Aga Khan University Examination Board

Notes from E-Marking Centre on HSSC-I Physics Examination May 2017

Introduction

This document has been produced for the teachers and candidates of Higher Secondary School Certificate (HSSC-I) Physics. It contains comments on candidates' responses to the 2017 HSSC-I Examination indicating the quality of the responses and highlighting their relative strengths and weaknesses.

E-Marking Notes

This includes overall comments on candidates' performance on every question and *some* specific examples of candidates' responses which support the mentioned comments. Please note that the descriptive comments represent an overall perception of the better and weaker responses as gathered from the e-marking session. However, the candidates' responses shared in this document represent some specific example(s) of the mentioned comments.

Teachers and candidates should be aware that examiners may ask questions that address the Student Learning Outcomes (SLOs) in a manner that requires candidates to respond by integrating knowledge, understanding and application skills they have developed during the course of study. Candidates are advised to read and comprehend each question carefully before writing the response to fulfil the demand of the question.

Candidates need to be aware that the marks allocated to the questions are related to the answer space provided on the examination paper as a guide to the length of the required response. A longer response will not in itself lead to higher marks. Candidates need to be familiar with the command words in the SLOs which contain terms commonly used in examination questions. However, candidates should also be aware that not all questions will start with or contain one of the command words. Words such as 'how', 'why' or 'what' may also be used.

General Observations

In questions that required short written answers, most candidates had knowledge of the correct answer, but were undisciplined in communicating that knowledge. This was particularly evident in Question 7, 11 and 16a. Candidates who considered how to communicate their knowledge in all types of questions were generally much more successful. Communication includes drawing field lines and vectors, labelling diagrams, using exact terminology, using correct formulae and answering the specific question asked.

This year candidates performed well on questions related to the measurement, work, energy and power, fluid dynamics and oscillation. Whereas low-scoring candidates did not perform well in questions based on vectors analysis, drawing and completing of ray diagrams of different phenomenon in physical optics, word problems and derivation based on conservation of momentum and angular momentum, Doppler's Effect and its causes, thermodynamics and also had problem in articulating their answers on reasoning and discussion type questions.

Question 1:

Write any TWO differences between accuracy and precision.

S. No.	Accuracy	Precision
i		
ii		

The question was generally well-attempted.

Better responses correctly wrote two differences between accuracy and precision. The following points were mostly highlighted in high scoring answers: how close the measured value is to the true value, how close together a group of measurements actually are to each other/ determined with only one measurement *verses* determined with multiple measurements/ less fractional or percentage uncertainty *verses* measurement has less absolute uncertainty/ depends upon fractional or percentage uncertainty *verses* depends on the ability to measure small changes of instruments/ depends upon method or way of measurement *verses* depends upon instruments/ depends upon least count.

Example:

S.No.	Accuracy	Precision
1	Accuracy is the closeness of the measured value from the known or standard value.	Precision is the closeness of the, two or more than two measured value from each other.
2	Accuracy depends upon percentage uncertainity or error.	Precision depends upon the least count or absolute uncertainity.

Weaker responses showed candidates' lack of understanding about accuracy and precision. They wrote difference on working rate or speed of a system that has to be completed *verses* conditions required to complete the process, accurate value *verses* readable value and personal error *verses* systematic or random error. All of the aforementioned were irrelevant to the demand of the question.

Example:

S.No.	Accuracy	Precision
1	The relative or the actual rate of any system is known as it Accuracy.	The value near to the relative value but far from the actual value is its precision.
2	It helps to find out the accurate value in a system	The precise value is found which can be taken as readings

Question 2:

The diameter of a cylinder is 20 cm. It is measured with the help of a Vernier calliper having least count of 0.01 cm. Calculate percentage uncertainty.

Better responses correctly calculated the percentage uncertainty by identifying least count as absolute uncertainty 0.01 cm. Candidates wrote the correct formula of percentage uncertainty, $\frac{\text{Absolute uncertainity}}{\text{Measured length}} \times 100$ and the correct answer, = 0.05% or 0.0005 or 5×10^{-4}.

Example:

Diameter = 20cm.

Least count = 0.01cm.

Percentage uncertainty = ?

Percentage uncertainty = $\frac{\text{least count}}{\text{Diameter}} \times 100$

$= \frac{0.01}{20} \times 100$

$= 0.05\%$

Weaker responses showed that candidates failed to extract values from the question, i.e. absolute uncertainty and measured value (length or diametre). Low scoring candidates were also not able to write the correct formula of percentage uncertainty, therefore, they failed to reach at the correct answer. Some of the candidates used formula of volume of a cylinder in place of percentage uncertainty and hence they mentioned their answer with ± variance, which was not required in the question.

Example:

r = 20 cm = d/2 = 10cm
Cylinder = 2/3 πr² = 209.3
%age U.C = Power x r
%age of r = 0.01 / 10 = 0.0001
%age U.C = 0.0005 x 2 = 0.002

%age U.C = 209.3 ± 0.00%
= 209.3 ± 0.004

Question 3:

Why is the magnitude of a vector always a positive value?

Better responses showed that candidates wrote the reason that the magnitude of a vector is always a positive value because a vector represents the *length* and length is always considered to be positive. Some of the high scoring candidates also mentioned that the magnitude of a vector is always a positive value because it is calculated by the formula, $|F| = \sqrt{Fx^2 + Fy^2}$.

Example:

The magnitude of a vector is always a positive value as $\sqrt{Fx^2+Fy}$ because the negative sign just show the direction of vector and are not considered as important as the magnitude should be always positive to acheive accurate magnitude of a vector.

Weaker responses failed to provide the correct reason in their answers. Low scoring candidates discussed types of vector quantities, e.g. negative vector, unit vector, null vector etc. Some of the low scoring candidates were unable to properly articulate their answers; they were confused in direction and the length of vector quantity.

Example:

There are 2 types of quantities. Vector quantities are those which have a magnitude and direction. And direction can not have a negative value.

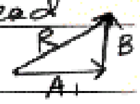
Question 4:

Describe the 'head to tail rule' of vector addition. In this rule, can vectors be placed in any order of succession? Why?

Better responses presented correct description of the 'head to tail rule' of vector addition, by mentioning that 'when the tail of first vector is attached to the head of the preceding vector and the resultant vector will be represented by an arrow with its tail end at the starting point and its tip end at the tip of the last vector added'. High scoring candidates also mentioned that if the head of the first vector joined with the tail of the second vector and vice versa, then vectors may be placed in any order of succession.

Example:

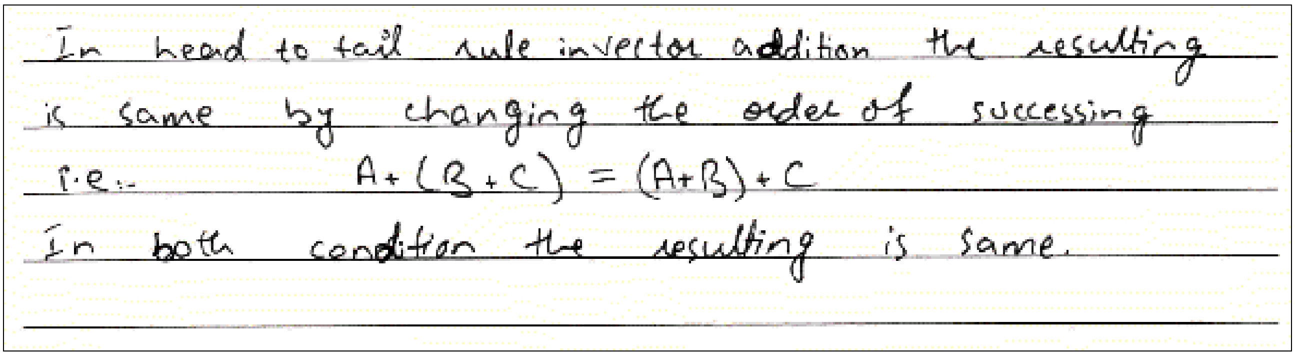
According to head to tail rule tail of one vector coincides with head of another vector in such a way that the resultant vector has its head coinciding with head of second vector and tail coinciding with the tail of first vector.



Yes! Vectors can be placed in any order of succession because vector addition is commutative A+B= B+A. No matter what is the order of vectors the resultant would be same.

Weaker responses presented incomplete or partially correct description of 'head to tail rule' of vector addition. In many cases, low scoring candidates wrote about associative and distributive properties of vector addition which was not the demand of the question. Occasionally, candidates were also unable to write about the correct reason about whether vectors can be placed in any order of succession or not.

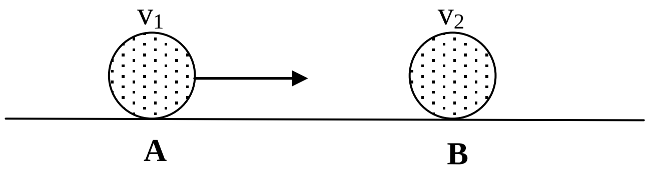
Example:


In head to tail rule invector addition the resulting is same by changing the order of successing
i.e. A + (B + C) = (A+B) + C
In both condition the resulting is same.

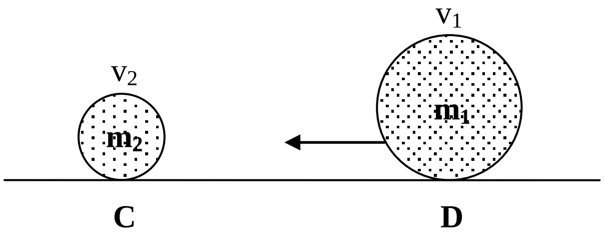
Question 5:

Consider two smooth, non-rotating balls colliding elastically in an isolated system. What will be the effect on the velocity and directions of the balls if

i. ball **A** moving in a straight line collides with the identical, stationary ball **B** of equal mass?



ii. heavy ball **D** moving in a straight line collides with a lighter ball **C** at rest?



Better responses presented correct understanding of the effect on the velocity and directions of the balls in both parts. In the first part of the question, high scoring candidates wrote that the first ball is moving with velocity v_1 and the second ball is at rest, as both balls have same masses, therefore, after collision, the first ball comes to rest and second ball moves forward with same velocity and direction of the first ball. In the second part of the question, candidates wrote that after collision with the smaller ball, the massive ball moves in forward direction with the same velocity but the smaller ball which was at rest, moves forward with twice of the velocity of the massive ball after collision.

Example:

i.

Here $m_A = m_B$, $V_B = O = V_2$	is $V_B = O = V_2$. As they have	Ball A will come
There are two balls A and B, ball	identical masses so when	at rest and Ball B
A has some velocity V_1 and is	(ball A) m_A will collide with (ball B) m_B	will start moving in the same
moving towards ball B whose velocity	the velocity will interchange $V_1' = 0$, $V_2' = V_1$	direction in which Ball A was moving.

ii.

$m_1 >> m_2$, $V_2 = 0$, $V_1 > 0$	ball C will move in the	Ball D will remain
When the heavy ball	same direction as ball D	unaffected.
D will colide with lighter	is moving but with double	$V_1' = V_1$
ball C at rest then	the initial velocity of Ball D.	$V_2' = 2V_1$

Weaker responses failed to describe the effect on the velocity and directions of the balls in both parts. Low scoring candidates wrote that 'after collision both balls have same velocity and direction as both have same masses'. In the second part, low scoring candidates wrote that as the heavier ball strikes the lighter ball which is at rest position, lighter ball moves in opposite direction with the velocity of heavier ball.

Example:

i.

If ball A collide with Ball B there will be no effect of on velocity because both the ball have same mass.

ii.

If a heavier ball D collide with a lighter ball C which is at rest the lighter ball will be disturbed and start moving and will some distance

Question 6:

An elevator's motor lifts a mass of 85 kg to the third floor of a building at a height of 15 m with a constant velocity in 12 s. Calculate the power of the elevator's motor.

(**Note**: Acceleration due to gravity 'g' = 9.8 m/s^2)

Better responses correctly calculated the power of the elevator's motor by extracting the correct data (values) from the question. Candidates wrote the correct formula of power, P = W/ t and converted it into $P = \frac{\text{mg} \cdot \text{d}}{\text{t}}$ form and calculated the power, P = 1041.25 Watt.

Example:

~~s = vt~~ ~~m = 85~~ m = 85kg

~~t = s/v~~ ~~t = 15/12 =~~ h = 15m

t = 12s

$P = \frac{W}{t}$

∴ W = mgh

$P = \frac{mgh}{t}$

$P = \frac{85 \times 9.8 \times 15}{12}$

$P = \frac{12495}{12}$

P = 1041.25 Watt

Weaker responses failed to extract the correct values from the question. Some of the low scoring candidates used the correct formula of power but were unable to calculate the correct value of power. It was observed that candidates made mistakes in substituting the correct values in the correct form of formula.

Example:

Power = $\frac{\text{Workdone}}{\text{time}}$

$= \frac{mgh}{t}$

$= \frac{85 \times 9.8 \times 15}{720}$

= 17.35 watt

Question 7:

The given figures show a skater who starts spinning and pulls his arms tightly towards his body once he gains angular momentum.

i. State the law of conservation of angular momentum with its mathematical expression.

ii. Describe TWO changes which occur after the skater pulls his arms as stated. Give your answer with reference to the law of conservation of angular momentum.

Most candidates did not attempt this question well which reveals that more focus and classroom practice is needed in this topic.

Better responses correctly stated that the total amount of angular momentum remains same before and after the application of the force and wrote the correct mathematical expression, $I_1 \omega_1 = I_2 \omega_2$. In the second part of this question, high scoring candidates described the changes which occur after the skater pulls his arms, i.e. the loss in angular momentum by the arms of the skater is gained by the rest of his body, skater gains angular momentum and is able to spin more rapidly than before and moment of inertia will be reduced with respect to the velocity of the skater.

Example:

i.

The total angular momentum of a system is always conserved. The product of angular velocity and moment of inertia rem-ains constant. $I_1 W_1 = I_2 W_2$ $L_{total} = L_1 + L_2 + \dots$ When I increases w decreases and when w increases I decreases.

ii.

When the scater pulls ~~its~~ his arms firstly its angular velocity increases and he spins faster than before ~~and~~ secondly when he pulls his arms ~~the~~ radius also ~~increases~~ decreases which cause the angular speed to decrease inorder to conserve angular momentum.

Weaker responses depicted that candidates were unable to state the law of conservation of angular momentum, and also failed to write the correct mathematical expression rather they wrote the formula of torque τ = F. d. In the second part of the question, low scoring candidates mentioned about equilibrium and state of equilibrium stating the changes which occur after the skater pulls his arms. This was irrelevant to the requirement of the question.

Example:

i.

If the external torque applied on the body is zero then the body's motion will be constant.

$$\tau = F \cdot d$$

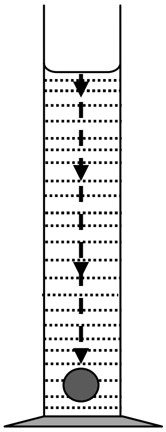
$$\tau = F \cdot r\omega$$

ii.

The skater will ~~not~~ be in state of equlbrium, the res. ultant torque will be zero and the force acting on him will also become zero.

Question 8:

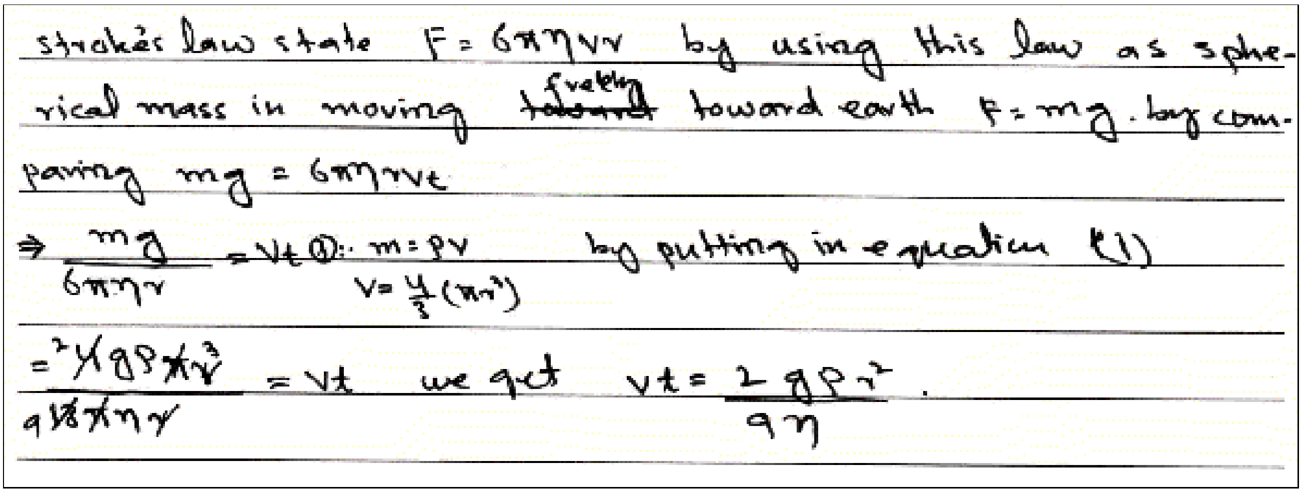
In the given diagram, a spherical ball of mass **m** and radius **r** is falling freely in a cylinder filled with honey.



When the magnitude of the drag force **F** becomes zero against the weight of the spherical ball, then the ball will fall with a constant velocity **v**. Derive an expression for the terminal velocity of the ball using Stoke's law.

Better responses presented the correct equations for the drag force, $6\pi\eta r V_t = mg$, volume of the ball, $V = \frac{4}{3}\pi r^3$ and density, $m = \rho V$. High scoring candidates correctly substituted and simplified the derivation in terms of terminal velocity, $V_t = \frac{2}{9}\frac{r^2 g\,\rho}{\eta}$.

Example:



strokes law state $F = 6\pi\eta v r$ by using this law as spherical mass in moving ~~toward~~ freely toward earth $F = mg$. by comparing $mg = 6\pi\eta r v_t$

$\Rightarrow \frac{mg}{6\pi\eta r} = v_t$ ① ∵ $m = \rho V$, $V = \frac{4}{3}(\pi r^3)$ by putting in equation (1)

$= \frac{{}^{2}4 g\rho\pi r^3}{9\,18\,\pi\eta r} = v_t$ we get $v_t = \frac{2 g\rho r^2}{9\eta}$.

Weaker responses revealed that candidates failed to derive the expression for the terminal velocity of the ball using Stoke's law. Candidates related the terminal velocity of the ball to the potential and kinetic energies, which was irrelevant to the demand of the question. It is a common observation that low scoring candidates usually appear confused while deriving a particular expression, when a real-life situation is given. Hence, it can be concluded that application of academic concepts in real-life situation find the required solution is not to the forefront of candidates' abilities.

Example:

$6\pi m r v = P.E$

$6\pi m r v = mgh$

$6\pi r v = gh \quad a = g = \frac{v}{t}$

$6\pi r v = \frac{v}{t} h$

$\frac{6\pi r}{t} = (h) \quad \therefore h = (v)(t)$

$\frac{6\pi r}{t} = (v)(t)$

$6\pi r = v$ The terminal velocity of the ball is.

Question 9:

i. Write any TWO differences between free and forced oscillations.

ii. Give ONE example of forced oscillation.

Better responses depicted that candidates correctly wrote the differences between free and forced oscillations. The following were included in the answers: total energy in free oscillations remains constant but in forced oscillation energy changes, amplitude of free oscillation always remains same but amplitude of forced oscillation changes with applied force, in free oscillations object vibrate with their natural frequency but in forced oscillations objects vibrate with other than their natural frequency and oscillation of free vibration is known as simple harmonic motion whereas of forced oscillation is known as driven harmonic motion. In the second part of the question, high scoring candidates wrote swing, suspension bridges, heavy machinery engines, pendulum of a wall clock as examples of forced oscillation.

Example:

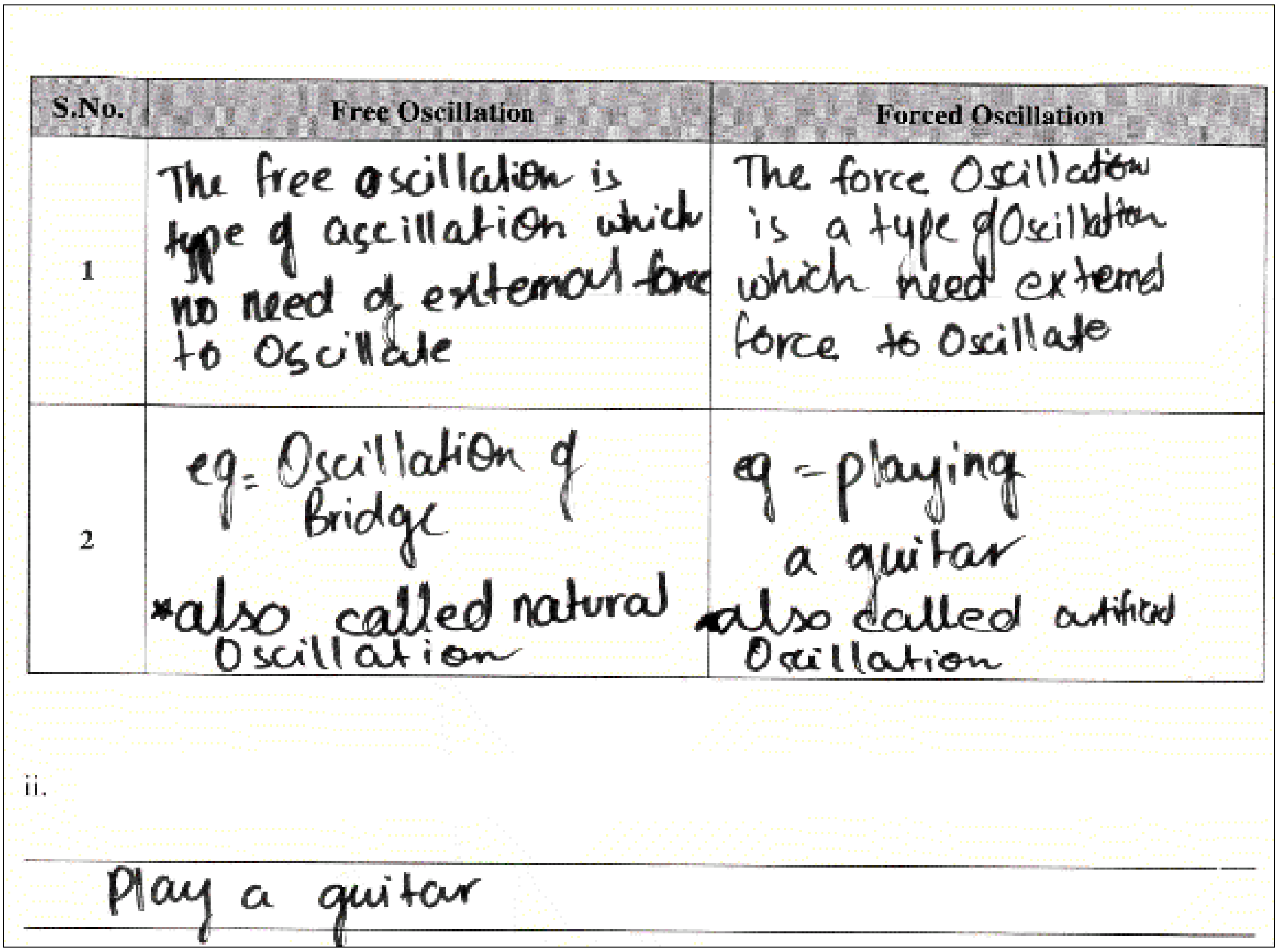
S.No.	Free Oscillation	Forced Oscillation
1	The object moves freely. No force is applied to keep the amplitude of oscillation constant.	To keep the amplitude of the oscillation constant, a force is applied continuously.
2	It will damp in non-isolated system.	It will not damp because force is being provided.
	The object moves (oscillates) with natural frequency.	The object oscillates with the frequency of oscillator.

ii.

① A child sitting on the swing and someone pushes her from behind so the swing keeps on moving. ② A pendulum bob, attached to string, struck by wall.

In weaker responses, candidates were not able to properly articulate their answers. Some of the low scoring candidates appeared confused and hence mixed-up differences with the examples of forces of oscillations. Such candidates lost marks.

Example:



S.No.	Free Oscillation	Forced Oscillation
1	The free oscillation is type of ascillation which no need of external force to Oscillate	The force Oscillation is a type of Oscillation which need extend force to Oscillate
2	eg= Oscillation of Bridge *also called natural Oscillation	eg - playing a guitar also called artificial Oscillation

ii.

Play a guitar

Question 10:

Define the following terms:

i. Oscillatory motion

ii. Periodic motion

The question was generally well-attempted.

Better responses correctly defined the oscillatory motion as to and fro motion about a mean position of a body and periodic motion as a motion which repeats itself after equal intervals of time.

Example:

i.

The to and fro motion of a body about its mean positions is called as oscillatory motion.

ii.

When a body oscillates about its mean position in equal intervals of time then it is called Periodic Motion.

Weaker responses failed to define the oscillatory and periodic motion. Most candidates defined linear and angular velocity and acceleration and low and fast speed objects. It was concerning to note that candidates (though few) were not able to recall the basic definitions of physics.

Example:

i.

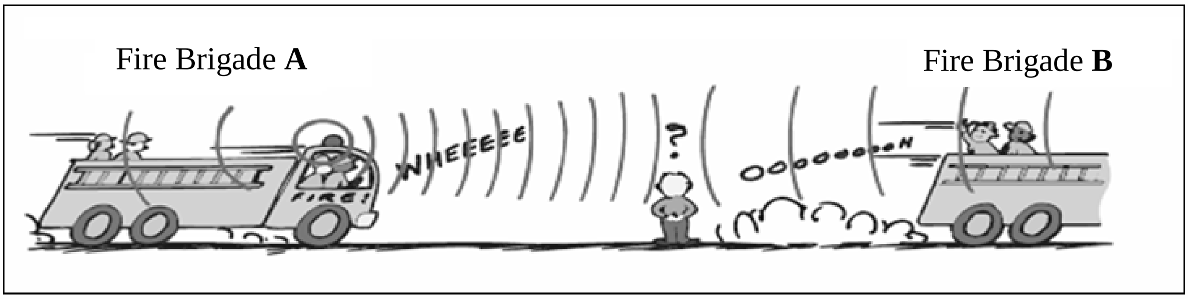
~~Oscillo~~ In oscillatory motion the body will move with angular Velocity.

ii.

The motion which ~~start~~ moves with Low speed and less velocity with respect to time.

Question 11:

Consider two fire brigade trucks, **A** and **B**, accelerating after each other with the same speed and generating the sound of same frequency. Nearby, a listener is standing, as shown in the given diagram.



i. To the listener, which fire brigade truck would appear to have lesser sound frequency?
ii. With reference to the stationary listener, write the mathematical expression of the apparent frequencies of sound produced by fire brigade **A** and fire brigade **B.**

Most candidates were not able to perform well in this question.

Better responses correctly identified the fire brigade truck that would appear to have comparatively lesser sound frequency. High scoring candidates also wrote mathematical expression of the apparent frequencies of sound produced by fire brigade **A**, $f = \left(\frac{v}{v - u_s}\right) f$ or $f_o = f_s \left(\frac{1}{1 - \frac{v_s}{v}}\right)$ and fire brigade **B**, $f = \left(\frac{v}{v + u_s}\right) f$ or $f_o = f_s \left(\frac{1}{1 + \frac{v_s}{v}}\right)$.

Example:

i.

The source which is receding from the listener would cause lesser frequency at listener i.e truck B.

ii.

$\lambda_A = \lambda - \Delta\lambda$

$\lambda_A = \left(\frac{v}{f} - \frac{u_s}{f}\right) = \left(\frac{v - u_s}{f}\right)$

$f_A = \frac{v}{\lambda_A} = \left(\frac{v}{\frac{v - u_s}{f}}\right)$

$f_A = \left(\frac{v}{v - u_s}\right) f$

$\lambda_B = \lambda + \Delta\lambda$

$\lambda_B = \left(\frac{v + u_s}{f}\right)$

$f_B = \left(\frac{v}{\frac{v + u_s}{f}}\right) = f\left(\frac{v}{v + u_s}\right)$

$f_B = f\left(\frac{v}{v + u_s}\right)$

Weaker responses showed candidates' inability to identify the correct fire brigade truck that had less sound frequency. Most low scoring candidates inverted the mathematical expressions of the apparent frequencies of sound produced by fire brigade **A** and fire brigade **B**. Candidates wrote $f = \left(\frac{v - u_s}{v}\right) f$ and $f = \left(\frac{v + u_s}{v}\right) f$ which were not relevant to the demand of the question in the given situation.

Example:

i.

Fire brigade A have lesser sound frequency because its at a distance from stationary listener.

ii.

Fire Brigade A:-

$\lambda = \frac{V - U_s}{f}$

$f_A = \left(\frac{V - U_s}{V}\right) f$

Fire Brigade B:-

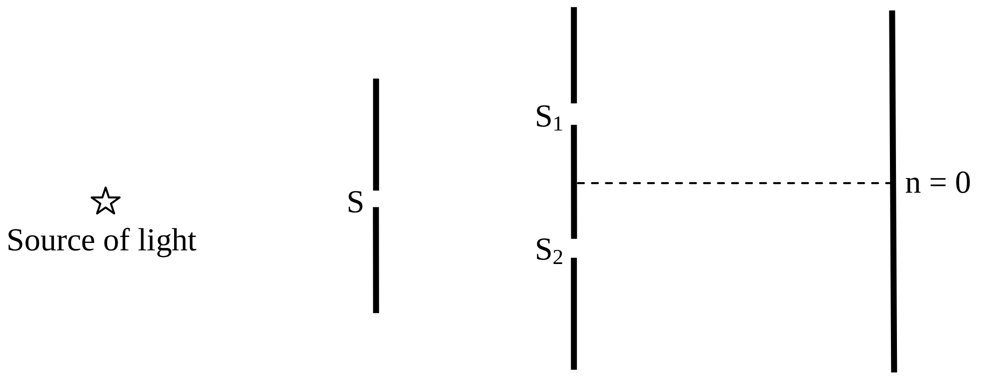
$\lambda = \frac{V + U_s}{f}$

$f_B = \left(\frac{V + U_s}{V}\right) f$

Question 12:

i. Name the experiment used for the production and observation of the interference of light shown in the given figure.

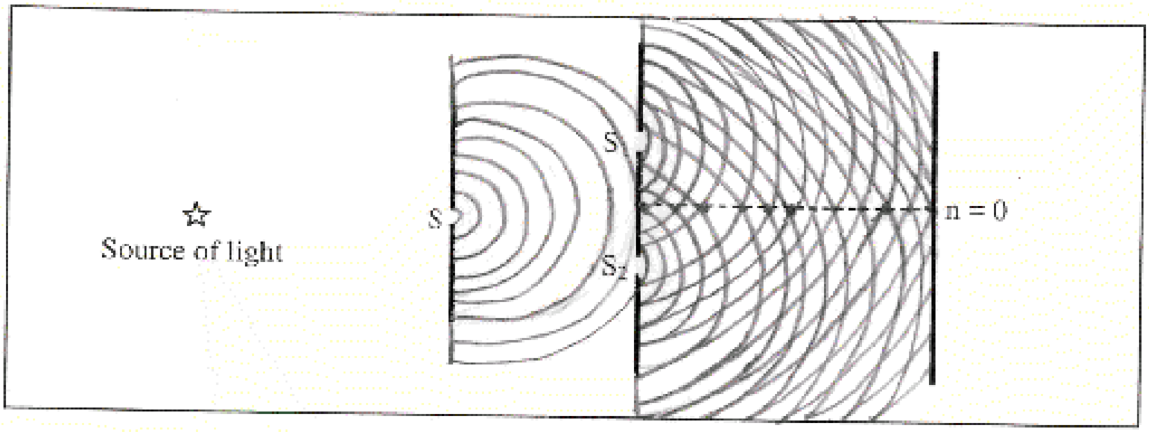
ii. With the help of Hygen's principle, complete the given figure by drawing the spread of light through slits, S, S_1 and S_2.



Better responses correctly named the experiment, Young's double slits used for the production and observation of the interference of light. High scoring candidates completed the given figure by drawing the wavefronts formed by source of light through slits, S, S_1 and S_2.

Example:

i.



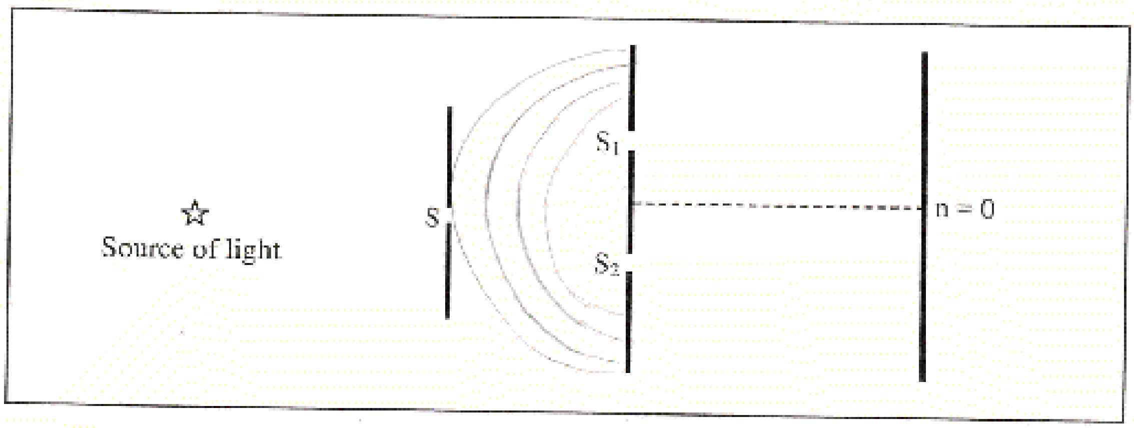
ii.

Young's double slit experiment is used in the given figure.

Weaker responses failed to name the correct experiment. Candidates mentioned wavefronts experiment/ Newton rings/ Huygen's principle/ Bragg's law and polarisation. Low scoring candidates were also unable to draw the wavefronts formed by source of light correctly.

Example:

i.



ii.

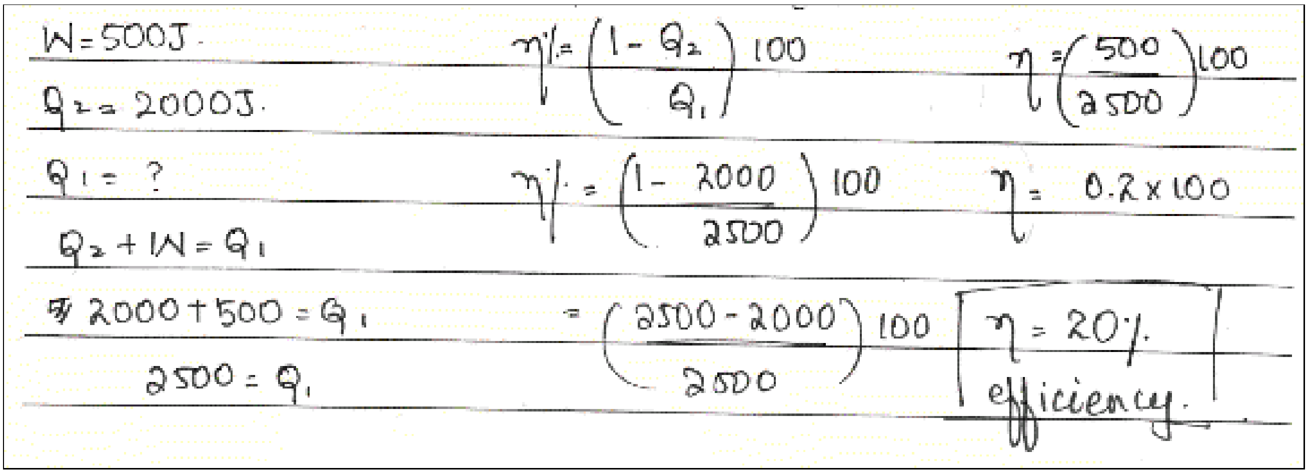
waves front experiment

Question 13:

If a Carnot engine performs 500 J of work and at the same time rejects 2000 J of heat energy to its cold reservoir, then find the percentage efficiency of the Carnot engine.

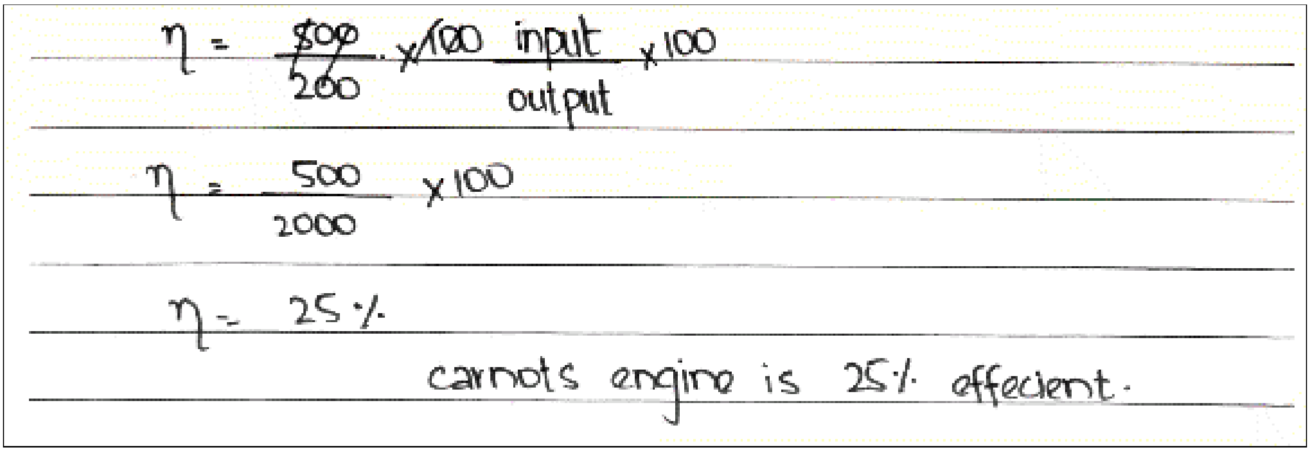
Better responses correctly wrote the formula of percentage efficiency, $\frac{\text{Work done}}{\text{Input}} = \frac{W}{Q_1}$, found the value of Q_1, 2500 J and calculated the correct value of percentage efficiency, i.e. 20%.

Example:


W = 500J.
Q_2 = 2000J.
Q_1 = ?
Q_2 + W = Q_1
2000 + 500 = Q_1
2500 = Q_1
$\eta\% = \left(1 - \frac{Q_2}{Q_1}\right)100$
$\eta\% = \left(1 - \frac{2000}{2500}\right)100$
$= \left(\frac{2500 - 2000}{2500}\right)100$
$\eta = \left(\frac{500}{2500}\right)100$
η = 0.2 x 100
η = 20% efficiency.

Weaker responses failed to extract the correct data (values) from the given question. Some low scoring candidates wrote the correct formula but were unable to substitute the values at the correct position. Candidates were unaware about the value of Q_1, therefore at the position of Q_1, candidates placed the value of Q_2. Due to this wrong substitution, candidates obtained wrong percentage efficiency.

Example:


$\eta = \frac{500}{200}$ x100 $\frac{\text{input}}{\text{output}}$ x100
$\eta = \frac{500}{2000}$ x100
η = 25%
carnots engine is 25% affecient.

Extended Response Questions (ERQs)

These questions offered a choice between part **a** and **b**

(**Note**: Majority of the candidates attempted Question **14a** and they scored well in this part.)

Question 14a

i. Why is it better to launch a spacecraft into its orbit from a location away from the equator? Justify your answer with the help of mathematical relation.

ii. Calculate the escape velocity of the Earth by using the given information.

Mass of the Earth = 6×10^{24} kg
Radius = 6.4×10^{6} m
g = 9.8 m/s^2
G = 6.67×10^{-11} Nm^2kg^{-2}

Better responses presented correct reason that it is better to launch a spacecraft into its orbit from a location away from the equator as the radius is greater at the equator than at the poles. Candidates also wrote the mathematical relation, $v_{orb} = \sqrt{\frac{GM}{R}}$ or $v_{orb} = \sqrt{2gR}$. In the second part of the question, high scoring candidates correctly calculated the escape velocity by the correct formula, $v_{esc} = \sqrt{2gR}$, substituted the correct values in the formula and obtained the correct answer, v_{esc} = 11.2 km/s.

Example:

a. It is better to launch a space-craft into its orbit from a location away from the equator because at equator the gravity has maximum value, radius is more so to escape a space craft from the gravitational pull of the Earth it would need more velocity if it is near the equator.

$V_{esc} = \sqrt{2gR}$ or

$V_{esc} = \sqrt{\frac{2GM}{R}}$.

so, Velocity is directly proportional to g and R therefore, lesser the gravity and radius lesser will be the velocity needed.

Escape velocity of Earth:

$V_{esc} = \sqrt{2gR}$

$V_{esc} = \sqrt{2(9.8)(6.4\times10^{6})}$

$V_{esc} = \sqrt{125440000}$

$V_{esc} = 11200/1000$

$V_{esc} = 11.2\ m/s$

OR

$V_{esc} = \sqrt{\frac{2GM}{R}}$

$V_{esc} = \sqrt{\frac{2(6.67\times10^{-11})(6\times10^{24})}{6.4\times10^{24}}}$

$V_{esc} = \frac{11183.13}{1000}$

$V_{esc} = 11.18\ m/s$.

Weaker responses showed that candidates misunderstood the question. In the first part, most candidates wrongly mentioned that less velocity by a spacecraft is required to overcome the gravitational force. Low scoring candidates incorrectly wrote the formula for the escape velocity, i.e. $v_{esc} = \sqrt{\frac{MRG}{g}}$ and calculated wrong value of escape velocity.

Example:

(ii) $V_{esc} = \sqrt{gMRG/g}$

$= \sqrt{\dfrac{\cancel{9.8m/s^2} \times 6\times10^{24} Kg \times 6.4\times10^{6} m \times 6.67\times10^{-11} Nm^2/kg^2}{9.8 m/s^2}}$

$= \sqrt{\dfrac{2.56\times10^{21}}{9.8 m/s^2}}$

$= \sqrt{2.613\times10^{20} m^2/s^2}$

$V_{esc} = 1.6166 \times10^{10} m/s$

(i) since the effect of gravity is greater near the equator. Therefore if a spacecraft is launced away from the equator it will ~~nea~~ need less velocity to overcome the earths gravitational force and will easily start orbiting the earth.

Question 14b

Suppose a car of mass 1200 kg is moving with velocity of 27.5 m/s. If the engine is applying a uniform force of 3500 N, then calculate power of the car at the end of 8 second.

Better responses presented correct data (values) from the given question, mentioned the correct formula of power, $P = \frac{F.d}{t}$ or P = F.v, substituted the correct values in the formula and calculated the correct answer with S.I. unit, P = 96250 W or P = 96.25 kW.

Example:

DATA

Mass = 1200 kg

Velocity = 27.5 m/s

Fosrce = 3500 N

Time = 8 sec

Power = ?

First we will find the distance covered at the end of 8th second

$\therefore V = \frac{S}{t}$

$S = V \times t$

$S = (27.5)(8)$

$\boxed{S = 220\ m}$

Now, we will find power,

A/c to def of power

$Power = \frac{work}{Time}$

$P = \frac{F.S}{t}$

$P = \frac{(3500).(220)}{8}$

$P = \frac{770000}{8}$

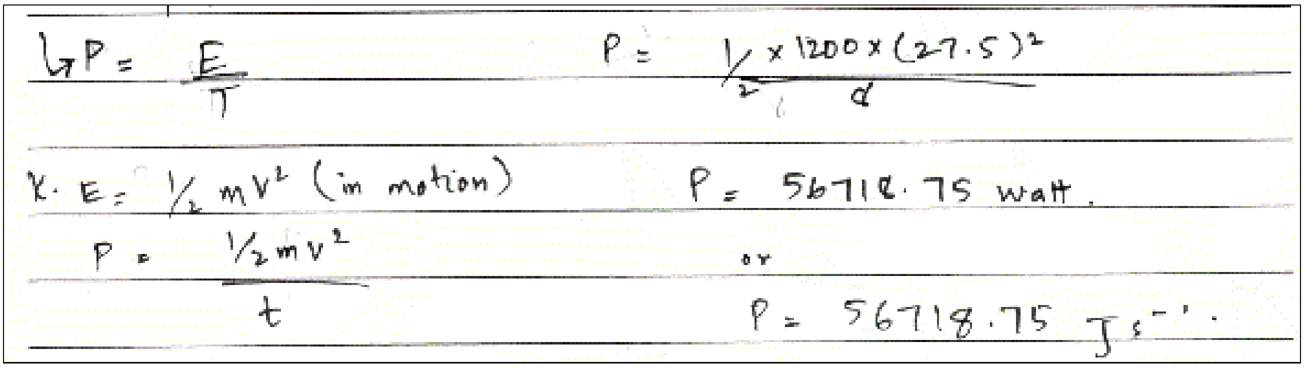
P = 96250 watt

1 K.W = 1000 watt

$\boxed{P = 96.25\ K.Watt}$

Weaker responses failed to present the correct values from the question. Candidates used the formula of kinetic energy and placed it in the formula of power, which was incorrect. Low scoring candidates were also unable to write the correct S.I. unit of power.

Example:


$P = \frac{E}{T}$

K. E = $\frac{1}{2}mv^2$ (in motion)

$P = \frac{\frac{1}{2}mv^2}{t}$

$P = \frac{\frac{1}{2} \times 1200 \times (27.5)^2}{d}$

P = 56718.75 watt.

or

P = 56718.75 Js^{-1}.

(**Note**: Majority of the candidates attempted Question **15a** and they scored well in this part. In both parts, candidates who did not score well lacked understanding of Doppler's effect.)

Question 15a
A source of sound emits a frequency of 800 Hz while moving at a speed of 120 m/s. Calculate the frequency and wavelength of sound when the source approaches a stationary observer.
(**Note**: The speed of sound in air is 340 m/s.)

Better responses correctly extracted the data (values) from the question, wrote the correct formula of frequency, $f' = \left(\frac{v}{v-u_s}\right)f$, calculated the correct answer, $f' = 1236.4\,\text{Hz}$. High scoring candidates also applied the appropriate formula of wavelength, $\lambda = \left(\frac{v-u_s}{f}\right)$ and hence calculated the correct answer, $\lambda = 0.275\,\text{m}$.

Example:

a. Data :-

frequency of sound = f = 800Hz

Speed of sound source = V_s = 120m/s

speed of sound waves in air = V = 340m/s

frequency of sound as heard by the listner = f_A = ?

i) $f_A = f\left[\frac{V}{V-V_s}\right]$

$f_A = 800\text{Hz}\left[\frac{340\text{m/s}}{340\text{m/s} - 120\text{m/s}}\right]$

$f_A = 800\text{ Hz}\left[\frac{340\text{m/s}}{220\text{m/s}}\right]$

$f_A = 800\text{Hz}\,(1.54)$

$f_A = 1236.3\text{ Hz}$

Thus $f_A > f$

ii) There will be a change in wavelength of waves equal to doppler's shift $\Delta\lambda$

$\Delta\lambda = \frac{V_s}{f} = \frac{120\text{m/s}}{800\text{Hz}} = 0.15\text{m}$

The wavelength of the sound waves orignally = λ

$\lambda = V/f = 340\text{m/s} / 800\text{Hz} = 0.425\text{m}$

The wavelength of sound as heard by the listner = λ_A

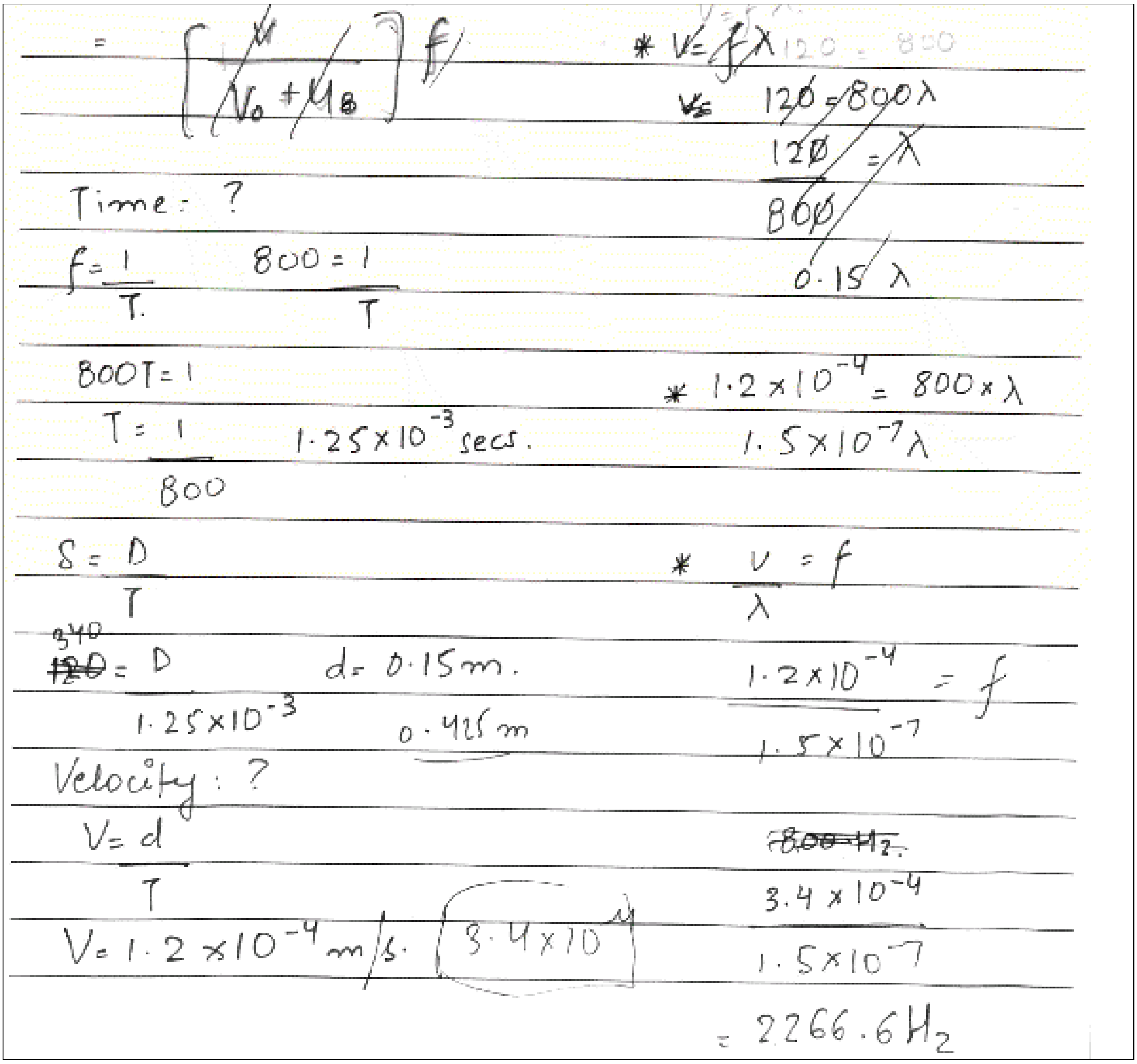
$\lambda_A = \lambda - \Delta\lambda$

$\lambda_A = 0.425\text{m} - 0.15\text{m}$

$\lambda_A = 0.275\text{m}$

Weaker responses failed to extract the correct data (values) from the question. Most candidates used incorrect formulae of $f = \frac{1}{T}$; $v = \frac{S}{t}$ and $f = \frac{v}{\lambda}$ in their calculations. It was observed during e-marking sessions that some of the candidates did not have any understanding of Doppler's effect – an important topic.

Example:



Time: ?

$f = \frac{1}{T}$ $800 = \frac{1}{T}$

$800T = 1$

$T = \frac{1}{800}$ 1.25×10^{-3} secs.

$S = \frac{D}{T}$

$\frac{340}{1.25 \times 10^{-3}} = D$ d = 0.15 m. 0.425 m

Velocity: ?

$V = \frac{d}{T}$

$V = 1.2 \times 10^{-4}$ m/s. 3.4×10^{-4}

$* \; V = f\lambda$

$120 = 800\lambda$

$\frac{120}{800} = \lambda$

$0.15\ \lambda$

$* \; 1.2 \times 10^{-4} = 800 \times \lambda$

$1.5 \times 10^{-7}\ \lambda$

$* \; \frac{v}{\lambda} = f$

$\frac{1.2 \times 10^{-4}}{1.5 \times 10^{-7}} = f$

~~800 Hz.~~

$\frac{3.4 \times 10^{-4}}{1.5 \times 10^{-7}}$

$= 2266.6\ Hz$

Question 15b:

A pod (group) of dolphins produces sound at the speed of 2050 m/s in cold water at a frequency of 100 kHz. If the pod produces sound at a frequency of 150 kHz, then calculate the velocity of the pod and the wavelength of the sound.

(**Note**: The speed of sound in air is 340 m/s).

Better responses correctly extracted the data (values) from the question, wrote the correct formula of frequency, $f' = \left(\frac{v}{v+u_s}\right) f$, calculated the correct answer, $u_s = 1025\,\text{m/s}$. High scoring candidates also applied the correct formula of wavelength, $\lambda = \left(\frac{u_s}{f}\right)$ and calculated the correct answer, $\lambda = 6.83 \times 10^{-3}$ m.

Example:

b) λ of sound = $\dfrac{\text{velocity of sound}}{\text{frequency of sound}}$

$\lambda = \dfrac{340}{150000}$ $\quad$ $150\,KHz = 150000\,Hz$

$\lambda = 0.0026\,m$ Ans

velocity of pod = $f \times \lambda$

" $= 150000 \times 0.0026$

velocity of pod = $3900\,m/s$ Ans

a) $f' = \left(\dfrac{v}{v - v_s}\right) f$, $f = 800$, $v_s = 120$, $f' = ?$, $\lambda = ?$
$v = 340$

$f' = \left(\dfrac{120}{340 - 120}\right) \times 800$

$f' = \left(\dfrac{120}{220}\right) \times 800$

$f' = (0.054) \times 800$

$f'' = 63.63\,Hz$ Ans

Weaker responses failed to extract the correct data (values) from the question. Some candidates selected wrong formula i.e., v = f λ; in their calculations. It was observed during e-marking sessions that some of the candidates did not have any understanding of Doppler's effect – an important topic.

Example:

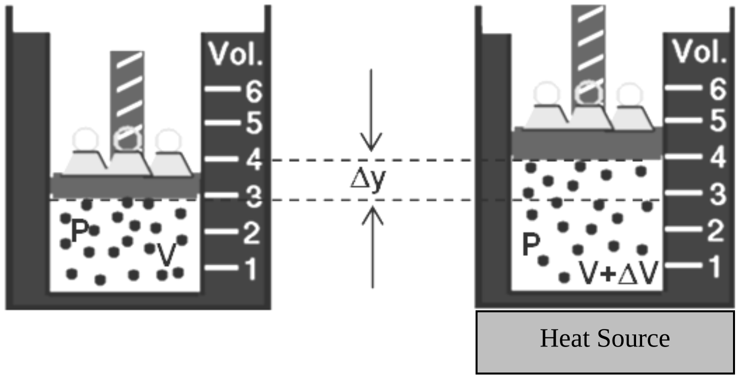
Speed of sound = 2050 v = f λ
frequency = 100 x 10³ Hz 2050 = 100x10³ x λ
λ = 0.0205 λ = 0.0205
If
frequency = 150 x 10³ Hz
v = ?
λ = ?
v is not changing so v = 2050

v = f λ
2050 = 150 x 10³ x λ
2050 / 150 x 10³ = λ
0.0136 = λ
1.36 x 10⁻² = λ

Majority of the candidates attempted Question **16b** and they scored well in this part.

Question 16a:

The given diagram shows the change in volume of a gas which is enclosed in a vessel, before and after the provision of heat.



Initial Volume (dm^3) Final Volume (dm^3)

Derive an expression for the work done by the gas in terms of its pressure and volume.

Few candidates chose to attempt Question 16a and they found this question challenging.

Better responses correctly derived the expression for the work done by the gas in terms of its pressure and volume. High scoring candidates started their derivation from the basic formula of work done W = F . d and W = F Δy and then applied the formula of power, $P = \frac{F}{A}$ and volume, A Δy = ΔV . The final expression of work done, W = P ΔV was also written correctly.

Example:

a) According to First Law of thermo dynamics change in heat is equal to work done by the system plus internal energy. Given by:

$$\Delta Q = \Delta W + \Delta U \longrightarrow (1)$$

$$W = F \cdot d. \qquad F = PA \qquad d = \Delta y$$

$$W = PA\,\Delta y.$$

Then = $\Delta Q = \Delta U + P A \Delta y.$

As $A \Delta y = \Delta V$ (volume).

$$\Delta Q = \Delta U + P \Delta V \longrightarrow (2)$$

Hence work done by gas in terms of pressure and volume is:

$$W = P \Delta V. \longrightarrow (3)$$

When the gases are at constant temperature means $\Delta Q = 0$. then $\Delta U = -P\Delta V$

And volume increases with increase in temperature.

Work done on the constant Pressure:

$$W = P\Delta V$$

Work done on the constant volume, means there is no increase in volume then,

$$W = 0$$

Means work done on constant pressure is greater than work done on constant volume.

Weaker responses wrote about the processes of isobaric, isochoric, adiabatic and isothermal. Low scoring candidates also wrote the first law of thermodynamics, $\Delta Q = \Delta U + W$ which was not the demand of the question. By looking through this method of derivation, it was noted that candidates mixed-up two different processes of thermodynamics and hence lost marks.

Example:

This is an isobaric process in which pressure is constant and so piston is movable. From 1st law of thermodynamics:

$$\Delta Q = \Delta U + W \rightarrow (1)$$

where Q = heat ; U = internal energy of the system; and W = work done by the system in moving the piston. So: $W = P\Delta V$

putting the value of W in eq(1)

$$\boxed{\Delta Q = \Delta U + P\Delta V}$$

Hence heat given to a system results in increase in its internal energy and work done by the system in moving piston to change the volume from V to ΔV.

So Work dome = $\boxed{\Delta Q - \Delta U = P\Delta V}$

The work done by the system in moving the piston is equal to the heat energy gained by the system minus the change in internal energy due to it.

Question 16b:

Outline any FIVE environmental crises as entropy crises.

Better responses correctly outlined five environmental crises as entropy crises, e.g. the environmental crisis is the disorder crisis resulting from our useless efforts to ignore the second law of thermodynamics; an increase in the order in a system will produce an even greater increase in entropy or disorder in the environment; an impact of large number of all individuals' disorder producing activities can affect the overall life support system; increase in thermal pollution of the environment means increase in the entropy, cause serious disruption of the overall ecological balance; small temperature changes in the environment can have significant effects on metabolic rates in plants and animals. The aforementioned constitutes some common high scoring answers.

Example:

FIVE ENVIROMENTAL CRISES AS ENTROPY CRISES:-

1. Due to Even small amount of change of Entropy, the metabolic rate of plant and animals gets disturb, eventually causing threat to living species.
2. Due to Entropy Crises, the temperature of our enviroment is increasing day by day, exposing us to many hazardous skin dieseases.
3. Entropy Crises is also involved in global warming of our Earth, increasing its temperature day by day.
4. Due to Entropy Crises, Glaciers are melting as a result of which water level is raising due to which many lands and islands have vanished.
5. Entropy Crises has caused great problems in crop cultivation, many plants can't grow in changed harsh conditions.
6. Due to entropy crises, air pollution is increasing day by day and is becoming threat to Man kind.

Weaker responses failed to write all five points on the environmental crises. Some of the low scoring candidates only wrote the definition of entropy. At times, candidates wrote only one or two valid points on environmental crises.

Example:

Entropy:

it defined as the value of the internal energy is equals to the external energy. the pressure which is exerted on a body /container is same in internal side and external side.