SUMMATIVE ASSESSMENT TERM I

STANDARD X — PHYSICS (SET - A) COMPREHENSIVE ANSWER KEY

SECTION A — (Questions 1 to 4 : 1 Score each) [Total: 4 Scores]

Question 1 [1 Score]

Question: Which of the following is a longitudinal wave?

Correct Answer: b) Sound wave

Explanation / Value Point: Sound waves travel through a medium as longitudinal mechanical waves involving periodic compressions and rarefactions where medium particles oscillate parallel to the direction of wave propagation. (Light waves, radio waves, and ripples on water surfaces are transverse waves).

Question 2 [1 Score]

Assertion (A): The walls of large halls like cinema theatres are made rough.
Reason (R): Rough surfaces reflect sound more effectively than smooth surfaces.

Correct Answer: a) A is correct, R is incorrect

Explanation: Rough, sound-absorbing surfaces are used on theatre walls to diffuse and absorb sound, preventing reverberation and unwanted echoes. Smooth, polished surfaces reflect sound more effectively, not rough surfaces. Thus, Assertion (A) is correct, but Reason (R) is incorrect.

Question 3 [1 Score]

Question: Statements regarding image formation by an astronomical telescope:

Correct Answer: b) ii & iv (ii: The image formed by the objective is small and real; iv: The image formed by the eyepiece is virtual)

Value Points: The objective lens has a large focal length and aperture, producing a real, inverted, and diminished (small) image near its focal plane. The eyepiece acts as a simple magnifier, producing a final magnified, virtual image.

Question 4 [1 Score]

Question: Match the items suitably in Column 1 with Column 2.

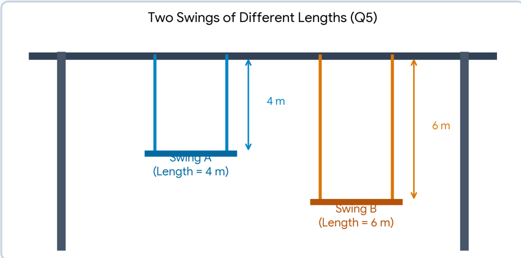
Column 1 (Incident Ray)	Column 2 (Refracted Ray Behavior)
A. Light ray parallel to optic axis falling on concave lens	**III.** Appears to come from the principal focus and moves away from optic axis
B. Light ray passing through optic centre	**IV.** Passes along a straight line without undergoing refraction
C. Light ray parallel to optic axis falling on convex lens	**II.** Passes through the principal focus
D. Light ray passing through concave lens directed towards principal focus	**I.** Passes parallel to the optic axis

Correct Option: b) A-III, B-IV, C-II, D-I

SECTION B — (Questions 5 to 11 : 2 Scores each) [Total: 14 Scores]

Question 5

[2 Scores]



Answer: Swing A (Length = 4 m) will complete 10 oscillations faster. [1 Score]

Justification: The time period of oscillation of a swing (pendulum) is directly proportional to the square root of its length ($T = 2\pi\sqrt{(L/g)}$). As Swing A has a shorter length ($4\ m < 6\ m$), its period of oscillation (T) is smaller (frequency is higher), so it completes 10 oscillations in less time. [1 Score]

Question 6

[2 Scores]

a) Name of the phenomenon: Echo (Reflection of sound waves). [1 Score]

b) Can you hear distinct sound if clapping close to the hill? No. [½ Score]

Explanation: The persistence of hearing in humans is $0.1\ s$ (1/10th second). To hear an echo distinctly, the reflected sound must reach the ear after at least $0.1\ s$, requiring a minimum obstacle distance of $d = (v \times t)/2 = (340 \times 0.1)/2 = 17\ m$ (or approx. $17.2\ m$). If standing close, the reflected wave returns before $0.1\ s$ and merges with the direct sound. [½ Score]

Question 7

[2 Scores]

a) Why low magnification of objective is not beneficial:

The total magnifying power of a compound microscope is given by $M = m_o \times m_e$. If the objective lens provides low magnification, the intermediate image is too small and the overall magnification becomes insufficient to clearly observe tiny microscopic objects. [1 Score]

b) Suggestion:

Use an objective lens of **shorter focal length** (higher refractive power). [1 Score]

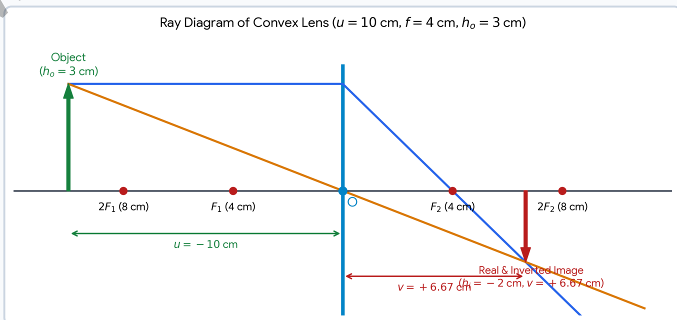
Question 8 (Ray Diagram)

[2 Scores]

Given Measurements: Convex lens with $f = 4\ cm$, Object distance $u = 10\ cm$ (i.e. beyond $2F_1 = 8\ cm$), Height $h_o = 3\ cm$.

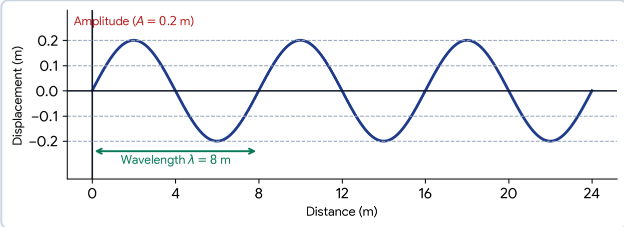
Calculation: $1/v - 1/u = 1/f \Rightarrow 1/v = 1/4 + 1/(-10) = 3/20 \Rightarrow v = +6.67\ cm$ (between F_2 and $2F_2$).

Image height: $h_i = h_o \times (v/u) = 3 \times (6.67 / -10) = -2.0\ cm$ (Real, inverted, diminished).



Scoring Distribution: Accurate ray diagram showing principal axis, optical centre O, marked foci (F_1, $2F_1$, F_2, $2F_2$), object beyond $2F_1$, correct ray paths (parallel ray through F_2, ray through optic centre undeviated), and real, inverted image between F_2 and $2F_2$. [2 Scores]

Question 9 **[2 Scores]**



a) Amplitude (A): $0.2\ m$ (Peak displacement from mean position). [1 Score]

b) Time required for the wave to travel $24\ m$:

Given speed $v = 8\ m/s$, Distance $s = 24\ m$.
$Time\ (t) = Distance / Speed = 24 / 8 = 3\ s$. [1 Score]

Question 10. A (Choice) **[2 Scores]**

Given: Convex lens with $f = +20\ cm$, Object distance $u = -25\ cm$, Height $h_o = 1\ cm$.

a) Image distance (v):

$1/f = 1/v - 1/u \Rightarrow 1/v = 1/f + 1/u = 1/20 + 1/(-25) = (5 - 4)/100 = 1/100$
$v = +100\ cm$.
The image is formed at a distance of $100\ cm$ on the other side of the lens (real image). [1 Score]

b) Height of the image (h_i):

$m = h_i / h_o = v / u \Rightarrow h_i = h_o \times (v / u) = 1 \times (100 / -25) = -4\ cm$.
Height of the image is $4\ cm$ (inverted). [1 Score]

Question 10. B (Choice OR) **[2 Scores]**

Given: Object height $h_o = 2\ cm$, Real image height $h_i = -5\ cm$ (real image is inverted), Image distance $v = +10\ cm$.

a) Magnification (m):

$m = h_i / h_o = -5 / 2 = -2.5$. [1 Score]

b) Object distance (u):

$m = v / u \Rightarrow u = v / m = (+10) / (-2.5) = -4\ cm$.
Distance of the object from the lens is $4\ cm$ in front of the lens. [1 Score]

Question 11. A (Choice) **[2 Scores]**

Statement: "Lower the focal length of a lens, greater its power is."
Agreement: **Yes, I agree with this statement.** [½ Score]
Mathematical Justification: Power of a lens (P) is the reciprocal of its focal length (f) in metres:

$P = 1 / f\ (in\ metres)$
Example: If $f_1 = 0.5\ m \Rightarrow P_1 = 1 / 0.5 = +2\ D$.
If focal length is reduced to $f_2 = 0.2\ m \Rightarrow P_2 = 1 / 0.2 = +5\ D$.
Since $P \propto 1/f$, as focal length decreases, the refractive power increases. [1½ Scores]

Question 11. B (Choice OR) [2 Scores]

Given: Lens power $P = +2\ D$, Image formed at $v = 100\ cm = 1\ m$. Child's remark: "Image size is half the object size".
Agreement: **No, I do not agree with the child's remark.** [½ Score]
Justification:

Focal length: $f = 1 / P = 1 / (+2) = 0.5\ m = 50\ cm$.
Position of $2F = 2 \times 50\ cm = 100\ cm$.
Since image is formed at $v = 100\ cm = 2F_2$, the object is placed at $u = -2F_1 = -100\ cm$.
When an object is placed at $2F$, magnification $m = v / u = 100 / (-100) = -1$. The image formed is of the **same size as the object** ($|h_i| = h_o$), not half size. [1½ Scores]

SECTION C — (Questions 12 to 17 : 3 Scores each) [Total: 18 Scores]

Question 12. A (Choice) [3 Scores]

a) Natural Frequency: The inherent frequency at which a body vibrates naturally when disturbed and allowed to oscillate freely without any external periodic force. [1 Score]
b) Why does the table vibrate? Due to **Forced Vibration** (the periodic vibration transmitted through the tuning fork stem forces the tabletop to oscillate). [1 Score]
c) Frequency of vibration of the table: $288\ Hz$ (Under forced vibration, the body oscillates at the frequency of the external vibrating body). [1 Score]

Question 12. B (Choice OR) [3 Scores]

a) Frequency of vibration of the metal plate: $256\ Hz$. [1 Score]
b) Change in vibration if the natural frequency of the plate is $200\ Hz$:
Change: The plate will vibrate at $256\ Hz$, but the **amplitude of vibration and loudness of sound will decrease significantly**. [1 Score]
Justification: When both frequencies matched at $256\ Hz$, **resonance** occurred, producing maximum amplitude and loud sound. When the plate's natural frequency is $200\ Hz$, resonance is lost and only ordinary forced vibration occurs. [1 Score]

Question 13 [3 Scores]

Three differences between Transverse Waves and Longitudinal Waves:

Feature	Transverse Waves	Longitudinal Waves
Direction of Oscillation	Medium particles vibrate **perpendicular** to the direction of wave propagation.	Medium particles vibrate **parallel** to the direction of wave propagation.
Form of Propagation	Propagates through alternating **Crests and Troughs**.	Propagates through alternating **Compressions (high pressure) and Rarefactions (low pressure)**.
Medium / Examples	Can propagate through solids and liquid surfaces (e.g. Light waves, water surface waves).	Can propagate through solids, liquids, and gases (e.g. Sound waves in air, ultrasound).

[1 Score for each complete point; 3 × 1 = 3 Scores]

Question 14 **[3 Scores]**

a) Four practical applications of ultrasonic waves: [2 Scores (½ mark each)]

- **SONAR:** For measuring water depth and locating underwater submarines, shipwrecks, and shoals of fish.
- **Medical Lithotripsy:** For pulverizing kidney stones into tiny fragments without surgical incisions.
- **Ultrasonic Cleaning:** For cleaning delicate components, spiral tubes, and intricate electronic boards.
- **Flaw Detection:** In industrial metallurgy to identify internal cracks or defects in metal blocks without breaking them.

b) Ultrasonography:
A non-invasive medical diagnostic imaging technique that transmits high-frequency ultrasonic waves into body tissues, detects reflected echoes from internal organs, and processes them into detailed visual images on a display screen for organ examination and pregnancy scans. [1 Score]

Question 15. A (Choice) **[3 Scores]**

Given: Time period of oscillation $T = 1\ s$.

Frequency: $f = 1 / T = 1 / 1\ s = 1\ Hz$. [1 Score]

Can humans hear this wave? No, humans cannot hear this sound. [1 Score]

Justification: The human audibility range is from $20\ Hz$ to $20{,}000\ Hz$. A frequency of $1\ Hz$ is below $20\ Hz$ (it is an **infrasonic wave**) and is imperceptible to human ears. [1 Score]

Question 15. B (Choice OR) **[3 Scores]**

Given: Wave speed $v = 350\ m/s$, Wavelength $\lambda = 1\ cm = 0.01\ m$.

Number of high pressure regions per second:

Each wave cycle creates one high-pressure region (compression) and one low-pressure region (rarefaction).
Number of high-pressure regions per second = Frequency (f):
$f = v / \lambda = 350 / 0.01 = 35{,}000\ Hz$.
Therefore, it produces $35{,}000$ **high-pressure regions in one second**. [1½ Scores]

Can we hear this sound? No, humans cannot hear this sound. [½ Score]

Justification: $35{,}000\ Hz$ exceeds the upper threshold of human hearing ($20{,}000\ Hz$); it is an **ultrasonic sound**. [1 Score]

Question 16 **[3 Scores]**

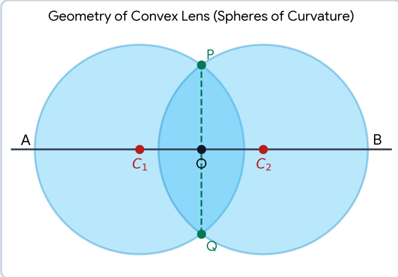
a) Four instances utilizing Forced Vibration & Resonance: [2 Scores (½ mark each)]

- **Tuning of Radio and TV channels:** Matching the receiver's resonant frequency with the transmitted carrier signal.
- **Sound boxes of musical instruments:** Enhancing acoustic richness in guitar, violin, veena, mridangam, etc.
- **Magnetic Resonance Imaging (MRI):** Utilizing magnetic resonance of hydrogen nuclei for medical diagnosis.
- **Microwave oven:** Resonant heating of water molecules in food items.

b) Two instances utilizing Reflection of Sound: [1 Score (½ mark each)]

- **Stethoscope:** Directing heartbeats and lung sounds to doctor's ears through multiple total reflections.
- **Sound boards** / **Curved auditorium ceilings:** Reflecting sound uniformly to all seating corners of a hall.

Question 17 **[3 Scores]**



a) Terminology: [2 Scores (½ mark each)]

- ***O*: Optic Centre** — The central point of the lens through which a ray passes undeviated.
- **C_1, C_2: Centres of Curvature** — The centres of the spherical surfaces of which the lens forms part.
- **Straight line AB: Principal Axis** — The line joining the centres of curvature (C_1, C_2) and passing through the optic centre (O).

b) Determination of Principal Focus of Convex Lens: [1 Score]
Hold the convex lens facing a distant light source (sunlight). Place a white screen/paper behind the lens and adjust its distance until a sharp, intense, smallest point of light is focused. The position of this point is the **Principal Focus (F)**, and its distance from the lens is the focal length (f).

SECTION D — (Question 18 : 4 Scores) [Total: 4 Scores]

Question 18. A (Choice) **[4 Scores]**

a) "A convex lens can form real images only." Do you agree?
Answer: **No, I disagree.** [½ Score]
Justification: When an object is placed between the optic centre (O) and the principal focus (F), the convex lens forms a **virtual, erect, and magnified image** on the same side as the object (working as a magnifying lens). [½ Score]

b) Focal Length Calculation:

Given: Real image on screen ⇒ Magnification $m = -3$.
Total distance between object and screen: $|u| + v = 80\ cm \Rightarrow -u + v = 80\ cm$.
Since $m = v / u = -3 \Rightarrow v = -3u$.
Substituting into distance equation: $-u + (-3u) = 80 \Rightarrow -4u = 80 \Rightarrow u = -20\ cm$.
Therefore, $v = -3(-20) = +60\ cm$.
Using lens formula: $1/f = 1/v - 1/u = 1/60 - (1/-20) = 1/60 + 1/20 = (1 + 3)/60 = 4/60 = 1/15$.
$f = +15\ cm$. Focal length of the lens is $15\ cm$. [2 Scores]

c) Half of the lens aperture covered with paper:
Answer: **Yes, complete image formation is still possible.** [½ Score]
Justification: Light rays from all points of the object pass through the uncovered portion of the lens and converge to form the complete image. However, because half of the incoming light is blocked, the **brightness (intensity) of the image is reduced**. [½ Score]

Question 18. B (Choice OR) **[4 Scores]**

a) "A concave lens can produce only virtual images." Do you agree?

Answer: Yes, I agree. [½ Score]

Justification: A concave lens is a diverging lens. Light rays incident from a real object always diverge upon refraction and never intersect in real space; they only appear to diverge from a virtual focus. Hence, it always forms a **virtual, erect, and diminished image**. [½ Score]

b) Focal Length Calculation:

Given: Concave lens forms virtual image with $m = +1/3$, Object distance $u = -30\ cm$.
From $m = v / u \Rightarrow v = m \times u = (+1/3) \times (-30\ cm) = -10\ cm$.
Using lens formula: $1/f = 1/v - 1/u = 1/(-10) - 1/(-30) = -1/10 + 1/30 = (-3 + 1)/30 = -2/30 = -1/15$.
$f = -15\ cm$ (Negative sign confirms concave lens).
The focal length of the concave lens is $15\ cm$. [2 Scores]

c) Position of image when object is at Principal Focus (F) of Concave Lens:

When $u = -f = -15\ cm$: $1/v = 1/f + 1/u = -1/15 - 1/15 = -2/15 \Rightarrow v = -7.5\ cm = -f/2$.
The image is formed **between the Principal Focus (F) and the Optic Centre (O) on the same side as the object** (midway at distance $f/2$). [1 Score]