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Provincial Department of Education - NWP

තෙවන වාර පරීක්ෂණය - 12 ශ්‍රේණිය - 2023

Third Term Test - Grade 12 - 2023

Index No: .....

PHYSICS – I

02 Hours

- **Answer all the questions.**
- **Mark the answers on the given answer sheet.**

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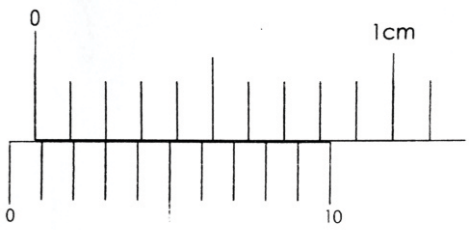
01. Which of the following is not an SI base unit ?
(1) mol (2) K (3) A (4) m (5) Cd

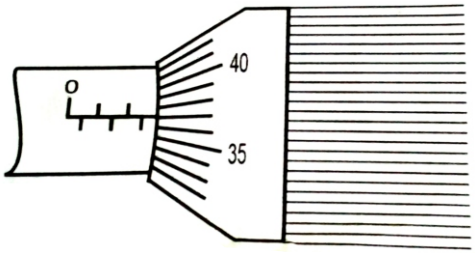
02. In the equation $V = \sqrt{\frac{k}{\rho}}$, V is speed and ρ is density. Which quantity has the same dimensions as the quantity of K ?
(1) Pressure (2) Force (3) Energy
(4) Power (5) Work done

03. The figure shows a part of a vernier calliper when its two external jaws are in contact. The zero error of the instrument is,



(1) 0.3 mm and it should be added to the reading obtained
(2) 0.3 mm and it should be subtracted from the reading.
(3) 0.7 mm it should be subtracted from the reading.
(4) 0.7 mm it should be added to the reading.
(5) 0.8 mm and it should be subtracted from the reading.

04. A micrometer screw gauge with a screw pitch of 0.5 mm has a circular scale divided into 50 divisions. When a reading is obtained from the above instrument, if the scales are positioned as follows, the fractional error of the reading.



(1) $\frac{100}{237}$ (2) $\frac{10}{237}$

(3) $\frac{10}{287}$ (4) $\frac{1}{237}$

(5) $\frac{1}{287}$

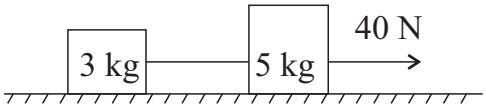
05. Two particles 48 m apart, start moving towards each other with constant velocities 6ms^{-1} and 2 ms^{-1} at the same instant. How long it takes the two particles to collide each other after starting the motion ?

(1) 6 s (2) 8 s (3) 12 s (4) 16 s (5) 24 s

06. Two players A and B moving towards each other while skating on ice move together after colliding with each other. It the velocities of A and B before the collision are 4 ms^{-1} and 6 ms^{-1} and their masses are 45 kg and 55 kg respectively, What id their velocity after the collision ?

(1) 1.5 m s^{-1} (2) 1.8 m s^{-1} (3) 3.3 m s^{-1}
(4) 5.1 m s^{-1} (5) Zero

07. The figure shows two masses attached by a light inelastic string and placed on a smooth horizontal surface. What is the tension in the connecting string when it is pulled by a horizontal force of 40 N on a mass of 5 kg ?



(1) 15 N (2) 20 N
(3) 24 N (4) 25 N
(5) 40 N

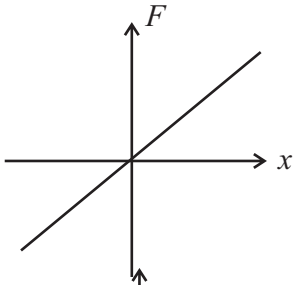
08. The percentage change in kinetic energy of an object when its momentum increases by 10 % is,

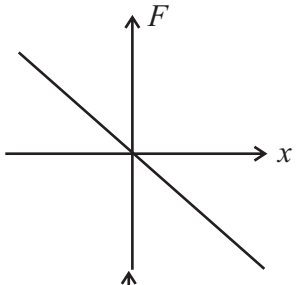
(1) 10% (2) 20% (3) 21% (4) 40% (5) 42%

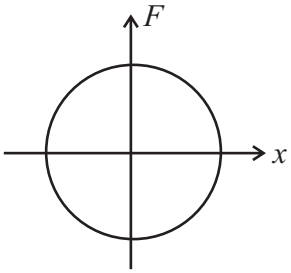
09. When a particle attached to a string rotates in a horizontal circular path of radius r, the tension in the string is T. When the radius of the path is doubled (2r) without changing the speed of the object, the new tension in the string is,

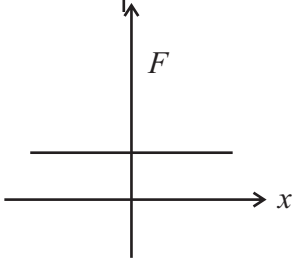
(1) $\frac{T}{4}$ (2) $\frac{T}{2}$ (3) T (4) 2T (5) 4T

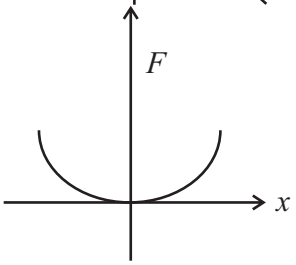
10. Which is the accurate graph from the following graphs that shows the variation of displacement (x) and force (F) of a particle in simple harmonic motion ?

(1)


(2)


(3)


(4)


(5)


11. A simple pendulum is hung in a stationary lift. Its time period is T. When this lift is moving down with acceleration of $\frac{g}{2}$, the fractional increasing in the period time of the simple pendulum is,

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

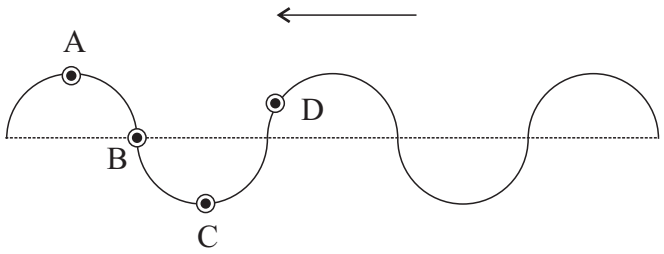
12. Consider the following statements about waves.
(A) All waves can be reflected and polarized
(B) The velocity of a wave depends on the properties of the medium.
(C) The velocity of each wave varies with frequency.

Which of the above statements is false ?
(1) Only A (2) Only B (3) Only A and B
(4) Only A and C (5) All A, B and C

13. When two tuning forks A and B were vibrated simultaneously, 12 beats occurred in 3 S. Frequency of the A tuning forks is 480 Hz. when tuning fork B slightly grinded and A and B are vibrated simultaneously, the number of beats increased to 18 during the above interval. The frequency of B before grinding is,
(1) 476 Hz (2) 484 Hz (3) 486 Hz (4) 474 Hz (5) 492 Hz

14. A uniform string of length l has mass M per unit length. This string is attached to a sonometer and a mass M is hung from it to provide tension to the string. The fundamental frequency of this string can be doubled ,
(1) by doubling the length of the string
(2) by halving the cross - sectional area of the string
(3) by doubling the tension in the string
(4) by handing a mass of 4 M instead of M.
(5) by quartering $\left(\frac{l}{4}\right)$ the length of the string.

15. A transverse wave propagating from right to left on a water surface is shown in the figure. The moving directions of A, B, C and D particles floating on the water surface are shown respectively,



(1) ↓ ↑ ↑ ↓ (2) ← ← ← ← (3) ↓ ↓ ↑ ↓
(4) ↓ ↓ ↑ ↑ (5) ↓ ↑ ↑ ↓

16. The sound intensity level at a point 10 m away from a source is 70dB. The sound intensity level at a point 100 m away will be,
(1) 10 dB (2) 20 dB (3) 30 dB (4) 40 dB (5) 50 dB

17. A convex lens of focal length 20 cm and a concave lens of focal length 5 cm are placed coaxially at a distance of d. A ray of light falling parallel to the convex lens should strike the concave lens and become parallel to what should be the value of d ?
(1) 50 (2) 30 (3) 25 (4) 15 (5) 10

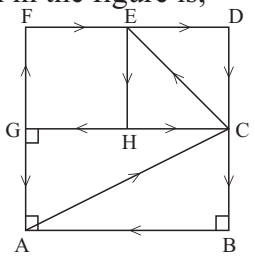
18. Consider the following statements ralated to astronomical telescope.
(A) In normal adjustment, the final image is formed at infinity.
(B) In normal adjustment, the distance between the two lenses is equal to the sum of their focal lengths.
(C) The focal length of the objective lense is greater than that of the eyepiecs.

Which of the above statements is true ?
(1) Only A (2) Only A and B (3) Only A and C
(4) Only B and C (5) All A, B and C

19. A nearsighted person's far point is2 m away from the eye. What is the focal length and type of the lens that should be worn to correct the defect ?
(1) Convex lens of 2 m (2) Concave lens of 20 cm
(3) Concave lens of 2 m (4) Concave lens of 2.5 m
(5) Concave lens of 2.5 cm

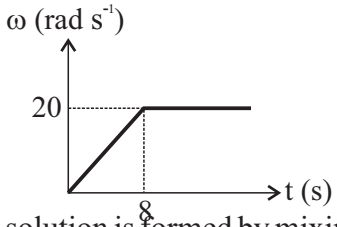
20. A convex lens used as a simple microscope has focal length of 5 cm. What is the maximum angular magnification that can be obtained when this is used in normal adjustment ?
(1) 6 (2) 5 (3) 25 (4) 10 (5) 12

21. The vector that can represent the resultant of the vector system shown in the figure is,
(1) $\overrightarrow{HB}$ (2) $\overrightarrow{GA}$
(3) $\overrightarrow{AG}$ (4) $\overrightarrow{BH}$
(5) $\overrightarrow{GB}$



22. An object of moment of inertia of 4 kgm^2 rotates about an axis of rotation with an angular velocity of 200 r. p. m. If the axis of rotation is smooth, the torque required to bring it to rest under a constant deceleration in 10 s is,
(1) 8 N m (2) 16 N m (3) 32 N m
(4) 40 N m (5) 80 N m

23. The graph below show the variation of angular velocity with time of a rotating object. After 15 s, the angular displacement of the object is,

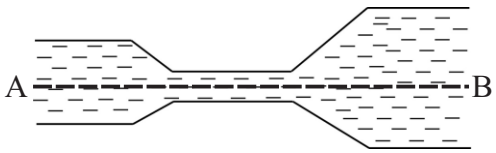


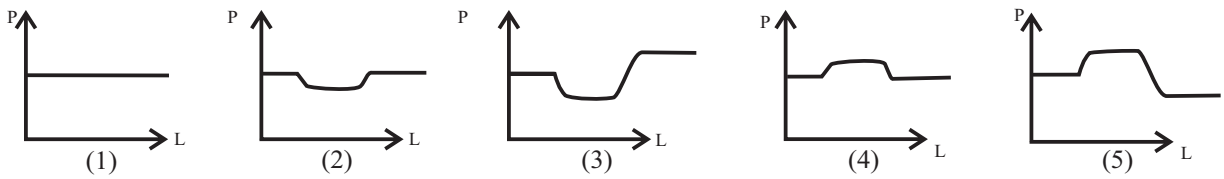
(1) 8 rad
(2) 160 rad
(3) 220 rad
(4) 300 rad
(5) 600 rad

24. A solution is formed by mixing equal masses of two liquids of densities d_1 and d_2. If there is no volume change during mixing, the density of the solution is,
(1) $\frac{d_1 + d_2}{2}$ (2) $d_1 + d_2$ (3) $\frac{d_1 d_2}{d_1 + d_2}$ (4) $\frac{2d_1 d_2}{d_1 + d_2}$
(5) $\frac{d_1 + d_2}{d_1 d_2}$

25. A wooden cube of mass 0.6 kg floats so that ¾ of its volume is in water. What is the minimum mass that should be placed on the cube to completely submerge it in water ?
(1) 100 g (2) 200 g (3) 400 g (4) 600 g (5) 800 g

26. Non viscous, incompressible fluid flow steadily through the pipe as shown in the figure. The variation of pressure P along the axis AB is best represented by,

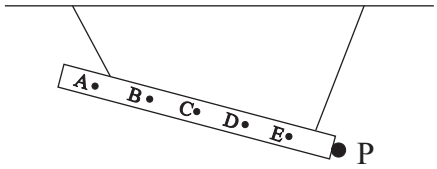




27. An object is in equilibrium under three forces. Consider the following statements about that system of forces.
(A) The resultant of the force system is zero.
(B) The lines of action of the three forces intersect at the same point
(C) The three forces are on the same plane

which of the above statement is always true ?
(1) Only A (2) Only A and B
(3) Only B and C (4) Only A and C
(5) All A, B and C

28. The figure shows a rod of mass m. hanging from two strings. A particle (P) of mass m is attached to the right end of the rod. The center of gravity of the rod is most likely to be found at ,
(1) A
(2) B
(3) C
(4) D
(5) E

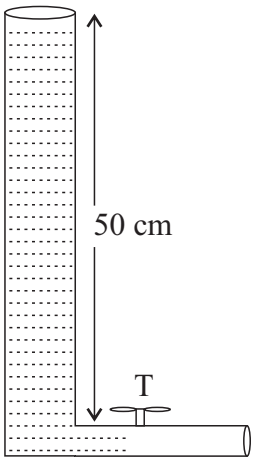


29. A uniform wooden block of mass (M- m) is suspended by a light inextensible string. A bullet of mass m coming horizontally with velocity u enters the wooden block and comes to rest in the middle of it. What is the maximum height to which the system rises ?
(1) $\frac{u^2}{2g}$ (2) $\frac{mu^2}{2Mg}$ (3) $\frac{mu^2}{2(M-m)g}$ (4) $\frac{m^2u^2}{2M^2g}$
(5) $\frac{m^2u^2}{2M\,(M-m)}$

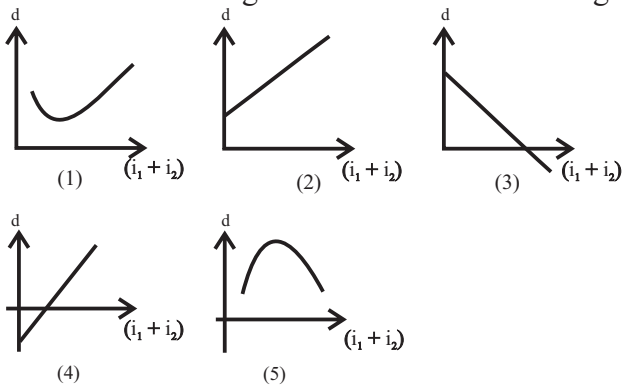
30. A sound wave generated by a vibration of one end of a rod of density 5000 kg m^{-3} must travel a distance of 60 m to travel to a certain point in the air,. If the velocity of sound in air is 300ms^{-1}, the distance traveled by the wave along the rod , during that time is, (Elastic modulus of the rod, $E = 2 \times 10^{10} Nm^{-2}$)
(1) 0.40 cm (2) 4 m (3) 40 m
(4) 400 m (5) 4000 m

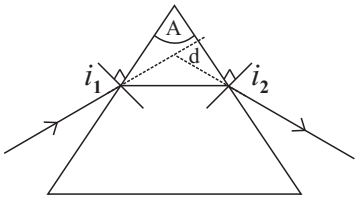
31. A driver in a car traveling at a speed of 72 kmh^{-1} on a straight line honks its horn. If the frequency of the horn is 600 Hz, then the wavelength of the wave propagating in the direction opposite to the direction of the car is, (The speed of sound in air is 340 ms^{-1})
(1) 0.6 cm (2) 60 cm (3) $\frac{17}{30}$ m (4) $\frac{16}{30}$ m
(5) $\frac{1}{3}$ m

32. A uniform open end tube of length 50 cm, calibrated from bottom to top, is filled with the water as shown in the figure. A tuning fork of 500 Hz is vibrated and keeps it above the open end of the tube and makes the water flow out of the "T" tap. When the water level was 35 cm, the air column resonated with a maximum sound for the first time. As the water was further removed the air column resonated with a maximum sound when the tube water level reached 4 cm. The speed of the sound in air is,
(1) 340 m s^{-1}
(2) 330 m s^{-1}
(3) 320 m s^{-1}
(4) 310 m s^{-1}
(5) 300 m s^{-1}



33. A monochromatic light ray passes through the prism as shown in the figure. Then what is the graph showing the variation of angle of deviation with the angle of (i_1+i_2)

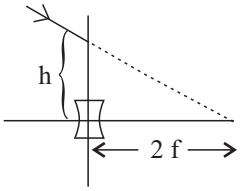




34. What is the deflection of a concave lens after refraction of a ray directed from the principal axis at a height h to a distance 2f from the lens ?

(1) $\tan^{-1}\left(\frac{h}{2f}\right)$ (2) $\frac{1}{4}\tan^{-1}\left(\frac{h}{2f}\right)$ (3) $\frac{1}{2}\tan^{-1}\left(\frac{h}{2f}\right)$

(4) $4\tan^{-1}\left(\frac{h}{2f}\right)$ (5) $2\tan^{-1}\left(\frac{h}{2f}\right)$



35. What is the most suitable thermometer for measuring rapidly changing temperatures on a metal surface?

(1) Mercury glass thermometer. (2) Constant - volume gas thermometer
(3) Thermocouples (4) Constant - pressure gas thermometer
(5) Radiation fire gauge

36. An incorrectly calibrated thermometer indicates a temeperature of $101c^0$ for boiling water and -1^0**C** for melting ice. When this thermometer shows a temperature of 30^0C the correct temperature is,

(1) 27.4 ºC (2) 28.4 ºC (3) 29.4 ºC (4) 30.4 ºC (5) 31.4 ºC

37. A degree is indicated by a length of 0.5 cm on the scale of a certain mercury thermometer. when the volume of mercury in the bulb is doubled and cross-sectional area of the capillary is halved, what is the approximate length of one degree on the scale ?

(1) 0.125 cm (2) 0.50 cm (3) 1 cm (4) 2.0 cm (5) 4.0 cm

38. A certain metal rod is 50 cm long at room temperature. The liner expansion of the metal is 1.5×10^{-5} ºC^{-1}. if the temperature of the metal rod is increase by 20^0C above room temperature, what is the percentage increase in the length of the rod ?

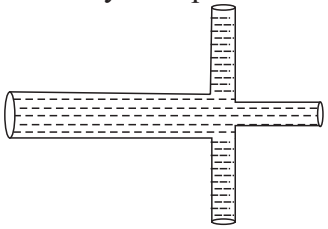
(1) 0.003 (2) 0.03 (3) 0.3 (4) 3 (5) 30

39. When a 3 mm^3 air babble released from a fish at the bottom of a 10 m deep tank. Reach to the atmosphere, the volume of the air bubble is, (The temperature of the tank remain constant, Atmospheric pressure is equal to the pressure exerted by10 m height water column.)

(1) 0.3 mm^3 (2) 0.6 mm^3 (3) 6 mm^3 (4) 30 mm^3 (5) 60 mm^3

40. The figure below shows a section of a pipe system through which liquid flows. The radius of the large pipe is 10 cm and the ladius of the small pipe is 5 cm. The liquid flows continuously and speed of the liquid in large pipe is 6 ms^{-1}.
What is the speed of the liquid in the small pipe ?

(1) 2 m s^{-1} (2) 4 m s^{-1}
(3) 8 m s^{-1} (4) 12 m s^{-1}
(5) 24 m s^{-1}



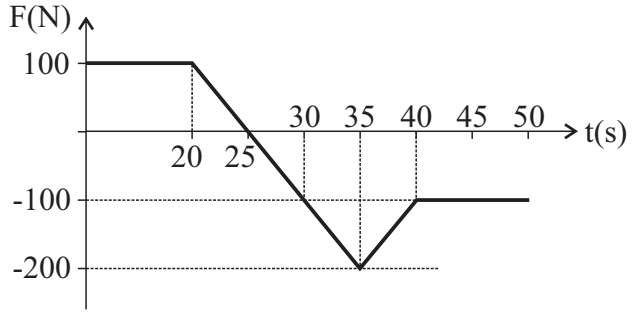
41. An object is floating in a container of liquid kept in stationary lift. When the lift begins to move upward with constant acceleration,
(A) the upward thrust on the object and the immersed volume of the object in the liquid increases.
(B) the upward thrust on the object increases but the immersed volume of the object does not change.
(C) the upward thrust on the object is greater than its weight.

Which of the above thrust on the object is greater than its weight.
(1) Only A (2) Only B (3) Only C (4) Only A and C
(5) Only B and C

42. An object is projected upward from the top of a tower with a velocity of 8 ms^{-1} at an angle of 30^0 to the horizontal. What is the displacement of the object 1s after the projection ?

(1) 1 m (2) $4\sqrt{3}$ m (3) $(4\sqrt{3}+1)$ m (4) 7 m
(5) 49 m

43. The resultant force acting on a object at rest varies with time as shown in the given graph. How long does it take for the object to come to instantaneous rest after starting the motion ?



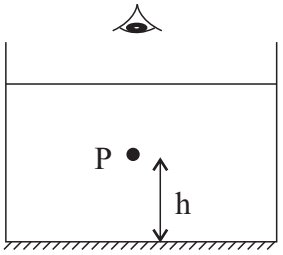
(1) 30 s
(2) 40 s
(3) 45 s
(4) 55 s
(5) 60 s

44. Which of the following statements about spectrometer is incorrect ?
(1) The order in which the spectrometer is adjusted is the telescope, parallelogram and the prism table.
(2) The telescope should be rotated in the opposite direction to the rotation of the prism table to obtain the minimum deviation position.
(3) By reducing the width of the slit, the error in the value obtained for the minimum deviation angle is reduced.
(4) The spectrometer has two vernier scales to minimize errors caused by non-coaxial of the axes of rotation of prism Table and the telescope.
(5) The prism table cannot be titled horizontally once leveled.

45. When a small object is observed using a compound microscope at normal adjustment, the magnifying power is 12 and linear magnification of the objective lens is 2. I the least distance of distinct vision is 25 cm, What is the focal length of the objective lens ?

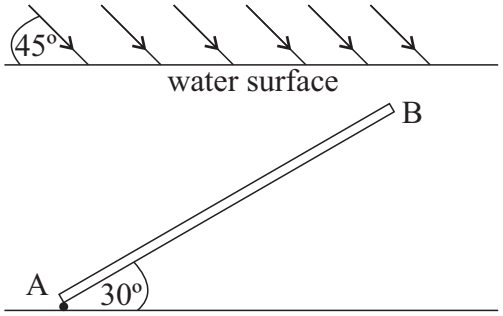
(1) 4 cm (2) 5 cm (3) 6 cm (4) 7 cm (5) 8 cm

46. A plane mirror is placed at the bottom of a tank containing a liquid of refractive index n. what is the distance between the two images seen from the air above a point object "P" placed at h height above the plane mirror ?



(1) $\frac{2h}{n}$ (2) 2nh (3) $\frac{2h}{(n-1)}$
(4) $h\left(1+\frac{1}{n}\right)$ (5) $h\left(1-\frac{1}{n}\right)$

47. AB is a thin uniform rod inclined at an angle of 30^0 to the horizontal fixed at the bottom of a horizontal reservoir. Refractive index of water is $\sqrt{2}$ As shown in the figure, when the sunlight falls on the surface of the water at an angle of 45^0 , the length of the shadow AB formed at the bottom is,



(1) 1.33 m (2) 1.41 m
(3) 1.25 m (4) 3.5 m
(5) 4 m

48. An air flow is maintained over one arm of a "U" tube filled with oil of density 900 kgm^{-3}. If the density of the air is1.2 kgm^{-3} and the speed of the flow is 15 ms^{-1}, what is the difference between the levels of the liquid in "U" tube.
(1) 7.5 mm (2) 15 mm (3) 20 mm (4) 22.5 mm (5) 25 mm

49. The engine of a car of mass 200 kg has a maximum input power of 150KW and an efficiency of 20% The car can travel up a inclined plane inclined 30^0 to horizontal at a maximum speed of 20ms^{-1}. What is the input power of the engine when it travels up the same incline road with a constant velocity of 10ms^{-1} ? (Consider the external resistive force acting on the car is directly proportional to its velocity)
(1) 12.5 kW (2) 15 kW (3) 62.5 kW (4) 75 kW (5) 150 kW

50. A disc of mass M and radius R rotates about its central axis with an angular velocity ω such that its plane is horizontal. A small object of mass 2 M is placed at a distance of $R/2$ from the center of the disc/ It the moment of inertia of the disk about the axis of rotation is $\frac{MR^2}{2}$ and all the surfaces are smooth, What is the angular velocity of the disk after placing the mass 2 M.

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

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Provincial Department of Education - NWP

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Third Term Test - Grade 12 - 2023

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PHYSICS – II

03 hours and 10 mns

* **PART A STRUCTURES ESSAY**
Answer all the question in the given space

* **PART B ESSAY**
Answer four question only.
Can answer question 9 (A) or 9 (B) only.
Can answer question 10 (A) or 10 (B) only.

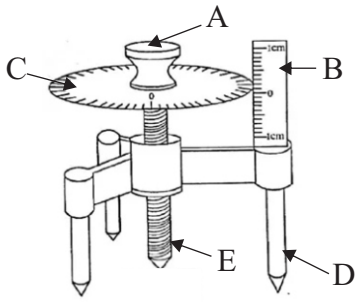
($g = 10\ ms^{-2}$)

PART - A - STRUCTURED ESSAY

01. A student selected spherometer as the most suitable instrument to find the thickness of a coin.

(i) Underline the principle used to construct the spherometer
principle of vernier / principle of lever / principle of screw

(ii) Label the following parts of the spherometer



A. ..... B. .....
C. ..... D. .....
E. .....

(iii) It was noticed that, while rotating C by A, E moves a 1mm up or down. if C has divided to 50 division What is smallest possible measurement of the spherometer ?

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(iv) Mention two possible improvements of the instrument to make the above measurement smaller.

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(v) The measuring process of thickness of the coin was started by placing the spherometer on glass sheet to bring D and E to the same level.

a) What is the next step of this process

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b) How do you confirm the success of the above step ?

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(vi) The student said, that, taking measurements using B and C is not very accurate, Is that true ? Give reasons.

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(vii) After doing the first step accurately that student rotated C using A by four complete rotations upward.

a) What is the next step to find thickness on the coin ?

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b) After doing that step successfully, What is the required measurement ?

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c) While doing the step vii (a), the student rotated C by two turns and 30 divisions downward by A. Find the thickness of the coin.

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(viii) Write two other uses of spherometer.

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02. (i) What is the most suitable apparatus from u-tube and hare's apparatus to find the ratio between densities of salt solution and water ?

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(ii) U - tube is used to find relative density of a solution A. The relative density of A is in the range 0.8-0.9

a) What solution is inserted first into the u-tube ?

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b) What solution is inserted next into the u-tube ?

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c) What are the steps required to follow while inserting second liquid to the first ?

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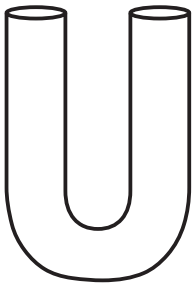
(iii) Indicate the positions of meniscus of the liquids after inserting them to the u-tube.



(iv) What are the necessary measurements to find relative density using graphical method ?

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(v) If the density of first solution is ρ_x and density of second solution is ρ_y and the measurement relevant to first liquid is H_x and second liquid is H_y, write an expression for H_y in terms of ρ_x, ρ_y and H_x

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(vi) Rearrange the above expression to plot a graph. (Y = mx)

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(vii) Sketch the expected graph.

(viii) Following co-ordinates are taken from such a plotted graph

(1, 1) (11, 9.5)

Determine the relative density of A.

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(ix) Why this method is not most suitable to find relative density of mercury ?

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03. Laser rays, which contain many of the properties of visible light, are a type of rays that are very useful in many different fields.

a) (i) Write down two properties of lasers.

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(ii) Mention two practical uses of lasers.

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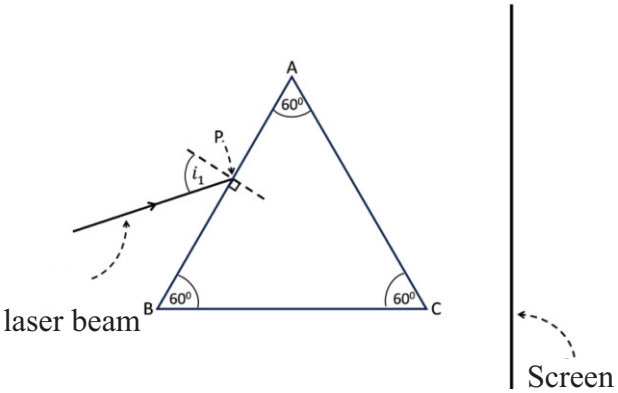
b) The diagram shows an experimental set up to study refraction of light using lasers. ABC is an equilateral triangular glass prism of refraction 1.5. A laser ray strikes on AB surface with an incident angle of i_1. When the prism is kept, the spot of light forms on the screen at y and when the prism is removed, the spot of light forms at x on the screen.



(i) complete the path of the given ray.

(ii) Mark the angle of deviation d.

(iii) Mark the positions X and Y on the screen.

(iv) What happen to angle of deviation d when the angle of incident i_1 increases? show the variation of i_1 and d using a graph.

(v) When rotating the prism slowly to clock wise direction, about the point P, the spot of light disappears at a certain point. What is the reason for that ?

(vi) Find the angle at which the laser beam must strike the surface AC when the light spot dissapears.

(vii) Then find the angle at which the ray is refracted from AB surface.

(viii) Find the corresponding angle i_1 for above (vi) situation.

04. A student designed an experiment to find the un known frequency of a tuning fork using a sono meter in laboratory. For this, a set of tuning forks and a tuning fork of unknown frequency were used. The vibration. length *l* was botained when the wire resonated in the fundamental tone with a tuning fork of known frequency *f*.

a) (i) In which place should the vibrating tuning fork be placed for this purpose ? Give reasons for your answer.

(ii) In the experimental procedure to obtain the length, at which point the small paper rider should be kept on the wire ? Mention the reason to keep it on that place ?

(iii) How to obtain the length *l* experimentally ?

(iv) Derive the equation to find the unknown frequency of the tuning fork using the graphical method in terms of l, f, tension of string T and mass per unit length m of the string.

(v) Sketch the expected graph and label the axis.

(vi) How to find the unknown frequency of the tuning fork from the graph.

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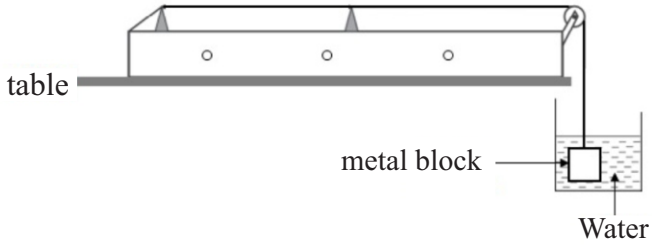
b) The student suppose to find the relative density of a metal block of known volume by using the above sonometer and tuning fork set. A wire made with same metal of the metal block is used in sonometer. The resonance length l is obtained when the wire resonates at the fundamental note with a given tuning fork of frequency f as before using following set up.



(i) If the relative density of metal is S and volume of metal block is V, Derive an expression for the frequency f in terms of the cross-sectional area A of the wire and the acceleration due to gravity g, *l*, and s.

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(ii) Re arrange the above expression to obtain a straight line graph of Y=mx It must not include square root terms.

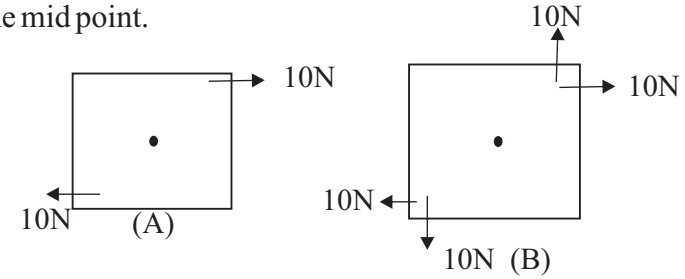
(iii) How do you find S from the graph.

(iv) If the gradient of the graph is 10^{-1} cm^2s^{-2} v = 400cm^3 and A = 0.8 mm^2, find the relative density S.

Part (B) - Essay

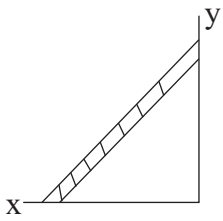
05. (i) What are the basic requirements for a rigid body to be in equilibrium ?

(ii) Below shows how several forces acting on two identical uniform square plates which smoothly pivoted from the mid point.



Explain with reasons whether A and B are in equilibrium.

(iii) A ladder balanced between a rough floor and a smooth vertical wall as shown below.



(a) Show the normal reactions and frictional forces clearly at X and Y ends of the ladder.

(b) Show the direction of resultant reaction acts on end *x* correctly on a diagram.

(c) Mention the knowledge of equilibrium that you used to mark the reactions.

(iv) A uniform ladder of mass 20 kg is placed in equilibrium with one end against a smooth veritical wall making an angle 60^0 to the horizontal and the other end on a rough floor. Find the reaction, at the ends of the ladder. ($\sqrt{3} = 1.73$, $\sqrt{13} = 3.60$)

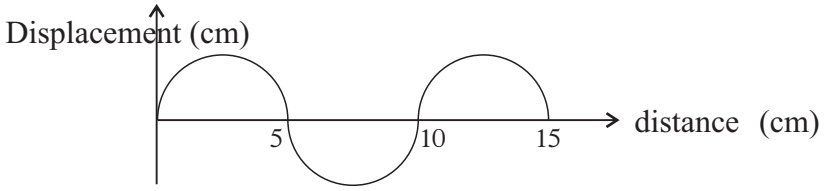
06. (a) Write an expression for the speed of sound in air V including pressure and name the remaining terms.

(b) On what factors does the speed of sound in a stationary gas depends ?

(c) Build up the relationship between the speed of sound in air and absolute temperature.

(d) On a rainy day, the speed of sound through air increases. Explain.

(e) The following figure shows how the displacement of particles in a sound waver travelling through the air varies with distance. (Temperature of the environment 27 ^{0}C)



(i) If the frequency of sound wave is 3400 Hz Find the speed of the sound wave in air

(ii) Calculate the speed of sound for below given situations.

(a) When the pressure doubled.

(b) when the temperature of the environment becomes 37^0C in a day.

$\left(\sqrt{\frac{31}{30}} = 1.016\right)$

(iii) When the air is blown into a closed tube, Derive an expression for the frequency of the fundamental note. consider the end correction as 'e'. Show that only odd harmonics of the fundamental occur in a closed tube.

(iv) When two tubes closed at one end resonates at their fundamental note the beat frequency that occured was 5Hz. If the length of the shorter tube is 110 cm, find the length of the other tube to the nearest whole number (Neglect the end correction)/

07. (i) State the Archimede's principle.
(ii) State the principle of buoyancy for an object floating on water.
(iii) It is easier to float a rod horizontally than vertically. Explain the reasons.

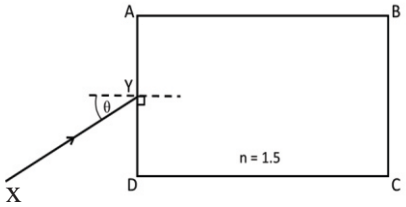
(iv) 20 divers are in a boat and 90% of the total volume of the boat is submerged. All the divers have equal weights. The density of water is 1000 kgm^{-3}. The boat sinks 10% from it's volume without men. The volume of the boat is 2 m^3.

(a) Find the weight of the boat and the weight of a diver.

(b) If 5 divers left the boat, what percentage from the boat's total volume would sink and float ?

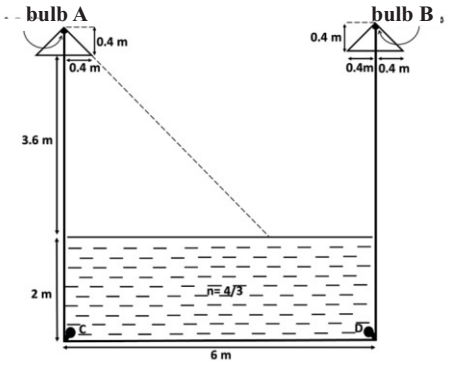
(v) The boat which was floating with the rest of the divers, hit a reef and a hole was created and water began to flow into the boat at a rate of 5 kg per minute. If the divers left the boat when it was damaged, calculate the time taken for the boat to sink completely from the time it was damaged. (rate of water flow is a constant)

08. (a) What are the two requirements for total internal reflection of a light ray.
(b) If the critical angle C for light ray which travels from a medium of a refractive index n_1 to a medium of a refractive index n_2 ($n_1 > n_2$) write down the relationship between n_1 , n_2 and C.
(c) A rectangular block of glass is placed on a horizontal plane as shown in the figure. The angle of incidence of a XY light ray falling to AD parallel to horizontal plane is θ.



(i) Show that the ray XY does not pass through. AB and DC into air for all θ
(ii) When θ= 60^0, find the minimum refactive index that can be exist for the liquid medium, which must be kept in contact with the surface AD in order for the ray to travel along the surface AB.

(d) The depth of a water tank is 2m, the length and width is 10 m and 6 m as shown in the figure. At the top of a lamp post, there are two identical bulbs A and B, Which emit yellow light at the center of the lengthy sides. The distance from the top of the lamp post to the bulb is 0.4m. The bottom of the covering shade of the bulb is circular and has a diameter of 0.8m.



(i) Find the maximum radius of the illuminated area on the water surface when only the bulb A is lit.
(ii) Find the maximum width of the brightly illuminated area on the surface of the water when both bulbs A and B are lit.
(iii) Find the maximum width of the brightly illuminated are a in the bottom of the pool when both A and B bulbs are lit. (The absolute refractive index of water =4/3)

(iv) There are two identical red bulbs C and D fixed at the bottom of the tank.

(1) Find the critical angle for red by considering the refractive index of water for red colour is 4/3.

(2) Find the radius of the illuminated area coloured in red, on the surface of the water when only the bulb C is lit.

(09) A Answer the questions by reading the following passage.

The doppler effect is the apparent difference in the observed frequency of the wave, when there is relative motion between the source which produce the wave and the observer. Here all velocities must be measured relative to the medium which the wave propogates, because both air and water are assumed to be in stationary relative to the earth. The relative velocities for sound waves are usually measured relative to the earth. The change in frequency Δf that occurs as a result of the doppler effect is called the doppler shift (Δf = observed frequency - emitted frequency)

At present submarines that can navigate to a depth of 4000 m in ocean are used for activities such as ocean - floor explorations, monitoring of the wreckage of the Titainc in the Atlantic ocean, and intelligence in military purposes. The Doppler effect is mainly used for technical processes such as finding the speed and the direction of ships sailing on the surface communicating with them. For that, the frequency difference that occurs as result of the Doppler effect is measured. Due to this, the possibility of two submarines colliding with each other in ocean can also be avoided.

Sonar waves emitted by submarines can be detected by the sonar equipment of cruise ships on the surface of the ocean as shown in below figure (1), Two submarines A and B are shown in figure (2).

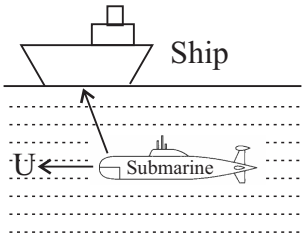


figure (1)

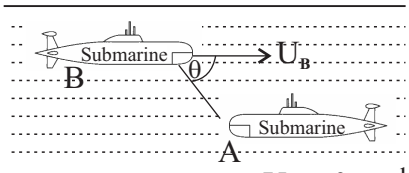


figure (2)

$U_A = 0\ ms^{-1}$

f_0 = Sonar frequcy

(a) What is Doppler effect ?

(b) In Doppler effect, relative velocities are usually measured for sound waves relative to the earth What is the reason for this ?

(c) As shown in the above figure (2) , A submarine is in stationary at a deep location about 1400m on the ocean floor, emitting sonar waves of frequency fo Submarine B travels along with an inclination of θ to the horizontal.

(i) Write an expression for the frequency of sonar waves f^1 detected by submarine B in trems of the speed of transmission of sound waves V in water, f^1 , U_B, and θ.

(ii) Now the submarine B acts as a moving source emitting sonar waves of frequency f^1 write an expression for the frequency of the sonar waves f'' that are re-detected by submarine A interims of f_o, , U_B, θ and V.

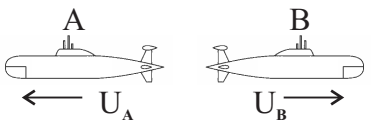
(iii) Derive an expression for f'' by combining the results above C (i) and C (ii) in terms of f_o, U_B, and θ.

(iv) Take V>>> U_B and show that the Doppler shift observed by the submarine A is given by

$$\Delta f = \frac{(2U_B \cos\theta) f_o}{V}$$

(v) If $f_o = 40\,kHz$, $\Delta f = 400\,Hz$ and $\theta = 60^0$, Find the speed U_B of submarine B by kmh^{-1} ($V = 1500\,ms^{-1}$)

(d) Now the submarines A and B move away from each other as shown in the figure. The speed of A is $U_A = 15ms^{-1}$. The speed of B is the calculated value. at (V) submarine B emits sonar waves with a wave length of 99 cm. what is the frequency of submarine B s sonar waves as observed by submarine A.



(e) Give a reason for using the Doppler effect in submarine technology.

(f) Write an application of Doppler effect in medical field.

(g) Explain with a suitable calculation why it is difficult to use submarines in practice to explore deep places such as the Mariana Trench about 11, 000 m depth.
(atmospheric pressure $\pi = 1 \times 10^5$ pa density of water $\rho = 1000\,kgm^{-3}$ acceleration due to gravity $g = 10\,ms^{-2}$)

(9) B (a) State Boyle's law and Charles's law.

(b) Derive equation of states using above laws.

(c) Derive ideal gas equation using equation of states.

(d) The maximum volume a balloon made up of inelastic, thin plastic layer is 1500 cm^3. It is filled with Helium gas at 27^0C under the pressure $1x10^5$ N m^{-2}. Find the mass of maximum amount of gas can exist in the balloon. (relative molecular mass of Helium =4 and R=8. Jmol-1K-1)

(e) A cylinder of volume 0.08 m^3 containing helium at 27^0C under the pressure $1.5x10^6$ Nm^{-2} is use to fill above balloons.

(i) . calculate the mass of the helium in the cylinder.
(ii) After filling the maximum number of balloons, what is the remaining mass of helium in the cylinder?
(iii) What is the mass of helium taken out from the cylinder to fill the balloons.
(iv) What is the maximum number of balloons that can be filled with the mass taken out from the cylinder.

(f) If a balloon filled as above is released to the atmosphere at 2^0C, the pressure inside itremains the same (1×10^5 Pa) calculate the volume of the balloon.

(g) The balloon with the above volume just rises up after releasing. Find the mass of the material of the balloon. The density of atmosphere is $1.3kg\,m^{-3}$.

(h) A balloon of volume 1500 cm^3 at 27^0C under pressure $1x10^5$ Pa is connected to a hollow glass bulb of volume 500 cm^3 inside a vacuum. Considering temperature remains the same.

(i) calculate the air pressure inside the balloon and bulb.
(ii) calculate the mass of air flowing to the bulb.

(10) A (a) The time measurement of a mechanical pendulum clock gives incorrect value when it is used in different temperature than the calibrated temperature

(i) Write an expression for the periodic time (T) of pendulum of length *l* in a pendulum clock.

(ii) What is the new length of the pendulum when it is used at a temperature θ ºC above the calibrated temperature. (liner expansivity of metal of the pendulum is α)

(iii) Write an expression for the periodic time, T_1 after increasing temperature by amount θ ºC

(iv) Write T_1 in terms of α, θ ,T.

(v) If the periodic time of the pendulum at the calibrated temperature is 2 s, calculate T_1

$\alpha = 1.2 \times 10^{-5}\ ^oC^{-1}$, $\theta = 20$ ºC {hint ; when x is very small $(1+x)^n = 1 + nx$]

(vi) The clock calibrated in England at 12 ºC and is used in Kurunegala at 32 ºC After 7 days what is the error of the time measurement of this clock.

(b) (i) Regarding to a liquid, without area expansion and linear expansion only volume expansion is considered.

Define real expansivity and apparent expansivity of a liquid.

(ii) A vessel made up of material of linear expansivity α contains a liquid of real expansivity (γ_R). If the apparent expansivity of the liquid is (γ_A), write the relationship between α, γ_R , γ_A

(iii) The internal volume of bulb of mercury-glass thermometer is $0.25 cm^3$ and internal cross sectional area of the capillary tube is $2.5 \times 10^{-4}\ cm^2$. At 0^0C the bulb is completely filled with mercury. (real expansivity of mercury is $18.7 \times 10^{-5}\ K^{-1}$, linear expansivity of glass is $9 \times 10^{-6}\ C^{-1}$)

1. Calculate the apparent increase in volume of mercury when the bulb is placed in boiling water (100^0C)
2. Calculate the height of mercury column in the stem when the bulb is at 100^0C.
3. Find the relevant height for 1^0C.
4. Height of the above thermometer is only sufficient for 100^0C. If its bulb is placed in an oil 300^0C, what should be the volume of space above the 100^0C mark to protect it.

(10) B The compound microscope that is used to check blood cells in blood transfusion laboratory has high magnifying power. A bulb or plane mirror is used to illuminate the sample in that microscope.

(a) (i) When an object is placed at the near point of the eye, a clear and enlarged image can be seen. Draw ray diagram for that and explain it using angles subtended at the eye.

(ii) Define magnifying power of compound microscope.

(b) A healthy person is observing a blood cell using compound microscope having, lenses of focal lengths 2 mm and 2.5 cm.

(i) When the microscope in normal adjustment draw ray diagram for the above observation and mark followings.
focal length of objective - f_o, focal length of eyepiece - f_e , least distance of distinct vision - D (=25 cm), image distance for objective lens = v.)

(ii) Derive an expression for magnifying power of microscope (M) in normal adjustment.

(iii) If V = 20.2 cm find the magnifying power of image observed by the healthy person.

(c) Another person observed the above cell through the eyepiece in the above adjustment and said that the image of the cell is not clear.

(i) What is the defect of vision of the person ?

(ii) Explain that defect using ray diagram.

(iii) If his range of vison is from 50 cm to infinity, to what direction he should move the eyepiece to see the image clearly. Find the moved distance.

(iv) Find the magnifying power regrading to this person. V for objective = 24 cm