6. a. Although the density of solid is high, the velocity of sound is greater in solid. Why? 1
   b. Write down the superiority of Laplace correction over Newton's formula of the velocity of sound in air. 2
   c. On a stormy day, a boy observes a lightening flash which is followed by thunder 3 secs later. How would you estimate the distance of the lightning strike from the boy? (Velocity of sound on that day = 332m/s) [$\mathbf{996.7\ m}$] 2
   d. If the frequency of a tuning fork is 512Hz and the velocity of sound in air is 340m/s. Find the distance through which sound travels while the fork completes 32 vibrations. [$\mathbf{21.25m}$] 2
   e. It is noticed that a sharp tap made in front of a flight of stone steps gives rise to ringing sound. Assuming that each step is $0.25m$ deep, estimate the frequency of the sound. [Velocity of sound in air= $340m/s$] [**680Hz]** 2

7. a. A soldier sets his watch upon hearing a distant siren. Will his watch record the correct time? Explain. 2
   b. Explain the factors on which the velocity of sound depends on a medium? 2
   c. Discuss the factors on which the velocity of sound in air depends with appropriate explanations. 3
   d. Sound travels through water at 20^oC with a speed of 1450m/s. Calculate the adiabatic compressibility of water. 2
   [Hint: Compressibility is the reciprocal of bulk modulus] [Ans: $\mathbf{4.76 \times 10^{-10} m^2/N}$]

8. a. What is longitudinal wave? Why are they called as pressure waves? 2
   b. What is echo? How is echo different from reverberation? Show that the minimum distance between the source and obstacle for the echo is about $17m$. 2
   c. A man standing at one end of a closed corridor $57m$ long blew a short blast on a whistle. He found that the blast to the sixth echo was 2 seconds. If the temperature was 17^oC, what was the velocity of sound at 0^oC? [**342m/s, 332m/s**] 2
   d. A tuning fork of frequency 220Hz produces sound waves of wavelength 1.5m in air at NTP. Calculate the increase in wavelength when the temperature of the air is 27^oC. [Ans: 8**64.8m**] 2

9. A fisherman notices that his boat is moving up and down periodically owing to waves on the surface of water. It takes 2.5 sec for the boat to travel from its highest point to its lowest point, a total distance of 62 cm. the fisherman sees that the wave crests are spaced 6m apart.
   a. What is the amplitude of wave?
   b. How fast are the waves travelling? [$\mathbf{0.31m, 1.2\ m/s}$] 3

10. A directional loud speaker aims sound waves of frequencies 200Hz at a wall. A man standing at a certain distance from the wall does not hear any sound at all. How far is the man from the wall? Velocity of sound in air= $334m/s$. 2

11. A metal rod with a length of $1.5m$ has a density of $6400Kg/m^3$. Longitudinal sound wave takes $3.9 \times 10^{-4} sec$ to travel from one end of the rod to the other. Calculate the Young's modulus of elasticity of the metal bar? [$\mathbf{9.5 \times 10^{10} pa}$] 2

12. A man stationed between two parallel cliffs fires a gun. He hears the first echo after 3 secs and next after 5 secs. What is the distance between two cliffs? Velocity of sound in air= $350m/s$. [Ans: **1400m**] 2

Additional questions:

13. At what temperature the velocity of sound in oxygen gas is the same as that in nitrogen gas at 20^oC. Assume that at 20^oC, the ratio of density of oxygen to that of nitrogen is 16: 14. [Ans: **335K**] 3

Hint: Let T be the required temperature.

According to question $V_T{}^{ox} = V_{20}{}^{Nit}$ **.... (1)** $\quad \frac{\rho_{Nit}}{\rho_{ox}} = \frac{14}{16}$ **..... (2)**

$$\left[\because v \propto \frac{1}{\sqrt{\rho}}\right] \rightarrow \frac{V_{20}{}^{ox}}{V_{20}{}^{Nit}} = \sqrt{\frac{\rho_{Nit}}{\rho_{ox}}} = \sqrt{\frac{14}{16}} \Rightarrow \quad \therefore V_{20}{}^{ox} = \sqrt{\frac{14}{16}}\ V_{20}{}^{Nit} \text{ .... (3)}$$

Finally, $\left[\because v \propto \sqrt{T}\right] \rightarrow \frac{V_T{}^{ox}}{V_{20}{}^{ox}} = \sqrt{\frac{T}{20+273}}$ **..... (4)**

Use eqn (3) and eqn (1) in eqn (4), and find T (in Kelvin)

14. Calculate the temperature at which the sound travels in hydrogen with the same velocity as in helium at NTP. The density of helium is twice that of hydrogen. [Ans: **136.5K**] 3

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