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Provincial Department of Education - NWP

01 | E | I

Second Term Test - Grade 12 - 2020

Index No. ....

Physics I

2 hours

- **This paper consists of 50 questions and Answer all the questions.**
- **Use of calculator is not allowed.**
- **Write your index number in the space provided in the answer sheet.**
- **In each of the questions 1 to 50 pick one of the alternatives from (1),(2),(3),(4),(5) which is correct or most appropriate and mark your response on the answer sheet with a cross (x) in the answer sheet.**

1. In the relation $F = \frac{kmv^2}{r}$ *F* represents force, *m* represents mass and *v* represents velocity, the dimensions of *k* is

(1) LT^{-1} (2) ML^2T^{-2} (3) ML^2T^{-4} (4) L^2T^{-4} (5) no dimensions.

2. An object of mass *m* starts from rest and travels for a given time under the action of a constant force. The speed which it acquires is

(1) proportional to *m*. (2) Proportional to $\frac{1}{m}$ (3) proportional to $\sqrt{m}$

(4) Proportional to $\frac{1}{\sqrt{m}}$ (5) independent of *m*

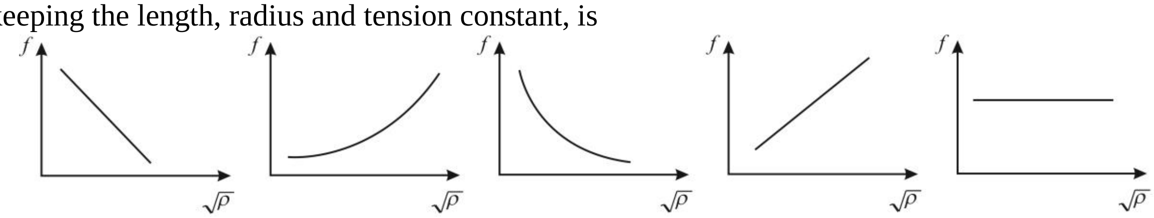
3. Speed of the transverse wave of frequency 60 Hz travelling along a stretched string is 90 m s^{-1}. The phase difference of two particles which are 75 cm apart will be

(1) 2π (2) $\frac{3\pi}{2}$ (3) π (4) $\frac{2\pi}{3}$ (5) $\frac{\pi}{2}$

4. During a short interval of time the speed *v* in m s^{-1} of an automobile is given by $v = at^2 + bt^3$, where the time *t* is in seconds. The units of *a* and *b* are respectively:

(1) m s^{-3}; m s^4 (2) m s^{-3}; m s^{-4} (3) m s^{-4}; m s^{-3} (4) m s^3; m s^4 (5) m s^{-4}; m s^{-3}

5. The correct graph between the fundamental frequency f and square root of density $\sqrt{\rho}$ of a wire, keeping the length, radius and tension constant, is



(1) (2) (3) (4) (5)

6. Which of the following waves cannot be polarized?

(A) Transverse waves on a Slinkey (B) Light rays

(C) Transverse waves on water surface. (D) Sound propagating through water

(1) Only (A) (2) Only (B) (3) Only (C) (4) Only (D) (5) Only (C) and (D)

7. Which of the following has the shortest wave length?

(1) visible light (2) radio waves (3) x- rays (4) microwaves (5) ultraviolet

8. A circular container of diameter 40 cm is filled with water. By tapping the edge, a circular wave front is formed on water. It s speed of propagation is 25 cm s^{-1}. Which of the following correctly state the radius and the direction of propagation of the wave front after 1 s?

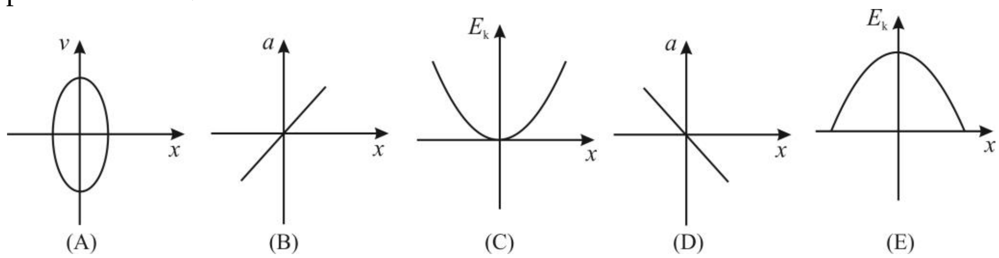
(1) 25 cm, towards the center (2) 5cm, towards the center (3) 15cm, away from the center

(4) 5cm, away from the center (5)15 cm, towards the center

9. What is the speed of transverse waves propagating along a brass wire with a radius of 0.500 mm stretched with a tension of 200 N? The density of brass is 7.70×10^3 kg m^{-3}.

(1) 0.152 m s^{-1} (2) 43 m s^{-1} (3) 270 m s^{-1} (4) 400 m s^{-1} (5) 182 m s^{-1}

10. Some of the graphs in Figure refer to simple harmonic motion, where v is the velocity, a is the acceleration, E_k is the kinetic energy and x is the displacement from the mean (zero) position. Which graphs are correct?



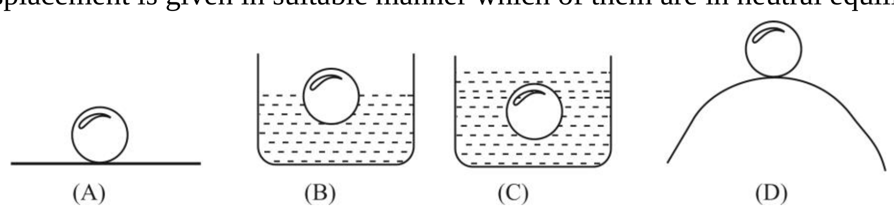
(1) only (B) and (E) (2) only (D) and (C) (3) only (A), (D) and (E)

(4) only (A), (C) and (D) (5) only (A), (B) and (E)

11. If equal masses of two liquids of densities d_1 and d_2 are mixed together, the density of the mixture is,

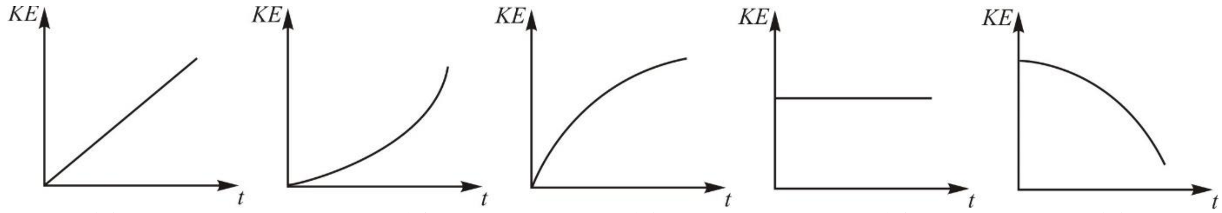
(1) $\frac{d_1 d_2}{d_1 + d_2}$ (2) $\frac{d_1 + d_2}{2}$ (3) $\frac{d_1 d_2}{2(d_1 + d_2)}$ (4) $\frac{d_1 - d_2}{d_1 + d_2}$ (5) $\frac{2d_1 d_2}{d_1 + d_2}$

12. Three different spheres are shown in the following figure. All of them are in equilibrium. In (B), it floats and in (C) it is fully immersed in two different liquids. Surfaces of (A) and (D) are rigid. If a small displacement is given in suitable manner which of them are in neutral equilibrium?



(1)only (B) (2) only (C) (3) only (D) (4) only (A) and (C) (5) only (A) and (B)

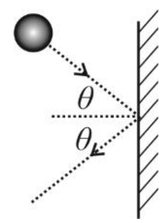
13. An object starts from rest and moves with a constant acceleration. Which of the following graphs best represents the variation of its kinetic energy KE with time t?



14. Water is flowing through a tube of non-uniform cross-section. If the radii of the tube at the entrance and the exit are in the ratio 3 : 2, then the ratio of the velocities of flow of water at the entrance and the exit is,

(1) 4 : 9 (2) 9 : 4 (3) 3 : 2 (4) 8 : 27 (5) 27 : 8

15. A particle of mass m travelling with a velocity u collide θ inclined to a wall and re-bounce with same speed. If the motion take place on a vertical plane and the collision lasts for δt time, the horizontal average force (direction and magnitude) on the wall is,



(1) $\rightarrow \frac{mu\cos\theta}{\delta t}$ (2) $\rightarrow \frac{2mu\cos\theta}{\delta t}$ (3) $\leftarrow \frac{mu\cos\theta}{\delta t}$

(4) $\leftarrow \frac{2mu\cos\theta}{\delta t}$ (5) $\downarrow \frac{2mu\cos\theta}{\delta t}$

16. Consider the following statements made on pressure

(A) Pressure is a vector.

(B) It acts always perpendicular to the surface.

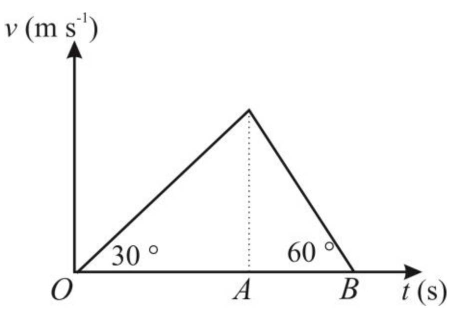
(C) Pressure on the bottom of a water tank is independent of surface area of the bottom.

Of the above statements,

(1) Only (C) is true. (2) Only (B) is true. (3) Only (A) and (B) are true.

(4) Only (B) and (C) are true. (5) All (A), (B) and (C) are true.

17. The velocity-time graph of an object moving on a straight line is given in the following figure. Its displacement during OA and AB intervals are S_1 and S_2 respectively. Then the ratio $\frac{S_1}{S_2}$ is



(1) $\frac{1}{3}$ (2) $\frac{1}{2}$ (3) 1

(4) 2 (5) 3

18. Harry Potter is sitting 2.0 meters from the center of a merry-go-round when Draco Malfoy casts a spell that glues Harry in place and then makes the merry-go-round start spinning on its axis. Harry has a mass of 50.0 kg and can withstand 5g of acceleration before getting unconscious. What is the magnitude of Harry's angular momentum when he get unconscious?

(1) 200 kg m^2 s^{-1} (2) 330 kg m^2 s^{-1} (3) 660 kg m^2 s^{-1}

(4) 1000 kg m^2 s^{-1} (5) 1200 kg m^2 s^{-1}

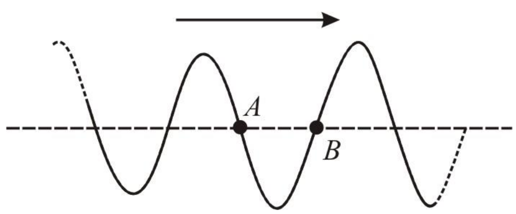
19. 

The figure shows a wave on a water surface at time t = 0. There is a small object floating on the surface. The path of its motion during a single period T is best represented by

 (1)
 (2)
 (3)
 (4)
 (5)

20. When a sound wave of frequency 300 Hz passes through a medium, the maximum displacement of a particle of the medium is 0.1 cm. The maximum velocity of particle is equal to
(1) 6π cm s^{-1} (2) 30π cm s^{-1} (3) 60π cm s^{-1} (4) 60 cm s^{-1} (5) 30 cm s^{-1}

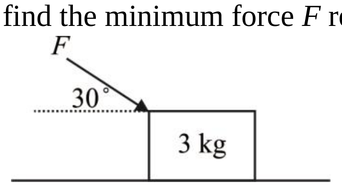
21. Figure shows the instantaneous position of a transverse wave travelling to the right on a water surface. *A* and *B* are two small floating objects. As the wave travels away from this position to the right



(1) both *A* and *B* begin to move to the right.
(2) both *A* and *B* begin to move to the left.
(3) both *A* and *B* begin to move downwards.
(4) *A* begins to move upwards and *B* begins to move downwards.
(5) *A* begins to move downwards and *B* begins to move upwards

22. A particle is executing S.H.M. What fraction of its energy is kinetic when the displacement is half the amplitude?
(1) $\frac{1}{2}$ (2) $\frac{1}{3}$ (3) $\frac{2}{3}$ (4) $\frac{3}{4}$ (5) $\frac{1}{4}$

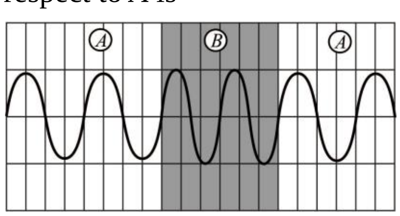
23. An object on a rough surface is given a force F as shown in the figure. If the coefficient of friction is 0.2 find the minimum force F required to push the object on the floor. (take $\sqrt{3} = 1.7$)



(1) 2 N (2) 4 N (3) 6 N (4) 8 N (5) 10 N

24. A U-tube is partially filled with water. Oil, which does not mix with water, is next poured into one side until water rises on the other side by 25 cm with respect to initial level of water. If the relative density of oil is 0.8, the oil level will stand higher than the water level by
(1) 5 cm (2) 10 cm (3) 15 cm (4) 20 cm (5) 25 cm

25. The figure shows how a wave passes through a medium *B*. The refractive index of the medium *B* with respect to *A* is



(1) 0.75 (2) 1.25 (3)1.33
(4) 1.55 (5) 1.75

26. An open resonance tube and one end closed tube resonate in the same frequency at first over tone. The ratio of their length is
(1) 1 : 2 (2) 2 : 1 (3) 2 : 3 (4) 4 : 3 (5) 3 : 2

27. Consider the following statements made about a standing wave in a medium.
(A) The displacement of the particles at the antinode is greater than the displacement at any other point.
(B) The velocity of the particles at the antinode is greater than the velocity at any other point.
(C) At any instant all the particles between any two consecutive nodes move in the same direction.
Of the above statements,
(1) only (A) is true. (2) only (A) and (B) are true. (3) only (B) and (C) are true.
(4) only (A) and (C) are true. (5) all (A), (B) and (C) are true.

28. The height *y* and the horizontal distance *x* of a projectile on a certain planet is given by $y = 8t - 5t^2$ and $x = 6t$ meters when *t* is in seconds. The velocity of projection is
(1) 6 m s^{-1} (2) 8 m s^{-1} (3) 7 m s^{-1} (4) 10 m s^{-1} (5) given data is not enough

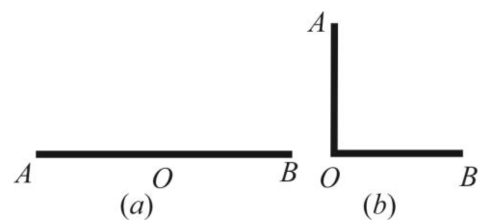
29. A string of length 2*l*, obeying Hooke's law, is stretched so that its extension is *l*. The speed of transverse waves in the string is *v*. If the string is further stretched so that the extension becomes 4*l*, the speed of transverse waves in the string will be (assume that the cross sectional area remain unchaged)
(1) $2\sqrt{2}\,v$ (2) $2\,v$ (3) $\frac{v}{\sqrt{2}}$ (4) $\sqrt{2}\,v$ (5) $\frac{v}{2}$

30. The temperature at which the speed of sound in air becomes double its value at 27 °C is
(1) 654 °C (2) 1200 °C (3) -123 °C (4) 327 °C (5) 927 °C

31. A rope is used to lower a block of mass *M* vertically, through a distance *d* at a constant downward acceleration of $g/4$. Then the work done **by the cord on the block** is
(1) Mgd (2) $\frac{Mgd}{4}$ (3) $-\frac{Mgd}{4}$ (4) $\frac{3Mgd}{4}$ (5) $-\frac{3Mgd}{4}$

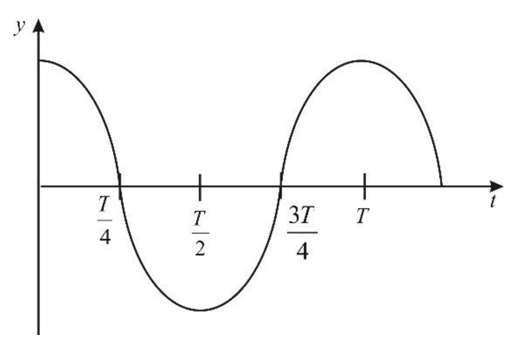
32. The density of aluminum is 2.7×10^3 kg m^{-3}. The speed of longitudinal waves in an aluminum rod is measured to be 5.1×10^3 m s^{-1}. What is the value of Young's modulus for aluminum?
(1)7.0×10^{10} N m^{-2} (2) 7.0×10^7 N m^{-2} (3) 2.2×10^{11} N m^{-2}
(4) 2.2×10^9 N m^{-2} (5) 1.4×10^7 N m^{-2}

33. *AOB* shown in the figure (*a*) is a uniform rod of length 2*l*. *O* is the center of gravity of the rod. Now it is bent from *O* as shown in the figure (*b*). If *O* is considered as the origin of co-ordinate axes, the new co-ordinates of the center of gravity of the bent rod in figure (*b*) is



(1) 0, 0 (2) 2*l* , 2*l* (3) 1.5*l* , 1.5*l* (4) *l* , *l* (5) 0.5*l* , 0.5*l*

34. The displacement-time graph of a particle executing simple harmonic motion is shown in the figure.
Which of the following statement(s) is/are true?
(a) The acceleration is maximum at $t = T$.
(b) force on the particle is zero at $t = \frac{3T}{4}$
(c) The potential energy equals the total energy at $t = \frac{T}{2}$



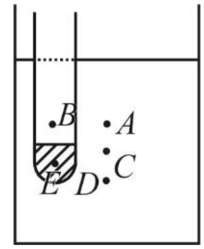
(1) only (a) is true (2) only (c) is true (3) only (a) and (b) are true
(4) only (a) and (c) are true (5) all (a), (b) and (c) are true

35. A uniform wooden plank of mass 200 kg and length 5 m is floating on still water with a man of 50 kg at one end of it. The man walks to the other end of the plank and stops. The distance moved by the man relative to water is

(1) 2.5 m (2) 4 m (3) 5 m (4) 7.5 m (5) zero

36. Weighted test tube floats on a container of water as shown in the figure. If the weight of the container is negligible, the center of gravity of the system can be at,

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



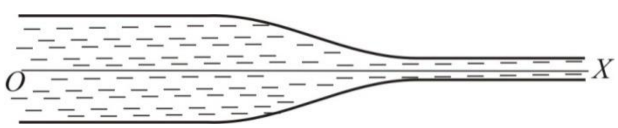
37. A wave on ripple tank enters from deep region to shallow region, then

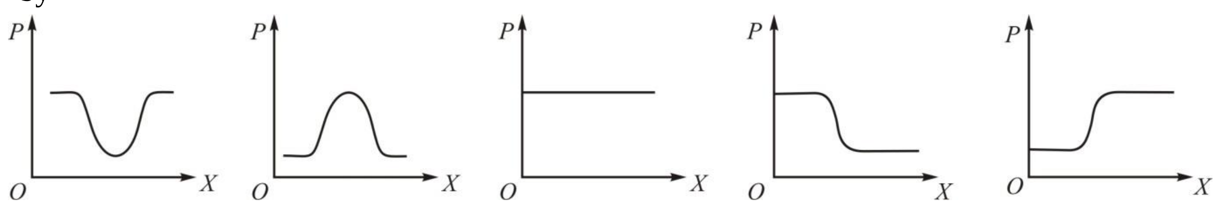
(A) Its wave length is decreased.
(B) Its frequency is increased.
(C) its velocity is decreased.

Of the above statements

(1) Only (A) is true. (2) Only (B) is true. (3) Only (C) is true.
(4) Only (A) and (B) are true. (5) Only (A) and (C) are true.

38. A non viscous and incompressible fluid flows through a tube in which the cross-section is varying as shown in the figure. The variation of pressure *P* along the axis, *OX*, is best represented by





(1) (2) (3) (4) (5)

39. Two sound waves, each of amplitude *A* and frequency *f*, superimpose at a point a phase difference $\pi/2$. The amplitude and the frequency of the resultant wave are, respectively,

(1) $\frac{A}{\sqrt{2}}, \frac{f}{\sqrt{2}}$ (2) $\sqrt{2}A, f$ (3) $\sqrt{2}A, \frac{f}{\sqrt{2}}$ (4) $\sqrt{2}A, \frac{f}{2}$ (5) $\frac{A}{\sqrt{2}}, f$

40. A car is negotiating a circular turn of radius *r* on a level road. The distance between the left and the right wheel is 2*a*. The height of the centre of gravity of the car above the road is *h*. The maximum speed of the car to avoid overturning is

(1) $\sqrt{\frac{gr^2a}{h}}$ (2) $\sqrt{\frac{ghr}{a}}$ (3) $\sqrt{\frac{gha}{r}}$ (4) $\sqrt{\frac{gra}{h}}$ (5) $\sqrt{\frac{gra^2}{h}}$

41. A body of mass 3 kg, moving with a speed of 4 m s^{-1}, collides head-on with a stationary body of mass 2 kg. Their relative velocity of separation after the collision is 2 m s^{-1}. Then

(A) The impulse of the collision is 7.2 N s
(B) The loss of kinetic energy due to collision is 7.2 J
(C) collision must be elastic.

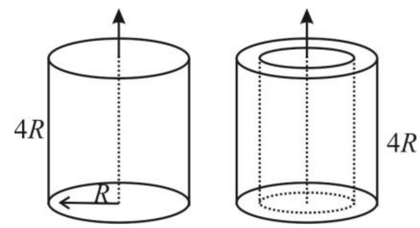
Of these statements

(1) Only (A) is true. (2) Only (B) is true. (3) Only (A) and (B) are true.
(4) Only (A) and (C) are true. (5) all (A), (B) and (C) are true.

42. A particle at rest starts moving in a straight line with a uniform acceleration. The ratio of the distances covered during the fourth and the third second is

(1) $\frac{4}{3}$ (2) $\frac{7}{5}$ (3) $\frac{9}{7}$ (4) 2 (5) $\frac{11}{7}$

43. Moment of inertia of a uniform solid cylinder of radius R and height $4R$ is I. Then, solid cylinder of radius $\frac{R}{2}$ is removed from this symmetrically so that it results a container of wall thickness $\frac{R}{2}$ as shown in the figure. The moment of inertia of the container is

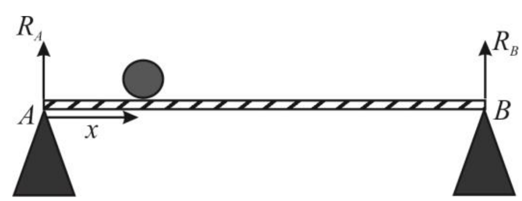


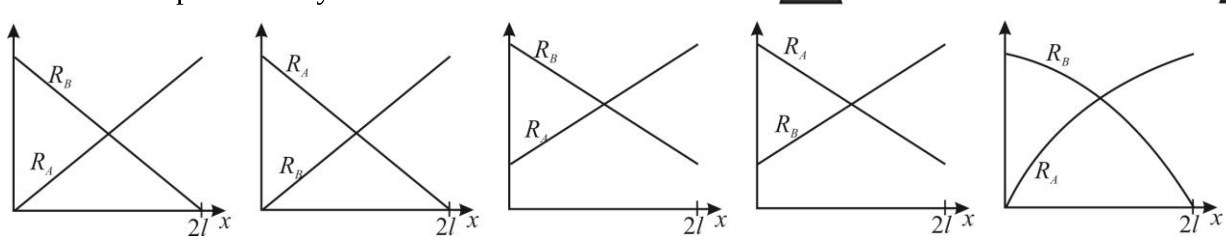
(1) $\frac{1}{16}I$ (2) $\frac{15}{16}I$ (3) $\frac{9}{16}I$ (4) $\frac{121}{128}I$ (5) $\frac{249}{256}I$

44. The period of a particle in simple harmonic motion is 8 s. At $t = 0$ it is at the mean position. Consider the following statements.
(A) The particle will travel equal distances during the first 4 s and the next 4 s.
(B) The particle will travel equal distances during the first 2 s and the next 2 s.
(C) The particle will travel equal distances during the first second and the next second.
of these statements
(1) Only (A) is true. (2) Only (C) is true. (3) Only (A) and (C) are true.
(4) Only (A) and (B) are true. (5) all (A) , (B) and (C) are true.

45. 26 tuning forks are arranged in order of increasing frequency. Any two successive forks produce 4 beats s^{-1} when sounded together. If the frequency of last for is three times the initial, the frequency of the first fork is,
(1) 25 Hz (2) 50 Hz (3) 75 Hz (4) 100 Hz (5) 150 Hz

46. A uniform heavy horizontal rod of length $2l$ is at equilibrium on two supports as shown in the figure. A sphere is then slowly rolling from A to B. If x is the distance measured from A to the sphere, the variation of reactions at two supports R_A and is best represented by





(1) (2) (3) (4) (5)

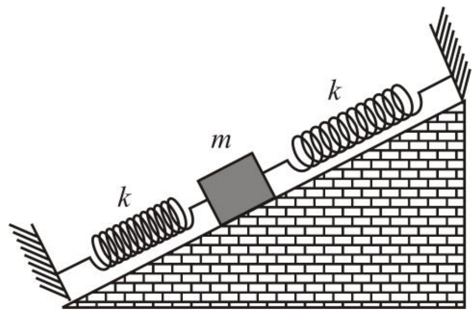
47. A ball projected 45 above the horizontal on a horizontal ground, just clears a wall at 2 m from the projection. The ball falls on the ground 4 m from the wall. The height of the wall can be,

(1) 2m (2) 3 m (3) 4 m (4) $\frac{4}{3}$ m (5) $\frac{3}{4}$ m

48. A hydrometer has a uniform stem calibrated uniformly downwards from 0, 1, 2, ... up to 10. When floating in pure water it reads 0 and in a liquid of relative density 1.5 it reads 10. The relative density of a liquid in which it reads 5 is

(1) 1.1 (2) 1.15 (3) 1.2 (4) 1.25 (5) 1.3

49. On a smooth inclined plane of inclination θ, a body of mass m is attached between two identical, light springs. The other ends of the springs are fixed to firm supports. If the force constant of each spring is k, the time period of oscillation of the body is



(1) $2\pi\sqrt{(2m/k)}$ (2) $2\pi\sqrt{\frac{m}{2k}}$

(3) $2\pi\sqrt{(mg/2k)}$ (4) $2\pi\sqrt{\frac{mg\sin\theta}{2k}}$

(5) $2\pi\sqrt{\frac{mg}{2k}}$

50. The speeds of an object in simple harmonic motion when the displacements from the center are x_1 and x_2 are $v_1$and v_2 respectively. The period of oscillation of the object will be,

(1) $2\pi\sqrt{\frac{x_1^2+x_2^2}{v_1^2+v_2^2}}$ (2) $2\pi\sqrt{\frac{v_1^2+v_2^2}{x_1^2+x_2^2}}$ (3) $2\pi\sqrt{\frac{v_2^2-v_1^2}{x_2^2-x_1^2}}$ (4) $2\pi\sqrt{\frac{x_1^2-x_2^2}{v_2^2-v_1^2}}$ (5) $2\pi\sqrt{\frac{x_1^2-x_2^2}{v_2^2+v_1^2}}$

වයඹ පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව

Provincial Department of Education - NWP

01 | E | II

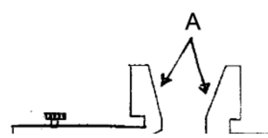
Second Term Test - Grade 12 - 2020

Index No. .... Physics II 3 hours

- This paper consists of two parts A and B allowed time for both parts is 3 (three) hours.
- Answer all the questions of **part A** on this paper itself. You must use th given space to answer. No lengthy answers are expected.
- **Part B** consists of 6 questions. Answer only four of them. After the exam, attach part A and part B and hand over to the staff.
- Use of calculators is not allowed.

Part - A (Structured Essay)

01. A Vernier caliper is used by a student to determine the volume of material of a uniform cylindrical solid object having two cylindrical cavities with internal diameters D_2 and D_3.



i) Name the parts of the Vernier caliper labelled as A,B,C,D and E in the above figure.

A - .... D - ....

B - .... E - ....

C - ....

ii) The figure below shows a situation in which the Vernier caliper used by the student is adjusted to determine the zero error.

a) How would you check whether there is a zero error in the Vernier caliper?

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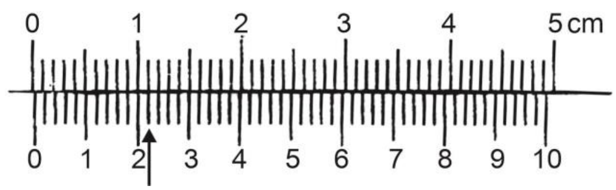
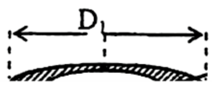


b) 1) What is the least count of the above Vernier caliper in cm?

....

2) What is the magnitude of the zero error in cm?

....

c) 

Write down the suitable parts of the Vernier caliper for the measurements of D_1, D_2, D_3, h_1 and h_2.

D_1 ....

D_2 ....

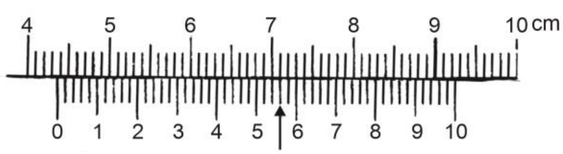
D_3 ....

h_1 ....

h_2 ....

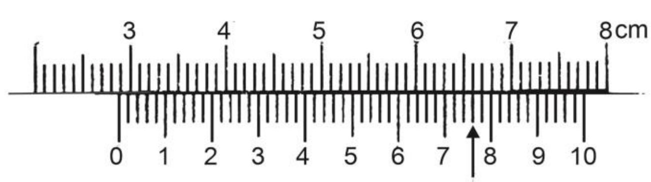
d) The figures below show the positions of the main and the vernier scales when taking the measurements of D_1 and D_2

1)



What is the magnitude of D_1 ? ....

2)



What is the magnitude of D_2 ?..

e) 1) If the above solid object is drawn according to a scale, which measurement has the minimum fractional error?

....

2) Give the reason for your answer.

....

....

f) Write down an expression for the volume V of the material of the object using the given symbols.

....

....

....

g) Explain why the internal diameter (about 3cm) of a rubber tube cannot be measured using a Vernier caliper.

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02. You are asked to determine the mass (M) of a uniform glass cube of side $3\ cm$ by performing the experiment which uses the principle of moments. You are provided with only the following items to carry out the experiment.

- A weight of mass $m(= 100g)$
- A meter ruler
- A knife edge and a suitable wooden block
- Pieces of thread

i) State the principle of moments.

....

....

....

ii) What is the purpose of balancing the meter ruler on the knife edge without masses?

....

....

iii) Draw a diagram of the arranged experimental set up on the space given below for the balanced situation just before you take a reading. Label the items. Take the balanced lengths from the knife edge to M and m as ℓ_1 and ℓ_2 respectively.

iv) Write down the relation among ℓ_1, ℓ_2, m and M when the system is balanced.

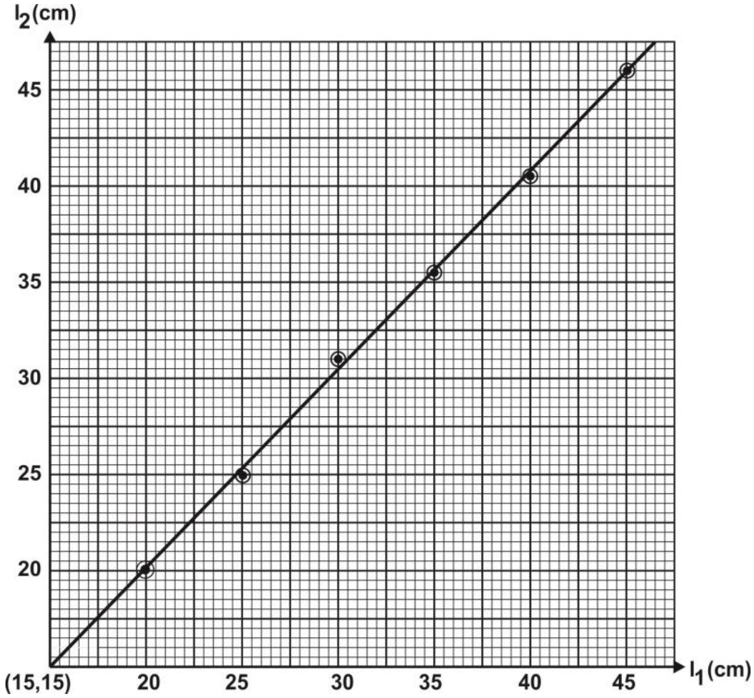
....

v) What is the reason of not taking readings for small values of ℓ_1 and ℓ_2 ?

....

....

vi) Suppose you have plotted a graph as shown below to find the mass M



a) By selecting the two most suitable points on the graph, calculate the gradient of the graph. The two points selected should be clearly marked on the graph using arrows.

....

....

....

vii) Calculate the mass M of the glass cube.

....

....

....

viii) A meter ruler with the centre of gravity at $52\ cm$ mark is balanced on a knife edge using the weight (m) and the glass cube (M) to find the mass m_0 of the meter ruler.

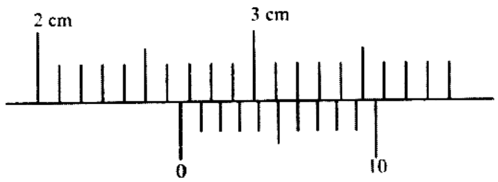
a) Draw a suitable diagram of an experimental set up that could be used for this situation in the space given below. Take the balanced lengths from the knife edge to the masses M and m as y and x respectively.

b) Write down an expression using the given symbols when the system is balanced.

....

....

ix) The figure below shows the positions of the main scale and the Vernier scale when taking the side length of the glass cube using a Vernier caliper.



a) What is the side length of the glass cube in cm?

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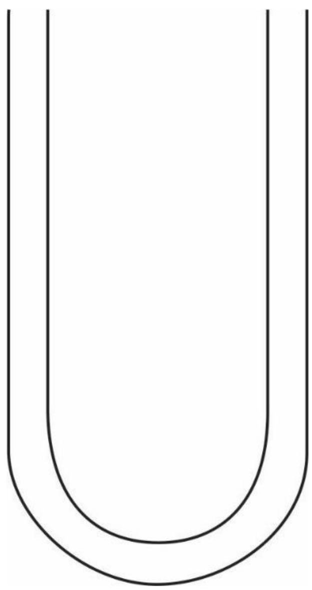
b) Substitute the values obtained to find the density of the glass cube in $kg\ m^{-3}$

....

....

03.



You are provided with a U tube, water and coconut oil to determine the relative density of coconut oil. The figure shows the U tube attached to the stand.

i) Mark the liquid levels in the given figure when they are at equilibrium. Label liquids and the common interface.

ii) If you are provided with two millimeter scales, show how you place it to measure the heights of liquid columns in the above figure.

iii) What are the readings you take to measure the height of a liquid column?

....

....

iv) a) Density of water and coconut oil are ρ_w and ρ_l respectively. Derive the relationship between heights of liquid columns. Take height of water column as h_w and that of coconut oil column as h_l. (If you use any other symbol other than g it must be introduced properly.)

....

....

b) Rearrange the above relation to plot a graph.

....

....

v) a) When you fill the U tube **at the beginning,** which liquid do you insert first? Liquid with higher density or with low density.

....

b) If you are given small amounts of unknown immiscible liquids to compare densities, how do you identify the liquid that should be inserted first to the U – tube. Assume you have permission to use usual laboratory apparatus but no any measuring instruments.)

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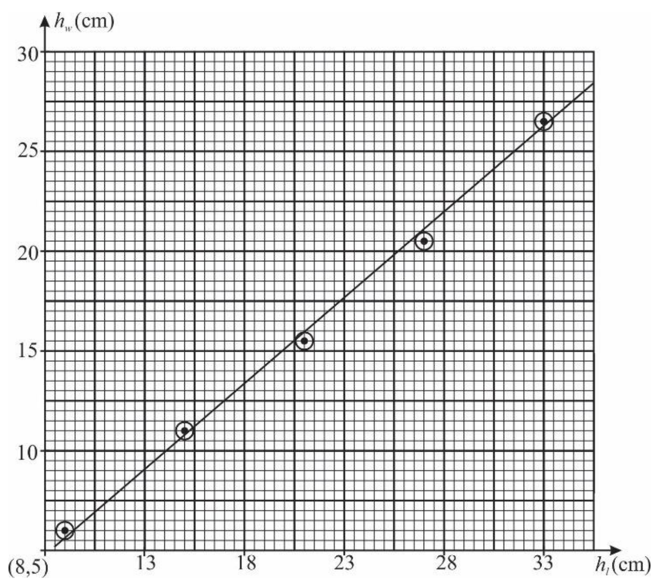
vi) The graph obtained in this experiment is shown below.



a) Write down the coordinates of two points of the graph that you can use to determine the gradient of the graph.

....

b) Determine the gradient of the graph.

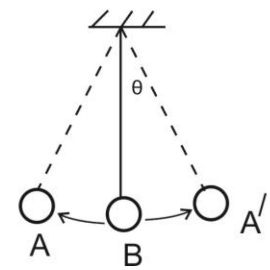
....

....

c) Calculate the relative density of coconut oil.

....

04. A student plans to find the acceleration due to gravity in the laboratory using a simple pendulum.



i) What are the other measuring instruments you need to perform this experiment?

....

....

ii) a) Write down an expression for the period of oscillations (T) of the simple pendulum in terms of the length (L) of the pendulum and the acceleration due to gravity (g).

....

b) Rearrange the above expression in the most suitable manner in order to obtain a value for g by plotting a graph.

....

....

iii) a) When taking readings for (T) a reference pin is used. To which point on the path of the pendulum should the reference pin be directed? ^A or B&

....

b) What is the reason of selecting the above point?

....

....

iv) a) In this experiment, small oscillations are given for the pendulum? Give the reason.

....

....

b) Give a suitable value for the angle of oscillation.

....

v) a) Instead of measuring the time for one oscillation, the student measured the time for 25 oscillations. Give the reason for this.

....

....

b) In the laboratory experiment to find the value of g, using the simple pendulum you are provided with a stop watch which can measure the time with an accuracy of $0.5s$. If the estimated value of the period T is $2\ s$, determine the minimum number of oscillations you should take to reduce the percentage error of T down to 1%.

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....

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vi) a) How would you start the counting of oscillations?

....

....

....

....

b) What type of error can be reduced from the above step?

....

vii) a) The period of oscillation obtained when the string used for this experiment is light is T_1 and it is T_2 when the string is not light. Are these two values same. ?

....

b) Explain your answer.

....

....

(viii) a) The student used a uniform metal sphere of radius R as the pendulum bob. The length of the string he used to suspend the pendulum bob is L and acceleration due to gravity is g. Write down an expression for the period of oscillation T in terms of L, g, R

....

....

b) After plotting the T^2 versus L graph he found that the gradient was $4\ s^2m^{-1}$ and the intercept was $0.025\ s^2$

i) Determine g.

....

....

....

ii) Determine the radius R of the sphere.

....

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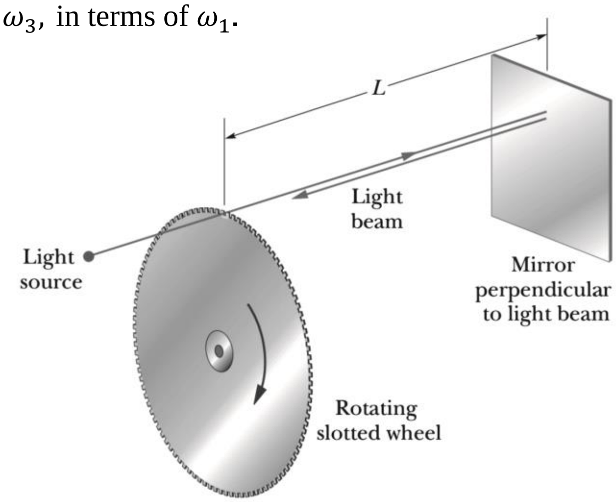
SecondTerm Test - 2020
Physics Part II - Grade 12
Part B (Essay)

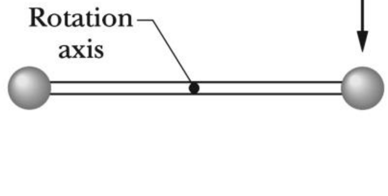
- **Answer four questions only.**

05. a) A cyclist moves along a horizontal circular track of circumference $88\ m$ with a constant speed. He takes $10\ s$ to complete one round.
   i) Find the angular velocity ω for the motion.
   ii) Find the tangential speed V .
   iii) If the circumference of a circle $(C) = 2\pi r,$ find radius of it.
   iv) Calculate the centripetal acceleration a_r
   v) Calculate the centripetal force, F if the mass of the rider and the bicycle is $70kg$.

b) Figure shows an early method of measuring the speed of light that makes use of a rotating slotted wheel. A beam of light passes through one of the slots at the outside edge of the wheel, travels to a distant mirror, and returns to the wheel just in time to pass through the next slot in the wheel. One such slotted wheel has 428 slots around its edge. Measurements taken when the mirror is $L = 500m$ from the wheel indicate a speed of light of $2.996x10^8\ ms^{-1}$.
   i) Write down an expression for the angular velocity (ω_1) of the wheel substituting the values.
   ii) When $L = 750\ m,$ the angular velocity of the wheel is ω_2 . Express ω_2 in terms of ω_1.
   iii) If the above beam of light travelled to the mirror returns to the wheel just in time to pass through the alternate slots in the wheel when $L = 750\ m$, Express the new angular velocity of the wheel $\omega_3,$ in terms of ω_1.



06. a) i) What are the dimensions of angular momentum?
   ii) State the principle of conservation of angular momentum.
   iii) Two $2\ kg$ balls are attached to the ends of a thin rod of length $1\ m$ and negligible mass. The rod is free to rotate in a vertical plane without friction about a horizontal axis through its center.
   Calculate the moment of inertia of the system.



iv) With the rod initially horizontal, a $50g$ wad of wet putty drops vertically on to one of the balls, hitting it with a speed of $9\ ms^{-1}$ and then sticking to it.

Show that the increase in moment of inertia of the system after sticking the wad of putty is about $\frac{1}{80}$.

v) What is the initial angular velocity (ω_0) of the system just after the putty wad hits?

vi) Find the initial kinetic energy of the system.

vii) Through what angle will the system rotate before it momentarily stops?

viii) The rod with a wad of putty of mass more than $50g$ stuck to one of the balls attached to the ends of the rod continuously rotates to one direction.

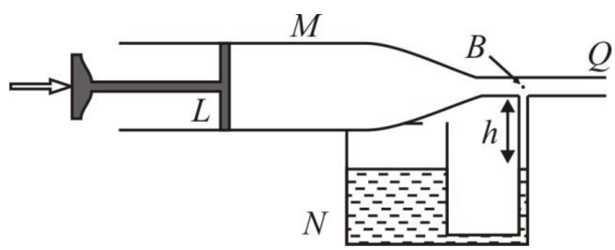
Draw a $\omega - t$ graph (angular velocity – time) for the rotation.

07. i) Write down the Bernoulli's principle as a mathematical expression. Identify each term of this relation

ii) Show that the relation is dimensionally correct and each term has the dimensions of energy per unit volume.

iii) State the conditions under which this relation is valid.

iv) Figure shows a household liquid sprayer. *N* is the tank where the liquid is kept. *L* is the hand operated piston. *M* is the pump through which the air can be pushed forward. The cross sectional area of M is *A* and that of the outlet tube *Q* is *a*. Assume that air behaves according to all the conditions that you have mentioned under (iii).



Consider a situation where *L* is pushed forward with a uniform speed *v*.

a) Obtain an expression for the speed of air in the outlet tube *Q*.

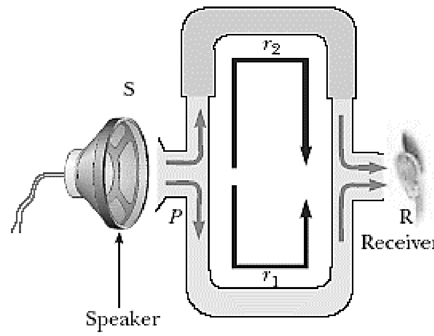
b) Get an expression for the pressure difference between air in the pump and point *B* which is in the outlet tube. Consider the density of air as *d*.

c) Get an expression for the minimum speed of the piston to lift the liquid up to *B*. Assume that the pressure in the barrel *M* is same as the atmospheric pressure. Consider the density of liquid as ρ.

d) Now consider an occasion where the speed of piston *L* is increased to *V*. The power of pushing the piston is *P*. Get an expression for the rate of volume of liquid flowing through the outlet tube Q. (Assume that the density of air is negligible compared with the density of the liquid.)

08. Any type of wave is basically generates to spread out the energy throughout the universe. Wave carries the characteristic identity of the source, the frequency along with it. Wave can undergo reflection, refraction, interference, diffraction and polarization. Then it becomes easy to spread the energy in every nook and corner of the universe.
Electromagnetic waves do not require a physical medium to propagate. It uses the electric and magnetic properties of the space.
All mechanical waves require some source of disturbance, a medium that can be disturbed, and some physical mechanism through which elements of the medium can influence each other.

Interference of waves can be explained using the superposition principle. Interference of sound waves is illustrated in Figure. Sound from a loudspeaker S is sent into a tube at point P, where there is a T-shaped junction. Half of the sound energy travels in one direction, and half travels in the opposite direction.



The distance along any path from speaker to receiver is called the path length r. The lower path length r_1 is fixed, but the upper path length r_2 can be varied by sliding the U-shaped tube, which is similar to that on a slide trombone.

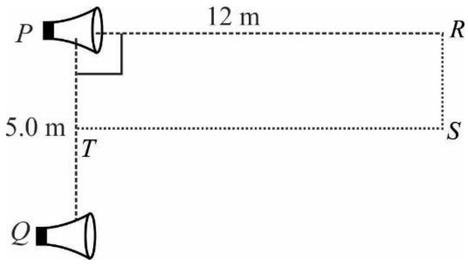
When the difference in the path lengths $\Delta r = | r_1 - r_2 |$ is either zero or some integer multiple of the wavelength λ (that is, $\Delta r = n\lambda$, where n = 0, 1,2,3,….) two waves are in-phase. Two waves which are in-phase interfere constructively and a loud sound will be resulted. If the path length r_2 is adjusted such that the path difference $\Delta r = n\lambda/2$, (for n odd), the two waves are exactly opposite phase at the receiver and hence cancel each other. In this case of destructive interference, no sound is detected at the receiver.

In order to observe the interference, two sources must be monochromatic and coherent. If not, waves from the same source can be lead to the detector through two paths as shown here.

Nice and colourful pattern appear through oil layer present on water is due to interference of light. Colours you see on the CD are also due to interference of light.

i) What is the primary purpose of generating a wave?

ii) What are the main characteristics of waves?
iii) Which of the above characteristics is related only to transverse waves?
iv) What is being used by electromagnetic waves to propagate?
v) Name three requirements to be satisfied for a mechanical wave to arise and propagate.
vi) Give three features that are common in mechanical transverse waves and mechanical longitudinal waves. (Except above characteristics)
vii) In order to observe interference, what characteristics are expected in two sources?
viii) Write down the principle of super position.
ix) What are coherent sources?



(x) P and Q shown in the figure are two sound sources connected to the same audio device that produce sound with characteristics specified in (vii) above. They are 5 m apart and T is the center of PQ. Sound frequency is 680 Hz and the speed of sound in air is 340 m s^{-1}.

a. If ST is the perpendicular bisector of PQ, give a reasonable argument to say that a loud sound can be heard anywhere on ST.

b. Given that PR and PQ are perpendicular to each other. $PR =$ 12 m, what type of interference take place at R. Prove your answer.

c. If a sensitive sound detector is brought from S to R, how many low sound positions (destructive interference positions) can be found.

(xi) Give two day to day observations which occur due to interference of light.

(xii) Usually we listen to music using two speakers connected to the same audio set. But we have never experience the interference of sound. What are the possible reasons for this?

09

<u>Answer either part (A) or Part (B) only.</u>

09. A) a) Show that the pressure at a point in a liquid is given by $= h\rho g$, where h is the depth to the point and ρ is the density of the liquid.

b) i) State the Archimedes' principle.

ii) Verify the above principle using a solid cylinder of height h and area of cross section A, fully immersed in a liquid of density ρ.

iii) Describe an experiment which can be done in the laboratory to verify the Archimedes' principle.

c) Two metals of densities $6000\ kgm^{-3}$ and $4000\ kgm^{-3}$ are mixed by taking same mass of them to make an alloy. The metallic volume of a tower made using the above alloy is $0.02\ m^3$. To test whether there are air bubbles enclosed inside the tower, it is totally immersed in water and in a liquid of density ρ. The apparent weights shown are $210\ N$ and $180\ N$ respectively.

i) Find the density of the alloy.

ii) What is the mass of the tower?

iii) Are there air bubbles enclosed inside the tower?
If your answer is "Yes", find the volume of the air bubbles.

iv) Calculate the value of ρ.

v) The above tower is constructed as a closed cylindrical object with a cavity. It floats in the liquid of density ρ such that $\frac{10}{13}$ of the whole volume of the object is submerged in liquid. What is the volume of the cylindrical object?

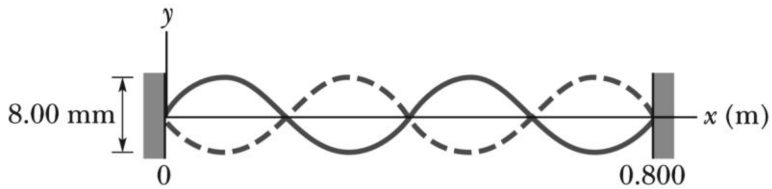
B) a) i) Write down an expression for the velocity of transverse waves (V) in a stretched string interms of tension (T) and mass per unit length (m).

ii) Show that the above equation is dimensionally correct.

b) i) Explain briefly how a transverse stationary wave is setup in a stretched string.

ii) Explain the difference between the stationary wave and a progressive wave based on the energy transmission, phase of the particles and amplitude of the particles.

c) Figure shows resonant oscillation of a string of mass $m = 2.50g$ and length L = 0.80 m and that is under tension $T = 320\ N$.



i) What is the harmonic number corresponding to the above transverse standing wave pattern?

ii) What is the distance between two adjacent nodes?

iii) What is the velocity of the transverse wave?

iv) What is the frequency of the progressive transverse wave?

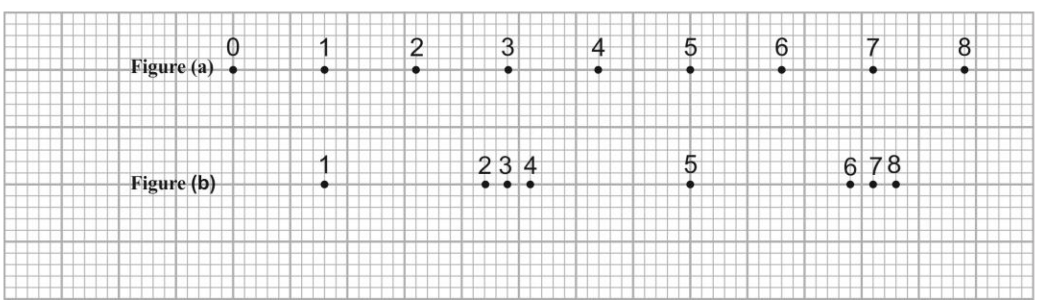
v) What is the amplitude of an antinode?

vi) What is the frequency of the string elements oscillating vertically in simple harmonic motion?

vii) Write down an expression in the form of $a = -\omega^2 y$ for the oscillations of the moving string elements.

- **<u>Answer either part (A) or Part (B) only.</u>**

10. A) i) Explain the difference between transverse waves and longitudinal waves using the vibrational direction of the particles of the medium.

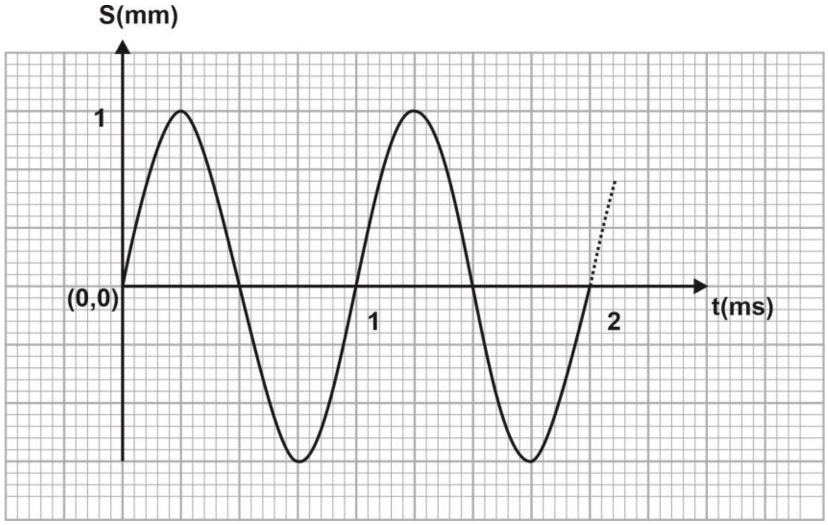


The figure (a) shows the actual positions of the nine air particles separated by the same distance. Figure (b) shows their positions when a sound wave propagates through the medium.

ii) What are the particles in a compression?

iii) Write down a particle in a rarefaction.

iv) Find the wavelength of the sound wave if the separation between 3rd and 7th particles is $34\ cm$



Graph C

Graph (c) shows the displacement (s) - time (t) graph of an air particle situated on the line of propagation of the wave. The time- axis is calibrated in millisecond (ms) and the displacement axis is calibrated in millimeter (mm)

v) What is the time period (T) of the particle?
vi) What is the frequency (f) of the particle?
vii) What is the frequency (f) of the sound wave?
viii) Find the sound velocity (v)
ix) Obtain the maximum displacement (A) of the particle using the graph(C)
x) Find the maximum velocity (V_{MAX}) of the particle.
xi) Find the maximum kinetic energy of the particle executing simple harmonic motion. (mass of the air particle $5x10^{-23}g$)
xii) Find the maximum potential energy of the particle executing simple harmonic motion.
xiii) Show the variation of kinetic energy and potential energy with the displacement using a graph.
xiv) Which frequencies give the beat frequency of $6Hz$ with the above sound wave?

B) a) An air column inside a tube open at both ends vibrates at its fundamental mode. Show the variation of relative displacement of the particles and pressure with the distance from one end of the tube along it. Mark displacement nodes and antinodes, pressure nodes and antinodes on your graphs.

b) i) The velocity of sound in a gas in given by $V = \sqrt{\frac{\gamma p}{d}}$.
Introduce the symbols of the equation.
ii) Obtain the equation that shows the variation of sound velocity with the temperature assuming the gas behaves ideally.
iii) Describe briefly, the dependence of sound velocity on the temperature, pressure, density and humidity of the gas.

c) i) At 27^0C, two tubes closed at one end, of lengths $\ell_1 = 34.5\ cm$ and $\ell_2 = 69.5\ cm$ resonate at their fundamental modes with the turning forks of frequencies $250\ Hz$ and $125\ Hz$ respectively. If both tubes have same diameter, find the end corrections of the two tubes and velocity of sound in air at 27^0C.
ii) Calculate the velocity of sound in air at 47^0C.
iii) Find the average molecular mass of the gas at 27^0C.
$\gamma = 1.4, R = 8.3\ Jmol^{-1}K^{-1}$