SAMPLE CONTENT

Exam Experts

4000+ MCQs

26 YEARS

PREVIOUS SOLVED PAPERS

1999 – 2024

MHT-CET

CHAPTER-WISE & TOPIC-WISE

PHYSICS

- Quick Review
- Important Formulae
- Smart Keys
- Statistical analysis of all the shifts of 2024

Target Publications® Pvt. Ltd.

Exam Experts

MHT-CET

26 YEARS 1999 - 2024

Previous Solved Papers

PHYSICS

Chapter-wise & Topic-wise

Salient Features

- **Unique Questions:**
  - A vast repository of **4000+** unique and **authentic MCQs** of **26 years** (1999-2024) to enhance your preparation.
  - For the years 1999 – 2020, only questions relevant to the current syllabus have been included.
- **Organized Learning:** Questions are meticulously categorized by chapter and topic.
- **Solutions That Simplify:** Clear, detailed solutions for even the trickiest questions, making complex concepts easy to grasp.
- **The Chapters Include:**
  - **Quick Reviews:** For concept revision
  - **MCQs:** Arranged in a year-wise flow for each topic
  - **Solutions:** Provided wherever required, with solutions from 1999 to 2021 available via QR codes at the end of each chapter
- **Includes Smart Keys for Holistic Learning:**
  - *Thinking Hatke*
  - *Caution*
  - *Shortcuts*
  - *Mindbenders*
- **2024 Trend Analysis:**
  Gain valuable insights with:
  - Graphs showing difficulty levels across shifts
  - Chapter-wise analysis tables for all shifts
- **QR Codes Provide:** Solutions to MCQs from **1999 to 2021**

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PREFACE

Target's **'MHT-CET Physics: Previous Solved Papers (PSP)'** is a compilation of past 26 years' (1999-2024) questions asked in the MHT-CET examinations conducted by State Common Entrance Test Cell, Maharashtra State. This book is curated as per the **latest MHT-CET syllabus**.

The book features chapter-wise categorization of questions, with each chapter following a topic-wise flow. All questions related to a topic are arranged year-wise, ending with the most recent year. A special topic,**Concept fusion** is drafted at the end of the MCQ section to cover multifarious questions. Answers for all questions from 1999 to 2024 are provided, with solutions from 1999 to 2021 accessible via QR codes and 2022 to 2024 solutions in the book. The solutions will serve as valuable learning tools in understanding the concepts.

Selection of **unique MCQs** is prioritized while making this book to prevent the recurrence of identical questions. This will enable students to save time spent on repetitive questions.

We have infused several **Smart Keys** such as **Caution, Thinking Hatke, Shortcuts** and **Mindbenders**. These Important Study Techniques are created to help students with key objectives such as time management, easy memorization, revision and non-conventional yet simple methods for MCQ solving. To ensure adequate revision, each chapter begins with a **Quick Review**, followed by all the key **Formulae** in the chapter.

A statistical analysis of the number of questions asked per chapter in each shift of MHT-CET 2024 examination is offered in tabular form. This analysis would help students understand the weightage allotted to each chapter. A graphical representation of analysis of all the papers (16 papers of PCM group & 14 papers of PCB group) is also included at the start of the book to elaborate on the breakdown of the difficulty level of questions asked in the examination. Studying these representations should undoubtedly aid students in planning their study strategy for the examination. *There is a possibility that the weightage to a chapter and the level of difficulty of the question paper in the future examination may vary.*

This book would provide students with confidence regarding their exam preparedness. We are confident that this book will comprehensively cater to the needs of students and effectively assist them to achieve their goal.

Publisher
Edition: Second

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

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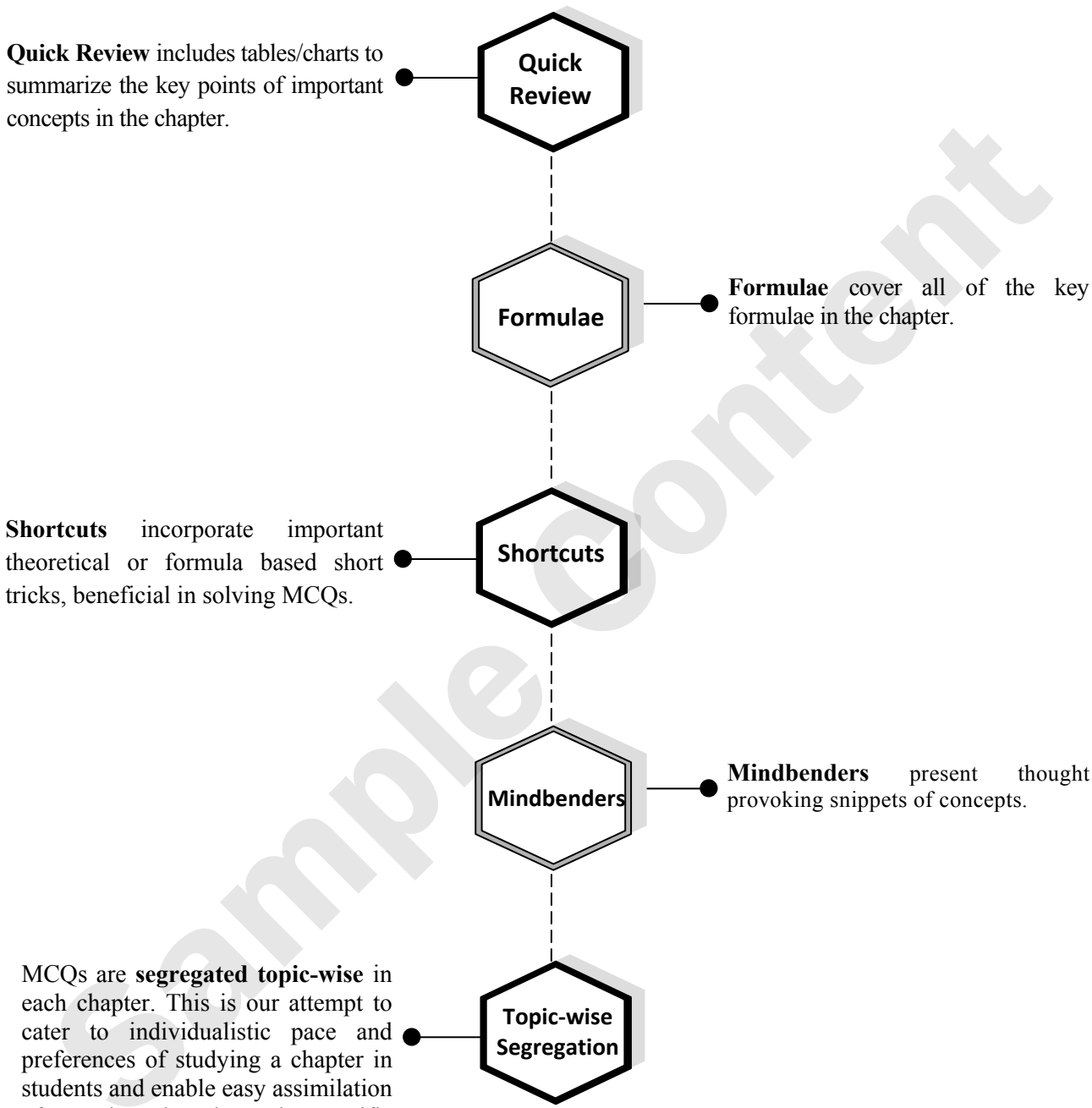
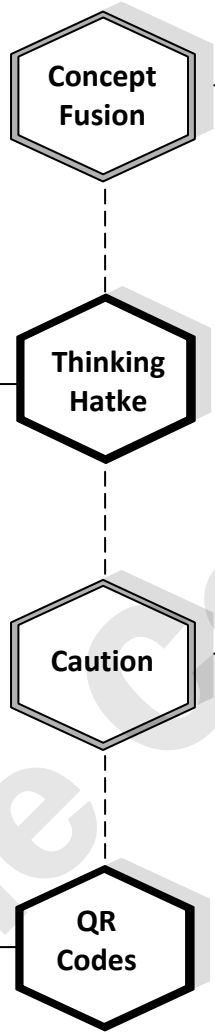
A book affects eternity; one can never tell where its influence stops.

FEATURES



FEATURES



Concept Fusion section encompasses questions whose solutions require knowledge of concepts covered in different sub-topics of same chapter or from different chapters.

Thinking Hatke reveals quick witted approach to crack the specific question.

Caution apprises students about mistakes often made while solving MCQs.

QR Codes include solutions to MCQs from 1999 to 2021

INDEX

MHT-CET PAPER PATTERN

- There will be three papers of Multiple Choice Questions (MCQs) in 'Mathematics', 'Physics and Chemistry' and 'Biology' of 100 marks each.
- Duration of each paper will be 90 minutes.
- Questions will be based on Syllabus of State Council of Educational Research and Training, Maharashtra with approximately 20% weightage given to Std. XI and 80% weightage will be given to Std. XII curriculum.
- Difficulty level of questions will be at par with JEE (Main) for Mathematics, Physics, Chemistry and at par with NEET for Biology.
- There will be no negative marking.
- Questions will be mainly application based.
- Details of the papers are as given below:

Paper	Subject	No. of MCQs based on		Mark(s) Per Question	Total Marks
		Std. XI	Std. XII		
Paper I	Mathematics	10	40	2	100
Paper II	Physics	10	40	1	100
	Chemistry	10	40		
Paper III	Biology	20	80	1	100

- Questions will be set on

i. the entire syllabus of Std. XII of Physics, Chemistry, Mathematics and Biology subjects prescribed by State Council of Educational Research and Training, Maharashtra and

ii. chapters / units from Std. XI curriculum prescribed by State Council of Educational Research and Training, Maharashtra as mentioned below:

Sr. No.	Subject	Chapters / Units of Std. XI
1	Physics	Motion in a plane, Laws of motion, Gravitation, Thermal properties of matter, Sound, Optics, Electrostatics, Semiconductors
2	Chemistry	Some Basic Concepts of Chemistry, Structure of Atom, Chemical Bonding, Redox Reactions, Elements of Group 1 and Group 2, States of Matter: Gaseous and Liquid States, Basic Principles of Organic Chemistry, Adsorption and Colloids, Hydrocarbons
3	Mathematics	Trigonometry - II, Straight Line, Circle, Measures of Dispersion, Probability, Complex Numbers, Permutations and Combinations, Functions, Limits, Continuity
4	Biology	Biomolecules, Respiration and Energy Transfer, Human Nutrition, Excretion and osmoregulation

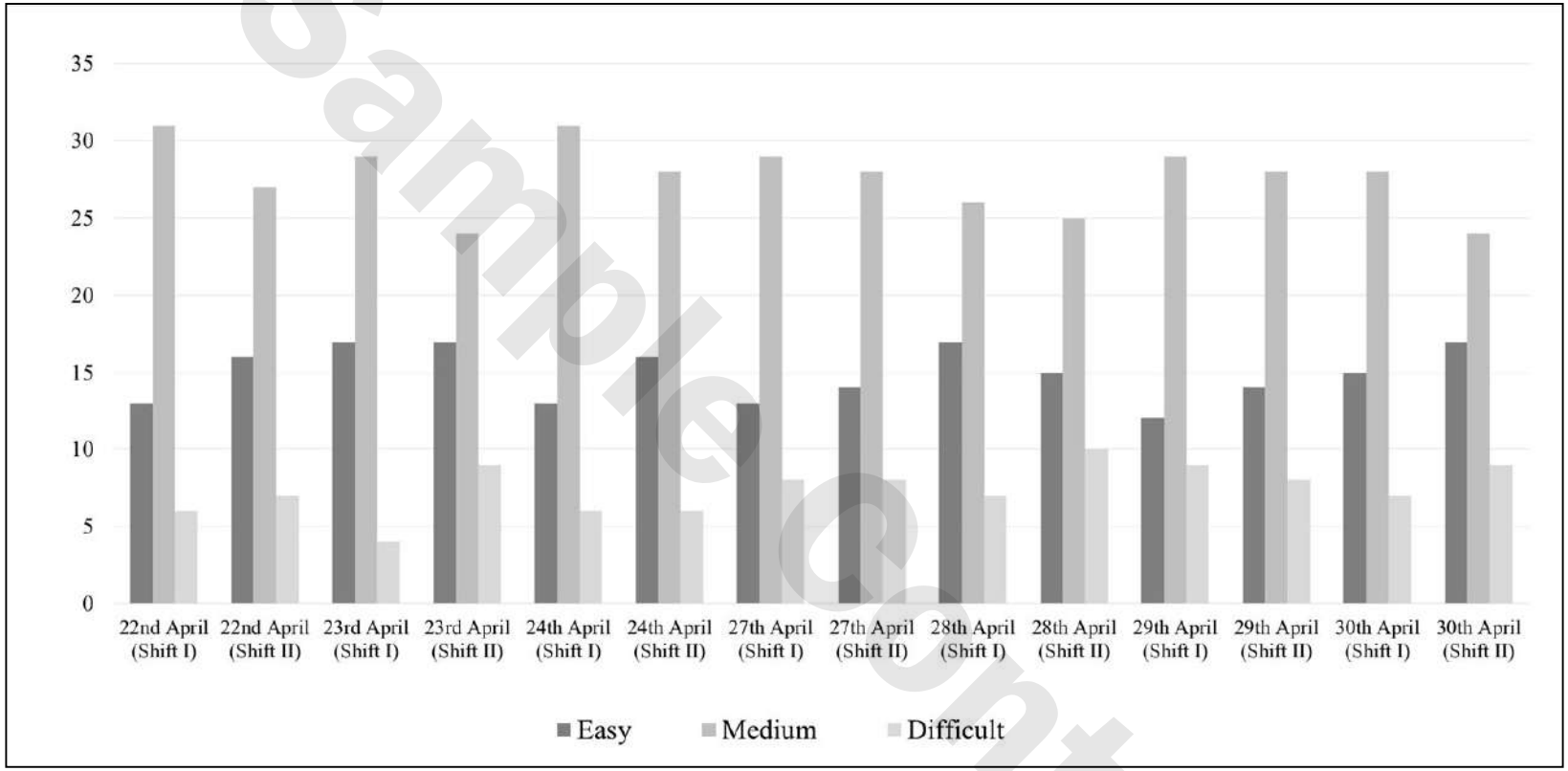
PHYSICS

Chapter-wise Analysis of MHT-CET 2024 Exam Papers (PCB Group)

Ch. no.	Std.	Chapter name	22nd April (Shift I)	22nd April (Shift II)	23rd April (Shift I)	23rd April (Shift II)	24th April (Shift I)	24th April (Shift II)	27th April (Shift I)	27th April (Shift II)	28th April (Shift I)	28th April (Shift II)	29th April (Shift I)	29th April (Shift II)	30th April (Shift I)	30th April (Shift II)	Total
3	11th	Motion in a Plane	1	2	1	1	1	1	1	1	0	1	2	1	3	1	**17**
4	11th	Laws of Motion	1	1	1	1	2	1	1	1	1	1	1	1	1	1	**15**
5	11th	Gravitation	2	2	2	2	1	2	2	3	2	2	2	2	2	1	**27**
7	11th	Thermal Properties of Matter	1	2	1	1	1	1	1	1	1	1	1	1	2	1	**16**
8	11th	Sound	1	1	0	1	1	1	1	0	1	0	1	2	1	1	**12**
9	11th	Optics	1	2	3	2	2	2	2	2	2	2	2	2	2	1	**27**
10	11th	Electrostatics	1	2	1	1	0	0	2	1	2	1	1	1	1	2	**16**
14	11th	Semiconductors	1	1	1	1	1	1	1	1	2	1	1	1	1	2	**16**
1	12th	Rotational Dynamics	3	2	2	2	3	3	3	2	4	3	2	3	1	4	**37**
2	12th	Mechanical Properties of Fluids	3	3	3	3	3	3	3	3	3	3	3	3	3	3	**42**
3	12th	Kinetic Theory of Gases and Radiation	3	2	3	3	4	2	2	3	3	3	2	3	3	3	**39**
4	12th	Thermodynamics	2	2	2	2	1	2	3	2	2	2	2	2	1	2	**27**
5	12th	Oscillations	4	2	5	4	3	3	3	3	3	3	3	4	3	3	**46**
6	12th	Superposition of Waves	2	4	3	3	3	4	3	4	3	4	3	0	3	3	**42**
7	12th	Wave Optics	3	3	2	3	3	3	3	3	3	3	3	4	3	4	**43**
8	12th	Electrostatics	3	2	3	3	4	4	2	3	2	3	3	3	3	2	**40**
9	12th	Current Electricity	3	2	2	2	2	2	2	2	2	2	2	2	2	2	**29**
10	12th	Magnetic Fields due to Electric Current	2	3	2	2	2	3	2	2	2	2	2	4	2	3	**33**
11	12th	Magnetic Materials	1	2	1	1	0	0	1	1	1	1	1	0	1	0	**11**
12	12th	Electromagnetic Induction	3	2	3	3	3	3	2	3	3	3	2	3	3	3	**39**
13	12th	AC Circuits	3	2	3	3	3	3	4	3	3	3	3	2	3	3	**41**
14	12th	Dual Nature of Radiation and Matter	2	2	2	2	2	1	2	2	2	2	3	2	2	1	**27**
15	12th	Structure of Atoms and Nuclei	2	2	2	2	3	3	2	2	2	2	3	2	2	2	**31**
16	12th	Semiconductor Devices	2	2	2	2	2	2	2	2	1	2	2	2	2	2	**27**
		Total	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**700**

PHYSICS

Difficulty level-wise Analysis of MHT-CET 2024 Exam Papers (PCB Group)



E – Easy: Questions whose answers can be directly and easily answered by the information given in Std. XI and XII Textbooks.
M – Medium: These questions require students to identify and apply the appropriate concepts which they studied from Std. XI and XII Textbooks.
D – Difficult: The most Challenging Questions that require application of various concepts and encourage students to think beyond the information given in the textbooks.

Analysis

- **Analysis of questions by difficulty level:** Although the proportion of easy, medium, and difficult questions varies amongst the fourteen papers, the number of medium questions is slightly higher than easy questions, with a few difficult questions.
  This indicates that the entrance exam emphasises a lot on understanding and application of concepts. Students are advised to focus on the application of formulae, concepts along with thorough revision while preparing for the entrance exam.

PHYSICS

Chapter-wise Analysis of MHT-CET 2024 Exam Papers (PCM Group)

Ch. no.	Std.	Chapter name	2nd May (Shift I)	2nd May (Shift II)	3rd May (Shift I)	3rd May (Shift II)	4th May (Shift I)	4th May (Shift II)	9th May (Shift I)	9th May (Shift II)	10th May (Shift I)	10th May (Shift II)	11th May (Shift I)	11th May (Shift II)	15th May (Shift I)	15th May (Shift II)	16th May (Shift I)	16th May (Shift II)	Total
3	11th	Motion in a Plane	2	1	1	1	1	1	1	1	1	1	2	1	0	2	1	2	**19**
4	11th	Laws of Motion	1	2	1	2	1	1	1	1	1	1	0	1	2	2	1	1	**19**
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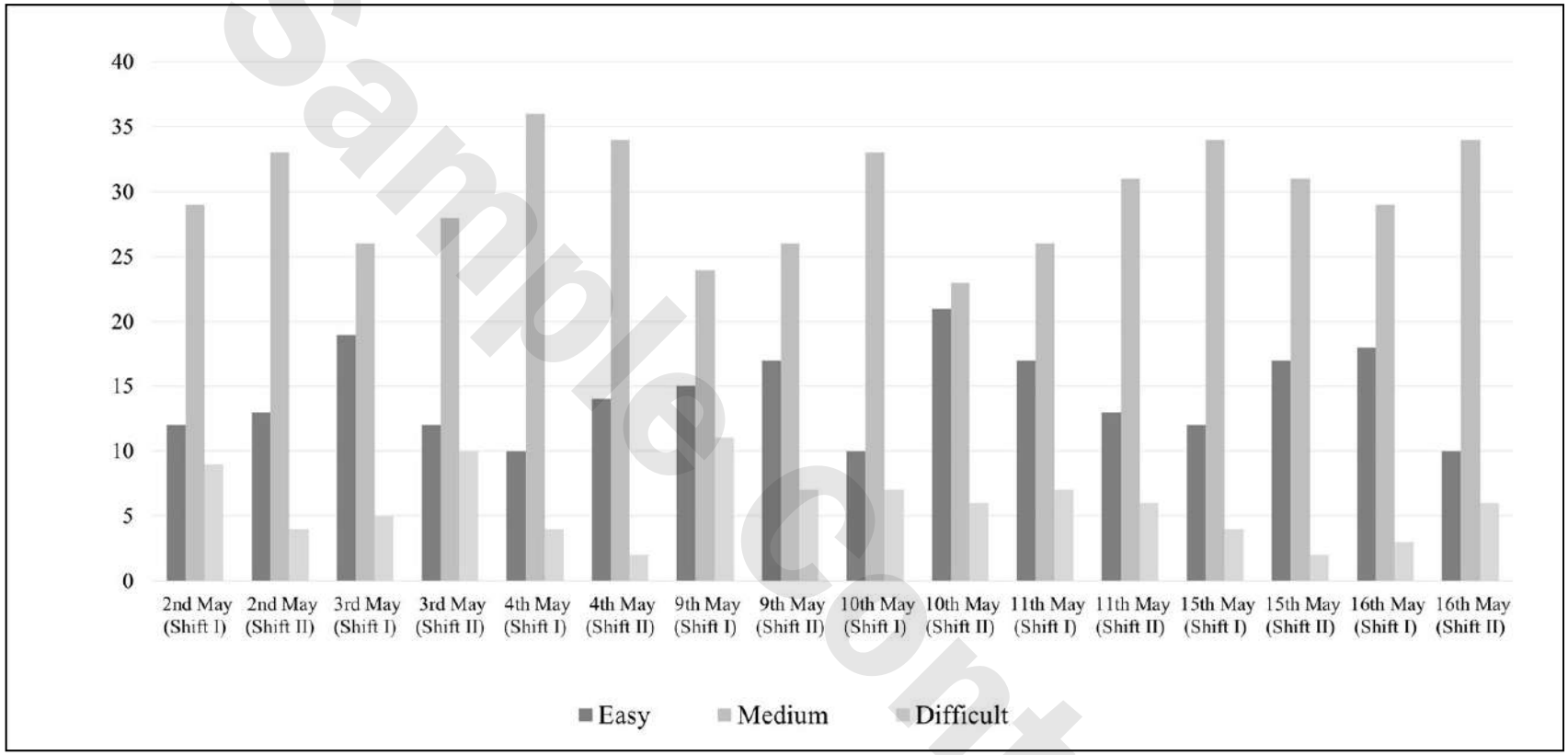
		Total	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**800**

PHYSICS

Difficulty level-wise Analysis of MHT-CET 2024 Exam Papers (PCM Group)



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- **Analysis of questions by difficulty level:** Although the proportion of easy, medium, and difficult questions varies amongst the sixteen papers, the number of easy and medium questions is almost equal, with a few difficult questions.
  This indicates that the entrance exam emphasizes on thorough reading and grasping of textual content as well as understanding and application of concepts.
  Students are advised to study the chapters minutely and focus on the application of formulae and concepts while preparing for the entrance exam.

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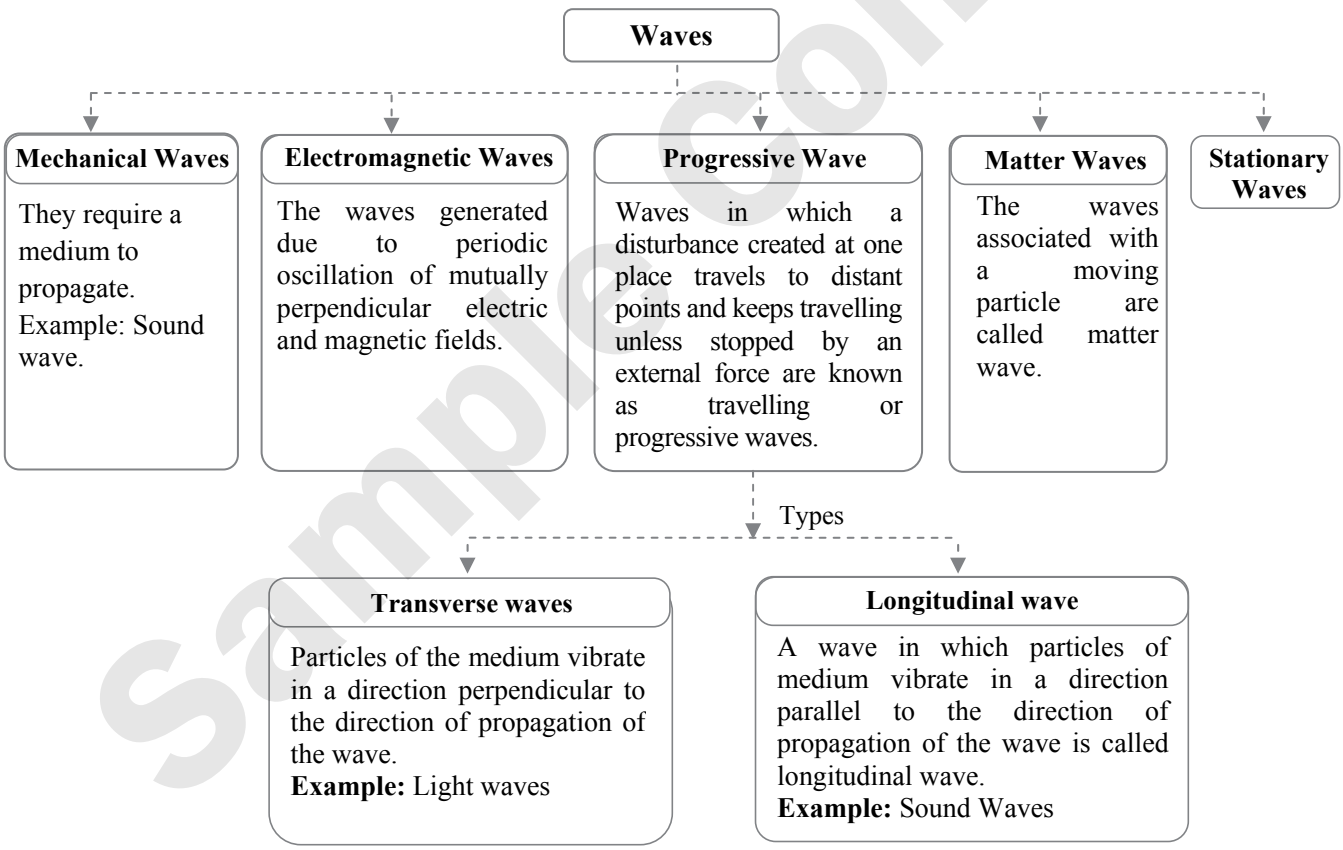
To see complete chapter buy **Target Notes** or **Target E-Notes**

Chapter

8 Sound

Quick Review

➢ **Types of Waves:**



Characteristics of Waves

Phase	The state of oscillation of a particle is called its phase.
Double periodicity	Wave is periodic in time and space.
Frequency (n)	The number of vibrations performed by a particle per second
Wavelength (λ)	The distance between two successive particles which are in the same state of vibration
Period (T)	The time taken by the particle of a medium to complete one vibration.
Velocity (v)	The distance covered by a wave per unit time.
Amplitude (A)	The largest displacement of a particle of a medium through which the wave is propagating, from its rest position

➢ **Factors affecting velocity of sound:**

Factors affecting velocity of sound

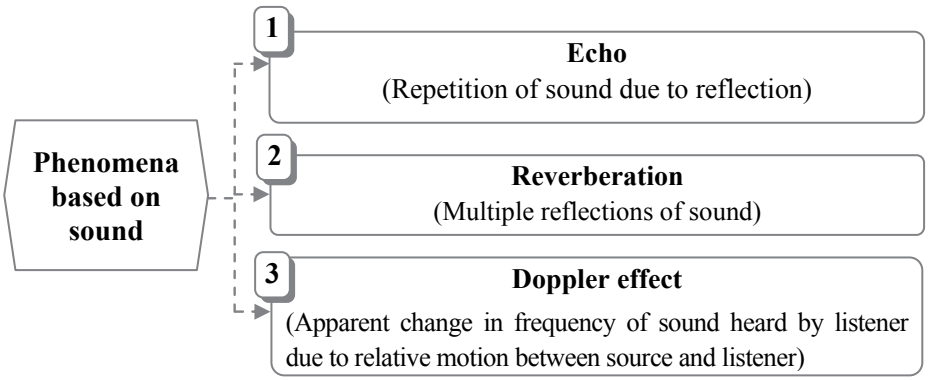
1	**Pressure**	Independent of pressure if temperature is constant
2	**Humidity**	Speed increases with moistness of air.
3	**Temperature**	$v \propto \sqrt{T}$ As T ↑, v ↑

➢ **Common characteristics of a medium transmitting sound wave:**

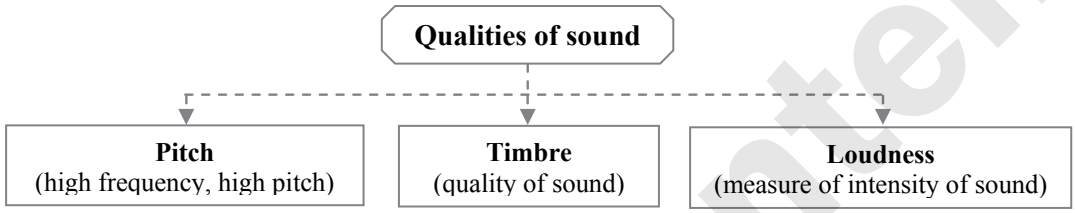
CHARACTERISTICS

- **Inertia:** This helps particles to store energy and oscillate about their mean position.
- **Uniform density:** This helps waves to have a unifom velocity.
- **Elasticity:** This helps particles to return to their mean position after being displaced.
- **Less friction:** This helps particles not to lose energy.

➢ **Phenomena based on sound:**



➢ **Qualities of sound:**



Formulae

1. Relation between v, n and λ:

i. $v = n\lambda$ ii. $v = \frac{\lambda}{T}$

2. Wavelength:

i. $\lambda = \frac{v}{n}$ ii. $\lambda = vt$

3. Velocity of sound wave:

i. Newton's formula: $v = \sqrt{\frac{E}{\rho}}$

ii. Laplace's formula:

$v = \sqrt{\frac{\gamma P}{\rho}}$ (In gases) where $\gamma = \frac{c_P}{c_V}$

iii. $v = \sqrt{\frac{\gamma PV}{M}} = \sqrt{\frac{\gamma nRT}{M}}$

4. Factors affecting velocity of sound:

i. Density: $v \propto \frac{1}{\sqrt{\rho}}$ i.e., $\frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}}$

ii. Temperature: $v \propto \sqrt{T}$

i.e., $\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}} = \sqrt{\frac{273 + t_1}{273 + t_2}}$

5. Velocity of sound at t °C: $v_t = v_0 \sqrt{\left(1 + \frac{t}{273}\right)}$

6. Loudness of sound:

$L_{bel} = \log_{10}\left(\frac{I}{I_0}\right)$

7. Doppler formula for apparent frequency:

i. Source approaching a stationary Listener, $n = n_0\left(\frac{v}{v - v_S}\right)$

ii. Source receding from a stationary observer, $n = n_0\left(\frac{v}{v + v_s}\right)$

iii. Listener approaching a stationary source, $n = n_0\left(\frac{v + v_L}{v}\right)$

iv. Listener receding from a stationary source, $n = n_0\left(\frac{v - v_L}{v}\right)$

v. Both source and Listener approaching each other, $n = n_0\left(\frac{v + v_L}{v - v_s}\right)$

vi. Both source and Listener receding from each other, $n = n_0\left(\frac{v - v_L}{v + v_s}\right)$

Shortcuts

1. To find the velocity of sound at any temperature t °C use the formula, $v = v_0 + (0.61)t$
2. When listener or source moves towards other, there is a **shift up** in frequency and whenever they move away from other , there is a **shift down** in frequency.

Mindbenders

1. A mechanical wave shall be transverse or longitudinal depending on the
   i. nature of the medium ii. mode of excitation of vibration
   For example, in solids, both transverse and longitudinal waves can propagate. This is because solids can sustain both, the shearing strain as well as compressional strain. On strings, mechanical waves are always transverse. Gases can sustain only compressional strain and not the shearing strain. Therefore, only longitudinal waves can pass through air and other gases.
2. Ripple is neither transverse wave nor longitudinal wave but occurs due to combination of these two waves.
3. If two or more persons are speaking simultaneously, we hear each of them due to an important property that "when two or more waves cross each other they are not affected in any way."
4. If two sounds of equal frequency are sounded together we hear a loud sound of constant frequency.
5. Sound produced in air is not heard by the diver inside the water because majority of sound energy is reflected from the water surface.
6. For sound waves $v_w > v_a$. Therefore, in travelling from air to water, a beam of sound bends away from normal, whereas a beam of light bends towards the normal.
7. The formula for velocity of sound does not involve frequency or wavelength. Hence sound of any frequency or wavelength travels through a given medium with the same velocity.
8. Although the densities of solids and liquids are higher than gases, speed of sound in solids > speed of sound in liquids > speed of sound in gases. This is because liquids and solids are less compressible than gases, i.e., liquids and solids have much greater bulk modulus than that of gases.
9. Doppler shift is a little greater when the source is approaching to the listener than when the listener is approaching to the source with the same speed.

Multiple Choice Questions

8.1 Introduction

1. Select the 'WRONG' statement out of the following. **[2023]**
   (A) Electromagnetic waves do not require any medium for their propagation.
   (B) Electromagnetic waves can travel through vacuum with speed of light
   (C) Material medium is necessary for propagation of electromagnetic waves.
   (D) Electromagnetic waves are transverse in nature.
2. Which of the following statements is NOT true? **[2024]**
   (A) Sound wave travels in a straight line.
   (B) Sound is propagated as waves.
   (C) Sound can travel through vacuum.
   (D) Sound is a form of energy.

8.2 Common Properties of All Waves

1. A tuning fork makes 256 vibrations per second in air. When velocity of sound is 330 m/sec, then wavelength of the tone emitted is **[1999]**
   (A) 0.56 m (B) 0.89 m
   (C) 1.11 m (D) 1.29 m
2. Which of the following requires a medium for their propagation? **[2013]**
   (A) Light wave
   (B) Electromagnetic wave
   (C) Microwave
   (D) Sound wave

3. The frequency of a tuning fork is 220 Hz and the velocity of sound in air is 330 m/s. When the tuning fork completes 80 vibrations, the distance travelled by the vibrations is **[2020]**

(A) 120 m (B) 60 m
(C) 53 m (D) 100 m

4. A sound wave of frequency 160 Hz has a velocity of 320 m/s. When it travels through air, the particles having a phase difference of 90°, are separated by a distance of **[2020]**

(A) 50 cm (B) 1 cm
(C) 25 cm (D) 75 cm

5. An obstacle is moving towards the source with velocity 'V'. The sound is reflected from the obstacle. If 'C' is the speed of sound and 'λ' is the wavelength, then the wavelength of the reflected wave (λ_r) is **[2020]**

(A) $\lambda_r = \left(\frac{C - V}{C}\right)\lambda$ (B) $\lambda_r = \left(\frac{C + V}{C}\right)\lambda$

(C) $\lambda_r = \left(\frac{C - V}{C + V}\right)\lambda$ (D) $\lambda_r = \left(\frac{C + V}{C - V}\right)\lambda$

6. A progressive wave of frequency 50 Hz is travelling with velocity 350 m/s through a medium. The change in phase at a given time interval of 0.01 s is **[2020]**

(A) $\frac{3\pi}{2}$ rad (B) $\frac{\pi}{4}$ rad

(C) π rad (D) $\frac{\pi}{2}$ rad

7. The frequency of a tuning fork is 'n' Hz and velocity of sound in air is 'V' m/s. When the tuning fork completes 'x' vibrations, the distance travelled by the wave is **[2021]**

(A) $\frac{V}{xn}$ (B) $\frac{Vn}{x}$ (C) $\frac{xV}{n}$ (D) $\frac{x}{Vn}$

8. Velocity of sound waves in air is 'V' m/s. For a particular sound wave in air, path difference of 'x' cm is equivalent to phase difference $n\pi$. The frequency of this wave is **[2021]**

(A) $\frac{Vn}{x}$ (B) $\frac{V}{nx}$

(C) $\frac{Vn}{2x}$ (D) $\frac{2x}{V}$

9. Two tuning forks of frequencies 320 Hz and 480 Hz are sounded together to produce sound waves. The velocity of sound in air is 320 ms^{-1}. The difference between wavelengths of these waves is nearly **[2021]**

(A) 48 cm (B) 16.5 cm
(C) 33 cm (D) 42 cm

10. An observer at sea-coast counts 42 waves in one minute. If the wavelength of the waves is 8 m then the velocity of the waves will be **[2023]**

(A) 4.8 m/s (B) 5.6 m/s
(C) 6.4 m/s (D) 7.2 m/s

11. A vibrating tuning fork produces concentric circular waves on the surface of water. The distance between 11 crests is 1 m and the velocity of the wave on the surface of water is 30 m/s. The frequency of the tuning fork is **[2024]**

(A) 200 Hz (B) 250 Hz
(C) 300 Hz (D) 400 Hz

12. A sound of frequency 448 Hz is emitted from the string instrument. The velocity of sound in air is 320 m/s. After completing 182 vibrations, distance covered by a wave is **[2024]**

(A) 60 m (B) 90 m
(C) 130 m (D) 180 m

13. When a wave travels through a medium, the phase difference between any two consecutive particles of the medium in same state of vibration is **[2024]**

(A) $[0]^c$ (B) $\frac{\pi^c}{2}$ (C) π^c (D) $2\pi^c$

14. Velocity of sound waves in air is 330 m/s. For a particular sound wave in air, path difference of 40 cm is equivalent to phase difference of $(1{\cdot}6)\pi$. The frequency of this wave is **[2024]**

(A) 165 Hz (B) 150 Hz
(C) 660 Hz (D) 330 Hz

15. Two sounding sources send waves at certain temperature in air of wavelength 60 cm and 60·6 cm respectively. The frequency of sources differ by 5 Hz. The velocity of sound in air at same temperature is **[2024]**

(A) 330 m/s (B) 313 m/s
(C) 303 m/s (D) 300 m/s

8.3 Transverse Waves and Longitudinal Waves

1. Which one of the following statements is true? **[2021]**

(A) The sound waves in air are longitudinal while the light waves in air are transverse.
(B) Both light and sound waves in air are transverse.
(C) Both light and sound waves in air are longitudinal.
(D) The sound waves are transverse and light waves are longitudinal.

2. In a vibrating string with fixed ends the waves are of type **[2024]**
(A) stationary longitudinal.
(B) stationary transverse.
(C) progressive transverse.
(D) progressive longitudinal.

8.4 Mathematical expression of a wave

1. If the equation of a transverse wave is y = 5 sin $2\pi\left[\frac{t}{0.04}-\frac{x}{40}\right]$, where distance is in cm and time in second, then the wavelength of the wave is **[2000]**
(A) 10 cm (B) 25 cm
(C) 40 cm (D) 60 cm

2. The equation of the progressive wave is $Y = 3\sin\left[\pi\left(\frac{t}{3}-\frac{x}{5}\right)+\frac{\pi}{4}\right]$ where x and Y are in metre and time in second. Which of the following is correct? **[2017]**
(A) velocity, v = 1.5 m/s
(B) amplitude, A = 3 cm
(C) frequency, f = 0.2 Hz
(D) wavelength, λ = 10 m

3. The equation of wave motion is $y = 6\sin\left[12\pi t - 0.02\pi x + \frac{\pi}{2}\right]$, where x is in m and t in second. The velocity of the wave is **[2020]**
(A) 400 m/s (B) 200 m/s
(C) 600 m/s (D) 100 m/s

4. A transverse wave is given by the equation $y = A\cos 2\pi\left(nt - \frac{x}{\lambda}\right)$. The value of '$\lambda$' if the maximum particle velocity is two times the wave velocity is **[2024]**
(A) πA (B) $\pi^2 A$
(C) $\frac{\pi A}{2}$ (D) πA^2

8.5 The Speed of Travelling Waves

1. Two monoatomic ideal gases A and B of molecular masses m_1 and m_2 respectively are enclosed in separate containers kept at the same temperature. The ratio of the speed of sound in gas A to that in gas B is given by **[2020]**
(A) $\sqrt{\frac{m_1}{m_2}}$ (B) $\frac{m_2}{m_1}$ (C) $\sqrt{\frac{m_2}{m_1}}$ (D) $\frac{m_1}{m_2}$

2. Sound waves take 3 minutes to travel between two stations, when the temperature of air is 27°C. If the temperature of air increases to 37°C, the sound waves will take how much time (in minutes) to travel between two same stations? **[2020]**
(A) $3\sqrt{\frac{31}{30}}$ (B) $2\sqrt{\frac{31}{30}}$
(C) $2\sqrt{\frac{30}{31}}$ (D) $3\sqrt{\frac{30}{31}}$

3. The velocity of sound in air is 'V_s'. If the density of air is doubled, then the velocity of sound will be **[2021]**
(A) $2V_s$ (B) V_s (C) $\frac{V_s}{\sqrt{2}}$ (D) $\frac{\sqrt{2}}{V_s}$

4. A uniform metal wire has length 'L', mass 'M' and density 'ρ'. It is under tension 'T' and 'V' is the speed of transverse wave along the wire. The area of cross-section of the wire is **[2021]**
(A) $\frac{T}{V^2\rho}$ (B) $\frac{T}{V^2\rho^2}$
(C) $\frac{V^2\rho^2}{T}$ (D) $\frac{T\rho}{V^2}$

5. What is the effect of pressure on the speed of sound in a medium, if pressure is doubled at constant temperature? **[2021]**
(A) Remains same
(B) Reduced to half
(C) Gets doubled
(D) Becomes 4 times

6. The wavelength of sound in any gas depends upon **[2021]**
(A) intensity of sound waves only
(B) density and elasticity of the gas
(C) wavelength of sound only
(D) amplitude and frequency of sound

7. The ratio of the speed of sound in helium gas to that in nitrogen gas at same temperature is $(\gamma_{He} = \frac{5}{3},\ \gamma_{N_2} = \frac{7}{5},\ M_{He} = 4,\ M_{N_2} = 28)$ **[2022]**
(A) $\frac{5}{\sqrt{3}}$ (B) $\sqrt{\frac{7}{5}}$ (C) $\sqrt{\frac{2}{7}}$ (D) $\sqrt{\frac{5}{3}}$

8. At what temperature will the speed of sound be nearly 1.5 times its value at N.T.P.? **[2022]**
(A) 409°C (B) 136°C
(C) 614°C (D) 341°C

9. Two copper wires of radii 'r_1' and 'r_2' ($r_1 > r_2$) are subjected to same tension and are plucked. The transverse waves will **[2022]**

(A) travel faster in the thinner wire
(B) travel faster in the thicker wire
(C) not travel through both the wires
(D) travel with the same velocity in both the wires

10. If the temperature of the gaseous medium drops by 2% then velocity of sound in that medium **[2023]**

(A) increases by 4%
(B) decreases by 1%
(C) decreases by 0.5%
(D) remains unchanged

11. At what temperature will the speed of sound in air be 2 times its speed at N.T.P? **[2023]**

(A) 546 K (B) 819 °C
(C) 1092 °C (D) 819 K

12. A uniform rope of length 'L' and mass 'm_1' hangs vertically from a rigid support. A block of mass 'm_2' is attached to the free end of the rope. A transverse wave of wavelength 'λ_1' is produced at the lower end of the rope. The wavelength of the wave when it reaches the top of the rope is 'λ_2'. The ratio $\frac{\lambda_1}{\lambda_2}$ is **[2023]**

(A) $\left[\frac{m_2}{m_1+m_2}\right]^{\frac{1}{2}}$ (B) $\left[\frac{m_1+m_2}{m_2}\right]^{\frac{1}{2}}$
(C) $\left[\frac{m_1}{m_1+m_2}\right]^{\frac{1}{2}}$ (D) $\left[\frac{m_2}{m_1-m_2}\right]^{\frac{1}{2}}$

13. A tuning fork of frequency 220 Hz produces sound waves of wavelength 1.5 m in air at N.T.P. The increase in wavelength when the temperature of air is 27°C is nearly $\left(\sqrt{\frac{300}{273}}=1.05\right)$ **[2023]**

(A) 0.06 m (B) 0.10 m
(C) 0.09 m (D) 0.07 m

14. A uniform wire 20 m long and weighing 50 N hangs vertically. The speed of the wave at mid point of the wire is
(acceleration due to gravity = g = 10ms^{-2}) **[2023]**

(A) 4 ms^{-1} (B) $10\sqrt{2}$ ms^{-1}
(C) 10 ms^{-1} (D) Zero ms^{-1}

15. If humidity in air increases, the speed of sound waves in air **[2024]**

(A) increases.
(B) decreases.
(C) remains the same.
(D) becomes zero.

16. When the temperature of an ideal gas is increased by 'T_0' K, the velocity of sound in the gas becomes $\sqrt{n}$ times the initial velocity $(n > 0)$. The initial temperature of the gas is **[2024]**

(A) $\frac{T_0}{(n-1)}$K (B) $\frac{T_0}{(n+1)}$K
(C) $\frac{T_0}{(n^2-1)}$K (D) $\frac{T_0}{(n^2+1)}$K

17. What is the ratio of the velocity of sound in hydrogen $\left(\gamma=\frac{7}{5}\right)$ to that in helium $\left(\gamma=\frac{5}{3}\right)$ at the same temperature? (Molecular weight of hydrogen and helium is 2 and 4 respectively.) **[2024, 2021]**

(A) $\frac{\sqrt{42}}{5}$ (B) $\frac{5}{\sqrt{42}}$
(C) $\frac{\sqrt{21}}{5}$ (D) $\frac{5}{\sqrt{21}}$

8.7 Echo, Reverberation and Acoustics

1. A man standing between two parallel cliffs fires a gun and hears two echoes, first after one second and 2nd after four second. If the velocity of sound is 340 m/s, the distance between the cliffs is **[2022]**

(A) 510 m (B) 1020 m
(C) 1700 m (D) 850 m

8.8 Qualities of sound

1. Which one of the following statements regarding pitch of sound is 'WRONG'? **[2024, 2023]**

(A) Pitch refers to sharpness of the sound.
(B) Tone refers to the single frequency of that wave.
(C) High pitch sound need not be louder.
(D) In general, male sound is sharper than that of a female sound.

2. How many times more intense is a 60 dB sound than a 30 dB sound? **[2024]**

(A) 2 (B) 4
(C) 1000 (D) 10000

8.9 Doppler Effect

1. A source is moving towards observer with speed of 20 ms^{-1} and having frequency 240 Hz and observer is moving towards source with a velocity of 20 ms^{-1}. What is the apparent frequency heard by observer, if velocity of sound is 340 ms^{-1} ? **[2004]**

(A) 270 Hz (B) 240 Hz
(C) 268 Hz (D) 360 Hz

2. If a source emitting waves of frequency f moves towards an observer with a velocity $\frac{v}{4}$ and the observer moves away from the source with a velocity v/6, the apparent frequency as heard by the observer will be (where, v = velocity of sound) **[2007]**

(A) $\frac{14}{15}f$ (B) $\frac{14}{9}f$
(C) $\frac{10}{9}f$ (D) $\frac{2}{3}f$

3. The pitch of the whistle of an engine appears to drop to $\left(\frac{5}{6}\right)^{th}$ of original value when it passes a stationary observer. If the speed of sound in air is 350 m/s then the speed of engine is **[2015]**

(A) 35 m/s (B) 70 m/s
(C) 105 m/s (D) 140 m/s

4. The observer is moving with velocity 'v_0' towards the stationary source of sound and then after crossing moves away from the source with velocity 'v_0'. Assume that the medium through which the sound waves travel is at rest. If 'v' is the velocity of sound and 'n' is the frequency emitted by the source then the difference between apparent frequencies heard by the observer is **[2017]**

(A) $\frac{2n v_0}{v}$ (B) $\frac{n v_0}{v}$
(C) $\frac{v}{2n v_0}$ (D) $\frac{v}{n v_0}$

5. When source of sound moves towards a stationary observer, the wavelength of sound received by him **[2018]**

(A) decreases while frequency increases
(B) remains the same whereas frequency increases
(C) increases and frequency also increases
(D) decreases while frequency remains the same

6. A bus is moving with a velocity of 5 m/s towards a wall. The driver blows the horn of frequency 165 Hz. If the speed of sound in air is 335 m/s, then after reflection of sound wave, the number of beats per second heard by the passengers in the bus will be **[2020]**

(A) 5 (B) 6
(C) 2 (D) 4

7. If a star appearing yellow starts accelerating towards the earth, its colour appears to be turned **[2020]**

(A) suddenly red. (B) gradually red.
(C) suddenly blue. (D) gradually blue.

8. A train blowing the whistle moves with a constant velocity 'V' away from an observer standing on the platform. The ratio of the natural frequency of the whistle 'n' to the apparent frequency is 1.2 : 1. If the train is at rest and the observer moves away from it at the same velocity 'V', the ratio of 'n' to the apparent frequency is **[2020]**

(A) 1.52 : 1 (B) 0.51 : 1
(C) 2.05 : 1 (D) 1.25 : 1

9. A police car travels towards a stationary observer at a speed of 20 ms^{-1}. The siren on the car emits a sound of frequency 320 Hz. If the speed of sound is 340 ms^{-1} then frequency recorded by the observer will be **[2021]**

(A) 170 Hz (B) 320 Hz
(C) 340 Hz (D) 640 Hz

10. A train is moving towards a stationary observer with speed 34 m/s. A train sounds a whistle of frequency 450 Hz. If the speed of sound in air is 340 m/s, the frequency heard by the observer in Hz is **[2023]**

(A) 440 (B) 480
(C) 500 (D) 540

11. Two sources are at finite distance apart. They emit sounds of wavelength 'λ'. An observer situated between them on the line joining them, approaches one source with speed 'u'. Then the number of beats heard per second by the observer will be **[2023]**

(A) $\frac{2u}{\lambda}$ (B) $\frac{u}{\lambda}$ (C) $\frac{u}{2\lambda}$ (D) $\frac{\lambda}{u}$

12. Two sources P and Q produce notes of frequency 660 Hz each. A listener moves from P to Q with a speed of 1 m/s. If the speed of sound is 330 m/s, then the number of beats heard by the listener per second will be **[2023]**

(A) zero (B) 2
(C) 4 (D) 8

13. A source of sound is travelling towards a stationary observer. The frequency of sound heard by observer is three times the original frequency. If the velocity of sound is V m/s, the speed of source is **[2023]**

(A) $\frac{2}{3}V$ (B) V (C) $\frac{3}{2}V$ (D) 3V

14. When both source and listener are approaching each other the observed frequency of sound is given by (V_L and V_S is the velocity of listener and source respectively, n_0 = radiated frequency) **[2023]**

(A) $n = n_0\left[\frac{V + V_L}{V - V_S}\right]$ (B) $n = n_0\left[\frac{V - V_L}{V + V_S}\right]$

(C) $n = n_0\left[\frac{V - V_L}{V - V_S}\right]$ (D) $n = n_0\left[\frac{V + V_L}{V + V_S}\right]$

15. Consider the Doppler effect in two cases. In the first case, an observer moves towards a stationary source of sound with a speed of 50 m/s. In the second case, the observer is at rest and the source moves towards the observer with the same speed of 50 m/s. Then the frequency heard by the observer will be
[velocity of sound in air = 330 m/s.] **[2023]**

(A) same in both the cases.
(B) more in the second case than in the first case.
(C) less in the second case than in the first case.
(D) less than the actual frequency in both the cases.

16. A car sounding a horn of frequency 1000 Hz passes a stationary observer. The ratio of frequencies of the horn noted by the observer before and after passing the car is 11 : 9. If the speed of sound is 'v', the speed of the car is **[2023]**

(A) v (B) $\frac{v}{2}$
(C) $\frac{v}{5}$ (D) $\frac{v}{10}$

17. A passenger is sitting in a train which is moving fast. The engine of the train blows a whistle of frequency 'n'. If the apparent frequency of sound heard by the passenger is 'f' then **[2023]**

(A) f = n (B) f > n
(C) f < n (D) f ≤ n

18. A source of sound is moving towards a stationary observer with $\left(\frac{1}{10}\right)^{th}$ the of the speed of sound. The ratio of apparent to real frequency is **[2023]**

(A) 10 : 9 (B) 11 : 10
(C) $(11)^2 : (10)^2$ (D) $(9)^2 : (10)^2$

19. The pitch of whistle of an engine appears to drop by 30% of the original value when it passes a stationary observer. If speed of sound in air is 350 m/s, then the speed of engine in m/s is **[2024]**

(A) 87.5 (B) 105 (C) 150 (D) 175

20. When the observer moves towards the stationary source with velocity, 'V_1', the apparent frequency of emitted note is 'F_1'. When the observer moves away from the source with velocity 'V_1', the apparent frequency is 'F_2'. If 'V' is the velocity of sound in air and $\frac{F_1}{F_2} = 2$ then $\frac{V}{V_1} = ?$ **[2024, 2020, 2016]**

(A) 2 (B) 3 (C) 4 (D) 5

21. A source of sound is moving towards a stationary observer with velocity 'V_s' and then moves away with velocity 'V_s'. Assume that the medium through which the sound waves travel is at rest. If 'V' is the velocity of sound and 'n' is the frequency emitted by the source then the difference between the apparent frequencies heard by the observer is **[2024, 2022, 2020]**

(A) $\frac{2nVV_s}{(V^2 - V_s^2)}$ (B) $\frac{nVV_s}{(V^2 - V_s^2)}$
(C) $\frac{2nV}{(V - V_s)}$ (D) $\frac{2nV_s}{(V - V_s)}$

22. The driver of a car travelling with a speed 'V_1' m/s towards a wall sounds a siren of frequency 'n' Hz. If the velocity of sound in air is 'V' m/s, then the frequency of the sound reflected from the wall and as heard by the driver in Hz is **[2024]**

(A) $\left(\frac{V_1}{V - V_1}\right)n$ (B) $\left(\frac{V_1 - V}{V + V_1}\right)n$
(C) $\left(\frac{V + V_1}{V - V_1}\right)n$ (D) $\left(\frac{V - V_1}{V + V_1}\right)n$

23. An observer moves towards a stationary source of sound with a velocity of one-fifth of the velocity of sound. The percentage increase in the apparent frequency is **[2024, 2019, 2008]**
(A) 5 % (B) 10 %
(C) 20 % (D) 25 %

24. A train sounding a whistle of frequency 510 Hz approaches a station at 72 km/hr. The frequency of the note heard by an observer on the platform as the train (1) approaches the station and then (2) recedes the station are respectively (in hertz) (velocity of sound in air = 320 m/s) **[2024]**
(A) 544, 480 (B) 480, 544
(C) 612, 544 (D) 544, 612

25. With what velocity an observer should move relative to a stationary source so that a sound of triple the frequency of source is heard by an observer? **[2024]**
(A) Same as velocity of sound towards the source.
(B) Same as velocity of sound away from the source.
(C) Half the velocity of sound towards the source.
(D) Twice the velocity of sound towards the source.

26. A source and listener are both moving towards each other with speed $\frac{V}{10}$. (where V is speed of sound) If the frequency of sound note emitted by the source is 'n', then the frequency heard by the listener would be nearly **[2024]**
(A) 1.1 n (B) 1.22 n
(C) n (D) 1.27 n

Concept Fusion

1. A stone is dropped into a well 80 m deep. The splash of sound is heard 4.25 second after the stone is dropped. The speed of sound in air is $\left(g = 10\frac{m}{s^2}\right)$ **[2020]**
(A) 340 m/s (B) 320 m/s
(C) 300 m/s (D) 330 m/s

Answers and Solutions to MCQs

8.1 Introduction

1. (C)
Electromagnetic waves can propagate through vacuum. This can be clearly understood from Maxwell's equations for EM waves. Self-sustaining electric and magnetic fields enable waves to travel through empty space.

2. (C)
Sound waves travel by vibrating particles of a medium. However, in vacuum due to absence of a medium, sound waves cannot travel.

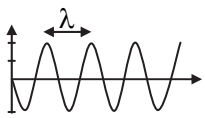
8.2 Common Properties of All Waves

1. (D) **2. (D)** **3. (A)**
4. (A) **5. (C)** **6. (C)**
7. (C) **8. (C)** **9. (C)**

[Note: *Detailed solutions for Q.1 to Q.9 (wherever applicable) can be accessed via QR code at the end of the chapter.*]

10. (B)
Given: n = 42 waves/min = 0.7 waves/s
Velocity, $v = n\lambda = 0.7 \times 8 = 5.6$ m/s

11. (C)
Distance between 11 crests is 1 m,
$\Rightarrow \lambda = \frac{1}{10}$
Wave velocity is given by,
$v = n\lambda$
$n = \frac{v}{\lambda} = \frac{30}{\left(\frac{1}{10}\right)} = 300$ Hz



Caution - Q.11
Wavelength is distance between 2 crests. Hence, when N number of crests/ troughs are given, then wavelength $\lambda = \frac{1}{N-1}$.

12. (C)
Given: v = 320 m/s, f = 448 Hz, N = 182
$v = f\lambda \Rightarrow \lambda = \frac{v}{f}$
Substituting the values, we get
$\lambda = \frac{320}{448} = \frac{5}{7}$
$\therefore$ The total distance covered after 182 vibrations is
$D = N \times \lambda$
$D = 182 \times \frac{5}{7} = 130$ m

13. (D)

The phase difference between any two consecutive particles in same state of vibration is 2π radians, as they are separated by one wavelength which goes through a complete cycle a 2π radians.

14. (C)

Given: $\phi = 1.6\pi$ and $\lambda = \frac{V}{f}$

We know,

Phase difference $\phi = \frac{2\pi x}{\lambda}$

$\therefore \quad 1.6\pi = \frac{2\pi x f}{330} \Rightarrow f = \frac{1.6 \times 330}{2 \times 40 \times 0.01}$

$f = 660$ Hz

15. (C)

$v = n\lambda$

Since, both the sound sources are at same temperature, velocity of sound in both cases would be the same.

$\therefore \quad v = (60n_1)$ cm/s ....(i)

$v = (60.6n_2)$ cm/s ....(ii)

$\frac{n_1}{n_2} = \frac{60.6}{60}$ ....[From (i) and (ii)]

$\therefore \quad \frac{n_1 - n_2}{n_2} = \frac{60.6 - 60}{60}$

$\therefore \quad \frac{5}{n_2} = \frac{0.60}{60} = \frac{1}{100}$ ....($\because n_1 - n_2 = 5$ Hz)

$\therefore \quad n_2 = 500$ Hz

$\therefore \quad v = \frac{60.6 \times 500}{100}$ m/s ....[From (ii)]

$\therefore \quad v = 303$ m/s

8.3 Transverse Waves and Longitudinal Waves

1. (A) 2. (B)

8.4 Mathematical expression of a wave

1. (C) 2. (D) 3. (C)

[Note: *Detailed solutions for Q.1 to Q.3 (wherever applicable) can be accessed via QR code at the end of the chapter.*]

4. (A)

We know,

$\therefore \quad y = A \sin\omega t$

$\therefore \quad v = A\omega \cos\omega t$

$v_{max} = A\omega = A \times \frac{2\pi}{T}$ ...($\because \cos\omega t = 1$)

Given $v_{max} = 2v$

But $v = \frac{\lambda}{T}$

$\Rightarrow A \times \frac{2\pi}{T} = 2 \times \frac{\lambda}{T}$

$\therefore \quad \lambda = A\pi$

8.5 The Speed of Travelling Waves

1. (C) 2. (D) 3. (C)

4. (A) 5. (A) 6. (B)

[Note: *Detailed solutions for Q.1 to Q.6 (wherever applicable) can be accessed via QR code at the end of the chapter.*]

7. (A)

Velocity of sound in air, $v = \sqrt{\frac{\gamma RT}{M}}$

$v_{He} = \sqrt{\frac{\gamma_{He} RT}{M_{He}}}$ and $v_{N_2} = \sqrt{\frac{\gamma_{N_2} RT}{M_{N_2}}}$

$\therefore \quad \frac{v_{He}}{v_{N_2}} = \sqrt{\frac{\gamma_{He} / M_{He}}{\gamma_{N_2} / M_{N_2}}}$

$= \sqrt{\frac{5/3}{7/5} \times \frac{28}{4}} = \sqrt{\frac{25}{7} \times \frac{7}{3}} = \frac{5}{\sqrt{3}}$

8. (D)

We know $v = \sqrt{\frac{\gamma RT}{M}}$

$\Rightarrow \frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}}$

$\therefore \quad 1.5 = \sqrt{\frac{T_2}{273}} \Rightarrow 2.25 = \frac{T_2}{273}$

$\therefore \quad T_2 = 614.25$ K $\approx 341°C$

9. (A)

Speed of wave in a wire is given by

$v = \sqrt{\frac{T}{m}}$

where T is the tension of the string and m is the mass per unit length.

As the value of m is smaller for a thinner wire, the speed is greater.

10. (B)

From velocity of sound formula

$v = \sqrt{\frac{\gamma nRT}{M}}$

$v \propto \sqrt{T}$

$\frac{\Delta v}{v} \times 100 = \frac{1}{2}\left(\frac{\Delta T}{7} \times 100\right) = \frac{1}{2} \times -2 = -1$

11. (B)

$T = 0\ °C = 0 + 273 = 273\ K$

$$\frac{v}{v_0} = \sqrt{\frac{T}{T_0}}$$

$$\frac{2v}{v} = \sqrt{\frac{T}{273}}$$

$\therefore$ $T = 4 \times 273 = 1092\ K$

$\therefore$ $T = 819\ °C$

12. (A)

Let velocity of pulse at lower end be v_1 and at top be v_2

$\therefore$ $\frac{\lambda_2}{\lambda_1} = \frac{v_2}{v_1}$ ....($\because \lambda = \frac{v}{n}$ and n = constant)

Velocity of transverse wave on a string is

$$v = \sqrt{\frac{T}{m}}$$

where, m is linear density.

In this case, $v \propto \sqrt{T}$

$\therefore$ $$\frac{\lambda_2}{\lambda_1} = \frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{(m_2 + m_1)}{m_2}}$$

Where, T_2 is tension at upper end of rope and T_1 is tension at lower end of rope.

$$\Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{m_2}{m_2 + m_1}}$$

13. (D)

$v_0 = f\lambda_0 = 220 \times 1.5$

$v_0 = 330$ m/s

We know,

$$\frac{v}{v_0} = \sqrt{\frac{T}{T_0}}$$

$$\Rightarrow v = 330\sqrt{\frac{300}{273}} = 330 \times 1.05$$

$v = 346.1$m/s

$\therefore$ $\lambda = \frac{v}{f} = \frac{346.1}{220}$

$\lambda = 1.57$ m

$\therefore$ The increase in wavelength is:

$\Delta\lambda = \lambda - \lambda_0 = 1.57 - 1.5$

$\Delta\lambda = 0.07$ m

14. (C)

$m = \frac{50}{10} = 5$ kg ....($\because W = mg$)

Tension in the mid-point of the wire is:

$$T = \frac{m}{2}g = \frac{5}{2} \times 10 = 25\ N$$

$\therefore$ Speed of the wave at mid-point of the wire is:

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{25}{\left(\frac{5}{20}\right)}} \quad \ldots\left(\because \mu = \frac{m}{L}\right)$$

$\therefore$ $v = 10$ m/s

15. (A)

16. (A)

$$v = \sqrt{\frac{\gamma RT}{M}}$$

$v \propto \sqrt{T}$

$$\frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}} \Rightarrow \sqrt{\frac{T + T_0}{T}} = \sqrt{n}$$

$\Rightarrow T_0 = nT - T$

$\therefore$ $T = \frac{T_0}{(n-1)}$

17. (A)

Velocity of sound is given by $v = \sqrt{\frac{\gamma RT}{M}}$

$\therefore$ $\frac{v_H}{v_{He}} = \sqrt{\frac{\gamma_H}{\gamma_H} \times \frac{M_{He}}{M_H}}$ ....(T is the same for both)

$$= \sqrt{\frac{7}{5} \times \frac{3}{5} \times \frac{4}{2}} = \frac{\sqrt{42}}{5}$$

8.7 Echo, Reverberation and Acoustics

1. (D)

For the 1st echo distance travelled by sound

$= 340 \times 1 = 340$ m

$\therefore$ Distance of the cliff from the man $= \frac{340}{2} = 170$ m

For the 2nd echo distance travelled by sound

$= 340 \times 4 = 1360$

Distance of the cliff from the man $= \frac{1360}{2} = 680$ m

$\therefore$ Distance between the two cliffs $= 680 + 170$

$= 850$ m.

8.8 Qualities of sound

1. (D)

2. (C)

Loudness of two sounds are given as $L_2 = 60$ dB and $L_1 = 30$ dB

Loudness of sound $L = 10 \log_{10} \frac{I}{I_0}$

$\therefore \quad L_2 - L_1 = 10 \log_{10} \frac{I_2}{I_1}$

$60 - 30 = 10 \log_{10} \frac{I_2}{I_1}$

$\therefore \quad \log_{10} \frac{I_2}{I_1} = 3$

$\frac{I_2}{I_1} = 10^3 \Rightarrow I_2 = 1000\, I_1$

8.9 Doppler Effect

1.	**(A)**	**2.**	**(C)**	**3.**	**(B)**
4.	**(A)**	**5.**	**(A)**	**6.**	**(A)**
7.	**(D)**	**8.**	**(D)**	**9.**	**(C)**

[Note: *Detailed solutions for Q.1 to Q.9 (wherever applicable) can be accessed via QR code at the end of the chapter.*]

10. (C)

Doppler formula for apparent frequency, when source is approaching a stationary listener,

$n = n_0 \left(\frac{v}{v - v_S} \right)$

$\therefore \quad n = 450 \times \left(\frac{340}{340 - 34} \right) = 500 \text{ Hz}$

11. (A)

From Doppler's effect

$n_1 = n \left[\frac{v + u}{v} \right]$ and $n_2 = n \left[\frac{v - u}{v} \right]$

Number of beats heard per second,

$x = n_1 - n_2$

$= n \left[\frac{v + u}{v} \right] - n \left[\frac{v - u}{v} \right]$

$= \left[\frac{v + u - v + u}{v} \right] n$

$= 2u \cdot \frac{n}{v} = \frac{2u}{\lambda}$

12. (C)

Frequency of sound heard by the man from approaching Q

$n_a = n \left(\frac{v}{v - v_s} \right) = 660 \left(\frac{330}{330 - 1} \right) = 662 \text{ Hz}$

Frequency of sound heard by the man from receding P

$n_r = n \left(\frac{v}{v + v_s} \right) = 660 \left(\frac{330}{330 + 1} \right) = 658 \text{ Hz}$

Hence, number of beats heard by man per second

$= n_a - n_r = 662 - 658 = 4 \text{ Hz}$

Thinking Hatke - Q.12

$\therefore$ Number of beats heard per second

$= \frac{2nvv_s}{v^2 - v_s^2}$

$= \frac{2nvv_s}{(v - v_s)(v + v_s)}$

$= \frac{2 \times 660 \times 330 \times 1}{(330 - 1)(330 + 1)} = 4 \text{ Hz}$

13. (A)

Apparent frequency, $n' = n \left(\frac{v - v_0}{v - v_s} \right)$

$3n = n \left(\frac{v - 0}{v - v_s} \right)$

$\therefore \quad 3v - 3v_s = v$

$\therefore \quad 3v_s = 2v$

$\therefore \quad v_s = \frac{2}{3} v$

14. (A)

Using Dopper's effect formula for approaching frequency when both source and listener are approaching each other, the observed frequency of sound is given by,

$n = n_0 \left[\frac{V + V_L}{V - V_S} \right]$

15. (B)

For observer moving towards a stationary source,

$n_1 = n_0 \left[\frac{v + v_L}{v} \right]$

For source moving towards a stationary observer,

$n_2 = n_0 \left[\frac{v}{v - v_S} \right]$

Substituting the values for v, v_L and v_S in the equations above

$n_1 = n_0 \left[\frac{330 + 50}{330} \right] = 1.15\, n_0$

$n_2 = n_0 \left[\frac{330}{330 - 50} \right] = 1.17\, n_0$

$\Rightarrow n_2 > n_1$

$\therefore$ The frequency heard will be more in the second case than in the first case.

16. (D)

Frequency of a source moving towards a stationary listener is $n_b = \left(\frac{v}{v - v_s} \right) n$

Frequency of a source moving away from a stationary listener is $n_a = \left(\frac{v}{v + v_s}\right)n$

Taking the ratio

$\frac{n_b}{n_a} = \left(\frac{v + v_s}{v - v_s}\right)$

$\frac{11}{9} = \left(\frac{v + v_s}{v - v_s}\right)$

$11v + 11v_s = 9v - 9v_s$

$2v = 20v_s$

$v_s = \frac{1}{10}v$

17. (A)

There is no relative motion between source and listener.

$\therefore \quad f = n$

18. (A)

For source of sound moving towards a stationary observer, the apparent frequency is given by, $n = n_0 \times \frac{v}{v - v_S}$

$\therefore \quad \frac{n}{n_0} = \frac{v}{v - \frac{v}{10}}$

$\therefore \quad \frac{n}{n_0} = \frac{10}{9}$

19. (C)

Given : Speed of sound = 350 m/s

Also,

$n' = n - \frac{30}{100}n = \frac{70}{100}n = 0.7n$ ....(given)

If n is the original (actual) frequency of the whistle and n′ the frequency as the engine passes the stationary observer, then

$\frac{n'}{n} = \left(\frac{v}{v + v_{engine}}\right)$

$\therefore \quad 0.7 = \frac{350}{350 + v_{engine}}$

$0.7v_{engine} + 245 = 350$

$\therefore \quad v_{engine} = 150$ m/s

20. (B)

Apparent frequency is given by,

$F' = \left[\frac{V \pm V_0}{V \mp V_S}\right]F$

Since source is stationary,

$\therefore \quad V_S = 0 \; ; V_0 = V_1$

$\therefore \quad F_1 = \left[\frac{V + V_1}{V}\right]F$

$F_2 = \left[\frac{V - V_1}{V}\right]F$

$\therefore \quad \frac{F_1}{F_2} = \frac{V + V_1}{V - V_1}$

$\therefore \quad 2 = \frac{V + V_1}{V - V_1}$

$\therefore \quad 2V - 2V_1 = V + V_1$

$\therefore \quad V = 3V_1$

$\therefore \quad \frac{V}{V_1} = 3$

21. (A)

When the source of sound moves towards the observer, the apparent frequency is

$n_1 = n\left(\frac{V}{V - V_s}\right)$

If the source of sound in moving away from the observer, the apparent frequency is

$n_2 = n\left(\frac{V}{V + V_s}\right)$

$\therefore \quad n_1 - n_2 = nV\left[\frac{1}{V - V_s} - \frac{1}{V + V_s}\right]$

$= nV\left[\frac{2V_s}{V^2 - V_s^2}\right] = \frac{2nVV_S}{\left(V^2 - V_S^2\right)}$

22. (C)

For the source moving towards the wall,

$\therefore \quad n_1 = n\left[\frac{V}{V - V_1}\right]$

For the reflected sound waves, the driver acts as an observer moving towards the wall

$\therefore \quad n_2 = n_1\left[\frac{V + V_1}{V}\right]$

$\therefore \quad n_2 = \left[\frac{V + V_1}{V}\right] \times \left[\frac{V}{V - V_1}\right] \times n$

$\therefore \quad n_2 = n\left[\frac{V + V_1}{V - V_1}\right]$

23. (C)

When observer moves towards the stationary source then apparent frequency,

$n' = \left(\frac{v + v_o}{v}\right)n$

Given, $v_o = v/5$

$\therefore \quad n' = \left(\frac{v + \frac{v}{5}}{v}\right) n = \frac{6}{5} n$

Increase in apparent frequency

$= n' - n = \frac{6}{5} n - n = \frac{1}{5} n \Rightarrow 20\ \%\ \text{of}\ n$

24. (A)

Given,

Frequency of source (n_o) = 510 Hz

Velocity of source = 72 km/hr

$= 72 \times \frac{5}{18} = 20$ m/s

Velocity of sound in air = 320 m/s

Doppler formula for apparent frequency, when source is approaching a stationary listener,

$n_1 = n_0 \left(\frac{v}{v - v_S}\right)$

$\therefore \quad n_1 = 510 \times \left(\frac{320}{320 - 20}\right) = 544\ \text{Hz}$

Doppler formula for apparent frequency, when source is moving away from a stationary listener,

$n_2 = n_0 \left(\frac{v}{v + v_S}\right)$

$\therefore \quad n_2 = 510 \times \left(\frac{320}{320 + 20}\right) = 480\ \text{Hz}$

25. (D)

Applying Doppler's effect to sound waves, we can write, $n' = n\left(\frac{v + v_0}{v}\right) = n\left(1 + \frac{v_0}{v}\right)$

$n' = 3n$ ....(given)

$\therefore \quad 3n = n\left(1 + \frac{v_0}{v}\right)$

$\therefore \quad 3 = 1 + \frac{v_0}{v}$

$\therefore \quad \frac{v_0}{v} = 2 \quad \Rightarrow v_0 = 2v$

26. (B)

$n' = \left(\frac{V + V_L}{V - V_S}\right) n$

$= \left(\frac{V + \frac{V}{10}}{V - \frac{V}{10}}\right) n$

$= \frac{11}{9} n$

$= 1.22\ n$

Concept Fusion

1. (B)

[Note: *Detailed solution for Q.1 (wherever applicable) can be accessed via QR code at the end of the chapter.*]

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