All Rights Reserved
SLGURU.LK

01 | S | I

Gampaha Education Zone

Second Term Evaluation - 2025

Grade	12	Subject	Physics I	Time	Two hours

Name .....

- ★ Answer all the questions.
- ★ In each of the questions 1 - 50 pick one of the alternatives (1) , (2) , (3) , (4, (5) which is correct of most appropriate and mark your response on the answer sheet with a cross (x) on the number of the correct option.
- ★ Use of calculators is not allowed

Speed of light = $3 \times 10^{8}\ ms^{-1}$ Avegadros constant = $6.022 \times 10^{23}\ mol^{-1}$

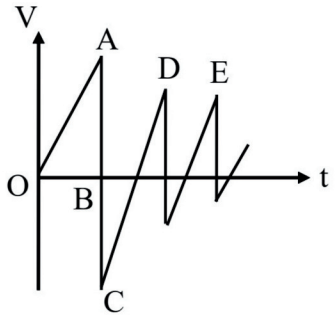
Plank constant (h) = 6.626×10^{-34} Js g = $10\ N\ kg^{-1}$

(01) The dimension of light year is

(1) $L\,T^{-1}$ (2) T (3) $ML^{2}\,T^{-2}$ (4) L^{2} (5) L

(02) The resultant force acting on a stationary mass when it is made to move with uniform acceleration is,

(1) Propotional to the displacement from the fixed point.
(2) Propotional to the velocity.
(3) Zero.
(4) Non - zero value.
(5) Increases with time.



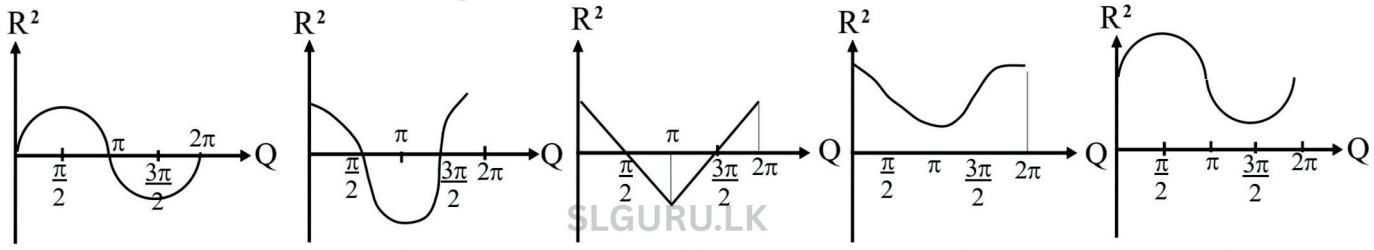
(03) A tennis ball released from a high position collides with a rough horizontal surface and bounces back.The graph showing the velocity changes with time. Which point indicates the point at which the maximum height is reached after the first bouncing.

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

(04) The mass is suspended by a spring of spring constant K is obtained frequency $F = Cm^{x} K^{y}$. The value of x and y are

(1) $x = ½$, $y = ½$ (2) $x = ½$, $y = -½$ (3) $x = -½$, $y = ½$
(4) $x = 0$, $y = ½$ (5) $x = ½$, $y = 0$

(05) The resultant of two constant forces P and Q inclined at an angle θ to each other is R. The variation of R^{2} is best represent when increase from O to 2π.



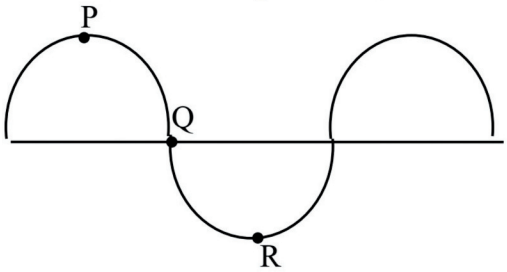
(1) (2) (3) (4) (5)

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

(06) The position of a transverse wave propagating along a string in the right direction at a certain instant is shown in the figure.

(A) - There is a $\frac{\pi}{2}$ phase difference between the particle P and R.
(B) - The speed of P and R particle are maximum while the speed of Q particle is minimum
(C) - The particle P and R are moving inthe direction of wave , while the particle Q remain stationary.



Of the above statements,
(1) Only A is true (2) Only B is true
(3) Only C is true (4) All statements are true.
(5) All are false

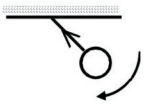
(07) The mass of object when it weigh in air is m_1 and the mass of object when it weigh in water is m_2. The relative density of object is,

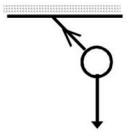
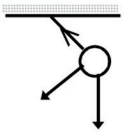
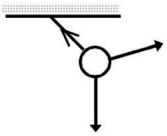
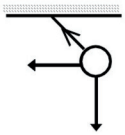
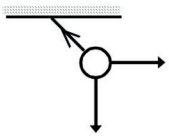
(1) $\frac{m_1}{m_2}$ (2) $\frac{m_1}{m_2 - m_1}$ (3) $\frac{m_2}{m_2 - m_1}$ (4) $\frac{m_2}{m_1}$ (5) $\frac{m_1 + m_2}{m_1 - m_2}$

(08) Two people moving from the same place in opposite directions towards each other along the straight line at speed $4\ m\ s^{-1}$ and $6\ m\ s^{-1}$. How long will it take to get seperation between them to be 55m.

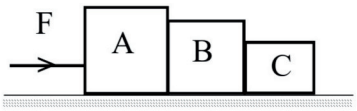
(1) 4s (2) 4.5s (3) 7.5s (4) 5.5s (5) 6s

(09) A simple pendulum oscillates on a vertical plane as shown in the figure. The correct force diagram acting on the bob when the bob is at the moment shown in figure.



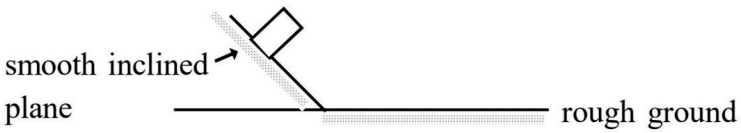
(1)  (2)  (3)  (4)  (5) 

(10) Three objects A , B and C of mass m , 2m and 2m are placed on a smooth surface and a force of magnitude F is applied horizontaly on A. If the system is moving with uniform acceleration what is the horizontal net force acting on B ?

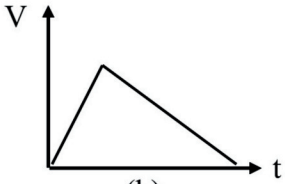


(1) $\frac{F}{5}$ (2) $\frac{F}{3}$ (3) $\frac{2F}{5}$ (4) $\frac{3F}{5}$ (5) F

(11)

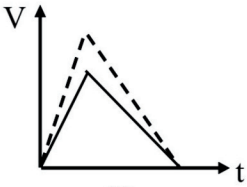


(a)



(b)

The graph (b) shows the change in velocity with time of an object placed at rest on smooth inclined plane until it slides down and moving along the rough ground. If the object is released from a higher point on the plane than the level at which it was initially released , the appropriate velocity time graph is given by dotted line. What is the best graph for the motion ?

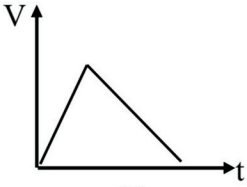


(1)

(2)

(3)

(4)

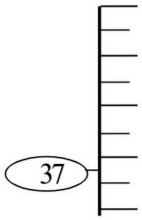


(5)

SLGURU.LK
For Educational Purpose Only

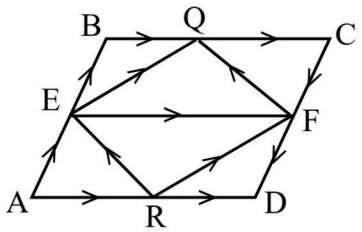
SLGURU.LK

(12) The circular scale of a sphere with 0.5 mm pitch is divided into 50 divisions. The reading shown in the figure is,



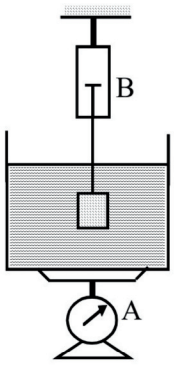
(1) 2.87 mm (2) 2.37 mm (3) 2.13 mm
(4) 2.57 mm (5) 2.63 mm

(13) The resultant of given coplanar system is,



(1) $\overrightarrow{EF}$ (2) $5\,\overrightarrow{EF}$ (3) $3\,\overrightarrow{EF}$
(4) $4\,\overrightarrow{EF}$ (5) 0

(14) A uniform cylinder of volume 30 cm^3 was suspended from the spring balance B and immersed into the water content beaker that placed on the compression balance.
The cylinder weighs 295 g before it is immersed in water and 90 g after it is submerged. When the cylinder is completely immeresed in water the new reading it produces is,



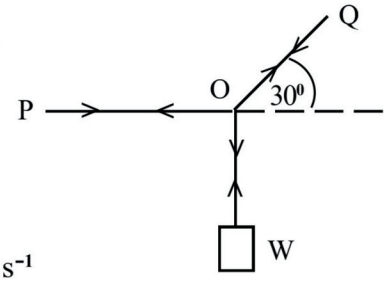
(1) (295 + 90) and 90 g
(2) (295 + 60) and 60 g
(3) (295 + 90) and 60 g
(4) (295 + 30) and 60 g
(5) (295 + 60) and 30 g

(15) When a gymnast pulls his knees towards his chest while doing a squat.Which of the following quantities increases ? (around the horizontal axis passing through his centre of mass)
(A) - His angular momentum.
(B) - His moment of inertia.
(C) - His angular velocity.

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

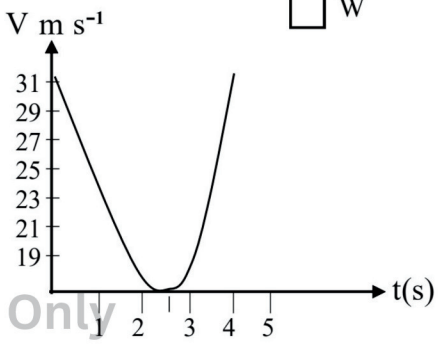
(16) The length of one part of main scale of a certain caliper is x cm and the "n" number of division in vernier caliper is coinciding with (n - 1) number of parts of main scale. The least count of vernier scale is ,
(1) $\frac{n-1}{n}$ (2) $\frac{nx}{n-1}$ (3) $\frac{x}{n}$ (4) $\frac{x}{n-1}$ (5) $\frac{x}{n+1}$

(17) PO and OQ are two light inelastic string. A weight W is hung at O. When the system is in equilibrium the tension along the PO is



(1) W tan 60^0 (2) W tan 30^0
(3) $\frac{W}{\sin 30^0}$ (4) $\frac{W}{\cos 30^0}$ (5) W sin 60^0

(18) The graph shows the variation of the speed of the ball with time (t) when a golfer hits a golf ball horizontally on horizontal surface at t = 0. What is the displacement at the time t = 4 s ?



(1) 19 cm (2) 38 cm
(3) 62 cm (4) 76 cm
(5) 124 cm

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

(19) The air resistance force f against the motion of a car travelling on a straight road with velocity V is given by the equation F = 4V. When the velocity is in meters per second , the values of F is given in Newtons. The power required for a car to maintain a uniform velocity on a horizontal road is,

(1) 360 kW (2) 108 kW (3) 27 kW (4) 7.2 kW (5) 3.6 kW

(20) The displacement - time graph of two objects when they execute simple harmonic motion is shown in figure.

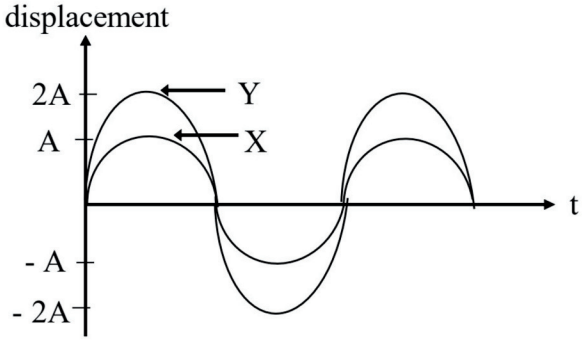
(A) - The frequencies of X and Y are equal.

(B) - The maximum velocity of the Y is twice that of the X.

(C) - At any given moment , the magnitude of the acceleration of Y is greater than that value of X.

Which of the above statement is true ?

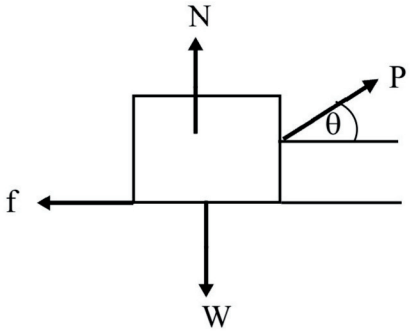
(1) Only A
(2) Only B
(3) Only C
(4) Only A and B
(5) All A , B and C



(21) A student applies a force P to an object which that on a rough horizontal surface and pulls it in right with uniform velocity.

Which of the following statement is true ?

(1) P > f and N < W
(2) P > f and N = W
(3) P = f and N > W
(4) P = f and N = W
(5) P < f and N = W

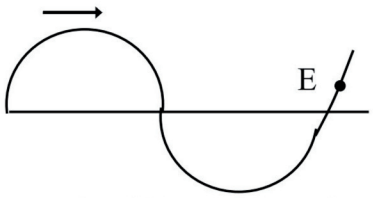


(22) A hydrometer floats in oil of 0.9 g cm^{-3} density with $\frac{1}{5}$th of its total volume above the liquid surface. If it floats in a liquid with $\frac{1}{10}$th of its volume above the liquid surface , what is the density of liquid ?

(1) 0.29 g cm^{-3} (2) 0.45 g cm^{-3} (3) 0.8 g cm^{-3} (4) 1.1 g cm^{-3} (5) 1.8 g cm^{-3}

(23) If the wave is propagating forward then after the indicated moment, that particle E , will be directed to

(1) ↓ (2) ↑ (3) → (4) ↗ (5) ↙



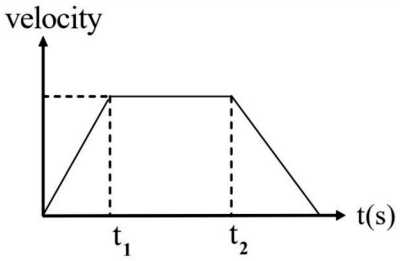
(24) Objects A and B have masses M_1 and M_2 and contain equal kinetic energies. What is the ratio between momentum of A and B ?

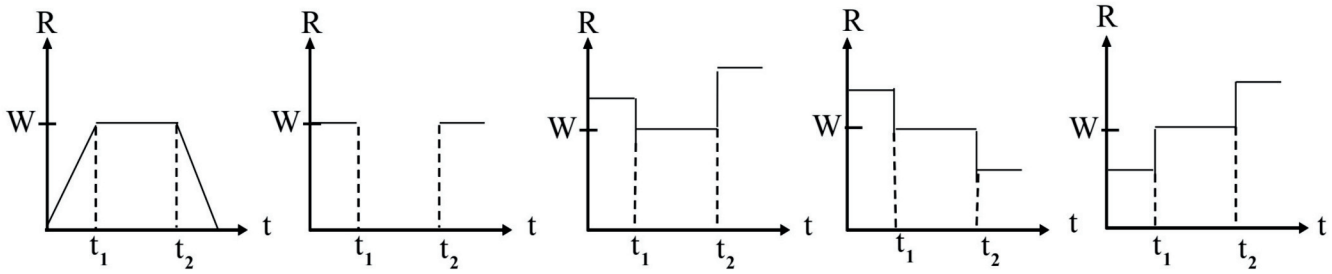
(1) $\frac{M_1}{M_2}$ (2) $\frac{M_2}{M_1}$ (3) $\frac{\sqrt{M_2}}{\sqrt{M_1}}$ (4) $\frac{M_1^2}{M_2^2}$ (5) 1

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

(25) An object of weight W is placed on a pane of compression balance which that placed inside the elevator. Velocity time graph of elevator is shown. The vertical direction is considered to be upward. The variation of reading R with time is correctly expressed by





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

(26) A wheel rotates at a speed of 1200 rpm and it also deceleration with angular deceleration of 4 $rads^{-2}$. The number of turns it rotated before coming to rest is ,

(1) 143 (2) 272 (3) 314 (4) 502 (5) 722

(27) Two projections X and Y are projected from top or hill at the same instant in the horizontal direction, X with the velocity 20 m s^{-1} and Y projected with an angle 60^0 to the vertical at the velocity 40 m s^{-1} .

If their motion occurs in the same plane which of the following statements is ture ?

(A) - X and Y travel equal vertical distance in equal time.

(B) - X and Y travel equal horizontal distance.

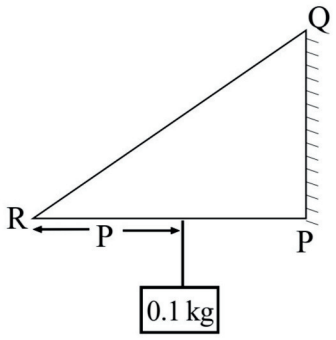
(C) - X and Y are never meet.

Which of the above statements is true ?

(1) Only A (2) Only C (3) Only A and B

(4) Only B and C (5) All A , B , C

(28) A uniform meter ruler of mass 0.5 kg is hinged at one end and other end R is attached to the string. At the **Q** , the string is fixed to the wall and held ruler horizontally. An object of mass 0.1 kg is attached at the distance of 30 cm from R. The magnitude of the moment about the point **P** due to the tension in the string.



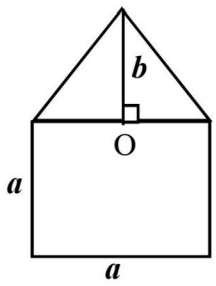
(1) 3.2 Nm (2) 1.05 Nm (3) 0.75 Nm

(4) 0.70 Nm (5) 0.25 Nm

(29) The time period of simple pendulum of length l is T. By what value should the length of simple pendulum change to make its time period in to 2T.

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

(30) The centre of gravity of composite object made by placing trangular laminar of height b on a square laminar with a side length a from the same sheet is O. The value b is equal to



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

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

(31) A sound wave produced in one medium enters another medium. Which of the following statements about that wave is true ?

(1) The frequency remains the same but the wave length changes.
(2) The wave length remains the same but frequency changes.
(3) Both frequency and wavelengths are change.
(4) Both frequency and wavelength are not change.
(5) The direction of propagtion is not change.

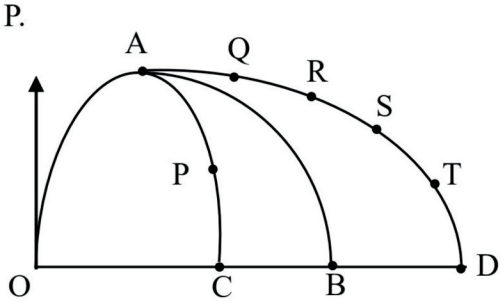
(32) A coin is placed on a disk rotation at a speed of 2 revs^{-1}. The coefficient of friction between the coin and disk is 0.4. The maximum radius of rotation of the coin to remain stationary relative to the table. ($\pi^2 = 10$)

(1) 1 cm (2) 2.5 cm (3) 10 cm (4) 25 cm (5) 100 cm

(33) In the equation $v^2 = K(a^2 - x^2)$,
v = velocity a = amplitude x = displacement
Dimension of K is ,

(1) $L^2 T^{-2}$ (2) LT^{-2} (3) LT^{-1} (4) T^{-2} (5) T^{-1}

(34) The path OAB refers to the projection of an object from any point on the earth's surface. If it had exploded into only two identical parts at point A one part would have travelled along the path AC and the other along the path AD. What is the point at which the segment along line AD reaches when the segment along line AC arrives at the P.



(1) Q (2) R

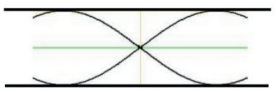
(3) S (4) T

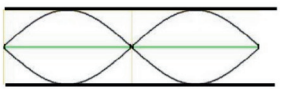
(5) Given informations are not suffucient

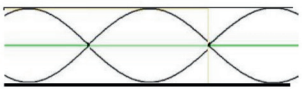
(35) A simple pendulum is suspended from the roof of a train. It's length is l and mass is m. When the train is travelling around 200 m horizontal curve at a speed of 20 m s^{-1} . The string makes an angle with vertical is ,

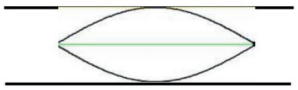
(1) $\sin^{-1}(0.2)$ (2) $\cos^{-1}(0.2)$ (3) $\tan^{-1}(0.2)$ (4) $\tan^{-1}(5.0)$ (5) $\cos^{-1}(0.5)$

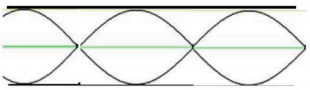
(36) The waxe pattern of first overtone of an open tube is


(1)


(2)


(3)


(4)


(5)

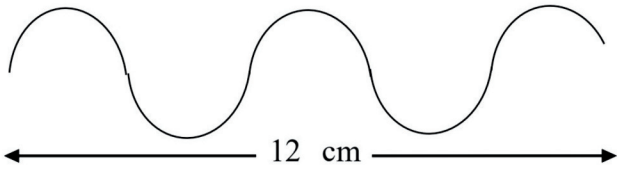
(37) Which of the following wave properties does not cause a sound wave in air.

(1) Diffraction (2) Refraction (3) Interference
(4) Polarization (5) Reflection

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

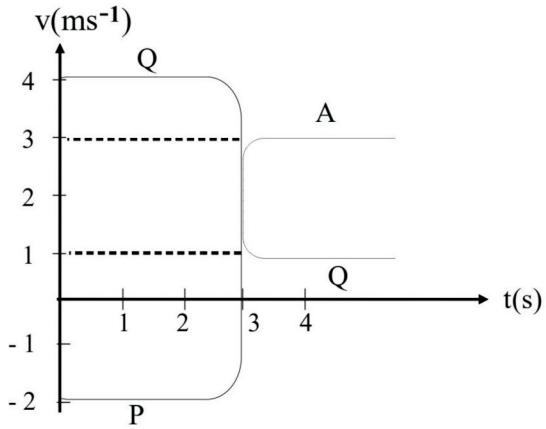
(38) The diagram shows a section of a rope along which a transverse wave travels. The wavelength of wave is,



(1) 10 cm (2) $\frac{10}{5}$ cm

(3) $\frac{10}{3}$ cm (4) 1 cm (5) $\frac{20}{5}$ cm

(39) The velocity time graph for two cars P and Q of masses m_1 and m_2 is shown in the figure. Three second later the two cars collide and the motion after the collision also shown in figure. The correct relationship between m_1 and m_2 is ,



(1) $m_1 = 3 m_2$ (2) $3 m_1 = m_2$

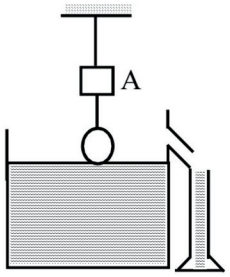
(3) $3 m_1 = 5 m_2$ (4) $3 m_1 = 7 m_2$

(5) $5 m_1 = 3 m_2$

(40) To obtain the linear graph that passing through the origin from the equation $V = \sqrt{\frac{g\lambda}{2\pi}}$ The graph should be

(1) λ Vs f^2 (2) $\frac{1}{\lambda}$ Vs f^2 (3) λ Vs f (4) $\frac{1}{\lambda}$ Vs f^2 (5) $\frac{1}{\lambda^2}$ Vs f^2

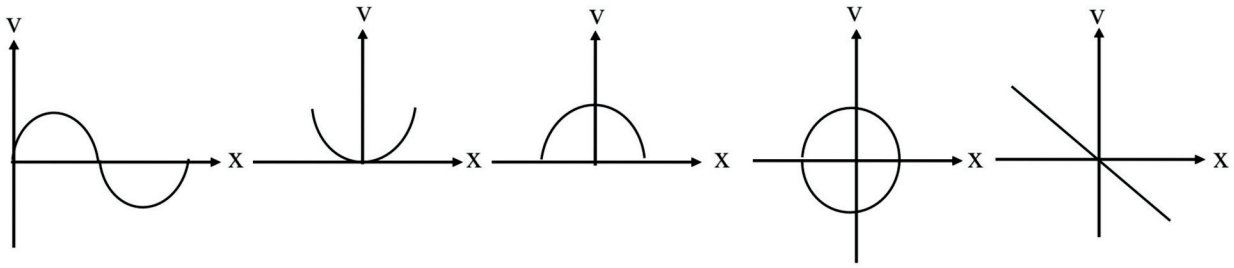
(41) When an object is suspended from a spring balance , the reading is 50 g when it completely immersed in coconut oil. The coconut oil is displaced 10 cm^3 when the object is in the coconut oil the reading of spring balance is,



(1) 60 g (2) 58 g (3) 50g

(4) 42 g (5) 40 g

(42) The graph showing the velocity of an object when it execute simple harmonic motion. The graph of velocity Vs displacement of an object when it execute simple harmonic motion is best represented by



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

(43) An invisible feature of a standing wave is ,

(1) There is point with zero displacement

(2) There is point with maximum displacement

(3) Energy transmission

(4) The distance between two consecutive nodes is half the wave length

(5) The presence of particles in the same phase between two consecutive nodes.

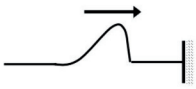
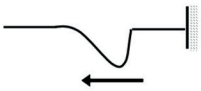
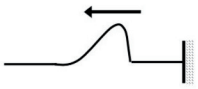
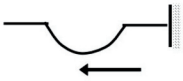
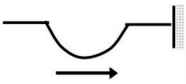
(44) A wooden cub has base length 6 cm and when it placed in water it sink to a height of 1.5 cm. The relative density of wooden is,

(1) $\frac{1}{2}$ (2) $\frac{1}{4}$ (3) $\frac{3}{8}$ (4) $\frac{5}{16}$ (5) $\frac{3}{16}$

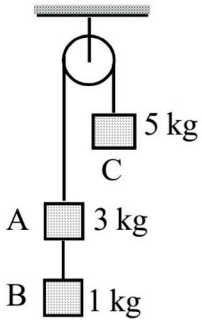
SLGURU.LK
For Educational Purpose Only

SLGURU.LK

(45) The figure shows a portion of wave that travels through a string which that fixed to a certain point. The shape of reflected wave accurately shows

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

(46) The tension of strings which connected to the loads A and B are,



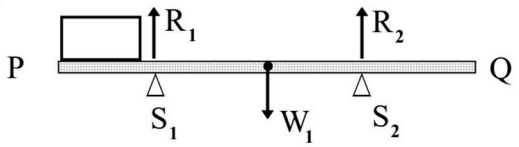
(1) g (2) $\frac{g}{9}$

(3) $\frac{5g}{9}$ (4) $\frac{10g}{9}$ (5) 2g

(47) The speed of air flowing over the roof during a tornado is 50 m s^{-1} The effective area of the roof is 1000 m^2. The density of air inside house is 1 kg m^{-3} .If the air inside the house is stationary the minimum mass the roof must have to prevent it from removing is ,

(1) 125 kg (2) 125 x 10^3 kg (3) 125 x 10^2 kg (4) 125 x 10^4 kg (5) 125 x 10^5 kg

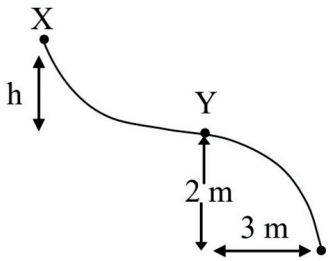
(48) The uniform rod of lengths PQ is placed on two supports S_1 and S_2 . The two supports of the rod are placed at equal distance from the center of the rod. The weight of the rod is W_1 .
A wooden box of weight W_1 is placed close to the points S_1.
The reaction of S_1 and S_2 are R_1 and R_2 respectively.
Which of the following is true is the rod does not start to slip.



(A) - $R_1 + R_2$ always equal to $W_1 + W_2$.
(B) - R_1 always greater than R_2
(C) - As the box close to the P , R_1 gradually decreases and R_2 increases.

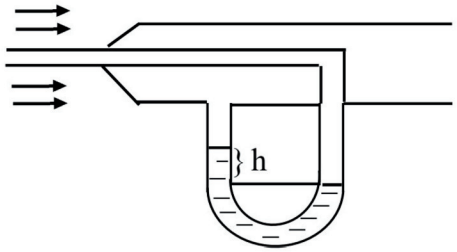
(1) Only A (2) Only B (3) Only A and B
(4) Only A and C (5) All A , B , C

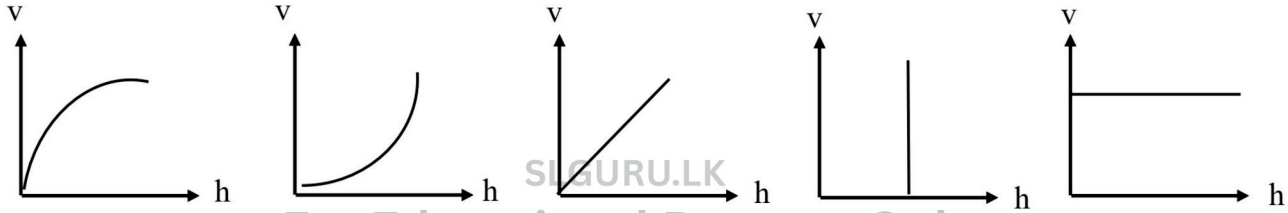
(49) The perticle released from X moves in smooth curved path and reached to Y , and then falls back to earth under gravity. The value of h is equal to



(1) $\frac{9}{8}$ m (2) $\frac{4}{3}$ m (3) 2 m
(4) 3 m (5) 4 m

(50) The figure shows a pitot tube placed in a flowing liquid. The pressure gauge indicates the variation in the velocity of the flowing liquid corresponding to the difference in height of two liquid columns. The graph that correctly shows the above is,





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

SLGURU.LK
For Educational Purpose Only

“Knowledge is power.” — Francis Bacon

SLGURU.LK

Visit SLGURU.LK to download papers and notes.

SLGURU.LK

සියලු ම හිමිකම් ඇවිරිණි
All Rights Reserved]

ගම්පහ අධ්‍යාපන කලාපය Gampaha Education Zone ගම්පහ අධ්‍යාපන කලාපය Gampaha Education Zone ගම්පහ අධ්‍යාපන කලාපය
Gampaha Education Zone ගම්පහ අධ්‍යාපන කලාපය Gampaha Education Zone ගම්පහ අධ්‍යාපන කලාපය Gampaha Education Zone
ගම්පහ අධ්‍යාපන කලාපය Gampaha ion Zone ගම්පහ අධ්‍යාපන කලාපය
Gampaha Education Zone ගම්පහ අ කලාපය Gampaha Education Zone
ගම්පහ අධ්‍යාපන කලාපය Gampaha ion Zone ගම්පහ අධ්‍යාපන කලාපය
Gampaha Education Zone ගම්පහ අධ්‍යාපන කලාපය Gampaha Education Zone ගම්පහ අධ්‍යාපන කලාපය Gampaha Education Zone

ගම්පහ අධ්‍යාපන කලාපය
Gampaha Education Zone

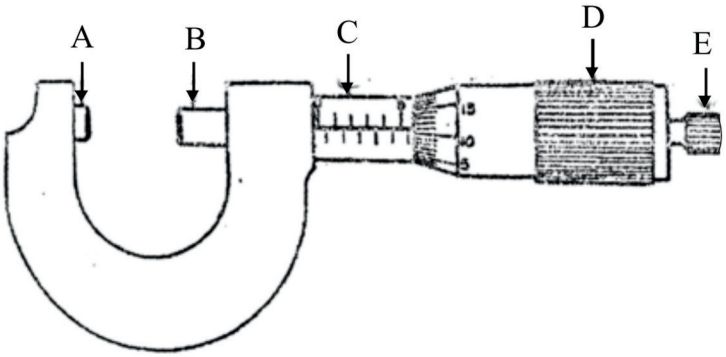
දෙවන වාර ඇගයීම - 2025
Second Term Evaluation - 2025

ශ්‍රේණිය Grade	12	විෂයය Subject	Physics II	කාලය Time	පැය 3 යි 3 hour

Name :- .....

Part A - Structured Essay

01. Micrometer screw guage is better to measure the diameter of a thin wire in laboratory.



(i) Name the parts of the diagram denoted by letters.

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

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

C - .....

(ii) What is the least count if "B" moves 5 mm when "D" is rotated 10 rounds ? The circular scale is divided in to 50 divisions.

.....

.....

(iii) What is the methodology you follow to increase the accuracy of the measurement when measuring the diameter of a wire ?

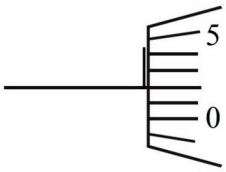
.....

.....

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

This is the way scales are seen, when A and B are in contact.



(iv) what is the error shown here ?

.....

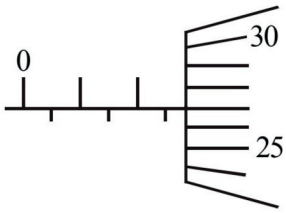
(v) What is the method you follow to take a measurement of an object, keeping between A and B without applying excess pressure on it ?

.....

.....

.....

Following is the way scales are seen when measuring the diameter of the wire.



(vi) What is the reading ?

.....

(vii) What is the correct measurement ?

.....

(viii) calculate the percentage error of the above measurement

.....

The corrected measurements obtained for the diameter of a wire, is given below.

d_1/mm	d_2/mm	d_3/mm	d_4/mm	d_5/mm	d_6/mm
2.01	2.02	2.01	2.03	2.02	2.03

(ix) What is the most accurate value for the diameter ?

.....

.....

.....

SLGURU.LK
For Educational Purpose Only

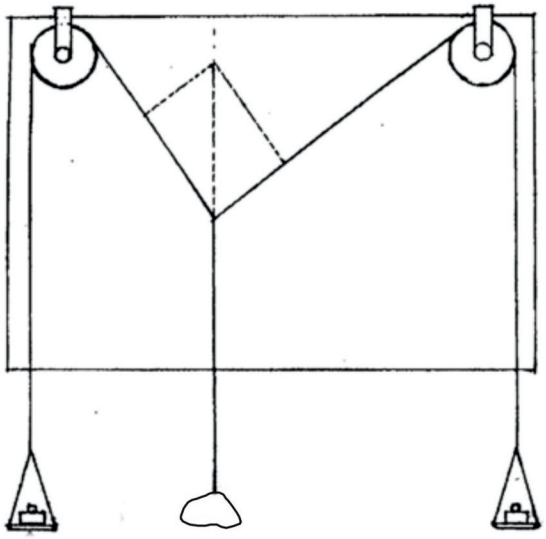
SLGURU.LK

(x) Find the density of the material of the wire is made of, if the length and the mass of the wire are 4 cm and 400 mg respectively. (Take $\pi = 3$)

.....

.....

02. An experiment to determine the mass of an object with unknown mass by parallelogram law of following items and instruments for that.
pins, A - 4 white papers, light strings, light balance pans, number of loads. set square, a ruler, a pair of compasses.



(i) Write down the parallelgran law of forces.

.....

.....

.....

(ii) What is the reason to use light strings in this experinent ?

.....

(iii) How do you check whether pulleys are fricition less ?

.....

.....

(iv) State the experimental steps that are needed to obtain the projection of strings on the paper, after the system is in equilibrium by keeping the loads on the balance pans.

.....

.....

.....

.....

(v) What is the reason for not drawing the parallelogram by using the shadow of the string in here.

.....

.....

SLGURU.LK
For Educational Purpose Only

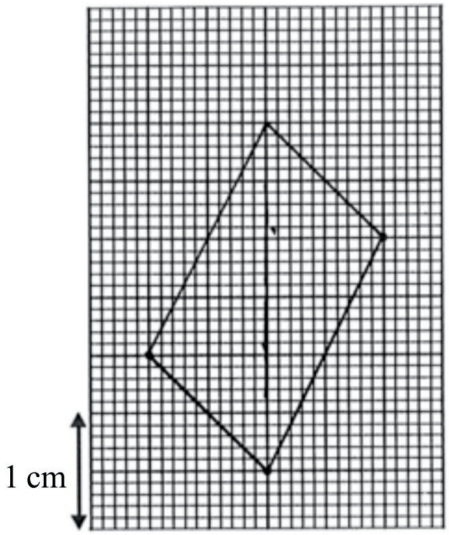
SLGURU.LK

(vi) What are the reasons for the diagonal of the parallelogram is not vertical after it is complefed

.....

.....

The parallelogram obtained when an unknown mass is placed on the middle balance pan is given below. (1 cm = 80 g)

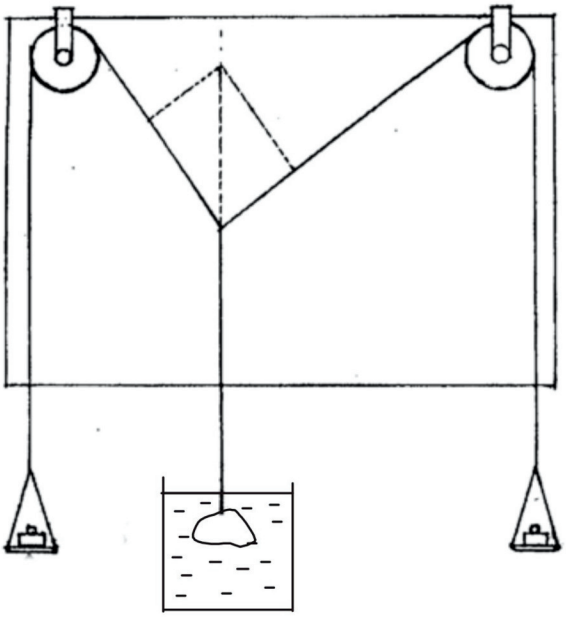


(vii) What is the value of the unknown mass.

.....

.....

A student plan to determine the relative density of the above object using this experiment.
He removes the middle balance pan and the object is connect to the string.
The object is totally immersed in the water and completed a prallelogram in the same way and same scale. The length of the diagonal of this parallelgram is 2 cm.



(viii) Mark all the forces acting on the object when it is in equilibrium (Tension of string T, weight of the mass is W, up thrust force - U)

(ix) Write down the expression for the equilibrium of the mass in terms of T, U and W.

.....

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

(x) Find the relative density of the object.

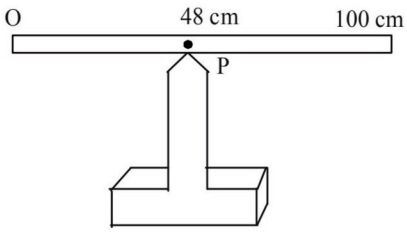
.....

.....

03. To find an unknown mass (m) of a irregular shaped object, a student is provided with following instruments and materials.

★ A meter ruler
★ A knife edge mounted on a wooden support.
★ sufficient amount of strings
★ set of weights.

(i) A meter ruler is balanced on the knife edge. Mark all the forces acting on it.



(ii) What is the nature of the meter ruler ? (uniform or not)

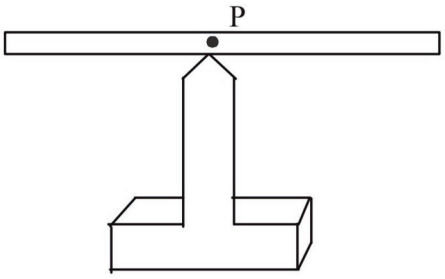
.....

(iii) Find the reason for balancing the meter ruler at ' P ' always, when measurenents are taken.

.....

.....

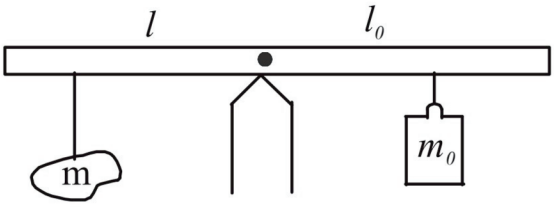
(iv) If you are provided with one string and not enough to hang both masses on it how they are placed on the ruler.



SLGURU.LK
For Educational Purpose Only

SLGURU.LK

(v) Obtain a relationship among m, m_0, l and l_0. for the equilibriun of meter ruler.



.....

(vi) Rearrange equation to plot a graph to find m, considering l is changed in known values and l_o is measured.

.....

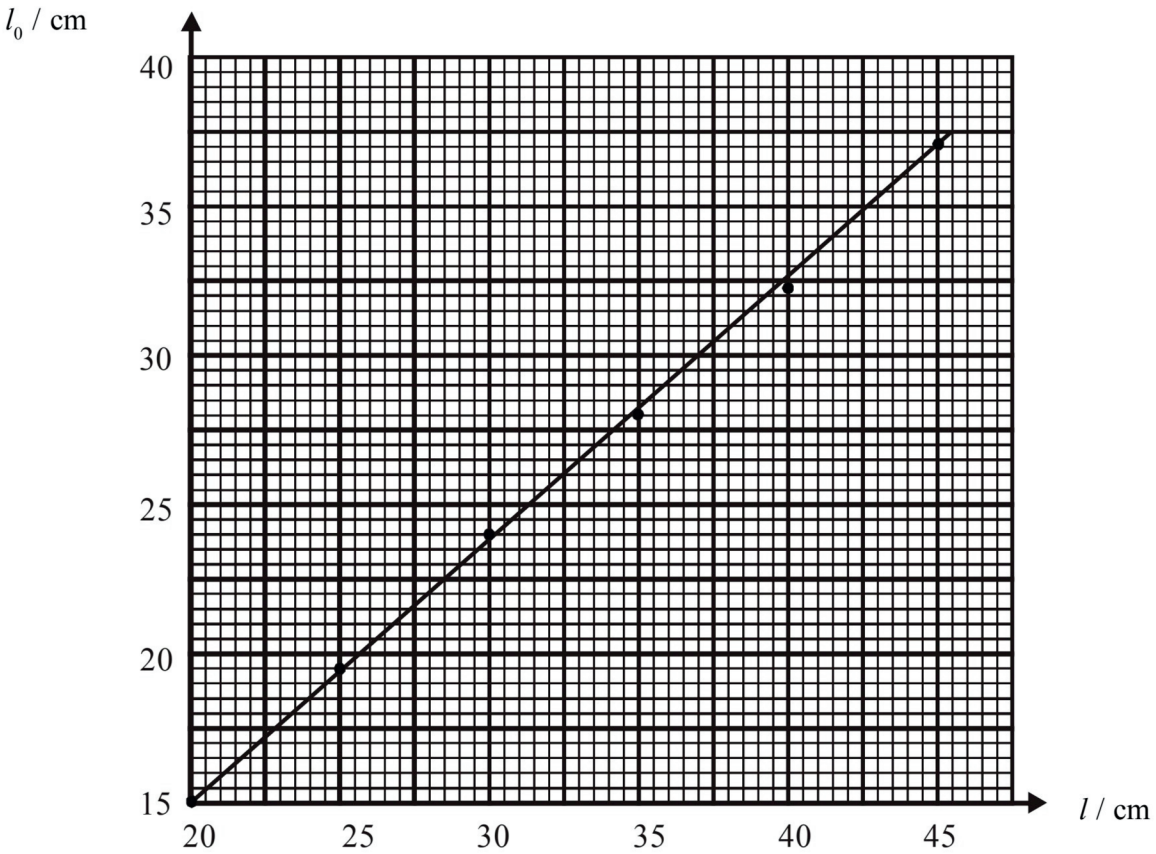
.....

(vii) According to the re-arrangement,

(a) independent variable .....

(b) dependent variable .....

Following graph is obtained according to the readings taken by a student.



SLGURU.LK
For Educational Purpose Only

SLGURU.LK

(viii) Select two points on the graph to find the gradient.

.....

(ix) Find the gradient using the coordinates of selected points.

.....

.....

(x) Find the value of unknown mass if the known mass is 50 g.

.....

.....

(xi) How do you check the accuracy of the obtained value for the unknown mass.

.....

.....

04. (a) 1 kg mass resting on smooth horizontal table is connected to a spring balance and pulled forward keeping the balance horizontal as follows.

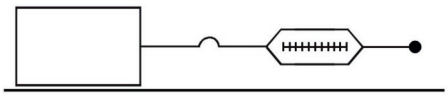


figure (i)

(i) Find the acceleration of the block, When the reading of the spring balance is 2N.

.....

.....

(ii) When the balance is slanted 30^0 horizontally, and the reading is 5N find the acceleration.

.....

.....

.....

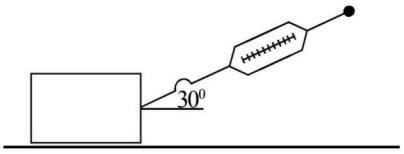


figure (ii)

(iii) Find the work to be done to move the block 2m along the surface as in (ii)

.....

.....

(iv) If the surface is rough, and the spring balance is kept as figure (i) and pulled, the spring balance reading is 5N, the block is at static limiting equilibrium. Find the coefficient of limiting friction.

.....

SLGURU.LK

For Educational Purpose Only

SLGURU.LK

(v) consider the above object moving at a constant velocity. The spring balance reading is 4.5 N. Find the coefficient of dynamic friction in between the mass and the surface.

.....

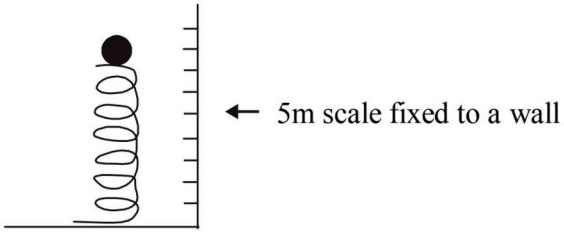
.....

(vi) Find the spring balance reading when the wooden block is kept on the rough surface as in figure (ii) and kept at static quillibriun.

.....

.....

(b) A simple experiment to find the spring constant of a small spiral spring is given below.



A ball 20 g kept on the spring is pressed down and released and moves up freely (The height of the spring is not significant compared to the height the ball rises up above)

(i) Find the gravitational potential energy. when the object rises up to 4 m after pressed down

.....

(ii) Find the maximum speed the object acquires ?

.....

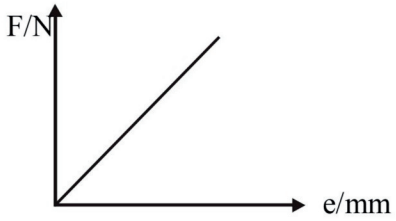
.....

(iii) Find the value of the spring constant, if the extension is l0 cm.

.....

.....

Following is the graph of force vs. extension graph.



(iv) Draw the graph for a spring of higher spring constant on the same axes.

SLGURU.LK

For Educational Purpose Only

SLGURU.LK

සියලුම හිමිකම් ඇවිරිණි / All Rights Reserved

දෙවන වාර ඇගයීම - 2025

Second Term Evaluation - 2025

Grade 12

භෞතික විද්‍යාව II

Physics II

PART B – Essay

*Answer **four** questions only.*

(Acceleration due to gravity $g = 10\ N\ kg^{-1}$)

5. A man sitting on a rotating chair in a physics laboratory begins to rotate from rest about the x-axis. He rotates with his arms outstretched as shown in the figure (1) and he rotates at a constant speed of 120 revolutions per minute.

Figure (1)

Figure (2)

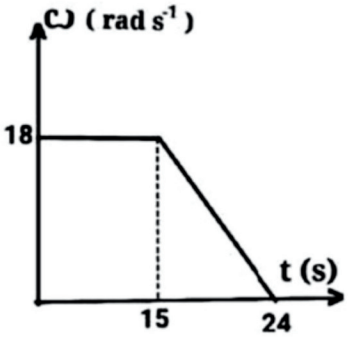


Figure (3)

a. What is his constant angular velocity when he extends his arm and rotates as shown in the figure (1)? (Take $\pi = 3$)

b. If he extends his arm in this way and rotates at a constant rotational frequency for 20 seconds,
   i. Find the angle rotated in that time.
   ii. Find the number of complete revolutions rotated in that time.
   iii. If the moment of inertia of the man about the axis of rotation is $12.3\ kg\ m^2$, what is his rotational kinetic energy?

c. Now he folds his hands as shown in the figure (2). Then his angular velocity increases to $18\ m\ s^{-1}$ and he rotates at the same velocity for 15 seconds. Then his angular velocity gradually decreased and he came to rest. The graph of angular velocity versus time for that rotational motion is shown in Figure (3).

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

i. What is the moment of inertia of the man when he folds his hands?
ii. Then, what is his rotational kinetic energy?
By what percentage did the kinetic energy increase due to folding his hands?
iii. Find the frictional torque exerted on him after 15 seconds.
iv. Find the number of complete revolutions he has made by folding his hands.

d. Now, when he removes the weights from his hands and sits still on the chair, he starts to rotate again by applying a torque of 13.5 N m. This torque is applied for 10 seconds. During that time, 15 complete revolutions have been made.
i. What is the angular acceleration exerted on him?
ii. Calculate the angular velocity he acquires.
iii. Find his moment of inertia.
iv. As soon as he reaches the angular velocity mentioned in (d). (ii). above, he expands his arms again. Then his rotational kinetic energy decreases by 30%.
1. Calculate his new angular velocity.
2. Find the new moment of inertia.

6. The following figure (1) shows how a motorcyclist engaged in a motorcycle race maintains his balance by leaning his motorcycle towards the curve at a curvy point on the track. The reaction force exerted by the track on the wheels is denoted by $\boldsymbol{R}$ and is inclined at an angle $\boldsymbol{\theta}$ to the vertex. The frictional force between the wheels and the track is $\boldsymbol{F}$. The total mass of the motorcycle with the rider is $\boldsymbol{m}$ and the coefficient of friction between the track and the wheels is $\boldsymbol{\mu}$.

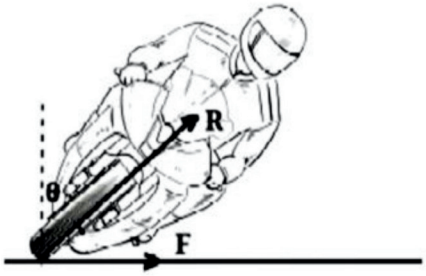


Figure (1)

a. Consider the vertical equilibrium and circular motion of the athlete.
i. Write $\boldsymbol{R}$ in terms of the $\boldsymbol{m}$, $\boldsymbol{g}$ and $\boldsymbol{\theta}$.
ii. Write the force of friction ($\boldsymbol{F}$) in terms of $\boldsymbol{m}$, $\boldsymbol{\mu}$, $\boldsymbol{g}$ and $\boldsymbol{\theta}$.
iii. If the speed of the motorcycle is $\boldsymbol{v}$ and the radius of the curve is $\boldsymbol{r}$, obtain an expression for $\tan\theta$ in terms of $\boldsymbol{\mu}$, $\boldsymbol{g}$, $\boldsymbol{v}$ and $\boldsymbol{r}$.
iv. If $\boldsymbol{v} = 108\ \text{km h}^{-1}$, $\boldsymbol{r} = 60$ m and $\boldsymbol{\mu} = 0.5$, find the value of $\boldsymbol{\theta}$.
v. If $\boldsymbol{m} = 300$ kg, find the value of $\boldsymbol{R}$ and $\boldsymbol{F}$. (**Take $\sqrt{2} = 1.41$**)

b. If the above track were inclined at an angle α to the horizontal, the motorcyclist would not need to lean the motorcycle against the track to maintain his balance. Figure (2)

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

shows how the motorcyclist moves forward along that inclined track. The radius of the track is $\boldsymbol{r}$ and the speed of the rider is $\boldsymbol{v}$. Here, the reaction exerted by the track on the wheels is perpendicular to the track. The frictional force ($\boldsymbol{F}$) acts downward on the track.

Figure (2)

i. Considering the vertical equilibrium of the cyclist, derive an expression for $\boldsymbol{R}$ in terms of $\boldsymbol{m}$, $\boldsymbol{g}$, $\boldsymbol{\mu}$ and α.
ii. By applying the equation $\boldsymbol{F} = \boldsymbol{ma}$ towards the center of the curve, derive another expression for $\boldsymbol{R}$ in terms of $\boldsymbol{m}$, $\boldsymbol{g}$, $\boldsymbol{\mu}$, $\boldsymbol{v}$, $\boldsymbol{r}$ and α.
iii. Derive an expression for the coefficient of friction ($\boldsymbol{\mu}$) of the track without $\boldsymbol{R}$ using the expressions obtained (i) and (ii) above.
iv. If $\boldsymbol{m}$ = 300 kg, $\boldsymbol{r}$ = 120 m, $\boldsymbol{\alpha} = 22^0$, $\boldsymbol{v}$ = 72 km h^{-1}, calculate the value of $\boldsymbol{\mu}$.
($\tan 22^0 = 0.4$)
v. Find the value of $\boldsymbol{R}$ using the value of $\boldsymbol{\mu}$ obtained above.
(Take $\sin 22^0 = 0.37$ and $\cos 22^0 = 0.92$)
vi. Find the frictional force ($\boldsymbol{F}$) exerted on the wheels by the track.
vii. What is the centripetal force exerted on the motorcycle?

7. The Bernoulli's equation for fluid flow is given by,

$$\boldsymbol{P + \frac{1}{2}dv^2 + dgh = constant}$$

Identify each term of the above equation.

a. (i) State the conditions necessary for the Bernoulli's equation to be valid.
(ii) Show that the above equation is dimensionally correct.

b. A siphon is a device for removing liquid from a container. A container filled with water of density $\boldsymbol{d_w}$ is shown in Figure (1). The tube (siphon) of uniform cross-section is initially filled with water by closing the end of the tube with the thumb. The water is then released by removing the thumb. Assume water to be a non-viscous, incompressible fluid and the water flow to be streamlined.

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

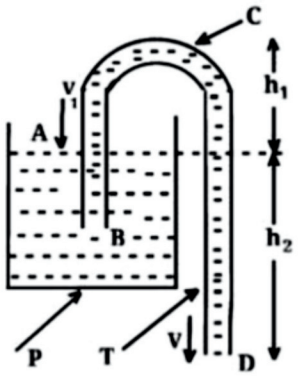


Figure (1)

i. If the speed of water flow at the lower end (D) of the pipe shown in the figure is $\boldsymbol{v}$, what is the speed of water just inside the pipe entrance (B)?
ii. If the cross-sectional area of the container is 100 times the cross-sectional area of the tube, write an expression for the downward velocity $\boldsymbol{v}_1$ of the free surface of the container in terms of $\boldsymbol{v}$.
iii. Since $\boldsymbol{v_1} \ll \boldsymbol{v}$, hence take $\boldsymbol{v_1} = 0$. Consider a streamline starting from A and ending at D, derive an expression for $\boldsymbol{v}$, using a suitable constant and a parameter given in the figure. Assume that the tube end D is opened to the atmosphere.
    1. If $h_2 = 80$ cm, determine $\boldsymbol{v}$.
    2. If $h_2 = 0$, show that the siphon action does not occur.

c. A pipe system for transporting water from a high point to a low point in a water pumping station is shown below. The method of transporting water from a pipe with a wide cross-section located above the ground through a narrow pipe located inside the ground is shown in Figure (2). Here, X and Y are pressure gauges.

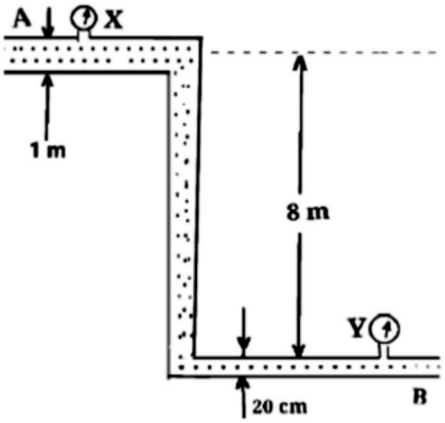


Figure (2)

Water enters the wide tube from the end A of the wide tube at a rate of 0.3 $m^3 s^{-1}$ and the reading of the pressure gauge X is 1.4×10^5 Pa. The diameter of the wide tube is 1 m. (Take $\pi = 3$.)

i. Find the speed of water flowing in the wide pipe.
ii. If the diameter of the narrow pipe is 20 cm, find the speed of water flowing in that pipe.

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

iii. Calculate the reading of the pressure gauge Y using the Bernoulli's equation.

8.

a. Rescue teams exert great effort to save a child trapped deep underground. The child, who fell 20 m below the ground surface, was stuck in a narrow underground cavity. However, because the opening from the ground surface to the cavity is very narrow, the rescue team members are unable to descend through it themselves. The rescue teams plan to create a parallel opening from the surface wide enough for a person to descend through, and use that route to rescue the child.

Usually, the soil is compacted by allowing a heavy weight (pile-driver) to fall onto a drill-bit. Accordingly, the broken soil particles, rock fragments, and dust are drawn into the soil, creating loosening through a suction pump. The pile-driver falls onto the drill-bit resting on the soil. This is driven vertically by machinery. After the pile-driver is pushed down 5 m, it is released and falls freely under gravity. The mass of the pile-driver is 400 kg, and the mass of the drill bit attached to the pile-driver is 100 kg. Now, the pile-driver falls onto the drill bit. A sudden impact occurs, and the system then moves downward. The contact time for the pile-driver and drill bit system is 0.8 seconds.

i. What is the velocity of the pile-driver just before it hits the drill bit after falling freely?
ii. What is the velocity of the system a moment before the impact?
iii. Considering the velocity of the system a moment after the impact, find the velocity at which the system begins moving vertically downward.
iv. Define impulse and indicate it on the two surfaces involved in the impact, as shown in the diagram below.
v. Find the impulse acting on the head of the impact.

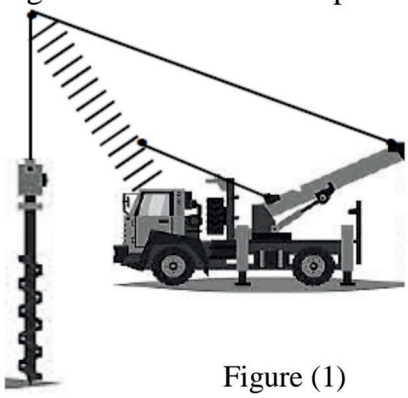


Figure (1)

b. In this way, the drill bit begins to move parallel to the child stuck in the bottom of the well, and within a minute, the drill bit rises from the drilling pad, comes back down, and makes one impact. This process is repeated. Consider the drill bit moves a distance 4 cm in one collision.
i. Calculate the frictional resistive force exerted by the rock surface on the drill bit.
ii. How many collisions occurred when the accident occurred near the child?
iii. How many hours did it take?
iv. Explain with reasons why the earth-drilling process is difficult in practice.

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

9.

a. A bus traveling in a mountainous area accidentally falls off a cliff due to a road accident. An operation is launched to recover it and it is pulled up from the cliff by a crane. In practice, the slope becomes rough. A bus is pulled up a slope using a crane with a steel cable attached to the car, as shown in Figure (1). The mass of the bus is 300 kg and there is a resistive force of 800 N acting on the bus against the direction in which the bus is pulling.

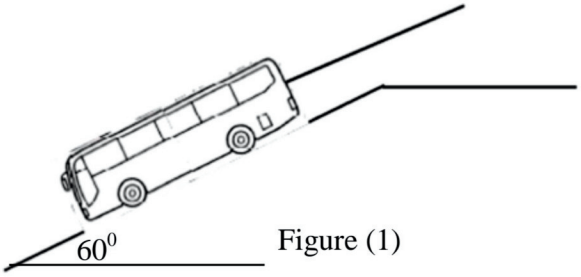


Figure (1)

i. Draw a diagram of the forces acting on this bus.
ii. A cable is wrapped around a cylinder attached to a crane and the cable is wrapped around a cylinder attached to the crane with a linear acceleration of 2 m s^{-2}. Then find the tension in the cable.
iii. The manufacturer has stated that the maximum tension that the cable can withstand is 6800 N. Accordingly, if the bus that has been involved in the accident needs to be recovered very quickly, what is the maximum acceleration that the bus can be pulled to?

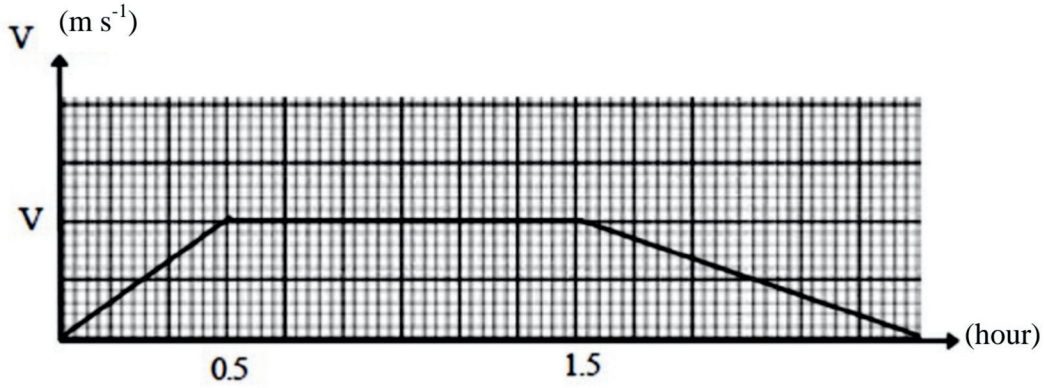
b. Due to the rainy conditions in the environment, the connecting jack of the crane mounted on the ground came loose. Accordingly, the rigid connection with the ground was removed. Due to this, the bus gradually stopped being pulled up and the bus began to roll down again as it could not withstand the impact of the crane. At this point, the process of winding the cable has also stopped. The resistive force acting on each mass is proportional to their weight.
i. If the mass of the crane is 500 kg, what is the resisting force on the crane?
ii. What is the new tension in the cable?
iii. What is the acceleration of the crane?
iv. The driver suggests that a new weight be added to prevent the bus from sliding down. Accordingly, what is the new mass that should be attached to the crane?

c. In the study of the processes occurring in the environment, three types of events can be observed when observing systems of objects: collisions, explosions, and coalescence. These collisions, explosions, and coalescences occur in very small time periods, that is, they occur instantaneously. In these cases, when considering the reaction forces acting on each object, the quantity called impulse is considered in addition to that reaction force. Impulse is represented by "force × time". This quantity can also be represented in another way by the change in momentum acting on an object.

SLGURU.LK
For Educational Purpose Only

SLGURU.LK

10. The diagram below shows the velocity-time curve for a balloonist in a capsule attached to a hot air balloon, who takes off from ground level in his helium-filled balloon and travels to a maximum height. The volume of the capsule increases as it rises above the ground level. Accordingly, when it reaches its maximum height, the velocity at the highest point becomes zero. The capsule took 3 *hours* to reach its maximum height and the maximum height it reached was 40 *km*. This is the highest altitude ever reached by a hot air balloon in the world.



a. Based on the graph;
   i. Write an expression for the maximum velocity *v*.
      Use that to find the value of the maximum velocity *v*.
   ii. Find the acceleration experienced by the capsule as it leaves the ground.
   iii. Find the deceleration experienced.
   iv. Draw the free force diagram acting on the capsule with the balloon at its maximum height.

b. At 40 km, he breaks free from the capsule and takes a "free jump" into space. He emerged from the capsule at rest, and "free jump" is defined as movement under gravity, while traveling at the speed of sound in air is called "supersonic speed."
   i. Show that within the first 40 *s*, he exceeds the speed of sound in air, which is "supersonic speed" of 340 $m\ s^{-1}$.
   ii. Explain with reasons whether the speed you sought above is possible.
   iii. Now he releases his parachute when he is 4 *km* above the earth's surface. How long did he travel during the free jump?
   iv. The time it took him to reach the ground from the maximum height of his full motion was 15 minutes. Considering that motion, what would be the acceleration with which he falls to the ground when the parachute is released?
   v. Draw a sketch of a velocity-time curve for falling to the ground from maximum height.

SLGURU.LK
For Educational Purpose Only

“Knowledge is power.” — Francis Bacon

SLGURU.LK

Visit SLGURU.LK to download papers and notes.