Royal College - Colombo 07
Grade 12
Third Term test – July 2018
Physics I

01 | E | I

Time : 2 hours

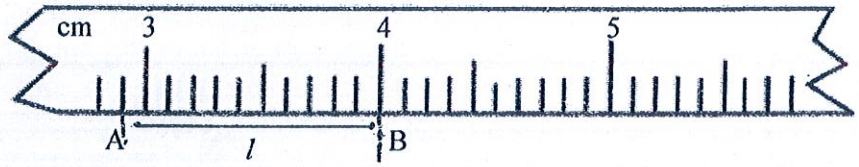
$g = 10\ N\ kg^{-1}$

Answer all questions.

1. The dimensions of refractive index would be,

1) L 2) L^{-1} 3) T 4) T^{-1} 5) මාන නොමැත.

2. A meter ruler is used to measure the length of the line AB (l) as shown in the figure.



The maximum percentage error whould be,

1) $\frac{1}{1.1} \times 100\%$ 2) $\frac{1}{10} \times 100\%$ 3) $\frac{1}{11} \times 100\%$ 4) $\frac{1}{20} \times 100\%$ 5) $\frac{1}{22} \times 100\%$

3. Following table shows the units of given physical quantities under two main unit systems which are using in the world.

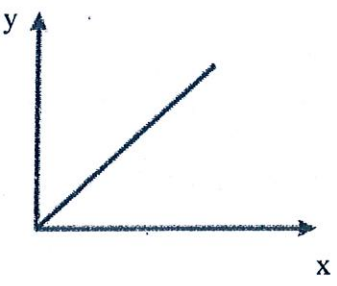
unit system	unit and the physical quantity			
	mass	length	time	energy
SI system	kg	m	s	J
Metric system (C. G. S.)	g	cm	s	erg

1J can be represented by

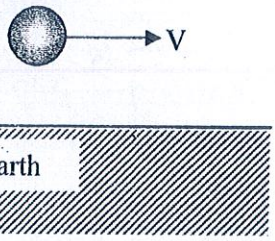
1) 10^{-7} erg 2) 10^{-5} erg 3) 10^{4} erg 4) 10^{5} erg 5) 10^{7} erg

4. The product of the gradient and the surface area of the given graph is equal to the square of velocity. y and x axes are given by

1) displacement, time
2) distance, time
3) velocity, time
4) acceleration, time
5) force, time.



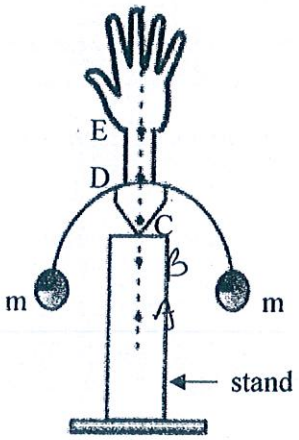
5. The path of the ball under gravity and without gravity are correctly represented by,



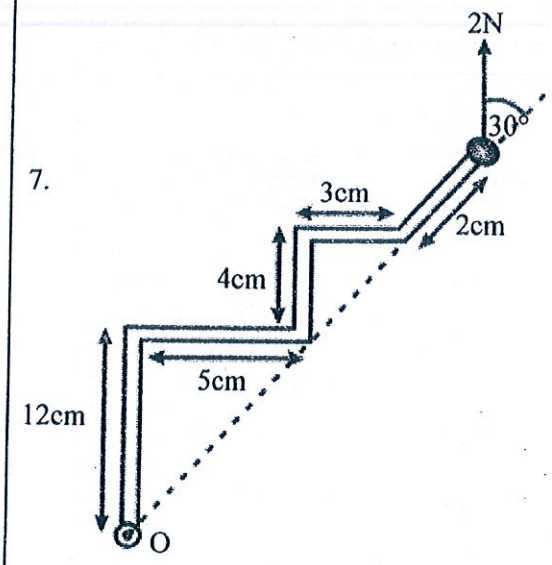
	(1)	(2)	(3)	(4)	(5)
under gravity					
without gravity					

6. A frame made for decorating a table is just touched at point C under stable equilibrium. If the two masses of 'm' are converted into '2m', the centre of gravity of the frame would be, at point.

1) A 2) B 3) C
4) D 5) E

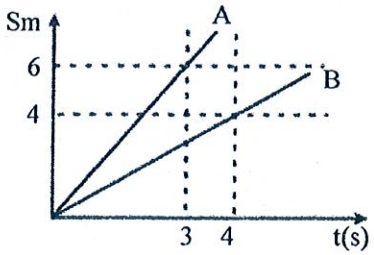


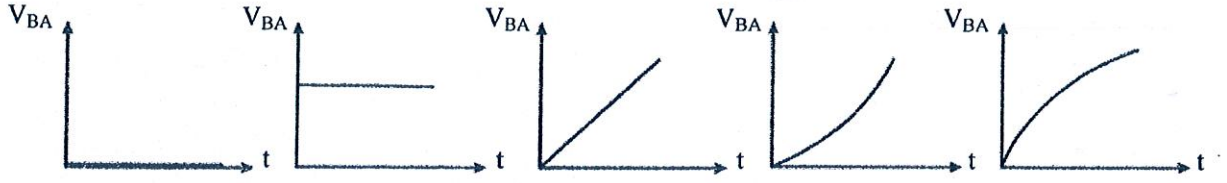
7. A gear rod of a bus is bended at number of points as given in the figure. If the force applied on the gear box by the driver is 2N the moment around the point O is given by,



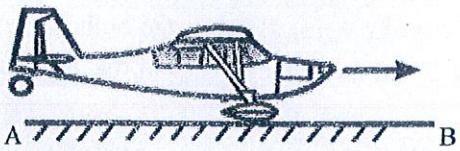
1) 0.16 Nm 2) 0.18 Nm 3) 0.2 Nm
4) 0.36 Nm 5) 0.4 Nm

8. Displacement – time graphs for two objects A and B are given in the figure. The best representation of the velocity of B, relative to the velocity of A (V_{BA}) is given by,





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

9. 

Ground track

Following figure shows an air craft is moving from A to B with constant acceleration before the launching. The velocity of the wind is V. The true statement from following is

1) When v = 0, the air craft can be uplifted very quickly.
2) When the wind flows from A to B, the air craft can be uplifted quickly.
3) When the wind flows from B to A, the air craft can be uplifted quickly.
4) When the wind flows vertically upwards, the air craft can be uplifted quickly.
5) The velocity of the wind not affected at all to uplift the air craft.

10. The variation of the displacement with time of two waves generated two sources are given as followers.

$x_1 = 3 \sin(\omega t)$ $\quad x_2 = 4 \sin\left(\omega t + \frac{\pi}{2}\right)$

When these two sources are vibrated in the same time, the amplitude of the resultant waves generated, is,

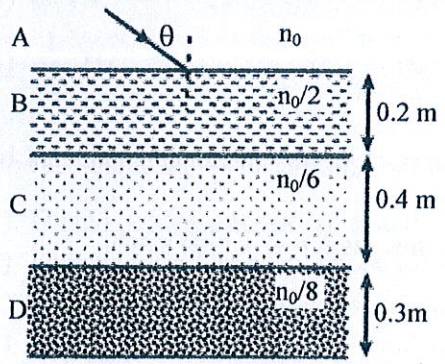
1) 7 m 2) 5 m 3) 4 m 4) 3 m 5) 1 m

11. Consider the following statements regarding a astronomical telescope

a) The final image is formed at infinity at the normal adjustment.
b) The situation of the final image is formed at the least distance of vision is not mostly applicable as there is less magnifying power.
c) The focal length of the objective lens is less than the focal length of the eye piece at all.

The true statement (s) is (are)

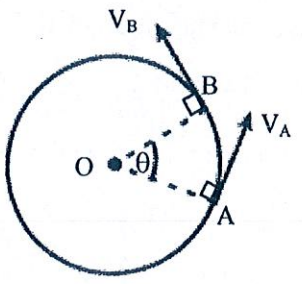
1) A only. 2) A and B only. 3) B and C only.
4) A and C only 5) A, B and C only.

12. 

A, B, C and D are four transparent mediums having refractive indexes n_0, $\frac{n_0}{2}$, $\frac{n_0}{6}$ and $\frac{n_0}{8}$ respectively. A light ray is entered in angle θ at the AB common surface. The angle θ, to be barely avoided to enter the ray to the medium D is

1) $\sin^{-1}\left(\frac{3}{4}\right)$ 2) $\sin^{-1}\left(\frac{1}{8}\right)$ 3) $\sin^{-1}\left(\frac{1}{4}\right)$ 4) $\sin^{-1}\left(\frac{1}{3}\right)$ 5) $\sin^{-1}\left(\frac{1}{6}\right)$

13. The velocities of two points A and B on the circumfarence of a rotating disc under constant angular velocity are V_A and V_B respectively. The value of $\frac{(V_A - V_B)}{(V_A + V_B)}$ is,



1) $2 \sin\left(\frac{\theta}{2}\right)$ 2) $2 \cos\left(\frac{\theta}{2}\right)$ 3) $2 \tan\left(\frac{\theta}{2}\right)$ 4) $\cos\left(\frac{\theta}{2}\right)$ 5) $\tan\left(\frac{\theta}{2}\right)$

14. A and B two cyclists are riding their bicycles with constant velocities of 20 ms^{-1} and 12 ms^{-1} respectively. At the starting point, B is in front of A. At the moment of passing B by A, the both cyclists are starting to move under acceleration. After 12 s A is passed by B and the velocity of B at that moment is 36 ms^{-1}. The velocity of A at the same moment is,

1) 24 ms^{-1} 2) 28 ms^{-1} 3) 32 ms^{-1} 4) 34 ms^{-1} 5) 36 ms^{-1}

15. Consider the statements regarding tsunami waves,

A) Tsunami wave generated due to landslides.

B) Tsunami waves are transverse waves.

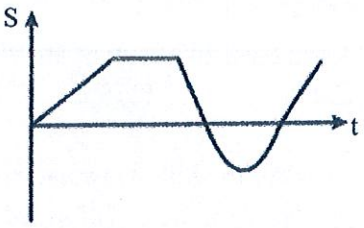
C) When the Tsunami waves are reaching to the land, the amplitude will be decreased due to the reduction of the speed of the wave.

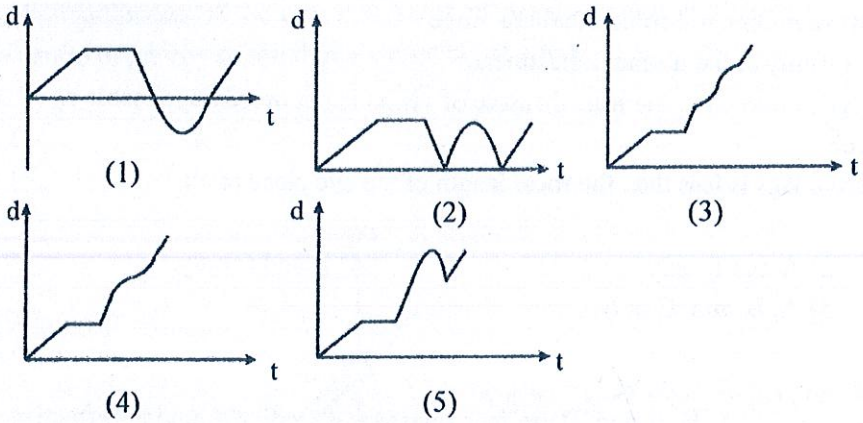
The true statement (s) is (are)

1) A and B only. 2) B and C only. 3) A and C only.

4) A, B and C all are true 5) A, B and C are false

16. The best representation of the distance – time graph, relevant to the given displacement - time graph is,

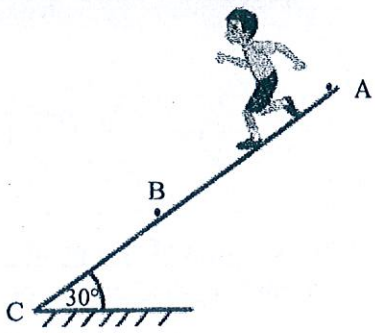


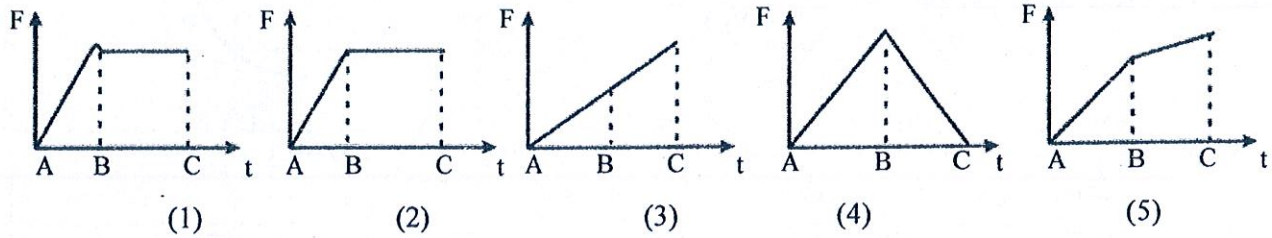


17. The true statement regarding echo from following is,

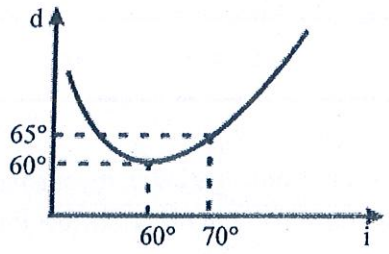
1) The intensity of echo received by the observes is greater than the intensity of direct sound sent by a source.
2) A high intensity, clear echo can be heard by a sound of having low pitch than a high pitch.
3) The pitch a sound is affected when forming an echo.
4) Rough surfaces form echoes very easily.
5) Echo can be experienced in the air medium only.

18. A man of 50 kg mass is sliding from A to C on a rough inclined surface which is inclined in 30° to the horizontal He became to a constant velocity at point B. The co-efficient of friction between the man and the surface is $\frac{1}{\sqrt{2}}$. The best representation of the variation of the friction force (F) with displacements (S) is,





19. The variation of the angle of deviation (d) with the angle of incidence (i) is represented by the given graph. Consider the following statements.



A) Angle of the prism is 60°.

B) refractive index of the prism is $\sqrt{3}$

C) Angle of incidence 45° gives 65° deviation.

The correct statement (s) is/are

1) A and B only. 2) B and C only. 3) A and C only.

4) All A, B and C 5) All A, B and C are false.

20. Relative densities of two liquids A and B are S_1 and S_2 respectively. V_1 and V_2 volumes from A and B liquids are mixed together. The relative density of the mixture is S. The change of the volume when mixing two liquids is,

1) $\frac{[v(S_1+S)+V_2(S_2+S)}{S}$

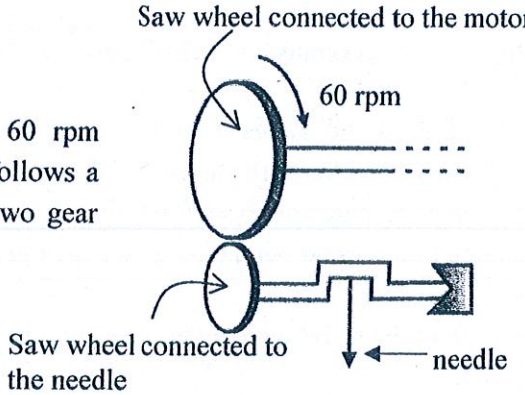
2) $[V_1(S_1-S)+V_2(S_2-S)]$

3) $\frac{[V_1(S_1+S)+V_2(S_2+S)}{S(V_1+V_2)}$

4) $\frac{[V_1(S_1-S)+V_2(S_2-S)}{S(V_1-V_2)}$

5) $\frac{[V_1(S_1-S)+V_2(S_2-S)}{S}$

21. When a motor of sewing machine is rotating in 60 rpm (revolutions per minute), the motion of the needle follows a simple harmonic motion. The ratio of the radii of two gear wheels is 2 1. The frequency of the needle is,



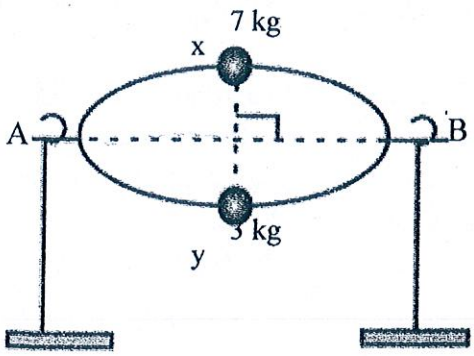
1) 60 Hz 2) 30 Hz 3) 2 Hz

4) $\frac{1}{30}$ Hz 5) $\frac{1}{60}$ Hz

22. The correct statement regarding the sound at a node or anti node of a stationary wave in air, is

1) There is a high intensity of sound at nodes due to maximum pressure.
2) There is a high intensity of sound at nodes due to maximum amplitude.
3) There is a high intensity of sound at anti nodes due to maximum amplitude.
4) There is a high intensity of sound at antinodes due to maximum pressure.
5) Same sound can be heard at both nodes and antinodes.

23. A light ring of 1 m radius is free to rotate smoothly about an AB horizontal axis. Two masses of 7 kg and 3 kg are fixed at x and y points on the circumference. The line xy is perpendicular to the line AB. Now the ring is released smoothly when the plane of the ring is at its horizontal position. The angular velocity of the ring when the plane of the ring became vertical is,



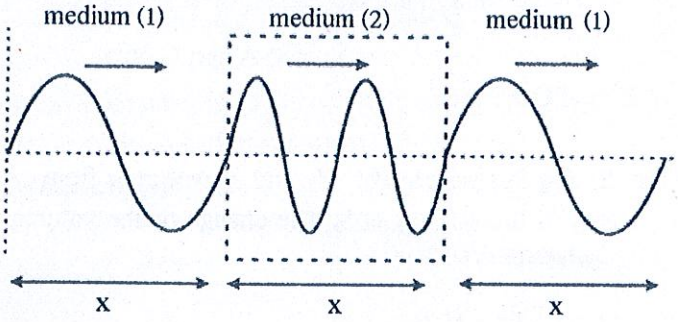
1) 2 rads^{-1} 2) 4 rads^{-1} 3) 6 rads^{-1}

4) 8 rads^{-1} 5) 10 rads^{-1}

24. Two objects of A and B are kept at a distance of 32 cm apart. When a convex lens of having 15 cm focal length is kept between two objects, the two images of A and B formed by the lens are coincided. The distance to one object from the lens is,

1) 20 cm 2) 18 cm 3) 16 cm 4) 14 cm 5) 10 cm

25. The wave propagating in the medium (1) enters to the medium (2) and again it enters to the medium (1) as shown in the figure. Consider the following statements,



A) First medium is denser than the second medium.

B) When the wave is entering to the second medium, the frequency is doubled as there are two cycles.

C) The velocity in the second medium with respect to the first medium would be half.

The true statement (s) is (are)

1) A only. 2) B only. 3) C only. 4) A and B only. 5) All A, B and C

26. The pitch of the sound waves emmitted from the musical instruments can be changed due to heating of the instruments when they are played.

The most accurate statemnet from following is,

1) The pitch of the wood wind instruments will be reduced while that of in string instruments will be increased.

2) The pitch of the wood wind instruments will be increased while that of in string instruments will be reduced.

3) The pitch of the both wood wind and string instruments will be increased.

4) The pitch of the both wood wind and string instruments will be decreased

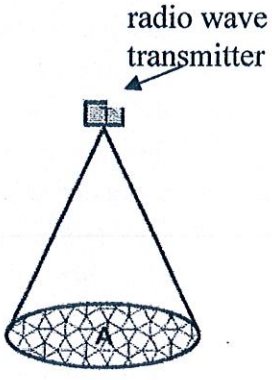
5) The pitch of the both wood wind instruments and the string instruments remain constant.

27. The distance between two lenses in a compound microscope under normal adjustment is 10 cm. The focal lengths of the lenses used in microscope are 0.5 cm and 1 cm. The magnifying power of the microscope is (Least distance of distinct vision is 25 cm)

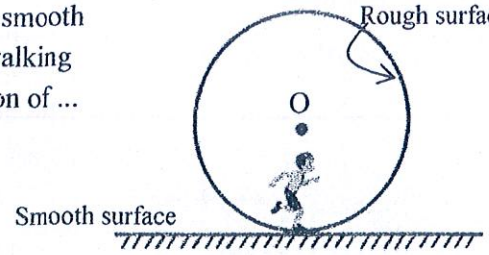
1) 111 2) 222 3) 333 4) 444 5) 555

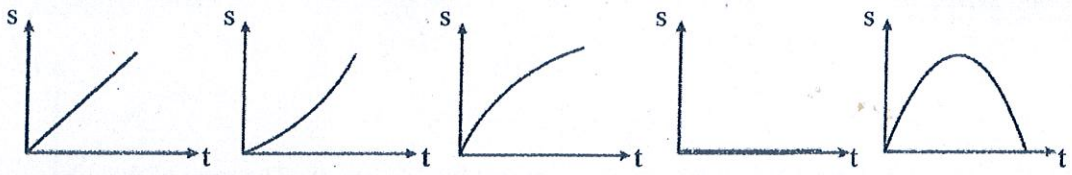
28. The signals emitted from a radio transmitter are spread on the earth surface in ' A' area. To increase this area, the transmitter should be raised up in a similar height to the present height. The new spread area of the signals on the earth is,

1) A 2) 2A 3) 3A 4) 4A 5) 5A

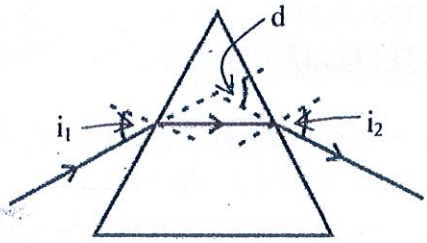


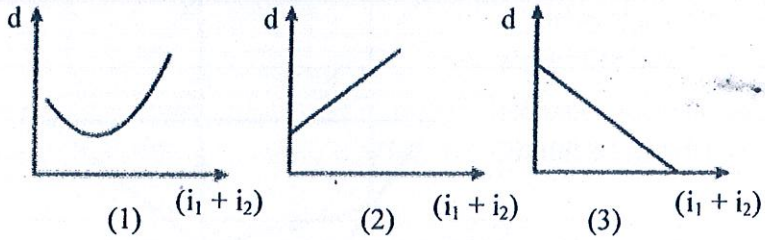
29. A hollow sphere of having rough internal surface is kept on a smooth surface as shown in the figure. The man inside the sphere is walking under constant velocity. The best representation of the variation of ... displacement of the centre of the sphere. (s)

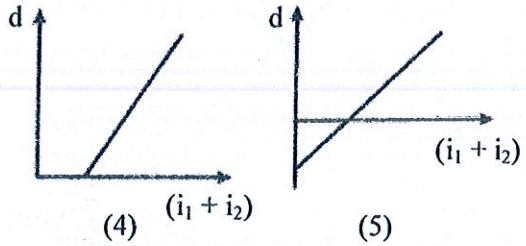




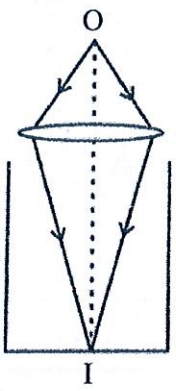
30. A monochromatic light ray is traveled through a prism as shown in the figure. The best representation of the variation of the angle of deviation (d) with $(i_1 + i_2)$ is,



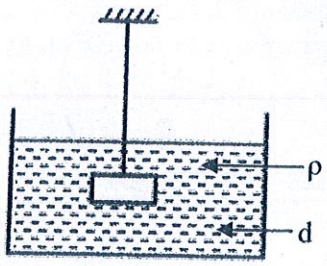




31. The radio signals transmitted via short waves can be heard at far distances. But when they are transmitted via medium waves cannot be heard much more distance.
The most suitable reason for this is,
1) In medium wave transmission the receiver will receive the waves having low energy, due to the large deviation of the signals by colliding the air particles than the short waves.
2) A large amount of energy is transmitted by short waves than the medium waves.
3) Short waves are reflected effectively by an ionized air layer in the upper atmosphere.
4) Medium waves are longitudinal and short waves are transverse.
5) Short waves travel easily around the earth than the medium waves.

32. 

The image (I) of the object 'O' formed by the convex lens is at the bottom of the beaker as given in the figure. Now a liquid of having 1.6 refractive index is poured in to the beaker up to 8 cm height. The distance of the beaker to be moved to form the image at the bottom of the beaker again, is,
1) 2 cm downward 2) 2 cm upward 3) 3 cm downward
4) 4 cm downward 5) 4 cm upward

33. 

An object of density ρ is hung by a string and completely immersed in a liquid having density d. At the moment of the string is cut, the beaker with the liquid is dropped vertically downward. The acceleration of the object would be,

1) $\left(1-\frac{d}{\rho}\right)g$ 2) $\left(1+\frac{d}{\rho}\right)g$ 3) $\left(\frac{d}{\rho}\right)g$

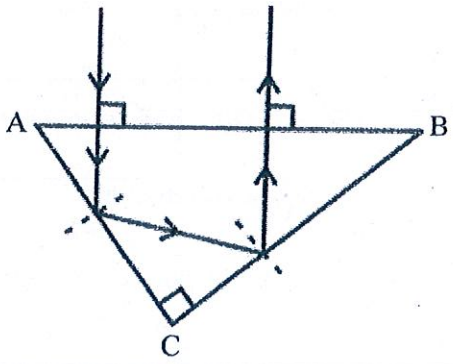
4) $\left(\frac{\rho}{d}\right)g$ 5) g

34. An object is moving vertically downward under gravity from rest for 10 second. The ratio of the displacements, completed by the objects within last 3 seconds.

1) 17 : 19: 21 2) 15: 17: 19 3) 13: 15: 17

4) 11 : 13 : 15 5) 9 : 11 : 13

35. A light ray entered perpendicularly to a right angle prism is emerged parallel to the incident ray after two total reflections as shown in the figure. When $\hat{B} \leq \hat{A}$, the minimum possible value for the refractive index of the prism material to be full fill the above condition would be



1) $n_{min} = \frac{1}{\sin(A)}$ 2) $n_{min} = \frac{1}{\sin(B)}$

3) $n_{min} = \frac{\sin(A)}{\sin(B)}$ 4) $n_{min} = \sqrt{\sin(A) \times \sin(B)}$

5) $n_{min} = \frac{\sin(B)}{\sin(A)}$

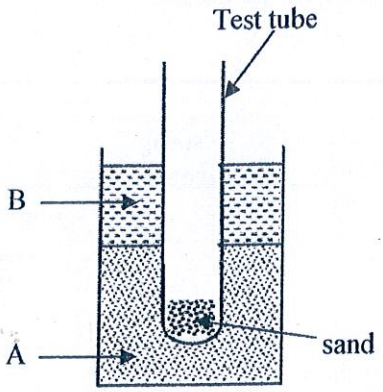
36. Consider the data given in the table regarding two rolling spheres A and B. (The moment of inertia of a sphere of having radius R and mass m, is $\frac{2}{5}mR^2$)

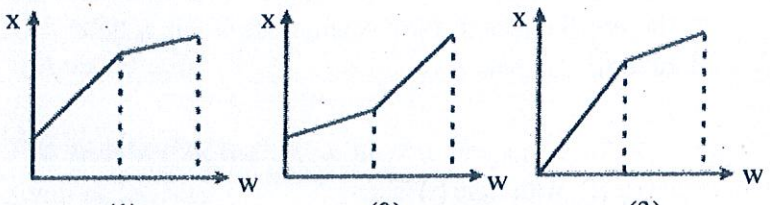
	A	B
mass	8m	3m
radius	2R	R
density	ρ	3ρ
tangential velocity	3V	V

According to the table $\frac{\text{angular moment of A}}{\text{Angular moment of B}}$ would be

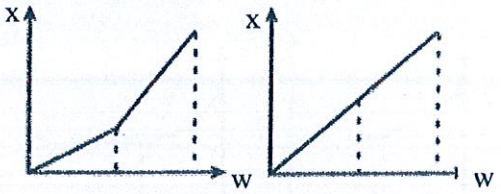
1) 32: 1 2) 16:1 3) 8: 1 4) 4:1 5) 2: 1

37. A and B are two immiscible liquids. A test tube is floating vertically in these two liquids. Initially this test tube is floating in only B liquid. By adding the sand, the tube is moving downward and floating in both liquids. The best representation of the variation of the depth (x) of the tube with the weight of the sand added (W) is,





(1) (2) (3)



(4) (5)

38.

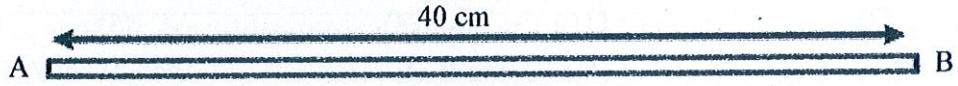


Figure (1)

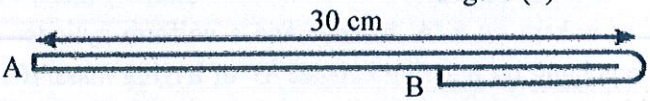


Figure (2)

When the uniform conducting rod AB in the figure (1) is folded as figure (2), the displacement of the centre of gravity is,

1) 5cm ← 2) 5cm → 3) 2.5cm ← 4) 2.5cm → 5) 1cm ←

39. A graph is drawn for a convex lens by changing the object distance (u) and obtaining the relevant image distance (v) for real objects. (u > f). Consider the following situations

(A) $\frac{1}{v}$ and $\frac{1}{u}$ (B) uv and (u + v) (C) $\frac{v}{u}$ and v

Linear graph can be expected from

1) A only 2) A and B only 3) B and C only
4) C and A only 5) All A, B and C

40

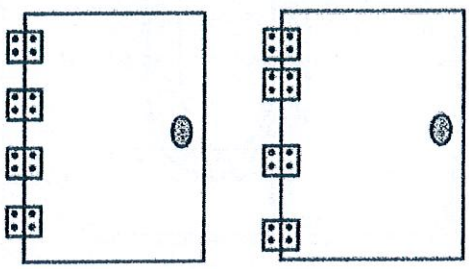


figure x figure y

Four door hinges are fixed in different points in two identical doors as shown in figures (x) and (y). Consider the following statements.

(A) The most suitable adjustment is x.
(B) The most suitable adjustment is y.
(C) As the number of door hinges used in both doors are equal, the positions of fixing them are not be considered.

The most accurate statement is,

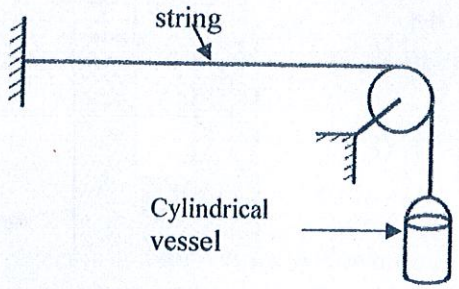
1) A only 2) B only 3) C only
4) A and C only 5) B and C only

41. A man of having a defective eye can see infinity. His near point is75cm. When he wears spectacles to eliminate his eye defect, the new far point that can be seen by him is,

1) infinity 2) 75cm 3) 50cm 4) 37.5cm 5) 25cm

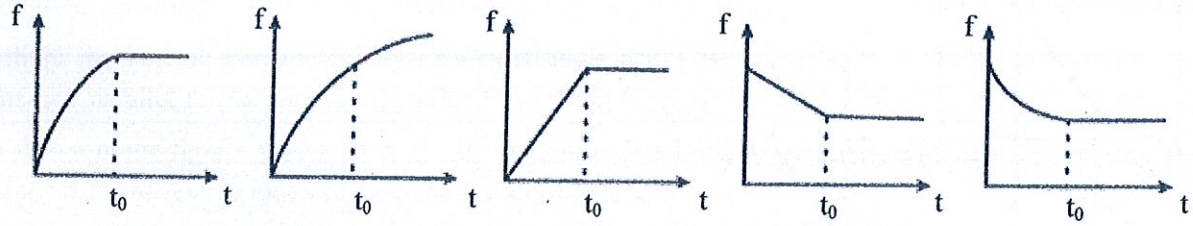
1

42.



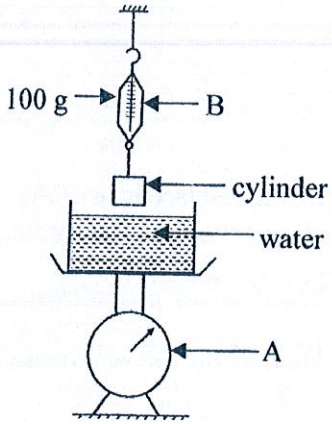
An empty cylindrical vessel is hung by a string which is gone through a pulley as shown in the figure. When plucking the string, it is vibrated in 'f' frequency. Now the water is added in to the vessel under uniform volume rate within t_0 time duration.

The best representation of the variation of the frequency (f) with time (t) is



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

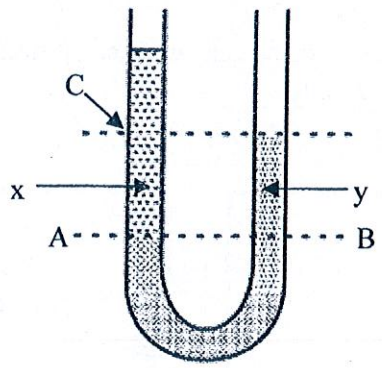
43.



A water beaker is kept on a 'A' balance and a uniform cylinder of $40cm^3$ volume is hung by a spring balance 'B' of having mass 100g. The reading of the balance 'A' is 230g and the reading of the balance 'B' is 195g. when the cylinder is completely immersed in the water, the readings of two balences A and B respectively are (density of the water = 1000 kgm^{-3})

1) 190g , 235g 2) 190g , 155g 3) 270g, 155g
4) 270g, 235g 5) 235g , 190g

44. A U – tube of having similar arms is filled with two immiscible liquids X and Y having densities of 900 kgm^{-3} and 1200 kgm^{-3} respectively. Heights of two liquid columns X and Y from the AB common surface are 24 cm and 18 cm respectively. The liquid X is leaking out from the tube due to a crack at the upper part of the tube from the level C. The change of the liquid level from the common surface AB is



1) 2.7cm upward 2) 2.7cm downward 3) 3.6cm upward
4) 3.6 cm downward 5) 6cm upward

45. Consider the following statements.

A) When the Mack number is greater than 1, a sonic boom is generated.

B) Primary (P) waves are a kind of a fastest seismic waves and having highest frequency.

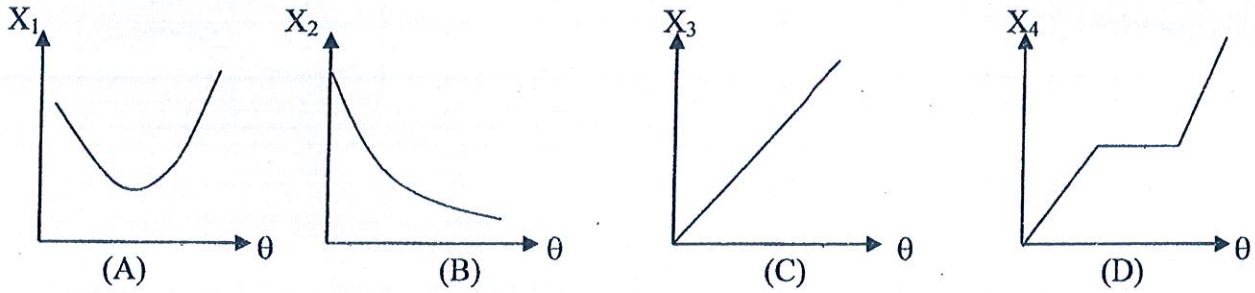
C) Tsunami waves can be generated by slipping of earth layers horizontally.

The false statement is,

1) A only 2) B only 3) C only

4) A and B only 5) A and C only

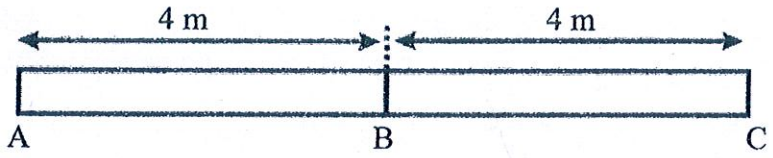
46. The variation of the thermometric properties of X_1, X_2, X_3 and X_4 with the temperature is given as follows.



The most suitable thermometric properties which can be used to make a thermometer are,

1) A and B only 2) B and C only 3) C and D only

4) A and C only 5) A and D only

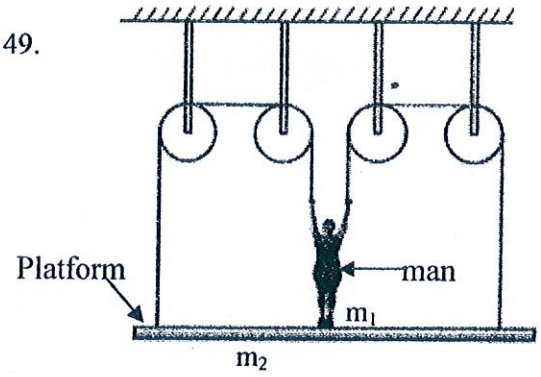
47. 

AB and BC are two metal rods having same dimensions. Young's modulus of AB and BC rods are 1×10^{11} Nm^{-2} and 2×10^{11} Nm^{-2} and the densities of them are 9000 kgm^{-3} and 8000 kgm^{-3} respectively. The time taken to send a sound wave from point A to point C is,

1) 1×10^{-3} s 2) 2×10^{-3} s 3) 3×10^{-3} s 4) 4×10^{-3} s 5) 5×10^{-3} s

48. The body temperature of a patient is said by a nurse as 102 without mentioning any unit. That temperature in Celsius (°C) would be,

1) 216 2) 102 3) 51 4) 39 5) 30

49. 

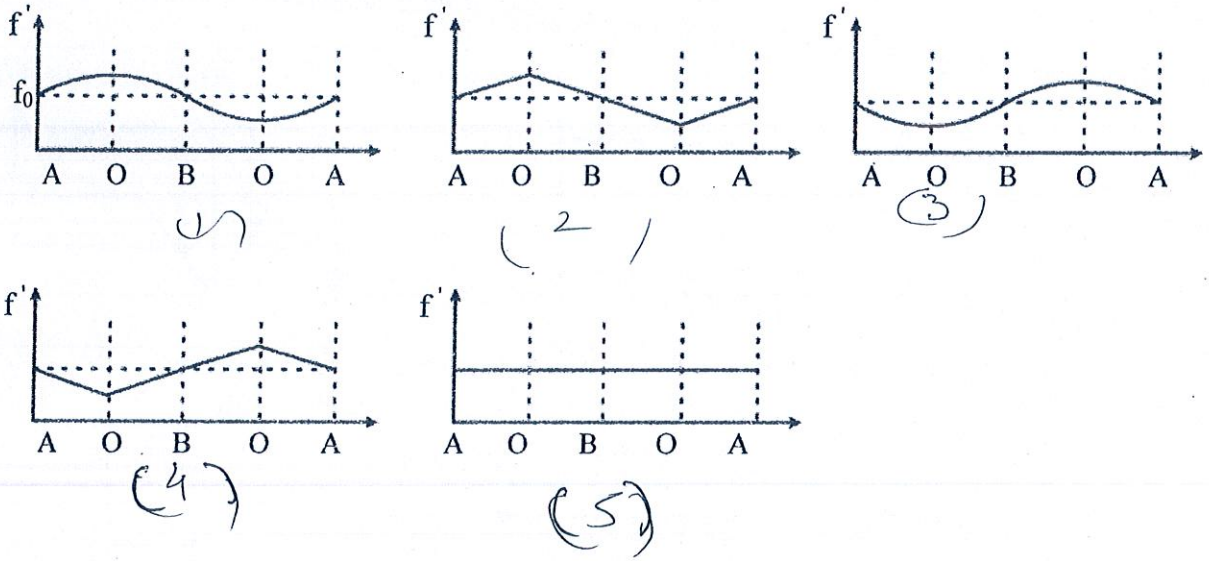
A platform set up to use in wall paintings as shown in the figure. The masses of the man and the platform are m_1 and m_2 respectively. The weight of the strings can be negligible through the smooth pulleys. When the man is applying two equal forces of F on the string, the acceleration of the platform towards the upward is,

1) $\frac{2F-(m_1+m_2)g}{(m_1+m_2)}$ 2) $\frac{2F-m_2g}{m_2}$ 3) $\frac{2F-m_1g}{m_1}$

4) $\frac{4F-(m_1+m_2)g}{(m_1+m_2)}$ 5) $\frac{4F-m_2g}{m_2}$

50.

X is an object performing a simple harmonic motion and S is a source kept at a point of anti node. S emits sound waves of constant f_0 frequency. The variation of the apparent frequency (f') received by the observer 'X' with its position correctly represented by,



Part B – Essay

- **Answer 03 questions only.**

05. The ladders are used when repairing the current carrying conductors.The figure -1 shows an arrangement of a ladder to reach the post. Consider the ladder is uniform and its length is 4m and its mass is 10kg.

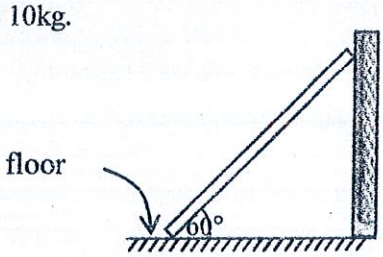


Figure (I)

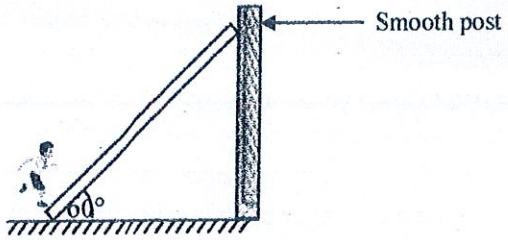


Figure (II)

(a) If the surface of the post is smooth, mark and name the forces acting on the ladder under equilibrium.

(b) Find the magnitude of reaction forces acting on the ladder by the post and the floor.

(c) Find the minimum coefficient of friction between the floor and the ladder to climb the man of 50 kg to the upper end of the ladder as shown in figure (II).

(d) Find the minimum angle (θ) should be made with the floor, to climb the man to the upper end without slipping the ladder. The coefficient of friction of the floor (μ) is 0.26.

(e) Calculate the minimum co-efficient of friction between the surface of the post and the ladder to climb the man to the upper end according to the figure (II) when the co-efficient of friction of the floor and the ladder is 0.26.

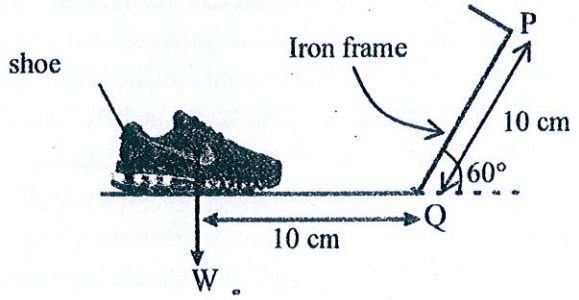


Figure (III)

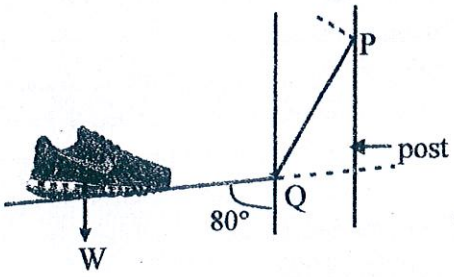


Figure (IV)

A special shoe frame is introduced to climb the post as shown in the figure (III) and figure (IV) shows that how to climb the post by using it.

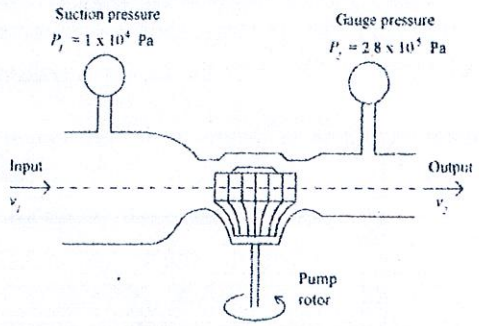
(f) Calculate the reaction forces acting at the points P and Q according to the figure (IV) and their angles between the post.(Assume that the man is at rest and a half of the weight of the man is applied on one shoe.)

(g) Write an advantage of using the above shoe arrangement rather than the ladder.

(sin 80 = 0.98), (sin 70 = 0.94), (sin 10 = 0.17), (sin 20= 0.34)

06. i) Give one reason for impossibility of applying Bernoulii principle for each one of the followings.
   a) For air
   b) For a flowing fluid through a narrow tube.

Figure shows a petrol pump in a garage. The pump delivers petrol with a density of 750 kgm^{-3} at a rate of 1.2×10^{-2} m^3 s^{-1}. The input to the pump is from a pipe with a cross-sectional area A_1 of 4×10^{-3} m^2 at a suction pressure P_1 of 1×10^4 pa. The discharge of the gauge pressure P_2 of 2.8×10^5 m^2 Pa into a pipe with a cross – sectional area A_2 of 8×10^{-4} m^2. The pipes at the entrance and exit at the same horizontal level and the temperature of the petrol remains constant throughout the floor.



(a) Find the average flow speeds V_1 and V_2 of the petrol into and out of the pump.
(b) Find the change in kinetic energy per unit mass of petrol.
(c) By considering the work done per unit mass of petrol at the entrance and exit of the pump, find the work done by the pump in delivering a unit mass of petrol.
(d) Find the mechanical power developed in the pump in order to maintain the above flow conditions.
(e) Explain why, in reality, the mechanical power of the pump required is higher than that calculated in (d)
(f) With the aid of a diagram, explain why an aircraft wing can generate a 'lift' when it moves in air.

7) The sound waves which the frequencies are greater than 20 kHz, cannot be heard by the human ear. These waves are called as Ultra sound waves, and they consist with short, wave lengths. These waves are mostly used in fields like medical science, communication.... etc.
Using of Doppler effect to determine the speed of red - blood cell in a blood vessel by Ultra – Sound waves, is an example in medical field. Also Ultra – Sound scaning is used to check organs inside the body to diagnose the disease.
The high frequency sound waves and their echoes which used in medical imaging technology is similler to the waves and their echoes used by the "Bats" and "Whales" to find their path. In this technique a pulse of range (1 – 5) MHz is aimed into the tissues by a small probe contact to the body. The wave reflected by a certain bone or tissue recieved by the probe again. The scan machine calculate the distance between the tissue and the mechine by using, the speed (1540 ms^{-1}) of the sound waves travel through the tissues and the time taken to travel back after reflection. By using the intensities of echoes and the distance, a two dimensional image is formed on the scan machine.
The speed of the blood cells are determined by the difference of the apparent frequencies occur due to Doppler's effect.
One of the side effect observed on the ultra sound scanning is, the slight increase of temperature of the tissues and fluids in the body after abosrbing the energy of the waves. This affect for the growth of the heart of the embryo when it is scanned some evidence may shows that, this caused to give birth infants of less weight.
Speed of the ultra sound in bone or hard tissues is about 4000 ms^{-1}. Scanning test are used to identify tumors formed inside soft tissues. But the tissues and the knots smaller than the wavelength of the ultra sound wave are cannot be identified by the scanning test. The ultra sound waves having high frequencies can not travel through tissues and therefore it get difficult to identify the small hoots present

inside the tissues. The maximum depth that such a wave can travel through tissue is considered as 500 λ. Therefore the tumors grown in tissues cannot be identified at their early stages, by these waves.

a) Write two instants which ultra sound waves used in medical field.

b) I. A sound wave of frequency 3 MHz is sent by the scan machine into the abdomen in a certain test. Find the wavelength of that wave. (Ultra sound waves have same speed in all tissues)

II. What is the maximum depth to the position of tissues that can be identified by a 3 Mhz signal?

III. What distance has to be set between two tissues to make the 6.75 μs time difference between two detecteded reflection waves?

c) I. The intensity of a wave used to check an embryo of surface area 12 cm^2 is 0.1 Wm^{-2}. If the embryo absorbed 40% of the energy and it takes 12 minuits to scanning process, then find the energy absorbed by the embryo.

II. Find intensity level of the wave used to above scanning process.
(absolute intensity I0 = 10^{-12} Wm^{-2})

III. Find the intensity of the wave that should be used decrese the above intensity level in part (II) in to a half.

d) To measure the speed of blood in a human body a pulse of ultra sound wave of 2MHz is sent to the blood cells and allowed it to reflect back. Then it is observed that the frequency of the reflected pulse was increased by 0.2 kHz. The probe emits waves with making an angle 60° with the direction of blood flow.

i) What is the direction of blood flow?

ii) Obtain an expression for the frequency of the reflected puls, by taking the speed of the blood as V_0. (the speed the ultra sound in tissues V = 1540ms^{-1})
If the speed of blood cells are comparatively very small than the speed of ultra sound waves, show that the difference of frequency between the incident and the reflected waves is $\frac{2V_0 \cos\theta}{V} f$. Hence find the value of V_0

(8) a) Write an expression for the refractive index of the refracted medium with respect to the incident medium, in terms of

n_1 – absolute retracting index of incident medium,
n_2 – absolute retracting index of refracted medium,
i – incident angle, r – angle of refraction

i) Draw the ray diagram for the refraction when $n_1 > n_2$ Indicate the angle of deviation (d) on that diagram
Write an expression for the angle of deviation (d); in terms of i and r

ii) Partial reflections can be occured in every refraction. In the situation in above (a), the angle between the refracted ray and the partial reflected ray gets 90° for a certain incident angle θ, Find the value of θ. ($n_1 = 1.5$, $n_2 = 1$)

b) A glass cube of one side 40cm, has a refractive index of 1.5. The ongle of incidence of a light ray on one surface of the cube is 60°

i) Find the angle of deviation after the refraction from that surface.

ii) Find the angle of emergent of the above ray when it emerges to the first medium through the opposite surface

iii) Find the displacement between the incident ray and the emergent ray

iv) As shown in figure I a point light source is fixed to the bottom of the inner surface of the vessel. A liquid is filled into the vessel up to a height of 20 cm from the light source. The thickness of the bottom is 6 cm. An observer observes a circular bright spot of diameter 55.056m on the surface of the 1.2 ..... when it is viewed from the above

(i) Find the critical angle for the liquid air surface
(ii) Find the refractive index of the liquid
(state the answer for two decimal places)

c) The vessel is then kept on a plane mirror as shown in figure II and the source is viewed from the above. Then two images of the light source is observed.

(i) Draw the ray diagrams to show the formation of the images.
(ii) Find the distance between the observed images.

(8) a) Write the relationship between following physical quantities, when a light ray is refracting from one medium to another medium.

n_1 – absolute retracting index of incident medium,
n_2 – absolute retracting index of refracted medium,
i – incident angle, r – angle of refraction

i) Draw the ray diagram for the refraction when $n_1 > n_2$ Indicate the angle of deviation (d) due to the refraction on the same diagram.
Write an expression for the angle of deviation (d); in forms of i and r

ii) Partial reflections can be occured in every refraction according to the laws of reflection. In the situation in above (a- i), the angle between the refracted ray and the partial reflected ray gets 90° for a certain incident angle θ.
Find the value of θ ($n_1 = 1.5$, $n_2 = 1$)

b) A glass cube of one side 40cm, has a refractive index of 1.5. The angle of incidence of a light ray on one surface of the cube is 60°

i) Find the angle of deviation after the refraction from the first surface.
ii) Find the angle of emergent if the above ray is emerged to the first medium from the opposite surface
iii).Find the displacement between the incident ray and the emergent ray
iv) A point light source is fixed to the bottom of the inner surface of the vessel having a bottom of 6cm thickness. A liquid is filled into the vessel up to a height of 20 cm and observe the light sourse from vertically above.The observer observes a circular bright spot of diameter 55.056cm on the surface of the liquid.

(I) Find the critical angle for the liquid air surface
(II) Find the refractive index of the liquid
(State the answer for two decimal places)

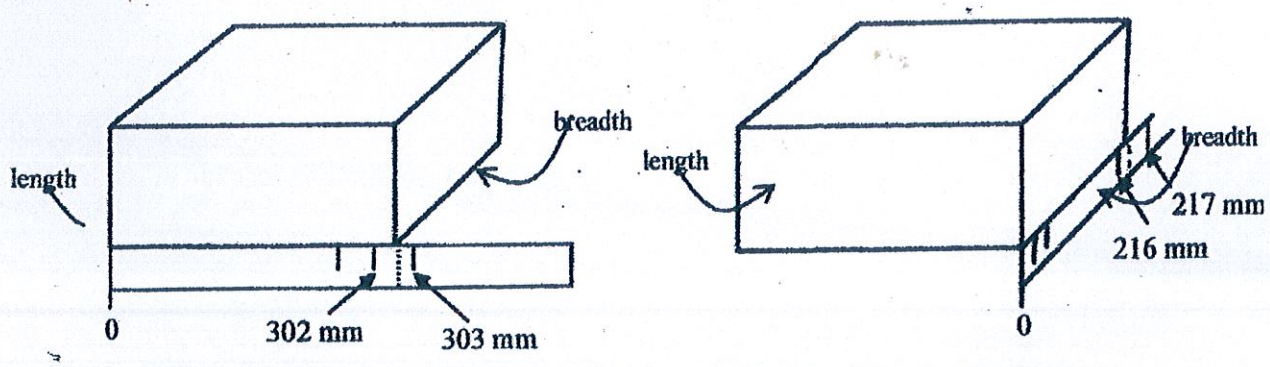
c) Now the vessel is kept on a plane mirror and the source is viewed from the vertically above. Then two images of the light source are observed.

(i) Draw the ray diagrams to show the formation of the images.
(ii) Find the distance between two images observed.

Part A – Structured Essay

1. To store A_4 sheets efficiently you are supplied several storage boxes made out of hard cardboard, in different heights. To take the required measurements a scientific meter ruler, a normal micrometer screw gauge and a vernier caliper using in the school lab are provided.

   a. Following diagram shows how to use a meter ruler to measure a length and breadth of a selected box.

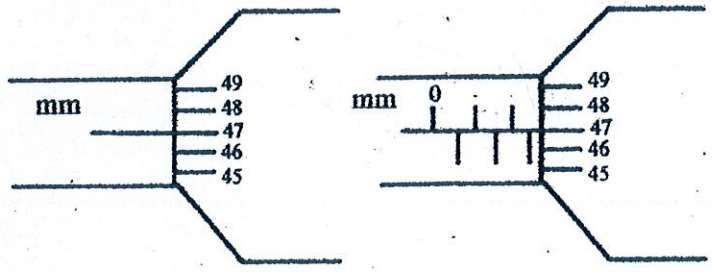


   i) i) Write down the corresponding fractional errors for the above two incidents if the zero mark of the meter ruler is exactly in line with the edge of the end of the box as shown in the figure.

   Length: $\frac{(1/2)}{303}$ width : $\frac{(1/2)}{216}$ (01)

   b. The thickness of the cardboard was measured by using the micro meter screw gauge as shown below.

Figure 1 Figure 2



When the anvil and the spindle are in contact together

When the object is gripped between the anvil and the spindle

   i) Find the thickness of the cardboard.

   Error = (50-47) x 0.01 = 0.03 mm.

   Reading = (2.5+0.47) + 0.03 = 3.00 mm (01)

   (01)

   ii) When the length and breadth of an A4 sheet are 29.7 cm and 21 cm respectively show that an A4 sheet can be stored horizontally in the above box according to the measurements got in part(a) (i) and (b) (i) (01)

   Internal reading = 303 mm - 3mm x 2 = 297 mm

   Internal breadth = 216 mm - 3x2 mm = 210 mm.

   These values are equal to the width and the length of A_4 sheet (01)

(7) a) To find the speed of blood cells., Scanning ——— (01)

b) i. $\lambda = \frac{1540}{3\times10^6} = 51.3\times10^{-6}\,m$. ——— (01)

ii. $500\lambda = 500\times51.3\times10^{-6}\,m = \underline{25.65\times10^{-3}\,m}$ ——— (01)

iii. distance $= \frac{vxt}{2} = \frac{1540\times6.75\times10^{-6}}{2}$ ——— (01)

$= \underline{5.2\times10^{-3}\,m} = \underline{5.2\,mm}$ ——— (01)

c) i. $I = \frac{E}{At}$

Energy of the wave $E = AIt$

$= 12\times10^{-4}\times0.1\times12\times60$

$= 864\times10^{-4}\,J$ ——— (01)

Energy absorbed by the embryo $= \frac{400}{100}\times864\times10^{-4}$

$= \underline{345.6\times10^{-4}\,J}$ ——— (01)

ii) Intensity level $= 10\log_{10}(I/I_0)$ ——— (01)

$= 10\log_{10}\left(\frac{0.1}{10^{-12}}\right) = 10\log_{10}10^{11}$

$= 110\,dB$ ——— (01)

iii) $55 = 10\log\left(\frac{I}{10^{-12}}\right)$

$= 10^{5.5}\times10^{-12} = \underline{3.16\times10^{-7}\,Wm^{-2}}$ ——— (01)

d) i) Towards the instrument ——— (01)

ii) when outwards from the rest source $f' = f\left(\frac{v\cos\theta - v_0}{v\cos\theta}\right)$

after reflection apparent frequency $f'' = f'\left(\frac{v\cos\theta}{v\cos\theta + v_0}\right)$ } (01)

$f'' = \left(\frac{v\cos\theta - v_0}{v\cos\theta + v_0}\right) f$ ——— (01)

iii) $f - f'' = f\left\{1 - \frac{v\cos\theta - v_0}{v\cos\theta + v_0}\right\}$ ——— (01)

$0.25\times10^3 = \frac{2v_0\times3\times10^6}{1540\cos60^\circ}$

$= \frac{0.25\times10^3\times1540\times\frac{1}{2}}{2\times2\times10^6}$

$= \underline{38.5\times10^{-3}\,ms^{-1}}$ ——— (01)

15

(6) i)a) The condition that the Fluid is incompressible is not valid for a gas. ——— (01)

(b) In a viscous liquid conservation of mechanical energy would not hold good - since work has to be done against the viscous force when fluid is moved. ——— (02)

ii) a) average flow speed = Flow rate / cross sedional area $= q/A$

average flow speed at entrance $v_1 = 1.2\times10^{-2}/4\times10^{-3}$

$= 3\,ms^{-1}$ ——— (01)

$v_2 = \frac{1.2\times10^{-2}}{8\times10^{-4}} = 15\,ms^{-1}$ ——— (01)

b) K.E gained by petrol $= \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$ ——— (01)

$= \frac{1}{2}m(15^2-3^2) = 108\,m$

energy output / mass $= 108\,J\,kg^{-1}$ ——— (01)

c) consider the flow of mass m of petrol through the system,

Work done on petrol at entrance $= P_1V_1 = mP_1/\rho$ ——— (01)

Work done by petrol at exit $= P_2V_2 = mP_2/\rho$

Let W be the work done on unit mass of petrol by pump

total input energy to petrol

$E_{in} = m(W + P_1/\rho - P_2/\rho)$

$E_{in} = E_{out}$

$W + (P_1-P_2)/\rho = 108$, $W = 108 + \frac{(2.8-0.1)\times10^5}{750}$

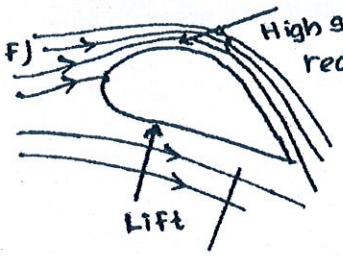
$= 468\,J\,kg^{-1}$ ——— (01)

d) Power $= \frac{W\times mass}{time} = V\rho q = 468\times750\times1.2\times10^{-2}$ ——— (01)

$= 4212\,W$ ——— (01)

e) Work done against viscous force or in producing turbulence in pump. ——— (01)

energy dissipated as heat ——— (01)



The velocity of air flow is faster at the upper side than the lower side of the wing. According to the bernoulli's principal pressure and hence the force is greater at the lower side of the aircraft wing. ——— (01)

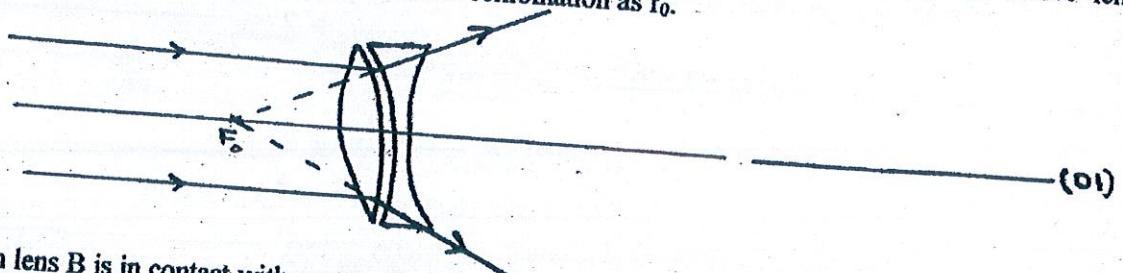
15

04) By using no paralax method you are asked to determine the focal length of a concave lens, by finding the image distance of a real image formed by a lens. For this you are supplied two convex lenses A and B of focal lengths f_1 and f_2, the concave lens which is to be found the focal length, two P_1 and P_2 indicators, a screen S and necessary stands.

a) i) When lens A and the concave lens are in contact it was unable to form the image of a distant object on to the screen. State ~~two~~ a reason for this.

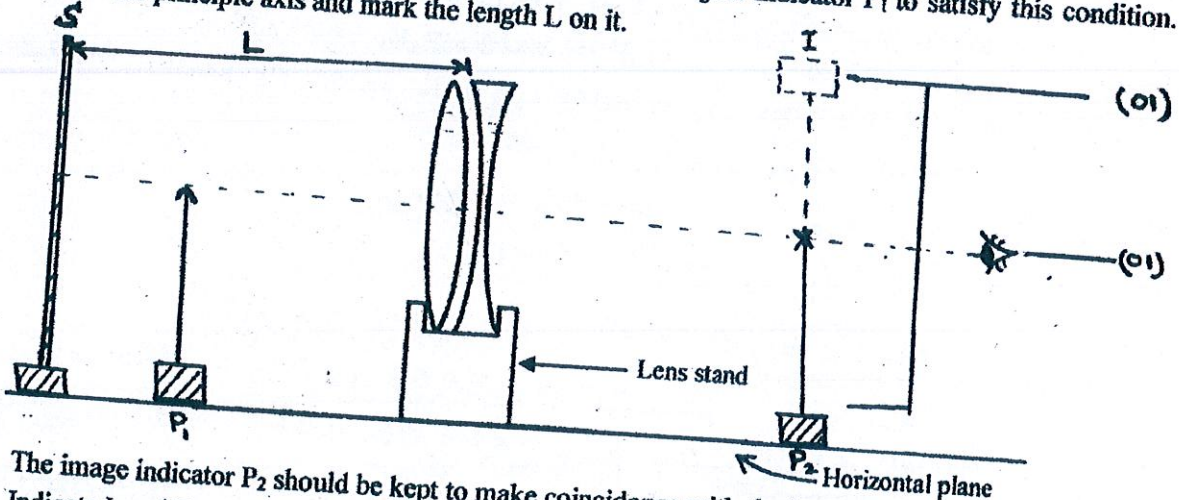
The Focal length of the concave lens might be greater than the concave lens. or Combined lens might be a concave lens. (01)

ii) Draw a suitable ray diagram to show the position of the image formed by the above lens combination. Mark the focal point of the combination as f_0.



b) When lens B is in contact with concave lens, it was able to form the image of a distant object on to the screen. The distance between lens combination and the screen was L

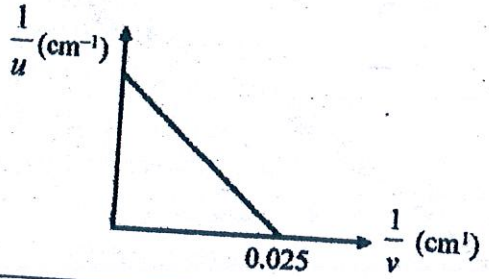
i) A student expects to observe only the real images formed by keeping P_1 object indicator in front of the above lens combination. Draw the screen and the object indicator P_1 to satisfy this condition. Draw the principle axis and mark the length L on it.

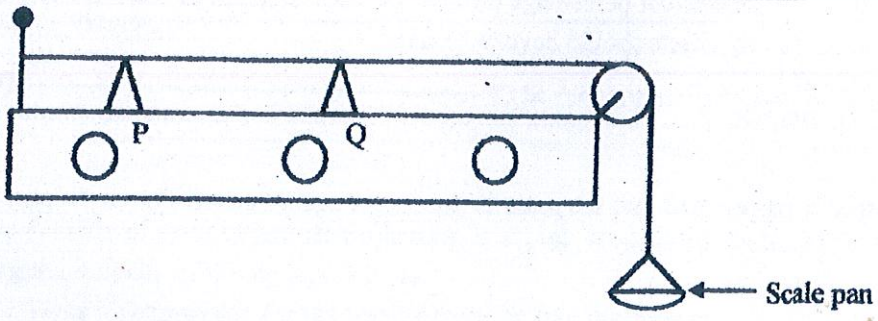


ii) The image indicator P_2 should be kept to make coincidence with the image (I) observed by the lens. Indicate I, and P_2 at the correct positions and mark the eye in the above figure.

iii) Explain how you can make assure that the image of P_1 and the image indicator are coincided each other. When moving the eye horizontally, perpendicular to the principal axis, there should not be a relative motion between P_2 and I

c) i) Following graph shows the variation of $\frac{1}{v}$ with $\frac{1}{u}$ after taking the image distance (v) with the object distance (u) (01)





i) Explain why it is most suitable to use sand instead of weights.

To change the tension of the string continuesly

(i) or (ii) (01)

ii) Write down the main experimental steps you follow to detect the optimum resonance state.

By taking the moment of the paper rider is quickly jumped off or jumped off to a maximum height.

iii) You are asked to find the resonating length with least tension and you are supplied tuning forks of frequencies 512Hz, 384Hz, 486Hz and 265Hz. Which tuning fork should be used to satisfy this condition? Explain.

256 Hz. and the reason.

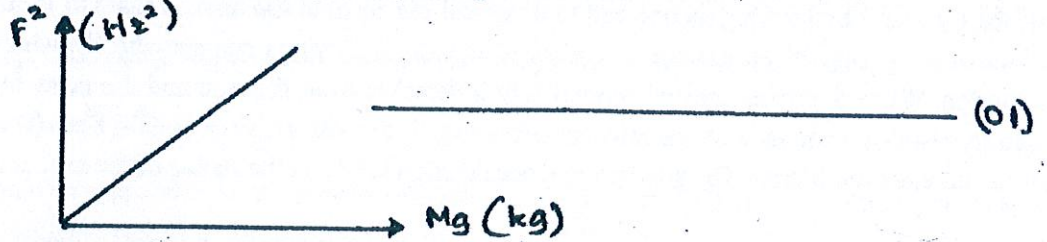
(01)

iv) When the string is resonating with a given tuning fork of frequency f, the mass of the sand with the pan (M) is measured.If you are supposed to draw a graph, identify the quantities you selected as indipendant and dependant variables.

M

F^2 (01)

v) Draw a rough sketch of the graph that you expect and name the axes with units.



(01)

vi) Obtain a mathematical relationship between the frequency (f) and the tension (T) of the string.

$F^2 \propto Mg$

$F \propto \sqrt{Mg}$

(vi) or (vii) (01)

vii) When resonating the string with the tuning fork of 256 Hz, mass of sand with the scale pan was 250 g. Find the frequency of the tuning fork which resonates the string with that of 400 g.

$256 \propto \sqrt{250 \times 10}$

$F \propto \sqrt{400 \times 10}$

$F = 323.82$ Hz

For substitution 10

iii) Thickness of an A_4 sheet is about 0.05 mm. To assure this value, the micrometer screw guage is used.In order to achieve the maximum percentage error of the measurement of the thickness of the paper bundle as 1%, how many sheets should have to be used

$\frac{1}{100} = \frac{0.01}{0.05n}$ $n = 20$ ——— (01)

c. The gsm value of a paper is represented that the mass in grams per square meter. For an A_4 sheet, this value is 75.

i) Find the mass of an A_4 sheet in grams.

$297 \times 210 \times 10^{-6} \times 75 = 4.6789$

$\simeq 4.68\,g$ ——— (01)

ii) When the mass of the cardboard box is 320g, find the maximum number of A4 sheets that can be stored in the box, without exceeding the total mass 5 kg.

$\frac{5000 - 320}{4.68} = 1000$ papers. ——— (01)

iii) Find the minimum internal height of the box that should be selected.

$1000 \times 0.05 = 50mm$

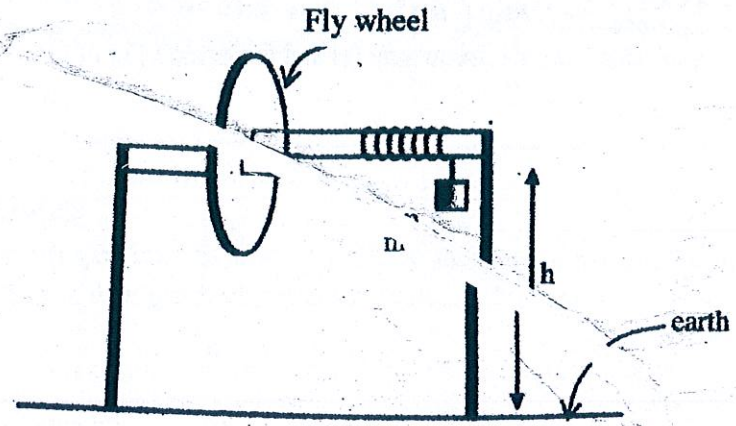
$= 5\,cm$ ——— (01)

iv) When selecting the storage box, the internal height should be measured .Which measuring instrument should be used to take this measurement and explain how do you use it.

Use the deapth bar of the vernier caliper at a edge of the box. ——— (01)

10

2. A fly wheel is a disc which is having its center of gravity on a horizontal axle. The two ends of the axel are mounted with bearing as shown in figure (1). This arrangement is kept in 'h' height from the ground level. The length of the string is approximately equal to the height h. The string is wound tightly and infirmly on the axle of the fly wheel by hooking its one end to a vertical pin fixed to the axle. A mass m is attached to the other end of the string. When the mass is released the string unwinds and sets the fly wheel in to a rotational motion. When the string unwinds completely it detaches from the axle and the mass falls to the ground. The flywheel is rotating continuously and becoming to the rest within a certain time (t) due to its rotational inertia under the friction.The gravitational acceleration is 'g' and the radius of the axel is r.



a) i) What is the potential energy of mass **m** at the beginning?

mgh (01)

b) The velocity of mass **m** just after releasing is **V** , the moment of inertia of the flywheel is **I** and the angular velocity of the fly wheel is **ω**

i) Write an expression for the linear kinetic energy for mass **m**

$\frac{1}{2} mv^2$

ii) Write an expression for the rotational kinetic energy of the flywheel.

$\frac{1}{2} I\omega^2$

either part(i) or part (ii) (01)

iii) Assume that the work done against the friction per revolution is **f** and it is constant; write an expression for the energy loss against friction when the mass **m** just touches the ground. The number of turns wound around the axis of the string is n_1.

$n_1 f$ (01)

c) Write an equation for energy transformation for two occations of mass **m** is freely hanging and touching the ground just after releasing from the fly wheel according to the law of conservation of energy.

$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 + n_1 f$ (01)

d) The fly wheel is moving under retardation after the mass **m** touched the ground. If the number of revolutions completed by the fly wheel when it became to the rest is n_2 then determine the work done against friction.

$n_2 f$ (01)

e) Apply the energy conservation law to write an eqution for the situation in part (d).

$n_2 f = \frac{1}{2} I\omega^2$ (01)

f) Obtain an expression for the moment of inertia of the fly wheel (**I**) in terms of n_1, n_2, **m**, **g**, **h**, **r** and **ω** by using the results in part (c) and (e).

$f = \frac{I\omega^2}{2n_2}$, $mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 + \frac{n_1 I\omega^2}{2n_2}$ (01)

$I = \frac{mn_2}{n_1+n_2}\left[\frac{2gh}{\omega^2} - r^2\right]$ [give this mark for any step]

g) Write the relationship between ω, h, t and r by taking the average value for ω as $\frac{\omega}{2}$.

$\frac{\omega}{2} = \frac{h}{rt}$, $\omega = \frac{2h}{rt}$. any step (01)

h) Hence obtain the following expression for (I) by using the results taken in part (f) and (g).

$$I = mr^2\left(\frac{gt^2}{2h} - 1\right)\left(\frac{n_2}{n_1 + n_2}\right)$$

$I = \frac{mn_2}{(n_1+n_2)}\left[\frac{2gh}{4h^2} \times r^2t^2 - r^2\right]$ ——— (01)

i) Write two errors that can be occurred when determining the I by using this method.

Error can be occured when counting the number of revolutions and measuring the time ——— (01)

03) The cross section of a string made of material of density ρ is A. The string is fixed to two points to be its tension T. 10

a) Write an expression for V where V is the velocity of the wave, when the string is vibrated at its mid point.

$V = \sqrt{\frac{T}{A\rho}}$ ——— (01)

b) Draw the wave pattern of the string vibrated in its second overtone.

——— (01)

c) Write an expression for the resonating frequency f for the second overtone when the length of the string is *l*.

$\frac{\lambda}{2} \times 3 = l$, $f = \frac{3}{2l}\sqrt{\frac{T}{A\rho}}$ ——— (01)

d) At this resonance when a small paper rider was kept at the mid point of the string is vertically flying off. What would be the acceleration of the mid point of the string when the paper rider flying off.

$mg - R = ma$

When $R = 0$, $mg = ma$

$a = g = 10\,ms^{-2}$ ——— (01)

e) Obtain an expression for the amplitude of the mid point of the string by using the results of part (c) and (d)

$\omega = 2\pi f$, $\omega = 2\pi \cdot \frac{3}{2l}\sqrt{\frac{T}{A\rho}}$, $a = \omega^2 A$

$A = \frac{A\rho l^2 g}{9T\pi^2}$ ——— (01)

f) A sonometer is used to find the relationship between the tension of the wire (T) and its vibration frequency (f) by using the resonance method. The length of the string (*l*) and its linear density (m) are constant. A scale pan is connected at the end of the string as shown in the figure. The tension of the string is changed by adding dry sand in to the scale pan. The length (*l*) is kept constat by keeping P and Q bridges at their original positions.

It is expected to take the fundamental tone of the sonometer wire by keeping the stem of the tuning fork on the box after vibrating it.

i) Find the focal length of the lens combination using the following graph.

$\frac{1}{F} = 0.025$

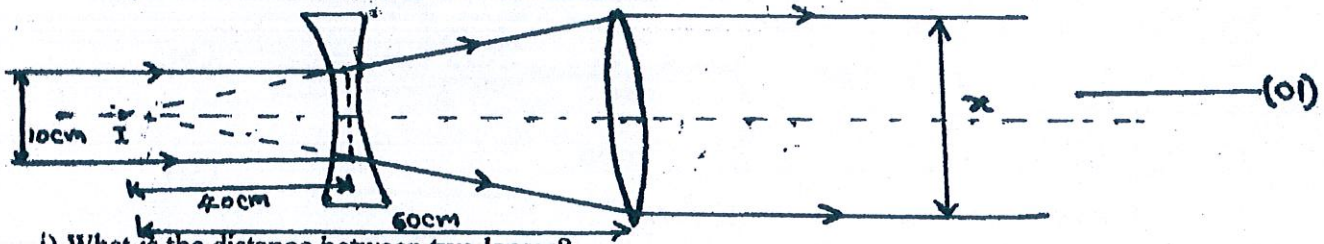
$F = 40\ cm$ ——— (01)

ii) If the focal length of convex lens B is 20 cm. Find the focal length of the concave lens.

$\frac{1}{-20} + \frac{1}{F} = \frac{-1}{40}$, $F = +40\ cm$ ——— (01)

iii) Two laser beams traveling parallel to each other in 10cm gap and enters to the concave and the A lenses. After refracting through the both lenses the gap between 2 beams was increased an emerged parallel to each other.

Draw the suitable ray digram to indicate this.



——— (01)

i) What is the distance between two lenses?

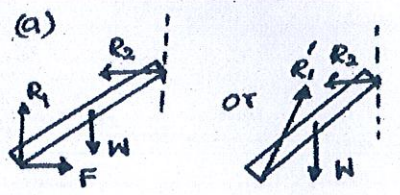
$60 - 40 = 20\ cm$ ——— (01)

ii) What would be the new gap between two beams after refracting through the both lenses?

$\frac{60}{40} = \frac{x}{10}$, $x = 15\ cm$. ——— (01)

Essay.

(5) (a)



(01)

(b) $R_2 = F$ $R_1 = 100N$

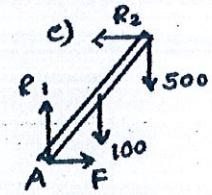
A) $100 \times 2\cos 60 = R_2 \times 4 \sin 60^\circ$ (01)

$R_2 = 28.87\ N$ (01)

$\therefore F = 28.87\ N$ $R_1' = 100^2 + (50\sqrt{3})^2$ (01)

$= 104.08\ N$ (01)

c)

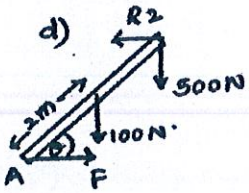


A) $R_2 \times 4\sin 60^\circ = 2\cos 60^\circ \times 100 + 4\cos 60^\circ \times 500$ (01)

$R_2 = 317.54\ N$ (01)

$\therefore F = \mu R$ $\mu = \frac{317.54}{600} = 0.53$ (01)

d)



$F = \mu R = 0.26 \times 600$

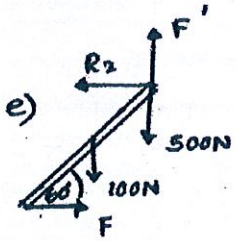
$= 156\ N$ (01)

A) $R_2 \times 4\sin\theta = 100 \times 2\cos\theta + 500 \times 4\cos\theta$ (01)

$\tan\theta = \frac{2200}{156} = 3.526$ (01)

$= 73^\circ$ $(73^\circ - 76^\circ)$

e)



$R_2 = F = 158.78\ N$

A) $158.78 \times 4\sin 60^\circ + F' 4\cos 60^\circ$

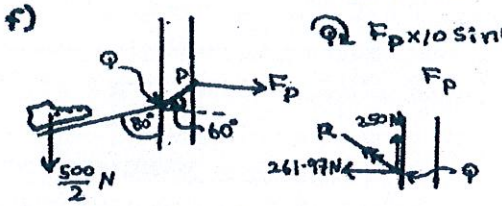
$= 100 \times 2\cos 60^\circ + 500 \times 4\cos 60^\circ$ (01)

$F' = 0.25\ N$

$F' = \mu R$

$\mu = \frac{0.25}{158.78} = 1.57 \times 10^{-3}$ (01)

f)



Q2 $F_p \times 10 \sin(70^\circ) = 250 \times 10 \sin(80^\circ)$ (01)

$F_p = 261.97\ N$ (01)

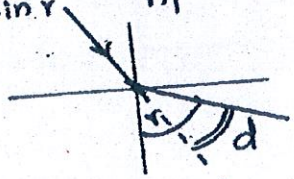
$F_Q = \sqrt{250^2 + 261.97^2} = 362.12\ N$

g) - Easy to carry.

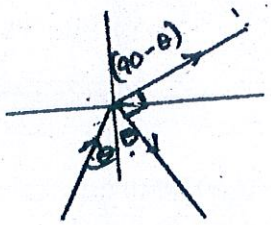
- Can be used at the places where the ladder cannot be properly placed. (01)

15

(08) a) $\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$ ——— (01)

i) 

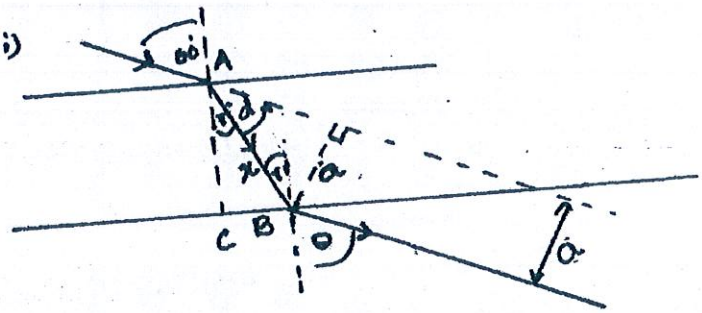
$d = (r - i)$ ——— (01)

ii) 

$\frac{\sin\theta}{\sin(90-\theta)} = \frac{1}{1.5}$

$\tan\theta = 0.6660$ ——— (01)

$\theta = 33^\circ 36'$

b) i) 

refraction at A, $\frac{\sin 60'}{\sin r} = \frac{1.5}{1}$, $r = 35^\circ 15'$ ——— (01)

$d = (59^\circ 60') - (35^\circ 15')$

$= 24^\circ 45'$

ii) $\frac{\sin 60'}{1.5} = \sin r$, $\frac{\sin r}{\sin\theta} = \frac{1}{1.5}$

$1.5 \times \sin r = \sin\theta$

$\theta = 60^\circ$ ——— (01)

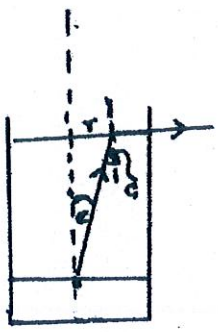
iii) ABC, triangle $\cos 35^\circ 15' = \frac{40}{x}$

$x = 48.90$ ——— (01)

$\sin d = a/x$, $\sin 24^\circ 45' = \frac{a}{48.90}$

$a = 0.4187 \times 48.98$ ——— (01)

$= 20.51$ cm

b iv) 

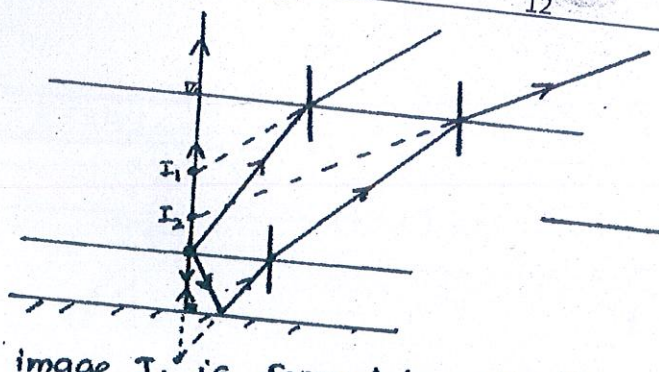
I) $r = \frac{55.056}{2} = 27.578$

$\tan c = 1.3785$

$c = 54^\circ$ ——— (01)

II) $\sin c = 1/n$, $n = \frac{1}{0.8090} = 1.23$ ——— (01)

e) i)



(01)

ii) image I_1 is formed by refraction at liquid air interface.

$\frac{V}{20} = \frac{1}{1.2}$, $V = 16.66$ cm (01)

image I_2 is formed by the reflection by plane mirror and refraction at liquid air interface.

For reflection $V = U$, $U = 6$ cm

$V = 6$ cm.

Image is formed at the glass - liquid interface.

$\frac{V}{12} = \frac{1.2}{1.5}$, $V = 9.6$ cm (01)

Image is formed at the liquid - air interface

$u = 20 + 9.6 = 29.6$ cm

$\frac{V}{29.6} = \frac{1}{1.2}$

$V = \frac{29.6}{1.2} = 24.6$ cm (01)

distance between two images $= 24.6 - 16.6$

$= 8.0$ cm (01)

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ROYAL COLLEGE - COLOMBO -07

Grade 12 - Final Term Test – July 2018

M C Q Answer Sheet

Subject and Subject No : PHYSICS 01 **Index Number** : ANSWERS

(01) ⑤	(11) ④	(21) ③	(31) ③	(41) ④
(02) ③	(12) ②	(22) ③	(32) ③	(42) ①
(03) ⑤	(13) ⑤	(23) ②	(33) ⑤	(43) ③
(04) ③	(14) ②	(24) ①	(34) ②	(44) ③
(05) ④	(15) ①	(25) ③	(35) ②	(45) ⑤
(06) ②	(16) ④	(26) ②	(36) ①	(46) ②
(07) ③	(17) ②	(27) ④	(37) ①	(47) ②
(08) ②	(18) ②	(28) ④	(38) ③	(48) ④
(09) ③	(19) ①	(29) ④	(39) ⑤	(49) ④
(10) ②	(20) ⑤	(30) ④	(40) ②	(50) ①

No. of correct answers

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