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Provincial Department of Education - NWP

01 E I

Third Term Test - Grade 12 - 2018

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.

$(g = 10 \text{ NKg}^{-1})$

1. Consider the following quantities used in physics.
(A) Electric current
(B) Mass
(C) Thermo dynamic Temperature.
Which of the above is/are base quantity/ quantities of the international system of units (SI)?
(1) B only. (2) A and B only. (3) A and C only.
(4) B and C only. (5) All A, B and C

2. The percentage error of a certain length measurement has to be kept below 1 %. If the error due to the measuring instrument is 0.5 mm, the measuring length has to be greater than
(1) 1 mm (2) 1 cm (3) 5 cm (4) 10 cm (5) 10 m

3. sound does not under go
(1) reflection (2) refraction (3) interference (4) defpraction (5) polarization

4. Dimensions of frequency is
(1) Hz (2) LT^{-1} (3) L (4) T^{-1} (5) ML^{-1}

5. Variation of the displacement (x) with time (t) for a particle executing a simple harmonic motion over a period (T) is shown in figure (a). The variation of the potential energy (K) of the panicle with time (t) over the period is best represented by

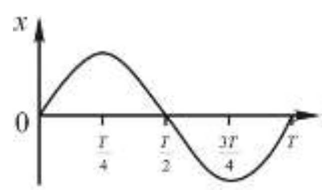
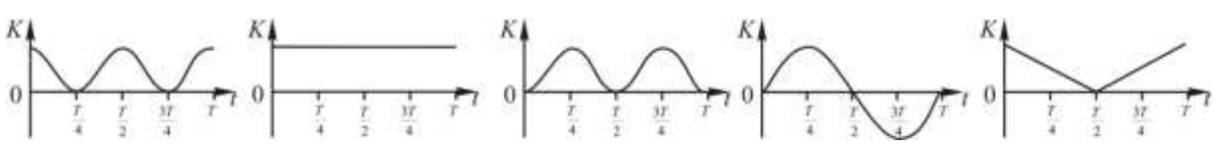


Figure (a)



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

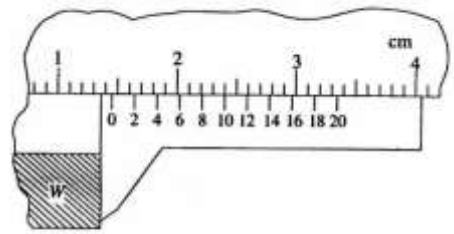
6. When a tuning fork A of frequency 100 Hz is sounded with a tuning fork B, the number of beats per second is 2. On putting some wax on the prongs of B, the number of beats per second becomes 1. The frequency of the fork B is

(1) 98 Hz (2) 99 Hz (3) 100 Hz (4) 101 Hz (5) 102 Hz

7. The thermometric substance used in a thermometer must

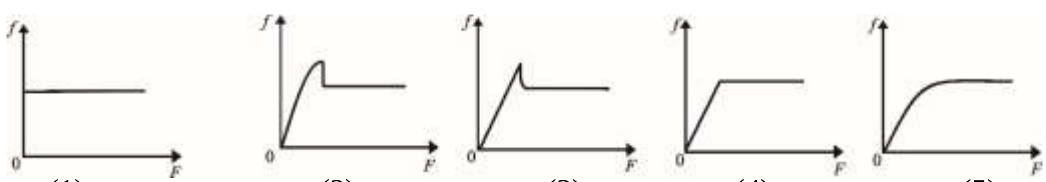
(1) remain a liquid over the entire range of temperature to be measured.
(2) have a property whose value increases linearly with temperature.
(3) have a property that varies with temperature.
(4) obeys Boyle's law.
(5) have a constant expansivity.

8. The length of a rectangular wooden block (W) is measured using vernier calipers. The figure shows the relevant sections of the vernier calipers and the block. (Only relevant divisions in the vernier scale are shown.) If there is no zero error in the vernier calipers, then the least count and the length of the wooden block respectively are



(1) 0.01 cm, 1.35 cm (2) 0.005 cm, 1.35 cm
(3) 0.005 cm, 1.45 cm (4) 0.005 cm, 1.50 cm (5) 0.01 cm, 1.55 cm

9. An object lies on a horizontal table. When the object is pulled by a horizontal force F that increases uniformly from zero, the variation of the frictional force f acting on the object is best represented by the graph

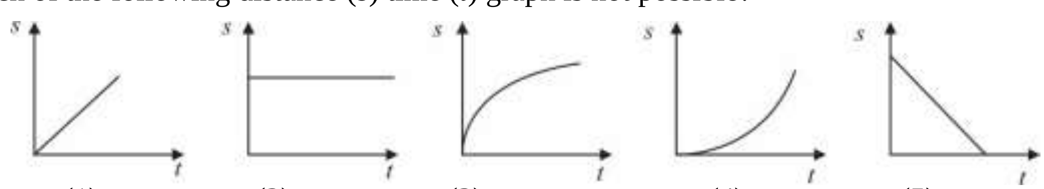


(1) (2) (3) (4) (5)

10. A circular hole is made in a steel sheet of linear expansivity 1.5×10^{-5} °C^{-1} sheet is raised by 100 °C the area of the hole

(1) is increased by a fraction of 3.0×10^{-3} (2) is decreased by a fraction of 2.4×10^{-3}
(3) is increased by a fraction of 1.2×10^{-3} (4) is decreased by a fraction of 1.2×10^{-3}
(5) remains unchanged.

11. Which of the following distance (s) time (t) graph is not possible?



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

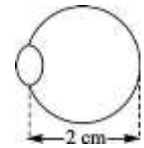
12. The speed of sound in air at 20 °C and 76 cm of mercury is 330 m s^{-1}. The speed of sound in air at 35 °C and 75 cm of mercury will be

(1) $330\sqrt{\frac{75}{15}}$ m s^{-1} (2) $330\sqrt{\frac{293}{308}}$ m s^{-1} (3) $330\sqrt{2}$ m s^{-1}

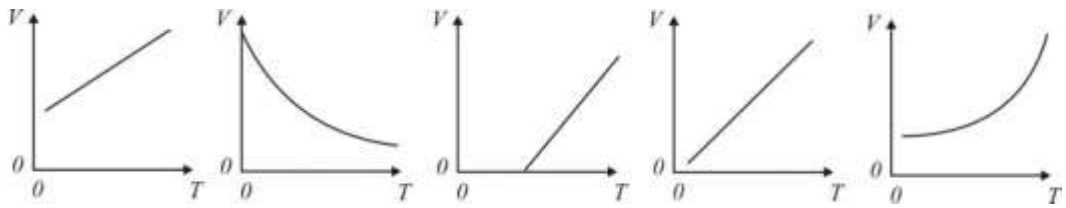
(4) $330\sqrt{\frac{2\times 75}{20}}$ m s^{-1} (5) $330\sqrt{\frac{308}{293}}$ m s^{-1}

13. A normal eye ball has a diameter of 2 cm as shown in the figure. The magnitude of the maximum power of the eye lens is (least distance of distinct vision = 25 cm)

(1) 10 D. (2) 18.5 (3) 25 D. (4) 54 D (5) 100 D



14. Which of the following graphs best the represents the variation of volume V off a fixed mass of an ideal gas at constant pressure, with its absolute temperature T?

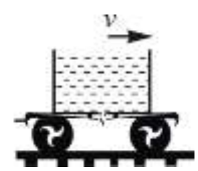


(1) (2) (3) (4) (5)

15. Which of the following statements is **not true** for a mixture of ideal gases at a given temperature?
(1) Different molecules have different speeds
(2) Molecules of each component of the gas mixture have the same average kinetic energy.
(3) Lighter gas molecules have a lower average kinetic energy.
(4) Average kinetic energy of a gas depends only on the temperature.
(5) Root mean square velocities of gas molecules of each component of the gas mixture depend on the molar mass of the gas.

16. A broad beam of parallel light is to be converted to a narrow beam of parallel light. This can be achieved with
(A) two convex lenses.
(B) two concave lenses.
(C) a convex lens and a concave lens.
Of the above statements
(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.

17. There is a tank of water on a trolley moving freely with a velocity 20 m s^{-1}. Tank contains 100 kg of water and the mass of the empty tank and trolley is 50 kg. Suddenly a hole at the bottom surface of the tank causes water to leak at a rate of 2 kg s^{-1}. The velocity of the trolley after 25 s is,



(1) 50 m s^{-1} (2) 30 m s^{-1} (3) 20 m s^{-1} (4) 10 m s^{-1} (5) 5 m s^{-1}

18. The relationship between speed, frequency and the wave length of a wave is given by $V = f\lambda$. Consider the following statements about this relation.
(A) It can be applied to any wave at any instant.
(B) Frequency of the wave depends on speed of wave.
(C) Since the speed of light is a constant, this cannot be applied to light waves.
Of the above statements
(1) Only (A) is true (2) Only (A) and (C) are true
(3) Only (A) and (B) are true (4) all (A), (B) and (C) are true
(5) all (A), (B) and (C) are **false.**

19. A tank of volume 0.75 m^3 is 20 m above the ground level. A pump must do 150 kJ of work to bring this amount of water from the well to ground level. The pump takes 5 minutes to fill this tank. If the density of water is 1000 kg m^{-3}, the power of the pump.
(1) 0.5 kW (2) 0.75 kW (3) 1 kW (4) 1.5 kW (5) 2 kW

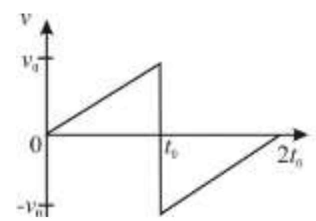
20. Which of the following is correct regarding the centripetal force and centrifugal force.
(A) Centrifugal force is the equal and opposite reaction of centripetal force.
(B) An object in a rotating frame appeared to have no centripetal force as observed by an observer in the same rotating frame.
(C) Both centripetal force and centrifugal force are required for the existence of circular motion.
Of the above statements
(1) Only is (A) true. (2) Only is (B) true.
(3) Only (A) and (B) are true. (4) Only (B) and (C) are true.
(5) All (A), (B) and (C) are **false.**

21. 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) $\frac{\pi}{2}$

22. A person doing his morning exercises is shown in the figure. If he is at equilibrium by standing on his heel, the position of his center of gravity is most likely to be at
(1) A (2) B (3) C (4) D (5) E

23. When 20 g of water at 100 °C it added to a certain amount of water at 30 °C the final temperature of the mixture is found to be 60 °C. Instead of 20 g if 40 g of water at 100 °C is added, the final temperature of the mixture will become (neglect the heat capacity of the container and heat losses In the surroundings)
(1) 85°C (2) 82 °C (3) 75 °C (4) 72 °C (5) 65°C

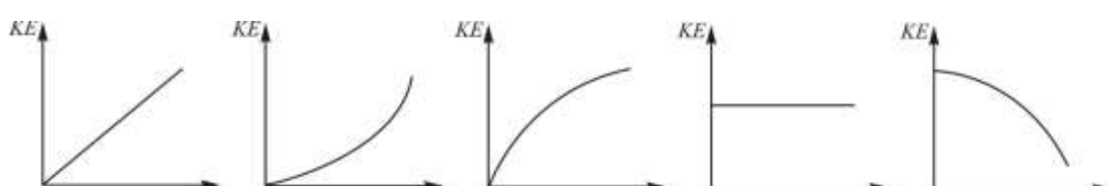
24. The velocity (V) - time (t) curve of a particle of mass m moving along a straight line is shown in the figure. Consider the following statements.
(A) The particle does not return to its initial position at the end of the motion.
(B) Acceleration of the particle does not change during the motion.
(C) At $t = t_0$ the impulse acting on the particle is zero.
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) All A, B and C are true.



25. Two wires of same length are under the same tension. The fundamental resonance frequency of one wire is four times of that of the other. The ratio of the diameter of these wires is
(1) 1 : 4 (2) 1 : 2 (3) 1 : 3 (4) 1 : 8 (5) 1 : 5

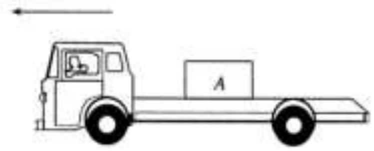
26. Which of the following sets of forces never produces a zero resultant?
(1) 3 N, 5 N, 4 N (2) 7 N, 5 N, 15 N (3) 5 N, 8 N, 10 N
(4) 15 N, 10N, 20N (5) 5N, 10N, 20N

27. 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?



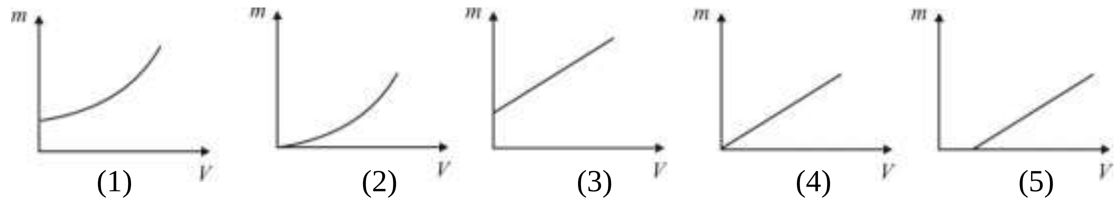
(1) (2) (3) (4) (5)

28. A box (A) of mass 100 kg is placed on the horizontal floor-bed of a lorry as shown in the figure. The coefficient of static friction between the box and the floor-bed is 0.2 and the lorry moving with a uniform velocity of 72 km h^{-1}. Find the minimum distance that the lorry can be stopped without slipping the box.



(1) 500 m (2) 400 m (3) 300 m (4) 200 m (5) 100 m

29. Which of the following graph best represent the variation of magnification m of a simple microscope with the image distance V



30. The intensity level of a class of 50 students is 50 dB. When the teacher of one class is absent, teaher of the next class was assigned to teach both classes together. If each student make the same noice as previous when the teacher leave the class, the intensity level of the combined class is nearly (log2 = 0.3010).

(1) 50 dB (2) 100 dB (3) 58.3 dB (4) 53 dB (5) 80 dB

31. A gymnastic player of mass 50 kg lands on the ground vertically with a velocity of 8 m s^{-1} and with his body straight. As his feet touches the ground he bends his knees while keeping rest of the body vertical, and brings his body to a complete stop in 0.1 s. The average value of the force exerted on the player by the ground during the period of 0.1 s is

(1) 40 N (2) 400 N (3) 4000 N (4) 4400 N (5) 3000 N

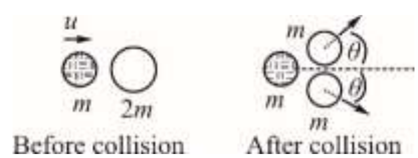
32. An immersion heater rated at 500 W is embedded in a large block of ice at 0 ^{0}C. The specific latent heat of fusion of ice is 3 x 10^5J kg^{-1}. How long does it take to melt 20 g of ice?

(1) 2 s (2) 10 s (3) 12 s (4) 20 s (5) 24 s

33. A travelling microscope is focused upon a mark at the bottom of an empty beaker. Now if the microscope is raised by 2 cm, to what depth should water be poured into the beaker so that the mark be again in focus? $\left(\text{Refractive index of water} = \dfrac{4}{3}\right)$

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

34. A particle of mass m is moving along the x-axis with speed u when it collides with a particle of mass $2m$ initially at rest. After the collision, the first particle has come to rest, and the second particle has split into two equal-mass pieces that move at equal angles θ with the x-axis, as shown in the figure. Which of the following statements correctly describes the speeds of the two pieces?



(1) Each piece moves with speed u.
(2) One of the pieces moves with speed u, the other moves with speed less than u.
(3) Each piece moves with speed $u/2$.
(4) One of the pieces moves with speed $u/2$, the other moves with speed greater than $u/2$.
(5) Each piece moves with speed greater than $u/2$.

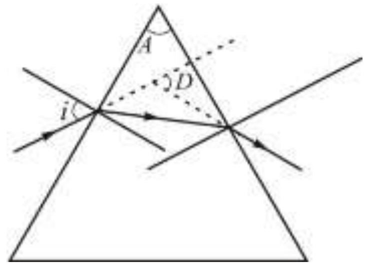
35. A train is moving at 30 m s^{-1} in still air. The frequency of the locomotive whistle is 500 Hz and the speed of sound is 345 m s^{-1}. The apparent wavelengths of sound in front of and behind the locomotive are respectively

(1) 0.63 m, 0.80 m (2) 0.63 m, 0.75 m (3) 0.63 m, 0.85 m
(4) 0.65 m, 0.75 m (5) 0.60 m, 0.75 m

36. Which of the following sets of forces never produces a zero resultant?

(1) 5N, 5N, 5N (2) 5N, 5N, 10N (3) 5N, 10N, 10N
(4) 10N, 10N, 20N (5) 5N, 10N, 20N

37. A monochromatic ray of light is incident upon a prism of refracting angle A and emerges as shown in the diagram. Consider the following statements made about the angle of deviation D.



(A) As the angle i is increased from zero the value of D passes through a maximum.
(B) D is zero when the ray enters the prism normally.
(C) For a given value of i, D does not depend on A.

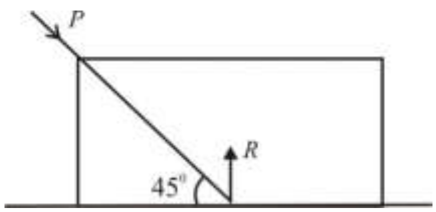
Of the above statements

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

38. A bullet of mass m penetrates a thickness x of a fixed block of mass M. What would be the thickness penetrated if M were free to move?

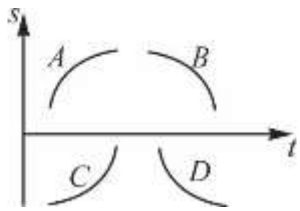
(1) $\frac{(M+m)x}{M-m}$ (2) $\frac{(M-m)x}{M+m}$ (3) $\frac{mx}{M+m}$ (4) $\frac{Mx}{M+m}$ (5) $\frac{2Mx}{M+m}$

39. As shown in figure a force P is applied on an object of mass 2 kg lying on a horizontal surface. The coefficient of kinetic friction between the two surfaces is 0.5. If the object moves with uniform velocity. Then magnitude of P would be



(1) 10 N (2) $10\sqrt{2}$ N (3) 20 N
(4) $20\sqrt{2}$ N (5) 40 N

40. Figure shows four displacement (s) - time (t) curves for four different objects. The object which has an **acceleration** in direction of its motion is/are represented by.

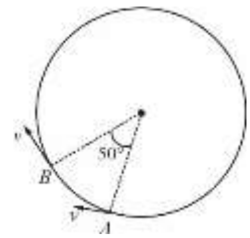


(1) only A (2) A and D
(3) B and C (4) all A,B , C and D
(5) non of A,B , C and D

41. A projectile is fired at an angle of 60° with the horizontal with a speed of 100 m s^{-1}. The time taken for the inclination of velocity vector with the horizontal to become 30° is

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

42 A particle is moving in a circle with constant speed v as shown in the figure. The magnitude of the change in velocity of the particle between points A and B is



(1) 0
(2) $v \sin 50°$
(3) $2v \sin 25°$
(4) $2v \cos 25°$
(5) v

43. A ball thrown vertically upwards return to the thrower's hand. Consider the following statements.

(A) If there is air resistance, it does not reach the expected height when no air resistance.
(B) If there is air resistance, the ball will reach the thrower's hand with a speed less than the speed with which it was thrown up.
(C) If there is air resistance, the time taken for the upward journey is less than that for the downward journey.

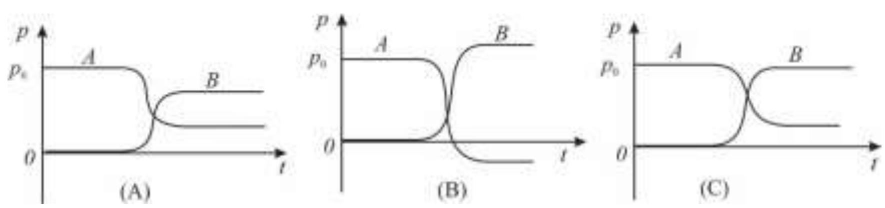
Of the above statements,

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

44. Two large tanks A and B, open at the top, contain different liquids. A small hole is made in the side of each tank at the same depth h below the liquid surface, but the hole in A has twice the area of the hole in B. If the mass flux is the same for each hole the ratio of the densities of the liquids in A and B should be

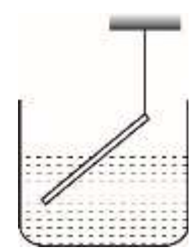
(1) 0.25
(2) 0.5
(3) 1
(4) 2
(5) 4

45. A particle A moving on a smooth horizontal table collides with another particle B which is at rest. If the magnitude of the initial momentum of A is p_0 which of the following curve/s can represents variation of momenta P of particles with time (t)



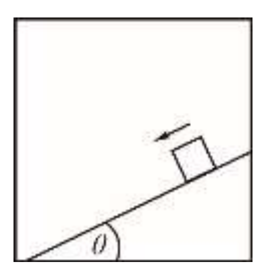
(1) Only B
(2) Only A and B
(3) Only A and C
(4) all A, B and C
(5) none

46. A uniform rod is hung at one end and is partially submerged in water. If the density of the rod is $5/9$ that of water, the fraction of the length of the rod above water.



(1) $5/3$
(2) $1/3$
(3) $1/4$
(4) $2/3$
(5) $3/4$

47. There is a smooth inclined plane in an elevator. An object is released from rest on the top of this inclined plane. When the elevator is at rest, it takes t_1 time to reach the bottom. It takes t_2 time for the same motion when the elevator is moving up with an acceleration of a. Then the ratio $\frac{t_1}{t_2}$ is.

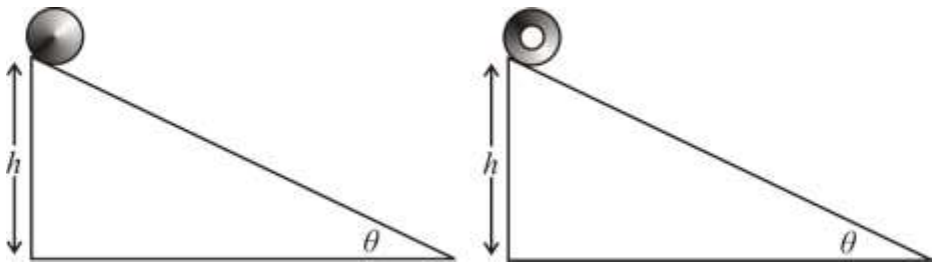


(1) 1
(2) $1+\frac{g}{a}$
(3) $\sqrt{1+\frac{g}{a}}$
(4) $1+\frac{a}{g}$
(5) $\sqrt{1+\frac{a}{g}}$

48. It is possible to project a particle with a given speed in two possible ways so as to have the same horizontal range R. If g is the acceleration due to gravity then the product of the times taken in the two possible paths is

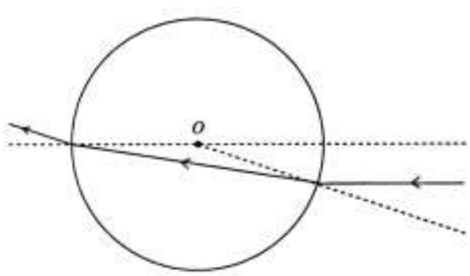
(1) $\frac{R}{g}$ (2) $\frac{2R}{g}$ (3) $\frac{R^2}{g^2}$ (4) $\frac{2R^2}{g^2}$ (5) $\frac{R}{2g}$

49. Two disks A and B of same mass and radius are released from the top of identical inclined planes. The disk B has a concentric hole. If both disks are rolling without sliding, which of the following is true?



(1) Both A and B come to the bottom at the same time.
(2) A comes to the bottom first because its translational kinetic energy is greater than that of B.
(3) B comes to the bottom first because the translational kinetic energy of A is less than that of B.
(4) B comes to the bottom first because its moment of inertia is greater than that of A.
(5) Data is insufficient to determine the time.

50. A monochromatic ray of light is incident close and parallel to a diameter of a transparent plastic sphere with centre O and refracted as shown in the figure. The refractive index of the plastic is closest to (take $\sin\theta \approx \theta$ for small θ angles)



(1) 1.2 (2) 1.3 (3) 1.5 (4) 2.0 (5) 2.5

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Provincial Department of Education - NWP

01 | S | II

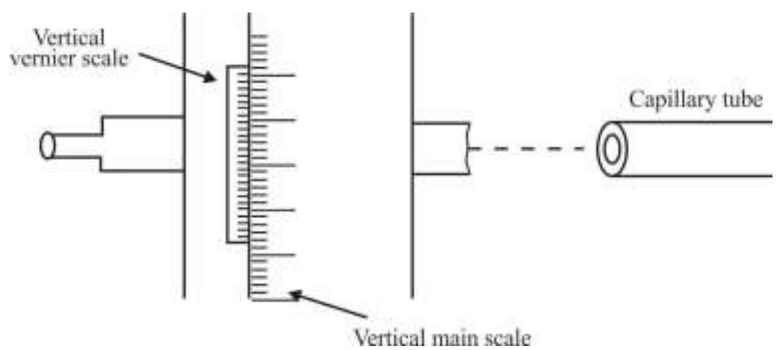
Second Term Test - Grade 12 - 2018

Index No.: .... Physics II Three 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 the 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.

Part A – Structured Essay

01). a) Following figure shows the apparatus setup arranged by a student to measure the internal diameter of a capillary tube using the vertical scale of travelling microscope.



i. The vertical main scale consists of $\frac{1}{2}\,mm$ parts and 50 divisions of vernier scale coincide with 49 main scale divisions. Find the least count of the instrument.

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ii. Write down the two adjustments that must be done to travelling microscope before taking the readings.

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iii. Draw diagrams to show the view of capillary tube and cross wires of the travelling microscope after adjusting it for taking each readings.

iv. The pair of reading that is taken from the above experiment are 14.08 mm and 13.20 mm. Find the internal diameter of the tube.

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v. For the accurate results, the student wants to measure the diameter perpendicular to above one. How would you do this without changing the position of the capillary tube and the basic adjustments of the instrument?

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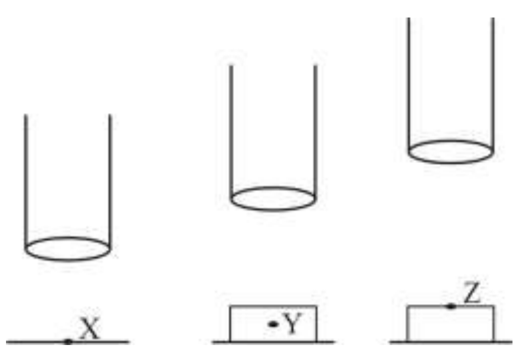
b.) Following diagrams gives three readings X,Y,Z for the positions of a ink mark observed through the travelling microscope in an experiment to determine the refractive index of glass.



(a) (b) (c)

Write down an expression for refractive index of glass using the above readings X, Y, Z.

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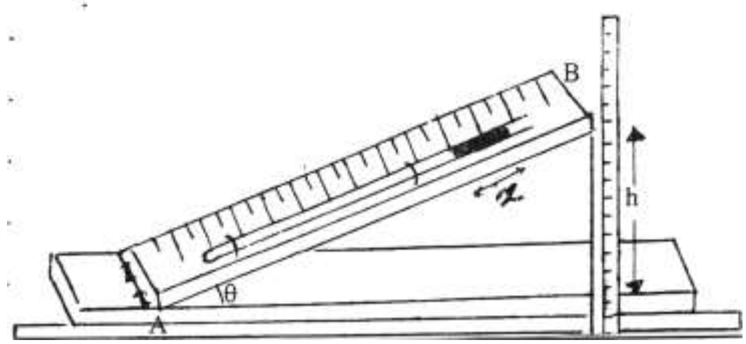
02). The following diagram shows a uniform narrow – bored glass tube closed at one end containing some dry air of length l trapped by a mercury thread of length x. h is the height from the surface of the table to the end of B of the meter ruler and the length of the ruler AB = L.



a.) Obtain the relation between h and l assuming the air column obeys the Boyle's law. Take the atmospheric pressure as H in cm of Hg.

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b.) What is the range selected for h ?

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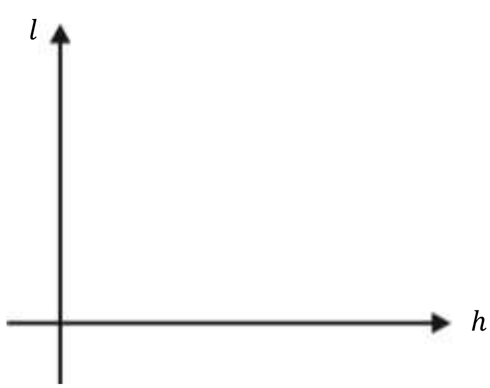
c.) Sketch below the expected variation of l with h.



d.) Rearrange the equation obtained in (a) above to determine the atmospheric pressure (H) by plotting a straight line graph.

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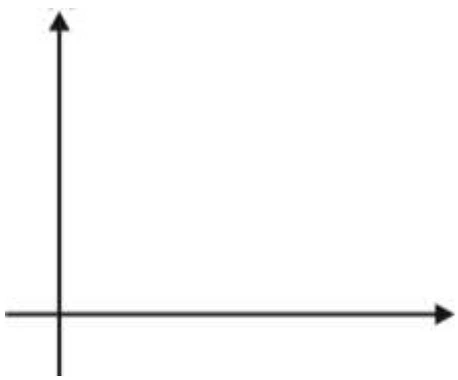
e.) Name the independent and dependent variables of the graph that you expect to plot.

Independent variable. : ....

Dependent variable : ....

f.) Draw the rough sketch of the graph and label the axes.



g.) How would you determine the atmospheric pressure, H using the graph.

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h.) What is the reason of selecting a narrow bored tube for the experiment?

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i.) If the graph is plotted after interchanging the independent and dependent variables mentioned above, what is the advantage of this ?

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j.) The length of the Mercury thread is $20\,cm$ and $L = 1m$. When $h = +100cm$, the air column is $28\,cm$ long, but when, $h = -100\,cm$, the air column is $48\,cm$ long. Calculate the atmospheric pressure in cm of Hg.

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03). A group of students designs an experiment to determine the speed of sound in air in the school laboratory using a graphical method. The following items are used for this.

1. A tall jar filled with water.
2. A PVC pipe open at both ends.
3. A set of tuning forks of known frequency.

a.) What are the other items needed to perform this experiment?

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b.) What is meant by the end correction of a resonance tube?

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c.) Which tuning fork would you select first to take data?

....

d.) Draw the experimental set up showing the wave pattern when the air column inside the tube vibrates with its fundamental mode.

e.) Show the meter ruler that should be kept correctly on the apparatus setup drawn in part (d) above to measure the resonant length (l) and mark the length l and end correction (e).

f.) Obtain the relationship among the resonance length of the air column (l), the end correction of the tube (e), resonant frequency (f) and the speed of sound (v) in air.

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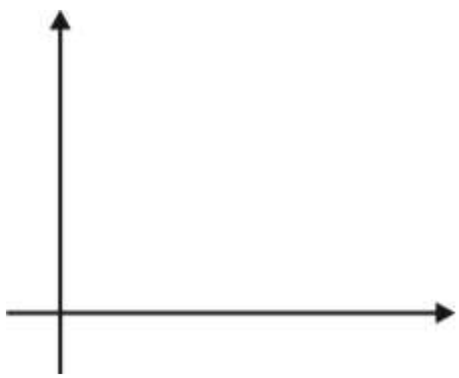
g.) Draw a rough sketch of the graph that you would expect in this experiment to find the speed of sound in air (v). Label the axes.



h.) How would you determine the speed of sound in air (v) and the end correction (e) of the tube using the graph.

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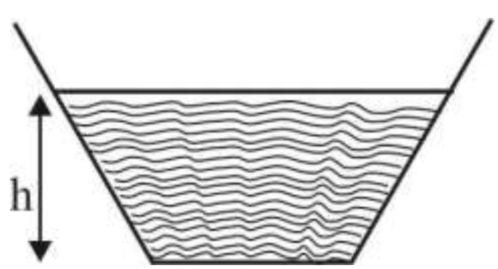
04). a) i. The water container is at equilibrium as shown in the figure below. Name and label the resultant force (F) acting on water by the curved surface of the container.



ii. If the volume of water is V, the density of water ρ_{ω}, area of the cross section of the bottom surface A, height of the liquid column h.

1) Find the force acting on the bottom surface of the container by the water.

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2) Find the resultant force acting on the curved surface of the container using above symbols. (neglect the thrust exerted by the atmosphere.)

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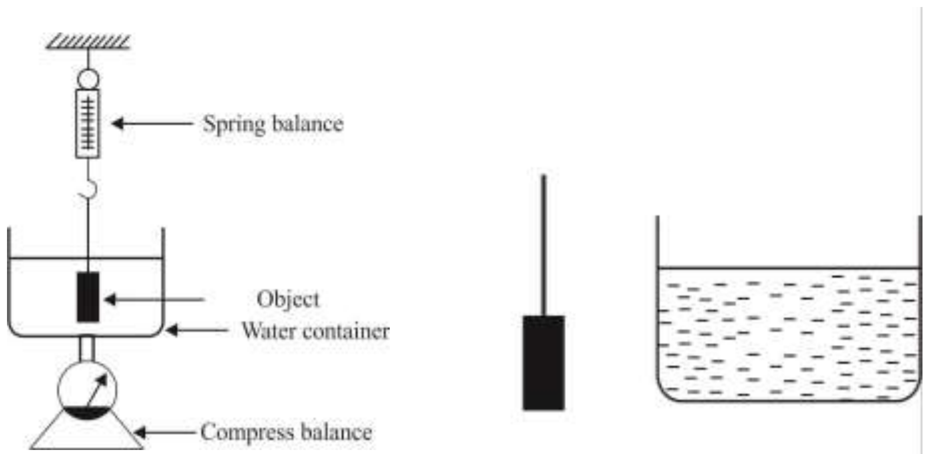
b.)



i. Mark the forces acting on the object and water container using the given diagram.

ii. Consider the mass of container is $5kg$, the mass of water is $10kg$, mass of the object is $2kg$, density of the material of object is $4000kgm^{-3}$ and the density of water is $1000kgm^{-3}$. Find,

1) reading of spring balance.

....

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2) reading of compress balance.

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c) Now above system is kept on a lift moving upwards with an acceleration of $2ms^{-2}$. Find,

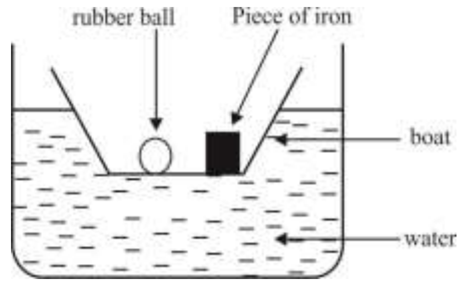
i. reading of spring balance.

....

ii. reading of compress balance.

....

d) The boat containing a rubber ball and piece of iron inside it floats on the water tank as shown in the figure.



i. When the rubber ball drops in to the water, the level of water in the tank rises, falls or no change? Explain with reasons.

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ii. When the piece of iron drops in to the water instead of rubber ball, the level of water in the tank rises, falls or no change? Explain with reasons.

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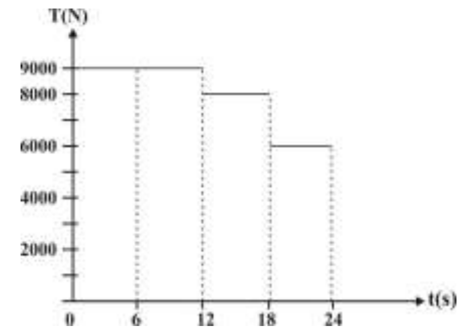
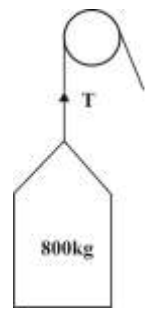
Third Term Test – 2018
Physics Part II - Grade 12
<u>Part - B (Essay)</u>

❖ **Answer four questions only.**

05). a) A box of good of 800kg is lifted upwards by a winch and cable of a helicopter. The variation of the tension of the cable with the lifted time interval is shown in the following graph. The box is at stationary when t = 0.





i. Describe the motion of the box during following time intervals of $0 - 12s,\ 12s - 18s$ and $18s - 24s$

ii. Find the lifted height of the box.

iii. If the maximum affordable tension of the cable is $10^4\ N$, find the minimum time taken by the box to lift above height in sudden occasion.

b) The rotor of the helicopter consists of 6 rotational blades. Consider the moment of inertia of one rotational blade is $I = \frac{M}{12}(7a^2 + 4b^2)$. If $a = 5m,\ b = 1m$ and $M = 50\ Kg,$ find,

i. the moment of inertia of rotor about its axis of rotation.

ii. the angular momentum of rotor, when it is rotating about its axis with a speed of 50 rps. (take $\pi = 3$)

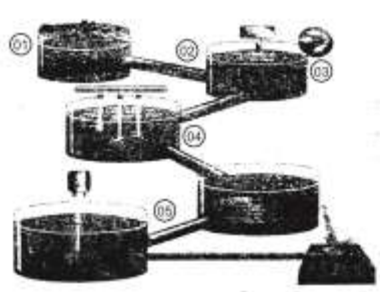
iii. when the rotor rotates in stationary air as it plane horizontal, helicopter can just lifted from the earth by passing the air downward with speed of $70\ ms^{-1}$. Find the mass of helicopter. Consider the density of air as $1\ kg\ m^{-3}$.

iv. when the helicopter is just lifted from the earth, it's frame rotates opposite direction to the rotor with speed $40\ rad\ s^{-1}$.

a). Find the moment of inertia of the frame of helicopter about the axis of rotor.

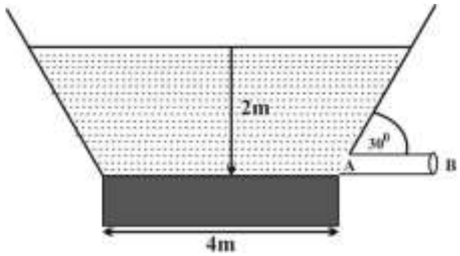
b). Write down the contraption to avoid the above opposite rotation.

06). Although $^2/_3$ of the earth consists of water, the useful volume of water is very law. Though ground water can be used as drinking water, at some instance ground water cannot be used due to salts. Therefore in south Asian countries like Sri Lanka, the town and cities are provided with drinking water from rivers and lakes after purification. The diagram shows a process used for purifying impure water.



01. Removing large impurities.
02. Carry out to deposit the mud.
03. Adding Micro Organisms
04. Carry out to purifying the water through sand.
05. Adding chlorine to destroy germ.

Cross section of the above purifying tank as shown in the following figure.



The tank consists of square base of side $4m$ and rectangular upper surface. There are two vertical walls and two inclined walls of inclination 30^0. The area of face B is $20cm^2$ and uniform tube of AB connects to the bottom of the tank as shown in the figure. The density of water is $1000\ kgm^{-3}$. Initially the hole A is closed.

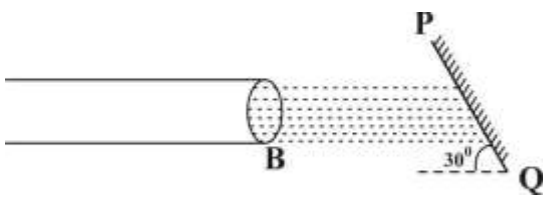
a) i. Find the average water pressure on one inclined wall of the tank. (Average pressure is half the pressure exerted at a depth h)

ii. Find the magnitude of force acting on one inclined wall of the tank and mark the direction.

iii. When A is open, find the speed of water emerging at end B of the tube.

iv. Write down the principle used in part (iii) and state the valid conditions of above principle.

b) Following diagram shows the method used to give the oxygen to the water for suitable activity of micro organisms. The water emerging from AB hits with the surface of PQ. After hitting the water on the surface, water flows downward along the surface.



i. Find the perpendicular force acting on the wall PQ .

ii. Find the pressure exerted by water on the wall PQ.

iii. Due to heavy rain, the water level rises in the tank and water flows outward from the tube AB with high speed. If the wall PQ can afford maximum pressure of $4x10^5 Pa,$ find the water level that can be filled to the tank without breaking the wall PQ.

07). A physical phenomenon called Doppler effect is studied regarding waves. Doppler effect has been used for more important scientific discoveries. This phenomenon can be applied for some day to day activities. Bats use the Doppler effect for hunting their prey.

a) i. Briefly explain the Doppler effect.

ii. Explain two activities with suitable diagrams which can be used to demonstrate the Doppler effect in the laboratory.

iii. What is meant by apparent frequency and real frequency?

iv. Give 3 applications of the Doppler effect.

b) A car approaches a fixed vertical reflector with a velocity of $36\ kmh^{-1}$ sounding a note of $800Hz$ from its horn. There is a man standing near the reflector. The velocity of sound is $340\ ms^{-1}$.

i. Calculate the apparent frequency heard by the man standing near the reflector.

ii. What frequency does the driver in the car detect in the returning waves from the reflector?

iii. Calculate the apparent frequencies heard by a motor cyclist behind the car travelling away from it with a velocity of $54\ kmh^{-1}$

08). The human ear can hear different sounds like music, sounds emitted by animals and noises. To describe the nature of sound, characteristic properties of sound are used. They are classified as loudness, pitch and quality. The human ear is an extremely sensitive organ for sound waves. It is responsive to a wide range of intensities.

a) i. Briefly explain the pitch, loudness and quality of a note.

ii. Define the physical quantity, intensity of sound.

iii. Calculate the intensity of sound at a distance of 20m from a source of sound emitting sound waves with a power of $1000\ W$.

b) i. Explain the terms, threshold of hearing and the threshold of pain.

ii. Calculate the intensity levels corresponding to the threshold of hearing and the threshold of pain.

iii. The sound emitted from the engine of an aeroplane flying horizontally produces the sound intensity level of $50dB$ at a vertical distance of $200m$ below the aeroplane. The same sound produces the sound intensity level of $40\ dB$ on the earth surface.

1) Find the sound intensity at a distance of $200m$ below the aeroplane.

2) Find the sound intensity produced by the engine on the earth surface.

3) What is the height to the aeroplane from the earth surface ?

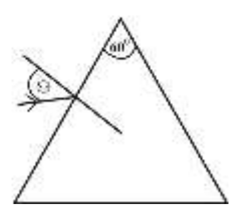
Answer either part (A) or part (B) only.

09). A) i. Write down the snell's law about refraction.

ii. Layer of oil of refractive index 1.4 is floating on water. A ray is incident on above layer of oil from air with an angle 35^0. Find the refractive angle of above ray in the water. (refractive index of water = 1.33)

i. What conditions are needed for total internal reflection?

ii. The refracting angle of a glass prism of refractive index 1.45 is 60^0. Find the maximum incident angle of a ray incident on the first surface to be undergone total internal reflection from the second surface.



iii. Name the 3 main adjustments of the spectrometer before taking the reading of the experiment to measure the angle of prism.

iv. Draw a clear diagram and name it to show the path of a monochromatic ray of light coming towards the eye through a correctly adjusted spectrometer.

B) i. Draw a ray diagram to show the action of compound microscope at normal adjustment.

ii. The compound microscope is made by using two thin converging lenses. When an object is kept at a distance of $3\ cm$ in front of the objective lens, the final image is formed at the same position of the object and at a distance of 25cm from eye piece. The angular magnification of it is 15. Find the focal length of objective lens and eyepiece.

iii. Two thin converging lenses of focal lengths, $15cm$ and $25cm$ respectively are kept in contact to each other and to become their axis co-linear. When an object is observed through the above combination of lenses, its final image is formed at 20 cm distance from lenses and also image is upright and its height is 2cm. Calculate the position of the object.

iv. The focal lengths of objective and eyepiece of the astronomical telescope are $100cm$ and $20\ cm$ respectively. The diameter of objective is 5 cm. Considering the normal adjustment of it find,

1) The distance between lenses. 2) Magnifying power.

3) The diameter of eye ring.

Answer either part (A) or part (B) only.

10). A) i. Write down the equation derived from the assumptions of the kinetic theory of gases and identify the terms of the equation.

ii. Using the above expression and the ideal gas equation, show that the average translational kinetic energy of a molecule of the ideal gas can be written as $\frac{3}{2}kT$ at the temperature $T.k$ is the Boltzmann constant.

iii. Find the value of k taking $R = 8.3\ JK^{-1}mol^{-1}, N_A = 6.0 \times 10^{23}mol^{-1}$. Give the answer to the second decimal place.

iv. Show that the root mean square speed of an ideal gas molecule is given by the equation $\sqrt{\frac{3RT}{M}}$ Where M is the molar mass.

v. Calculate the average kinetic energy of a gas molecule at 127^0C. Hence calculate the kinetic energy of molecules of one mole of the ideal gas at 127^0C.

vi. Calculate the kinetic energy of $100\ cm^3$ of Nitrogen gas molecules at a pressure of $2 \times 10^5\ Nm^{-2}$.

vii. Oxygen gas of mass $32\ g$ contained in a cylinder has a temperature of 27^0C and a pressure of $1\ atm$ $(1 \times 10^5 Nm^{-2})$. Find the number of collisions made by the gas molecules on the wall of the container of area $1\ m^2$ in $1s$ assuming gas molecules move normal to the wall with the root mean square speed (V_{rms}). The mass of a oxygen gas molecule is $= 5.3 \times 10^{-26}kg$.

B) i. 1) Write down the first law of thermodynamics.

2) Under constant pressure P, the volume of a gas is increased from V_1 to V_2. Write an expression for work to be done on the system W.

ii. Molar mass of Argon gas is $0.018\ kgmol^{-1}$. $6g$ of Argon gas is trapped inside an air tight cylinder by a smooth piston. Its pressure is equal to atmospheric pressure, $1 \times 10^5 Pa$. This gas is heated by a heater of 5W. It takes *25 s* to heat it. It is heated by two different methods as described below.

1) It is heated while piston remained fixed and the increase in temperature of the gas was by 30K. What is the molar heat capacity of the gas?

2) When the piston was free to move and the increase in temperature of the gas was by 18K. What is the molar heat capacity of the gas?

3) Explain why you obtained two different values for the molar heat capacity of Argon.

4) what was the change in volume of the gas when piston was free to move?

5) What was the work done by the gas?

Grade 12 - Physics - 2018

Part I - Third Term Test Answers

1.	(5)	11.	(5)	21.	(3)	31.	(3)	41.	(3)
2.	(3)	12.	(5)	22.	(2)	32.	(3)	42.	(3)
3.	(5)	13.	(4)	23.	(4)	33.	(2)	43.	(5)
4.	(4)	14.	(4)	24.	(2)	34.	(5)	44.	(2)
5.	(3)	15.	(3)	25.	(1)	35.	(2)	45.	(2)
6.	(5)	16.	(4)	26.	(2)	36.	(5)	46.	(2)
7.	(3)	17.	(3)	27.	(2)	37.	(4)	47.	(5)
8.	(3)	18.	(1)	28.	(5)	38.	(4)	48.	(1)
9.	(3)	19.	(3)	29.	(3)	39.	(3)	49.	(2)
10.	(1)	20.	(2)	30.	(4)	40.	(5)	50.	(4)

Part I - Structured Essay

(01) (a) (i) 1 main scale division $= \frac{1}{2}$ mm

50 vernier divisions $= 49 \times 0.5$ mm

1 vernier division $= \frac{49 \times 0.5}{50}$ mm

$= 0.49$ mm

least count $= 1M - 1V$

$= 0.5 - 0.49 = \underline{0.01 \text{ mm}}$ — (01)

(ii) 1. level the base of the instrument using levelling screws and a spirit level. — (01)

2. Focus the image of the face of the capillary tube on the cross-wires — (01)

(iii)  — (01)  — (01) (or any other correct diagram)

(iv) The internal diameter $= 14.08 - 13.20$

$= \underline{\underline{0.88\ mm}}$ — (01)

(v) By moving the microscope in a horizontal direction readings at the two ends of the hole are taken using →

the horizontal main scale and vernier scale. — (02)

(b) real depth $= z - x$
apparent depth $= z - y$ } — (01)

$$n = \frac{z-x}{z-y}$$ — (01)

(02) (a) $P = H + x \sin\theta$

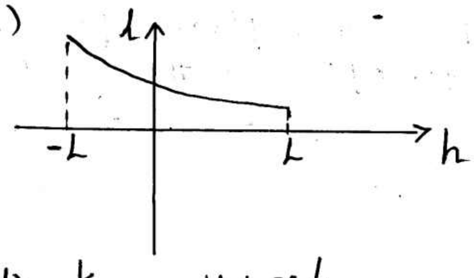
$= H + x \cdot \frac{h}{L}$

$PV = k$ (Boyle's law)

$$\left(H + x\frac{h}{L}\right) l A = k$$ — (01)

(b) $+L$ to $-L$ — (01)

(c)



— (01)

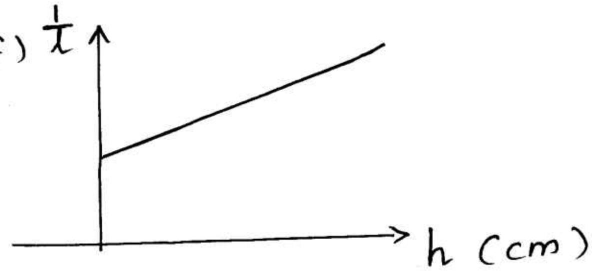
(d) $\frac{k}{lA} = H + \frac{xh}{L}$

$$\frac{1}{l} = \left(\frac{xA}{Lk}\right) h + \frac{HA}{k}$$ — (01)

$y = m\ x + c$

(e) Independant = h
Dependent = $\frac{1}{l}$ } —— (01)

(f)



—— (01)

(g) $m = \frac{xA}{kL}$ m – gradient

$c = \frac{HA}{k}$ c – intercept

$\frac{c}{m} = \frac{HL}{x}$, $H = \frac{cx}{mL}$ —— (01)

(h) To enclose an air column with a sufficient length. —— (01)

(i) To determine the atmospheric pressure (H) from the intercept of the graph (c) —— (01)

(j) $(H+20)28 = (H-20)48$

$H+20 = (H-20)\frac{48}{28}$

$5H = 380$

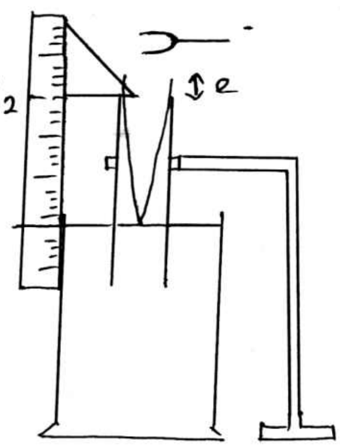
$H = 76 \text{ cm Hg}$ —— (01)

(03) (a) meter ruler, set square, stand — (01)

(b) The short distance from the open end of the tube to the position of the displacement antinode — (01)

(c) The tuning fork with the highest frequency. — (01)

(d)



— (01)

(e) (01)

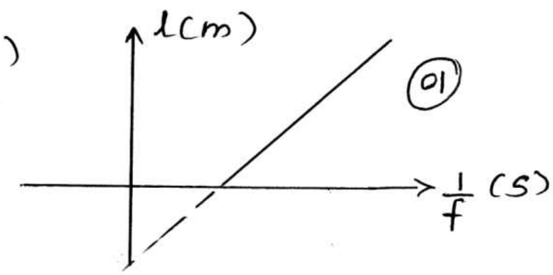
(f) $l + e = \frac{\lambda}{4}$

$\lambda = 4(l+e)$

$v = f\lambda$

$v = f \cdot 4(l+e)$ — (01)

(g)



(01)

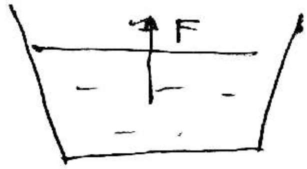
$l = \left(\frac{v}{4}\right)\frac{1}{f} - e$ — (01)

(h) gradient (m) $= \frac{v}{4}$

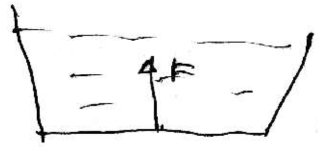
$\therefore v = 4m$ — (01)

intercept (c) = e — (01)

(4) a) (1)



or

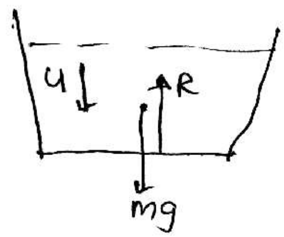


- - - (1)

(2) (1) $h\rho_w g A$ - - - - - - (1)

(11) $V\rho_w g - h\rho_w g A$ - - - - - (1)

b)



If both correct - - - (1)

(1) $T = mg - u$

$= \left(20 - \frac{20}{400} \times 1000\right) 10$

$T = \underline{1.5 \text{ kg}}$ - - - - - - - - (1)

(2) $R = mg + u$

$= 150 + 5 = 155$

$= \underline{15.5 \text{ kg}}$ - - - - - (1)

(c) $T + u - mg = ma$

$T = ma + mg - u$

$T = (m - V\rho)(a + g)$

$T = \left(2 - \frac{2}{400} \times 1000\right)(10 + 2)$

$T = \underline{1.8 \text{ kg}}$ - - - - - - - (1)

(ii) $R - mg - U = ma$

$R = mg + U + ma$

$R = (m + V\rho)(a + g)$

$= \left(\frac{2 \times 10^3}{4000} + 15\right)(10 + 2)$

$= 18.6$ kg ---- (1)

(d) (i) No change & correct reasons --- (1)

(ii) Decrease & correct reason --- (1)

(5)

(i) 0–12 s → moving upwards with constant acceleration. - - - - - (1)

$\uparrow$ $9000 - 8000 = 800a$

$a = \frac{1000}{800} = 1.25\ ms^{-2}$ - - - - (1)

12–18 s → moving with constant velocity - - - - (1)

18–24 s → moving with constant deceleration

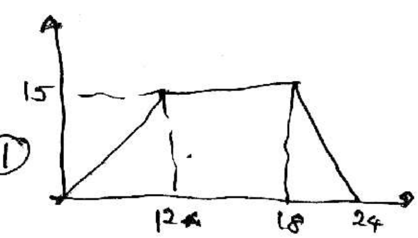
$\uparrow$ $6000 - 8000 = 800a$

$a = -2.5\ ms^{-2}$ - - - - (1)

(ii) using $V = u + at$

$V = 0 + 1.25 \times 12$

$V = 15\ ms^{-1}$ - - - (1)



the distance (height) $= \left(\frac{24 + 6}{2}\right) \times 15$

$= \underline{\underline{225\ m}}$ - - - - (1)

(iii) maximum acceleration, (a_1)

$10000 - 8000 = 800a$

$2000 = 800a$

$a = \frac{2000}{800} = 2.5\ ms^{-2}$ - - - - (1)

using $s = ut + \frac{1}{2}at^2$

$225 = 0 + \frac{1}{2} \times 2.5 \times t^2$

$t = 13.4\ s$ - - - - (1)

(b) (1) $I' = \frac{M}{12}(7a^2 + 4b^2) \times 6$

$I' = \frac{50}{12}(7 \times 5^2 + 4 \times 1^2) \times 6$

$= 4475 \text{ kg m}^2$ ---- (1)

(2) $L = I'\omega$

$= 4475 \times 2\pi \times 50$

$= 1342500 \text{ kg m}^2 \text{ rad s}^{-1}$ ---- (1)

(3) $F = \frac{mv - mu}{t}$

$F = \frac{A\rho(vt)v - 0}{t}$

$F = A\rho v^2$ — (1)

To helicopter

$\uparrow F = mg$

$mg = A\rho v^2$ — (1)

$m = \frac{A\rho v^2}{g}$

$= \frac{\pi r^2 \rho v^2}{g}$

$m = \frac{3 \times 5^2 \times 1 \times 70^2}{10}$

$m = 36750 \text{ kg}$ — (1)

(4 a) using conservation of Angular momentum

$I_1\omega_1 = I_2\omega_2$

$1342500 = I_2 \times 40$

$I_2 = 33562.5 \text{ kg m}^2$ — (1)

(b) correct reason ---- (1)

(5)

(a) (I) Average pressure P,

$$P = \frac{h\rho g}{2} = \frac{2 \times 10^3 \times 10}{2} \text{ ---- (1)}$$

$$P = 10^4 \text{ Pa} \text{ ---- (1)}$$

(II) correct direction ----- (1)

$$F = PA = 10^4 \times 16 = 16 \times 10^4 \text{ N} \text{ ---- (1)}$$

Perpendicular Force = $F \sin 30°$

$$= 16 \times 10^4 \times \frac{1}{2} = 8 \times 10^4 \text{ ---- (1)}$$

(III) $P_1 + \underbrace{\frac{1}{2}\rho v_1^2}_{0} + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \underbrace{\rho g h_2}_{0}$

$$\pi + \rho g h = \pi + \frac{1}{2}\rho v^2 \text{ ---- (1)}$$

$$v^2 = 2gh$$

$$v^2 = 2 \times 10 \times 2$$

$$v^2 = 40$$

$$v = \sqrt{40} = 6.32 \text{ ms}^{-1} \text{ ---- (1)}$$

(IV) bernoulli's principle & correct states. ---- (1)

(b) (I) $F = mv \sin\theta$

$$= \rho \times Av \times v \sin 30° \text{ ---- (1)}$$

$$= \rho A v^2 \sin 30°$$

$$= 10^3 \times 20 \times 10^{-4} \times 40 \times \frac{1}{2}$$

$$= 40 \text{ N} \text{ ---- (1)}$$

(II) $P = \frac{F}{A} = \frac{40}{20 \times 10^{-4}}$ ---- (1)

$$P = 2 \times 10^4 \text{ Pa} \text{ ---- (1)}$$

(iii) $F_{max} = \rho A v^2 \sin 30°$

$$v^2 = \frac{F_{max}}{\rho A \sin 30} \quad \text{- - - - (1)}$$

$$v^2 = \frac{800}{10^3 \times 20 \times 10^{-4} \times 0.5}$$

$$v^2 = 800 \quad \text{- - - - (1)}$$

$$v^2 = 2gh$$

$$800 = 2gh$$

$$h = 40\ m \quad \text{- - - - (1)}$$

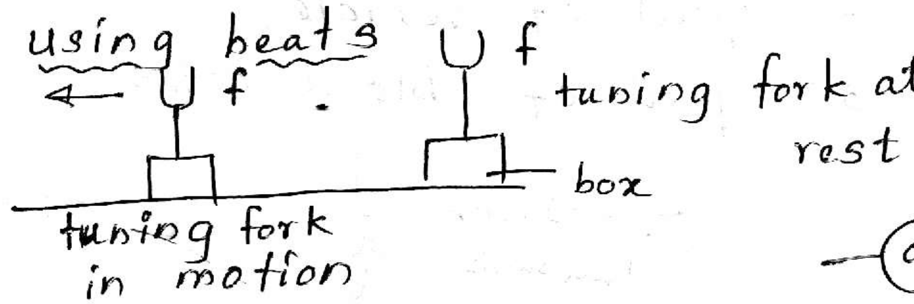
$F_{max} = PA$

$= 4 \times 10^5 \times 20 \times 10^{-4}$

$= 800\,N$

(07) (a) (i) Whenever there is relative motion between a source of waves and an observer, the frequency of the wave motion as noted by the observer is different from the actual frequency of the waves. This is the Dopple effect — (02)

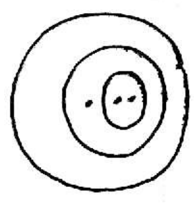
(ii) 1. Using beats



— (01)

After making both identical tuning forks to vibrate, one box is moved away from the fixed box, beats could be heard.

2. Using the ripple tank — (01)



When the tip of the oscillator in the ripple tank is moved forwards slowly it can be seen that the distance between ripples change.

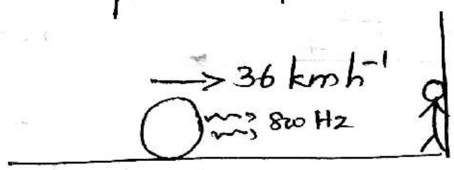
for the two diagram — (01)

III real frequency – frequency of the waves emitted by the vibrating source. (01)

apparent freq. – frequency heard by an observer whenever there is relative motion between the source of waves and the observer.

(iv) 1. To measure the depth of sea
2. Speed of vehicle
3. Speed of blood cells } (01)

(b)



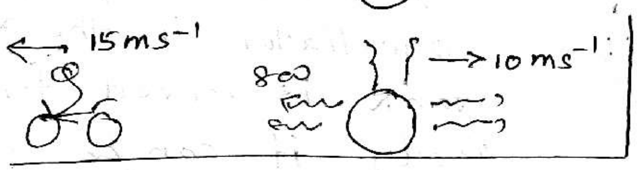
$U_s = \frac{36 \times 10^3}{3600}$
$= 10\ ms^{-1}$

I $f_1 = \left(\frac{340}{340 - 10}\right) 800$ — (01)

$= \frac{340}{330} \times 800 = \underline{\underline{824.24}}\ Hz$ — (01)

II $f_2 = \frac{350}{330} \times 800$ (01) $= \underline{\underline{848.48}}\ HZ$ — (01)

III



Two frequencies are heard by the motor cyclist.

$f_3 = \left(\frac{340 - 15}{340 + 10}\right) \times 800$ (01) $= \frac{325}{350} \times 800$

$= \underline{\underline{742.86}}\ Hz$ — (01)

$f_4 = \frac{340 - 15}{340 - 10} \times 800$ (01) $= \frac{325}{330} \times 800$

$= \underline{\underline{787.88}}\ Hz$ — (01)

(8) (a) I

Pitch

The pitch of a note depends only on the freq. of the sound vibrations. A high freq. gives rise to a high pitched note ; a low freq. produces a low-pitched note — (01)

Loudness

Loudness depends on the amplitude of the sound waves. The greater the amplitude of the wave, the greater is the energy of the wave. So, Loudness is higher. — (01)

Quality

The Quality of the sound depends upon the number of overtones present and their intensity distribution. The greater the number of overtones, the better is the tonal quality of the sound. Thus two notes of the same freq. can be distinguish because they have diff^{t} quality. — (01)

II The rate at which energy is transferred per unit area of a surface held perpendicular to the direction of propagation — (02)

III $I = \frac{P}{A} = \frac{1000}{4\pi r^2} = \frac{1000}{4 \times 3.14 \times 20^2}$ — (01)

$= 0.199\ Wm^{-2} = \underline{\underline{0.2\ Wm^{-2}}}$ — (01)

(b) I Threshold of hearing

The minimum intensity of a sound wave that is audible to the human ear — (01)

Intensity level corresponding to the threshold of hearing.

$\beta_1 = 10 \log_{10}\left(\frac{I}{I_0}\right)$

$= 10 \log_{10}\left(\frac{10^{-12}}{10^{-12}}\right) = \underline{\underline{0\ dB}}$ — (01)

Threshold of pain

The maximum intensity of a sound wave that is audible to the ear without giving pain — (01)

Intensity level corresponding to the threshold of pain —

$$\beta_2 = 10 \log_{10}\left(\frac{1}{10^{-12}}\right) = \underline{\underline{120\ dB}} \quad — (01)$$

III (1)

$$\beta = 10 \log_{10}\left(\frac{I}{I_o}\right)$$

$$50 = 10 \log_{10}\left(\frac{I_1}{I_o}\right)$$

$$\left(\frac{I_1}{I_o}\right) = 10^5$$

$$I_1 = 10^5 \times 10^{-12} = \underline{\underline{10^{-7}}}\ W m^{-2} \quad — (01)$$

(2)

$$\beta = 10 \log_{10}\left(\frac{I_2}{I_o}\right)$$

$$40 = 10 \log_{10}\left(\frac{I_2}{I_o}\right)$$

$$\left(\frac{I_2}{I_o}\right) = 10^4$$

$$I_2 = 10^4 \times 10^{-12} = \underline{\underline{10^{-8}}}\ W m^{-2} \quad — (01)$$

(3)

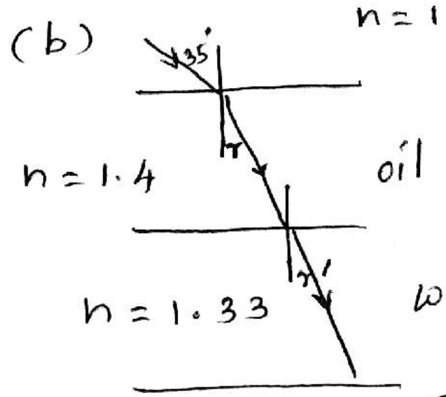
$$I_1 r_1^2 = I_2 r_2^2$$

$$h^2 = \frac{I_1 r_1^2}{I_2} = \frac{10^{-7} \times 200^2}{10^{-8}} \quad — (01)$$

$$h = \underline{\underline{632\ m}} \quad — (01)$$

(9 A) (a) Snell's law — (02)

(b)



— (01)

$1 \sin 35 = 1.4 \sin r$ — (01)

$= 1.33 \sin r'$

$\frac{0.5736}{1.33} = \sin r'$ — (01)

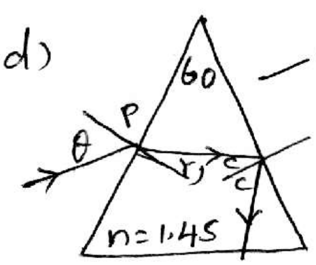
$\sin r' = 0.4313$

$r' = \underline{\underline{26^{\circ}}}$ — (01)

(c) 1) incident ray is in an optically more dense medium — (01)

2) incident angle > critical angle — (01)

(d)



— (01)

$c = \sin^{-1}\frac{1}{n}$ — (01)

$c = \sin^{-1}\frac{1}{1.45} = \sin^{-1} 0.6896$

$c = \underline{\underline{43^{\circ}}}$ — (01)

$r + c = 60^{\circ}$, $r = \underline{\underline{17^{\circ}}}$ — (01)

<u>at P</u>

$1 \times \sin\theta = 1.45 \sin r$ — (01)

$= 1.45 \times 0.2924$ — (01)

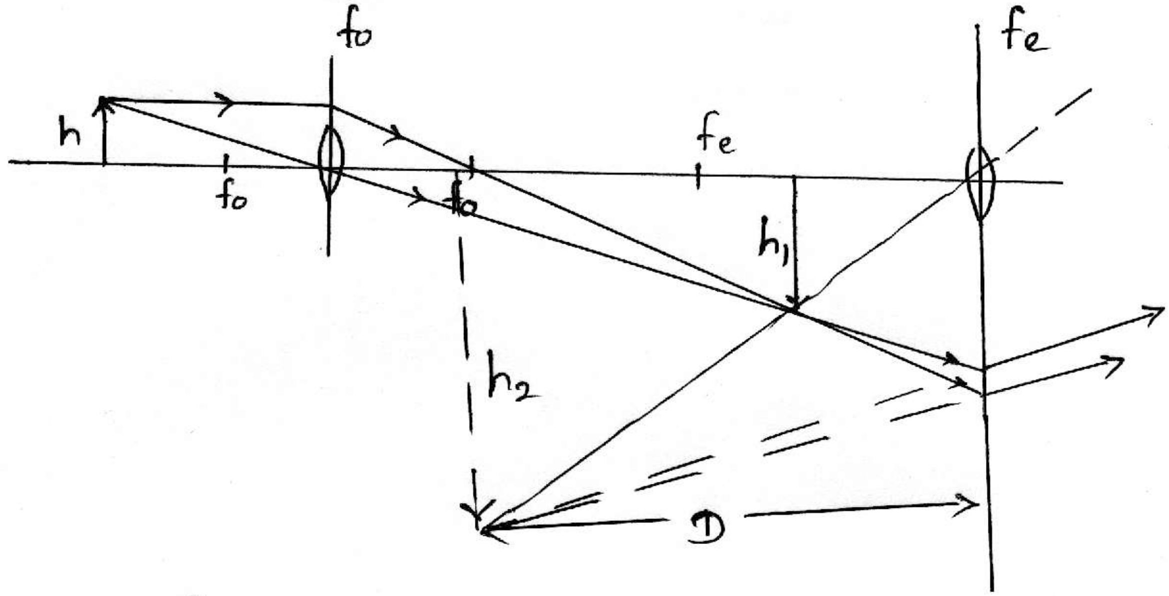
$\sin\theta = 0.4240$

$\theta = \sin^{-1} 0.4240$

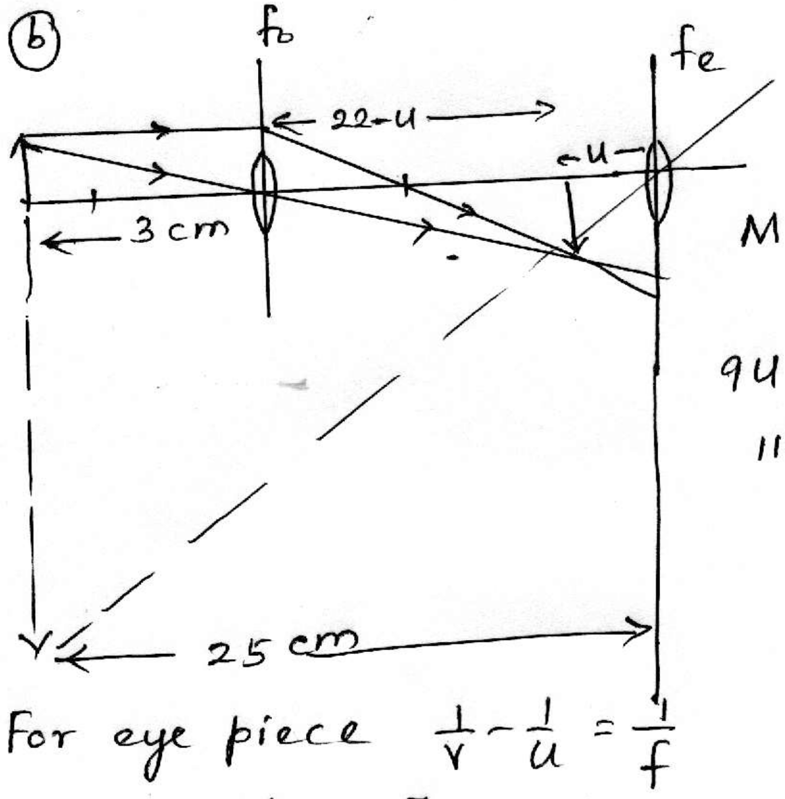
$\theta \approx \underline{\underline{25^{\circ}}}$ — (01)

(9B)

(a)



(b)



$$M = \left(\frac{22-u}{3}\right)\frac{25}{u} = 15$$

$$9u = 5(22-u)$$

$$110 = 14u$$

$$u = \frac{55}{7}$$

For eye piece $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{25} - \frac{7}{55} = \frac{1}{f_e}$$

$$f_e = \frac{25 \times 55}{55 - 175} = -\frac{25 \times 55}{120} = -\frac{275}{24}$$

$$= -11.49 = -11.5\text{ cm}$$

For objective,

$$-\frac{1}{(22-55/7)} - \frac{1}{3} = \frac{1}{f_o}$$

$$-\frac{7}{99} - \frac{1}{3} = \frac{1}{f_o}$$

$$\frac{-7-33}{99} = \frac{1}{f_o}, \quad f_o = -\frac{99}{40} = -2.47\ cm$$

(c) $\frac{1}{f} = -\frac{1}{15} + \left(-\frac{1}{25}\right) = \frac{-5-3}{75} = -\frac{8}{75}$

$$\frac{1}{20} - \frac{1}{u} = \frac{-8}{75} \Rightarrow \frac{1}{u} = \frac{1}{20} + \frac{8}{75} = \frac{15+32}{300} = \frac{47}{300}$$

$$u = 6.38 = 6.4\ cm$$

(d) i) 120 cm

ii) $M = \frac{100}{20} = 5$

iii) $\frac{1}{v} - \frac{1}{120} = -\frac{1}{20}$

$$\frac{1}{v} = \frac{1}{120} - \frac{1}{20} = \frac{1-6}{120}; \quad v = \frac{-120}{5} = -24\ cm$$

diameter of the eye ring (h)

$$\frac{24}{120} = \frac{h}{5}$$

$$h = 1\ cm$$

(10) A) i) $PV = \frac{1}{3} m N \overline{c^2}$ —— (01)

a) P – pressure
V – volume
m – mass of a gas molecule
N – number of molecules
$\overline{c^2}$ – mean square speed.

} —— (01)

(ii) $nRT = \frac{1}{3} m N \overline{c^2}$

$nRT = \frac{2}{3} N \left(\frac{1}{2} m \overline{c^2}\right)$ —— (01)

Average KE of a molecule $= \frac{1}{2} m \overline{c^2} = E$

$E = \frac{3nRT}{2N}$

$N = n N_A$ ← Avagadro's number

$E = \frac{3}{2}\left(\frac{R}{N_A}\right) T = \frac{3}{2} kT$ —— (01)

(b) $k = \frac{R}{N_A} = \frac{8.3\ JK^{-1} mol^{-1}}{6 \times 10^{23}\ mol^{-1}} = 1.38 \times 10^{-23}\ JK^{-1}$ —— (01)

(c) considering one mole of gas,

$RT = \frac{1}{3} m N_A \overline{c^2}$

$\overline{c^2} = \frac{3RT}{mN_A} = \frac{3RT}{M}$

$\sqrt{\overline{c^2}} = \sqrt{\frac{3RT}{M}}$

} —— (01)

(d) $\overline{E} = \frac{3}{2} kT = \frac{3}{2} \times 1.38 \times 10^{-23} \times 400$

$= 828 \times 10^{-23}$ J. — (01)

KE of one mole of molecules $= 6.0 \times 10^{23} \times 828 \times 10^{-23}$

$= 4968$ J — (01)

(e) $V = 100\,cm^3$, $P = 2 \times 10^5\, Nm^{-2}$

$PV = \frac{1}{3} mN\overline{c^2} = \frac{2}{3} \times \left(\frac{1}{2} mN\overline{c^2}\right)$

$PV = \frac{2}{3}$ KE — (01)

$KE = \frac{3PV}{2} = \frac{3 \times 2 \times 10^5 \times 100 \times 10^{-6}}{2}$

$= 30$ J — (01)

(f) $\frac{1}{3} mN\overline{c^2} = nRT$

$\overline{c^2} = \frac{3nRT}{mN} = \frac{3RT}{mN_A} = \frac{3 \times 8.3 \times 300}{5.3 \times 10^{-26} \times 6.0 \times 10^{23}}$ — (01)

[$mN_A = 32g = 32 \times 10^{-3}$ kg is also a correct substitution]

$V_{r.m.s} = \sqrt{\overline{c^2}} = \sqrt{2.349 \times 10^5} = 484.6\, ms^{-1}$ — (01)

momentum change of a molecule $= 2mV$

surface area of a side $= A$

"t" is the time taken to collide n number of molecules — (01)

Force on a wall of a container $= \frac{2mVn}{t}$

pressure on a wall $= \frac{2mVn}{tA} = P$ — (01)

$= \frac{n}{tA} = \frac{P}{2mV} = \frac{1 \times 10^5}{2 \times 5.3 \times 10^{-26} \times 484.6} = 1.95 \times 10^{27}$ — (01)

10 B

a (i) The heat energy (ΔQ) supplied to a closed system is equal to the increase in the internal energy (ΔU) of the system + the work done (ΔW) by the system on its surroundings. — (02)

$\Delta Q = \Delta U + \Delta W$ — (01)

(ii) $W = P(V_2 - V_1)$ — (01)

b) (i) $Q = mc\Delta\theta$ (01)

$C_V = \frac{Q}{n \cdot \Delta\theta}$ — n = number of moles

$= \frac{5\,W \times 25\,s}{(6\times10^{-3}/0.018) \times 30}$ — (01)

$= 12.5\ J\,mol^{-1}K^{-1}$ — (01)

ii) $C_P = \frac{5 \times 25}{6/18 \times 18} = 20.83\ J\,mol^{-1}K^{-1}$ — (01)

iii) Work is done by the system to move the piston in (ii). — (02)

(iv) $PV = nRT$ — (01)

$P\Delta V = nR\Delta T$

$\Delta V = \frac{6}{18} \times \frac{8.314 \times 18}{1\times10^{5}} = 49.884 \times 10^{-5}\ m^3$ — (01)

v) Work done by the sy^m $= P\Delta V$ — (01)

$= nR\Delta T$

$= \frac{6}{18} \times 8.314 \times 18$

$= 49.884\ J$ — (01)