ordinary masses not noticeable in everyday life?
Gravitational force between the two bodies of ordinary masses is not noticeable because, the gravitational force is the weakest force among the fundamental forces. But this force plays an important role in the birth of a star, controlling the orbits of planets and evolution of the whole universe.

2. State the universal law of gravitation.
The law states that every particle of matter in the universe attracts every other particle with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

2. Define gravitational constant. Give its value, unit and dimensional formula
The Gravitational constant ‘G’ is numerically equal to the gravitational force of attraction between two bodies of mass 1 kg each separated by a distance of 1 m. The value of G is \(6.67 \times 10^{-11}\) N m\(^2\) kg\(^{-2}\) and its dimensional formula is M\(^{-1}\) L\(^3\) T\(^{-2}\).

3. The acceleration due to gravity is minimum at equator and maximum at poles. Give the reason.
The value of \(g\) varies inversely as the square of radius of the Earth. The radius at the equator is the greatest. Hence the value of \(g\) is minimum at the equator. The radius at poles is the least. Hence, the value of \(g\) is maximum at the poles. The value of \(g\) increases from the equator to the poles.

4. Why a man can jump higher on the moon than on the Earth?
On the moon surface, the value of acceleration due to gravity is approximately equal to 1/6 th of that value on Earth. The value of \(g\) on earth is 9.8 m/s\(^2\), that of moon is 1.6 m/s\(^2\). Since the value of \(g\) on the moon is less than that value of \(g\) on earth, a man can jump higher on the moon than on the Earth.

5. Define gravitational field intensity.
Gravitational field intensity or strength at a point is defined as the force experienced by a unit mass placed at that point. It is denoted by \(E\). It is a vector quantity. Its unit is N kg\(^{-1}\).

6. Define gravitational potential.
Gravitational potential at a point is defined as the amount of work done in moving unit mass from the point to infinity against the gravitational field. It is a scalar quantity. Its unit is N m kg\(^{-1}\).

7. What is escape speed? Obtain an expression for it.
The escape speed is the minimum speed with which a body must be projected in order that it may escape from the gravitational pull of the planet.
8. The moon has no atmosphere. Why?
The molecules of a gas move with certain average velocity, which depends on the nature and
temperature of the gas. At moderate temperatures, the average velocity of oxygen, nitrogen
and carbon–di–oxide is in the order of 0.5 km/s to 1 km/s and for lighter gases hydrogen and
helium it is in the order of 2 to 3 km/s. It is clear that the lighter gases whose average
velocities are in the order of the escape speed, will escape from the moon. So moon has no
atmosphere.

9. Differentiate between inertial mass and gravitational mass.
Intertial mass of a body is a measure of the ability of a body to oppose the production of
acceleration in it by an external force.
Gravitational mass is the mass of a body which determines the magnitude of gravitational
pull between the body and the Earth.

10. What is orbital velocity?
The horizontal velocity that has to be imparted to a satellite at the determined height so that it
makes a circular orbit around the planet is called orbital velocity.

11. What will happen to the orbiting satellite, if its velocity varies?
If the value of horizontal velocity (injection or orbital velocity) in not equal to the calculated
value, then the orbit of the satellite will not be circular. If its value is greater than the
calculated value but not greater than the escape speed, the satellite will not move along an
elliptical orbit. If the orbital velocity exceeds the escape speed, the satellite will not revolve
around the earth. It will escape into the space. If the injection velocity is less than the
calculated value the satellite will fall back to the Earth.

12. Why a man can jump higher on the moon than on the Earth?
On the moon surface, the value of acceleration due to gravity is approximately equal to 1/6
th of that value on Earth. The value of g on earth is 9.8 m/s², that of moon is 1.6 m/s². Since
the value of g on the moon is less than that value of g on earth, a man can jump higher on
the moon than on the Earth.

13. What are the called geo-stationary satellites?
A number of communication satellites which appear to remain in fixed positions at a
specified height above the equator are called synchronous satellites or geo-stationary
satellites.

14. Why do the astronauts feel weightlessness inside the orbiting spacecraft?
Let us consider an astronaut standing on the ground. He exerts a force (his weight) on the
ground. At the same time the ground exerts an equal and opposite force of reaction on the
astronaut. Due to this force of reaction, he has a feeling of weight.
When the astronaut is in an orbiting satellite, both the satellite and astronaut have the
same acceleration towards the centre of the earth. Hence, the astronaut does not exert any
force on the floor of the satellite. So the floor of the satellite also does not exert any force of
reaction on the astronaut. As there is no reaction, the astronaut has a feeling of
weightlessness.
15. What is solar system?
The part of the universe in which the Sun occupies the central position of the system holding together all the heavenly bodies such as planets, moons, asteroids, comets ... etc., is called Solar system.


The law of orbits
Each planet moves in an elliptical orbit with the Sun at one focus. A is a planet revolving round the Sun. The position P of the planet where it is very close to the Sun is known as perigee and the position Q of the planet where it is farthest from the Sun is known as apogee.

The law of areas
The line joining the Sun and the planet (i.e radius vector) sweeps out equal areas in equal interval of times.

The law of periods
The square of the period of revolution of a planet around the Sun is directly proportional to the cube of the mean distance between the planet and the Sun.

17. What is albedo?
The ratio of the amount of solar energy reflected by the planet to that incident on it is known as albedo.

18. What are asteroids?
Asteroids
Asteroids are small heavenly bodies which orbit round the Sun between the orbits of Mars and Jupiter. They are the pieces of much larger planet which broke up due to the gravitational effect of Jupiter. About 1600 asteroids are revolving around the Sun. The largest among them has a diameter of about 700 km is called Ceres. It circles the Sun once in every 4½ years.

19. What are constellations?
Most of the stars appear to be grouped together forming interesting in the sky. The configurations or groups of star formed in the patterns of animals and human beings are called constellations. There are 88 constellations into which the whole sky has been divided.

20. What is the reason for the formation of craters on the surface of the moon?
The formation of craters on the surface of the moon is due to the fact that they have been bombarded by large number of meteorites. Sharp boundaries represents no atmosphere in moon.
5. Mechanics of Solids and Fluids

1. Define: i) elastic body ii) plastic body iii) stress iv) strain v) elastic limit vi) restoring force

**Elastic body:**
The property of a material to regain its original state when the deforming force is removed is called elasticity. The bodies which possess this property are called elastic bodies.

**Plastic body:**
Bodies which do not exhibit the property of elasticity are called plastic.

**Stress:**
This restoring force per unit area of a deformed body is known as stress.

**Stress = restoring force / area**

**Strain:**
strain produced in a body is defined as the ratio of change in dimension of a body to the original dimension.

\[ \text{Strain} = \frac{\text{change in dimension}}{\text{original dimension}} \]

**Elastic limit**
If an elastic material is stretched or compressed beyond a certain limit, it will not regain its original state and will remain deformed. The limit beyond which permanent deformation occurs is called the elastic limit.

**Restoring force:**
When the deforming force is removed, the body regains its original state due to the force developed within the body. This force is called restoring force.

2. **State Hooke’s law.**
Its states that, within the elastic limit, strain produced in a body is directly proportional to the stress that produces it.
(i.e) stress \( \alpha \) strain

\[ \frac{\text{Stress}}{\text{Strain}} = \text{a constant}, \]

3. **Which is more elastic, rubber or steel? Support your answer.**
Steel is more elastic than rubber. Elasticity is measured as ratio of stress to strain. For a given stress stain is much smaller in steel than in rubber. So steel is more elastic than rubber.

4. **What is Reynold’s number?**
Reynolds number is a pure number which determines the type of flow of a liquid through a pipe. It is denoted by \( NR \).
It is given by the formula

\[ NR = \nu_c \rho D / \eta \]

where \( \nu_c \) is the critical velocity, \( \rho \) is the density, \( \eta \) is the co-efficient of viscosity of the liquid and \( D \) is the diameter of the pipe.
5. **State pascal’s law.**
Pascal’s law states that if the effect of gravity can be neglected then the pressure in a fluid in equilibrium is the same everywhere.

6. **What is critical velocity of a liquid?**
The streamline flow is possible only as long as the velocity of the fluid does not exceed a certain value. This limiting value of velocity is called critical velocity.

7. **Why Aeroplanes and cars have streamline shape?**
Aeroplanes and cars have streamline shape in order to reduce the friction of air. During motion, all particles coming in front of them will be directed tangentially. So they can move with greater speed easily.

8. **What is terminal velocity?**
Terminal velocity of a body is defined as the constant velocity acquired by a body while falling through a viscous liquid.

9. **Define cohesive force and adhesive force. Give examples.**
**Cohesive force**
Cohesive force is the force of attraction between the molecules of the same substance. This cohesive force is very strong in solids, weak in liquids and extremely weak in gases.

**Adhesive force**
Adhesive force is the force of attraction between the molecules of two different substances. For example due to the adhesive force, ink sticks to paper while writing. Fevicol, gum etc exhibit strong adhesive property.

10. **Define i) molecular range ii) sphere of influence iii) surface tension.**
**Molecular range:**
Molecular range is the maximum distance upto which a molecule can exert force of attraction on another molecule. It is of the order of $10^{-9}$ m for solids and liquids.

**Sphere of influence:**
Sphere of influence is a sphere drawn around a particular molecule as centre and molecular range as radius. The central molecule exerts a force of attraction on all the molecules lying within the sphere of influence.

**Surface tension:**
Surface tension is the property of the free surface of a liquid at rest to behave like a stretched membrane in order to acquire minimum surface area.

11. **How do insects run on the surface of water?**
The surface of water behaves like a stretched elastic membrane due to the tendency of water to reduce its surface area. There is a less adhesive force between the water and the insect and so the insect can run on the surface of water.
12. Why hot water is preferred to cold water for washing clothes?
The temperature of hot water is more than the temperature of cold water. Surface tension of water decreases with rise in temperature. So surface tension of hot water becomes less. When hot water is used for washing clothes, the suspended dirt particles over the clothes can be easily removed. The easy removal of dirt from the clothes is due to the reduction of surface tension of water.

13. Why the blood pressure in humans is greater at the feet than at the brain?
At the feet, the height of the blood column in the human body is more than at his brain so blood exerts more pressure at the feet.
Pressure of the liquid \( P = \rho g h \), when \( \rho, g \) are constant, \( P \) proportional to \( h \). As the value of \( h \) increases the value of pressure will increase.

14. Why two holes are made to empty an oil tin?
When oil comes out of one hole with high velocity, the pressure inside the tin decreases. To have continuous flow of oil, proper pressure is to be maintained inside the tin. To achieve this, atmospheric air has to be entered inside the tin. For this purpose, another hole is made out. Hence two holes are made to empty an oil tin.

15. A person standing near a speeding train has a danger of falling towards the train. Why?
According the Bernoulli’s theorem, sum of pressure head and velocity head is constant. The high speed moving train creates high speed wind near the railway track and the pressure near the railway line decreases. The high atmospheric pressure pushes the man towards the fast moving train.

6. Oscillations
1. Define simple harmonic motion.
A particle is said to execute simple harmonic motion if its acceleration is directly proportional to the displacement from a fixed point and is always directed towards that point.

simple harmonic motion is defined as oscillatory motion about a fixed point in which the restoring force is always proportional to the displacement and directed always towards that fixed point.

2. Every SHM is periodic motion but every periodic motion need not be SHM. Why?
Support your answer with an example.
If the motion is repeated after a certain interval of time, the motion is called periodic. The motions like rocking in a cradle or swinging on a swing are different from the periodic motion of a planet. Here the object moves to and fro about a mean position being a periodic motion. So the motion is SHM. But other periodic motions like the periodic motion of a planet, planet is not moving to and fro about a mean position. So every SHM is periodic motion but every periodic motion need not be SHM.
3. What is the phase difference between (i) velocity and acceleration (ii) acceleration and displacement of a particle executing SHM?

(i) The phase difference between velocity and acceleration is $\pi / 2$
(ii) The phase difference between acceleration and displacement of a particle executing SHM is $\pi$. (i.e.) The acceleration ahead of the displacement by a phase angle $\pi$.

4. Define the terms (i) time period (ii) frequency

(i) time period:
The time taken by a particle to complete one oscillation is called the time period $T$.

(ii) frequency:
The number of oscillations produced by the body in one second is known as frequency. It is represented by $n$.

5. Define force constant. Give its unit and dimensional formula.

\[ F \propto y \therefore F = -ky = -F / y, \quad k \text{ is called force constant.} \]

Force constant is defined as the force required to produce unit displacement.
Its unit is Nm$^{-1}$ and dimensional formula is MT$^{-2}$.

6. What is an epoch? Give its unit.

It is the initial phase of the vibrating particle (i.e) phase at $t = 0$.
\[ \therefore \phi = \phi_0 \]

The phase of a vibrating particle changes with time but the epoch is phase constant.

Unit is rad.

7. What is a spring factor?

Force is proportional to $dl$. $F = kdl$, $k = F / dl$; $k$ is called spring factor.
Spring factor is defined as the force acting on a spring required to produce unit displacement.

8. The bob of a simple pendulum is a hollow sphere filled with water. How does the period of oscillation change if the water begins to drain out of the sphere?
The time period of a simple pendulum $T = 2 \sqrt{l/g}$.
Time period depends upon length of the pendulum and gravity.
The period of oscillation does not change if the water begins to drain out of the sphere. Because time period of a simple pendulum is independent of the mass of the bob.
9. Why does the oscillation of a simple pendulum eventually stop?
The oscillations of a simple pendulum eventually stops due to air friction and inertia. When a pendulum oscillates at a particular place in a room or a lab it undergoes forced vibrations. As medium offers some resistive force on the pendulum, a part of energy is dissipated in overcoming the resistive forces. Consequently, the amplitude of oscillation goes on decreasing exponentially and finally dies out. Now, the pendulum undergoes damped oscillations. As time goes on, the oscillation of a simple pendulum eventually stops.

10. What will happen to the time period of a simple pendulum if its length is doubled?
The time period of a simple pendulum is directly proportional to square root of length of the pendulum. $T=2\sqrt{l/g}$.
If the length of the simple pendulum is doubled its time period will be increased to root two ($\sqrt{2}$) times the initial time period.

11. On what factors the natural frequency of a body depend on?
When a body vibrates with its own natural frequency, it is said to execute free oscillation. The natural frequency of a body depends on the inertial factor and spring factor.
$n=\frac{1}{2} \pi \sqrt{k/m}$
$k$ – spring factor and $m$ - inertial factor

12. What is forced vibration? Give an example.
When a vibrating body is maintained in the state of vibration by a periodic force of frequency (n) other than its natural frequency of the body, the vibrations are called forced vibrations. Example : (i) Sound boards of stringed instruments execute forced vibration.

13. What force keeps the simple pendulum in SHM?
A restoring force acts on a simple pendulum that makes its acceleration to be proportional to its displacement. So a simple pendulum undergoes SHM. Restoring force is directly proportional to displacement of a particle from equilibrium position. A body executing SHM should have constant amplitude and single frequency.

14. Illustrate an example to show that resonance is disastrous sometimes.
(i) Resonance can cause disaster in an earthquake, if the natural frequency of the building matches the frequency of the periodic oscillations present in the Earth. The building begins to oscillate with large amplitude thus leading to a collapse.
(ii) A singer maintaining a note at a resonant frequency of a glass, can cause it to shatter into pieces.
15. If two springs are connected in parallel, what is its equivalent spring constant?
If two springs of spring constant $k_1$ and $k_2$ are connected in parallel its equivalent spring constant is given by $k = k_1 + k_2 = 2k$ (if $k_1 = k_2 = k$)

16. If two springs are connected in series, what is its equivalent spring constant?
If two springs of spring constant $k_1$ and $k_2$ are connected in series its equivalent spring constant is given by $k = k_1 k_2 / (k_1 + k_2)$.

7. Wave Motion

1. In solids both longitudinal and transverse waves are possible, but transverse waves are not produced in gases. Why?
For propagation of transverse waves, the medium must possess force of cohesion and volume elasticity. In solids both transverse and longitudinal waves are possible because solid possess cohesion and volume elasticity. Transverse waves are not produced in gases, because they do not possess cohesion. But transverse waves can be produced on surfaces of liquids.

2. Sound travels faster on rainy days. Why?
When the humidity of air increases, the amount of water vapour present in it also increases and hence its density decreases, because the density of water vapour is less than that of dry air. Since velocity of sound is inversely proportional to the square root of density, the sound travels faster in moist air than in dry air. Due to this reason it can be observed that on a rainy day sound travels faster.

3. Progressive wave
A progressive wave is defined as the onward transmission of the vibratory motion of a body in an elastic medium from one particle to the successive particle.

4. On what factors does the intensity of sound depend?
Intensity of sound depends on (i) Amplitude of sound wave produced by a source ($I \propto a^2$), (ii) Surface area of the source ($I \propto A$), (iii) Density of the medium ($I \propto \rho$), (iv) Frequency of the source ($I \propto n^2$) and (v) Distance of observer from the source of sound.

5. What is an echo? Why an echo cannot be heard in a small room?
An echo is a sound wave reflected from a reflecting surface at a distance from the listener. Due to persistence of hearing, we keep hearing the sound for 1/10th of a second, even after the sounding source has stopped vibrating. Assuming the velocity of sound as 340 m/s, if the sound reaches the obstacle and returns after 0.1 second, the total distance covered is 34 m. No echo is heard if the reflecting obstacle is less than 17 m away from the source. Hence an echo cannot be heard in a small room.
6. Write a short note on whispering gallery.

The famous whispering gallery at St. Paul’s Cathedral is a circular shaped chamber whose walls repeatedly reflect sound waves round the gallery, so that a person talking quietly at one end can be heard distinctly at the other end. This is due to multiple reflections of sound waves from the curved walls.

7. State the principle of superposition.

When two waves travel in a medium simultaneously in such a way that each wave represents its separate motion, then the resultant displacement at any point at any time is equal to the vector sum of the individual displacements of the waves.

8. What are the essential conditions for the formation of beats?

The essential conditions for the formation of beats are -

1. Two waves that would superimpose upon each other, must have nearly equal frequencies.
2. Those two waves must travel in the same direction.

9. What are beats?

The phenomenon of waxing and waning of sound due to interference of two sound waves of nearly equal frequencies are called beats.

10. How are stationary waves formed?

When two progressive waves of same amplitude and wavelength travelling along a straight line in opposite directions superimpose on each other, stationary waves are formed.

11. State the laws of transverse vibrations in stretched strings.

The laws of transverse vibrations of stretched strings are (i) the law of length (ii) law of tension and (iii) the law of mass.

(i) For a given wire (m is constant), when T is constant, the fundamental frequency of vibration is inversely proportional to the vibrating length
(ii) For constant l and m, the fundamental frequency is directly proportional to the square root of the tension
(iii) For constant l and T, the fundamental frequency varies inversely as the square root of the mass per unit length of the wire

12. What are overtones and harmonics?

Overtones are the musical notes having frequency which is greater than that of fundamental frequency.

Harmonics is a mixture of the frequencies of musical notes. It is expressed in the form of ratio of fundamental frequency to the frequency of overtones of sound.
13. Why open organ pipes are preferred for making flute?
In open organ pipes the frequency of $P^{th}$ overtone is $(P+1)n_1$ where $n_1$ is the fundamental frequency. The frequency of harmonics are in the ratio 1:2:3..... with the help of open organ pipes any type of overtone based on requirement can be produced. Hence open organ pipes are preferred for making flute.

14. What is meant by end correction?
The antinodes is not exactly formed at the open end, but a small distance above the open end. This is called the end correction.

15. What is doppler effect?
The phenomenon of the apparent change in the frequency of sound due to the relative motion between the source of sound and the observer is called Doppler effect.