

Grade 13

PhysicsI

Time : 2 Hrs

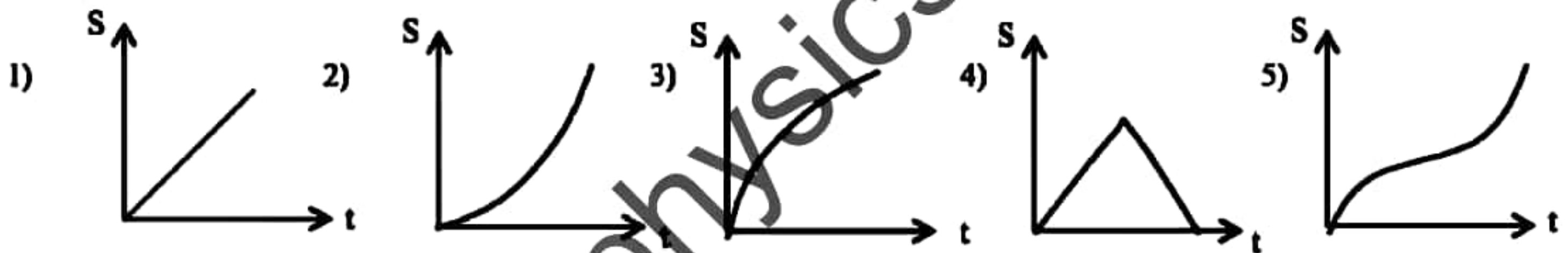
Rathnavali Balika Vidyalaya - Gampaha. Rathnavali Balika Vidyalaya - Gampaha. Rathnavali Balika Vidyalaya - Gampaha. Rathnavali Balika Vidyalaya - Gampaha.

- **Answer all the questions.**

(1) In the Equation $E = hf$, E and f represent energy of a photon and frequency respectively.
Dimension of h is,

- 1) ML^2T^{-3} 2) MLT^{-3} 3) ML^2T^{-1} 4) MLT^{-2} 5) ML^2T^{-4}

(2) What is the correct variation of horizontal displacement with time for a particle projected 60° with horizontal,



(3) Two forces acting on a point object. One force is horizontal and other one is 60° inclined to the horizontal. Magnitude of both forces are same. The horizontal component of the inclined force is 10 N. The resultant acting on the point object is,

- 1) 20 N 2) $20\sqrt{3}$ N 3) 40 N 4) $10\sqrt{19}$ N 5) $40\sqrt{2}$ N

(4) Which factor the **maximum velocity** of a vehicle on a circular bend is depending on to move if the road is not banked.

- A. On gravitational acceleration
B. Radius of the bend
C. Centre of gravity of the vehicle

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

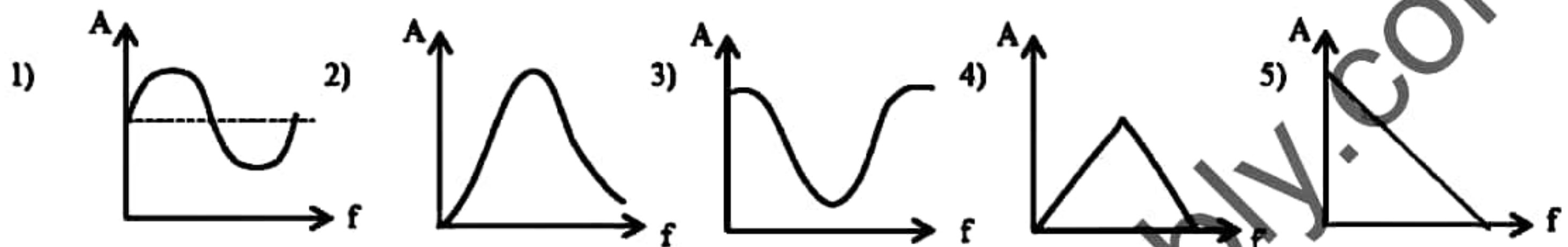
(5) Intensity level of a person is 60dB. How many people can increase the intensity level until 80 dB of the room.

- 1) 25 2) 50 3) 100 4) 200 5) 400

(6) What is the correct ascending order of magnitude of four fundamental forces in universe.

- 1) Gravitational force, electromagnetic force, strong force, weak force.
- 2) Electromagnetic force, gravitational force, weak force strong force.
- 3) Gravitational force, weak force, electro magnetic force, strong force.
- 4) Weak force, gravitational force, electromagnetic force, strong force.
- 5) Gravitational force, strong force, weak force, electromagnetic force.

(7) An oscillator vibrates with a source having variable frequency(f). What should be the correct variation of amplitude(A) of oscillator with forced frequency of source .



(8) When an object is placed 25 cm ahead the naked eye it will subtend 1° angle at eye lens. When a simple microscope is used under normal adjustment it subtended 11° , what is the focal length of simple microscope.

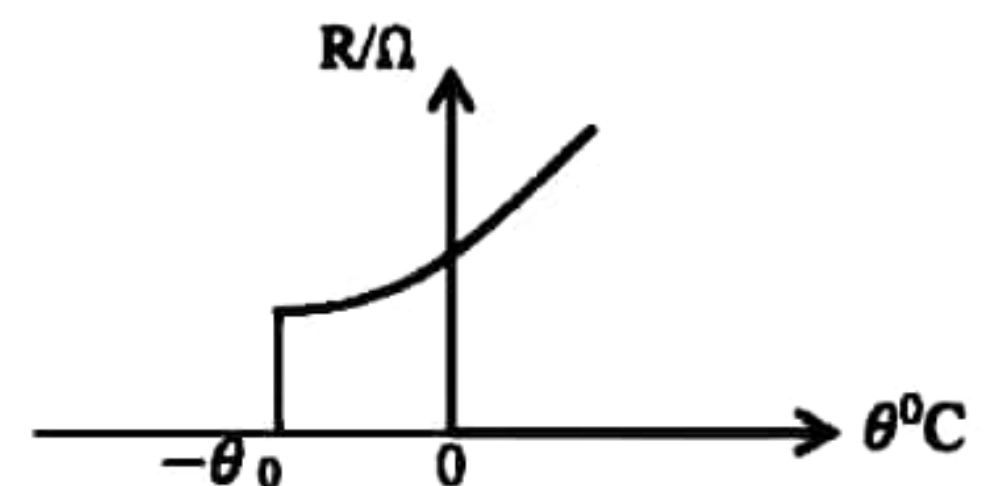
- 1) 5 cm
- 2) 2.5 cm
- 3) 2.1 cm
- 4) 2.3 cm
- 5) 25 cm

(9) The Variation of Resistance with temperature is shown in the graph.

- A. Temperature coefficient of resistance is always constant, and it doesn't depend on temperature.
- B. Conductivity decreases with the increasing of temperature.
- C. This shows Superconducting properties when $\theta < -\theta_0$

The incorrect statement/ statements.

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



(10) Fundamental frequency of a both end open resonance tube is n . What would be the fundamental frequency of the tube when one end is closed"

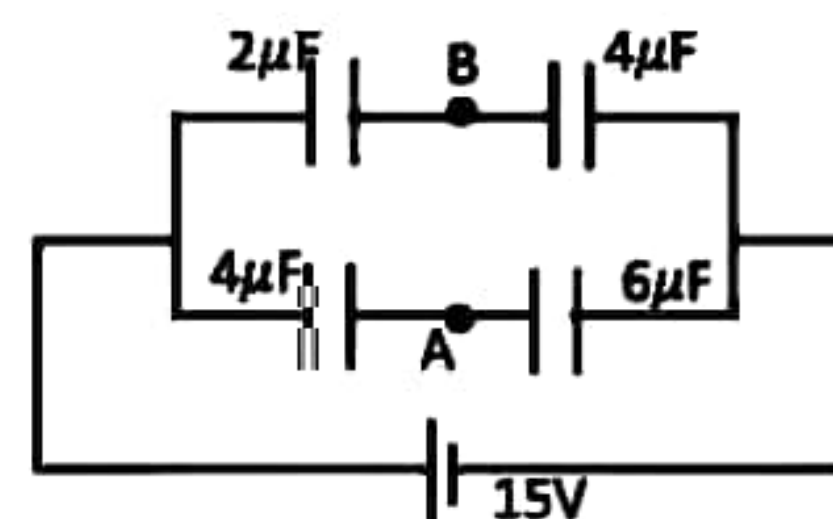
- 1) $\frac{n}{4}$
- 2) $\frac{n}{2}$
- 3) n
- 4) $2n$
- 5) $4n$

(11) Find the correct statement.

- 1) Neutrons can be generated by nuclear fusion.
- 2) Alpha particles can be generated by nuclear fusion.
- 3) Nuclear fusion done by using heavy atoms like radium(Ra).
- 4) Neutrons can be generated by nuclear fission.
- 5) Light atoms can be subjected to nuclear fusion at the low temperature.

(12) The figure shows a circuit of four capacitors connected to a power supply 15 V. The potential at B with respect to A is. '

- 1) 0 2) -1 V 3) -4V
4) 1V 5) 4 V



(13) Magnitude of the velocity at the maximum height is $\frac{1}{4}$ of its initial velocity (U) of a projectile motion. How long has it taken to reach its maximum height"

- 1) $\frac{U}{g}$ 2) $\frac{2U}{g}$ 3) $\frac{3U}{5g}$ 4) $\frac{4U}{5g}$ 5) $\frac{U}{5g}$

(14) Consider the following statements.

- A. When a steady flow goes through a horizontal tube its pressure decreases when the tube is narrowed.
B. Process of spray machine can be explained by Bernoulli principle
C. The Bernoulli Principal can be Applied only for a viscous incompressible steady flow

The correct statement/ statements.

- 1) A only 2) A and B only 3) BandConly
4) Aand C only 5) A, B, C all correct

(15) Temperature of three liquids A, B and C are 12°C , 19°C and 28°C respectively. Final temperature of mixture of A and B is 16°C . The final temperature of the mixture of B and C is 23°C . What should be the final temperature of mixture of A and C

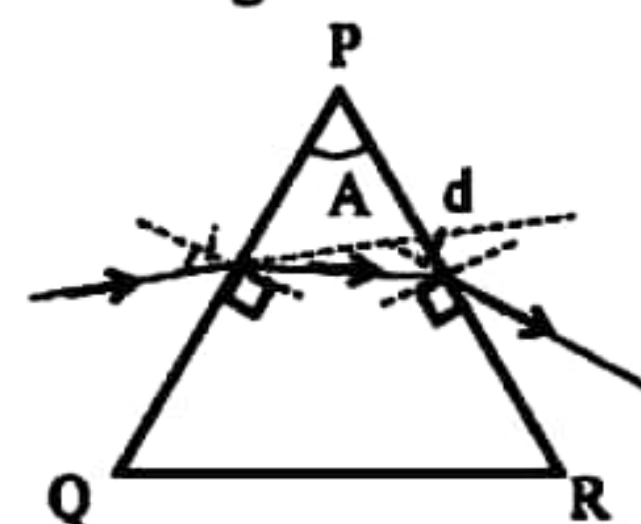
- 1) 18.4°C 2) 22.6°C 3) 25.6°C 4) 20.3°C 5) 24.2°C

(16) Path of a light ray through a prism is given below. The prism angle is A and Angle of deviation is d. Consider the following statements"

- A) With the increase of incident angle i the angle of deviation 'd' is decreased at the beginning and then increased '
B) The ray falls normally on PQ emerge with no deviation.
C) The angle of deviation doesn't depend on prism angle for a given value of incident angle '

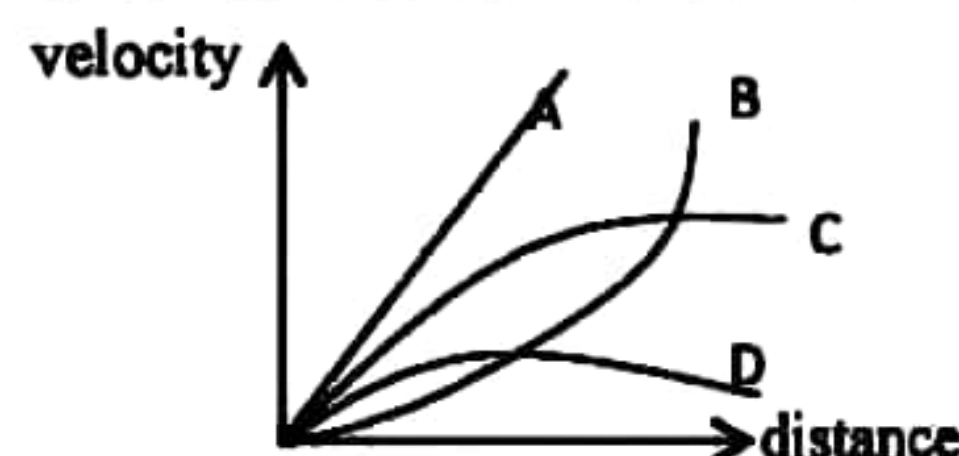
Correct statement/ statements,

- 1) A only 2) A and C only 3) B only
4) B and C only 5) A, B, C all correct



(17) The correct variation of velocity with distance d for a spherical object released in a viscous medium"

- 1) A 2) B
3) C 4) D
5) none of the above

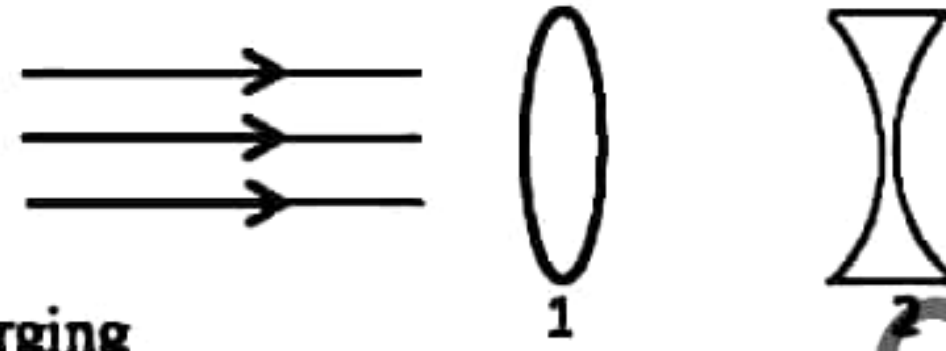


(18) Two cables P and Q are made in same material. Cross-sectional area of Q is twice that of P. Tension of P is twice that of Q. The ratio between speed of transverse wave in P and Q"

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

(19) Convex lens of focal length 10 cm and Concave lens of focal length 5 cm are placed coaxially 5 cm apart as shown in figure. A narrow parallel beam of light falls on convex lens as shown in figure. The nature of the emergent beam after refraction through both lenses,

- 1) Parallel
2) Converge
3) Diverge
4) At the beginning and then converging
5) Converging at the beginning and then diverging

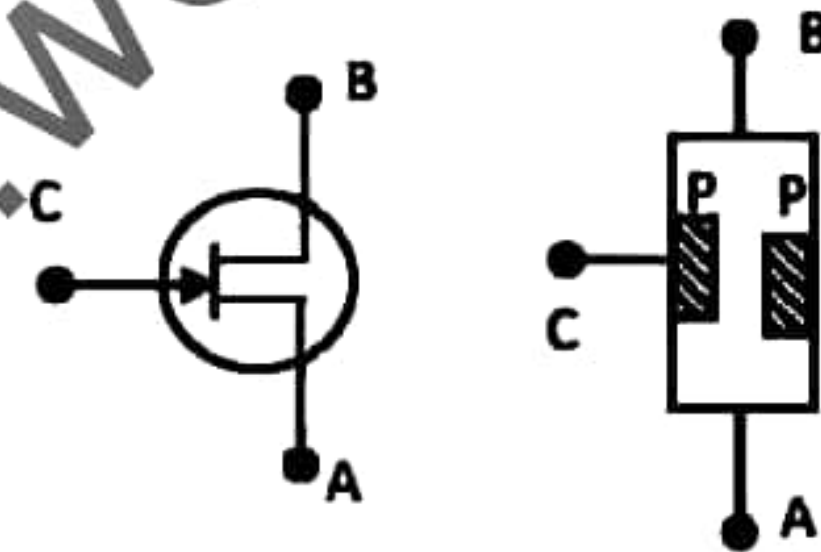


(20) Height of Mercury column in mercury glass thermometer are 100 °C and 20 °C temperature are 200 mm and 80 mm respectively. What would be the height of Mercury column at 0 °C"

- 1) 33.0 mm 2) 40.0 mm 3) 50.0 mm 4) 100.0 mm 5) 104.0 mm

(21) Terminals of junction field effect transistor are given by A,B,C. The correct combination of terminals" A, B,C respectively.

- 1) Source(S), Drain(D), Gate(G)
2) Drain (D), Source (S), Gate(G)
3) Gate(G), Drain (D), Source (S)
4) Source (S), Gate(G), Drain (D)
5) Gate(G), Source (S), Drain (D)



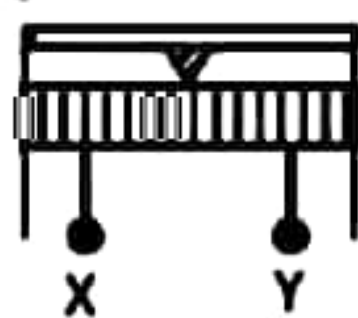
(22) When two identical spheres A and B carrying charges +8q and -2q are placed distance 'r' apart. 'F' force is generated between A and B. Then A touches B and after that A and B are placed at their initial positions, What should be the new force between A and B"

- 1) $9F/16$ 2) $16F/9$ 3) $9F/4$ 4) $4F/9$ 5) $2F/3$

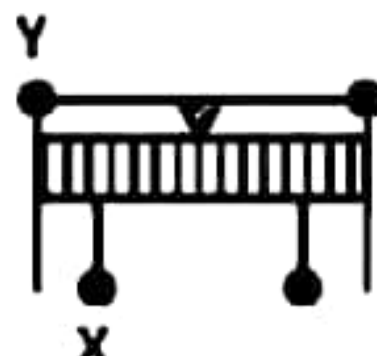
(23) A disc of moment of inertia 2 kgm² is rotating at rate of 210 RPM. It becomes rest by applying external torque for 14 Nm on it. The number of turns rotated by the disc is"

- 1) 34 2) 25 3) 10 4) 5 5) 2

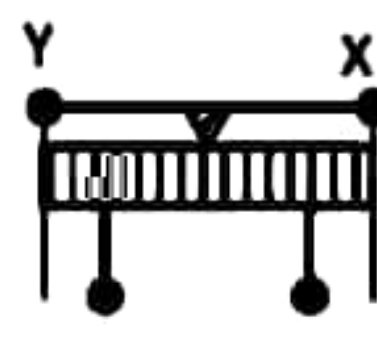
(24)



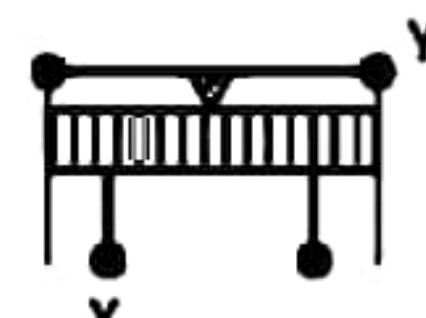
(A)



(B)



(C)



(D)

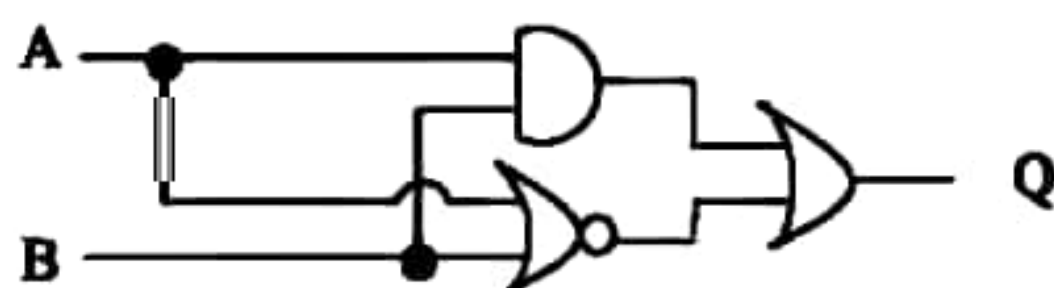
Correct X and Y connection for a rheostat.

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

(25) Average density of an object of volume 0.5 m^3 is $1/4$ times of density of water. What would be the mass that kept on it, to sink it completely in water.

- 1) 375 kg 3) 125 kg 3) 3750 kg 4) 1250 g 5) 500 kg

(26)



For the logic circuit given in figure A and B input and Q is output. Consider the following statements.

A. Always $Q = 1$, when the output of "AND" Gate is zero.

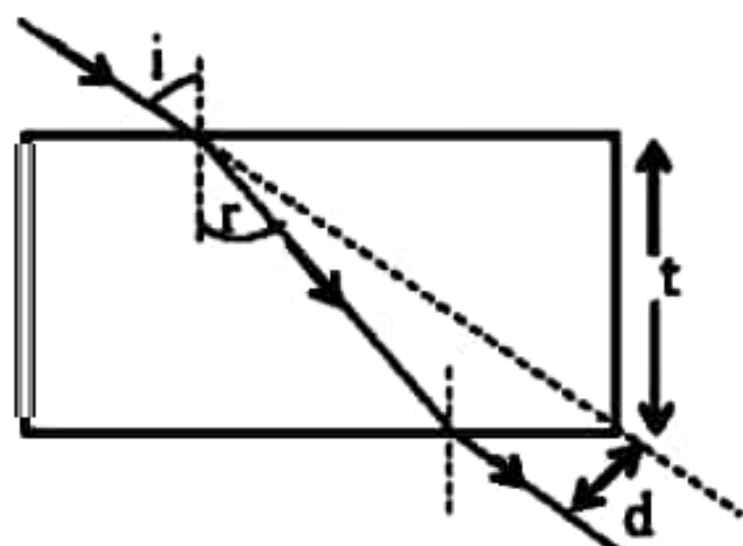
B. $Q = 1$, When $A=B=1$

C. $Q=1$, When $A=B=0$

The True statements are

- 1) A only 2) B only 3) A and B only
4) B and C only 5) A, B and C all correct

(27) Monochromatic Ray Travels through a glass block of 't' thickness. The lateral displacement 'd' of the light ray is given by"



- 1) $d = \frac{t \sin i}{\cos(i-r)}$
2) $d = \frac{t \sin(i-r)}{\cos i}$
3) $d = \frac{t \cos(i-r)}{\sin i}$
4) $d = \frac{t \sin r}{\cos(i-r)}$
5) $d = \frac{t \sin(i-r)}{\cos r}$

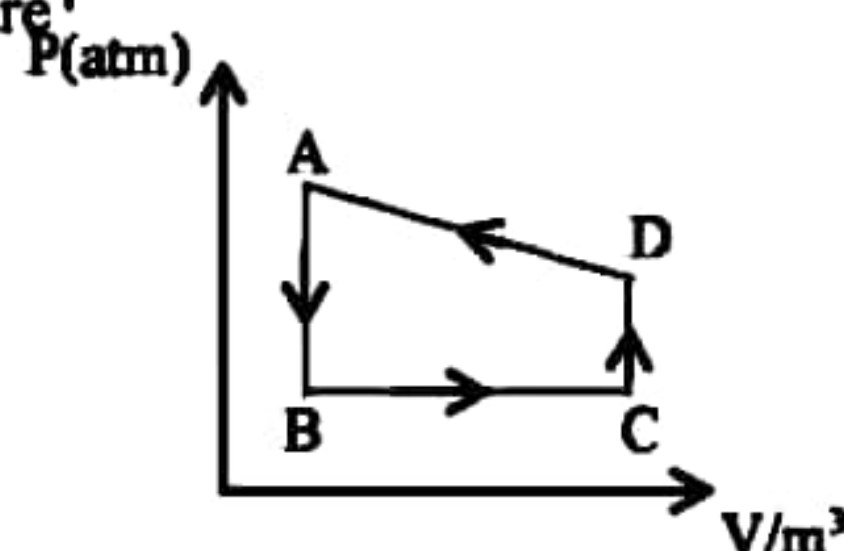
(28) Water drop is broken into 8 identical drops. The correct statement regarding excess pressure of initial water drop"

- 1) Should be equal to excess pressure of one of small droplet.
2) Should be half of the excess pressure of one of small drop.
3) $1/4$ times of the excess pressure of the excess pressure of one of the drop.
4) 2 times of the excess pressure of the excess pressure of one of the drop.
5) 8 times of the excess pressure of the excess pressure of one of the drop.

(29) Masses and radii of the Earth and the Moon are M_E , M_M , R_E and R_M respectively. The distance between two centres of the earth and the moon is d. From the midpoint of that line a particle of mass m is projected. Find the minimum velocity should be given to m to project that to infinity"

- 1) $\sqrt{\frac{2G(M_E + M_M)}{d}}$ 2) $\sqrt{\frac{G(M_E + M_M)}{2d}}$ 3) $\sqrt{\frac{G(M_E + M_M)}{d}}$
4) $2\sqrt{\frac{(M_E + M_M)G}{d}}$ 5) $\sqrt{G(M_E + M_M)d}$

(30) P- V curve for a cyclic thermodynamics process is given in this figure



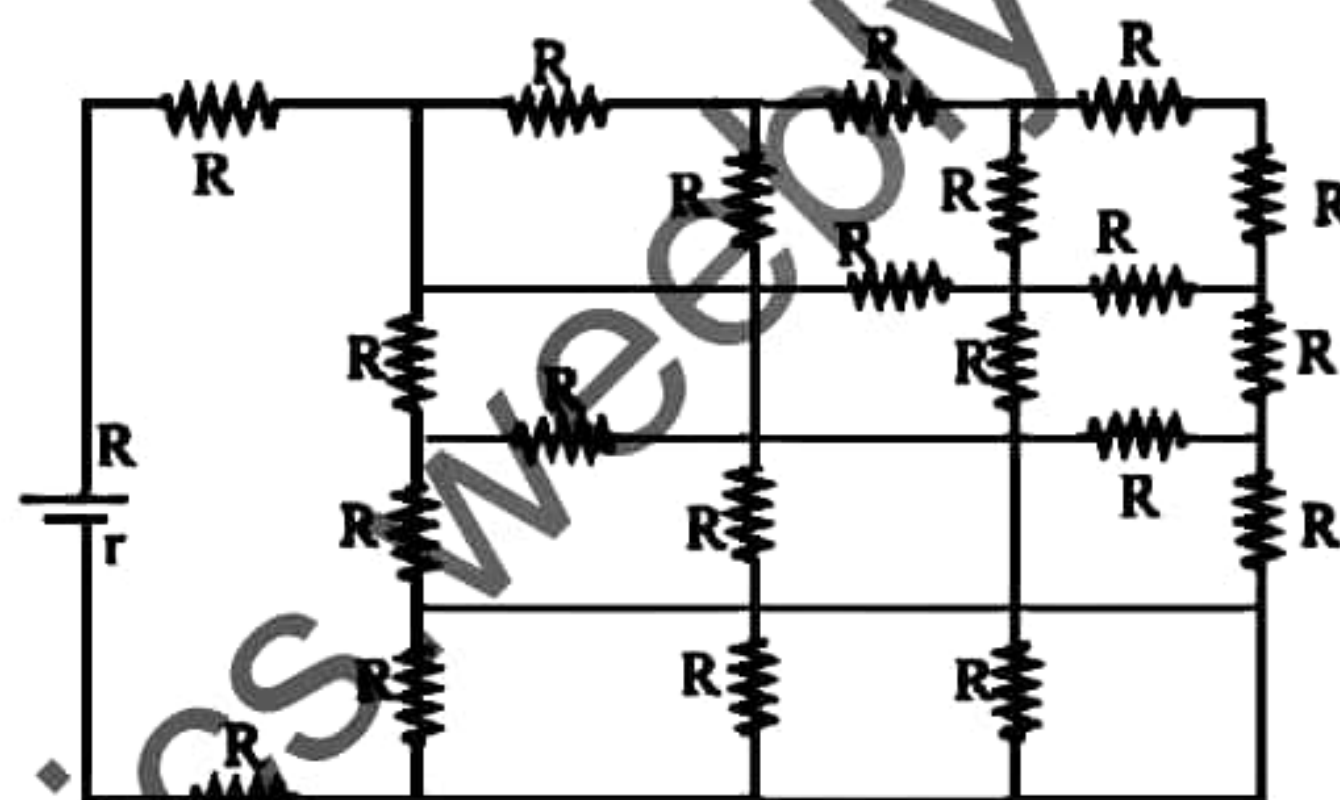
- A) $A \rightarrow B$ Process $\Delta Q > 0$
 B) $B \rightarrow C$ Process $\Delta Q < 0$
 C) $D \rightarrow A$ Process $\Delta W < 0$

- 1) A only
 2) B only
 3) A and B only
 4) A and C only
 5) all incorrect

(31) Vehicle of mass 1200 kg is lifted 20 m up by using a crane of power 5kW. It has taken 2 minutes for this. The efficiency of the motor of the crane is"

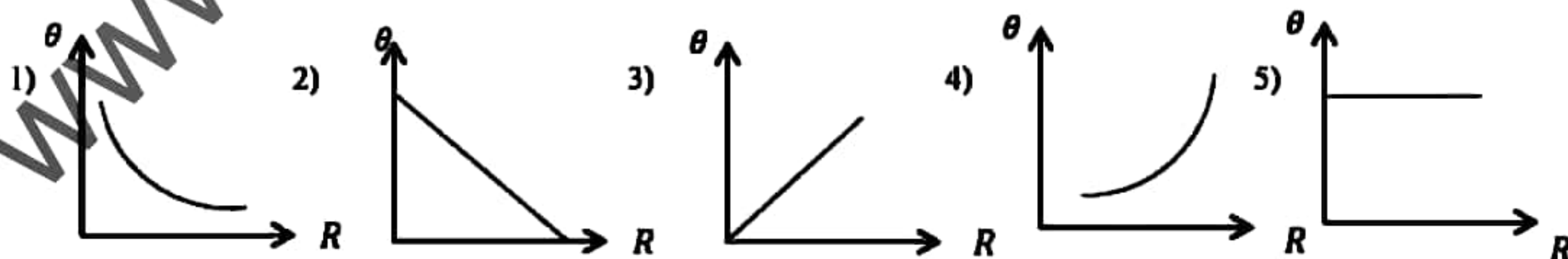
- 1) 4% 2) 40% 3) 8% 4) 80% 5) 50%

(32) A network of resistors containing resistors having resistance R each are connected to a cell of emf E , and internal resistance r , as shown in above figure. Current through the circuit is,



- 1) $I = \frac{E}{(2R + r)}$
 2) $I = \frac{E}{(R + r)}$
 3) $I = \frac{E}{(11R + r)}$
 4) $I = \frac{E}{(2R + r)}$
 5) $I = \frac{E}{2R}$

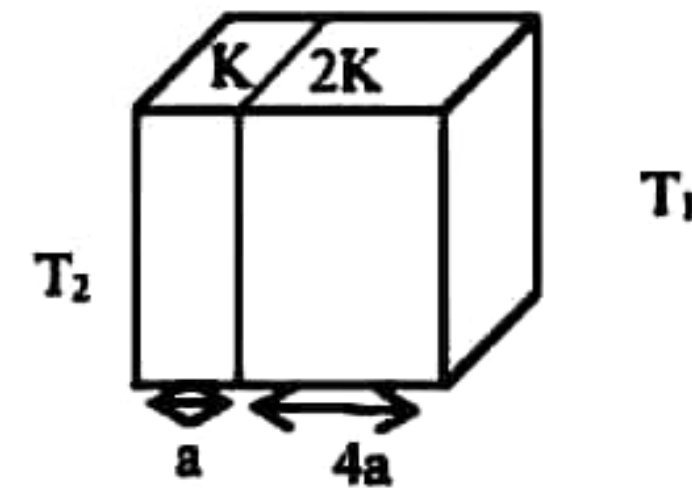
(33) A galvanometer having negligible internal resistance, a cell and variable resistance R has been connected as shown in the figure. What should be the correct variation of deflection θ of galvanometer with resistance R ?"



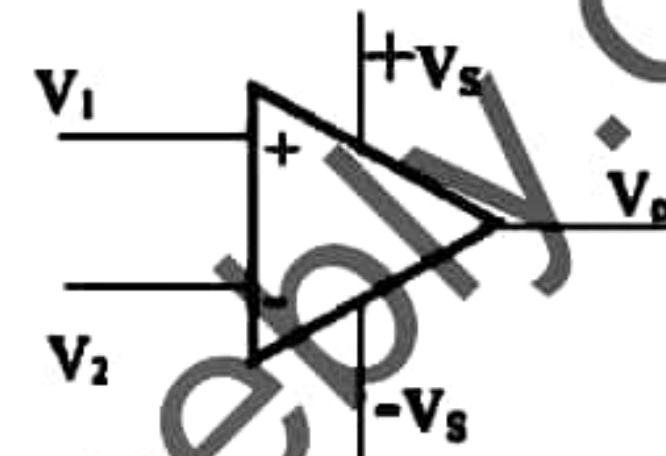
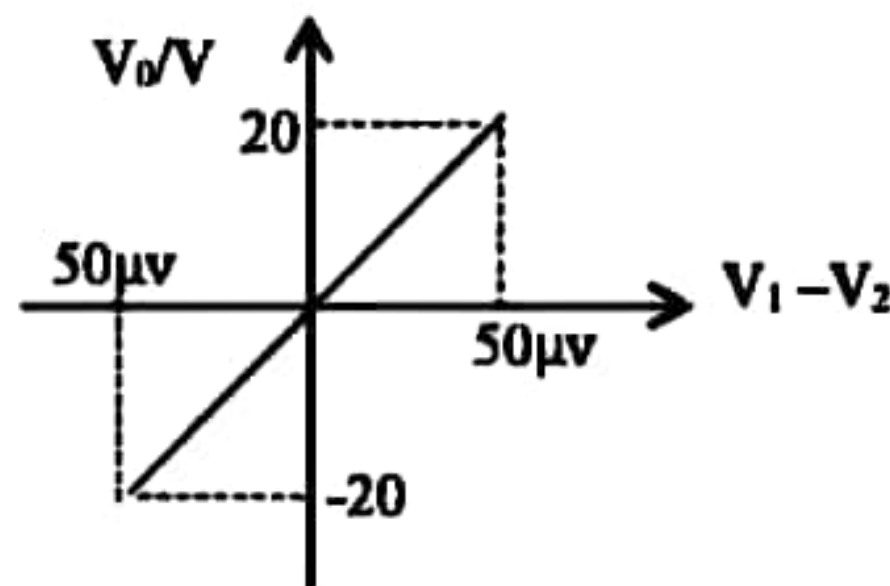
(34) Compound object is made by using two metal blocks having thickness a and $4a$ and thermal conductivities K and $2K$. And it has been lagged properly. Temperature at both ends of compound object are T_1 and T_2 . ($T_2 > T_1$)

The rate of conduction at steady state is given by $A \frac{(T_2 - T_1)Kf}{a}$ where A is common cross section area volume of f should be

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



(35) Characteristic for an operational amplifier and open loop condition is given in figure. Open loop Amplification of the voltage amplifier"



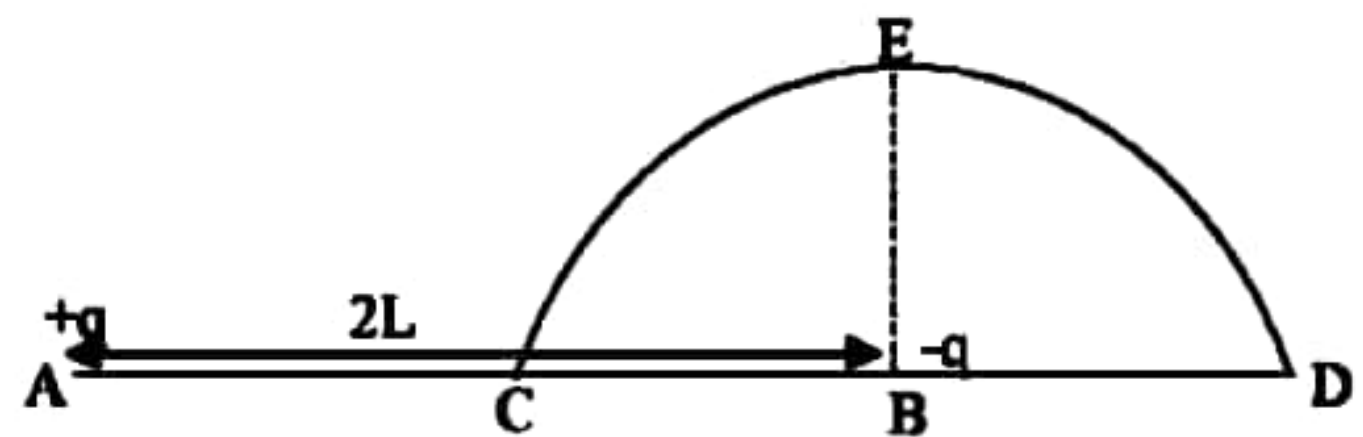
- 1) 1×10^6 2) 1×10^5 3) 4×10^5 4) 2×10^6 5) 2×10^5

(36) Two rods having same length and same cross sectional area are placed tightly between two rigid supports. Linear expansion and Young's modulus of rods are α_1, α_2, E_1 and E_2 . If it generates same trust in both rods when heated by same temperature, The ratio E_1/E_2 should be, ($\frac{\alpha_1}{\alpha_2} = \frac{2}{3}$)

- 1) 2 : 3 2) 1 : 1 3) 3 : 2 4) 4 : 9 5) 1 : 3

(37) $+q$ and $-q$ charges are placed on A and B respectively. The distance between A and B is $2L$. C is the mid point of AB. Another charge Q is brought from C to D along a circular path as shown in figure. Amount of work done should be, ($\epsilon_0 = \text{Permittivity of freespace.}$)"

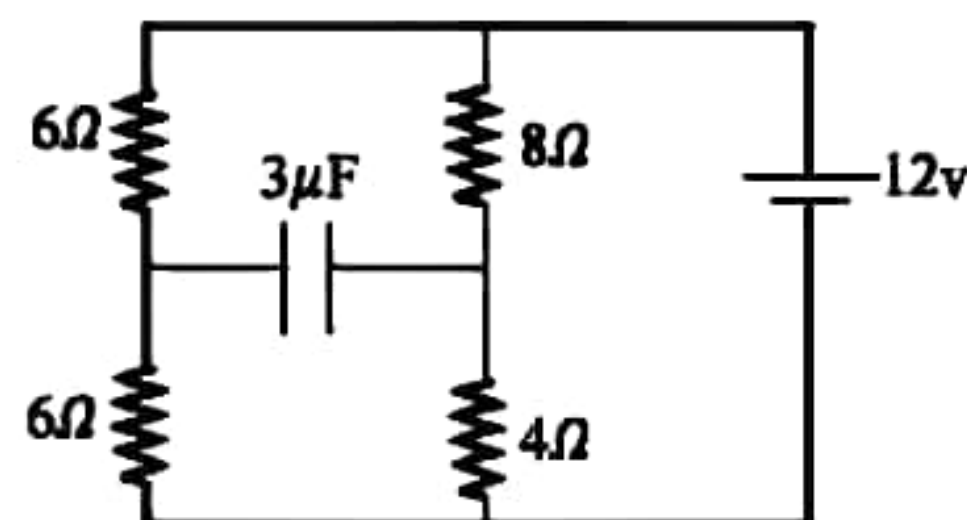
- 1) $\frac{qQ}{2\pi\epsilon_0 L}$ 2) $\frac{-qQ}{6\pi\epsilon_0 L}$
3) $\frac{qQ}{6\pi\epsilon_0 L}$ 4) $\frac{-qQ}{2\pi\epsilon_0 L}$
5) $\frac{qQ}{4\pi\epsilon_0 L}$



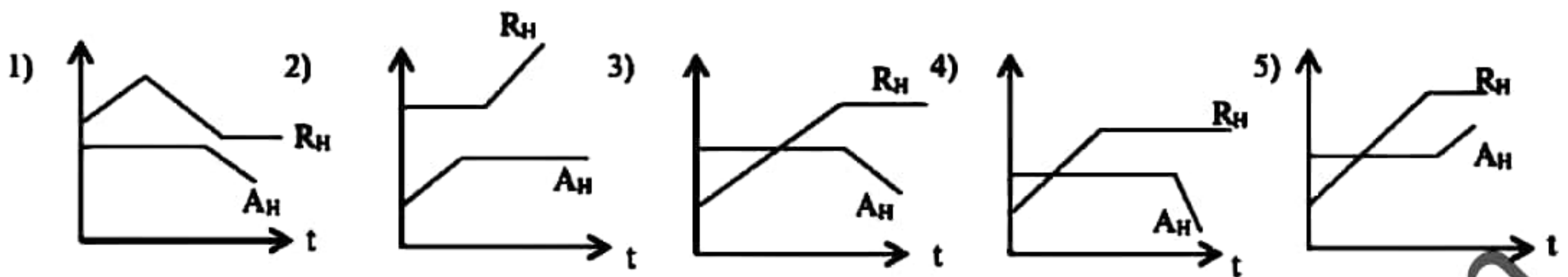
(38) As shown in figure capacitance of capacitors $3\mu F$. Is connected to circuit as shown in figure.

Electric energy stored in capacitor is"

- 1) $1\mu J$
2) $2\mu J$
3) $3\mu J$
4) $5\mu J$
5) $6\mu J$

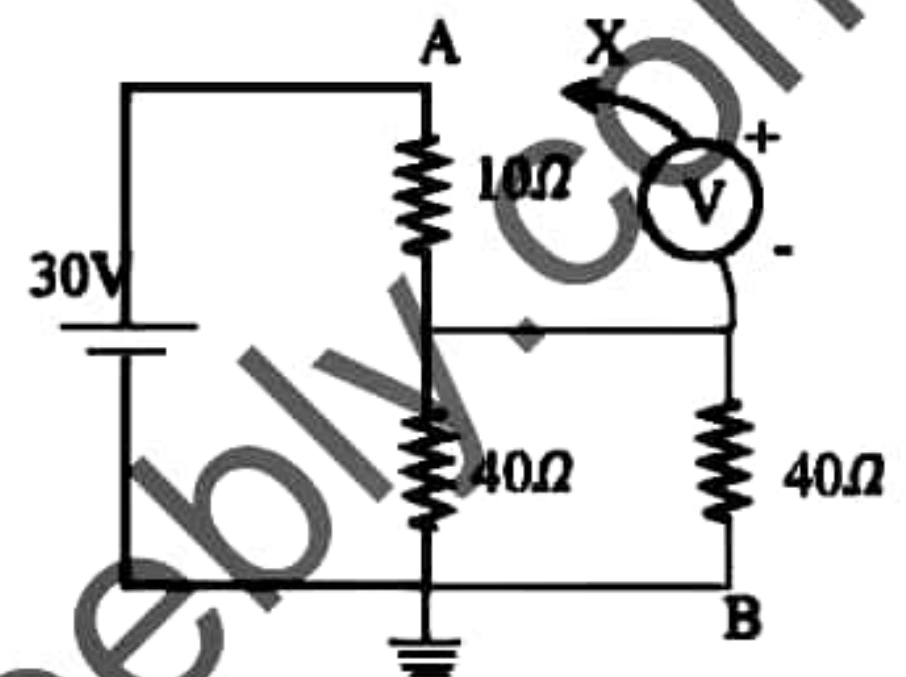


- (39) Temperature of a closed chamber of Volume 0.5m^3 is 28°C and dew point is 22°C . This is heated to 75°C and let it cool gradually. What is the correct variation of absolute humidity (AH) and Relative Humidity (RH) with time?



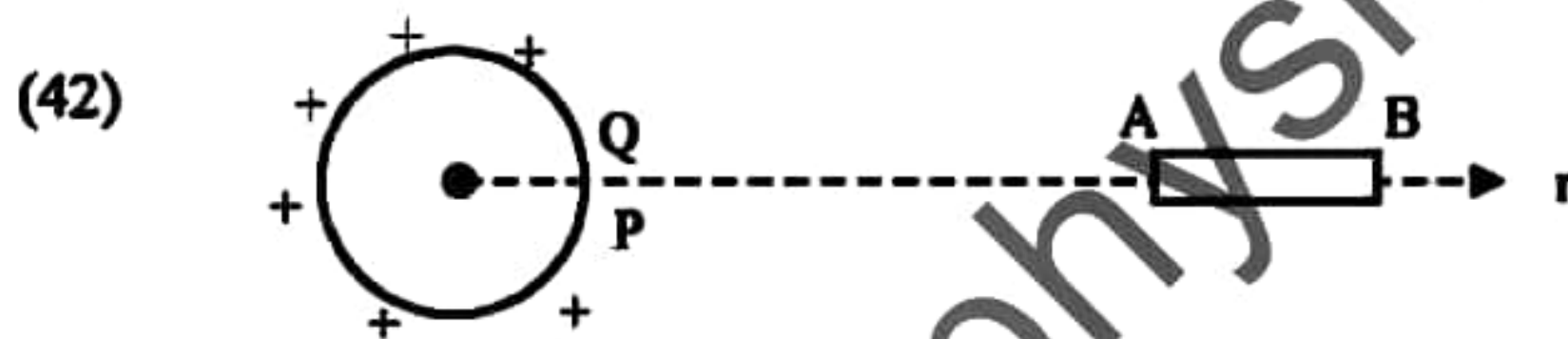
- (40) 30V cell in the given circuit has negligible internal resistance. \odot is an ideal Centre zero voltmeter. What are the readings of voltmeter when X is connected A and B,

- 1) 10V, 10V 2) 10V, -10V 3) -10V, 20V
 4) -10V, -20V 5) 10V, -20V

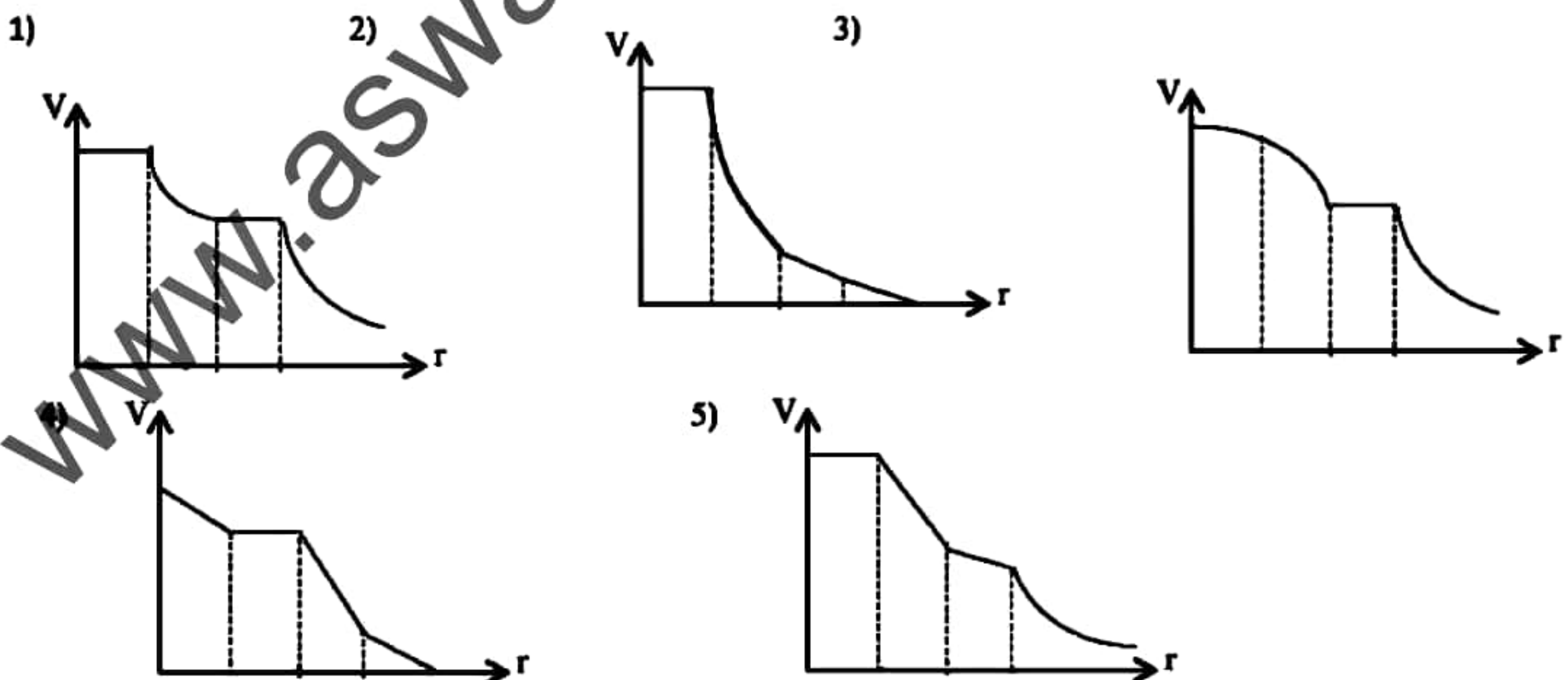


- (41) A ball of mass 50 gram hits on a wooden block 10ms^{-1} velocity. It bounces back with 5ms^{-1} velocity during 0.01 seconds. What should be the minimum force should applied on block to keep it stationary

- 1) 250 N 2) 750 N 3) 50 N 4) 75 N 5) 30N



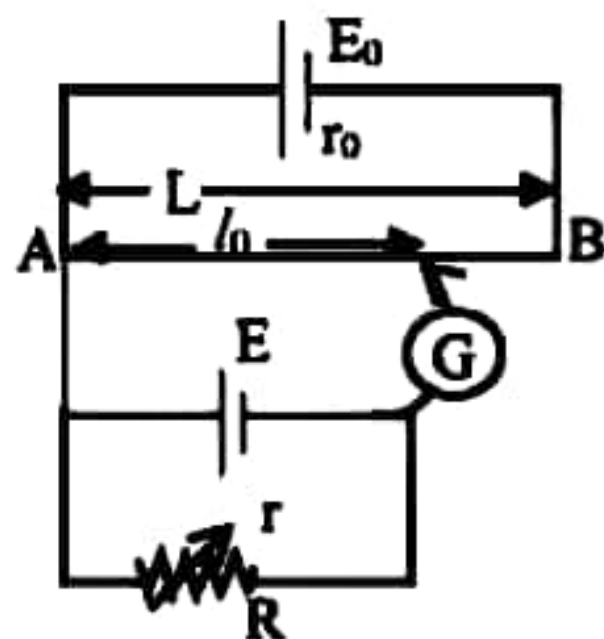
The figure shows a charged sphere. It is carrying Q charge and AB is a neutral rod. The correct variation of electric potential from the centre of the sphere is,"



(43) Two light beams A and B of wavelength λ_A and λ_B and with same intensities fall on unit area of a metal. Find the ratio between number of photoelectrons emitted by A and number of photoelectrons from B,

- 1) $\left(\frac{\lambda_A}{\lambda_B}\right)^2$ 2) $\left(\frac{\lambda_B}{\lambda_A}\right)^2$ 3) $\frac{\lambda_B}{\lambda_A}$ 4) $\frac{\lambda_A}{\lambda_B}$ 5) 1

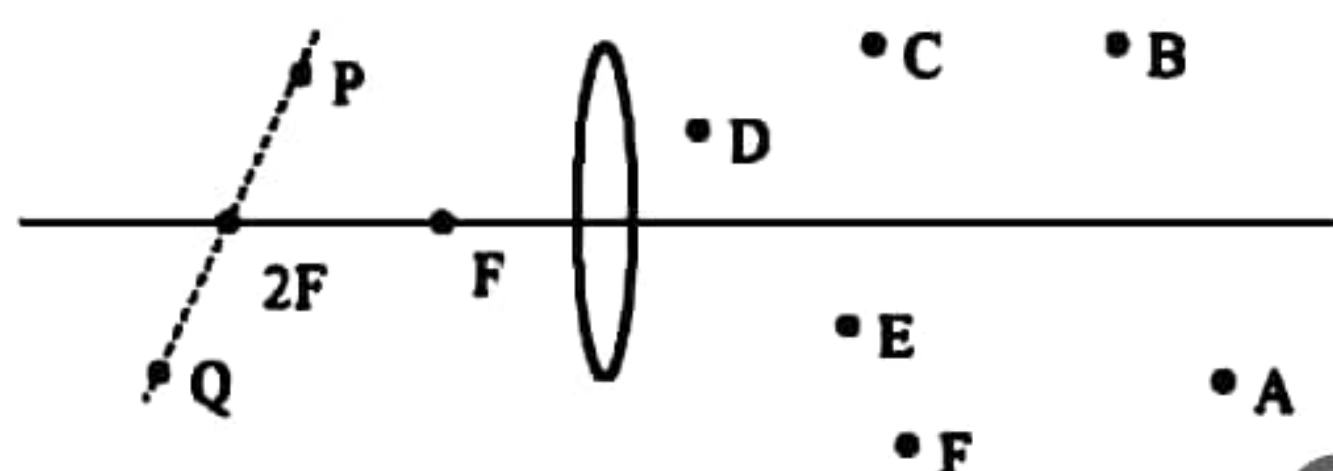
(44)



Internal resistance and electromotive force of accumulator are r_0 and E_0 . In given potentiometer circuit length of AB wire is L and its resistance R_0 . A variable resistance R is connected to cell E and R is changed until E gives maximum power. What would be the balance length for this occasion"

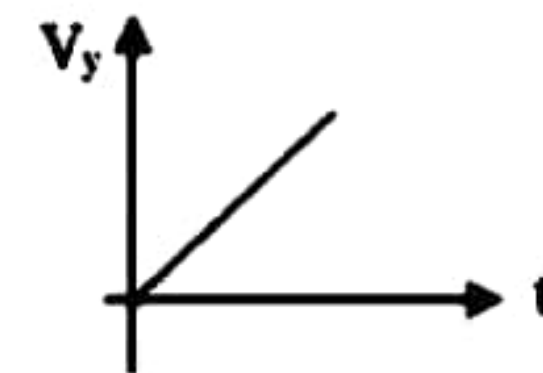
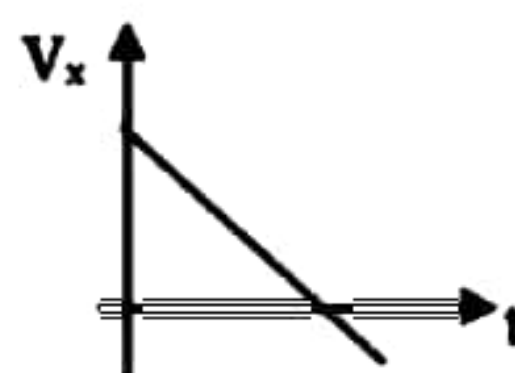
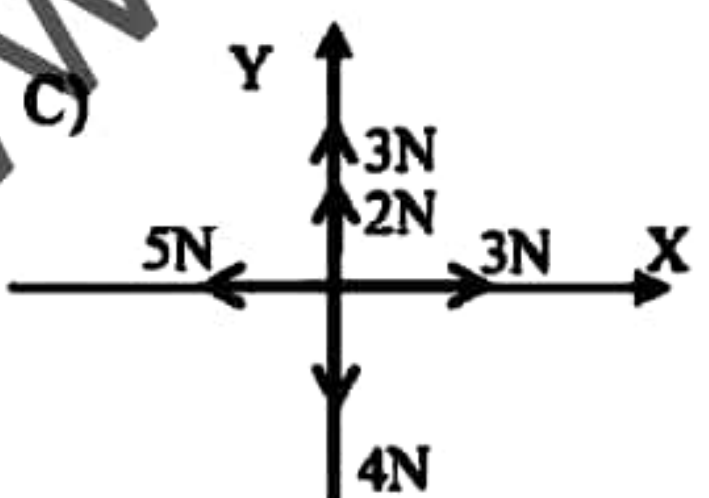
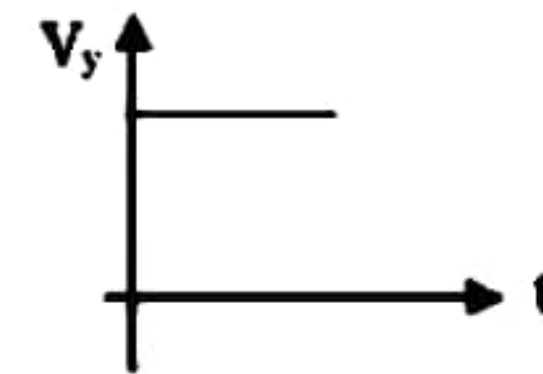
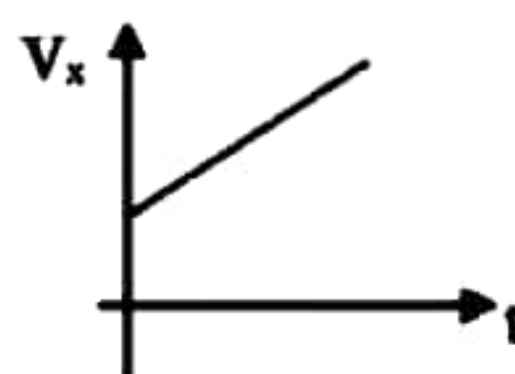
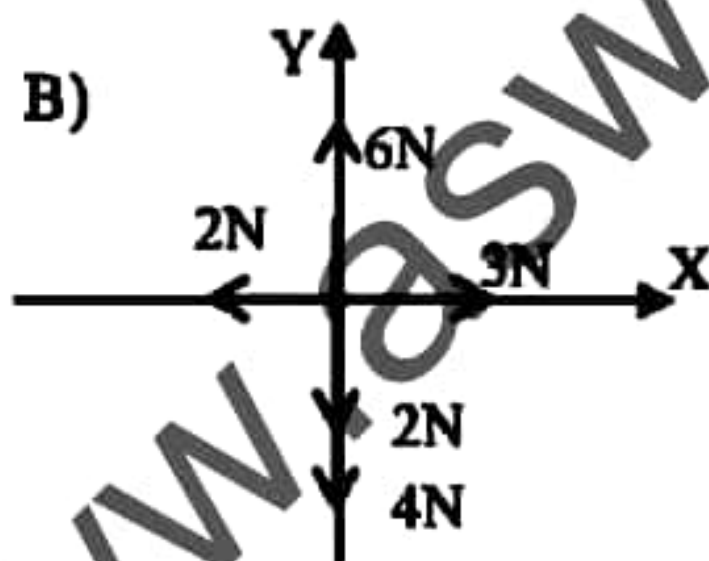
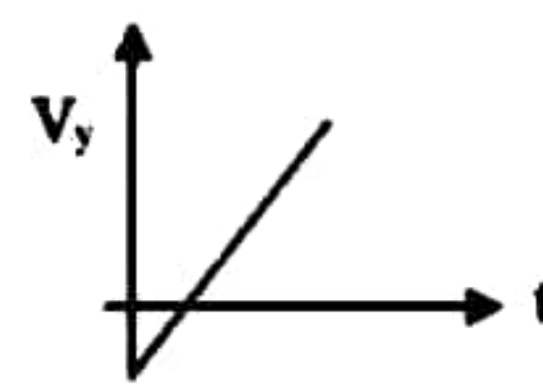
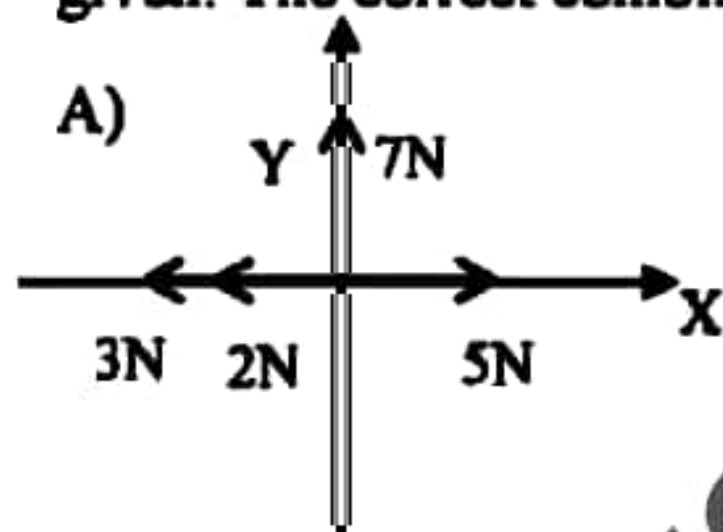
- 1) $l_0 = \frac{E_0 r_0 L}{E}$ 2) $l_0 = \frac{2E_0(r+R_0)}{E}$ 3) $l_0 = \frac{E(r_0+R_0)L}{2E_0 R}$ 4) $l_0 = \frac{EL}{E_0(R+r_0)}$ 5) $l_0 = \frac{E_0 L r_0}{E(R+2r_0)}$

(45) A point object O is brought from P to Q as shown in figure,. The locus of the image of O is



- 1) AB
2) AC
3) AD
4) AE
5) AF

(46) System of forces acting on body is given. the variation of velocity V_x and vertical velocity V_y are given. The correct combination is,



- 1* A only 2) B only 3) C only 4) A and B only 5) A, B, C all

(47) Current sensitivity of a moving coil galvanometer can be increased by"

Enu

A) By increasing number of turns of coil.

B) By increasing flux density of radial magnetic field.

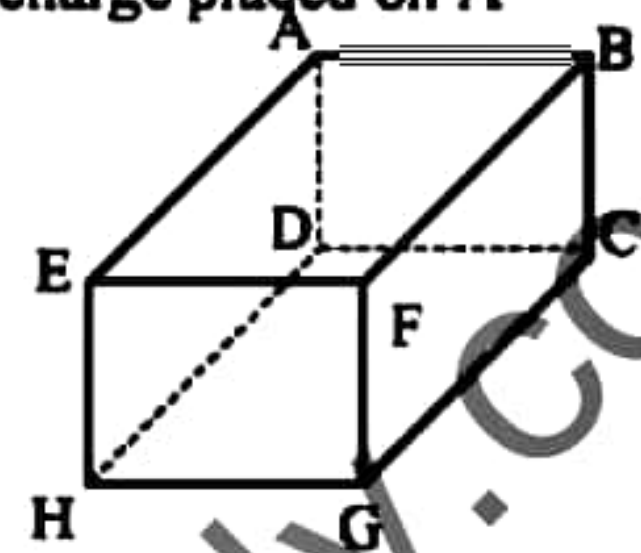
C) By reducing area of the coil.

The true statements,

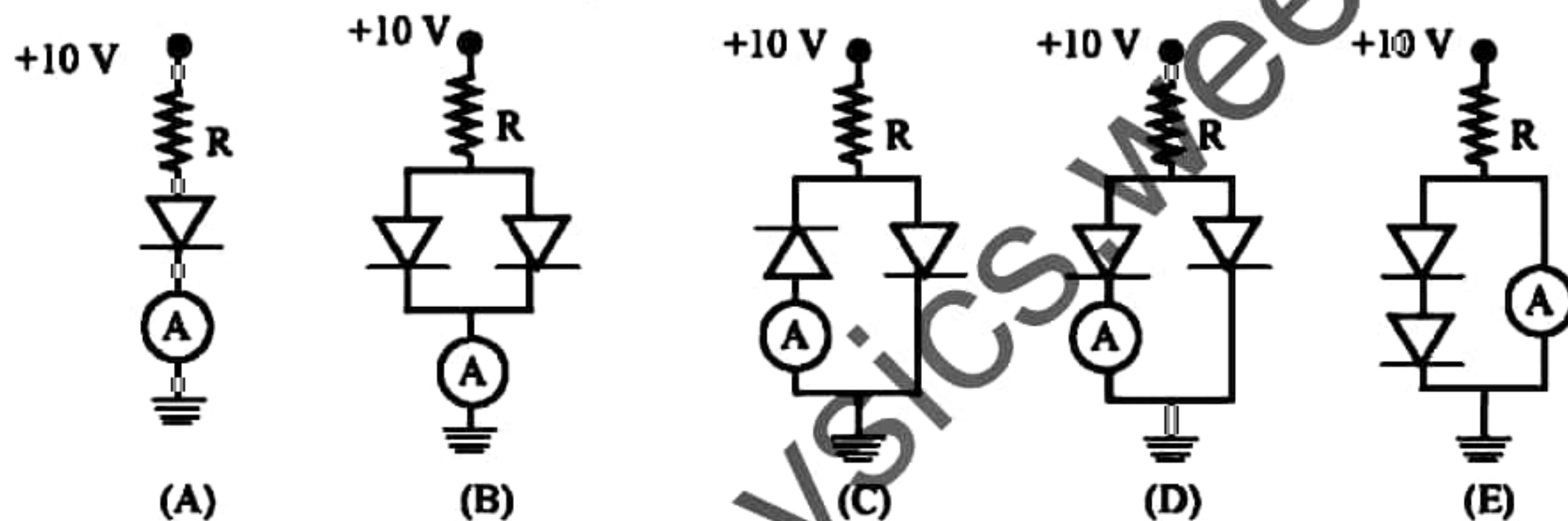
- 1) A only 2) A and B only 3) A and C only
4) B and C only 5) A, B, C all

(48) 7 charges. $q, 2q, 3q, 4q, 5q, 6q$ and $7q$ are placed on B, C, D, E, F, G and H of cube as shown in figure. If the electric flux across e-f-g-h is $\frac{q}{3\epsilon_0}$. What should be the charge placed on A?

- 1) q 2) $2q$
3) $3q$ 4) $4q$
5) $5q$

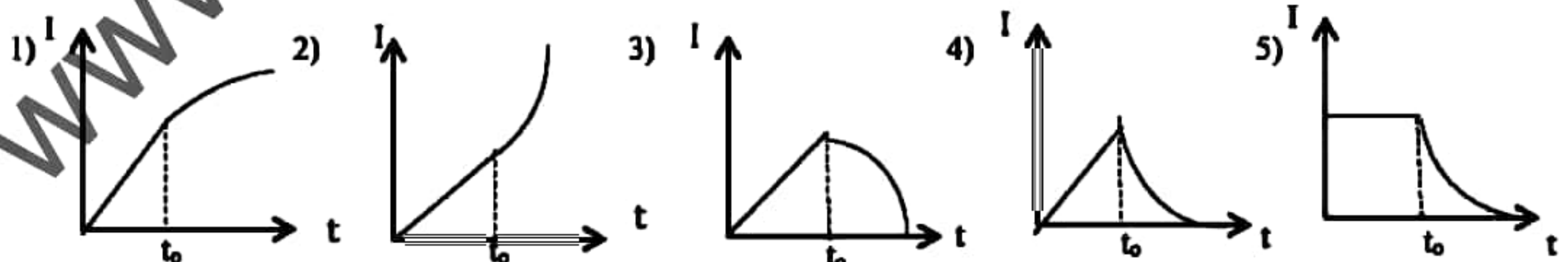
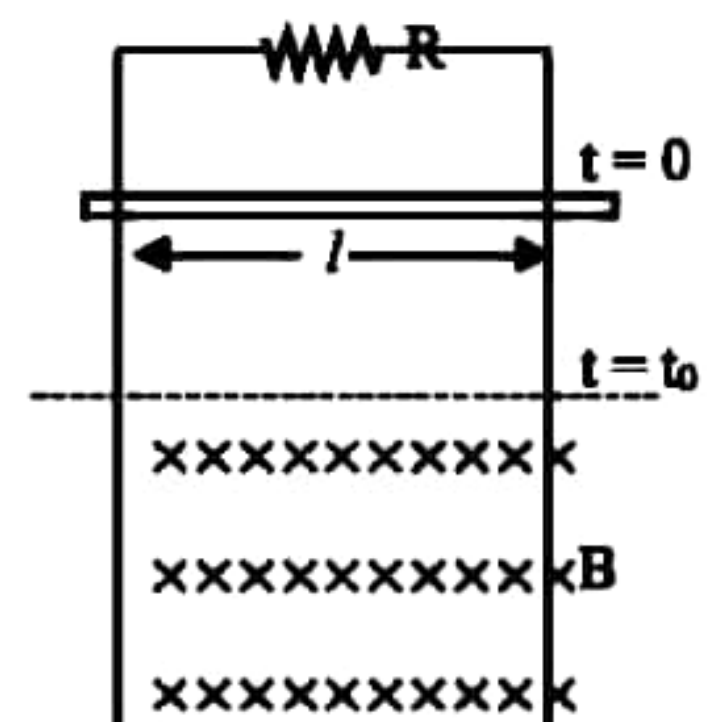



(49) All diodes in circuits are silicon and A is an ideal ammeter. Which circuit gives maximum and minimum ammeter reading respectively.



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

(50) A rod of mass M length L released from rest when $t=0$. As shown in the figure. It enters into uniform magnetic field when $t=t_0$. Which of the following graph gives correct variation of velocity of rod with time?



	01 E II
Final Term Test- 2021	
Grade 13	
PHYSICS II	
3 HOURS	

Name :

Index Number.....

Important:

- This question paper consists of 19 pages.
- This question paper comprises Part A and Part B.
- The time allocated for both parts is 3 hours

Part A _ Structured Essay

Answer all the questions on this paper itself. Write the answers in the space provided for each questions. Please note that the space provided is sufficient for your answers.

Part B _ essay

This part contains 6 questions of which Four are to be answered. Use your papers for this purpose.

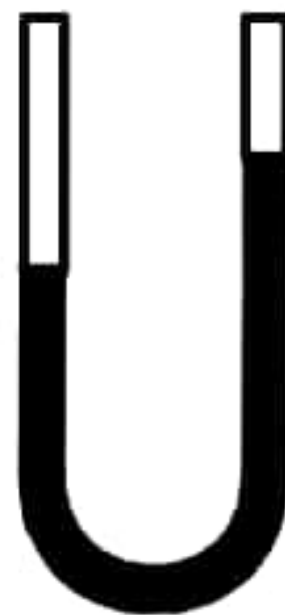
Answer only one of Part A or B from question number 9 and 10.

For Examiner's Use only

A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
	8	
	9	
	10	
Total		

PART A- Structured Essay

- I. The U tube experiment was used to determine the density of coconut oil .



- I. Which arm contains coconut oil?

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- II. Densities of Coconut oil and water are ρ_1 and ρ_2 respectively. Heights of liquid columns from common interface are h_1 and h_2 respectively. Give an expression for ρ_1 in the given terms.

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- III. Which liquid insert the U tube first. Give reasons for your answer.

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- IV. ρ_1 should be determined using a graphical method. Which arm pours the relevant liquid. Give reasons for your answer.

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- V. The gradient of the graph is 0.82. What is the density of the coconut oil?

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b) A U tube of 'r' internal radius was used to determine the surface tension of water and coconut oil. Arms of U tube are capillary tubes.

These data has been given.

- Height of water column from common interface is $= h_w$
- Height of oil column from common interface is $= h_o$
- Density of water $= \rho_w$
- Density of oil. $= \rho_o$
- The angle of tangent of coconut oil with glass $= \theta$
- The angle of tangent of water with glass $= 0$

i. The surface tension of water is T_w . Write an expression for surface tension of oil.

ii. How to clean the tube.

iii. The readings obtained from a travelling microscope to determine the internal radius is given below.



Measurment	Radius(cm)
X1	11.211
X2	11.261
Y1	6.632
Y2	6.686

Calculate the internal radius of the capillary tube.

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iv. How do you measure the 'h'

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v. How do you plot a graph using above Values.

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2. You are required to determine the specific heat capacity of iron in the school laboratory. Some of provided items are given below.

- Insulated copper calorimeter and a stirrer.
- Small iron balls at 100°C temperature.
- Sufficient water

a. What are the other required items?

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b. Environment temperature and the dew point were noted as 30°C and 24°C respectively.

i. What should be the initial temperature of water ?

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ii. What would be the final temperature of water at the end of the experiment.

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iii. Give reasons for your choice of above (i) and (ii)

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c. Write the measurements that you should have to obtain before adding the iron balls to the water.

...X1.....

...X2.....

...X3.....

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d. You must be very concern about the water level of the calorimeter.

i. What is the error that can be occurring if water level is too small?

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ii. What is the error that can be occurring if water level is too large?

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iii. What is the most appropriate water level in the calorimeter?

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e. What are the factors that you should be concerned after adding the iron ball .

...1.....

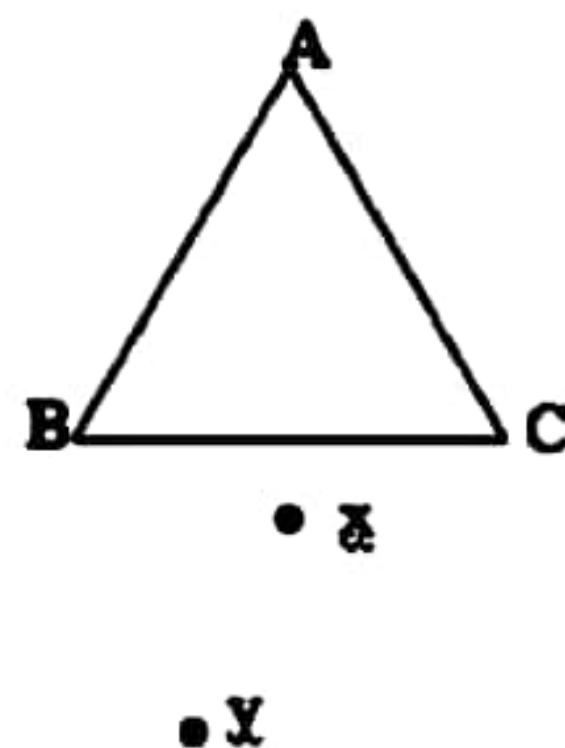
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f. Write the measurements that you should have to obtain after adding the iron balls to the water.

...X4.....

...X5.....

3. A student wants to determine the refractive index of prism material in total internal reflection method. X and Y represents two points on emergent ray. Two vertical pins are placed on X and Y.

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a. i. Mark the initial pin on the given diagram.

ii. The provided pin is shorter than height of prism. This is incorrect. How could he avoid the effect arising from this error.

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iii. How does he obtain the emergent ray?

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iv. Why does the student can not use a single pin to mark the emergent ray?

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VI. Construct the ray diagram.

vi. The critical angle was $42^\circ 12'$. Find the refractive index of prism material.

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b. A separate experiment was done to determine the refractive index. P and Q represent two pins on incident ray.

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- i. How do you obtain the emergent ray experimentally?

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- ii. Complete the ray diagram.

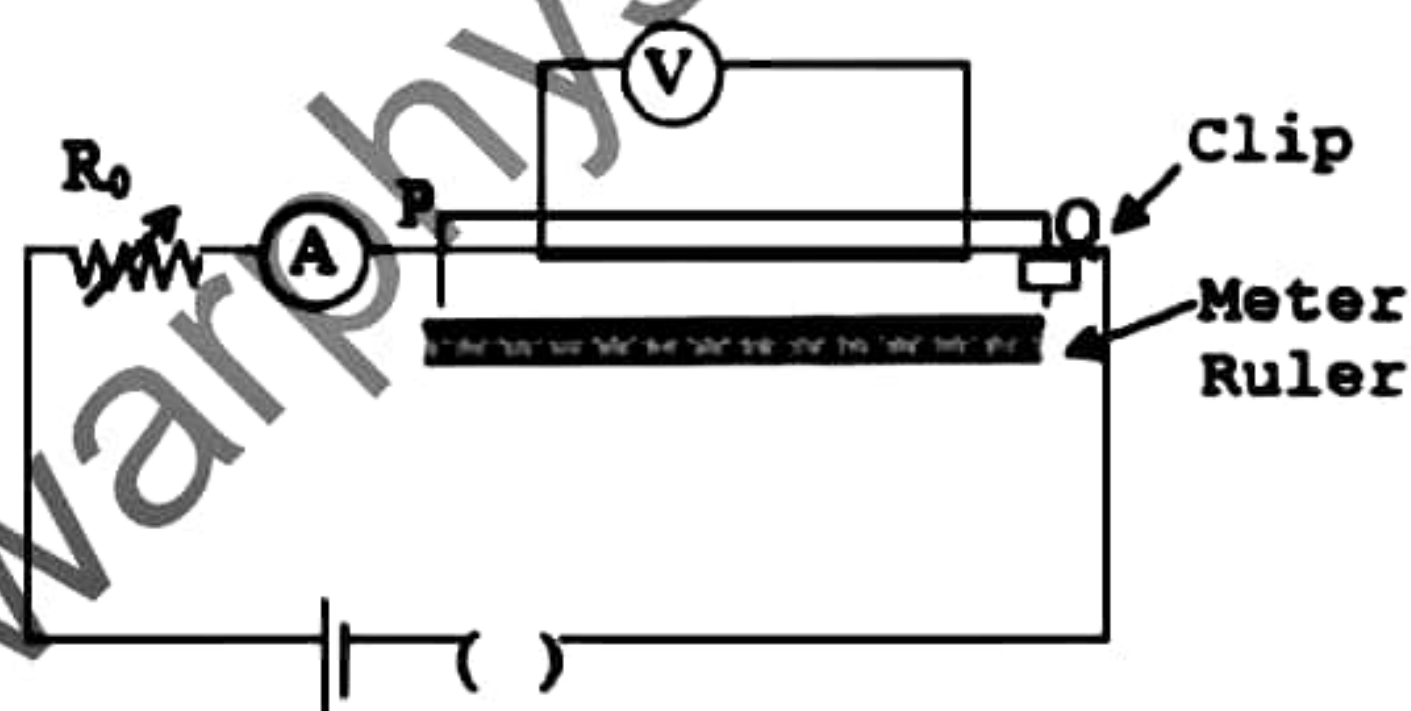
- iii. Mark the followings on the diagram

- Angle of incident i_1
- Angle of refraction on AB surface r_1
- Angle of incident on BC surface r_2
- Angle of emergent i_2 .
- Angle of deviation d
-

- iv. Give an expression for 'd' in the terms of i_1, i_2, r_1, r_2

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4. A circuit set up used to measure the resistivity of a Nicrome wire is shown below. Resistance of PQ wire is 100Ω . Diameter of the wire is 0.10 mm. The used voltmeter and ammeter are perfect and internal resistance of the cell is negligible.



- a) Length of the Nicrome wire is 'l', Diameter 'd', and Resistivity ρ . Write an expression for resistance 'R' in the given terms.

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- b) Give the relationship between conductivity σ and resistivity ρ .

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c) What is the device R_0 ?

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Write the purpose of use R_0 .

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d) A student said $50 \mu A$ current is better than $1 A$ current passing through the PQ wire. Do you agree with that statement? Give reasons for your answer.

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e) A series of voltmeters are provided to do this experiment. Which is the maximum deflection of voltmeter most suitable.

$1 V$, $100 mV$, $10 mV$, $1 mV$, $100 \mu V$.

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Give reasons for your answer.

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f) The student decided to find the resistivity in graphical method. How does he develop the experimental methodology?

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g) The graph drawn, the voltmeter reading was taken as dependant variable. Sketch the graph obtained and name the axis.



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h) Calculate the resistivity if gradient of the graph is 0.005.

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i) A separate physical quantity must be present with the resistivity. What is that physical quantity.

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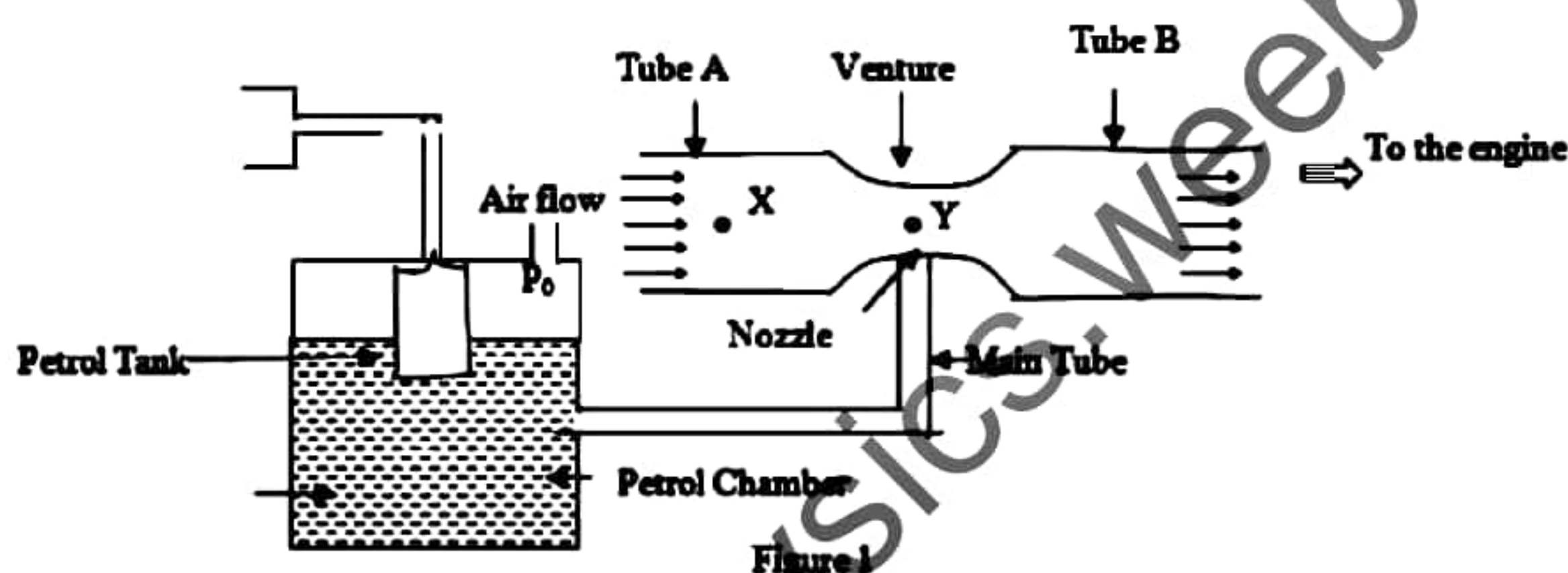
Part B – Essay

5. The B'Nouli equation for a fluid flow is given in following equation.

$$P + \frac{1}{2}\rho V^2 + h\rho g = K$$

All the terms has usual meaning.

- a. What are conditions required for apply the B, Nouli equation?
 - ii. Show that the term $\frac{1}{2}\rho V^2$ has the dimensions same as dimensions of Kinetic energy per unit volume.
- b. The device called CARBURATOR is used to supply petrol in to the internal combustion engine. The carburettors' job is to supply fuel with to the engine as air – fuel mixture. The cross section of carburettor is given below.



The atmospheric air enters in to tube A during the process. The velocity is increased when flowing through the Venture. Due to the pressure difference as change of velocities the petrol enters to the Venture then to the tube B. At Y the petrol is mixed with air.

The internal radii of A and Venture are r_1 and r_2 respectively. Density of air is ρ_0 and atmospheric pressure is P_0 .

- i. The atmospheric air enters to the tube X with V_1 velocity. Write an expression for velocity V_2 of air at Y.
- ii. If Pressure at Y is P_y then show that.

$$P_0 - P_y = \frac{\rho_a v_1^2}{2r_2^4} (r_1^4 - r_2^4)$$

- iii. The velocity of air enters to the tube A at X is V_0 . Show that $V_0 = r_2^2 \sqrt{\frac{2h\rho_f g}{\rho_a(r_1^4 - r_2^4)}}$

ρ_f = Density of Fuel

h = Height from petrol level in petrol chamber and Ventur

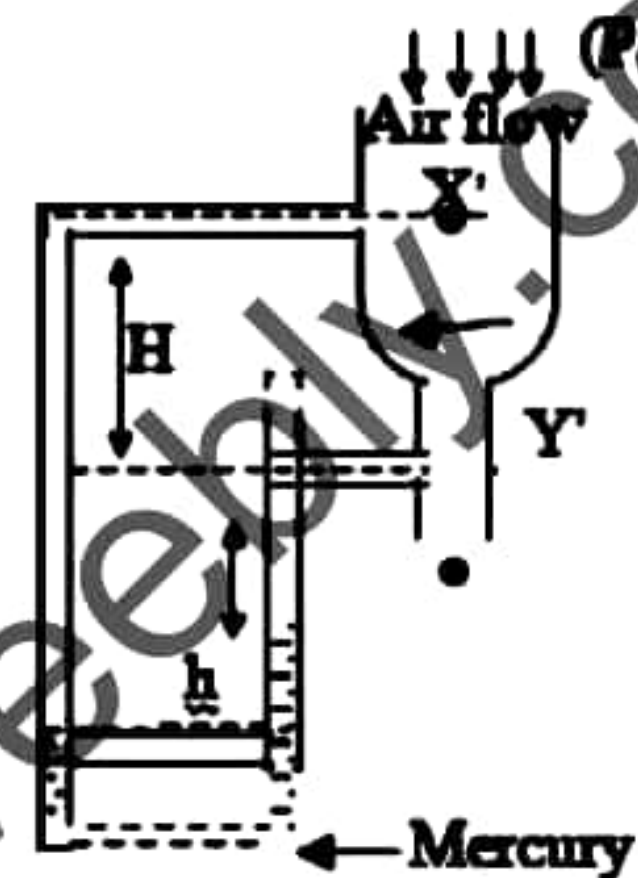
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- iv. Find V_0 if.) $r_1 = 20\text{mm}$, $r_2 = 10\text{mm}$, $h = 5\text{mm}$, $\rho_a = 1.2\text{ kg m}^{-3}$ and $\rho_f = 720\text{ kg m}^{-3}$
- v. The ratio between volume of petrol and air is 1: 15 during acceleration of the vehicle. At this instant velocity of air enters tube A at X is increased till $12V_0$.
- Find the velocity of air at Y to fulfil above condition.
 - The internal radius of the tube from Fuel chamber to the venturi is 2mm. Find the velocity of fuel at this instant.
- vi. Structure of another Carburettor is shown below. The air flow tube is vertical in this structure. Find $(\rho_0 - \rho_{y'})$

$$H = 16\text{ mm}, h = 4\text{ mm},$$

$$\rho_a = 1.2\text{ kg m}^{-3}$$

$$\text{Density of Mercury} = 13600\text{ kg m}^{-3}.$$



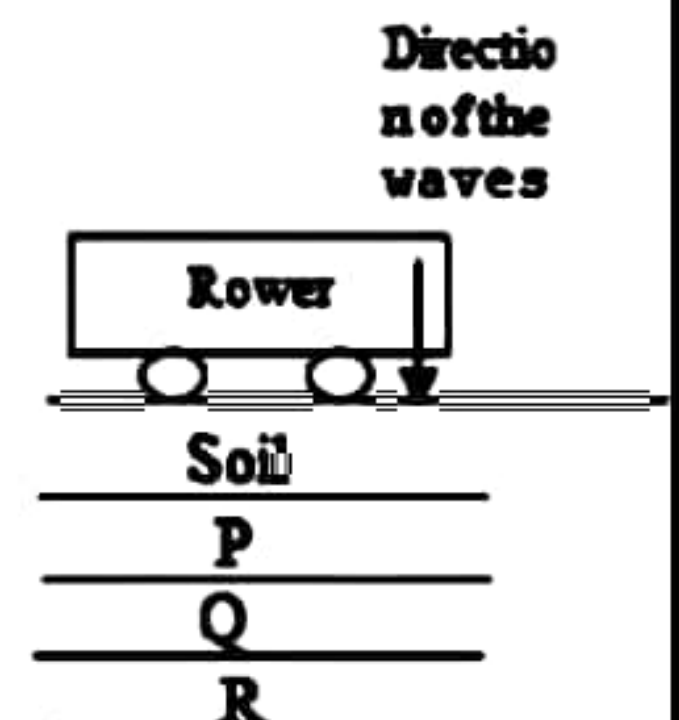
6. A. There was a doubt about the surface of planet MARS for underground ice layers and underground water. In 2020 a ROVER was used to identify this underground water and ice layers. The ROVER used Transverse and Longitudinal waves and their reflections to identify them.

- The transverse waves can transmit through solid materials but not through liquids.
- The longitudinal waves can transmit through both solids and liquids.

- Define the term Transverse Waves and Longitudinal waves.
- What is wave reflection?
- What is wave refraction?

Two transverse pulses and 3 longitudinal pulses were identified as reflections from MARS surface.

- Identify the underground water layer from P, Q and R. Other two layers are underground ice.



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- v. The longitudinal wave velocity in soil is 7500 ms^{-1} and that of in ice is 2800 ms^{-1} . Wave velocity in water is 1500 ms^{-1} . The reflections were received after 20 s, 40 s and 50s from emitting the wave pulses. Find the thickness of P,Q and R layers.

B. Doppler radar is an application of Doppler Effect.

A Security center uses Doppler Radar to identify Unauthorized flights. The reflections of ultrasounds emit from radar machine are used to identify the direction and velocity of unauthorized flight.

The velocity of ultrasound in air is 340 ms^{-1} .

Frequency of emitted Wave is 30 kHz

The frequency of received wave is 500 Hz larger than the emitted frequency.

Take the velocity of the flight is U.

- Write an expression for the sound frequency(f') that reach to the unauthorized aircraft.
- Write an expression for the sound frequency(f'') that is determined by the Security centre.
- Calculate the velocity of the aircraft.

B. An unauthorized aircraft was attend to this radar zone in night time. For identify that aircraft a spy plane has been take off from the security centre. Velocity of this Spy plane is 10 ms^{-1} . It emits 66 kHz ultrasound frequency. The received frequency after reflection is 200 Hz larger than the emitted frequency. If the velocity of unauthorized flight is U_1 ,

- Write an expression for the sound frequency that reach to the unknown aircraft.
- Write an expression for the sound frequency that is determined by the Spy plane.
- Calculate the velocity (U_1) of the unknown aircraft.
- Is this unknown aircraft moving towards or away from the Spy Plane?

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7. A free liquid surface has an ability to bear a weight due to Surface Tension. Spherical Soap bubble is a result of Surface tension.

- i. Give an example for bear a load by a liquid surface.
- ii. Define the Surface tension of a liquid surface.
- iii. Radius of a soap bubble is 'r', The coefficient of surface tension of soap is 'T'.

Show that the excess pressure of the soap bubble is $\Delta P = \frac{4T}{r}$

- iv. a. Calculate the excess pressure of a soap bubble of radius 0.5 cm. The surface tension of soap is $25 \times 10^{-2} \text{ Nm}^{-1}$.
- b. Find the pressure inside the soap bubble if atmospheric pressure is $9.94 \times 10^4 \text{ Pa}$.

c. Find the number of air molecules inside the soap bubble at 27°C .

(Universal Gas Constant (R) = $8.3 \text{ J mol}^{-1} \text{ K}^{-1}$)

Avogadro number (L) = 6×10^{23}

- v. Two soap bubbles are joined as shown in the diagram. Radii of them are r_1 and r_2 ($r_2 > r_1$)

a. Copy down the above diagram on your answer script. Draw the common meniscus of soap bubbles.

b. If the radius of common meniscus is R, then show that

$$\frac{1}{R} = \frac{1}{r_1} - \frac{1}{r_2}$$



- vi. Radius of a soap bubble is 'a'. The outside pressure is 'p' and Surface tension is T.

a. Write an expression for air pressure inside the soap bubble.

b. What is the volume of the soap bubble

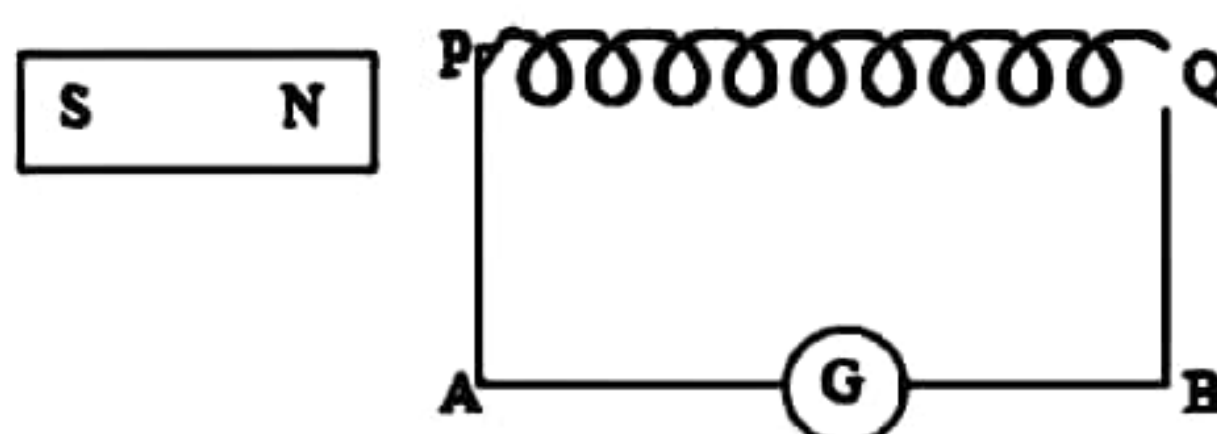
c. Two soap bubbles of radii a and b are joined together to form a single soap bubble of radius 'r'. If surface tension of soap is T, then show that

$$T = \frac{P(r^3 - a^3 - b^3)}{4(a^2 + b^2 - r^2)}$$

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8. a). Write down the Faraday's law and Lenz's law about the electromagnetic induction.

b) To demonstrate electromagnetic induction the following set up was prepared. It consists with a horizontal solenoid which is connected with a centre zero Galvanometer.

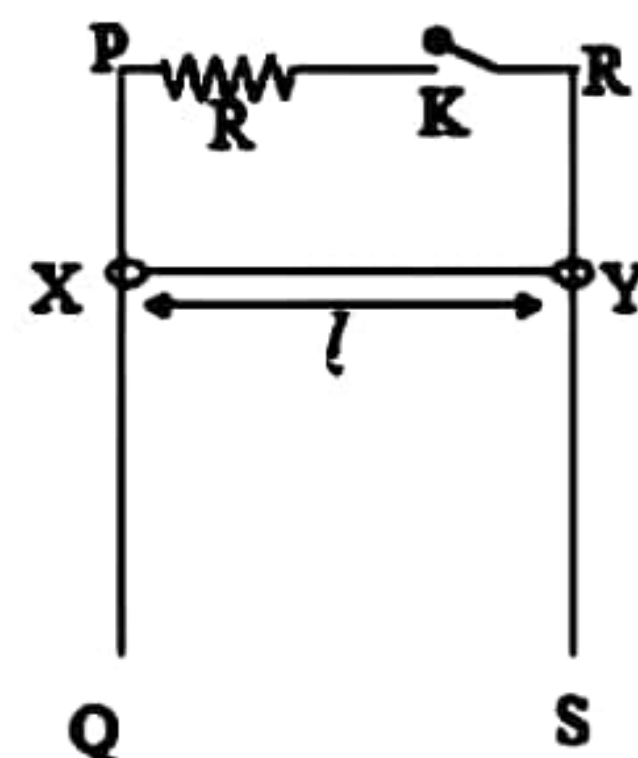


- Show the direction of the current through the Galvanometer when North pole of the magnet is moving towards P.
- Show the direction of the current through the Galvanometer when North pole of the magnet is moving away from the P.
- Describe how to determine the direction of current on above (i) instant using the Lenz's law and Maxwells Cork screw law.

c) A conductor of length 'l' is moving with 'U' velocity across a perpendicular magnetic field of field density B. Show that the induced EMF across the rod is $E = BlU$

d) PQ and RS are two smooth vertical copper strips. The gap between them is l . The XY rod is freely released and moving along the copper rods downwards. Mass of XY is 'm'. A magnetic field of field density B is acting into the plane as perpendicular to the PQRS plane.

$$l = 1\text{m}, \quad m = 0.5\text{ kg}, \quad B = 2\text{T}, \quad R = 100\Omega$$



- Write down an expression for induced EMF across the rod after 't' time from releasing the rod.
- Illustrate the variation of induced EMF with time on the graph.
- Find the induced EMF after 10 s from releasing.
- The switch K was closed at this instance. Find the current flowing through R resistor.
- What is the power dissipation across the resistor at this instance?

9. Answer only part A or B.

A. The present power production of Sri Lanka is $14 \times 10^3 \text{ GWh}$. ($1 \text{ GW} = 10^9 \text{ W}$)

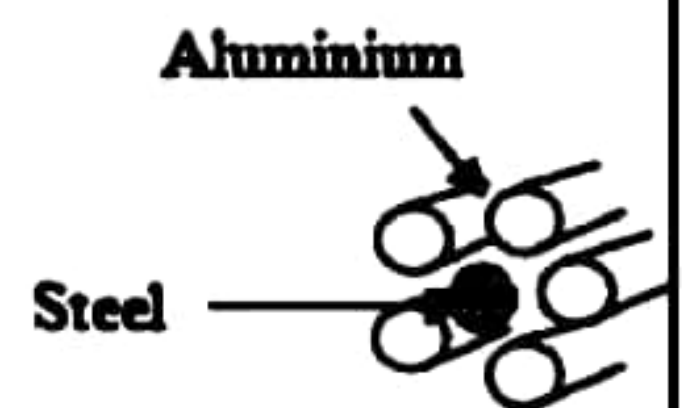
30% of it is covered by the natural sources such as water and solar power. Rest is covered by fossil fuels. 10% of power is getting lost during production and distribution.

The produced power is converted into high voltages of 132 kV and 220 kV using transformers. Then it is converted into 11 kV at the sub distribution centers. Finally turns into 230 V to domestic usage.

- Calculate the daily electricity consumption of the Sri Lanka.
- Draw a graph to illustrate the variation of voltage produced by a power station.
- Describe the Physical theorem of transformers when transforming energy.
- The primary coil of transformer has 500 number of turns. Find the number of turns of secondary coil when transforming 11 kV in 230 V Voltage.
- The current flowing through the Primary and Secondary coils are I_p and I_s respectively. The number of turns are N_p and N_s . Give an expression for $\frac{I_p}{I_s}$.
- What is the assumption you have used.
- Copper Strips are used as secondary coil. Give reason for this.

b) A high tension cable is consisting with a Steel cable and 6 Aluminium cables. The resistivity of steel is $12 \times 10^{-8} \Omega \text{m}$ and the resistivity of Aluminium is $2.5 \times 10^{-8} \Omega \text{m}$. Thickness of each wire is 3.0 mm.

- Find the resistance of a steel and an Aluminium cable of 1km long. R_s and R_l
- Calculate the resistance of the combined cable of a 1 km long.
- What is the advantage of using this kind of combined cable.
- Resistance of steel is large when comparing copper and Aluminium. Explain why steel is using when prepare this cable.

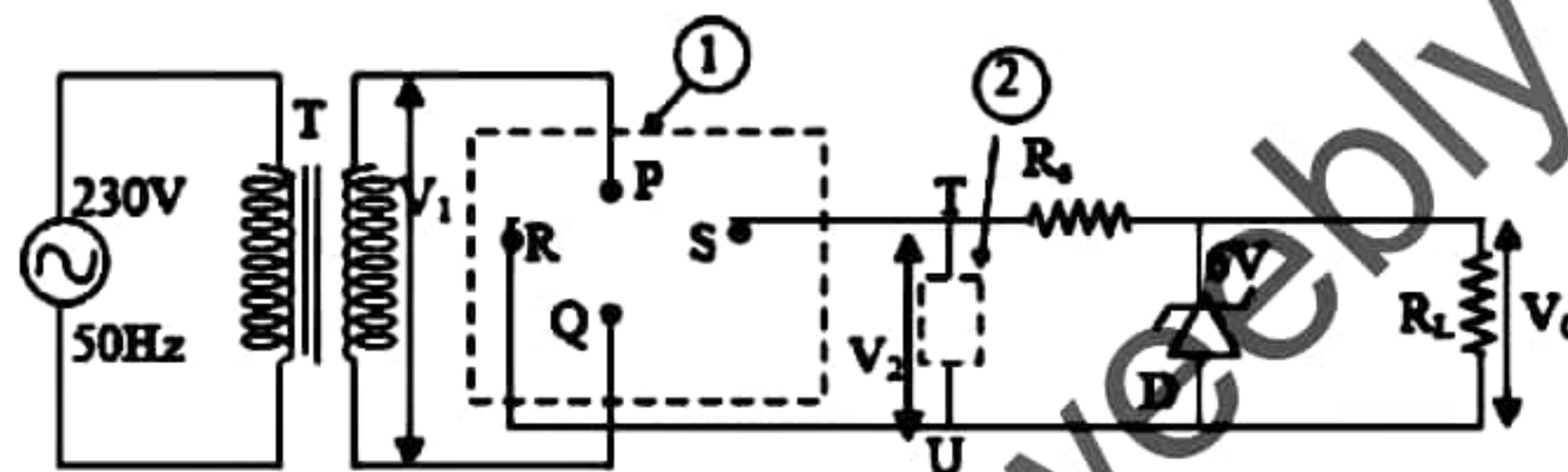


Trip switch (RCCB) is a protective device in domestic electric system when supply voltage is 230 V. If domestic current flow is larger than 30 A or live wire transmit 35 mA current to earth if there is an electric shortage the trip switch gets open. MCB (Miniature Circuit Breaker) is used to disconnect a segment of domestic circuit from the main circuit. If current flow through a Light circuit is larger than 6A or a current flowing through a plug circuit is larger than 13A then the MCB disconnect the segment.

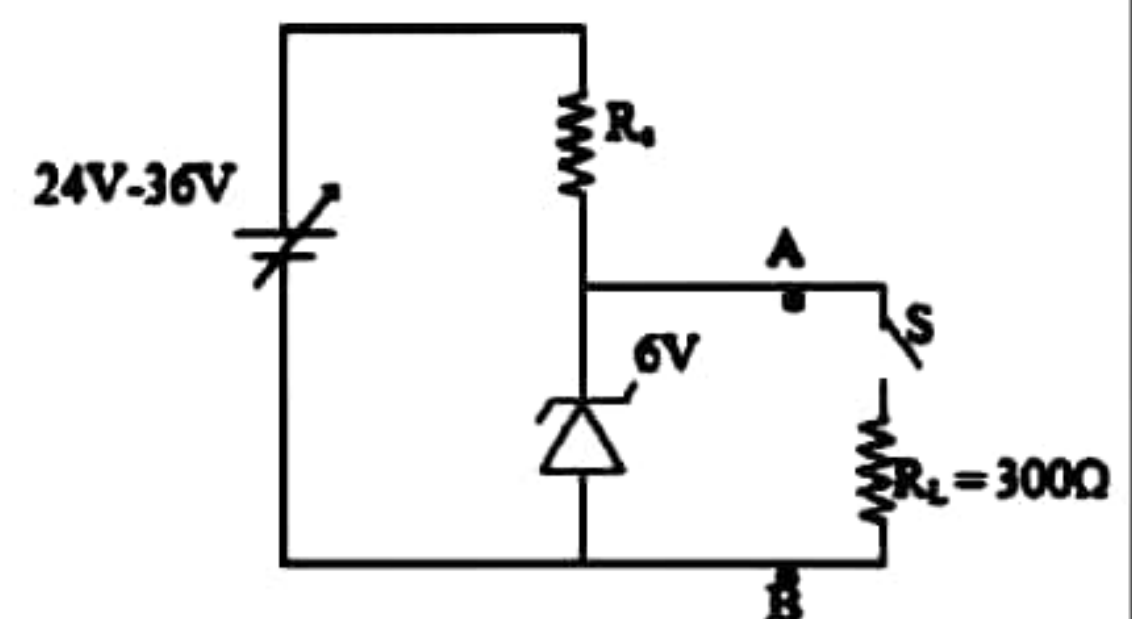
- Two 40 W bulbs and one 750 W water pump is connected in a MCB circuit. Find the current flow through the circuit.

- ii. Owner of the house decided to connect two series of bulbs to the above circuit. One bulb series consists of 60 number of 5W bulbs. Is this suitable or not? Explain your answer.

B. T is a Step down transformer. V1 alternate secondary voltage received from the transformer is turns to V2 direct voltage by rectifying from PQRS set up. V2 smooth from TU item. Then regulate from Zener Diode(D). The final output voltage is V_0 across R_L . The Zener voltage is 6V.



- a) i) Draw the PQRS rectifier circuit.
 ii) Draw the device in TU connection, Indicate + and - on the device.
 iii) Draw the variation of V2 rectifying voltage, Smooth voltage and V_0 output voltage with time. Show the value of V_0 on the graph.
- b) A 24V- 36V variable voltage source is used to operate 6V electronic device. A circuit diagram with 6V zener diode to use this purpose given below. The minimum current required to operate the zener diode is 16 mA. The maximum current is 60 mA. Resistance of the electronic device is $300\ \Omega$.

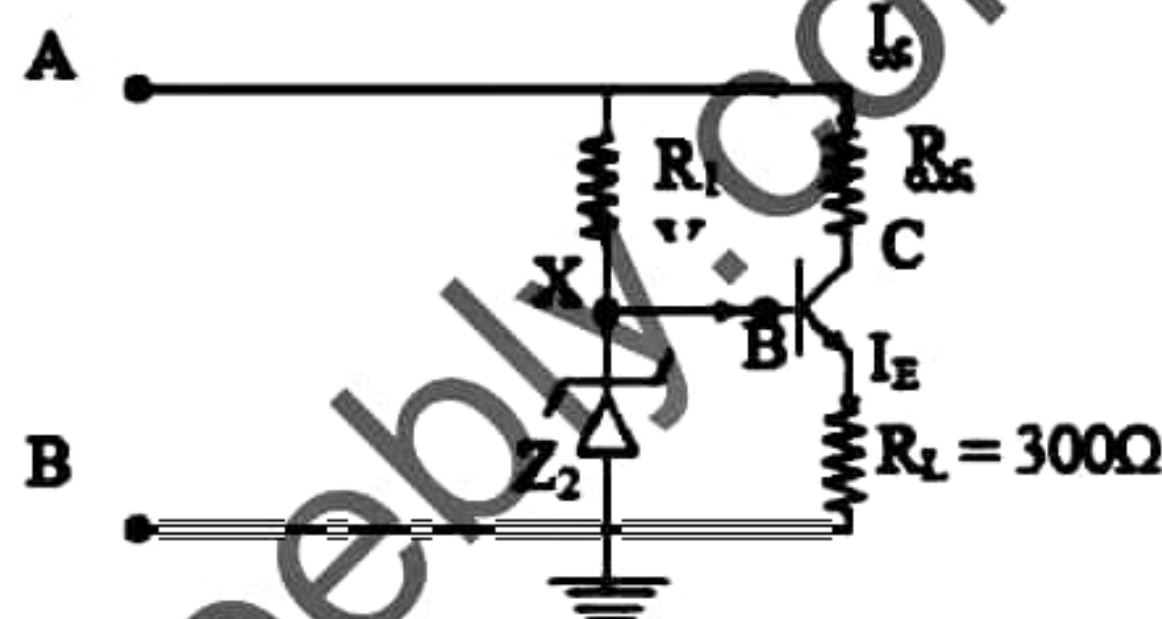


- i. Find the value of R_1 safety resistor.
 ii. Find the maximum power dissipation of the zener diode.
- If the input voltage is 36 V and S switch is closed
- iii. Find the current through R_L .

- iv. Find the current and power across the zener diode.
- v. Find the minimum current across the zener diode under above variable conditions. Is the zener diode working properly under this current? Explain.

c) AB terminal of the above circuit is connected to another circuit as shown in the diagram. The input voltage is 36 V. A constant 3V voltage must be maintained across R_L load resistance. The transistor is Silicon and Base- Emitter voltage is 0.6 V.

- i. What should be the zener voltage to operate R_L at 3V.
- ii. Find the minimum value of R_1 resistor if I_B is very small.



10. Answer only part A or B.

A) A. The phase change from solid state to liquid state is known as fusion.

- i) What is specific Latent Heat of Fusion.
- ii) How does the absorbed heat involved to the fusion process.
- iii) Titanium is widely used in develop the artificial human bones. It needs to have 500 g of titanium liquid from 500 g of solid Titanium at 30 °C room temperature.
Melting point of titanium = 1630 °C
Specific heat capacity of titanium is 523 J kg⁻¹ K⁻¹
Specific Latent Heat of titanium is = 520 kJ kg⁻¹.

b. Usually a liquid can expand when increasing of temperature and contract when decreasing of temperature.

- i. What is the anomaly expansion of water?
- ii. Illustrate the variation of density of water when increase its temperature from 0 °C to 70 °C on a graph.
- iii. In the winter the environment temperature of some lands becomes – 50°C. Explain how does the anomaly expansion of water helps to continue living of sea animals.
- iv. In the winter it was determined the thickness of ice layer of a pond is 30 cm at 6 am in the morning. The environment temperature is – 50°C.
Specific Latent Heat of water is 336 kJ kg⁻¹
Density of ice 900 kgm⁻³
Heat conductivity of ice = 1.6 W m⁻¹ °C⁻¹

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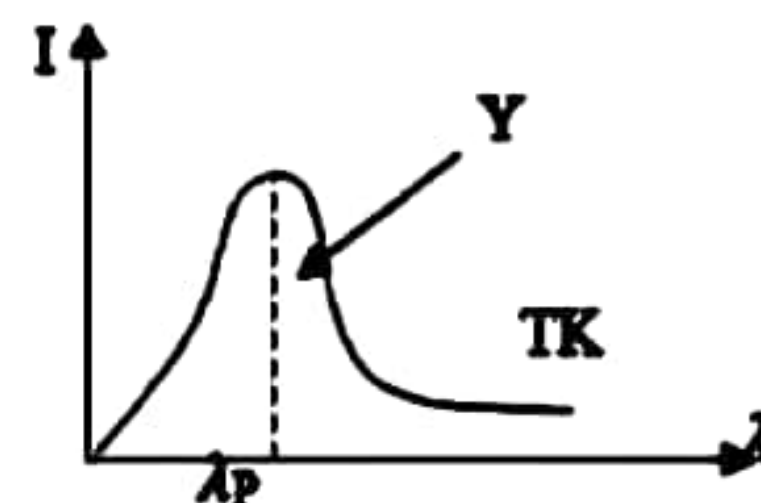
- What is the temperature of the water in contact with ice layer at the bottom surface of ice layer.
- Find the rate of transfer of heat through 1 m^2 area of ice.
- Due to the continues heat loss through the ice layer its thickness getting increased gradually. After 12 hours, at 6pm of the same day it was determined thickness of the ice layer was increased from 'h cm' height.

Write an expression for amount of loss of heat across 'h cm' height ice layer for A area.

- This total heat amount is transferred from water to environment during 12 hours across the ice layer.
The initial thickness of the ice layer at the beginning of the day is 30 cm. After 12 hours it was (h + 30) cm. Find the increased height of ice layer during 12 hours.

- B) a. The change of intensity of Black Body Radiation with wave length is given below. λ_p is the wave length that corresponding to maximum intensity of radiation.

- Copy down this graph on your answer script. Then draw the corresponding curve for T_1 temperature if $T_1 > T$. Name it as X.
- Write two changes can be seen from the graph when increasing of temperature.
- State the equations of Stefan's law for Perfect Black body and Non-perfect Black body. Introduce the terms.
- Temperature and λ_p wave length of the curve 'Y' are 4000 K and 725 nm. Find the temperature (T_1) of X if λ_p of the X is 500 nm.



- b. Some cardio therapy devices are powered by the energy of radioactive Plutonium ($^{238}_{94}\text{Pu}$). Plutonium disintegration releases an alpha particle with energy of 5.5 MeV. The daughter atom produced by this disintegration is an isotope of Uranium. The decay constant of $^{238}_{94}\text{Pu}$ is $2.4 \times 10^{-10} \text{ s}^{-1}$.

- What is the number of neutrons of $^{238}_{94}\text{Pu}$?
- Write the corresponding disintegration equation.
- Find the half life of $^{238}_{94}\text{Pu}$.

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The initial $^{238}_{94}\text{Pu}$ mass is 100 g.

The Avogadro constant is $6 \times 10^{23} \text{mol}^{-1}$

Charge of an electron is $1.6 \times 10^{-19} \text{C}$

- i. Calculate the number of radioactive atoms.
- ii. Find the number of initial disintegration .
- iii. Mass of the Neutron and Proton is $1.7 \times 10^{-27} \text{kg}$. Find the velocity of alpha particle.
- iv. Find the De Broglie Wave length of the above alpha particle.
- v. Consider initially the Plutonium atom is in rest. Find the energy obtained by the Uranium atom when alpha particle is emitting.

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