தேசிய வெளிக்கள நிலையம் தொண்டைமானாறு
ஐந்தாம் தவணைப் பரீட்சை - 2024
National Field Work Centre, Thondaimanaru
5th Term Examination - 2024
FWC

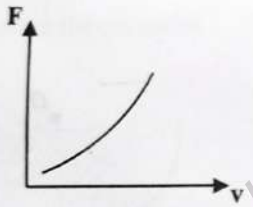
பௌதிகவியல் - I Physics - I	Two Hours Gr. 13 (2024)	01	E	I

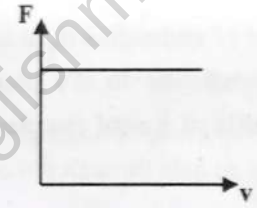
$g = 10ms^{-2}$

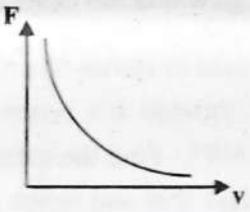
01) Which is not a unit of derived physical quantity from the following units?
(1) N (2) Hz (3) K (4) Pa (5) J

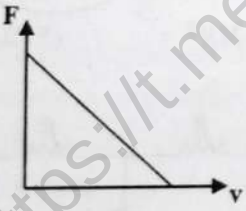
02) Which is not a characteristic of simple harmonic of simple harmonic motion,
(1) Periodical motion
(2) Acceleration is directly proportional to the displacement from the oscillating centre.
(3) Acceleration always directed towards the oscillating centre
(4) Maximum kinetic energy is greater than the maximum potential energy.
(5) General equation for the acceleration is in a form of $a = -\omega^2 x$

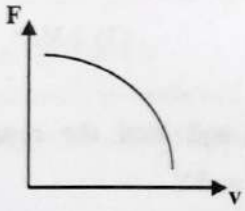
03) Denote the best graph of exerted force (F) against the speed (V) for an engine that is working with constant power.

(1) 

(2) 

(3) 

(4) 

(5) 

04) Choose the false statement about the seismic waves,
(1) They are divided into two types, such as body waves and surface waves.
(2) P - wave is a high velocity longitudinal wave.
(3) S - wave is a transverse wave.
(4) S - waves and P - waves can travel through all the mediums.
(5) Surface waves have the frequency less than the frequency of body waves.

05) An object hangs from a spring balance that is fixed on a roof of a lift. The lift moves with an acceleration of $2\,ms^{-2}$ along the downward direction and then the reading of the spring balance is 20N. Find the mass of the object?
(1) 1.67 kg (2) 2 kg (3) 3.33 kg (4) 3 kg (5) 2.5 kg

06) Which is not a character of a LASER beam of light?

(1) It is an integrated beam of light

(2) Energy of the beam is high.

(3) Photon energy in the LASER is higher than the photon energy in normal beam of light.

(4) Formed by stimulated emission.

(5) A LASER beam of light has same phase.

07) Consider the following statements about simple microscope and compound microscope and choose the correct statement/s.

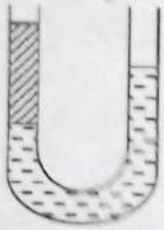
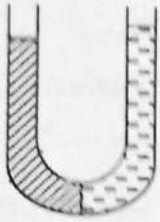
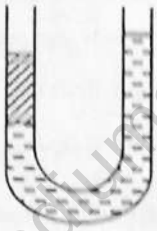
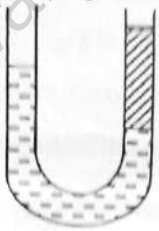
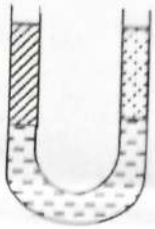
A - Final image formed by both of them are always virtual.

B - Final image formed by both of them always have a magnification greater than one.

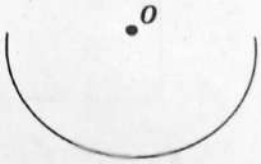
C - Final image formed by both of them are always situated at infinity.

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

08) Consider the liquid levels from the following figures and choose which is **impossible,**

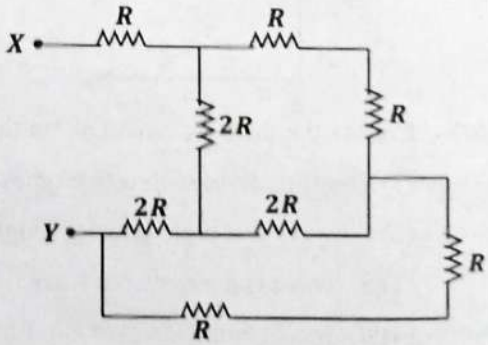
(1)  (2)  (3)  (4)  (5) 

09) Moment of inertia of a ring of mass M and radius R, about an axis through it's centre and perpendicular to it's plane is $I = MR^2$. Find the moment of inertia of a semi circular ring of mass $2\,M$ and radius $2R$, about an axis through it's centre O and perpendicular to it's plane.



(1) $\frac{1}{2}\,MR^2$ (2) MR^2 (3) $2\,MR^2$ (4) $4\,MR^2$ (5) $8\,MR^2$

10) Consider the given network and find the resultant resistance between the points X and Y



(1) $\frac{R}{2}$

(2) $2\,R$

(3) $3\,R$

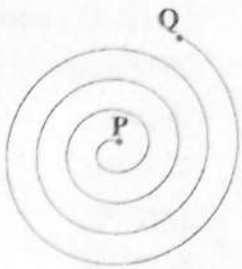
(4) $4\,R$

(5) $6\,R$

11) A geostationary satellite, orbiting around a circular path of radius r is now allowed to orbit in a circular path of radius $2\,r$. Find the new period of revolution in earth days.

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

12) A charged particle entering into a uniform magnetic field, is moving in a spiral path on the plane of the paper due to the effect of the air resistive force. Consider the following statements and choose the correct/s..



A - The charged particle enters into the magnetic field with an inclination from the magnetic field intensity.

B - If the magnetic field intensity is in the outward direction to the paper, then the charge of the particle is positive.

C - On behalf of the magnetic force acting perpendicular to it's direction of motion, it's angular momentum is constant.

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

(4) A, C only (5) A, B, C all.

13) Two small spheres made by aluminium and brass, of same radius, are released into a viscous liquid which is kept into a cylindrical container. Consider the following statements and choose the correct/s.

(A) Initial acceleration to both of the spheres are equal.

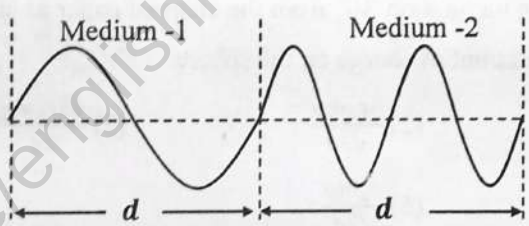
(B) Both of the spheres reach the termainal velocity at the same moment.

(C) Both of the spheres have same terminal velocity

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

(4) C only (5) A, B, C all

14) A wave is transmitted from a medium (1) to an another medium (2). Consider the following statements and choose the correct/s



A - Medium (1) is optically rarer than the medium (2)

B - While the wave entering into the medium(2) is frequency is doubled.

C - The velocity of the wave into the medium (2) is half of the velocity into the medium (1)

Which of these statements is/are correct?

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

(4) A, C only (5) A, B, C all

15) An object is freely falling under the gravity from rest the distance travelled in the last second is equal to the distance travelled in the intial three seconds. Find the time taken to fall?

(1) $9s$ (2) $8s$ (3) $7s$ (4) $6s$ (5) $5s$

16) The ratio between the intensities of two sound waves is 9:4. These two waves are made to overlap and the resultant wave pattern was obtained on a screen. Find the ratio between the maximum and minimum intensities of the resultant wave?

(1) 5 : 1 (2) 25 : 1 (3) 3 : 2 (4) 9 : 1 (5) 25 : 2

17) A convex lens of focal length 10cm is kept as shown in the figure, used to get the image of the point P, on a screen.

Find the distance of the screen from the lens

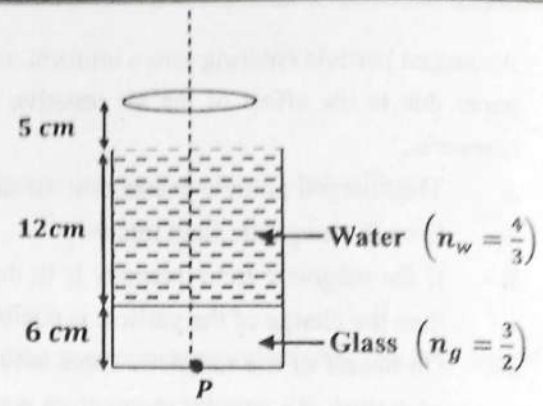
(1) 18 cm

(2) 30 cm

(3) 20 cm

(4) 15 cm

(5) 3 cm



18) In a region where a uniform magnetic field of $B = 4T$ directed perpendicularly in to the paper, a straight conducting rod $PQ = 1\ m$ moves towards the right side with velocity $2ms^{-1}$ on two smooth conducting rails Find the charge stored in the capacitor

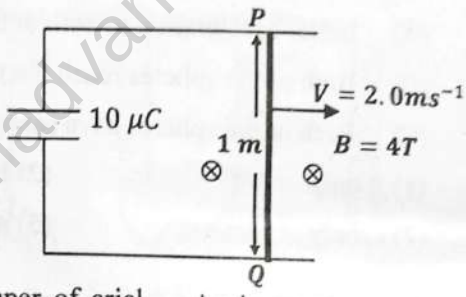
(1) Zero

(2) 20 μC

(3) 40 μC

(4) 80 μC

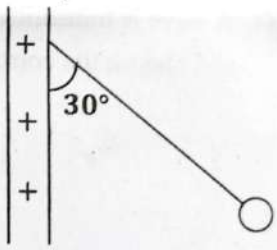
(5) Increased with time



19) A charged sphere of mass m is situated near a charged paper of arial charge density $+\sigma$ at an inclination 30° from the charged paper as shown in the figure. Find the amount of charge on the sphere.

(1) $\frac{\varepsilon_0 mg}{\sqrt{3}\sigma}$ (2) $\frac{3\varepsilon_0 mg}{\sqrt{3}\sigma}$ (3) $\frac{\sqrt{3}\varepsilon_0 mg}{2\sigma}$

(4) $\frac{\sqrt{3}\varepsilon_0 mg}{\sigma}$ (5) $\frac{\varepsilon_0 mg}{\sqrt{3}\sigma}$



20) One of the gas A of 3mol at 300K temperature and an another gas B of 2mol at 400K temperature are being mixed without any energy loss. Then find the temperature of the gas mixture.

(1) 310 K (2) 320 K (3) 330 K (4) 340 K (5) 350 K

21) Same volume of two liquids X and Y are taken separately into two identical calorimeters and they are made to cool down in same conditions. At the time $t = 0$ the temperature of the liquids is 70°C . At the time $t = t_0$ the temperature of the liquids is 50°C. Room temperature is 30°C Consider the following statements and choose the correct/s

A - The rate of cooling is same for the liquids X and Y from the time $t = 0$ to $t = t_0$

B - The rate of heat loss to the environment is same for X and Y from the time $t = 0$ to $t = t_0$

C - $\frac{\text{Mass of X}}{\text{Mass of Y}} = \frac{\textit{Specific heat capacity of X}}{\textit{Specific heat capacity of Y}}$

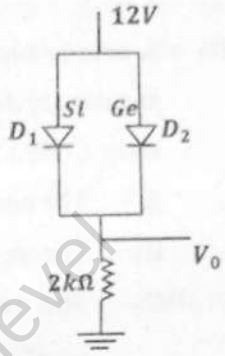
(1) A is only correct (2) B, C are only correct (3) A, B are only correct

(4) A, C are only correct (5) A, B, C all are correct

22) A thin plate of area $10\,cm^2$ is separated by an oil layer of thickness 1mm from a large plate. Coefficient of viscosity of oil is $2\,kg\,m^{-1}s^{-1}$. Find the velocity of the small plate, white it is moved by a force $2 \times 10^{-2}\,N$

(1) $0.1\,ms^{-1}$ (2) $0.01\,ms^{-1}$ (3) $1\,ms^{-1}$ (4) $0.001\,ms^{-1}$ (5) $10\,ms^{-1}$

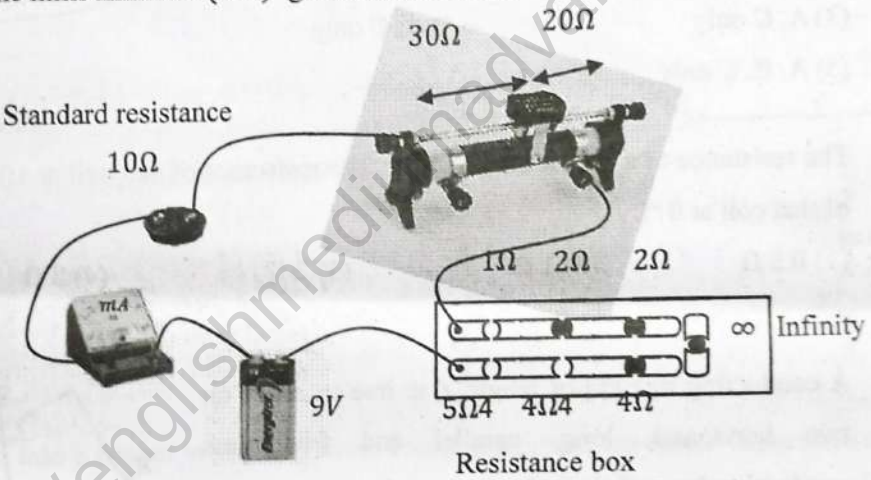
23) The diodes D_1 *and* D_2, shown in the figure are silicon and Germanium. The forward biasing voltages of them are $0.7\,V$ *and* $0.3\,V$ respectively. Find the value of V_0.



(1) $0.7\,V$
(2) $0.3\,V$
(3) $0\,V$
(4) $11.7\,V$
(5) $11.3\,V$

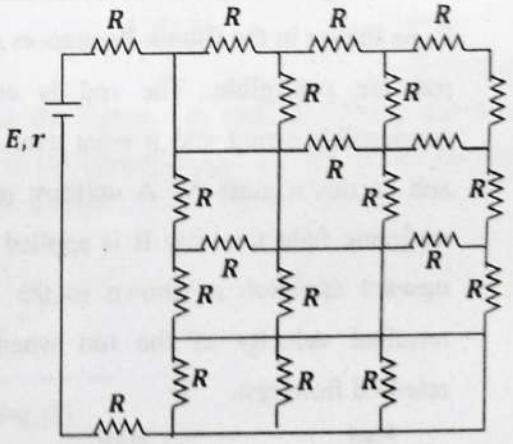
24) What is the reading of the milli ammeter (mA) given in the circuit.

(1) $110\,mA$
(2) $160\,mA$
(3) $190\,mA$
(4) $225mA$
(5) $500\,mA$



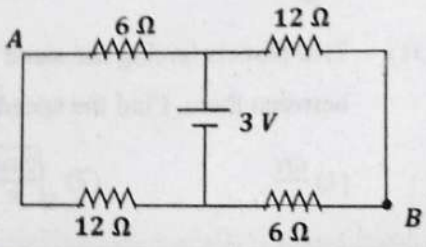
25) The electric cell given in the electrical network has an electro motive force E and internal resistance r. All the resistors in the network has a resistance R then find the current flow through the cell?

(1) $\frac{E}{2R+r}$ (2) $\frac{E}{22R+r}$ (3) $\frac{E}{11R+r}$
(4) $\frac{E}{R+r}$ (5) $\frac{E}{2R}$



26) Find the electric potential at the point B with respect to the point A, in the electrical circuit, shown in the figure.

(1) $-2\,V$ (2) $-1\,V$ (3) $0\,V$
(4) $1\,V$ (5) $2\,V$



27) Diameter of a normal eye is 2.5cm. Diameter of an eye defected from birth is 2.3cm. Find the range of vision of the defected eye.

(1) 28.8 cm, 191.6 cm (2) 25 cm, Kbtpyp (3) 28.8 cm, 174 cm

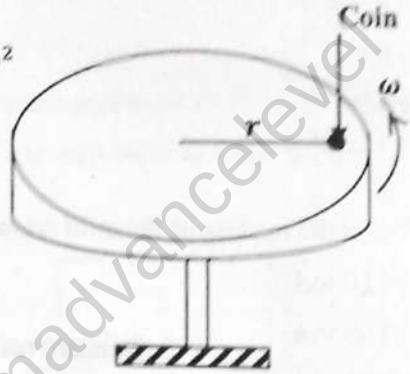
(4) 25 cm, 175 cm (5) 25 cm, 100 cm

28) A coin is kept at a distance r from the centre of a horizontal table, that is rotating with a uniform angular acceleration α. At a moment the angular velocity of the table is ω and then the coin did not slide. Choose the correct statement/s from the followings.

A - The momentary velocity of the coin is $r\omega$

B - The momentary velocity in the radial direction is $r\omega^2$

C - The momentary resultant acceleration of the coin is $r\sqrt{\alpha^2+\omega^2}$



(1) A only (2) A, B only

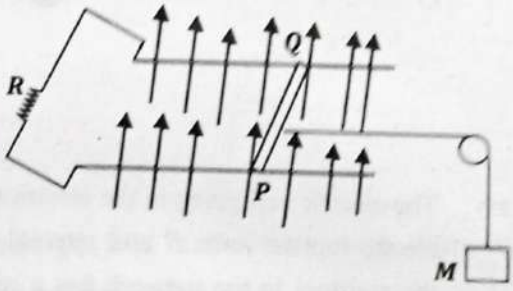
(3) A, C only (4) B, C only

(5) A, B, C only

29) The resistance of a coil at 50°C is 5 Ω. The resistance of that coil at 100°C is 6 Ω. Find the resistance of that coil at 0 °C

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

30) A conducting rod PQ of length ℓ is free to move on two horizontal, long, parallel and frictionless conducting beams, that are connected to a resistance R, as shown in the figure. Resitances of the beams and rod are negligible. The rod is connected by an inextensible string and it went over a smooth pulley and carries a mass M. A uniform magnetic field of magnetic field intensity B is applied in the vertically upward direction as shown in the figure. Find the terminal velocity of the rod when the system is released from rest.



(1) $\frac{MgR}{B^2\ell^2}\rightarrow$ (2) $\frac{MgR}{B^2\ell^2}\leftarrow$ (3) $\frac{MgR}{2B^2\ell^2}\rightarrow$ (4) $\frac{MgR}{2B^2\ell}\rightarrow$ (5) 0

31) Two planets having the same mass M revolute in a circle of radius R due to the gravitational attraction between them. Find the speed of each planet?

(1) $\frac{GM}{R}$ (2) $\sqrt{\frac{2GM}{R}}$ (3) $\sqrt{\frac{\sqrt{2}\,GN}{R}}$ (4) $\sqrt{\frac{GM}{4R}}$ (5) $\sqrt{\frac{GM}{2R}}$

32) Frequency of the fundamental tone of a stretched wire of length 1m is 320Hz. An another stretched wire of the length 1m and the same tension, but the diameter 4 times of the first one. Find the fundamental frequency of the second wire. Both wires are made by same material.

(1) $80\ Hz$ (2) $160\ Hz$ (3) $320\ Hz$ (4) $640\ Hz$ (5) $1280\ Hz$

33) Two resonance tubes of lengths 50.0cm and 50.5cm are synchronized and then 3 beats are heard within a unit second. If the end corrections are negligible, find the frequencies of the tubes respectively.

(1) $303\ Hz,\ 300\ Hz$ (2) $300Hz,\ 303\ Hz$ (3) $101\ Hz,\ 100\ Hz$

(4) $100\ Hz,\ 101\ Hz$ (5) $153\ Hz,\ 150\ Hz$

34) A catapult is made by using a rubber tape of 42cm length and 6mm diameter. A stone of mass 20g was kept on this catapult and the rubber tape was pulled to 62cm and released. If the velocity of the stone leave from the tape was 20 ms^{-1}, then find the Young's modulus of the rubber tape.

(1) $2.66 \times 10^6\ Nm^{-2}$ (2) $2.97 \times 10^6\ Nm^{-2}$ (3) $3.14 \times 10^6\ Nm^{-2}$

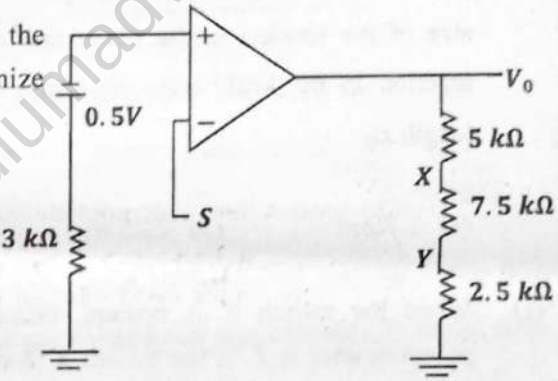
(4) $5 \times 10^6\ Nm^{-2}$ (5) $6.18 \times 10^6\ Nm^{-2}$

35) Figure shows the outline circuit of an op-amp . Find the place where the sliding key S being touched to minimize the output voltage V_0 and find the minimum value V_0

(1) $X, -0.75\ V$ (2) $Y, -3.0\ V$

(3) $Y, -0.75\ V$ (4) $X, -2.0\ V$

(5) $Y, -2.0\ V$



36) While heating a liquid into a copper vessel and silver vessel separately, the linear expansivities are C and S respectively. The real linear expansivity of copper is α then find the linear expansivity of silver?

(1) $\frac{C+S-3\alpha}{3}$ (2) $\frac{C+3\alpha-S}{3}$ (3) $\frac{S+3\alpha-C}{3}$ (4) $\frac{C+S+3\alpha}{3}$ (5) $\frac{C-3\alpha-s}{3}$

37) Water levels into a container, in a slope are shown in the figure. (1) and (2). The water level is horizontal in the figure (1) and it is parallel to the slope in the figure(2). Choose the correct motions of the container on the slope in figure(1) and figure(2) respectively.

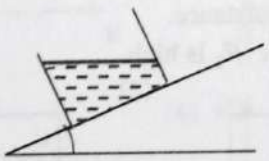


Fig. (1)

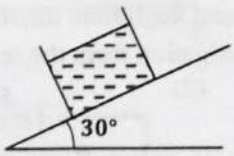


Fig (2)

(1) rest, acceleration $\frac{g}{2}$ upwardly

(2) acceleration $\frac{g}{2}$ downwardly, acceleration $\frac{g}{2}$ upwardly

(3) downwardly constant velocity, downwardly acceleration $\frac{g}{2}$

(4) downwardly constant velocity, upwardly acceleration $\frac{g}{2}$

(5) upwardly acceleration $\frac{g}{2}$, upwardly acceleration $\frac{g}{2}$

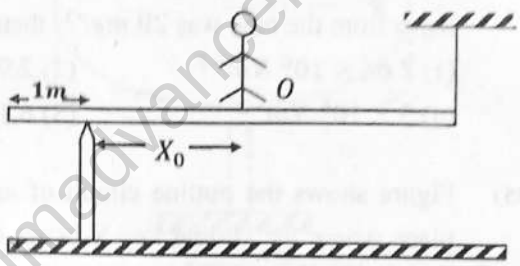
38) A heater of 45Ω resistance is connected to 300V, maintains the temperature of a room at 20 °C , The heat is transferred from a glass window of area 1 m^2 and thickness 2mm only. Find the temperature of the outer surface of the window? [conductivity of glass is $2 \times 10^{-1} Wm^{-1}k^{-1}$]

(1) 0 °C (2) 10 °C (3) 20 °C (4) 5 °C (5) 2 °C

39) An insulated vessel contains water of 0.6kg, at 0°C temperature. While the air above the water surface is evacuated, a small amount of water is being freezed and a small amount of water at 0°C is being vapourised. Finally any of water not left into the vessel. Find the mass of ice that being freezed into the vessel? Latent heat of vaporization of water at 0°C is $1.75 \times 10^7 Jkg^{-1}$.
Latent heat of fusion of ice at 0°C is $3.5 \times 10^6 Jkg^{-1}$.

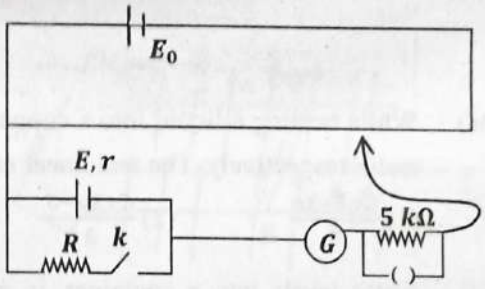
(1) 300 g (2) 450 g (3) 500g (4) 400 g (5) 425 g

40) A uniform beam of mass 20 kg and length 5 m is kept horizontally by a knife edge, a distance 1 m from one end and by a vertical string at the other end. While a boy of mass 40 kg is standing on the beam at O, the size of the tension in the string and the size of the reaction in the knife edge are same. Then find the length x_0



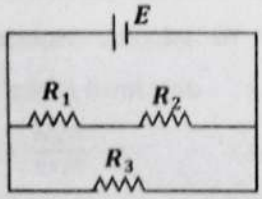
(1) 1.75 m (2) 2.25 m (3) 2.75 (4) 3.25 m (5) 2.5 m

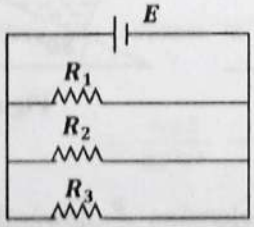
41) When the switch K is opened, balance length of the potentiometer is ℓ. If the switch K is closed the balance length is $\frac{\ell}{3}$. Find the relationship between the internal resistance r and R.

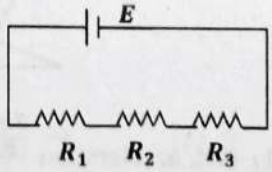


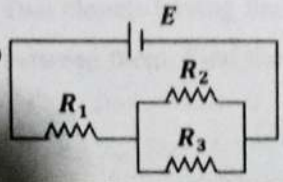
(1) $r = \frac{R}{3}$ (2) $r = \frac{R}{2}$ (3) $r = R$
(4) $r = \frac{3R}{2}$ (5) $r = 2R$

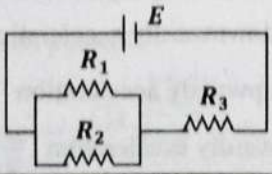
42) There are five electrical circuits formed by using three resistors R_1, R_2 and R_3 and an electric cell of electro motive force E and negligible internal resistance.
At which circuit the power dissipation from the resistor R_1 is high.

(1)


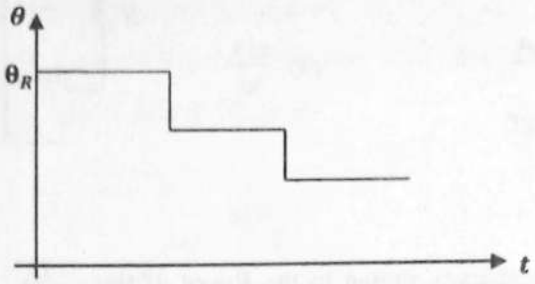
(2)


(3)


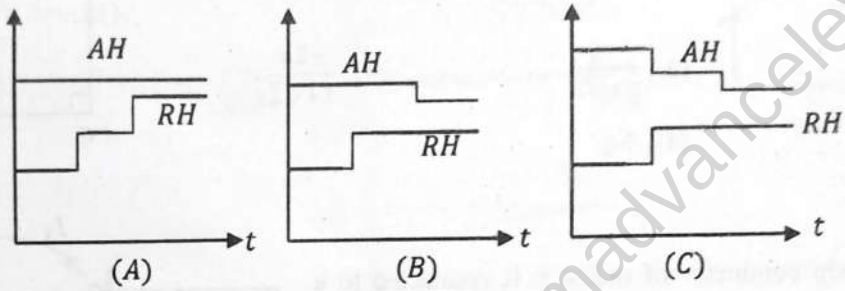
(4)


(5)


43) The relative humidity of a closed room is 80%. The given figure shows, how to the room temperature (θ) varies with time (t).



Consider the relative humidity (R.H) and the absolute humidity (A.H), how they varying with time (t),



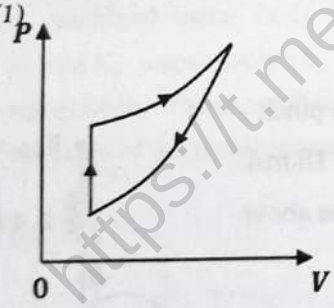
choose the correct graph/s.

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

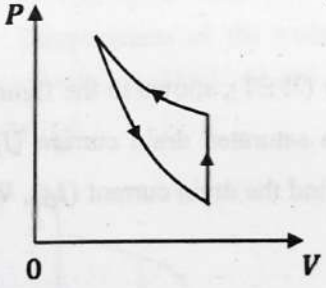
(4) A, B Only (5) A, B, C all

44) Initially an ideal gas of a particular mass is allowed to expand isothermally, and after that it is compressed adiabatically. Finally it is maintained in constant volume and also recovers its initial state. Choose the suitable P.V diagram for these processes.

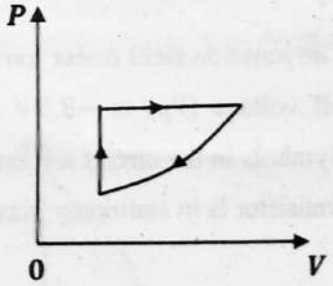
(1)



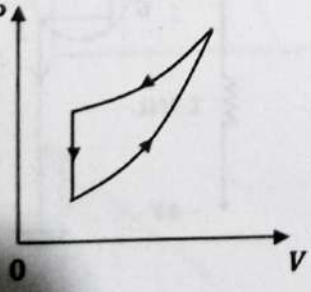
(2)



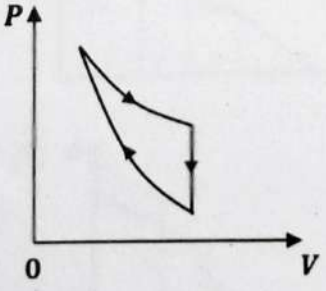
(3)



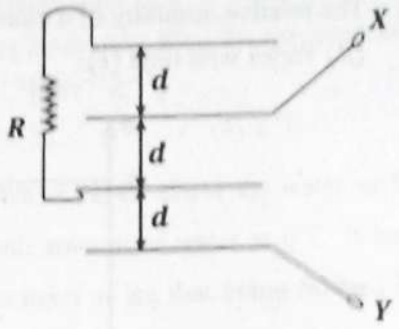
(4)



(5)



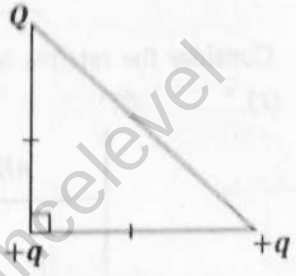
45) In the figure, there are four identical plates of area A, kept with a separation d. Find the resultant capacitance between the terminals X and Y.



(1) $\frac{2\varepsilon_0 3A}{d}$ (2) $\frac{3\varepsilon_0 A}{d}$ (3) $\frac{\varepsilon_0 A}{3d}$

(4) $\frac{3}{2}\frac{\varepsilon_0 A}{d}$ (5) $\frac{2}{3}\frac{\varepsilon_0 A}{d}$

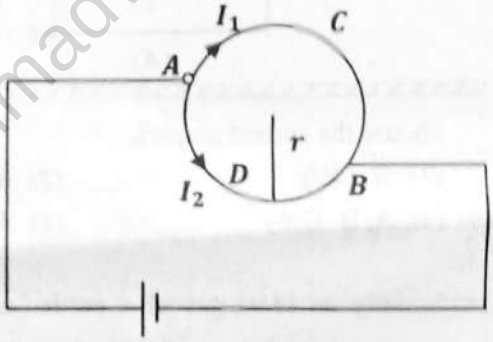
46) Consider a system of three point charges shown in the figure. If the electrostatic potential of the system is zero find the charge Q related with charge q.



(1) $\frac{-2q}{2+\sqrt{2}}$ (2) $\frac{-q}{1+\sqrt{2}}$ (3) $\frac{-2q}{1+\sqrt{2}}$

(4) $-2q$ (5) $+q$

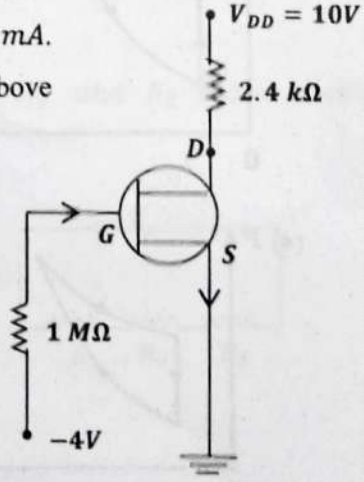
47) A circular loop conductor of radius r is connected to a battery at the positions A and B as shown in the figure. A current I_1 flows through the portion ACB and an another current I_2 flows through the portion ADB. Find the magnetic flux density at the centre of the circle.



(1) Zero (2) $\frac{\mu_0}{2\pi r^2}(\ell_2 I_2 - \ell_1 I_1)$

(3) $\frac{\mu_0}{4\pi r^2}(\ell_2 I_2 - \ell_1 I_1)$ (4) $\frac{\mu_0}{4\pi r^2}(\ell_2 I_2 + \ell_1 I_1)$ (5) $\frac{\mu_0}{2\pi r^2}(\ell_2 I_2 + \ell_1 I_1)$

48) The junction field effect transistor (JFET), shown in the figure has a pinch - off voltage (V_P) is $-8.0\,V$ and a saturated drain current (I_{DSS}) is $18\,mA$. Symbols in the circuit are usual. Find the drain current (I_D), While the above transistor is in stationary biasing.



(1) $2.25\,mA$

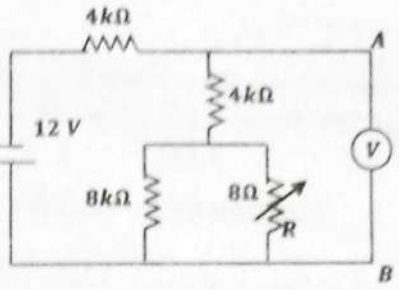
(2) $40.5\,mA$

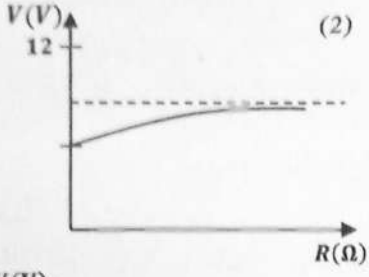
(3) $4.5\,mA$

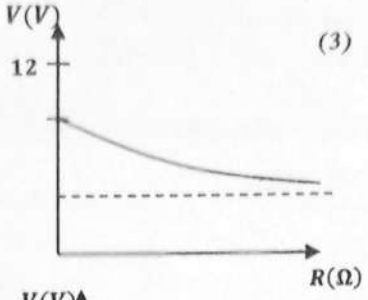
(4) $9\,mA$

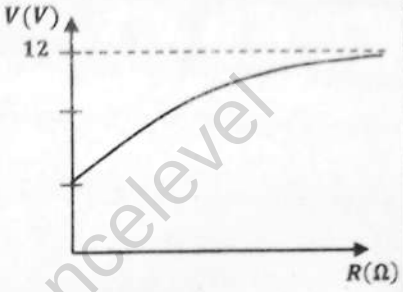
(5) $13.75\,mA$

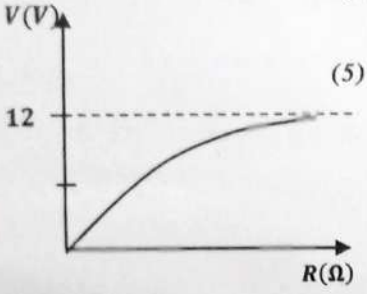
49) The variable resistor, shown in the figure is adjustable from 0 to 8Ω. Internal resistance of the 12 V battery is negligible. An ideal volt meter is connected between the terminals A and B. Choose the correct graph, while the resistance R increased from 0 to 8Ω, the voltmeter reading variation.

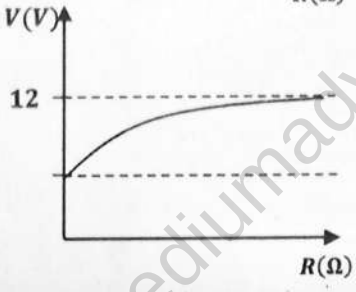


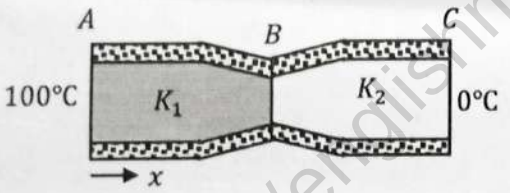
(1)


(2)


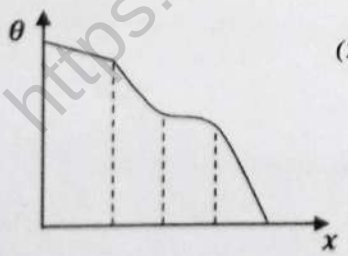
(3)


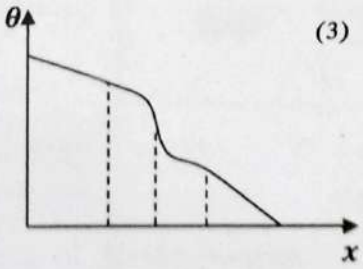
(4)


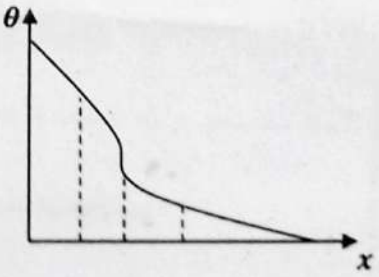
(5)


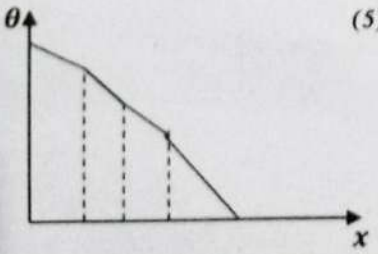
50)


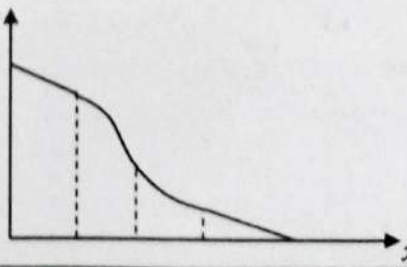
A combined metal body formed by two metal rods AB and BC having thermal conductivities K_1 and K_2 respectively $(K_1 > K_2)$ Temperatures of the ends A and C are kept at 100°C and 0°C respectively. Outer surfaces are perfectly insulated. At the steady state choose the graph of the variation of the temperature along the rod.

(1)


(2)


(3)


(4)


(5)


தேசிய வளவாளர் நிலையம் தொண்டைமானாறு
தேசிய தவணைப் பரீட்சை - 2024
National Field Work Centre, Thondaimanaru
5th Term Examination - 2024

பௌதிகவியல் - II Physics - II	Three Hours 10 Min. Gr. 13 (2024)	01	E	A

Index No: .....

Important:

* This question paper consists of 16 pages.
* This questions paper comprises of two parts, part A and Part B. The time allotted for both parts is two hours and ten minutes.

Part A – Structured Essay: **(Pages : 2 - 8)**

Answer all the questions on this paper itself. Write your answers in the space provided for each question. Note that the space provided is sufficient for your answers and that extensive answers are not expected.

Part B – Essay: **(Pages : 1 - 8)**

This part contains **seven** questions, of which, **four** are to be answered. Use the papers supplied for this purpose.

At the end of the time allotted for this paper, tie the two Parts together 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 the Examination Hall.

For Examiner's Use Only

For the second paper		
Part	Question Nos.	Marks Awarded
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
	8	
	9	
	10	
Total	In numbers	
	In Words	

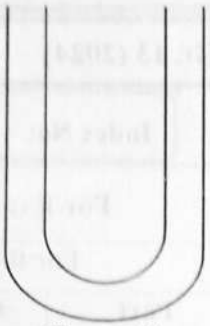
Code Numbers

Marks checked by 1	
Marks checked by 2	
Marking Examiner	
Supervised by	

Part - II(A)

Structure Essay

01) You need to find the relative density of kerosene using a U-tube. You have been provided with a U-tube, kerosene, and brine. The relative density of the brine is 1.02. An incomplete experimental setup is shown in the following diagrams.



(figure (1)

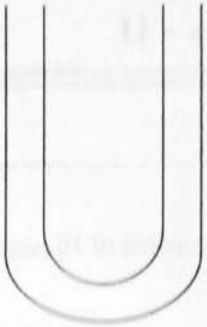


Figure (2)

(a) Provide the measuring instruments and additional items needed to conduct this experiment.

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(b) Indicate the liquids levels when taking the initial reading in Figure (1), and the final reading in Figure (2) for plotting.

(c) Indicate the height of the brine as h_s and the height of the kerosene as h_k in the figure.

(d) Obtain the relationship between h_s, h_k, the density of brine ρ_s, and the density of kerosene ρ_k by equating the pressures at the appropriate points.

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(e) Identify the dependent and independent variables, and rearrange the equation obtained in part (d) above to draw a linear graph.

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(f) What should be done to obtain different readings?

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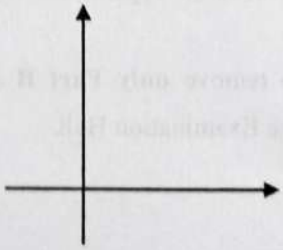
(g) Draw the linear graph as you expect it to be.



(h) If the gradient of the graph is 0.78, calculate the specific gravity of kerosene.

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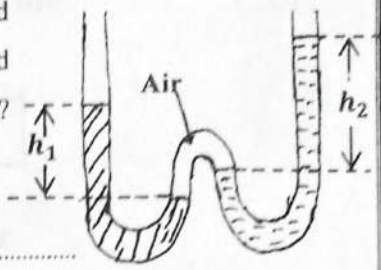
(i) Air is trapped, as shown in the figure, when the liquid is poured into the tube with the shape shown. Can the ratio between h_1 and h_2 be considered a reading in the experiment described above? Explain it.



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02) You are provided with a tuning fork set, a set of weights, and a paper rider to verify the relationship between the frequency and the length of the vibrations of a sonometer wire.

(a) Write down the types of waves appearing on the tuning fork and the sonometer.

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(b) How can you find the tuning forks with the maximum and minimum frequencies using only their physical dimensions?

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(c) What is the practical procedure to verify that the all given tuning forks obtain the fundamental resonance?

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(d) If you cannot obtain the resonance lengths of all the given tuning forks, what change would you make to this test setup?

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(e) Write the practical steps to obtain the fundamental resonance length for a tuning fork with the maximum frequency.

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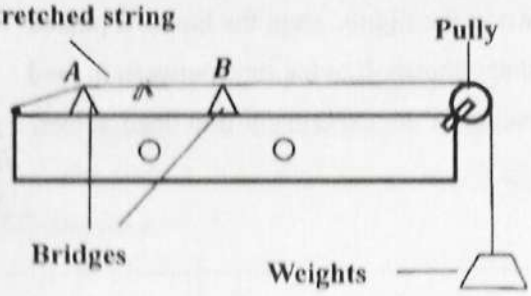
(f)



The tension in the sonometer string, is obtained by applying a load mg as shown in the figure above. Assume that the tension in the string due to this load is 18.75 N. However, the tension between bridge B and the string sometimes differs from this value. What practical steps can be taken to minimize such errors?

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(g) Given that the tension, diameter, and density of the string are T, d and ρ respectively, and the fundamental resonance length for a tuning fork with frequency f is l, obtain an expression for f in terms of these quantities.

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(h) Rearrange the expression provided above to obtain the expected curve, and identify the independent and dependent variables.

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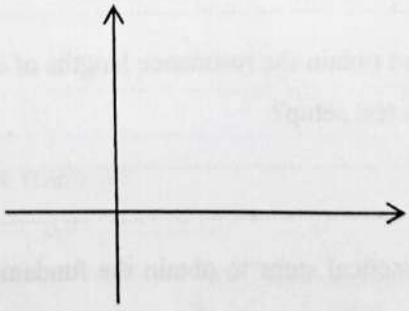
(i) Draw the expected graph on the axes provided below and label the axes accordingly.



(j) Calculate the density of iron if gradient of graph above is 250 ms and diameter of string is 0.1 mm. (take $\pi = 3$)

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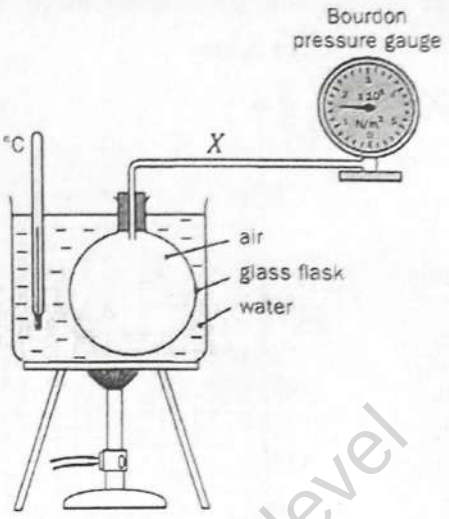
03) The experimental arrangement for verifiying the gas law is shown below. the flask contains dry ideal gas.



(a) (i) Underline the appropriate word representing the law to be verified using the above arrangement (Boyle's law, Charles law, Dalton's law of partial pressure)

(ii) State the law in words

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(b) (i) What is the important item required for the experiment not mentioned above?

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(ii) What is the main use of that item?

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(c) Why should there be dry gas in the flask?

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(d) Briefly explain the reasons for the following choice of flask in this experiment.

(i) Choosing a large volume flask

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(ii) Chosing a thin-walled flask.

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(e) (i) Which tube should be used for Tube X in this experiment?

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(ii) State the reason for it.

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(f) Give the readings to be taken in this experiment.

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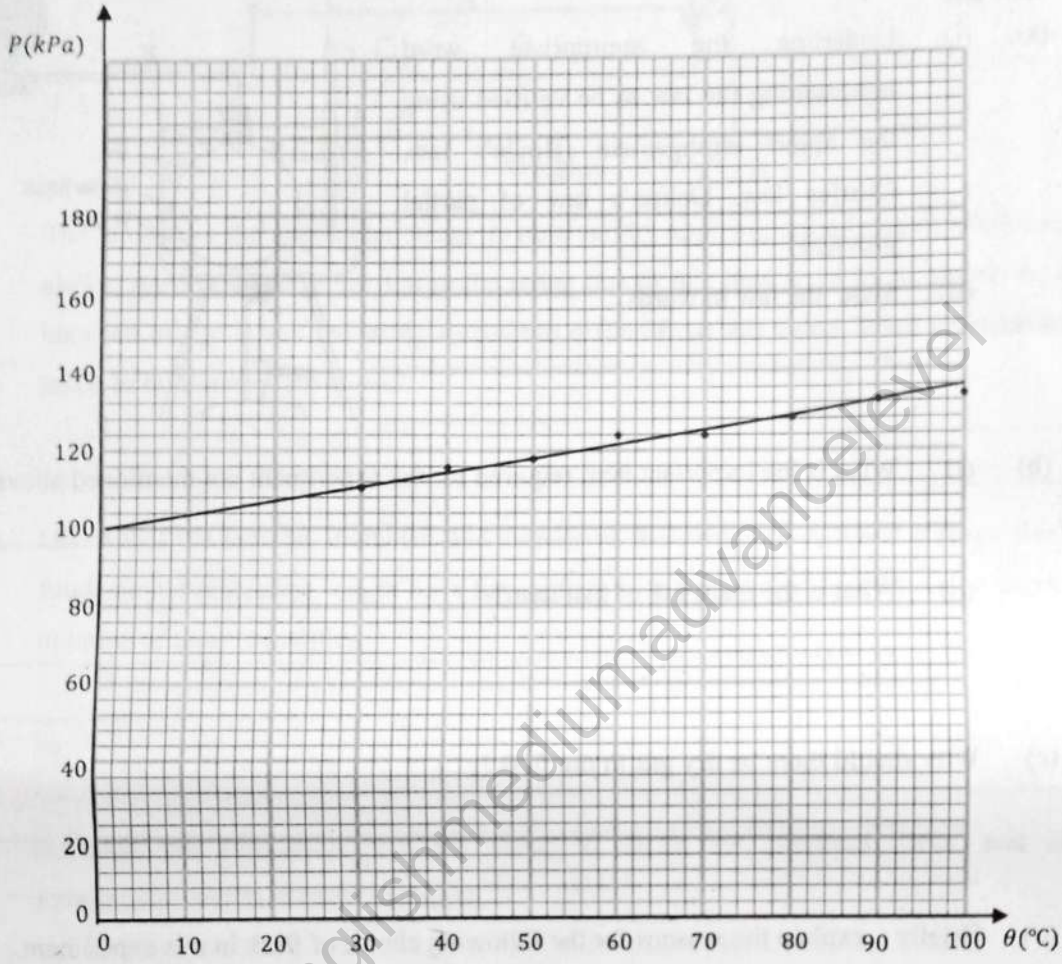
(g) The plot of gas temperature ($\theta(°C)$) versus gas pressure($P(kPa)$) in the experiment is shown in the figure below.



(1) Find the gas pressure at 0 and 100 degrees from the graph

Pressure at 0°C .....

Pressure at 100 °C .....

(2) Show, by calculation the accuracy of the verification rule based on the values obtained in (g) (i) above.

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(h) Determine the coefficient of pressure expansion of the gas from the values obtained (g) (i) above.

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04) (a) It is better to use a potemtiometer than a voltmeter for accurate measurement of potential difference. Give the reason.

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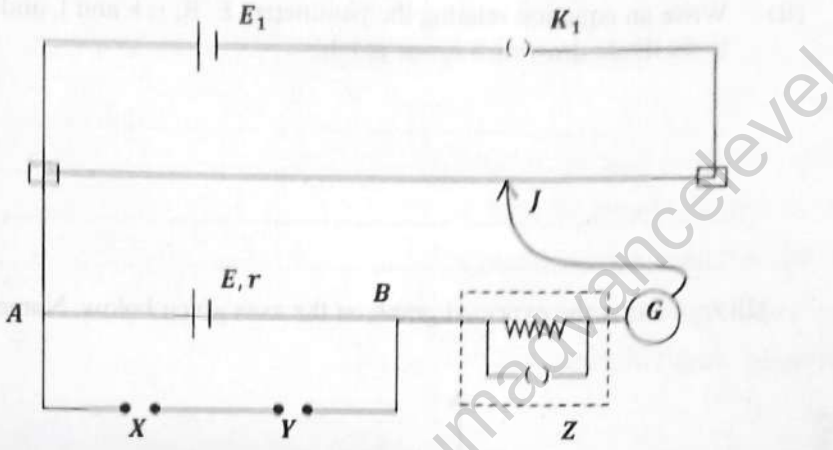
(b) An incomplete circuit diagram set up to determine the internal resistance of a cell using graph method is shown in figure.



Underline the correct choice in the second column in table given below

	Correct choice	Reason for the choice
(1) Cell E1	Series connection 1.5V EMF dry cell, 2V lead acid storage cell	
(2) The object to connect at gap X	Resistance box Rheostats	
(3) The switch to be connected in the gap AB	Plug key Tap key	

(c) What is the function of the area z shown by the dotted line?

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(d) (i) Derive an expression for V, the potential difference betwwen A and B, when the switch at region X is connected, in terms of the resistance R connected at location Y, the internal resistance of the cell, and the EMF E.

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(ii) A value of R less than 20 ohms is desirable, Mention the reason.

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.....

(e) In the cass mentioned in part (d) above, the equivalent balance length of the potentiometer is obtained as l. Let K (in V/cm) be the potential drop per unit length of the potentiometer.

(i) State the practical procedure regarding the sliding key J When obtaining the balance length. State the importance of this experimental procedure.

.....

.....

(ii) Write an equation relating the parameters E, R, r, k and l, and then rearrange this equation to facilitate drawing a linear graph.

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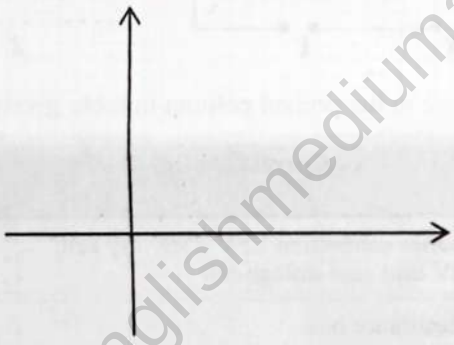
(iii) Draw the expected graph on the axes given below. Name the axes.



(iv How would you find r using graph above?

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தேசிய வெளிக்கள நிலையம் தொண்டைமானாறு
ஐந்தாம் தவணைப் பரீட்சை - 2024
National Field Work Centre, Thondaimanaru
5th Term Examination - 2024

FWC

பௌதிகவியல் - II
Physics - II

Gr. 13 (2024) | 01 | E | B

Part - II(B)

Essay Questions

➢ **Answer only four questions**

05) An athlete reaches the maximum height while moving towards the high jump bar with high velocity during a high jump. If his take-off speed and direction are suitable, he will be able to reach maximum height. Also brings his body into a horizontal position while passing over the bar. He may use a flexible pole to achieve the maximum height. Jumping to the maximum height using a pole is known as the pole vault. Diagrams of the high jump and pole vault are shown in figures (a) and (b).

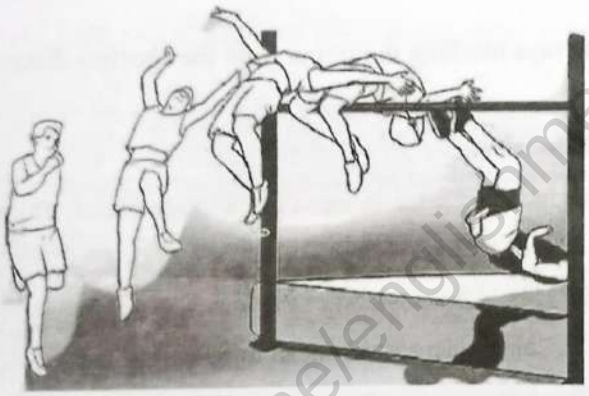


Figure (a)

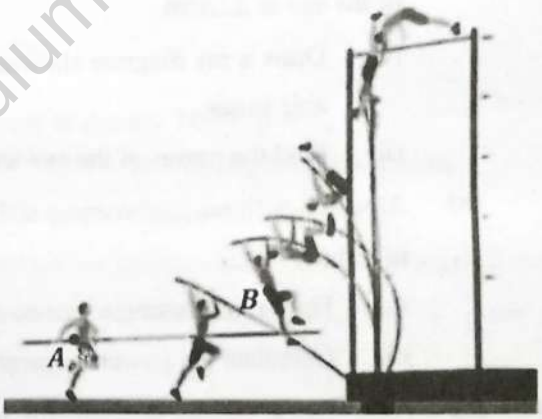


Figure (b)

(a) The center of gravity of an athlete with a mass of $60kg$ is at a distance 'a' from the legs and 'b' from the side. The takeoff velocity of the athlete towards the bar is V_1 , and the velocity of the athlete at the maximum height point over the bar is V_2.

(i) Find the vertical height h_1 of the center of gravity of the athlete while passing over the bar, in terms of V_1 and V_2 . What assumptions do you use?

(ii) Provide an expression for the jumping height of the athlete, h, in terms of the given quantities.

(iii) A student states that a taller person can jump higher. Do you agree with this statement? Explain your reasoning.

(iv) If $a = 80cm, b = 10cm, V_1 = 10ms^{-1} and V_2 = 8ms^{-1}$, determine the athlete's jumping height.

(v) What is the kinetic energy of the athlete when passing over the bar?

(b) The athlete mentioned in part (a) above is jumping using a light carbon fiber rod. He reaches point A with the same velocity, and then, while the center of gravity of the athlete is at point B, he comes to rest momentarily, then passing the maximum height with zero velocity.

(i) What is the stored energy in the rod if point B is $3m$ above the ground? What form of energy is stored?

(ii) What is the total energy when athlete in maximum height.

(iii) What is the maximum height that the athlete can jump?

(iv) Is this height higher or lower than the height obtained in part (a)(iv) above? What is the reason for this?

(v) The height of the high jump mat sponge is $70cm$. What is the speed of the athlete when he reaches the mat? (Assume that his body is horizontal when he reaches the mat.)

(vi) If the compression of the mat is $50cm$ when he falls on it, calculate the average vertical force acting on him.

06) (a) The visual range of a visually impaired person extends from $50cm$ to $400cm$. The diameter of the eye is $2.5cm$.

(i) Draw a ray diagram showing the rays reaching the retina from the shortest distance he is able to see.

(ii) Find the power of the eye lens at that time.

(b) A person with nearsightedness and farsightedness plans to use a glass to see clearly from $25cm$ to infinity.

(i) How can this single lens be made? (Show the position of the lens.)

(ii) Calculate the powers separately for the two lenses that need to be combined.

(c) (i) Draw the ray diagram for the image formation of an object that is $2cm$ in height and $50cm$ in front of the eye when not wearing glasses.

(ii) Calculate the angle in radians set at the eye.

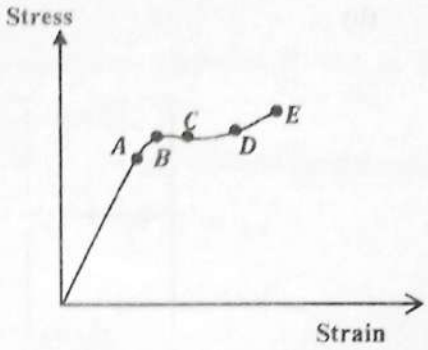
(d) A person with normal vision has a near point of $25cm$ and observes a cell through a normal adjustment compound microscope with lenses having focal lengths of $10cm$ and $8cm$. At the same time, the visually impaired person mentioned that he could not observe a cell through the microscope without wearing glasses.

(i) Draw the diagram showing how a person with normal vision observes a cell using a microscope with normal adjustment.

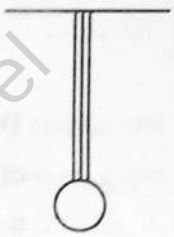
(ii) Find the distance the objective lens needs to be adjusted to observe the image for a visually impaired person.

(iii) Calculate the angular magnification of a compound microscope in normal adjustment.

07) (a) Figure (1) shows the stress-strain curve for a uniform steel rod. Identify the points A, B, C, D, and E on the curve.



(b) A sphere with a mass of $930kg$ and a radius of $20cm$ is hanging by two wires, one made of steel and the other of copper, each with a length of $2m$ as shown in the figure. The diameters of the steel and copper wires are $8\,mm$ and 10 mm, respectively. (Take $\pi = 3$)



Young's modulus of steel $= 2 \times 10^{11} Nm^{-2}$

Young's modulus of copper $= 1.2 \times 10^{11} Nm^{-2}$

(i) Determine the extension in the combined wire.

(ii) Find the force (F_1) acting on the steel wire.

(iii) Find the force (F_2) acting on the copper wire.

(c) This sphere is immersed in a vessel filled with water of density $1000kgm^{-3}$.

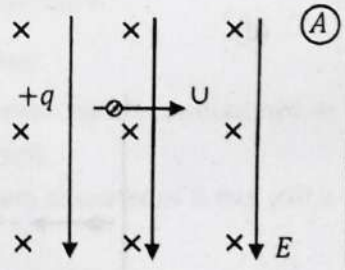
(i) Plot the variation in the extension of the combined wire with depth of immersion.

(ii) Determine the extension of the wire when the sphere is fully submerged.

(iii) Determine the terminal velocity of the sphere if the connection to the wire is immediately severed while the sphere is fully submerged. (Coefficient of viscosity of water is $0.1Nsm^{-2}$)

(iv) Can you determine the terminal velocity obtained in (d)(1) above the sphere under practical conditions without performing any calculations.

08) A particle with charge q enters a uniform electric field with electric field intensity E and velocity V as shown in the figure. There is a magnetic field with magnetic flux density B, directed into the paper.



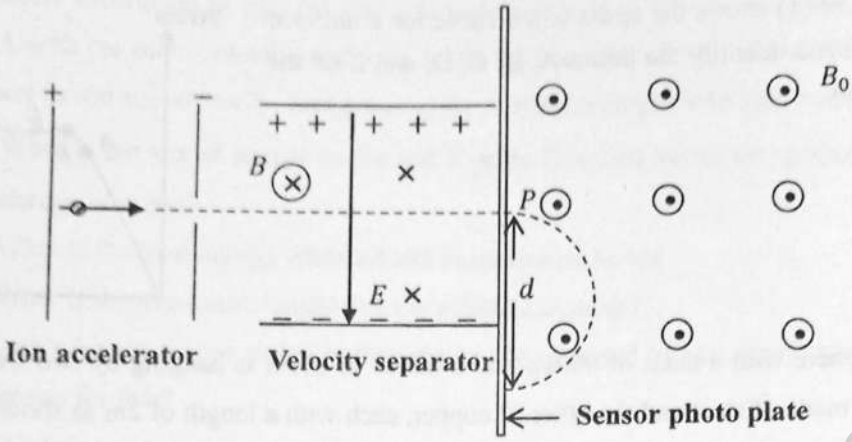
(a) (i) Write the expression for the force F_E acting on the charged particle due to the electric field.

(ii) Write the expression for the force F_B acting on the charged particle due to the magnetic field.

(iii) Draw the diagram showing the two forces acting on the charged particle. (Ignore the effects of gravity.)

(iv) Draw the paths of the charged particle separately for the cases when $F_E > F_B, F_E < F_B, F_E = F_B$.

(b)



The figure shows the basic structure of a mass spectrometer, which is used to measure the mass of atoms or molecules.The positive ion moves through the ion accelerator and velocity separator to the aperture P and then reaches the sensor, which is located a distance d from aperture P.

(i) If the potential difference between the ion accelerator electrodes is V, obtain an expression for the speed of the ion exiting the accelerator in terms of the ion's mass m and charge q.

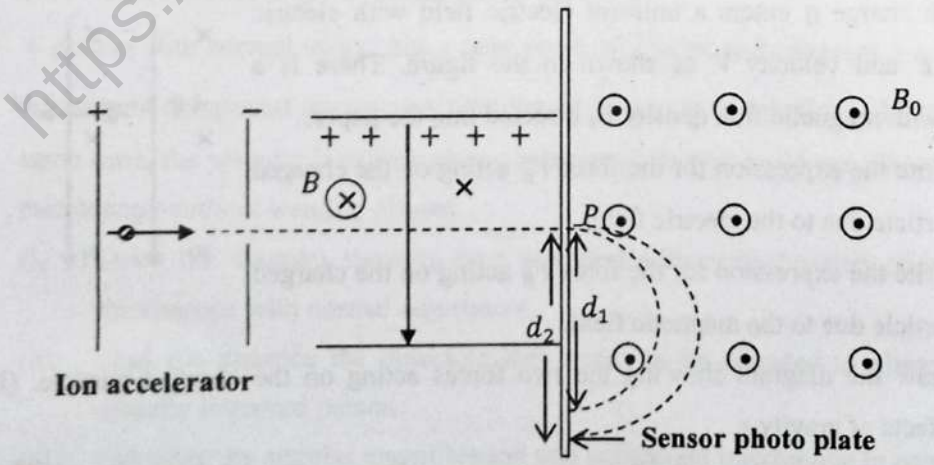
(ii) A velocity separator is used to linearize positive ions with different velocities.
If magnetic and electric field are applied to velocity separator are B and E respectively, write the expression for the velocity V_0 of ion in terms of E and B. Draw and label clearly the paths of ions with velocities greater than V_0 and those with velocities less than V_0.

(c) At the sensor region, there is a magnetic field with a magnetic flux density B_0 that is perpendicular to the direction of ion motion.

(i) What causes the path of an ion to be circular?

(ii) If the point where the ion hits the sensor is at a distance d from point P, obtain an expression for the mass of the ion in terms of B_0 and the ion charge q.

(d)



Two chlorine ions enter with velocity V_0 hit the sensor at distance d_1 and d_2 from point P respectively.

(i) Calculate the velocity V_0 of chlorine ions if $B = 50mT, E = 2 \times 10^3 Vm^{-1}$.

(ii) Calculate the masses of chlorine ions hitting the sensor at distances d_1 and d_2 if $B_0 = 0.4T, d_1 = 7.2cm, d_2 = 7.6cm$ Charge of ion is $1.6 \times 10^{-19}C$.

(iii) If the proton and neutron have masses of $1.66 \times 10^{-27}kg$, calculate the integer mass numbers of the chlorine ions striking the sensor at distances d_1 and d_2.

(09) **Answer either Part (A) or Part (B) only.**

(A) (a) (i) Define the electromotive force (EMF) of an electric cell.

(ii) What is the difference between the EMF of a cell and the potential difference across its terminals?

(iii) Assume that the current through the external resistor R is I when an electric cell with electromotive force E connected to the resistor R. Identify the quantities given by IE and I^2R.

(iv) A Battery with a $12V$ EMF and 1Ω internal resistance is shown in the diagram. Electric capacity of this battery is $90Ah$. Find the following,

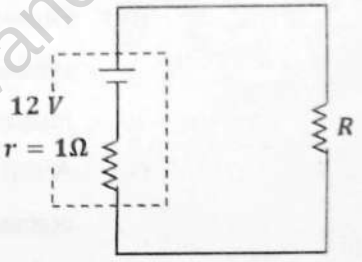


Figure (1)

(1) The current drawn from the battery when it is providing high power.

(2) Power dissipation in the internal resistance of the cell.

(3) How long can a fully charged battery supply power when operating at its maximum power rating?

(b)

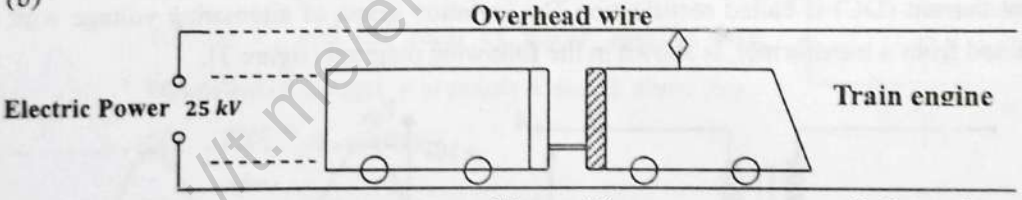


Figure (2)

Figure 2 shows a train powered by electricity through an overhead wire.

One of the supply terminals of the $25kV$ power supply from the power station is connected to the overhead wire, while the other terminal is connected to the rail track.

(i) Calculate the resistance of a $1km$ overhead wire with a uniform diameter of 8 mm and a resistivity of $1.44 \times 10^{-8}\Omega m$. (Take $\pi = 3$).

(ii) What is the current drawn by the engine when the power absorbed by the engine is $6500kW$ near the power station? (Neglect the resistance of the rail track.)

(iii) When the engine is $30km$ from the power station, the current drawn from the power supply is $180A$. Find the following,

(1) Potential difference across the engine.

(2) Fraction of power used by the engine and the power supplied to the circuit

(iv) Explain the following observations regarding the power supply arrangement.

(1) Even though a high current passes through the rail track, the cleaner does not get an electric shock from touching the rail track.

(2) High power requirements, such as $25kV$, are needed for this type of train operation.

(3) The current drawn by the train while climbing an inclined track at a constant speed is greater than the current drawn when moving at a constant speed on a flat track.

(B) (a) (i) Draw the two-dimensional structure of an intrinsic semiconductor (Si) at $0K$.

(ii) What type of extrinsic semiconductor is formed when an intrinsic semiconductor (Si) is doped with a group III element like Al?

(iii) What happens to the conductivity of semiconductors when impurities are added? Explain briefly.

(iv) Draw the circuit diagram of a forward-biased p-n junction diode using circuit symbols, and plot the forward-bias I-V characteristic curve for a silicon p-n junction diode.

(v) A cell with negligible internal resistance is connected to two resistors of $1k\Omega$ and $2k\Omega$ and two Si diodes ($0.7V$), as shown in the figure. Find the currents through the diodes D_1 and D_2.

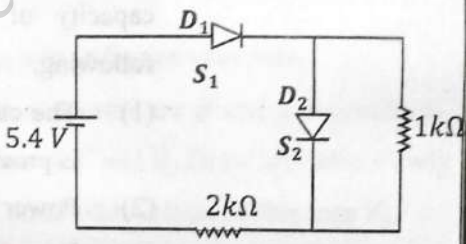


Figure (1)

(b) Diodes are generally used as rectifiers. The process of converting alternating current (AC) to direct current (DC) is called rectification.The variation graph of alternating voltage with time, obtained from a transformer, is shown in the following diagram (figure 3).

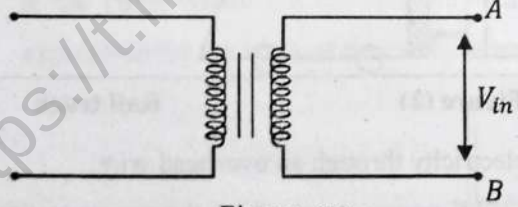


Figure (2)

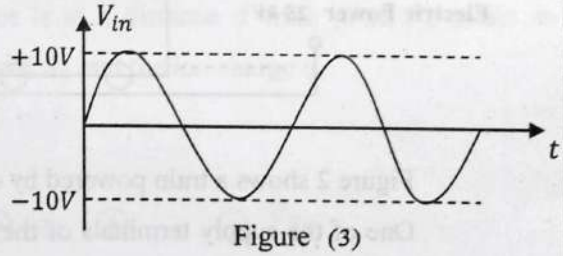


Figure (3)

(i) Draw the bridge rectifier circuit using four silicon diodes and a load resistor R. (Draw Fig. 2 on your answer sheet and complete the circuit.)

(ii) Draw the graph of the variation in potential difference (V_o) across the load resistance R with time.

(iii) Draw a capacitor in the circuit to reduce fluctuations in the potential difference (V_o), and then draw a graph of the smoothed potential difference with time.

(iv) What is the maximum potential difference that can be obtained across the resistor R if the forward bias potential difference across the diode is $0.7V$?

(c) A transistor is used to amplify the voltage. A common emitter circuit is shown in the figure (4).

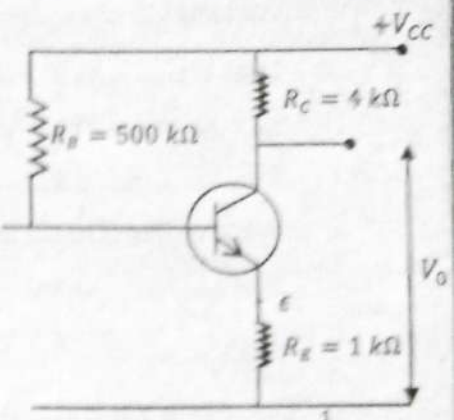


Figure (4)

(i) What type of transistor is shown in the figure? (npn transistor or pnp transistor)

(ii) Draw the input characteristics of the given transistor. The forward bias voltage of the base-emitter junction is $0.6V$.

(iii) Find the collector current (I_C) if current gain (β) is 100.

(iv) What is the magnitude of supply voltage (V_{CC}) if the base current is $10\mu A$.

(v) Find the collector- emitter potential difference (V_{CE}).

(vi) If given circuit using amplification ,

(1) Draw the output signal for the input signal shown in figure (5) below.

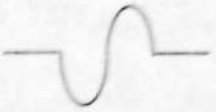
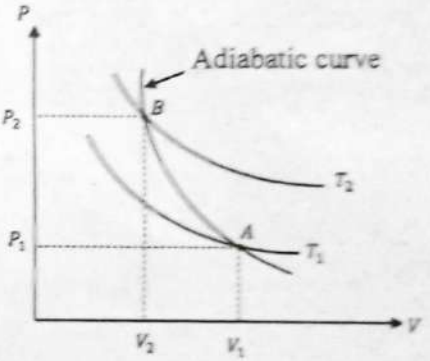


Figure (5)

(2) Why is the resistance Re used in amplifier circuits?

10) (a) (i) What is an adiabatic process?

(ii) Isothermal curves and an adiabatic curve for temperatures T_1 and $T_2 (T_2 > T_1)$ in the PV graph are shown in Figure 1.By applying the gas formula $PV = nRT$and the relationship among pressure P, volume V, and the ratio of molar specific heat capacities of the gas γ at points A and B, show that:



(1) $TV^{\gamma-1} =$ constant

(2) $\frac{P^{\gamma-1}}{T^{\gamma}} =$ constant

(b)

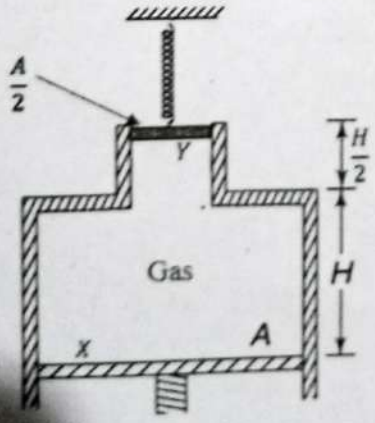


Figure (1)

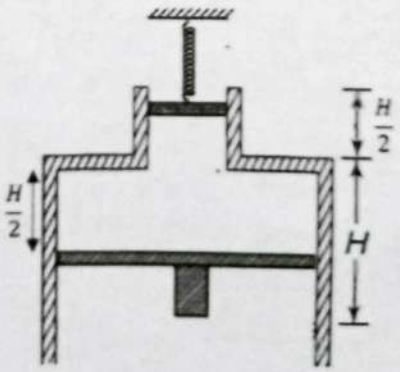


Figure (2)

An ideal gas is enclosed in a vertical adiabatic container at temperature TK. The container has a large region with a cross-sectional area A and a smaller region with a cross-sectional area $\frac{A}{2}$. See the figure. Two pistons can move freely along the inner walls of the cylinders without friction. A spring with a spring constant K is connected to the top part, with the other end fixed to the ceiling. The mass of piston Y is M. The spring is in its unstretched state as shown. Piston X is suddenly pushed upward by a distance of $\frac{H}{2}$. At this time, the upward movement of the small piston from its initial position and the height reduction in the small container are $\frac{3H}{32}$. Assume that atmospheric pressure $P_0 = 1 \times 10^5 Nm^{-2}$.

(i) Give the volume V_1 of the gas in the container at the initial stage in terms of A and H.

(ii) Give the volume $\frac{V}{2}$ of the gas in the container at the final stage in terms of A and H.

(iii) Give an expression for P_2 in term of P_1 if the gas pressure in the container at the beginning is P_1 and at the final is P_2. (Assume γ for the gas is 1.5)

(iv) Give an expression for P_1 in terms of P_0, M, A and g.

(v) Give an expression for P_2 in terms of P0, M, A, g and K.

(vi) If $A = 27cm^2, M = 13.5kg, K = 3700Nm^{-1}$ determine the magnitude of H.

(vii) Find the final temperature of the gas if $T = 3000K$.