**15-WAVES**

**1.Relation Between Frequency, Wavelength and Wave Velocity**

1. Wave velocity = Frequency x Wavelength or  2. Wave velocity =  or  3. Wavelength =  or 

**2. Velocity of Transverse Waves in Solids and Strings**

1. Velocity of transverse waves in a solid of modulus of rigidityand density,  2. Velocity of transverse waves in a string of mass per unit length *m* and stretched under tension T, 

**3. Velocity of Longitudinal Waves**

1. Velocity of longitudinal waves in a solid of bulk modulus, modulus of rigidityand density is given by  2. Velocity of longitudinal waves in a long rod of Young’s modulus Y and densityis given by  3. Velocity of longitudinal waves in liquid of bulk modulus and densityis given by  4. *Newton’s formula* for the velocity of sound in a gas is



where P = pressure of a gas 5. *Laplace formula* for the velocity of sound in a gas is  , where 

**4. Factors affecting Velocity of Sound through Gases**

1. *Effect the pressure.* There is no effect of pressure on velocity of sound. 2. *Effect of density* or  3. *Effect of temperature *  or  Also  where *M* = molecular mass of the gas. 4. *Temperature coefficient of sound*. It is give by  for air, α = 0.61 ms-1 0C-1.

**5. Progressive Waves**

1. A plane progressive harmonic wave travelling along positive direction of X- axis can be represented by any of the following expressions: (i)   (ii)  (iii)  whereis the wavelength, *v* is the velocity, *A* the amplitude and *x* is the distance of observation point from the origin. 2. For a progressive wave travelling along – ve X-axis.  or  3. Phase,  where is the initial phase. 4. Phase change with time,  5. Phase change with position,  6. Instantaneous particle velocity  Velocity amplitude,  7. Instantaneous particle acceleration  Acceleration amplitude, 

**6. Equation of Stationary Waves**

1. Let  (incident wave)  (refracted wave) Then stationary wave formed by the superposition is given by  It involves the product of separate harmonic functions of time *t* and position *x*. 2. For (+) sign in the above equation, antinodes are formed at the positions *x = 0, x/2, x, 3x/2*,…. And nodes are formed at *x = x/4, 3x/4, 5x/4,……* 3. For (-) sign, antinodes are formed at the positions *x = * and nodes at  4. The distance between two successive nodes or antinodes is and that between a node and nearest antinodes is.

**7. Modes of Vibrations of Strings**

1. Fundamental frequency,  2. When the stretched string, vibrates in *p* loops,  3. For a string of diameter D and density,  4. Law of length, or *v L* = constant or 

**8. Organ Pipes and Rods clamped in the Middle**

1. *In an organ closed at one end,* only odd harmonics are present. Fundamental mode, (First harmonic) Second mode,  (third harmonic or first overtone)

Third mode, v3 = 5v (fifth harmonic or second overtone) nth mode,  (2n -1)th harmonic or (n-1)th overtone) 2. *In an organ pipe open at both ends.* Both odd and even harmonics are present. Fundamental mode, (First harmonic) Second mode,  (second harmonic or first overtone) Third mode v’3 = 3v’ (Third harmonic or second overtone) *nth* mode *v’n* = *nv* (*n*th harmonic or (n-1)th overtone) Clearly, *v’1* = 2v1 3. *Resonance tube*. If L1 and L2 are the first and second resonance lengths with a tuning fork of frequency v, then the speed of sound, *v = 4v* (L1 + 0.3D) D = internal diameter of resonance tube or *v = 2v (L2 – L1*) End correction = 0.3 D = 

**9. Beats Formation**

1. Beat frequency = Number of beats per second. = Difference frequencies of two sources or *b* (v1 – v2) or (*v2 – v1*) 2.  3. If the prong of tuning fork is *filed*, its frequency increases. If the prong of a tuning fork is *loaded with* a little wax, its frequency decreases. These facts can be used to decide about + or – sign in the above equation.

**10. Doppler Effect in Sound**

1. If *v, v0, vs and vm* are the velocities of sound, observer, source and medium respectively, then the apparent frequency  2. If the medium is at rest (*vm = 0), then * 3. All the velocities are taken *positive* in the *source* to *observer* (S O) direction and *negative* in the opposite (O S) direction.