දේවි බාලිකා විද්‍යාලය - කොළඹ
DEVI BALIKA VIDYALAYA - COLOMBO
Final Term Test - December 2021
Grade 13

මනසා සංවුතා ධීරා
Manasā Sanvutā Dheerā

භෞතික විද්‍යාව I Physics I	01 E I	පැය දෙකයි Two hours

Note
- This questions paper consists of 50 questions.
- Answer all the questions.
- In each of the questions 1 to 50, pick one of the alternatives (1), (2), (3),(4),(5) which is correct of most appropriate.
- Mark on the number corresponding to your choice in the answer sheet provided.
- Further instructions are given on the back of the answer sheet, follow them carefully.

$g = 10Nkg^{-1}$

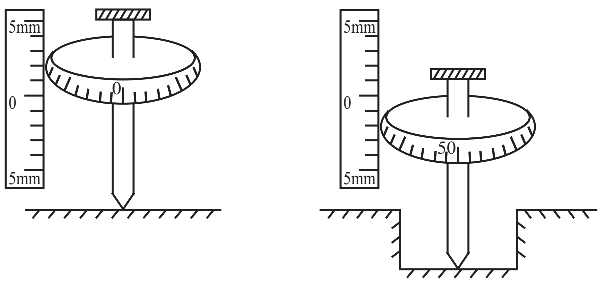
(01) In the equation $A=\frac{1}{\sqrt{M_0 \varepsilon_0}}$, M_0 and ε_0 are permeability and perceptivity constant of the free space Dimension of A is,

(1) $M^{-1}L^{-1}T$ (2) $M^{0}L^{-1}T$ (3) MLT^{-1} (4) $M^{0}LT^{-1}$ (5) $ML^{0}T^{-1}$

(02) Momentum of on object is 0.6 according to the cgs unit system. According to SI units its value is,

(1) 6×10^{-5} (2) 6×10^{-6} (3) 6 (4) 6×10^{3} (5) 6×10^{6}

(03) A spherometer having 100 decision in the circular scale and the pitch 1 mm is used to measure the depth of a hole. The figure shows two positions of the measurement. The depth of the hole is,



(1) 3.36 mm (2) 3.43 mm (3) 3.50 mm (4) 3.57 mm (5) 3.64 mm

(04) The particles that are emitted respectively in the following radioactive decay are,

$${}^{A}_{Z}P \longrightarrow {}^{A}_{Z+1}Q \longrightarrow {}^{A-4}_{Z-1}R \longrightarrow {}^{A-4}_{Z-1}S$$

(1) α, β, γ (2) β, γ, α (3) γ, α, β (4) β, α, γ (5) γ, β, α

(05) A beam of white light is made to travel through a prism in a Vaccum,

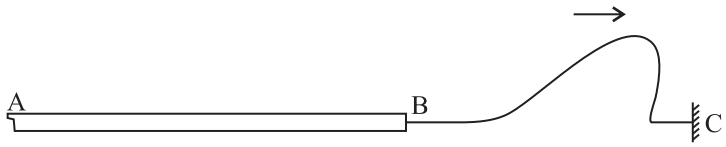
A - Blue light passes at a low velocity than the red light.

B - Different colours have different refractive indices when they travell through the prism.

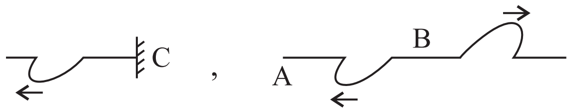
C - All the colours travel with the same velocity before entering the prism.

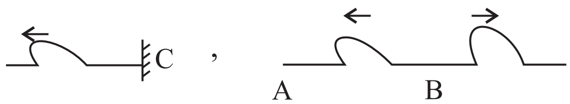
Of the above the true statement/s is/ are,

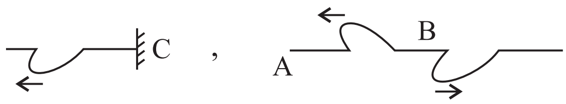
(1) Only A (2) Only A and B (3) Only A and C
(4) Only B and C (5) All A, B, C

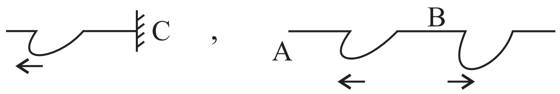
(06) 

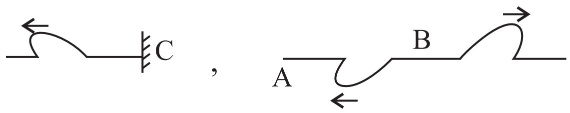
A heavy string AB and a light string BC are connected to a rigid boundary at C. As shown in the diagram a pulse of a wave is sent from the point B. Which of the following diagram correctly represents the reflection of the wave ?

(1) 

(2) 

(3) 

(4) 

(5) 

(07) Two solid objects A and B float in water so that 1/2 of the volume of A and 2/3 of the volume of B submerge in water. The ratio of $\frac{\text{Density of A}}{\text{Density of B}}$ is

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

(08) An object (A) initially at rest is sliding down along a smooth inclined plane. Another object (B) is dropped vertically down from rest from the same height simultaneously. Consider the following statements,

A - Acceleration of B is greater than that of A.

B - The object A reaches the ground first.

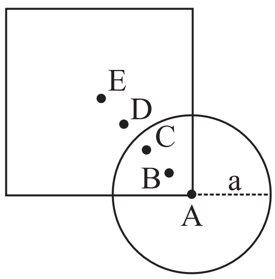
C - At the level ground, velocity of A is equal to that of B.

of the above the true statement/ s is / are,

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

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

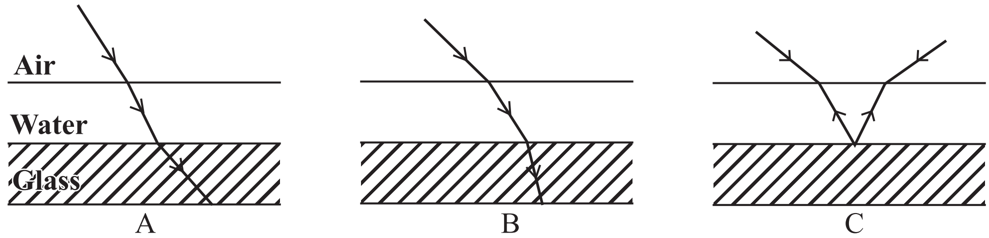
(09) A combined object is made by pasting a circular metal plate of radius **a** to a vertex of a square shaped metal plate having side length **2a.** The position of the centre of gravity of the combined object is most likely to be at,



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

(4) D (5) E

(10) Which of the following is a possible path of a monochromatic ray of light through water and glass layers placed in air ? (n glass = 1.5, n water = 1.33)

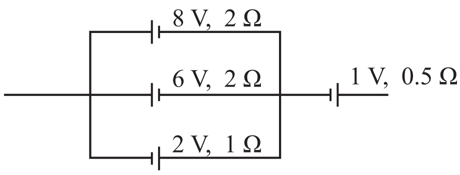


of the above the true statement/ s is / are,

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

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

(11) The E.M.F and internal resistance of the cell which is equivalent to the following system of cells would be,



(1) 1.5 V, 1 Ω (2) 2.5 V, 0.5 Ω

(3) 3.5 V, 1 Ω (4) 4.5 V, 0.5 Ω

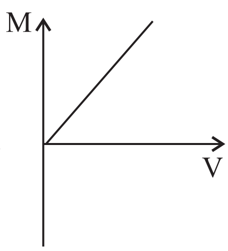
(5) 5.5 V, 1 Ω

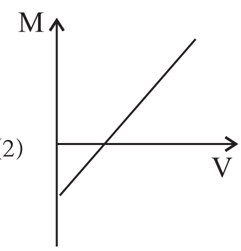
(12) Gas leaks at a constant rate of 3cm s^{-1} from a hole of a balloon which completely filled with 10 g of a certain gas. The balloon is completely empty in 1.5 s. The force exerted on the balloon would be,

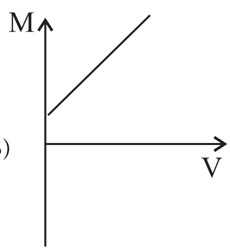
(1) 2×10^{-4} N (2) 1×10^{-4} N (3) 5×10^{-4} N

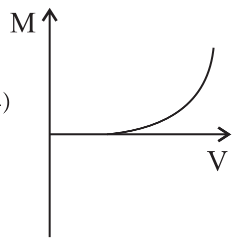
(4) 8×10^{-5} N (5) Zero

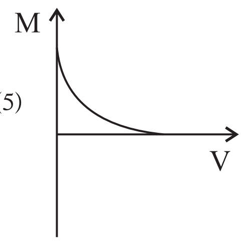
(13) Which of the following graph best represents the variation of the image length of a real image of a convex lens with its magnification ?

(1)


(2)


(3)


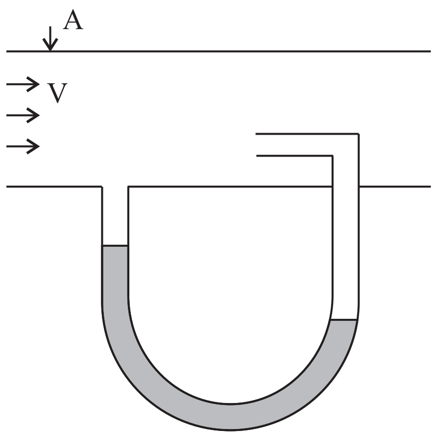
(4)


(5)


(14) If a flexible wire is subjected to a tensile force with 0.1% extension, the ratio between the fundamental frequencies corresponding to the longitudinal and transverse waves produced is give by,

(1) $10\sqrt{10} : 1$ (2) 10 : 1 (3) 1 : 10 (4) $1 : 10\sqrt{10}$ (5) 1 : 5

(15) A sketch of a pitot tube used to find the velocity of an air-craft is shown in the diagram. The difference between the liquid heights of the manometer as air travels through the tube A is given by (ρ - Density of the manometer liquid. ρ_0 - Density of air)



(1) $\frac{\rho_0 V^2}{2\rho g}$ (2) $\frac{\rho V^2}{2\rho_0 g}$ (3) $\frac{\rho^2 V^2}{2\rho_0^2 g}$

(4) $\frac{\rho_0^2 V^2}{2\rho^2 g}$ (5) $\frac{\rho V}{2\rho_0 g}$

(16) A streamlined flow of water flowing through two capillary tube A and B having equal length and radii r and 2r respectively. Pressure difference of the tube A is P and that of the tube B is 2p. The ratio between the rate of volume of the water flow inside the two tubes is,

(1) 1 : 4 (2) 1 : 8 (3) 1 : 16 (4) 1 : 32 (5) 1 : 64

(17) When an object is placed at a distance of 30 cm in front of a converging lens of focal length f, its image is formed on a screen 90 cm away from the lens. How far should the lens move from the above position to get the image back on the screen without changing the position of the object and the screen ?

(1) 60 cm (2) 30 cm (3) 20 cm (4) 45 cm (5) 10 cm

(18) The distance between the two wooden bridges of a sonometer wire is 75 cm. Two consecutive resonance frequencies of the wire is 480 Hz and 360 Hz. The fundamental frequency and the velocity of transverse waves along the wire are respectively,

(1) 60 Hz , 180 ms^{-1} (2) 120 Hz , 90 ms^{-1} (3) 60 Hz , 90 ms^{-1}

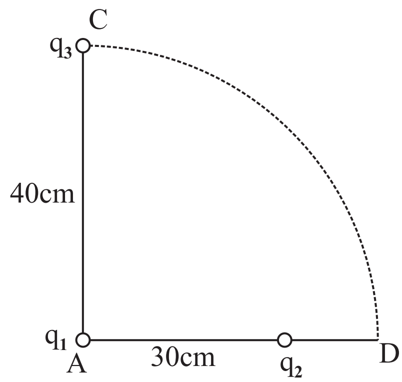
(4) 120 Hz , 60 ms^{-1} (5) 120 Hz , 180 ms^{-1}

(19) Of the two tubes, one end closed and both ends opened, one end closed tube is twice as long as the opened tube. At the same temperature open tube resonates at the first overtone whereas one end closed tube resonates at the fundamental frequency. Ignore the end correction of the two tubes. The rato of

$$\frac{\text{The frequency of the wave produced in the opened tube}}{\text{The frequency of the wave produced in the closed tube}} \text{ is}$$

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

(20) Two charges q_1 and q_2 are kept 30 cm apart from each other. Another charge q_3 is kept 40 cm away from q_1. The charge q_3 travels along a circular arc of radius 40 cm and reach the point D as shown in the figure. The potential difference of the system between the two position is given by, $\frac{q_3 K}{4 \pi \varepsilon_0}$. The value of K would be,



(1) $8q_2$ (2) $8q_1$ (3) $6q_2$

(4) $6q_1$ (5) $9q_3$

(21) The figure shows the position of the electric field lines when the two charges q and Q are close to tach other. Which of the following statement is true,

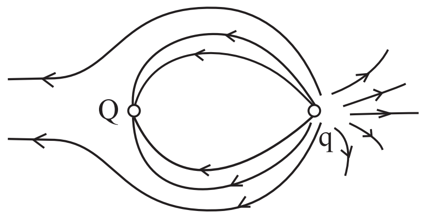
(1) Q is a positive charge and $|Q|>|q|$

(2) Q is a negative charge and $|Q|>|q|$

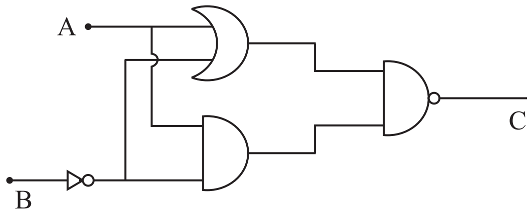
(3) q is a positive charge and $|Q|<|q|$

(4) q is a negative charge and $|Q|<|q|$

(5) Q is a negative charge and $|Q|=|q|$



(22)



In the circuit shown here the bulb (E) is lit when the output signal is 0. Which of the following input combinations is correct ?

(1) A = 1 B = 0 (2) A = 0 B = 0

(3) A = 0 B = 1 (4) A = 1 B = 1

(5) None of the above

(23) A 40 year old woman uses a lens with power of diopter 2 to read a book 25 cm in front of her. When she is 45 years old, she has to keep the book at 40 cm away from the eye to read it using the same lens. What is the power of the lens should she use to read a book 25 cm infront ?

(1) 2.5 D (2) 3 D (3) 3.5 D (4) 4 D (5) 5 D

(24) A mass of 31.4 kg is suspended by means of a wire having radius 1×10^{-3} m and density 9×10^{3} kgm^{-3}. What is the temperature difference of the wire If 75% of the elastic potential energy of the wire is converted into thermal energy? (Youngs' modulus of the wire = $9.8 \times 10^{10} Nm^{-2}$, specific heat capacity 490 $Jkg^{-1}K^{-1}$)

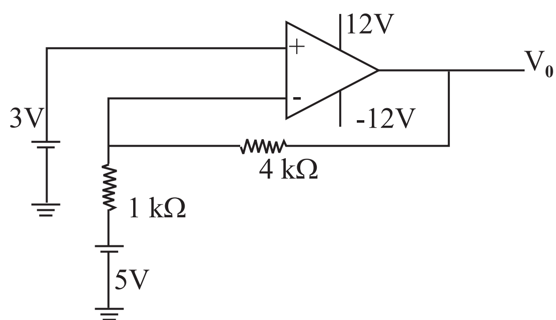
(1) 4.2×10^{-3} K (2) 8.7×10^{-3} K (3) 1.6×10^{-3} K (4) 3.33×10^{-3} K (5) 3.12×10^{-3} K

(25) The output voltage of the circuit shown would be approximately,

(1) + 12 V (2) - 12 V

(3) + 15 V (4) + 10 V

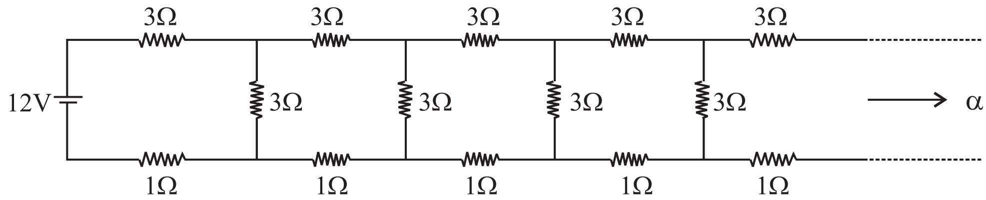
(5) - 10 V



(26) One end of a lagged copper wire having 1 m length and area of the cross section $0.1\ m^2$ is maintained at the temperature of 100 °C using a heater of 0.4 kW . At the steady state, the temperature of the other end would by,

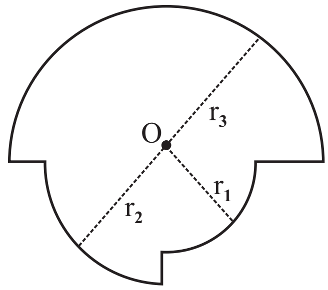
(1) 40 °C (2) 50 °C (3) 70 °C (4) 80 °C (5) 90 °C

(27) An infinite ladder resistance network as shown in the figure is connected to a battery of EMV 12V. The current passing through the battery would be,



(1) 0.25 A (2) 0.5 A (3) 1.0 A (4) 1.5 A (5) 2.0 A

(28) A current I flows around a closed loop as shown in the figure. The magnitude of the flux density produced at the centre O is given by,



(1) $\frac{\mu_0 I}{4}\left(\frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{r_3}\right)$

(2) $\frac{\mu_0 I}{4}\left(\frac{1}{2r_1}+\frac{1}{r_2}+\frac{1}{r_3}\right)$ (3) $\frac{\mu_0 I}{4}\left(\frac{1}{2r_1}+\frac{1}{2r_2}+\frac{1}{r_3}\right)$

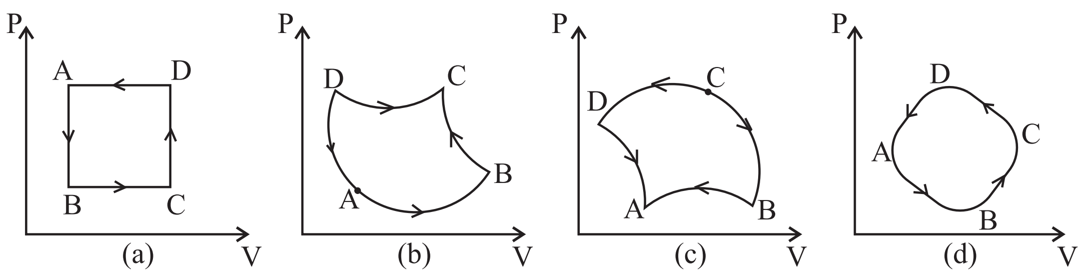
(4) $\frac{\mu_0 I}{4}\left(\frac{1}{2r_1}+\frac{1}{2r_2}+\frac{1}{2r_3}\right)$ (5) $\frac{\mu_0 I}{4}\left(\frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{2r_3}\right)$

(29) The work done by heating a mole of a given gas by θ °C at the constant pressure wold be, (R - universal gas constant. C_P - Specific heat capacity of the gas at constant pressure. C_V - Specific heat capacity of the gas at constant volume.)

(1) $R\theta$ (2) $C_P\theta$ (3) $C_V\theta$

(4) $(C_P+C_V)\theta$ (5) $(C_P-C_V)R\theta$

(30) Figure shows a closed P-V cycle for an ideal gas. The change in internal energy of the gas is,



(1) Zero in (a) and (b) and Positive in (c) and (d).

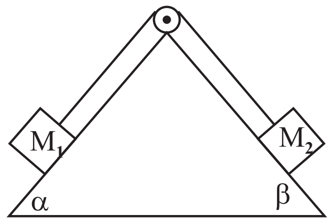
(2) Zero in (a) and (d) and Positive in (b) and Negative in (c).

(3) Zero in (a) and (d) and Positive in (b) and (c).

(4) Zero in (a) and (d) and Negative in (b) and (c).

(5) Zero in all the cases.

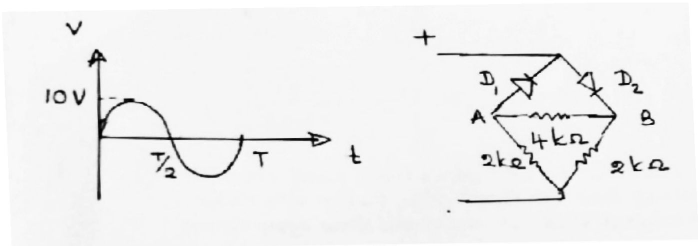
(31) Two masess M_1 and M_2 are kept on two smooth inclined planes by means of a light inextensible string passing over a smooth pully as shown in the figure. If $M_2 > M_1$ the acceleration of the system would be,



(1) $\dfrac{M_2 g \sin\beta}{M_1 + M_2}$ (2) $\dfrac{M_1 g \sin\alpha}{M_1 + M_2}$

(3) $\dfrac{(M_2 \sin\beta - M_1 \sin\alpha)\, g}{M_1 + M_2}$ (4) $\dfrac{(M_1 \sin\alpha - M_1 \sin\beta)\, g}{M_1 + M_2}$ (5) Zero

(32)

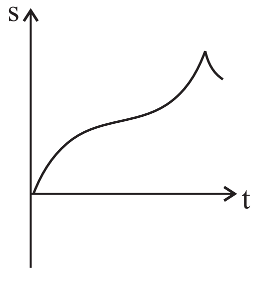


D_1 and D_2 are two Sillicon diodes. The maximum potential difference between A and B would be,

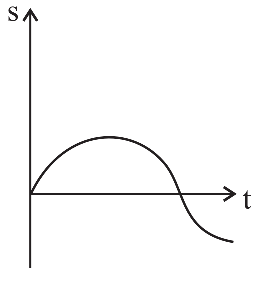
(1) 0 V (2) 3.1 V (3) 6.2 V (4) 9.3 V (5) 10 V

(33) A particle is projected down at an angle to the horizontal from a point on a tower mounted on the horizontal ground. Which of the following graphs best represents the variation of vertical displacement (s) with time (t) for the motion of the particle ?

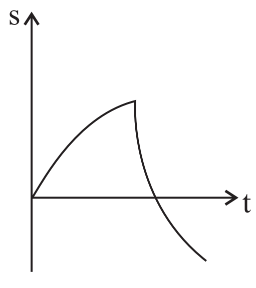
(1)



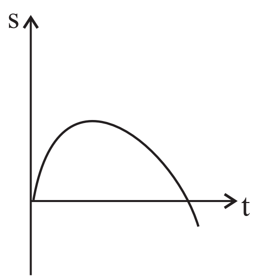
(2)



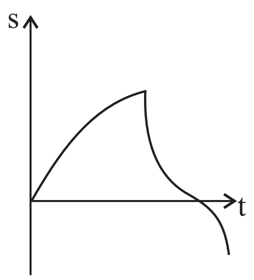
(3)



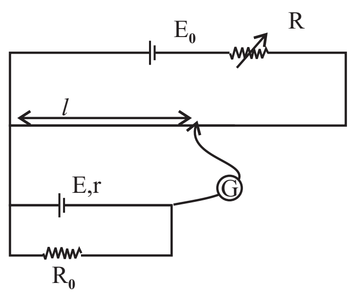
(4)

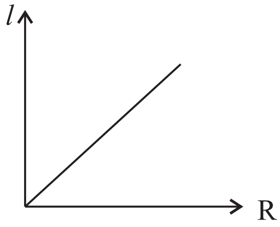


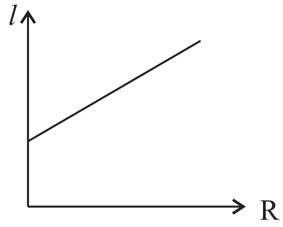
(5)

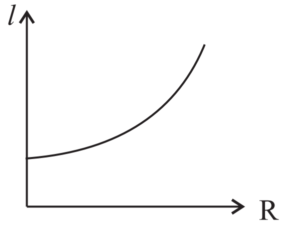


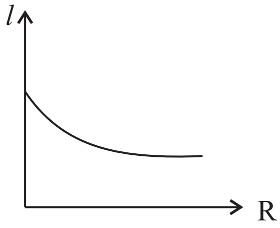
(34) Which of the following graphs best represents the variation of balance length (l) with the resistance R of the Variable resistor, when (R) increases gradually ?

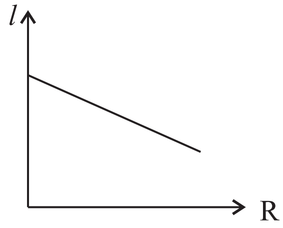


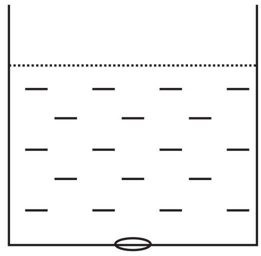
(1) 

(2) 

(3) 

(4) 

(5) 



(35) As shown in the figure a container with a circular hole at the bottom, contains a liquid to a height 5 cm. Surface tension of the liquid is 0.03 Nm^{-1} and the density is 800 kgm^{-3}. Consider the following statements,

A - If the excess pressure exerted by the fluid is less than the maximum possible extra pressure inside bubble, the bubble will burst.

B - If the radius of the bubble is smaller than or equal to the radius of the hole the bubble can not break.

C - In the above case the liquid does not leak out of the hole.

of the above, the true statement/ s is/ are,

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

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

(36) An express train A and a freight train B run on two parallel lines. Length of the train A is 100m and that of B is 150 m. They pass each other in 15s when moving in the same direction and in 10s when moving in the opposite direction. The velocity of the train A is, (Kmh^{-1})

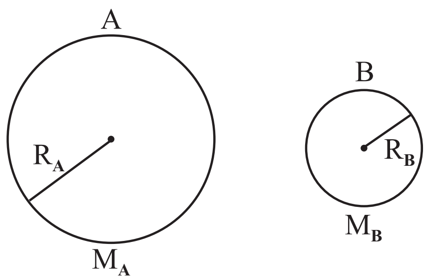
(1) 90 (2) 75 (3) 20 (4) 15 (5) 4

(37) The ratio between escape velocities of two planets. A and B is give by $\frac{V_A}{V_B} = 2$. How many times the ratio $\frac{M_A}{R_A}$ of A than the ratio $\frac{M_B}{R_B}$ of B ?

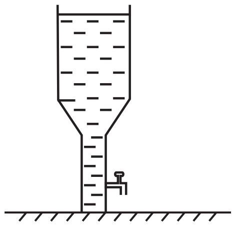
(1) ½ (2) 1

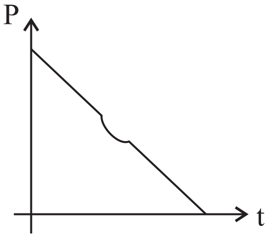
(3) 2 (4) 3

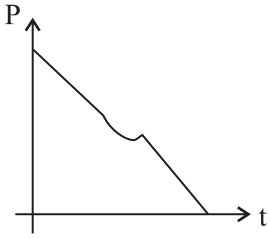
(5) 4

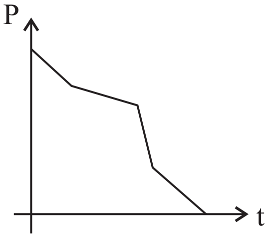


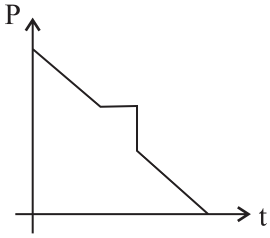
(38) As shown in the figure the tap at the bottom of the water tank allowed water to flow out at a constant rate. Which of the following graphs would represents the variation of hydrostatic pressure (P) on the bottom with time (t) ?

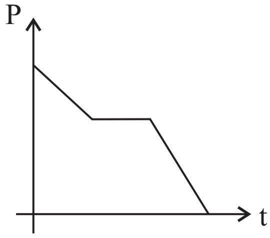


(1)


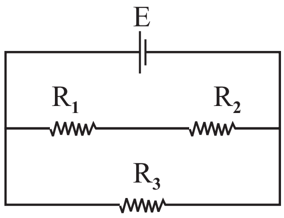
(2)


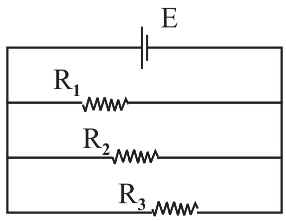
(3)


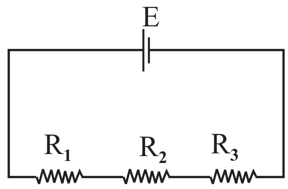
(4)


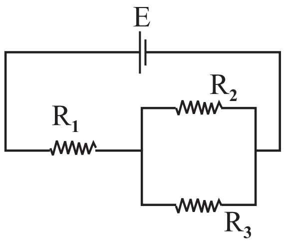
(5)


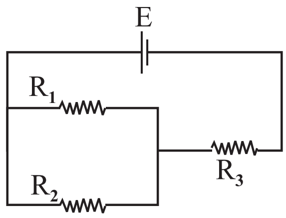
(39) In which of the following circuits the maximum heat is dissipated through the R_1 resistor ?

(1)


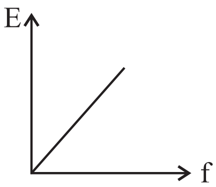
(2)


(3)


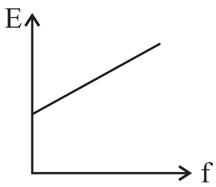
(4)


(5)


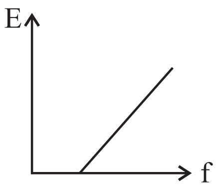
(40) Which of the following graphs that accurately represents how the maximum kinetic energy (E) of photo electrons emitted by radiation falling on a metal surface, varies with the frequency (f) of the radiation ?



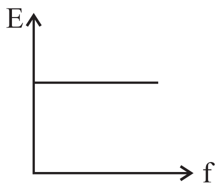
(1)



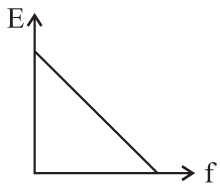
(2)



(3)

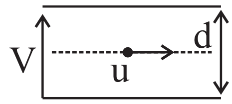


(4)



(5)

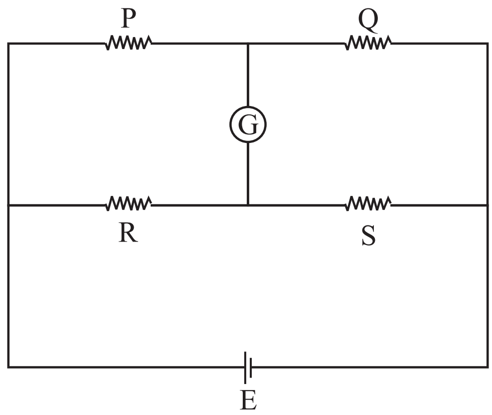
(41) In a space between two metal plates placed horizontally at a distance d from each other, a particle of mass m, charge Q is released with velocity of V in the horizontal direction. At what horizontal distance does the object collide with the plate ?



(1) $ud\sqrt{\dfrac{m}{VQ}}$ (2) $ud\sqrt{\dfrac{2m}{VQ}}$ (3) $ud\sqrt{\dfrac{m}{(VQ - mdg)}}$

(4) $ud\sqrt{\dfrac{2m}{VQ - mdg}}$ (5) $ud\sqrt{\dfrac{2}{VQ}}$

(42) The wheatstone ridge shown in the circuit is balanced. Consider the following statements.



A - Event if the R and Q resistors are exchanged the balance does not change.

B - Even if the P and R resistors are exchanged the balance does not change.

C - Even if the galvanometer G and the battery E are exchanged the balance does not change.

of the above,

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

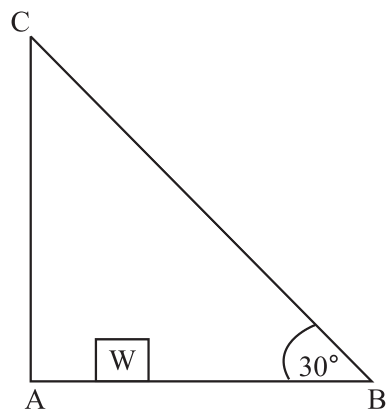
(3) Only A and C are true. (4) Only B and C are true.

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

(43) An object having surface area $10cm^2$, and temperature 727 °C emits thermal radiation at a rate of 5W. Surface emissivity of the object is (steffan constant = $5 \times 10^{-8} Wm^{-2}K^{-4}$)

(1) 0.1 (2) 0.15 (3) 0.20 (4) 0.5 (5) 1

(44) A uniform rod AB, having mass 20 kg and length 3 m is hinged at A and held in horizontal equilibrium by means of a steel wire BC as shown in the figure. The maximum tension of the wire is 500 N. The maximum distance from A that a load of 30 kg (W). Can be placed on AB, such that the wire does not break is,

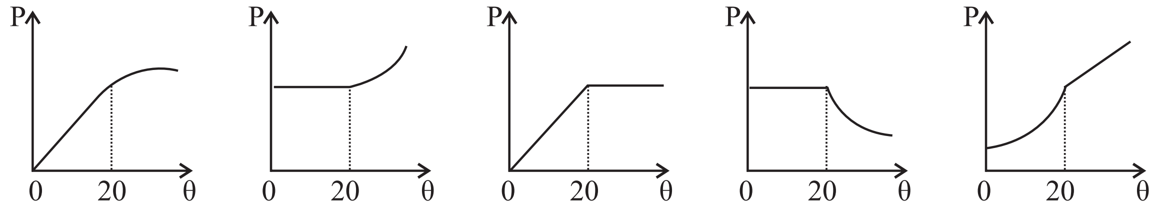


(1) 0.50 m (2) 0.67 m

(3) 1.25 m (4) 1.50 m

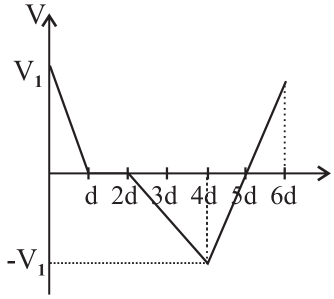
(5) 2.0 m

(45) At 20 °C, the air is saturated with water vapour in a sealed container **without** water. The container is cooled to 0 °C and then heated to 50 °C. Which of the following graphs best represents the variation between saturated vapour pressure (P) with temprtions θ °C,

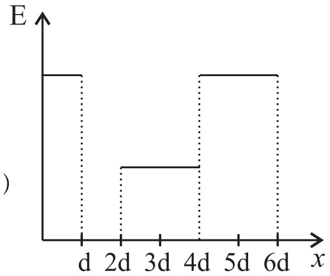


(1) (2) (3) (4) (5)

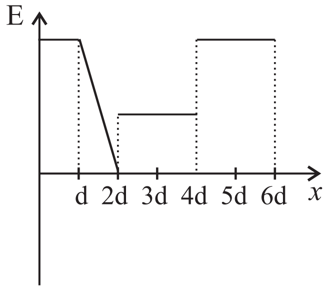
(46) The graph in the figure shows how the electric potential (V) changes along a given axis in a given space. The graph which shows the changed in electric field (E) along the same axis would be,



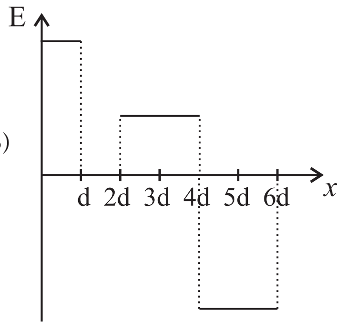
(1)



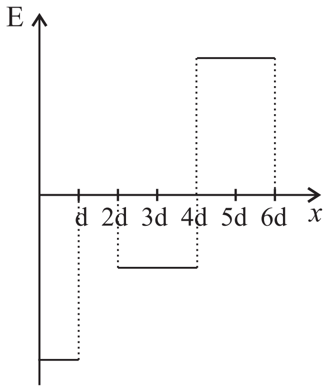
(2)



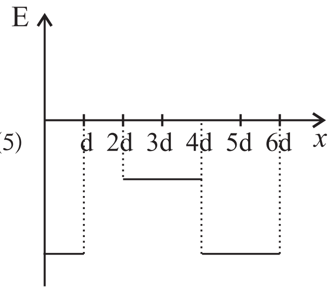
(3)



(4)



(5)



(47) The energy staved in the capasitors $2\mu F$ and $10\mu F$ respectively in the given circuit is,

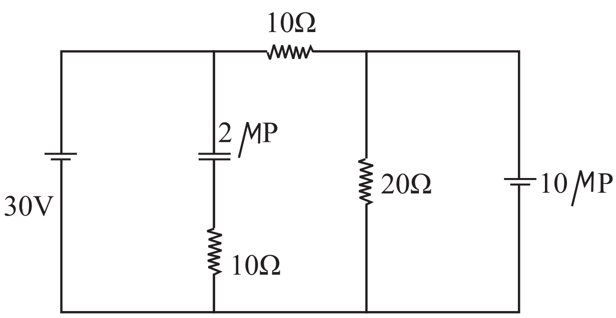
(1) 9×10^{-4} J and 2×10^{-3} J

(2) 9×10^{-3} J and 2×10^{-3} J

(3) 4×10^{-4} J and 4.5×10^{-3} J

(4) 4×10^{-4} J and 9×10^{-3} J

(5) 9×10^{-4} J and 2×10^{-4} J

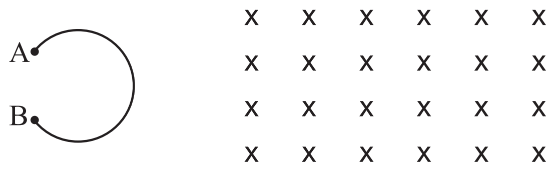


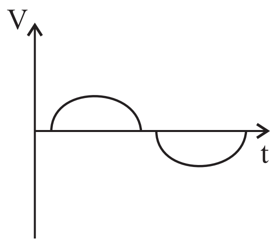
(48) In a nuclear power plant cool water at 6°C enters through a turbine cooling pipe and water at 14 °C exits from it. If the rate at which heat from the turbine is dissipated by water is 6.72×10^{9} $Jmin^{-1}$. The rate of flow of water through pipe is, (in $kg^{-1}s$)

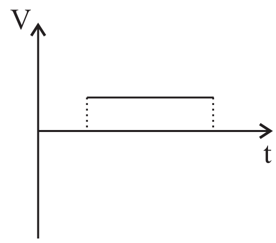
(1) 2.0×10^{5} (2) 1.2×10^{7} (3) 8.33×10^{-10}

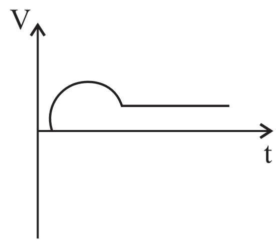
(4) 3.3×10^{3} (5) 3.0×10^{-4}

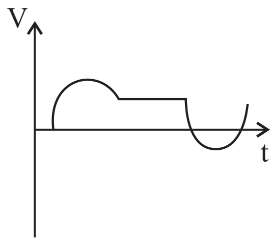
(49) A piece of wire AB in the shape of a circle, travels through an area with a uniform magnetic field at a constant velocity as shown in the figure. Which of the following graphs is best represented the variation of the potential induced (v) at A relative to B, with time (t) is,

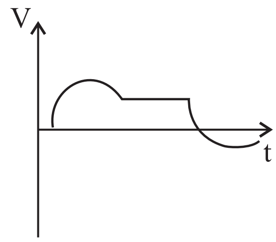


(1)


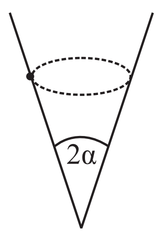
(2)


(3)


(4)


(5)


(50) A smooth hollow cone having vertex angle 2α is placed so that the vertex is at the bottom. A glass ball moves on the inner surface of the cone with angular velocity $10 rads^{-1}$ in a horizontal circle having the diameter 20 cm. The value of 2α would be,



(1) 120° (2) 90° (3) 60°

(4) 45° (5) 20°

දේවි බාලිකා විද්‍යාලය - කොළඹ

DEVI BALIKA VIDYALAYA - COLOMBO

Final Term Test - December 2021

Grade 13

භෞතික විද්‍යාව II Physics II	01	E	II	පැය 3 Three hours

Name : .... Class : .... Index No. : ....

Important :

- ✶ *The question paper consists of* ***20*** *pages.*
- ✶ *The question paper comprises* ***Part A*** *and* ***Part B****. The time allocated for both part is 3 hours.*
- ✶ *Use of Calculators is not allowed.*

Part A - Structured Essay (10 pages)

Answer all the questions on this paper itself. The space provided is sufficient for your answers and that extensive are not expected.

Part B - Essay (10 pages)

This part contains eight questions. Use the papers supplied for this purpose. At the end of the time allocated for this paper, tie the two papers so that ***Part A*** *is on top of* ***Part B*** *before handing them over to the Supervisor.*

You are permitted to remove ***only Part B*** *of the question paper from Examination hall.*

$g = 10\ Nkg^{-1}$

For Examiner's use only

For the second paper

Part	Question Nos.	Marks
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
	8	
	9A	
	9B	
	10A	
	10B	
Total		

Final Marks

In numbers	
In words	

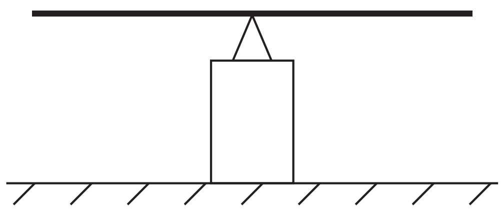
Part A - Structured Essay

Answer all questions on this paper itself.

$g = 10\ Nkg^{-1}$

මෙම තීරුවේ කිසිවක් නොලියන්න.

(01) You are asked to determine the mass of a rectangular glass cube (M) using the principle of moments. As the first step of this experiment, a meter ruler of mass W is balanced on a knife edge as shown in the diagram below.



(a) (i) Mark all the forces acting on the meter ruler when it is in equilibrium.

(ii) State the reason for the meter ruler to be in equilibrium as shown in the diagram.

....

....

(b) (i) You are provided with sufficient amount of strings and a weight with a suitable mass (m) (m < M). Draw a diagram of the arranged experimental set up for the balanced situation just before you take a reading, in the above diagram itself. Lengths to the masses from the point of equilibrium are l_1 and l_2 ($l_1 > l_2$)

(ii) Explain the reason why the given masses are hung by using strings without keeping them on the meter ruler.

....

....

(iii) Write down an expression for l_1 using the above diagram.

....

....

(iv) In order to obtain M using a graphical method the mass of m should be approximately similar to the mass of M. Give two reasons for this.

....

....

මෙම තීරුවේ කිසිවක් නොලියන්න.

(v) Explain how M is obtained using the graph.

....

....

(c) If M is known, how can this experiment be extended to obtain the mass of the meter ruler (W) ? Draw a suitable diagram and explain..

....

....

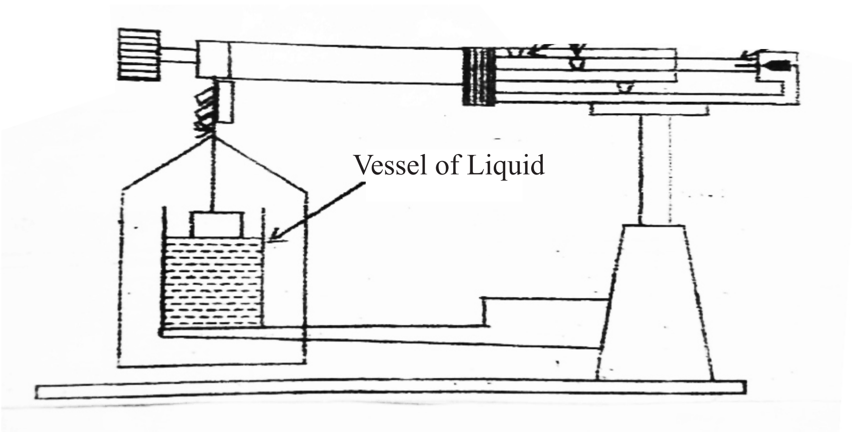
....

....

....

....

(d) The diagram below shows an experimental set up using the four beam balance which is used to determine the density of the above rectangular glass cube.



(i) What is the least count of the four beam balance ?

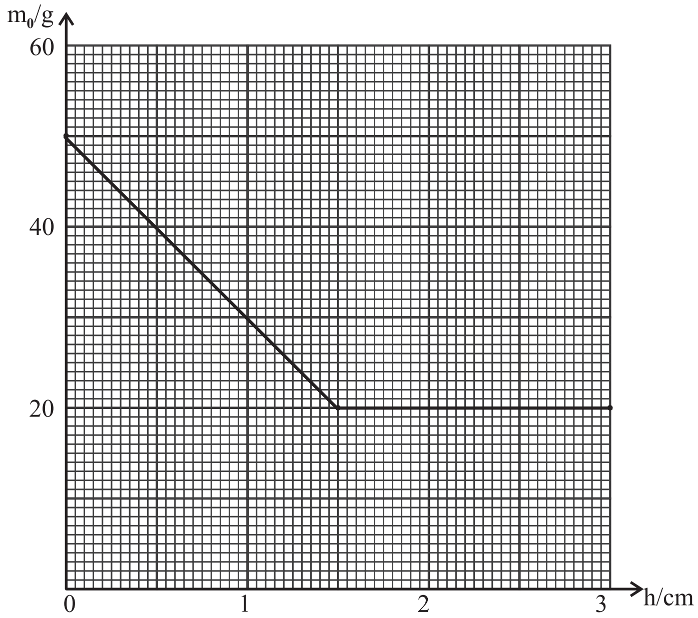
....

(ii) What is the adjustment that should be made first, before measuring a weight using the balance.

....

....

(e) The rectangular glass cube tied to the four beam balance is gradually immersed in a liquid container as shown in the diagram. Height of the glass cube is x and its surface area is 16 cm^2. The depth to the bottom surface of the glass cube from the liquid surface (h) varies with the reading of the balance (m_0) as shown by the following graph. The reading marked by m_1 is equal to 30g.



(i) Calculate the density of the liquid.

....

....

....

....

....

....

(ii) Determine the density of the glass the cube is made of.

....

....

....

....

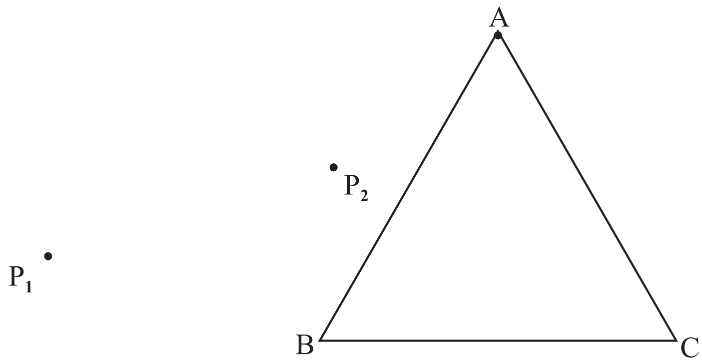
මෙම තීරුවේ කිසිවක් නොලියන්න.

20

මෙම තීරුවේ කිසිවක් නොලියන්න.

(02) A student uses a white a paper, drawing board and pins to determine the deviation a light ray undergoes, when it travels through a prism with an equilateral cross section.

(a) (i) The following diagram shows the experimental set up arranged by the student, to determine the emergent ray for a certain incident ray. Mark how P_3P_4 pins should be placed after observing $P_1\,P_2$ pins through surface AC.



(ii) Draw the relevant ray diagram in the above diagram itself and clearly mark the angle, of deviation.

(iii) Draw a rough sketch of the expected graph for the variation of the angle of deviation (d), with the angle of incidence (i).

(iv) Which result can be obtained by the above graph that can be used to determine the refractive index (n) of the prism material.

....

(v) Write down the equation which consists both the above result and prism angle (A) for the refractive index.

....

....

(vi) The student determines that the refractive index of the prism $n = 1.5$. Can an emergent ray be expected for the range of $0°$ to $30°$ of the incident ray ? Explain your answer.

....

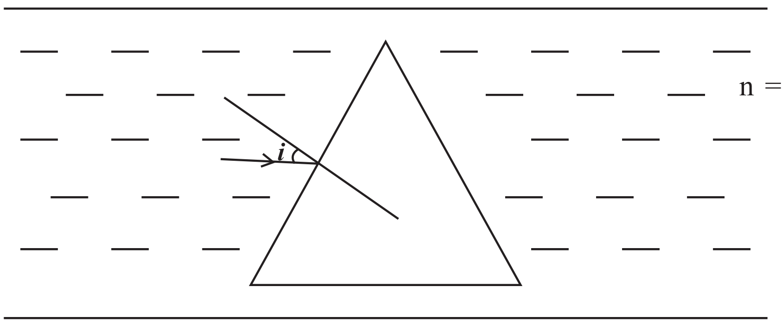
....

....

....

(b) A cavity of air inside a glass of refractive index $n = 1.5$ has the shape of a prism of equilateral cross section as shown in the diagram.

A ray which incident with an angle of i for the glass air interface, has and angle of minimum deviation 35°.



(i) Complete the path of the above ray and obtain an expression for the angle of minimum deviation.

....

....

....

(ii) Calculate the angle of incidence (i). (Sin 19.47° = 0.33333)

....

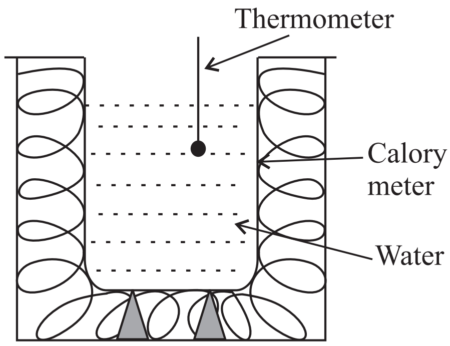
....

....

20

මෙම තීරුවේ කිසිවක් නොලියන්න.

(03) The following diagram shows an incomplete experimental set up for determining the latent heat of fusion of ice (L).



(a) Define what is meant by the latent heat of fusion of ice.

....

....

....

(b) (i) What is the item and the measuring instrument which are essential for this experiment that are not mentioned here.

Item ....

Measuring instrument ....

(ii) What are the three readings that are obtained before adding ice to the water?

R_1 - ....

R_2 - ....

R_3 - ....

(iii) What is the reason for using melting ice for this experiment ?

....

....

(iv) What are the two readings that are obtained after adding ice to the water?

R_4 - ....

R_5 - ....

(v) Which data should be obtained from a reference book in order to calculate L.

X_1 - ....

X_2 - ....

(vi) Using the above (ii) , (iv) and (v) give an expression to obtain L.

....

....

....

මෙම තීරුවේ කිසිවක් නොලියන්න.

(c) The mass of the added ice should be measured accurately in this experiment. What is the reason for this ?

(d) Due to the errors mentioned below, explain with reasons whether the value obtained for L increases or decreases.

(i) Adding ice without wiping out properly.

Reason

(ii) Ice cubes floating on the water surface.

Reason

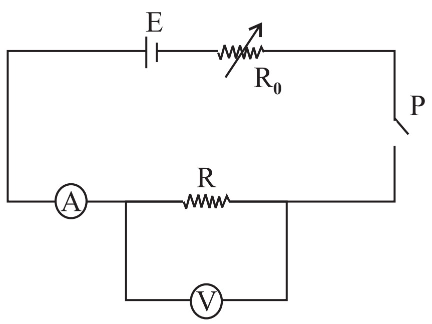
(e) Calculate the percentage error of L if a large ice cube at -5°C is used for this experiment.

(Specific heat capacitance of ice = 2700 $Jkg^{-1}K^{-1}$ L = 3 x 10^5 $JKg)^{-1}$

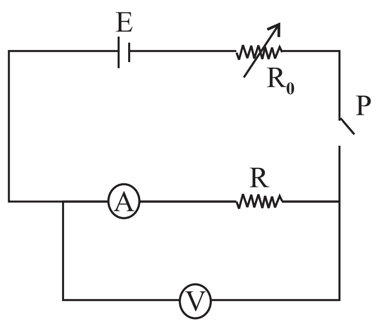
20

(04) You are asked to determine the accurate resistance (R) of an unknown resistor.

(a) The current (I) and the voltage (v) through the resistor R of the following circuits need to be measured & a suitable graph should be plotted to determine R.



Circuit (X)



Circuit (Y)

මෙම තීරුවේ කිසිවක් නොලියන්න.

(i) Mark the (+) and (-) ends of the voltmeter and the ammeter in the above circuits.

(ii) Mention the most suitable circuit according to the magnitude of R, when V and A are not ideal.

for small values of R ....

....

for large values of R. ....

....

(iii) What is the reason for using a tap key as P in the above circuits ?

....

....

(iv) Explain how you would obtain the accurate value of R using a suitable graph, if the resistance R is known approximately.

....

....

....

(b) The accurate value of R is to be determined using a meter bridge.

(i) For what type of resistors the meter bridge is more suitable in accordance with the magnitude of the resistor? Explain.

....

....

....

(ii) The experiment is arranged to obtain the balance point between 30 cm - 70 cm of the wire. Give two reasons.

1. ....

....

2. ....

....

(iii) What is the strategy which is used to minimize the effect of the resistance of the wires?

....

....

මෙම තීරුවේ කිසිවක් නොලියන්න.

(iv) How would you determine the accurate value of resistor R, if you are provided a meter bridge, a resistance box and all the other items needed? Explain briefly.

....

....

....

....

(c) The accurate reading of R is to be determined using a potentiometer if a known resistor is provided.

(i) Draw the circuit to compare R and S if you are provided the potentiometer, driven cell (E), known resistor (s) and a two way switch.

(ii) Explain how would you obtain the accurate value of R using the above circuit.

....

....

....

(iii) What type of cell should be used in the potentiometer circuit as the driven cell?

....

....

(iv) Potentiometer method is most suitable in order to determine the accurate value of R. Explain the reason.

....

....

20

දේවි බාලිකා විද්‍යාලය - කොළඹ
DEVI BALIKA VIDYALAYA - COLOMBO
Final Term Test - December 2021
Grade 13

භෞතික විද්‍යාව II
Physics II

01 E II

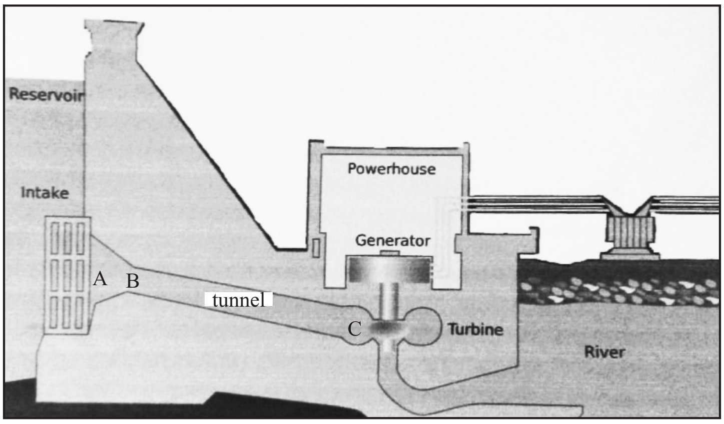
Part B - Essay
Answer 02 questions only.
$g = 10\ Nkg^{-1}$

(05) (a) Mention the conditions where the Bernoulli's principle is applicable for a flowing liquid.

(b) Write down Bernoulli's Principle as an expression and identify its terms.

(c) Write down the terms for dynamic pressure and static pressure of the above separately.

(d) A small hydro-electic power-station is planned to run on the potential energy of water. The power-station will provide hydro-electricity to the neighbouring villages. A rough sketch of the power-station is shown below.



A tunnel with a circular cross section of diameter 35 cm is used to carry water to the power-station. The center of the cross section of the tunnel (A) is situated. 4 m below the water surface of the tank.

The tunnel gradually becomes narrower as shown in the diagram. The diameter is 14 cm at the point B. The tunnel becomes uniform from that point onwards. From B to C, the tunnel is inclined 30° to the horizontal. The length of BC = 200m.

Assume that at the starting point of the tunnel, the water in the tank is still and the water flows through the tunnel according to Bernoulli's Principle. Water stream which exit from the end of the tunnel hits the fans of the turbine perpendicularly and electricity is generated.

Atmospheric pressure is $1 \times 10^5\ Nm^{-2}$ Density of water is $10\ kgm^{-3}$

(i) At the starting point (A) of the tunnel, the static pressure of water inside the tunnel is 1.2 m of a water barometer. Calculate the velocity the water enters the tunnel.

(ii) What is the dynamic pressure difference of water at that point ?

(iii) Find the velocity of water at point B in the tunnel.

(iv) Calculate the static pressure difference between B and C.

(v) Calculate the speed the water stream hits the fans of the turbine. (Assume that the hydrolic pressure is almost equal at C and inside the turbine chamber)

(vi) Find the water mass per second which exists at the end C of the tunnel.

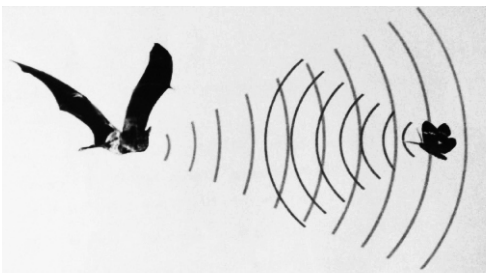
(vii) Calculate the transnational kinetic energy given by water per 1 s to rotate the turbine. (Assume that there is no energy loss of water when it hits the turbines)

(viii) If the turbines rotate at 70% efficiency of the translational kinetic energy given by water, calculate the rate of rotational kinetic energy it obtains.

(06) (a) What is Doppler effect ?

(b) Give three applications of Doppler effect.

(c) Bats are evolved to find their location and prey using sound waves at night. They have the ability to identify any obstacle in their way even if it is as thin as a hairline, using the reflection of sound. Also some insects are evolved to identify the frequency range of bats and escape from them. A bat which moves in uniform velocity looking for pray at night emits a wave of frequency of 2×10^5 Hz at a prey. The bat moves in uniform velocity directly towards the stationary prey along a straight line. The bat receives the reflected wave after 0.5 s of its emissions. Speed of sound in air is 340 ms^{-1}.



(i) In the above situation the waves which the bat emits is received again by the bat at a frequency of 2.25×10^5 Hz. Calculate the velocity V_1 of the bat.

(ii) Calculate the distance to the prey from the bat when it emits the sound wave.

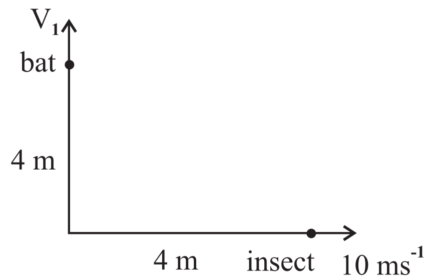
(iii) If the prey is a flying insect and the power of the sound emitted by the bat is 6.16 W. Minimum intensity level the insect sensitive to is 80 dB

(a) What is the minimum sound intensity the insect is sensitive to ? (Threshold of audibility is $10^{-12}Wm^{-2}$)

(b) The insect becomes aware of the bat after he bat moves a certain distance. Calculate the distance the bat moves.

(iv) If the insect starts moving away from the bat just as it becomes aware of the bat, at a uniform velocity of 10 ms^{-1}, what would be the frequency received by the insect ?

(v) While following the insect, the bat sees a better prey and changes its direction in 90°. After time "t" the positions of the bat and prey are as shown below. Calculate the apparent frequency the insect receives from the bat



(07) (a) Define "Surface tension"

(b) Soap bubbles with different sizes are released to the air by a device.

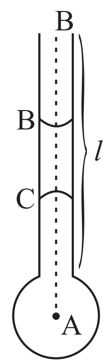
(i) Write down an expression for the excess pressure inside a soap bubble, in terms of the surface tension of the soap liquid (T) and the radius of the soap bubble (r).

(ii) A soap bubble of radius r_1 is mixed with another of radius r_2 and a soap bubble of radius R. If the atmospheric pressure is P, show that the surface tension of liquid T is

$$T = \frac{P\,(R^3 - r_1^3 - r_2^3)}{4\,(r_1^2 + r_2^2 - R^2)}$$

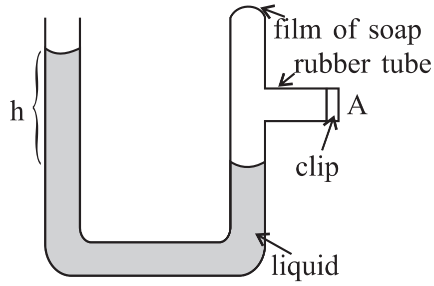
(Suppose that the atmospheric air and the air inside the soap bubble is ideal)

(c) (i) The soap bubble mentioned above is formed at one end of a capillary tube as shown in the figure. Plot a graph to show the variation of pressure from O to A.



(ii) A soap bubble of radius 2.5 mm is formed at the lower end of a thin glass tube of internal radius of 0.5 mm. Length of the tube is 15 cm. Bubble is balanced by a small liquid column of length 4.0 mm which is formed by the same liquid. (Find the surface tension of the soap solution. Assume that the angle of contact for glass and soap solution is zero. (density of soap solution is 1050 kgm^{-3})

(d) A soap bubble is attached to one end of an arm of a U tube and make a film of soap. The U tube contains a liquid of density ρ and the other end of the U tube arm is open to the air ?

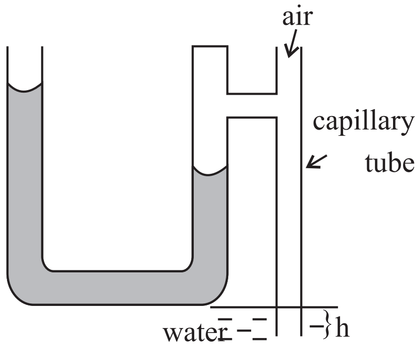


(i) Show that the multiple of the radius r of the bubble and the difference of the liquid levels in the U tube h is a constant. ($h \times r = K$)

(ii) Calculate the density of the liquid in the U tube if that constant is $1.23 \times 10^{-5}\ m^2$.

(iii) Then the film of soap is removed and that end of the arm of the U tube is sealed. It is connected to a capillary tube of internal radius 0.7mm which is immersed in water as shown in the figure. Then the liquid level inside this arm is increased by 3.5 cm.

Then air is inserted gradually from the open end of the other arm, the U tube acts as a pressure guage. The gap between the liquid levels of the arms is increased to 9.1 cm first, then decreased to 4.0 cm and increased again to 9.1 cm. Depth for the lower end of the capillary tube (h) from the water surface is 2.0 cm. (density of water is 1000 kgm^{-3})

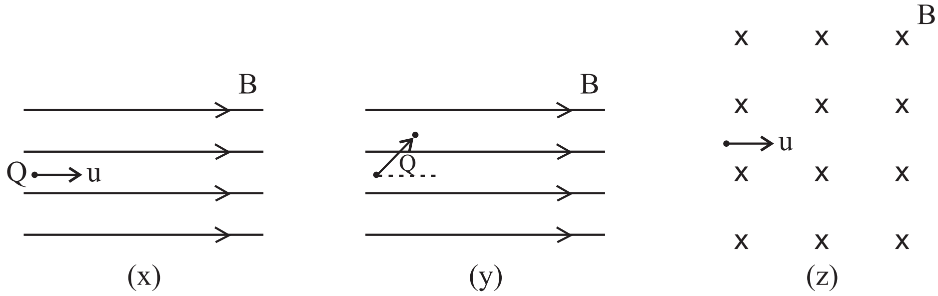


(1) Explain why does the gap between the liquid levels of the pressure guage is varied.

(2) Find the surface tension of water.

(3) Calculate the angle of contact for water and glass.

(08) (a) The following diagrams x, y, z show three ways of a charge of Q enters a magnetic field of B with a velocity of U.



(i) Obtain three expressions of the magnitudes for force acting on Q in the above three instances x,y,z.

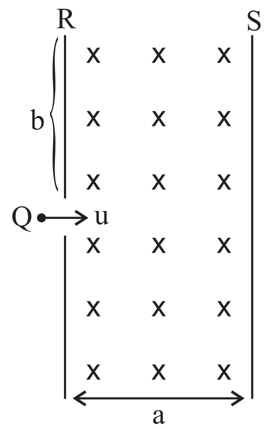
(ii) Draw the paths of charge Q in the three instances x, y, z.

(iii) Calculate the work done by the field when the charge Q moves a distance d in the field, in the above three instances x, y, z.

(iv) Find the magnitude and the direction of the electric field which should be used to make the charge Q move in a straight line at the instance Z.

(v) Calculate the work done by the electric field on the charge Q at (iv).

(b) A charge of Q enters a magnetic field of magnitude B with a velocity u, through a hole. The magnetic field is between the plates R and S. The separation between R and S is a. The hole is at a distance b from the edge of the plate.

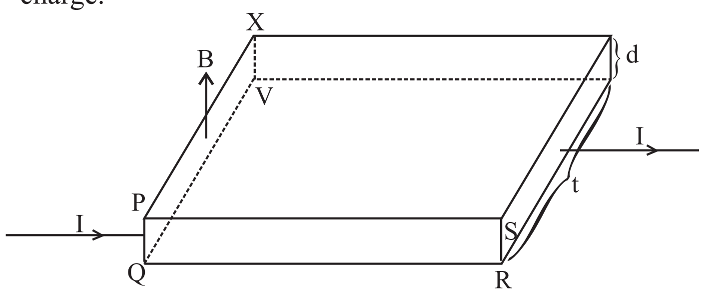


(i) If a > b and also if the charge Q moves away barely touching plate s, copy the above diagram in your answer sheet and draw the path of charge Q.

(ii) When the charge Q moves as shown in (i), if the radius of curvature of the path is R. obtain a relationship between a, b and R.

(iii) If the charge Q moves away at a point between R and S when the point is at a distance b from R, show that $U = \frac{2k}{BQb}$. Here k is the kinetic energy of the charge.

(c)



A metal cuboid as shown in the diagram is kept in a magnetic field of magnitude B. The direction of the field is vertically upwards. A current I flows through the cuboid.

(i) What would be the direction of force acting on an electron at the instance the current starts flowing ?

(ii) If the electron density of a unit volume of the metal is n and the charge of an electron is e, obtain an expression for the drift velocity u_0 of an electron.

(iii) Due to the force exerted on the electrons within a very small time period, one surface of the metal cuboid becomes positively charge and the other becomes negatively charged. Name those two surfaces.

(iv) An electric field is created between the surfaces mentioned in above (iii). Obtain an expression for its magnitude E.

(v) Due to the electric field created between the surfaces, named in (iii) above a voltage is created. This is called the Hall Voltage (V_H). Obtain an expression for V_H

(vi) If the electron density of the metal, (n) = 10^{29} m^{-3} magnetic flux density (B) = 2.4 T, I = 2A, e = 1.6 x 10^{-19} C, t = 6 cm, d = 2 cm calculate V_H

09 Answer either part (A) or part (B)

(A) (a) When a current flows through a metalic conductor, free electrons drift towards a certain direction while moving randomly. Then the electrons move while making impacts with the other electrons and nucleai. Due to these impacts a resistance to the motion of the electrons is created. How does this resistance vary with the Explain your answer.

(b) Define the temperature coefficient of resistance of a metallic conductor

(c) A meter bridge is used in order to test the variation of resistance with temperature. When the circuit is arranged, one gap is connected to a nickel wire and the other gap is connected to a 10 Ω standard resistor. When the nickel wire is at 0°C, the balance point is at 40 cm distance from the end close to the nickel wire. When it is at 100°C, the balance point is at 50 cm distance from that end.

(i) What is the temperature of nickel wire when the balance point is at 42 cm distance?

(ii) Calculate the temperature coefficient of resistence for nickel.

(iii) What is the advantage of using 100 Ω standard resistance more using 100Ω standard resistance in this experiment?

(B) (a) Write down an expression for the power P of a resistance R, in terms of the current I and the potential difference V through it.

(b) Hence obtain the equations $P = I^2R$ and $P = \frac{V^2}{R}$

(c) A cell of 6 V is connected with a resistance R as shown in the figure. Then the current through it is 0.2 A and the potential difference through it is 5.8 V. This current flows through this circuit during 5 minutes.

(i) Find the internal resistance of the cell

(iii) Calculate the energy produced in the cell

(iv) Calculate the energy dissipates in the resistance R.

(v) Explain the reason for the difference between the energy produced in the cell and energy dissipates from R.

(vi) Another identical cell is connected in series with this cell. Than the current through the circuit is 0.3 A. What is the new value of R in this situation ?

(vii) Explain the reason for the difference of the value of R in above two situations.

(d) Two motors x,y and two bulbs A, B are connected with the above cell to make a electrical circuit for a toy car, as shown below.

Bulbs A and B are rated at 5V, 0.5 W and 2.5 V, 0.5 W respectively. Resistance of dc motors x and y are 4Ω and 2Ω respectively and they are identical in every other way.

(i) Explain "back emf" of a motor.

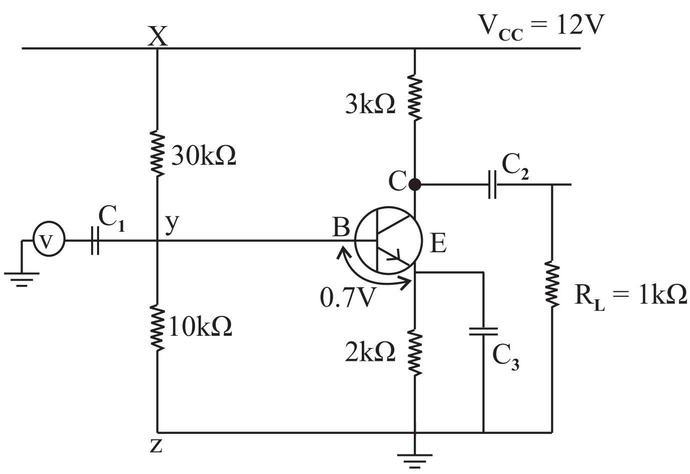
(ii) Find the currents through the bulbs when they are operating at rated power.

(iii) Calculate the back emf of the motors at the above situation.

(iv) Find the currents through the bulbs just the switch s is closed.

(v) The maximum currents that can be beared by the bulbs are higher than 20% of the standard value. Explain about the protection of the bulbs when the switch s is closed.

(B) (a) Draw the output characteristic curve of a npn transistor of in common emitter configuration and mark cut off, saturated and active regions on it.



(i) According to the above circuit, current gain of the transistor is 100. Calculate.

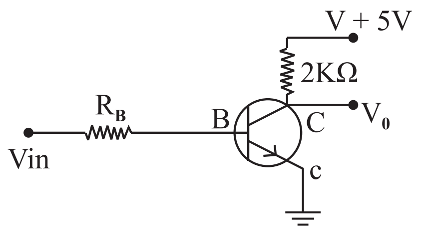
1) Blassed potential of the base.
2) collector current
3) collector potential

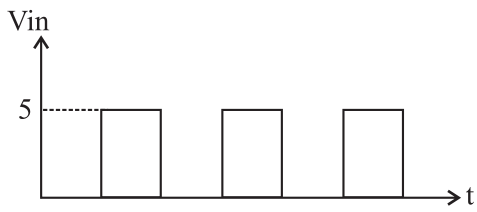
(ii) Calculate the voltage gain for direct current. (DC)

(iii) Explain in which of the following regions the transistor exists, cut-off, active or and saturated.

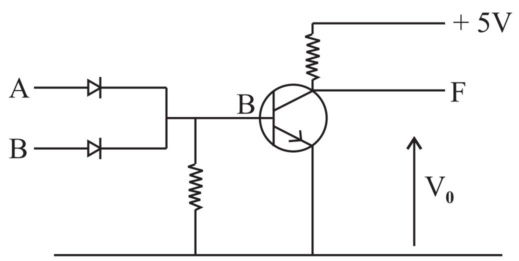
(iv) Is the temperature of the transistor in this amplifire circuit controlled by R_E ?

(b) (i) What the transistor acts as a switch, sketch the input voltage (V_{in}) against output voltage (V_{out})





(ii) When this circuit is given an input as shown above, draw the variation of the output with time.



When the above circuit is saturated, $\beta = 5$. If the transistor is saturated when $V_{in} = 5V$ find a value for R_B

(Take $V_{BE} = 0$)

When an input is given for A and B, show that this works as a NOR gate.

10 Answer either part (A) or part (B)

(A) (a) Define latent heat of vapourization.

A steel sphere of densit 8000 kgm^{-3} , volume 10^4 cm^3 and specific heat capacity 420 $Jkg^{1}K^{-1}$ is kept at room temperature. (27°C). If heat is given to the sphere at a rate of 560 Js^{-1} for one minute,

(i) Find the final temperature of the sphere reaches.

(ii) If the co-efficient of linear expansion of steel is $1 \times 10^{-5}K^{-1}$, find the final volume of the sphere after being heated.

(b) The heated sphere is dropped into a water container of volume 2000 cm^3 kept at room temperature (27°C). Heat capacitance of the container is 210 Jk^{-1}. The system is properly insulated so that there's no heat exchange with the environment. At 27°C, density of water is 1000 kgm^{-3}. Find the final temperature of water.

(i) If this sphere was heated upto 400°C and then dropped into this container, find the mass of water which vapourizes. Latent heat of vapourization of water is 2.3 x 10 Jkg^{-1}

(ii) If the volume expansivity of water is 2.1 x $10^{-4}K^{-1}$, find the volume of water which remains after vapourization.

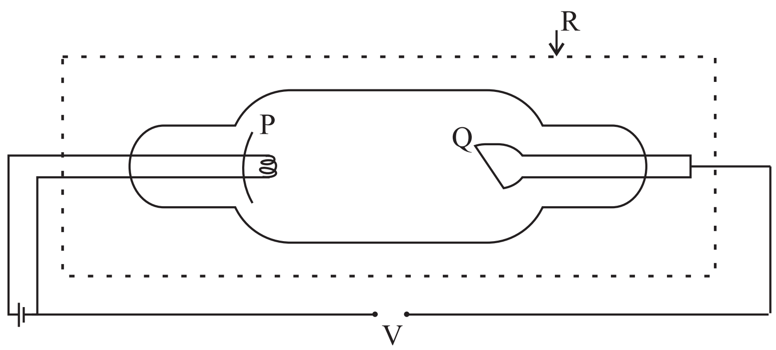
(c) (i) Write down Newton's Cooling Law and state the conditions where it is valid.

(ii) This steel sphere was heated upto 50° and then it was allowed to cool down under an air stream of velocity 1 m^3s^{-1}. If the rate of cooling is 0.5 cs^{-1} at that instance, calculate the rate of cooling at 40°C. Take the room temperature as 30°.

(iii) If the above sphere was made into 8 equal small spheres, and they were allowed to cool down under the same conditions, find the rate of cooling of the spheres at 50°C.

(iv) If the above sphere was separated into two equal halves, calculate the rate of cooling for one piece at 50°C.

(B) X rays are produced by making fast electrons to strike a target. The device used to produce x rays is shown below.



(a) (i) Mention the anode and the cathode of this tube.

(ii) What is the purpose of R ?

(iii) Write down two methods used to make strikes of fast electrons.

(iv) Explain why the x-ray tube should be evacuated ?

(b) (i) If potential difference through the x ray tube is V and the velocity which the electrons obtained when reaching Q is u, show that $u = \sqrt{\dfrac{2eV}{m}}$

e and m are charge and mass of electron.

(ii) What is de Broglie wave length of the electron just before it reaches Q, if the supply voltage of a x-ray tube is 120 KV?

(iii) Assume that 99% of the energy of electrons in the above tube is transferred into heat after striking Q. Find the wave length of a photon emitted in this.

(c) Area of the metallic anode is 4 cm^2 Intensity of the x-rays produced is 12000 Wm^{-2}.

(i) Find the number of electrons released from the filament during 1 second.

(ii) Find the total energy on Q during 1 second.

(d) Photons are emitted by the interaction of electrons and matter inside the x-ray tube. In photo - electric effect electrons are emitted by the interaction of photon and matter. X rays with the wavelength of above b (ii) strikes the cathode of a photo cell and emit electrons. Work function of cathode metal is 5 keV.

(i) Find the kinetic energy of photo electrons emitted.

(ii) Calculate the stopping potential of that electrons.

Change of an electron	= 1.6×10^{-19} C
Mass of an electron	= 9×10^{-31} kg
Velocity of light	= 3×10^{8} ms^{-1}
h	= 6.6×10^{-34} Js