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Provincial Department of Education - NWP

01 | E | I

Second Term Test - Grade 13 - 2019

Index No : ....

Physics I

2 Hours

- **This paper consists of 50 questions and Answer all the questions.**
- **Use of calculator is not allowed.**
- **Write your index number in the space provided in the answer sheet.**
- **In each of the questions 1 to 50 pick one of the alternatives from (1),(2),(3),(4),(5) which is correct or most appropriate and mark your response on the answer sheet with a cross (x) in the answer sheet.**

$(g = 10 \text{ Nkg}^{-1})$

01. The units of angular velocity is rad s^{-1}. The dimensions of angular velocity is same as that of

(1) linear velocity (2) time (3) angle (4) frequency (5) None of these.

02. The units of electric field intensity is?

(1) $V\ C^{-1}$ (2) A m (3) $N\ C^{-1}$ (4) $V\ m^{-1}$ (5) $C\ m^{-2}$

03. A perfect gas at 27°C is heated at constant pressure so as to double its volume. The temperature of the gas becomes

(1) 54 K (2) 327 K (3) 54°C (4) 327°C (5) 150 K

04. Which of the following responses gives them in the order of decreasing conductivity?

(1) copper, Mica, silicon.
(2) silicon, copper, ebonite
(3) Alumenium, Germanium, ebonite
(4) silicon, ebonite, Germanium.
(5) copper, silicon, Alumenium,

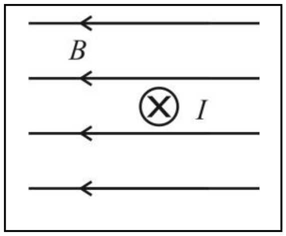
05. Dimensions of stress strain and young modulus respectively are

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

06. A lens of power 4 D and a lens of power -3 D are placed in contact. the equivalent power of the combination is,

(1) $\frac{3}{4}$ D (2) 7 D (3) $\frac{4}{3}$ D (4) 5 D (5) 1 D

07. The figure shows a uniform magnetic field B directed to the left and a wire carrying a current into the page. The magnetic force acting on the wire is:



(1) toward the top of the page
(2) toward the bottom of the page
(3) toward the left
(4) zero
(5) toward the right

08. There is a viscous flow of a liquid on a flat surface. The variation of speed of layers of flow is best represented by,

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

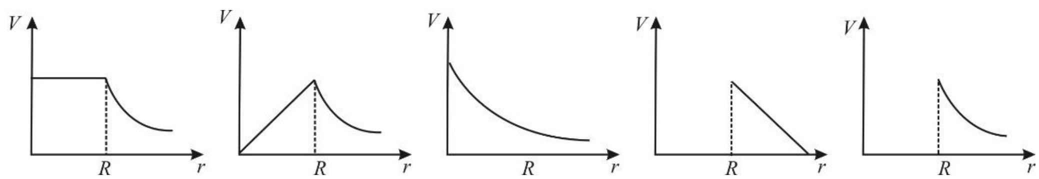
09. Thermistor has
(1) positive thermo resistance coefficient
(2) Zero thermo resistance coefficient
(3) negative thermo resistance coefficient
(4) negative thermo resistance coefficient at low temperature and positive at high temperature
(5) positive thermo resistance coefficient at low temperature and negative at high temperature

10. For an ideal gas, the specific heat capacity at constant pressure C_P is greater than the specific heat capacity at constant volume C_V because the,
(1) gas does work on its environment when its pressure remain constant while its temperature is increased.
(2) heat input per degree increase in temperature is the same in processes for which either the pressure or the volume is kept constant.
(3) pressure of the gas remain constant when its temperature remain constant.
(4) increase in gas's internal energy is greater when the pressure remain constant when the volume constant.
(5) heat needed is greater when the volume remain constant than when the pressure remains constant.

11. Which of the following is correct for electric field lines?
(A) they can be present through any media air, liquid or solid
(B) they are directed towards negative charges.
(C) they cannot cros each other.

of the above statements
(1) Only (A) is correct. (2) Only (C) is correct. (3) Only (A) and (C) are correct.
(4) Only (B) and (C) are correct. (5) All (A), (B) and (C) are correct.

12. An isolated conducting sphere of radius R has a charge $+Q$. Which graph best represents the electric potential (V) as a function of r, the distance from the center of the sphere?

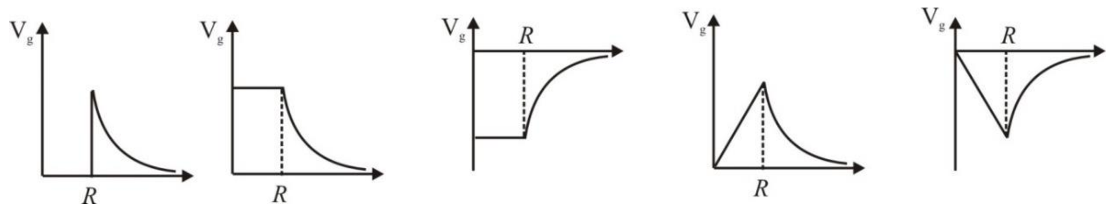


(1) (2) (3) (4) (5)

13. In an isothermal expansion of an ideal gas
(A) there is no change in the internal energy of the gas.
(B) the work done by the gas equals the heat supplied to the gas.
(C) the work done by the gas equals the change in its internal energy.
Of the above statements
(1) only (A) is true (2) only (C) is true (3) only (A) and (B) are true
(4) only (A) and (C) are true (5) only (B) and (C) are true

14. Air bags in vehicles are usefull in crash because they,
(A) increase the duration of impulse acting.
(B) decrease the change of momentum.
(C) decrease the rate of change of momentum.
Of the above statements
(1) Only (A) is true. (2) Only (C) is true. (3) only (A) and (B) are true.
(4) only (A) and (C) are true. (5) all (A), (B) and (C) are true.

15. The correct graph between the gravitational potential (V_g) due to hollow sphere of radius R and distance from its centre x will be



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

16. A source of 1 kHz sound is moving straight towards you at a speed of 0.9 times the speed of sound. The frequency you receive is,

(1) 0.1 kHz (2) 0.5 kHz (3) 1.1 kHz (4) 0.9 kHz (5) 10 kHz

17. A cooper block of mass 2.5 kg is heated to 500°C and then placed on an ice block. If the specific heat of copper is 04 J g^{-1}° C^{-1} and the latent heat of ice is 335 J g^{-1}, the maximum amount of ice that can melt is approximately,

(1) 1 kg (2) 1.5 kg (3) 2 kg (4) 2.5 kg (5) 3.0 kg

18. A beam of monochromatic blue light of wave length 4200 Å in air travels in water refractive index, n = 4/3. Its wavelength in water will be,

(1) 4000 Å (2) 5600 Å (3) 2800 Å (4) 3150 Å (5) 3500 Å

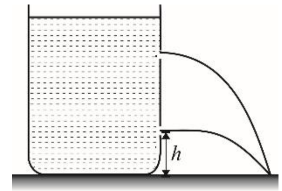
19. Which of the following statements made about the information that can be obtained from dimensional analysis is/are **incorrect**?

(A) Numerical values of constants of proportionality that may appear in a physical equation can be determined by dimensional analysis.
(B) Numerical signs of constants of proportionality that may appear in a physical equation can be determined by dimensional analysis.
(C) The units of constants of proportionality that may appear in a physical equation can be determined by dimensional analysis.
(1) only (A) (2) only (B) (3) only (C)
(4) only (A) and (B) (5) all (A), (B) and (C)

20. A wire A of resistivity ρ must be replaced by a wire B of resistivity ρ which is four times long as A in a circuit. If, however, the total resistance is to remain as before, the diameter of the new wire must be,

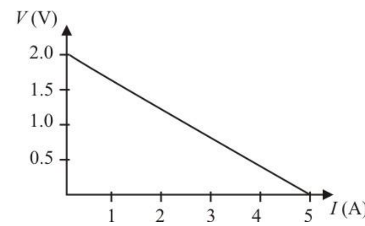
(1) remain unchanged (2) half (3) quarter
(4) two times larger. (5) four times larger.

21. Two holes are made in the side of the tank such that the jets of water flowing out of them meet at the same point on a surface at the level of the bottom. If one hole is at the height h above the bottom, then what will be distance of the other hole from the top?



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

22. For a cell, the graph between the potential difference (V) across the terminals of the cell and the current (I) drawn from the cell is shown in the figure.
The emf and the internal resistance of the cell respectively are



(1) 2 V and 0.5 Ω (2) 2 V and 0.4 Ω
(3) 1.8 V and 0.5 Ω (4) 1.8 V and 0.4 Ω
(5) 2.2 V and 0.5 Ω

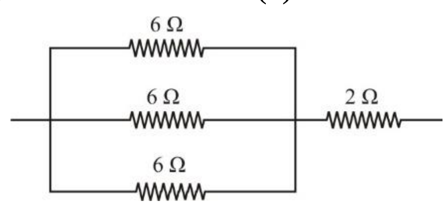
23. The value of acceleration due to gravity at height h from earth surface will become half its value on the surface if (R - radius of earth)

(1) $h=(\sqrt{2}+1)R$ (2) $h=(\sqrt{2}-1)R$ (3) $h= 2R$ (4) $h= 3R$ (5) $h=(\sqrt{2}-2)R$

24. A uniform glass tube contains mercury. The height of mercury at 25 °C is 50 cm. the height of the mercury column at 45 °C will be,
(coefficient of volume expansion of mercury is 180×10^{-6} °C^{-1} and the coefficient of linear expansion of gals is 9×10^{-6} °C^{-1})

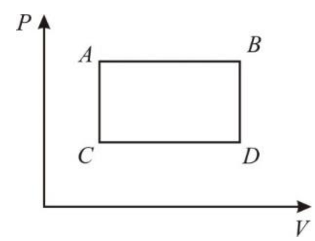
(1) 49.85 cm (2) 50 cm (3) 50.10 cm (4) 50.153 cm (5) 50.20 cm

25. The rated power for any of the resistor in the following circuit is 72 W. The maximum possible power of the circuit.



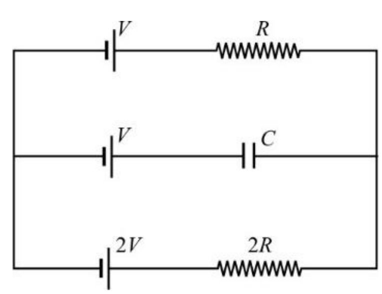
(1) 144 W (2) 108 W (3) 72 W (4) 54 W (5) 36 W

26. A gas is transferred from state A to D via paths A-B-D and A-C-D Choose the correct statement,
(A) the work done is the same in both the cases.
(B) the increment of internal energy is the same in both the cases.
(C) the increment of temperature is the same in both the cases.
Of the above statements,



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

27. In the given circuit, with steady current, the potential drop across the capacitor must be,

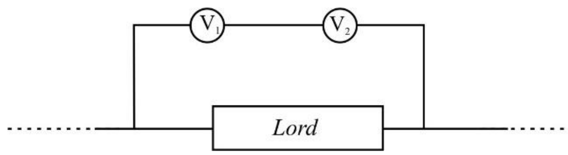


(1) V (2) $\frac{V}{2}$ (3) $\frac{V}{3}$ (4) $\frac{2V}{3}$ (5) $2V$

28. The focal lengths of the objective and the eyepiece of a compound microscope are 2 cm and 3 cm respectively. The distance between the objective and eyepiece is 15 cm. The final image formed by the eyepiece is at infinity. The two lenses are thin. The distance of the object and the image produced by the objective, measured from the objective lens, are respectively,

(1) 2.4 cm and 12 cm (2) 2.4 cm and 15 cm (3) 2.3 cm and 12 cm
(4) 2.3 cm and 13 cm (5) 2.3 cm and 15 cm

29. Voltmeters V_1 and V_2 are connected in series across a DC line. V_1 reads 80 V and has a per volt resistance of 16 kΩ. V_2 has a total resistance of 32 kΩ. The line voltage is,

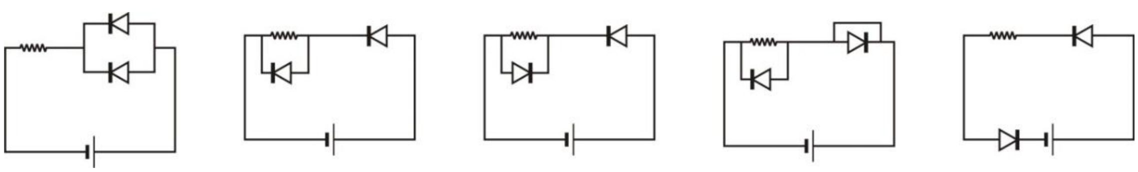


(1) 120V (2) 160V (3) 200V (4) 220V (5) 240V

30. Two tuning forks *A* and *B* give 5 beats s^{-1}. *A* resonates with a column of air 15 cm long, closed at one end, and *B* with a column 30.5 cm long, open at both ends. Neglecting end correction, the frequencies of *A* and *B* are respectively,

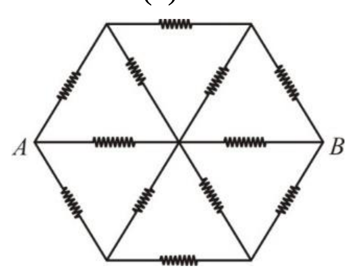
(1) 300 Hz, 295 Hz (2) 295 Hz, 300 Hz (3) 305 Hz, 300 Hz
(4) 300 Hz, 305 Hz (5) 310 Hz, 305 Hz

31. Diodes and resistors in the following circuits are identical. Select the circuit with highest current.



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

32. If the resistance of each resistor of the following network is *R* , Find the equivalent resistance of the following circuit between *A* and *B.*



(1) 2.8 *R* (2) 2 *R* (3)1.8 *R* (4) 0.8*R* (5) 0.5 *R*

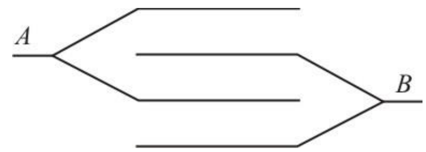
33. Consider the following statements on evaporation and vaporization (boiling).
(A) Rate of vaporization depends on the surface area of the liquid.
(B) Rate of evaporation depends on the surface area of the liquid.
(C) Rate of vaporization depends on the boiling point hence on atmospheric pressure.
Of the above statements

(1) Only (A) is true. (2) Only (B) is true. (3) Only (B) and (C) are true.
(4) Only (A) and (C) are true. (5) Only (A) and (B) are true.

34. A thin hoop of diameter 0·5 m and mass 2 kg rolls down an inclined plane from rest. If its linear speed on reaching the foot of the plane is 2 m/s, its rotational kinetic energy at that instant is,

(1) 2J (2) 3 J (3) 4 J (4) 5 J (5) 6 J

35. Four metallic plates, each having area a, are placed parallel to each other such that the distance between the consecutive plates is d. The two plates are connected to point A and the two plates to point B as shown in the figure. The equivalent capacitance between A and B is,



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

36. Two sound waves, each of amplitude A and frequency f, superimpose at a point a phase difference $\pi/2$. The amplitude and the frequency of the resultant wave are, respectively,

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

37. A thin rod of uniform area of cross-section a, length l is pivoted at its lowest point P inside a stationary homogeneous and non-viscous liquid. The rod is free to rotate in a vertical plane about a horizontal axis passing through P. The density d_1 of the material of the rod is smaller than the density d_2 of liquid. The rod is displaced through small angle θ from its equilibrium position and then released. The restoring torque about P is,

(1) $\frac{\theta a l^2 g}{2}(d_2 - d_1)$ (2) $\frac{\theta a l^2 g}{3}(d_2 - d_1)$ (3) $-\frac{\theta a l^2 g}{2}(d_2 - d_1)$

(4) $2\theta d l^2 g(d_2 - d_1)$ (5) $-\frac{\theta a l^2 g}{4}(d_2 - d_1)$

38. A vessel of depth $2d$ is half filled with a liquid of refractive index μ_1 and the upper half with a liquid of refractive index μ_2. The apparent depth of the vessel seen at near normal observation is,

(1) $2d\frac{1}{\mu_1\mu_2}$ (2) $d\left(\frac{1}{\mu_1} + \frac{1}{\mu_2}\right)$ (3) $2d\left(\frac{1}{\mu_1} + \frac{1}{\mu_2}\right)$ (4) $2d\frac{\mu_1 + \mu_2}{\mu_1\mu_2}$ (5) $2d\frac{\mu_1\mu_2}{\mu_1 + \mu_2}$

39. The energy stored per unit volume of a strained wire is (Y is the Young's modulus of the material of the wire)

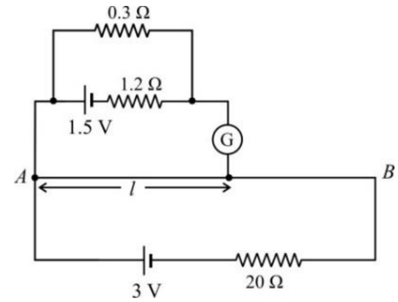
(1) $\frac{1}{2} \times \text{Load} \times \text{Extension}$ (2) $\frac{1}{2}\frac{Y}{(\text{Strain})^2}$ (3) $\frac{1}{2} \times Y \times (\text{Strain})^2$

(4) $\text{stress} \times \text{strain}$ (5) $\frac{1}{2} \times \text{stress} \times \text{strain}$

40. When an object is moved along the axis of a lens, images three times the size of the object are obtained when the object is at 16 cm and at 8 cm respectively from the lens. The focal length and nature of the lens are,

(1) 12 cm concave (2) 4 cm concave (3) 12 cm convex
(4) 4 cm convex (5) 8 cm concave

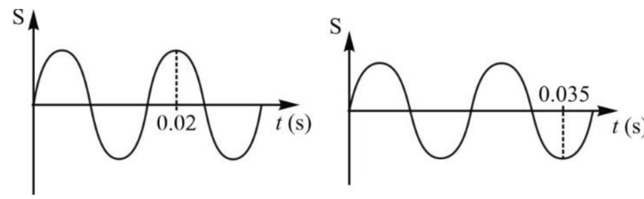
41. A 1 m potentiometer wire having resistance 10 Ω is used to find the null point. At the null point condition l is equal to



(1) 37.5 cm (2) 30 cm (3) 24 cm (4) 20 cm (5) 45 cm

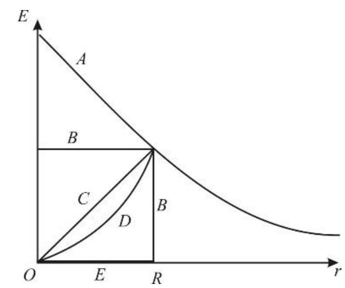
42. Consider the following statements made about thermometers.
(A) if it has a low heat capacity, the thermometer is accurate.
(B) it must have a linear variation of thermometric property in order to produce an accurate value for the temperature.
(C) in order to measure quick changing temperature, the thermometer must have a law heat capacity.
Of the above statements,
(1) Only (A) is true. (2) Only (C) is true. (3) Only (A) and (B) are true.
(4) Only (B) and (C) are true. (5) All (A),(B) and (C) are true.

43. Two sound waves are shown the following figure. If both are sounden together, the beat frequency will be



(1) 10 Hz (2) 12.5 Hz (3) 15 Hz
(4) 17.5 Hz (5) 20 Hz

44. An isolated sphere of radius R contains a uniform distribution of positive charge over its **volume**. Which of the curves on the graph below correctly illustrates the variation of the magnitude of the electric field of the sphere with the distance r from the center?

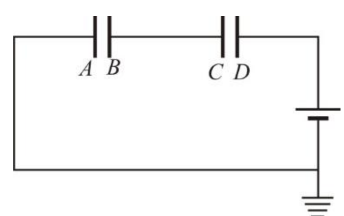


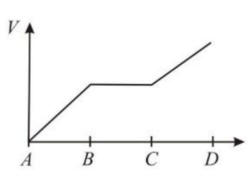
(1) *A* (2) *B* (3) *C* (4) *D* (5) *E*

45. Two steel wires of radii r and $2r$ are welded together end to end. The combination is used as a sonometer wire and is kept under a tension T. The welded point is mid-way between the bridges. The ratio of the number of loops formed in the wires, such that the joint is a node when stationary vibrations are set up in the wires, is

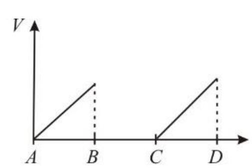
(1) $\frac{1}{4}$ (2) $\frac{1}{3}$ (3) $\frac{1}{2}$ (4) $\frac{2}{3}$ (5) $\frac{3}{4}$

46. Two identical parallel plate capacitors are connected in series with a battery as shown in the figure. The negative terminal of the battery is grounded. Which of the following best represents the variation of potential across *A*, *B*, *C*, *D*

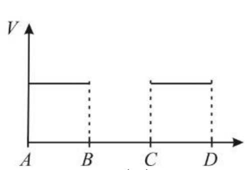




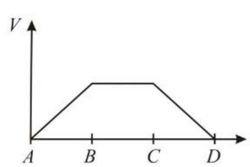
(1)



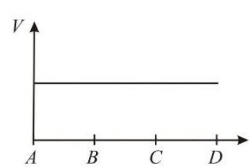
(2)



(3)



(4)



(5)

47. Atmospheric pressure and temperature at a certain day are P_0 and T_r respectively. Dew point and the saturated vapor pressure at dew point are T_d and p respectively. Molar mass of water and dry are M_w and M_a respectively. The mass of 1 m^3 of air at this day is, (R universal gas constant).

(1) $\frac{P_0 T_r M_w + pT_d M_a - P_0 T_r M_a}{RT_r T_d}$

(2) $\frac{pT_r M_w + P_0 T_d M_a - pT_r M_a}{RT_r}$

(3) $\frac{pT_r M_w + P_0 T_d M_a + pT_r M_a}{RT_r}$

(4) $\frac{pT_r M_w + P_0 T_d M_a + pT_r M_a}{RT_r T_d}$

(5) $\frac{pT_r M_w + P_0 T_d M_a - pT_r M_a}{RT_r T_d}$

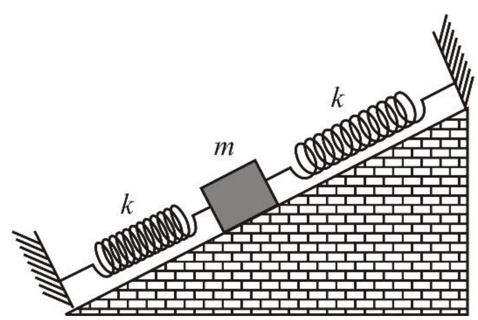
48. A well lagged cylindrical rod with one end in a steam chamber and the other end in ice results in melting of 0.1 g of ice per second. If the rod is replaced by another well lagged one with half the length and double the radius of the first, and if the thermal conductivity of the material of the second rod is $\frac{1}{4}$ that of the first, the rate at which ice melts in gram per second will be,

(1) 3.2 g (2) 1.6 g (3) 0.8 g (4) 0.4 g (5) 0.2 g

49. N molecules, each of mass m of an ideal gas A, and $2N$ molecules, each of mass $2m$ of an ideal gas B, are in the same vessel at temperature T. The x component of mean square velocity of the molecules of gas A is w^2 and the mean square velocity of molecules of gas B is v^2 and. The ratio w^2/v^2

(1) 1 (2) 2 (3) $1/3$ (4) $2/3$ (5) $1/2$

50. On a smooth inclined plane of inclination θ, a body of mass m is attached between two identical, light springs. The other ends of the springs are fixed to firm supports. If the force constant of each spring is k, the time period of oscillation of the body is



(1) $2\pi\sqrt{(2m/k)}$ (2) $2\pi\sqrt{\frac{m}{2k}}$

(3) $2\pi\sqrt{(mg/2k)}$ (4) $2\pi\sqrt{\frac{mg\sin\theta}{2k}}$ (5) $2\pi\sqrt{\frac{mg}{2k}}$

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Provincial Department of Education - NWP

01	E	II

Second Term Test - Grade 13 - 2019

Index No : ....

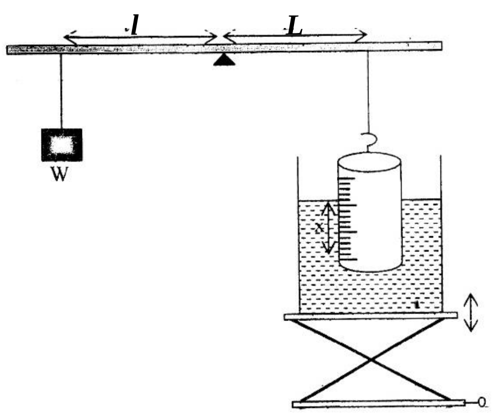
Physics II

3 Hours

- This paper consists of two parts A and B allowed time for both parts is 3 (three) hours.
- Answer all the questions of **part A** on this paper itself. You must use th given space to answer. No lengthy answers are expected.
- **Part B** consists of 6 questions. Answer only four of them. After the exam, attach part A and part B and hand over to the staff.
- Use of calculators is not allowed.

Part - A (Structured Essay)

$(g = 10Nkg^{-1})$



01). The above apparatus set up is used by a student to determine the density of a liquid by a graphical method. The external surface of the uniform solid metal cylinder is calibrated with a vertical linear *mm* scale. The height of the cylinder is *15cm* and its diameter is *5 cm*. At the beginning only the meter ruler is balanced on the knife edge and then it is kept at the same position throughout the experiment.

By adjusting the lab jack vertically on which the beaker of liquid is placed, the immersed height x of the cylinder can be varied. The standard weight counterbalancing the moment is hanging from a thin string.

A – cross sectional area of the cylinder.

M – mass of the cylinder

W – mass of the standard weight

ρ – density of the liquid

(a) When the beaker of liquid is gently raised up, explain why the horizontal balancing of the system breaks?

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(b) Explain how you rebalance the system horizontally again while the distance L and position of the knife edge remain unchanged.

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(c). If the distance to the standard weight from the knife edge is l, write down the relationship between W, M, A, l, L, x and ρ.

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(d). Name the quantities you select as the independent variable and dependent variable in this experiment.

Independent variable ....

Dependent variable ....

(e). Rearrange the above relationship to plot a straight line graph by separating the variables.

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(f). Draw the rough graph on the following axes and label the axes.

(g). As you know the value of standard weight you can calculate the density of the liquid by the gradient of the graph. Name the other two measurements required to calculate the density of the liquid. Also name the instrument used to measure those two.

Measurement	**Instrument**
1.	....
2.	....

(h). If you are provided with the above metal cylinder, spring balance, the beaker of liquid and a beaker of water, how would you determine the relative density of the liquid using the Archimedes' principle?

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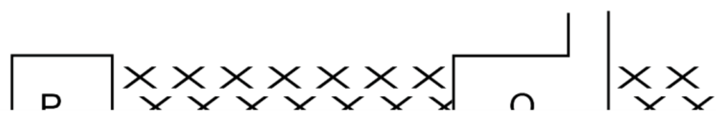
02). An experiment is planned to determine the thermal conductivity of metal using a metal rod that is made of the same material.



(a) In this experiment, the temperature of the chamber, P should be maintained at $100^0\ C$ for a long period of time. How would you do this?

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(b) The temperature of the chamber Q should be maintained at $0^0\ C$ for a long period of time. How would you do this ?.

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(c) What is the important physical property of the material that is used for lagging the metal rod?

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(d) Draw a rough sketch to show the variation of temperature along the rod when the rod is at the steady state.

(e) If the length of the rod is $50cm$, find the temperature gradient along the rod at steady state.

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(f) The substance inside the chamber Q melts due to heat flow along the rod AB. The specific latent heat of fusion of the substance is $3 \times 10^5\ Jkg^{-1}$ and the rate of melting of the substance is $0.02kgs^{-1}$. Find the rate of flow of heat along the rod.

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(g) If the area of cross section of the rod is $0.4cm^2$, find the thermal conductivity of the material of the rod.

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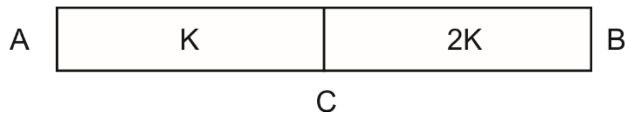
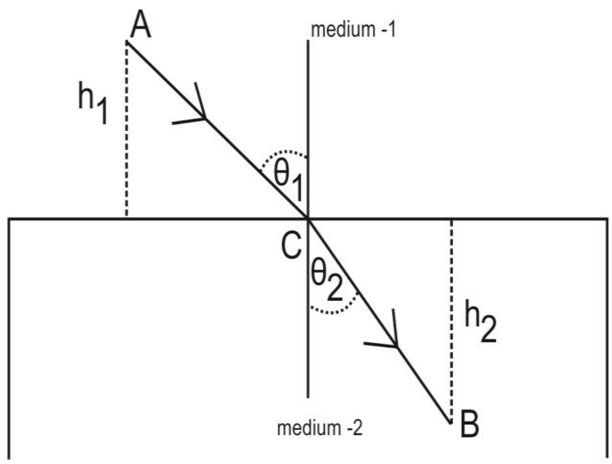
(h) If two rods of equal length and thermal conductivities K and $2K$ connected in series is used instead of the rod AB, draw the variation of temperature along the rod at steady state.





(i) Calculate the temperature at the junction C.

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03). The figure shows a light ray travelling from a point A in medium – 1 to the point B in medium - 2. The velocities of light in medium – 1 and medium – 2 are V_1 and V_2 respectively.

a. Write down an expression for the absolute refractive index (n_1) of the medium – 1 in terms of V_1 and C. C is the velocity of light in air.

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b. Obtain an expression for the relationship between the refractive indices of two media in terms of V_1 and V_2 .

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c. Show that the time taken by the light ray moving from A to B is given by the equation,

$$t = \frac{h_1}{V_1 Cos\ \theta_1} + \frac{h_2}{V_2 Cos\ \theta_2}\ .$$

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d. There is a mark, O at the bottom of a rectangular glass slab of thickness, t. Show that the displacement (d) of the point, O when observed from above the top surface is given by the equation, $d = t(1 - \frac{1}{n})$ where n is the absolute refractive index of glass.

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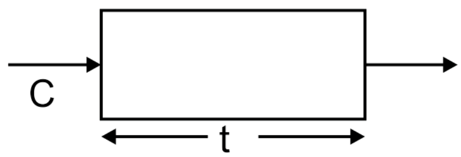

The above figure shows a light wave of frequency f travelling from air in to the glass slab given above.

i. What is the frequency of the light wave in glass slab?

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ii. What is the speed of light wave in glass?

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iii. Obtain an expression for the number of wave lengths present in glass slab.

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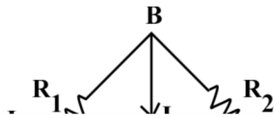
4). a. The four arms of a Wheatstone bridge have following resistances.

$R_1 = 100\Omega\,,\ R_2 = 10\Omega\,,\ R_3 = 5\ \Omega\ ,\ \ R_4 = 60\Omega$



i. Mark the current passing through the path BC and DC using the given symbols.

ii. If the galvanometer resistance is 15Ω, obtain the relation between the currents passing through the loop ABDA using the Kirchhoff's rules.

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iii. Write down the equations to find the currents passing through the loops, $BCDB$ and $ADCEFA$.

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iv. Find the value of I_g using above equations. (I_g − current passing through the galvanometer.)

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b. i. Draw the circuit diagram of meter bridge to determine the unknown resistance and name all the parts correctly.

ii. When the known resistance is 20Ω, the balance length is $60\ cm$. Find the value of unknown resistance.

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iii. If another 20Ω resistance is connected parallel to the known resistance, find the new balance length.

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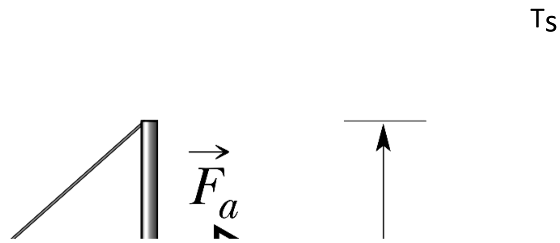
Second Term Test -2019

Physics (Grade 13)

Part – B (Essay)

- **Answer four questions only.**

05). Figure (a) shows a vertical uniform beam of length L that is hinged at its lower end. A horizontal force $\overrightarrow{F_a}$ is applied to the beam at distance y from the lower end. The beam remains vertical because of a cable attached at the upper end, at angle θ with the horizontal. Figure (b) gives the tension T in the cable as a function of the position of the applied force given as a fraction y/L of the beam length. The scale of the T axis is set by $T_S = 600\ N$. Figure (c) gives the magnitude F_h of the horizontal force on the beam from the hinge, also as a function of y/L.



a) Mark the horizontal force F_h and vertical force F_V on the beam from the hinge and other forces acting on it.

b) Obtain an expression to show the relationship between T and y.

c) Obtain an expression to show the relationship between F_h and y.

d) Find the magnitude of $\overrightarrow{F_a}$.

e) Find the angle of θ .

f) Without a force $\overrightarrow{F_a}$, the beam is lowered slowly in the clockwise direction by increasing the length of the cable gradually. Draw a rough sketch to show the variation of the tension T in the cable with the vertical height h to the upper end of the beam.

g) i. Without the tension in the cable and the horizontal force $\overrightarrow{F_a}$, the beam is let to fall down freely rotating about the hinged point. Find the angular velocity of the beam when it comes to the horizontal position. The moment of inertia of a rod about an axis passing through one end of it is $\frac{ML^2}{3}$ where M is the mass of the rod.

ii. state the principle you used for the above calculation.

(06) Read the paragraph carefully and answer the questions.

Seismic Waves are the waves of energy caused by the sudden breaking of rock within the earth or an explosion. There are several different kinds of seismic Waves. The two main types of waves are body waves and surface waves. Body waves can travel through the earth's inner layers, but surface waves can only move on surface of the earth. Body waves are of a higher speed and frequency than surface waves. Therefore body waves are the first to arrive at a seismic station.

The first kind of body wave is the P wave or primary wave. It pushes and pulls the rock it moves through just like sound waves push and pull the air. P waves are a kind of longitudinal wave. The P wave can move through solid rock and the liquid layers of the earth. The velocity of longitudinal waves is given by $V = \sqrt{\frac{E}{\rho}}$ where E is the young's modulus of the medium and ρ is the density of the medium. The second type of body wave is the S wave or secondary wave and can only move through solid rock, not through any liquid medium. S waves move rock particles up and down or side – to – side perpendicular to the direction of wave propagation. S waves are a kind of transverse wave.

Surface waves are of a lower speed and frequency than body waves. Though they arrive after body waves at a seismic station, surface waves are almost entirely responsible for the damage and destruction associated with earthquakes. The first kind of surface wave is called a love wave and it moves the ground from side to side. Love waves produce entirely horizontal motion. The other kind of surface wave is the Rayleigh wave. A Rayleigh wave rolls along the ground and because of it rolls, it moves the ground up and down in the vertical direction.

The Richter scale is the best known scale for measuring the magnitude of earthquakes. This is defined in terms of the intensity (I) of the earthquake. Intensity depends on the amplitude of the wave.

The magnitude value of the Richter Scale (m) is given by $m = \log_{10}\left(\frac{I}{I_0}\right)$ Where (I) is the intensity (or amplitude) of the strongest wave during an earthquake and (I_0) is the intensity (amplitude) of a standard wave.

The change in energy (E) released by an earthquake is given by $E = (10^d)^{\frac{3}{2}}$ where d is the change in the Richter Scale.

A Tsunami is a series of huge waves that can cause great devastation and loss of life when they strike a coast. An earthquake has to be over about magnitude 6.75 on the Richter scale for it to cause a Tsunami.

Tsunamis are caused by an underwater earthquake, a volcanic eruption, a submarine rockslide and an asteroid or meteoroid crashing in to in the water from space. Tsunamis have an extremely long wavelength (up to 100 km long) and in the deep sea, a tsunami's height can be only about 1m tall. Therefore tsunamis are often barely visible when they are in the deep sea.

(i) (a) Which waves are the first to arrive at a seismic station?
(b) Write down two differences between P and S waves.
(c) Give two differences for each body waves and surface waves.

(ii) The speed of a P – wave moving through solid rock is $6\ km\ s^{-1}$ and density of solid rock is $2000\ kg\ m^{-3}$. Find the young's modulus of solid rock and units of it.

(iii) What is the recording on the Richter Scale by an earthquake if its magnitude is twice the magnitude of a certain earthquake which records '6' on the Richter scale? ($\log_{10} 2 = 0.3$)

(iv) If the increase in the Richter scale is 2, what is the increase in energy released by the earthquake?

(v) What is called a Tsunami?

(vi) One wave of tsunami has a speed of $225\ ms^{-1}$, when it reaches the coast. If the wavelength of the wave is $450\ m$, find the time that the tsunami situation is persisted near the coast.

07). When the temperature of the liquids and solids are increased, the volume of them are increased without changing the mass.

a) i. Define the terms of linear expansivity, area expansivity and volume expansivity of a solid substance.

ii. Write down the relationship between linear expansivity and area expansivity and also linear expansivity and volume expansivity.

iii. Define the terms of real expansivity and apparent expansivity of a liquid.

iv. Write down the relationship among the real expansivity and apparent expansivity of a liquid and linear expansivity of the container.

b) The mass of a metal ball in air is $50g$. When it is immersed in a liquid at $25^0\ C$, the mass is $45\ g$. When the temperature of the liquid is increased up to 100^0C, the mass becomes $45.1\ g$. The linear expansivity of the metal is $12 \text{ x } 10^{-6}\ {}^0C^{-1}$.

i. Calculate the volume expansivity of the metal.

ii. If the volume of the metal ball at 25^0C is V_1 and it is V_2 at $100\ {}^0C$, find the ratio of $\frac{V_2}{V_1}$.

iii. Find the upthrust on the ball at 25^0C and at $100\ {}^0C$.

iv. If the density of the liquid at 25^0C is ρ_1 and it is ρ_2 at $100\ {}^0C$, find the ratio of $\frac{\rho_1}{\rho_2}$.

v. Calculate the volume expansivity of the liquid.

c) At all temperatures, the length of a steel rod should be greater than a copper rod by 5 cm. To satisfy above condition, find the initial lengths of steel rod and copper rod.

(linear expansivity of copper - $1.7 \text{ x } 10^{-5}\ {}^0C^{-1}$, linear expansivity of steel - $1.1 \text{ x } 10^{-5}\ {}^0C^{-1}$)

08). Many practical advantages can be obtained by using the magnetic field that is created by current passing through a long conducting wire, a circular wire loop or a solenoid. The respect has gone to the French scientists, *Hans Christian*, *Oersted*, *Baptist Biot* and *Phelix Savart* who worked in the past for the important discoveries related to the magnetic fields.

(a) i. Write down the *Biot – Savart* Law as an expression and introduce all the terms. .

ii. Write down the law that is used to find the direction of magnetic flux density.

iii. Derive an expression for the magnetic flux density at the centre of circular wire loop of radius r, carrying a current I using the *Biot – Savart* Law.

iv. Calculate the magnetic flux density at the centre of the circular wire loop of diameter $20cm$. The current passing through it is $14\ A$ and number of turns in the coil is 80. ($\mu_0 = 4\pi \text{ x } 10^{-7}\ Hm^{-1}$)

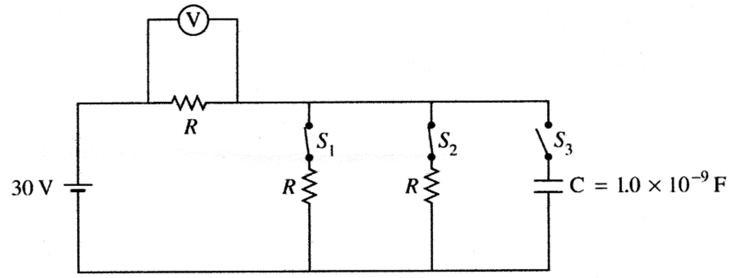
(b)

A and B are two infinitely long straight conducting wires, 60 cm apart, kept perpendicular to the plane of paper in vacuum. The currents passing through the conducting wires are 12A and 8A respectively. 'x' is the midpoint of line joining two conductors. 'y' is an outside point on the line joining two conductors. The distance between 'y' and B wire is 40 cm. Find the magnitude and direction of the net magnetic flux density at the above two points.

(magnetic flux density at a point, at a perpendicular distance r from an infinitely long current carrying wire is given by $B = \frac{\mu_0 I}{2\pi r}$, ($\mu_0 = 4\pi \text{ x } 10^{-7}\ Hm^{-1}$))

- **Answer either part (A) or part (B) only.**

09). (A)



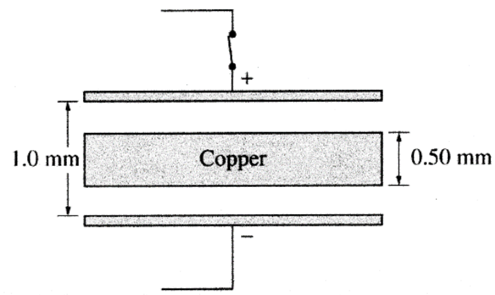
(1) Three identical resistors, each with resistance R, and a capacitor of $1.0 \times 10^{-9}\,F$ are connected to a $30V$ battery with negligible internal resistance, as shown in the circuit diagram above. Switches S_1 and S_2 are initially closed and switch S_3 is initially open. A voltmeter is connected as shown.

a) Determine the reading on the voltmeter.

b) Switches S_1 and S_2 are now opened and then switch S_3 is closed.

Determine the charge Q stored on the capacitor after S_3 has been closed for a very long time.

After the capacitor is fully charged, switches S_1 and S_2 remain open, switch S_3 remains closed, the plates are held fixed, and a conducting copper block is inserted midway between the plates, as shown below. The plates of the capacitor are separated by a distance of $1.0\,mm$ and the copper block has a thickness of $0.5mm$.



i. What is the potential difference between the plates ?

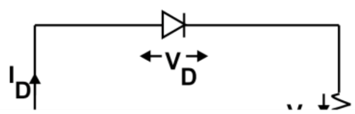
ii. What is the electric field intensity inside the copper block?

iii. On the diagram above, draw arrows to clearly indicate the direction of the electric field between the plates.

iv. Determine the magnitude of the electric field intensity in each of the spaces between the plates and the copper block.

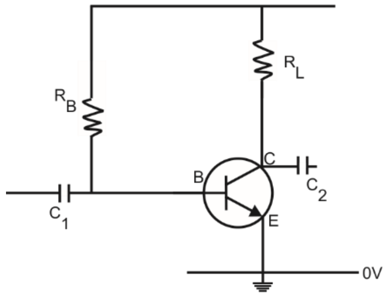
(B) a) (i) For the series diode configuration of following figure, determine V_D , I_D and V_R.

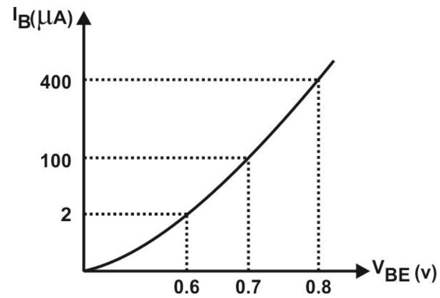
(Consider the potential barrier of Si diode is $0.7V$)



(ii). Determine V_D , I_D and V_R when the diode is reversed.

b) Following figure shows the circuit of transistor used as a amplifier and it's characteristic curve of I_B Vs V_{BE}.



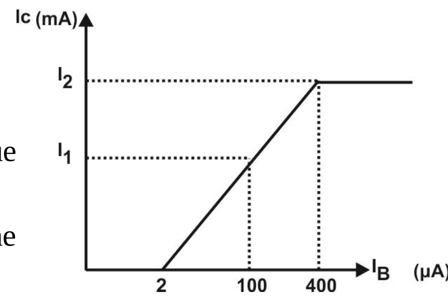


(i). Find the range of I_B when the voltage of V_{BE} is changed in between 0.6V and 0.8V.

(ii). If $V_{BE} = 0.7$, find the value of R_B.

(iii). When the $V_{BE} = 0.7\ V$, identify the region of transistor.

The characteristic curve of I_C Vs I_B is given below.



(iv). Find the value of I_1 when $I_B = 100\mu A$ and $\beta = 100$.

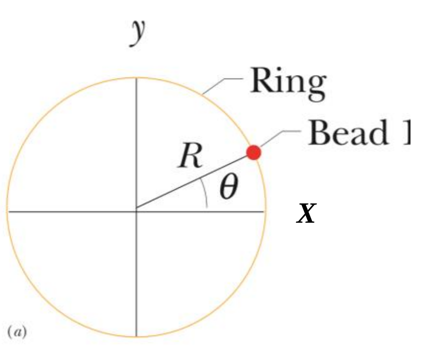
(v). When the transistor acts in the saturated region, find the value of I_2.

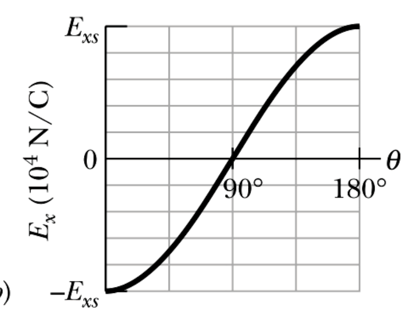
(vi). Considering the transistor acts in the saturated region, find the value of R_L.

- **Answer either part (A) or part (B) only.**

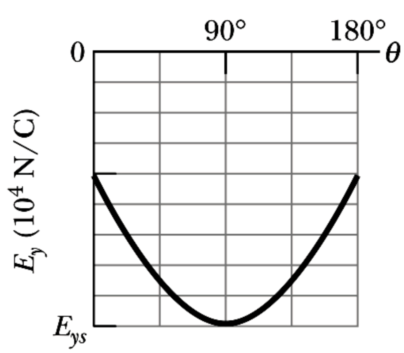
10). (A) **Answer both part (a) and part (b)**

(a) Two charged beads are on the plastic ring as shown in the figure (a). Bead (2), which is not shown, is fixed in place on the ring, which has radius R = 40.0 cm. Bead (1) which is not fixed in place, is initially on the x axis at angle $\theta = 0^0$. It is then moved to the opposite side, at angle $\theta = 180^0$, through the first and second quadrants of the xy coordinate system. Figure (b) gives the x component of the net electric field produced at the origin by the two beads as a function of θ and figure (c) gives the y component of that net electric field. The vertical axis scales are set by $E_{Xs} = 5.0 \times 10^4 NC^{-1}$ and $E_{Ys} = -9.0 \times 10^4 NC^{-1}$.





(b)



(c)

i) (1) At what angle θ is bead (2) located?

ii) (2) What are the charges of bead (1) and bead (2) ?

(Take $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ N\ m^2\ C^{-2}$)

(b) An alpha particle (two protons, two neutrons) moves in to a stationary gold atom (79 protons, 118 neutrons), passing through the electron region that surrounds the gold nucleus like a shell and headed directly towards the nucleus. The alpha particle slows until it momentarily stops when its center is at radial distance $r = 9.23\ fm$ from the nuclear center. Then it moves back along its incoming path. (Because the gold nucleus is much more massive than the alpha particle, we can assume the gold nucleus does not move.)

i. What was the kinetic energy of the alpha particle when it was initially far away. (hence external to the gold atom)? Assume that the only force acting between the alpha particle and the gold nucleus is the coulomb force and treat each as a single charged particle.

ii. Express the kinetic energy in MeV.

iii. Explain the following using the Gauss' law

- Net electric field intensity is zero outside the electron cloud.
- The electric field between the electron cloud and the nucleus of the gold atom is produced by the protons in the nucleus.

(B) (a) What is meant by the stream line flow.

(b) A liquid of coefficient of viscosity η is flowing through a capillary tube of internal radius a and length l. The volume of the liquid flowing per second is given by the expression given below.

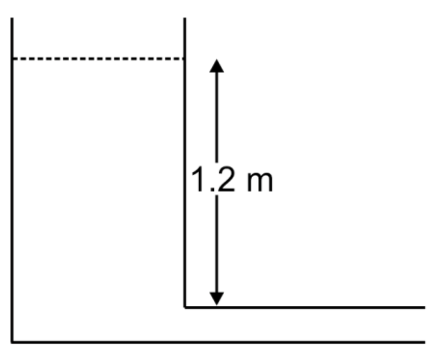
$\frac{v}{t} = \frac{\pi a^4 p}{8\eta l}$, p is the pressure difference between two ends of the tube.

(i) Show that the above equation is dimensionally correct.

(ii) The figure shows a tank containing a light, lubricant (oil). The oil flows out from a horizontal tube of length 10cm and internal diameter 4mm, connected to the tank. Calculate the volume of oil flowing through the tube in 1 minute. Oil stands at a height 1.2m above the horizontal tube and assume that the level of oil remains unchanged during this time period.
density of oil = $9.2 \times 10^2\ kgm^{-3}$
coefficient of viscosity $\eta = 8.4 \times 10^{-2}\ Nsm^{-2}$

(iii) A second tube of internal diameter 2mm and length 20cm is horizontally connected to the above tube so that the second tube is coaxial with the first one. Calculate the new rate of flow of volume of oil through the tubes.

(iv) Explain how the lubricating property of oil changes with temperature.



Second Term Test Grade - 13
Physics I

(1)	4	(11)	4	(21)	2	(31)	4	(41)	2
(2)	3, 4	(12)	1	(22)	2	(32)	4	(42)	1
(3)	4	(13)	3	(23)	2	(33)	2	(43)	2
(4)	2	(14)	4	(24)	4	(34)	3	(44)	3
(5)	3	(15)	3	(25)	1	(35)	2	(45)	3
(6)	5	(16)	5	(26)	4	(36)	2	(46)	1
(7)	1	(17)	1	(27)	3	(37)	3	(47)	5
(8)	3	(18)	4	(28)	1	(38)	2	(481	5
(9)	3	(19)	4	(29)	5	(39)	3	(49)	4
(10)	1	(20)	2	(30)	3	(40)	3	(50)	2.

Second Term Test Grade - 13
Physics II

(01) (a) The cylinder rises up without changing the immersed height (x). Meter ruler rotates in the anti-clockwise direction and again comes to the equilibrium position. — (01)

(b) Displacing the standard weight (W) towards right — (01)

(c) $(M - Ax\rho)gL = Wgl$ — (01)

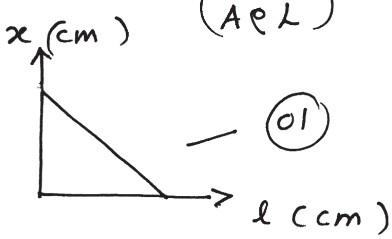
$M - Ax\rho = \frac{Wl}{L}$

$x = -\left(\frac{W}{A\rho L}\right) l + \frac{M}{A\rho}$

(d) Independent variable : l
Dependent variable : x } — (01)

(e) $x = -\left(\frac{W}{A\rho L}\right) l + \frac{M}{A\rho}$ — (01)

(f)



— (01)

(g) gradient $(m) = \frac{W}{Ae L}$; $A = \pi \left(\frac{d}{2}\right)^2$

Measurement	Instrument
1. Diameter of the cylinder (d)	Vernier calliper
2. Distance from the knife edge to the string attached to the cylinder (L)	Meter ruler.

(h) Weigh the cylinder in air using the spring balance } = m_0

weigh it totally immersed in the liquid } = m_1

weigh it totally immersed in water = m_2

$m_0 - m_2$ = upthrust in water

$m_0 - m_1$ = upthrust in liquid

specific gravity of liquid $= \frac{m_0 - m_1}{m_0 - m_2}$

— (02)

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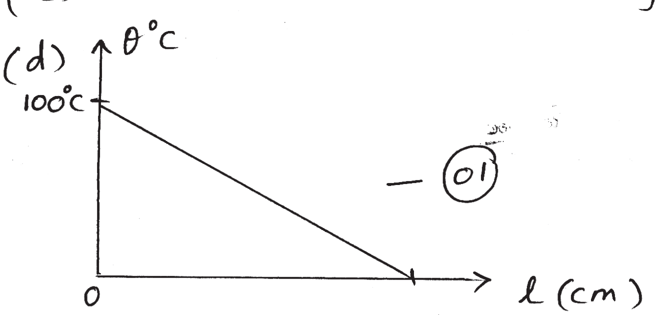
(02) (a) Enter the steam from Y (and then steam leave the chamber from X) — (01)

(b) using melting ice at 0°c inside the chamber — (01)

(c) Low thermal conductivity — (01)

(d)



— (01)

(e) Temperature gradient $= \frac{\theta_1 - \theta_2}{d} = \frac{100 - 0}{50 \times 10^{-2}} = 2 \times 10^2$

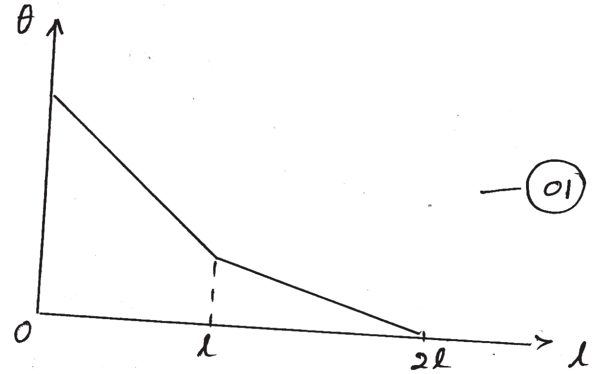
$= 2 \times 10^2 \ °c\,m^{-1}$ — (01)

(f) $\dot{Q} = \dot{m}L = 0.02 \times 3\times10^5 = 6\times10^3\ J\,s^{-1}$ — (01)

(g) $KA\left(\frac{\theta_1-\theta_2}{d}\right) = \dot{Q}$ — (01)

$$k = \frac{6\times10^3}{0.4\times10^{-4}\times2\times10^2} = 7.5\times10^5\ W\,K^{-1}$$ — (01)

(h)



— (01)

(i) $$\frac{KA(100-\theta_c)}{l} = \frac{2KA(\theta_c-0)}{l}$$

$$100-\theta_c = 2\theta_c$$

$$\theta_c = \frac{100}{3} = 33.33\ ^\circ C$$ — (01)

(03) (a) $n_1 = \frac{c}{V_1}$ — (01)

(b) $\frac{n_2}{n_1} = \frac{c/V_2}{c/V_1} = \frac{V_1}{V_2}$ — (01)

(c) Using Snell's Law, $\frac{n_2}{n_1} = \frac{\sin\theta_1}{\sin\theta_2}$ — (01)

time taken by the light ray to move from A to C in medium-1 $= t_1$

$$t_1 = \frac{AC}{V_1}$$

Similarly,
To move from C to B ; $t_2 = \frac{CB}{V_2}$ — (01)

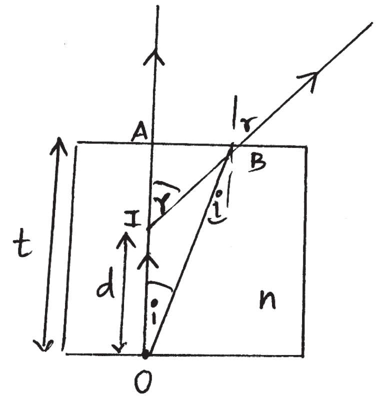
$$AC = \frac{h_1}{\cos\theta_1} \quad \text{and} \quad CB = \frac{h_2}{\cos\theta_2}$$

Total time to move from A to B $= t_1 + t_2$

$$t = \frac{AC}{V_1} + \frac{CB}{V_2}$$ — (01)

$$= \frac{h_1}{V_1\cos\theta_1} + \frac{h_2}{V_2\cos\theta_2}$$

(d)



$n \sin i = 1 \sin r$ — (01)

for small angles $\sin i \approx \tan i$

$\therefore n \tan i = \tan r$

$n \times \frac{AB}{AO} = \frac{AB}{AI}$ — (01)

$n = \frac{AO}{AI} = \frac{t}{t-d}$

$nt - nd = t \Rightarrow d = t\left(1 - \frac{1}{n}\right)$

(e) (i) f — (01)

(ii) $n = \frac{c}{v} \Rightarrow v = \frac{c}{n}$ — (01)

(iii) $\lambda = \frac{v}{f} = \frac{c}{nf}$

number of wavelengths $= \frac{t}{\lambda} = \frac{t}{c/nf} = \frac{nft}{c}$ — (01)

(4)(a) To mark the current correctly — (1)

(ii) using the loop ABDA,

$I_1 R_1 + I_g R_g - I_2 R_4 = 0$

$100 I_1 + 15 I_g - 60 I_2 = 0$ — (a) — (1)

(iii) using the loop BCDB,

$(I_1 - I_g)10 - 5(I_2 + I_g) - 15 I_g = 0$

$10 I_1 - 5 I_2 - 30 I_g = 0$ — (b) — (1)

considering the loop ADCEFA,

$60 I_2 + (I_2 + I_g)5 = 10$

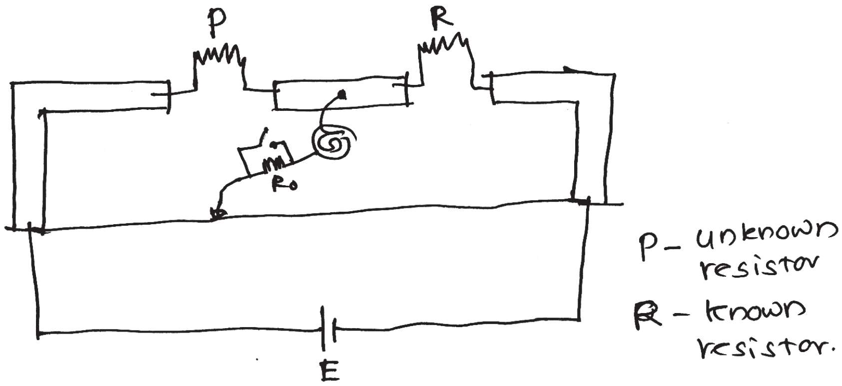
$65 I_2 + 5 I_g = 10$ — (c) — (1)

by solving (a), (b) and (c)

$I_g = 4.87\ mA$ — (1)

to simplification — (1)

(b) (i)

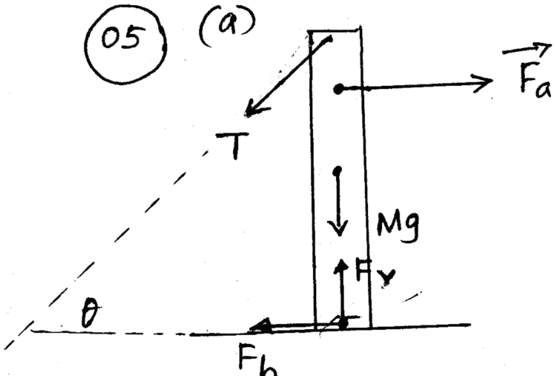


— (1)

(ii) $\frac{P}{20} = \frac{60}{40} \Rightarrow P = 30\ \Omega$ — (1)

(iii) $\frac{30}{10} = \frac{l}{(100-l)} \Rightarrow l = 75\ cm$ — (2)

(05) (a)



Marking forces — (01)
(if all correct)

(b) $T\cos\theta \times L = \vec{F_a}\, y$ — (01)

(c) $F_h \times L = \vec{F_a}(L-y)$ — (01)

(d) From the graph (c)
when $y = 0$, $F_h = 300\ N$ — (01)

$300\ L = \vec{F_a}(L-0)$ — (01)

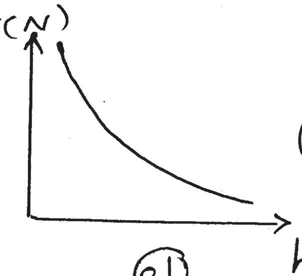
$\vec{F_a} = 300\ N$ — (01)

(e) From the graph (a) when $y = L$, $T = 600\ N$ — (01)

$600\cos\theta \times L = 300 \times L$ — (01)

$\cos\theta = \frac{1}{2}$; $\theta = 60^\circ$ — (01)

(f)



(01)

(g) $\frac{1}{2} I\omega^2 = mg\frac{L}{2}$ — (01) (01)

$\frac{1}{2} \times \frac{ML^2}{3} \omega^2 = Mg\frac{L}{2}$

$\omega^2 = \frac{3g}{L}$; $\omega = \sqrt{\frac{3g}{L}}$ — (01)

(h) The principle of conservation of energy (02)
(state the principle) →

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(06) (i) (a) P waves — (01)

(b)

P- Waves	S - Waves
1. a kind of longitudinal waves.	1. Transverse Waves — (02)
2. Can move through solid rock and liquid layers.	2. Can only move through solid rock — (02)

(c)

Body Waves	Surface Waves
1. Travel through the earth's inner layers.	1. can only move on surface of the earth.
2. The first to arrive at a Seismic station.	2. Though they arrive after body waves, they are responsible for the damage and destruction.
3. have higher frequency and speed.	lower frequency and speed.

(04)

(ii) $V = \sqrt{\frac{E}{\rho}}$; $(6 \times 10^{3})^{2} = \frac{E}{2000}$; $E = 36 \times 10^{6} \times 2000$

$= 72 \times 10^{9}$ (01)

$= 7.2 \times 10^{10}\ N\,m^{-2}$

(iii) $x = \log\left(\frac{2I}{I_0}\right)$

$6 = \log\left(\frac{I}{I_0}\right)$ } — (01)

$x - 6 = \log\left(\frac{2I}{I_0} \times \frac{I_0}{I}\right) = \log(2)$

$x = 6 + 0.3 = 6.3$ — (01)

(iv) $E = (10^{2})^{3/2} = 10^{3} = 1000\ J$ — (01)

(v) A tsunami is a series of huge waves that can cause great devastation and loss of life when they strike a coast. — (01)

(vi) $V = f\lambda$

$225 = f \times 450$

$f = \frac{225}{450} = \frac{1}{2}$

$\frac{1}{T} = \frac{1}{2}$; $T = 2\ s$ — (01)

(07) (a) (i) Definition of the linear expansivity – (01)

Def^{n} of the area expansivity – (01)

Def^{n} of the volume expansivity – (01)

(ii) $\beta = 2\alpha$, $\gamma = 3\alpha$ } (01)

(iii) Definition of real expansivity — (01)

Def^{n} of apparent expansivity — (01)

(iv) $\gamma_{real} = \gamma_{apparent} + \gamma_{container}$ — (01)

(b) (i) volume expansivity of the metal

$\gamma = 3\alpha = 3 \times 12 \times 10^{-6} = 36 \times 10^{-6}\ {}^{\circ}C^{-1}$ — (01)

(ii) $V_2 = V_1\left[1 + \gamma(\theta_2 - \theta_1)\right]$

$\frac{V_2}{V_1} = 1 + 36 \times 10^{-6}(100 - 25)$

$= 1.0027$ — (01)

(iii) density of the liquid at $25^{\circ}C$ is ρ_1 and

" " " " $100^{\circ}C$ is ρ_2.

$V_1 \rho_1 g = (50 - 45)\ 10^{-3} g = 5 \times 10^{-2} N$ – (01)

$V_2 \rho_2 g = (50 - 45.1)\ 10^{-3} g = 4.9 \times 10^{-2} N$ – (01)

(iv) $\frac{V_1 \rho_1}{V_2 \rho_2} = \frac{5}{4.9}$; $\frac{\rho_1}{\rho_2} = \frac{5}{4.9} \times \frac{V_2}{V_1} = \frac{5}{4.9} \times 1.0027$

$\frac{\rho_1}{\rho_2} = 1.0232$ — (01)

(v) $\rho_2 = \frac{\rho_1}{1 + \gamma \Delta\theta}$

$\frac{\rho_1}{\rho_2} = 1 + \gamma \Delta\theta$

$1.0232 = 1 + 75\gamma$

$\gamma = \dfrac{0.0232}{75}$

$\gamma = \underline{3.093 \times 10^{-4}\ {}^{\circ}C^{-1}}$ — (01)

(c) Steel rod - 14.17 cm — (01)

Cu rod - 9.17 cm — (01)

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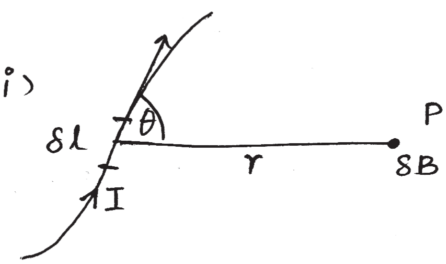
(08) (a) (i)



$\delta B = \dfrac{\mu_0}{4\pi} \cdot \dfrac{I\,\delta l \sin\theta}{r^2}$ — (01)

$I\delta l$ - current-length element

r - distance to the point P from the current element

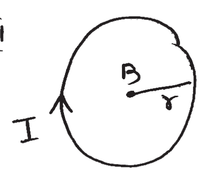
θ - angle between the direction of $\vec{\delta l}$ and the line joining the point P and δl.

δB - magnetic flux density at P. (02)

μ_0 - permeability of free space

II The Right hand rule — (01)

III

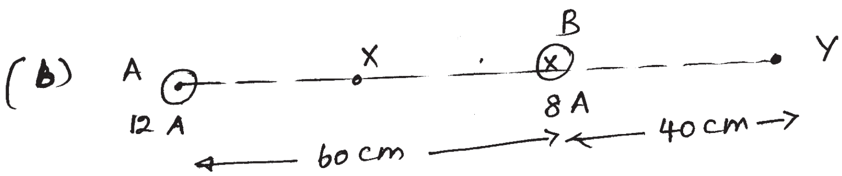


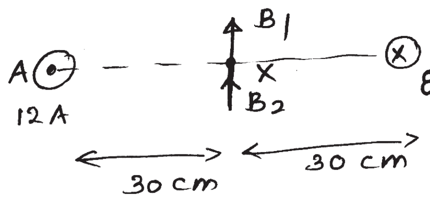
$B = \left(\dfrac{\mu_0}{4\pi}\right) \cdot \dfrac{2\pi I}{r} = \dfrac{\mu_0}{2} \cdot \dfrac{I}{r}$ — (01)

IV $B = \dfrac{\mu_0}{2} \cdot \dfrac{I}{r}, N = \dfrac{4\pi \times 10^{-7}}{2} \times \dfrac{14}{10 \times 10^{-2}} \times 80$

$= \underline{7.04 \times 10^{-5}\ T}$ — (01)

(b)





At X

$$B = \frac{\mu_0}{4\pi} \times \frac{2I}{d}$$

$$= 10^{-7} \times \frac{2I}{d}$$

$$\therefore \quad B_1 = \frac{2 \times 12 \times 10^{-7}}{30 \times 10^{-2}} = 8 \times 10^{-6}\ T \quad \text{— (01)}$$

$$B_2 = \frac{2 \times 8 \times 10^{-7}}{30 \times 10^{-2}} = \frac{16}{3} \times 10^{-6}\ T \quad \text{— (01)}$$

net magnetic flux density at the point X,

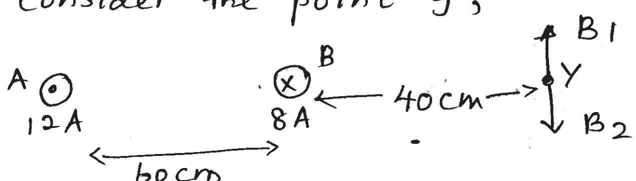
$$\uparrow B = B_1 + B_2$$

$$= 8 \times 10^{-6} + \frac{16}{3} \times 10^{-6} \quad \text{— (01)}$$

$$= \frac{40}{3} \times 10^{-6}\ T \quad \text{— (01)}$$

Direction – ↑ upwards — (01)

Consider the point Y,



$$B_1 = \frac{2 \times 12 \times 10^{-7}}{100 \times 10^{-2}} = 24 \times 10^{-7}\ T \quad \text{— (01)}$$

$$B_2 = \frac{2 \times 8 \times 10^{-7}}{40 \times 10^{-2}} = 4 \times 10^{-6}\ T \quad \text{— (01)}$$

net magnetic flux density at Y,

$$B = \downarrow 4 \times 10^{-6} - 2.4 \times 10^{-6}$$

$$= 1.6 \times 10^{-6}\ T \quad \text{— (01)}$$

Direction ↓ downwards — (01)

9(A) (I) (a) when the S_1 & S_2 are closed.,

equavelent resistance $= \frac{3R}{2}$ — ①

∴ Potential Difference betwen Voltmeter $= \frac{R}{3R/2} \times 30$

$= 20V$ — ②

(b) When the S3 has been closed long time,

Potential Difference between capacitor $= 30V$ — ②

∴ using $Q = CV$

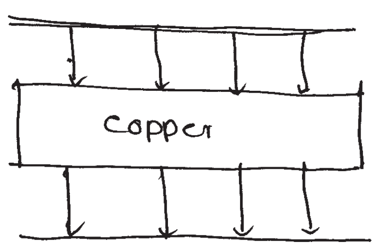
$= 1 \times 10^{-9} \times 30$

$= 3 \times 10^{-8}\,C$ — ②

(I) 30 V — ②

(II) E = 0 — ②

(III)



— ②

(IV) $E = \frac{30V}{0.5\,mm} = 60\,V\,mm^{-1}$ — ②

9(B)(a)(i) $V_D = 0.7$ —— (1)

$V_R = E - V_D$

$= 8 - 0.7$

$= 7.3\ V$ —— (1)

$I_D = I_R = \frac{V_R}{R}$

$I_D = \frac{7.3V}{2.2\ k\Omega}$

$= 3.32\ mA$ —— (1)

(ii) $V_R = 0,\ I_D = 0$ —— (1)

$V_D = E - V_R$

$V_D = 8V$ —— (1)

b) 1) From $2\mu A$ to $400\mu A$ —— (1)

2) Applying $V = IR$ to R_B,

$6 - 0.7 = I_B R_B$ —— (1)

$R_B = \frac{5.3}{100 \times 10^{-6}}$

$R_B = 53\ k\Omega$ —— (1)

(3) In the active region —— (1)

(4) Using $\beta = \frac{I_C}{I_B}$

$100 = \frac{I_C}{100 \times 10^{-6}}$ —— (1)

$I_C = 10\ mA$ —— (1)

(5) using $\beta = \frac{I_c}{I_B}$

$I_C = \beta I_B$

$= 100 \times 400 \times 10^{-6}$ —— (1)

$I_2 = 40\ mA$ —— (1)

(6) using $V = IR$

$6 = 40 \times 10^{-3} R_L$ —— (1)

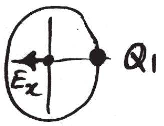
$R_L = 150\ \Omega$ —— (1)

10(A)

(a) Since $E_x = 0$ when $\theta = 90°$; both beads are on the y- axis. ∴ the bead (2) fixed on the ring is at a point $y = +40$ cm or $y = -40$ cm. — (01)

When $\theta = 0°$, from the graph E_x is $-ve$. — (01)
∴ bead (1) is +vly charged.

$$E_x = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q_1}{r^2} \Rightarrow Q_1 = \frac{E_x r^2}{1/4\pi\varepsilon_0} = \frac{5\times10^4 \times (40\times10^{-2})^2}{9\times10^9} \text{ — (01)}$$



$$Q_1 = \frac{5\times16\times10^{-7}}{9} = \frac{80}{9}\times10^{-7}\ C = \frac{8}{9}\times10^{-6}\ C$$

$$Q_1 = \underline{\underline{0.89\ \mu C}} \text{ — (01)}$$

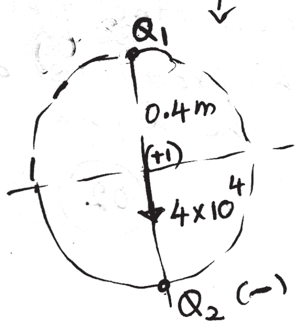
When $\theta = 90°$, the field at the origin due to beads(1) and (2) is $-9\times10^4\ NC^{-1}$ — (01)

$E_{Q_1} + E_{Q_2} = -9\times10^4$

$-5\times10^4 + E_{Q_2} = -9\times10^4$

$\downarrow E_{Q_1} = -5\times10^4$

$\therefore \downarrow E_{Q_2} = -4\times10^4$



$$4\times10^4 = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q_2}{(0.4)^2}$$

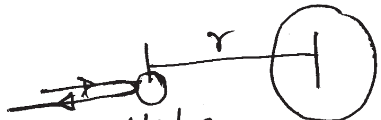
$$Q_2 = \frac{4\times10^4 (0.4)^2}{1/4\pi\varepsilon_0} = \frac{4\times10^4 \times 16\times10^{-2}}{9\times10^9} \text{ — (01)}$$

$$= \frac{64}{9}\times10^{-7}\ C = 7.1\times10^{-7}\ C$$

$$= 0.71\times10^{-6}\ C = \underline{\underline{0.71\ \mu C}} \text{ — (01)}$$

Q_2 is (−ve) (01) and $\theta = -90°$ — (01)

(b)



As the incoming α- particle is slowed by the repulsive force, its kinetic energy is transferred to electric potential energy of the system.

* The principle of conservation of mechanical energy

$$K_i + U_i = K_f + U_f \; ; \quad U_i = 0 \text{ and } K_f = 0 \quad \text{—(01)}$$

$$K_i = \frac{1}{4\pi\varepsilon_0} \cdot \frac{(2e)(79e)}{9.23\ \text{fm}} = \frac{8.99\times10^{9}\,(158)(1.6\times10^{-19})^2}{9.23\times10^{-15}} \quad \text{—(01)}$$

$$= 3.94\times10^{-12}\ \text{J} \quad \text{—(01)}$$

$$= 24.6\ \text{MeV} \quad \text{—(01)}$$

When the α- particle is outside the atom, the systems initial electric PE U_i is zero because the atom has an equal no. of e^{ns} and protons, which produce a net electric field of zero. Once the α- particle passes through the electron region surrounding the nucleus on its way to the nucleus, the electric field due to the e^{ns} goes to zero. The reason is that the electrons (e^{ns}) act like a closed spherical shell of uniform negative charge and such a shell produces zero electric field in the space it encloses. The α- particle still experiences the electric field of the protons in the nucleus which produces a repulsive force on the protons within the alpha particle.

(02)

(10 B) (a) Def^n of stream line flow — (01)

(b) (i) $\left[\frac{V}{t}\right] = L^3 . T^{-1}$ — (02)

$$\left[\frac{\pi a^4 P}{8 \eta l}\right] = \frac{L^4 . ML^{-1}T^{-2}}{ML^{-1}T^{-1} . L} = L^3 T^{-1}$$

$[L.H.S] = [R.H.S]$

(ii) $\frac{V}{t} = \frac{\pi a^4 P}{8 \eta l} \Rightarrow \frac{V}{60} = \frac{\pi \times (2\times10^{-3})^4 \times 1.1\times10^4}{8\times 8.4\times10^{-2} \times 10\times10^{-2}}$ — (01)

$V = 4.93\times10^{-4} m^3$ — (01)

(Pressure diff^{ce} $P = P_0 + h\rho g - P_0 = h\rho g$ — (01)

$= 1.2\times 9.2\times10^2\times10 = 1.1\times10^4$ Pa — (01)

(iii) For large tube ; $\frac{V}{t} = \frac{\pi\times(2\times10^{-3})^4 [1\times10^5 + 1.1\times10^4 - P]}{8\times8.4\times10^{-2} \times 10\times10^{-2}}$ — (01)

$= 7.48\times10^{-10}(11.1\times10^4 - P)$ — (01)

$(11.1\times10^4 - P) = \frac{V}{t}\frac{10^{10}}{7.48}$ — ①

For small tube ; $\frac{V}{t} = \frac{\pi(1\times10^{-3})^4 \times (P - 1\times10^5)}{8\times8.4\times10^{-2} \times 20\times10^{-2}}$ (01)

$= 2.34\times10^{-11}(P - 1\times10^5)$

$(P - 1\times10^5) = \frac{V}{t}\frac{10^{11}}{2.34}$ — ② — (01)

① + ② ; $11.1\times10^4 - 1\times10^5 = \frac{V}{t}\left(\frac{10^{10}}{7.48} + \frac{10^{11}}{2.34}\right)$ (01)

$1.1\times10^4 = 10^{10}\frac{V}{t}(0.13 + 4.27)$

$\frac{V}{t} = 2.5\times10^{-7} m^3 s^{-1}$ — (01)

$(2.45\times10^{-7} - 2.55\times10^{-7})$

(iv) When temperature of oils increases, their coefficient of viscosity decrease. ∴ the lubricating property of oil decreases with increasing temperature.

— (02)