PHYSICS

BOOKS - BHARATI BHAWAN PHYSICS (HINGLISH)

VIBRATIONS OF STRING

Examples

1. A string whose length is $200cm$ weight $2g$. It is stretched by a weight of $20g$. Calculate the velocity with which a transverse wave will travel along the string.

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2. A note from a tuning fork is in unision with the note of a $25cm$ long stretched wire. If the length is changed to $25.5cm$ the tension remaining

unchanged, 3 beats per second are heard. Find the frequency of the fork.

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3. A tuning fork gives 15 beats per second when sounded with a sonometer wire of length 200 cm and 20 beats per second with that of length of 250 cm. calculate the frequency of the fork.

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4. A certain fork is found to give $2beats/s$ when sounded in conjuction with a stretched string vibrating transversely under a tension of either 10.2 or $9.9kgweight$. Calculate the frequency of fork.

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5. In a transverse arrangement in a Melde's experiment in the string vinrates in 3 loops when the tension is 200 g. Calculate the tansion to

make the string vibrate in two loops in the longitudinal arrangement.

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6. A sonometer wire is stretched by a solid mass M. It produces a fundamental note of a certain frequency in tune with a tuning fork when its length is 70 cm. When the mass is immersed in water it is found that the length has to be changed by 5 cm in order to bring it in tune with the same tuning fork. Calculate the relative density of the material of the hanging mass.

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Exercise

1. Calculate the frequency of a ntoe emitted by a wire 20cm in length when stretched by a weight 8 kg, If 2m of the wore is found to weight 4g. Also calculate the velocity of transverse waves along the string

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2. A stretched sonometer wire gives 2 beats per second with a tuning frok when its length is 14.3 cm and also when its length is 14.5 cm.What is the frequency of the tuning frok ?

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3. Two wires of a sonometer are in union.When the length of one of the wires is increased by 1%, three beats in 2 second.Calculate the original frequency of each wires

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4. The length of a sonometer wire between two fixed ends is 110cm. Where should the two bridges the placed so as to divide the wire into three segments, whose fundamental frequencies are in the ration $1:2:3$?

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5. A wire 50cm long vibrates 100 times per second .If the length is shortened to 30 cm and the stretching force is quadrupled, what will be the frequency ?

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6. A stone hangs in air from a wire which is stretched over a sonometer. The bridges of the sonometer are 40 cm apart when the wire is in unison with a tuning frok. When the atone is immersed in water the length is changed to 32 cm to re-establish unison wtih the wire .Calculate the specific geavity of the stone

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7. Two tuning frok when sounded together give 4 beats per second.One is in unison with a length of 96 cm of a sonometer wire under a certain

tension and the with 97 cm of the same wire under tension.Find the frequencies of the forks

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8. the frequency of a note emitted by a silver wire of length 25 cm is 256 when the tension is 10 kg.Calculate the radius of the wire (Density of silver $= 10.5 \times 10^3 kgm^{-3}$)

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9. When the stretching forec of a wire increased by 2.5 kg, the frequency of the note emitted is changed in ration 2/3.Calculate the original force

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10. A fork and a monochord string 100 cm long give 4 beats per second.The string is made shorter without any change of tension untill it

is in unsion the frok.If its length is now 99 cm, what is the frequency if the frok ?

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11. Two tuning forks A and B produce 5 beats per second when sounded together.A is in unsion with under a constant tension and B is in unison with the same wire of length 40.5 cm under same tension.Calculate the frequency of the forks

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12. A string vibrates with a frequency 320 Hz.It is divied into three parts by using two bridges in ratio 1:2:3,Calculate the frequency of each part

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13. In Melde's experiment the srting vibrates in 4 loops when a 50 g weight is placed on the pan of weight 15 g.How much weight must be added or removed to make the string vibrate in 6 loops ?

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14. In Melde's experiment the srting is stretched by an iron weight and the virbrates.When an electromagnet is switched on under the iron weight, the srting vibrates in 4 segments. Compara the pull of the magnet with that on the earth

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15. Two srting of the same length, radius and material are stretched by $\eta_1 = 2\,\%$ and $\eta_2 = 4\,\%$ respectively.Find the ratio of frequency of the strings .The tension of the string may be assumed to be proportional to the elongation

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16. Ordinary cotton thread, 200cm of which weight 1g, is used in Melde's experiment It is attached at one to a vibrator of frequency 100 Hz and at the order to a pan weights 6g.What length of the srting will vibrate in 4 loops in the longitudinal arrangement if 10g weight is put on the pan ?

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17. In Melde's ecperiment a srting is found to vibrate in 8 loops and the total weight by which it is stretched of it will in same arrangement in 6 loops when the weight is reduced to 15 g?

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18. A vibrator makes 150 cm of a arting vibrate in 6 loops in the longitudinal arrangement when it is stretched by 15 g. The entire length

of the string is then weighed and is found to weigh 500mg.What is the frequency of the vibrator ? Wjat is the sidtance beween two nodes?

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19. A string in Melde's experiment in the transverse arrangement vibrates in 4 loops when it is stretched by of 100 g.What additional load will be needed to make the same string vibrate on 1 loops in the longitudinal arrangement ?

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20. A bridges is placed under the string the of a monochord at a point near the middle and it is found that the parts produce 3 beats per second when the streching force is 8 kg.if the load be then increased to 12 kg , determene the ratio of beating of the two parts of the string

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21. A wire of density $9000 kgm^{-3}$ is stretched two clamps 2 m apart and its length increase by 0.05 cm. Calculate the frequecny of the fundamental trasverse vibration of the srting . $(\text{y of the material of wire } \ 9 \times 10^{10} N/m^2)$

hint: Calculate tension of the wire from formula, young's modulus $= \dfrac{\text{stress}}{\text{strain}}$

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22. With what force must a wire of radius 1 mm be stretched so that the velocity of transverse wavesalong it may be the same as that of longitudinal wave ? Give answer in kg wt.(young's modulus of material of wire $2 \times 10^{11} Nm^{-2}$ .It it physically possible ?

hint : $C_{\text{longi}} = \sqrt{Y/D}, C_{\text{trans}} = \sqrt{T/m}$

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23. If $n_1, n_2 \text{and} n_3$ are the fundamental frequencies of three segments into which a string is divided, then the original fundamental frequency n of the string is given by

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24. A metal wire of diameter $1mm$ is held on two knife edges by a distance $50cm$. The tension in the wire is $100N$. The wire vibrating with its fundamental frequency and a vibrating tuning fork together produce $5beats\,/\,s$. The tension in the wire is then reduced to $81N$. When the two are excited, beats are heard at the same rate. Calculate

(a) frequency of a fork and

(b) the density of material of wire.

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25. An aluminium wire of length 0.6 m and cross sectioal are and length 0.866 m .The compound wire is loaded with 10kg.Find the lowest

frequency of exciation for which the joint In the the wire.The density of alumimium is 2600 kg m^{-3} and that of steel is 7800 kgm^{-3}

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26. Two wires of radii r and $2r$ are welded together end to end . The combination is used as a sonometer wire and is kept under a tension T. The welded point lies midway between the bridges. The ratio of the number of loops formed in the wires , such that the joint is a node when the stationary waves are set up in the wire is

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27. A string $120cm$ in length sustains a standing wave, with the points of the string at which the displacement amplitude is equal to $3.5mm$ being separated by $15.0cm$. Find the maximum displacement amplitude. To which overtone do these oscillations correspond ?

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28. A srting of length l hangs freely from a rigid support under its own weight Calculate the time required by transverse waves to travel from the lower end to the upper end

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29. A string tensioned by 4.5kg resonates at two consecutive frequencies 420Hzand 490.Calculate the length of the srting its linear density is 5 mg per cm .Take $g = 10m / s^2$

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30. A string of length l and mass m is fixed at both ends with tension t and excited in its fundamental mode.The maximum displacement at the mid point is A Find (a) the maximum kinetic energy of the string ,9b0 the mean kinetic energy of the srting averaged over one oscillation period

hint Take sine distribution of amplitudes

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31. A non-uniform wire of length l and mass M has a variable linear mass density given by $\mu = kx$, where x is distance from one end of wire and k is a constant. Find the time taken by a pulse starting at one end to reach the other end when the tension in the wire is T.

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32. A uniform circular hoop of string is rotating clockwise in the absence of gravity. The tangential speed is v_0. Find the speed of the wave travelling on this string.

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33. One end of a string of length 120 cm is tied to a peg and other is attached to a weightless ring that can slide along a frictionless vertical

rod fixed at a distance slightly greater then 120 cm .Find the three longest possible waveleghts

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34. A wire of length l is kept just taut horizontally between two walls.A mass m hanging from its mid point depresses it by δ.Calculte the time in which a pulse set up at one end will reach the other end . The mass of the wire per unit length of it is μ

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35. A wire of length 1 m is clamped between two support 1.01 m apart It vibrates with frequency 500 Hz at 20^(@0

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36. the linear density of a wire under tension t varies linearly from μ_1 to μ_{20}.Calculate the time that a pulse would need to pass one to the other.The length of the wire is l

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