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Provincial Department of Education - NWP

තෙවන වාර පරීක්ෂණය - 13 ශ්‍රේණිය - 2026
Third Term Test - Grade 13 - 2026

Examination No.: .....

PHYSICS - I

Time : 02 hours

Important :

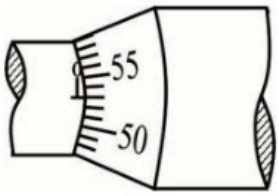
- *This question paper consists of* **50** *questions in* ***10*** *pages.*
- *Write your* ***index number*** *in the space provided in the answer sheet.*
- *In each of the question* **1** *to* **50** *pick one of the alternatives from* (1), (2), (3), (4),(5) *which is* ***correct*** *or* ***most appropriate*** *and* ***mark your response on the answer sheet with a cross*** (X) *on the number of the correct option in accordance with the instructions given on the back of the answer sheet.*

Use of calculators is not allowed.

(g = 10 m s^{-2})

1. The physical quantity which has the same dimension as plank's constant is
   (1) Force (2) energy (3) power
   (4) linear momentum (5) angular momentum.

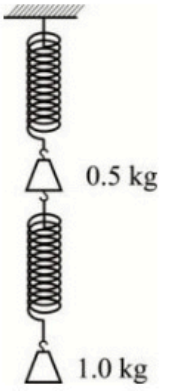
2. A micrometer screw gauge having a pitch of 1 mm has 100 divisions in the circular scale. Its zero error is shown the diagram. Which of the following is correct regarding the zero error?



   (1) It is 0.53 mm and it should be added.
   (2) It is 0.47 mm and it should be subtracted.
   (3) It is 0.55 mm and it should be subtracted.
   (4) It is 0.53 mm and it should be subtracted.
   (5) It is 0.47 mm and it should be added.

3. If full break is applied on a moving bus with no passengers, it moves a distance S before coming to rest. When the passengers are on board its mass increases by 40%, now the bus is moving with the same velocity and full break is applied again. The distance it moves before coming to rest is,
   (1) 1.4 S (2) $\sqrt{1.4}\ S$ (3) $1.4^2\ S$ (4) 1.2 S (5) S

4. Two identical light springs are connected with two masses of 1.0 kg and 0.5 kg as shown. Which of the following statements is/are correct?



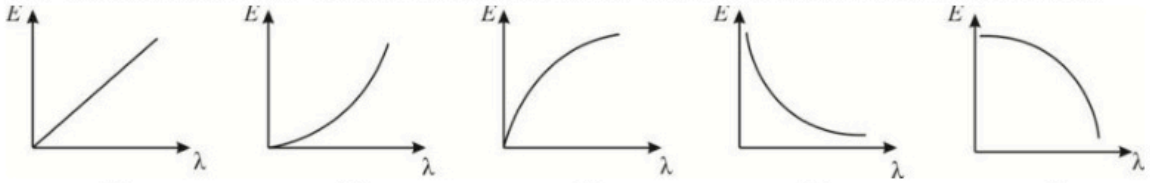
   (A) The tension in the upper spring is double that in the lower spring.
   (B) The force acting on the ceiling by the whole system is 15 N.
   (C) The tension in the upper spring will remain unchanged if the two masses are exchanged in position.
   (1) (A) only (2) (C) only (3) (A) and (B) only
   (4) (B) and (C) only (5) (A), (B) and (C)

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5. Two spheres of masses $2M$ and M are initially at rest at a distance R apart. Due to mutual force of attraction they approach each other. When they are at separation $R/2$, the acceleration of the centre of mass of spheres would be

(1) 0 (2) 10 m s^{-1} (3) 30 m s^{-1} (4) 20 m s^{-1} (5) 12 m s^{-1}

6. The variation of energy E of a photons with their wave length λ is best represented by



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

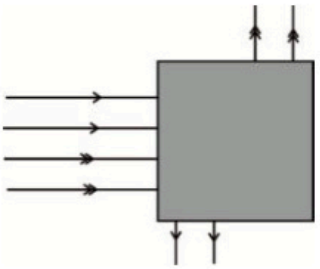
7. A particle at rest starts moving in a straight line with a uniform acceleration. The ratio of the distances covered during the fourth and the third second is

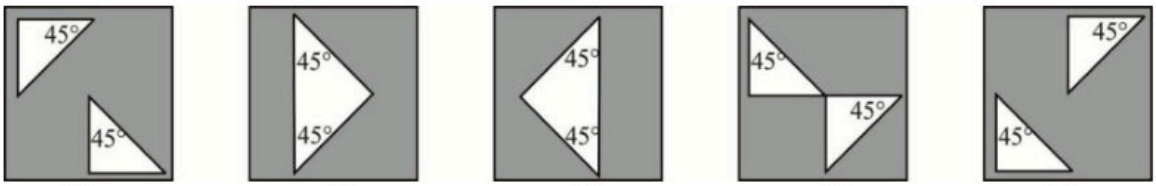
(1) $\frac{4}{3}$ (2) $\frac{7}{5}$ (3) $\frac{9}{7}$ (4) 2 (5) $\frac{11}{7}$

8. A solid cylinder of mass 3 kg rolls down on an inclined plane from a height of 5 m. What is its rotational kinetic energy when it reaches the bottom of the plane? (Moment of inertia of a cylinder with usual notation $\frac{1}{2}MR^2$)

(1) 40 J (2) 50 J (3) 25 J (4) 30 J (5) 20 J

9. A monochromatic beam of light passed through an optical device as shown in the diagram. The device is shown by the box. The possible optical device is





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

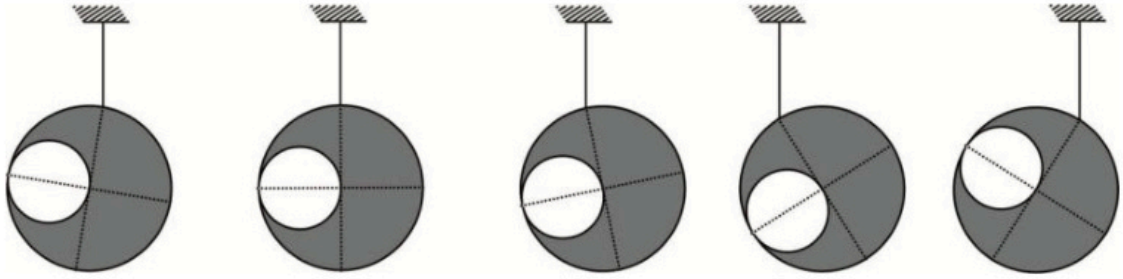
10. A train blowing its whistle at a frequency of 800 Hz is moving directly away from a stationary observer at a velocity of $0.2v$, where v is the speed of sound in air. What is the frequency of the sound heard by the observer?

(1) 640 Hz (2) 667 Hz (3) 720 Hz (4) 960 Hz (5) 1000 Hz

11. Lenz's law, which is used to determine the direction of the induced electromotive force (emf) in electromagnetic induction, is a direct consequence of the:

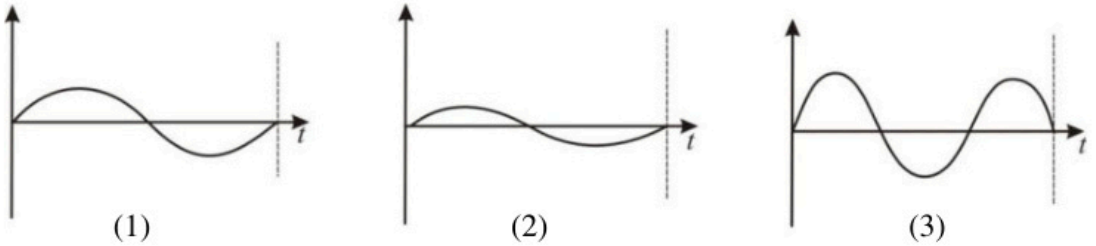
(1) law of conservation of charge.
(2) law of conservation of energy.
(3) law of conservation of mass.
(4) law of conservation of linear momentum.
(5) law of conservation of angular momentum.

12. A circular part of radius r is cut form a uniform circular disc of radius $2r$. The remaining part is suspended freely by a thin string. Which of the followings correctly shows the equilibrium position of the disc?

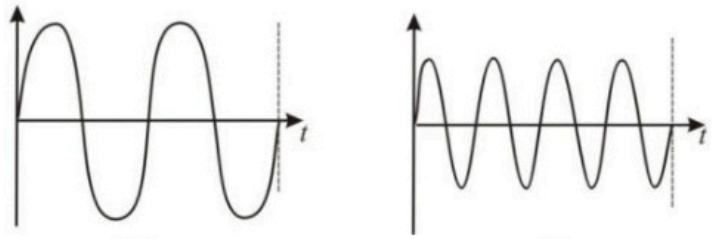


(1) (2) (3) (4) (5)

13. If all of the followings are sound waves, which of them has the highest pitch?



(1) (2) (3)

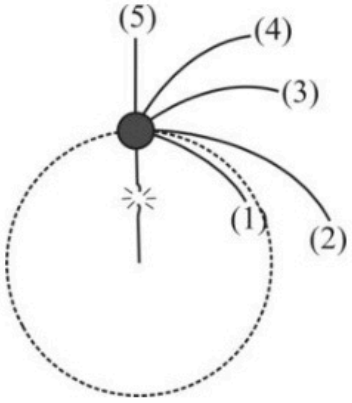


(4) (5)

14. The input power of an ideal transformer is 10 kW. The current in the secondary coil is 25 A. The ratio of number of turns between the primary and secondary coils is 8:1. The input voltage is

(1) $\frac{10^4 \times 8}{25}$ V (2) $\frac{10^4 \times 8^2}{25}$ V (3) $\frac{10^4}{25}$ V (4) $\frac{10^4}{25 \times 8}$ V (5) $\frac{10^4}{25 \times 8^2}$ V

15. A ball is connected to a string and is whirled in a vertical circle. The string breaks suddenly at the highest point of the path. Which one is the most possible path of the ball afterwards?

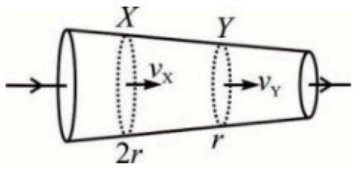


16. In which of the following situations is the magnitude of the normal reaction of the supporting surface always equal to the weight of the body?
(A) The moment a ball bouncing vertically touches the horizontal ground.
(B) An astronaut in a space station which performs circular motion around the earth.
(C) A boy standing in a lift which is moving vertically upward with a uniform velocity.
(1)(A) only. (2) (C) only . (3) (A) and (B) only.
(4) (B) and (C) only. (5) (A), (B) and (C).

17. The rate of emission of thermal radiation from a hot body depends on,
(1) temperature of the objet and the atmospheric pressure
(2) temperature and the surface area of the objet
(3) the nature of the surface of the object and the atmospheric pressure
(4) surface area of the objet and the humidity of air.
(5) temperature of the object and the nature of its surface

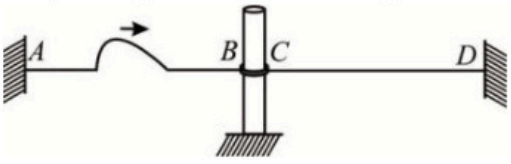
18. When a diver looks up towards the surface from underwater, the surface is seen like
(1) a converging lens.
(2) a diverging lens.
(3) a plane mirror covering the entire surface.
(4) a plane mirror with a circular hole in it, centred above the diver's head.
(5) a circular plane mirror of limited extent, centred above the diver's head.

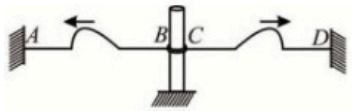
19. The diagram shows a conductor of uniformly decreasing cross section area. The radius at x and y are $2r$ and r respectively. The conductor is connected across a battery. The drift velocity of electrons at X and Y are v_X and v_Y respectively. The ratio $\frac{v_X}{v_Y}$ is



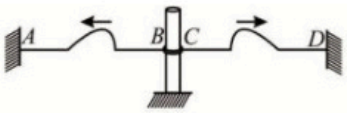
(1) $\frac{1}{16}$ (2) $\frac{1}{12}$ (3) $\frac{1}{8}$ (4) $\frac{1}{6}$ (5) $\frac{1}{4}$

20. Two strings AB and CD are connected to a smooth light ring which goes through the rod as shown in the diagram. A wave pulse on the string AB is moving towards the ring. The shapes and directions of the pulses moving along the strings after the pulse reaches the ring are best represented by

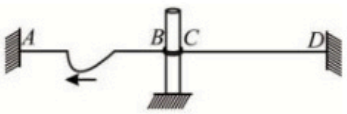




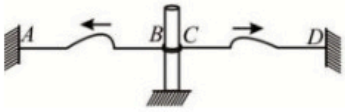
(1)



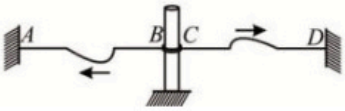
(2)



(3)



(4)



(5)

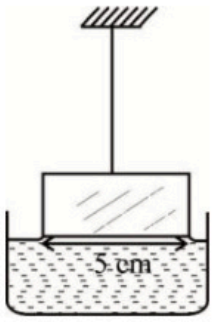
21. Four wires P, Q, R, and S made of the same material (equal Young's Modulus) have the following dimensions.

Wire	Length (L) m	Radius (r) mm
P	1	1
Q	1	2
R	2	1
S	2	2

They are all subjected to the same tensile force, which of the following statements is true?

(1) Wire P has the largest extension.
(2) Wire Q has the largest extension.
(3) Wire R has the largest extension.
(4) Wire S has the largest extension.
(5) All wires have the same extension.

22. A thin vertical glass slide of length 5 cm and negligible thickness is held so that its lower edge just touches the surface of a liquid. If an additional downward force of 0.006 N is exerted on the slide due to surface tension, what is the surface tension of the liquid? (Contact angle is zero)



(1) 0.03 N m^{-1}
(2) 0.06 N m^{-1}
(3) 0.12 N m^{-1}
(4) 0.15 N m^{-1}
(5) 0.6 N m^{-1}

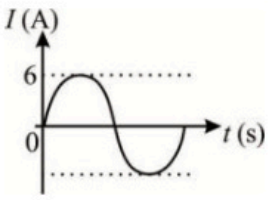
23. A potential difference V is applied between two large parallel plates, at distance s apart. An electron of mass m and charge $-e$ starts from rest at the negative plate and travels across the gap to the positive plate. The time taken is

(1) $\frac{2s}{V}$ (2) $\frac{s^2}{V}$ (3) $\frac{2s^2}{eV}$ (4) $\sqrt{\frac{2ms^2}{eV}}$ (5) $\sqrt{\frac{m}{2eV}}$

24. The capillary rise of water, in a certain glass capillary tube is h. The angle of contact between glass and water is zero. Another capillary tube having the same dimensions as the glass tube is made with a material for which the angle of contact with water is 60°. The capillary rise of water in the second tube is

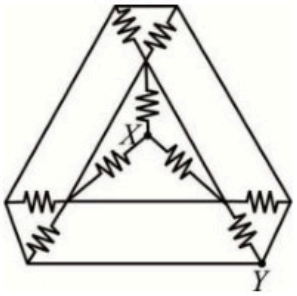
(1) 0 (2) $\frac{h}{4}$ (3) $\frac{h}{2}$ (4) h (5) $2h$

25. The alternating current shown in the graph is sent through 10 Ω resistors. Then the power of heat dissipation from the resistor is



(1) 18 W (2) 60 W (3) 120 W
(4) 180 W (5) 360 W

26. Nine identical resistors each of R are connected in a network as shown in the figure. The equivalent resistance between X and Y is



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

27. A radioactive sample contains two radioactive elements X and Y. At the time $t = 0$ activity of both elements are equal and activity of the sample is A_0. The half life time of X is 24 days and that of Y is 16 days. The activity of the sample after 48 days is

(1) $\frac{A_0}{4}$ (2) $\frac{3A_0}{5}$ (3) $\frac{A_0}{2}$ (4) $\frac{3A_0}{16}$ (5) $\frac{3A_0}{8}$

28. Consider the following statements regarding water vapour in the atmosphere.

(A) The relative humidity is low when absolute humidity in low.

(B) The relative humidity is low if the dew point is low

(C) The vapour pressure in the atmosphere is equal to the saturated vapour pressure at the dew point only in open space.

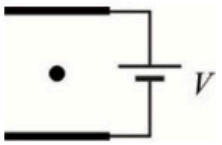
Of the statements

(1) only (A) is correct (2) only (B) is correct

(3) only (B) and (C) are correct (4) only (A) and (C) are correct

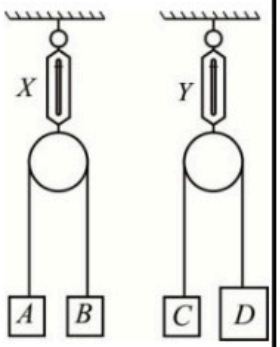
(5) all (A), (B) and (C) are correct

29. In a Millikan experiment type experiment, a droplet of oil of radius r with $2e$ charge , remains stationary when a potential difference V is applied to the plates. When the potential difference is increased to $4V$, a droplet of oil of radius $2r$ remains stationary. What is the charge on the second droplet?



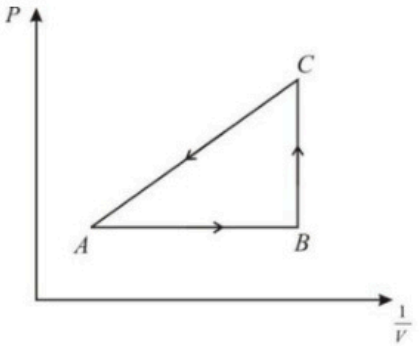
(1) $e/2$ (2) e (3) $2\,e$ (4) $4\,e$ (5) $8\,e$

30. Of the two diagrams X and Y are spring balances. Two light strings connected to the objects A, B, C and D is passing over a smooth pulley. Masses of A and B are 5 kg each and the masses of C and D are 4 kg and 6 kg respectively. The readings of balances X and Y when the two systems are released from rest will be,



	X	Y
(1)	10 kg	10 kg
(2)	10 kg	12 kg
(3)	0	02 kg
(4)	0	3.2 kg
(5)	10 kg	9.6 kg

31. An enclosed gas is taken through a cycle $ABCA$ (see figure). It can be concluded that



(A) Along AB the temperature decreases, and along BC the temperature increases

(B) Along CA work is done by the gas.

(C) Along CA the internal energy of the gas remains constant

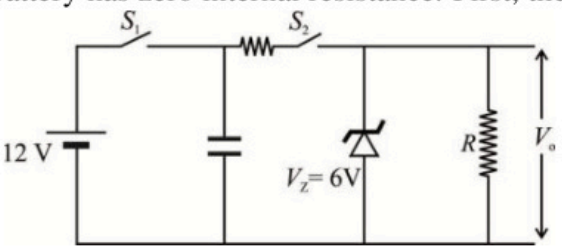
Of the above statements

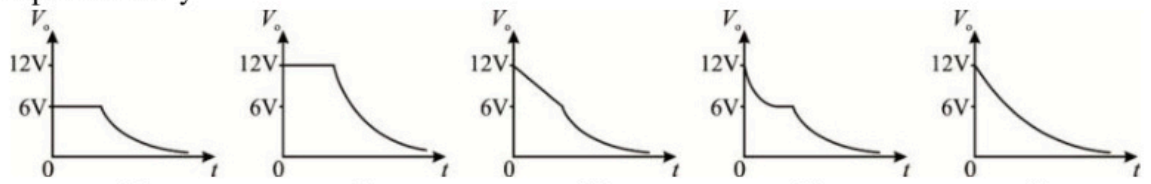
(1) only (A) is true (2) only (B) is true

(3) only (A) and (B) are true (4) only (A) and (C) are true

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

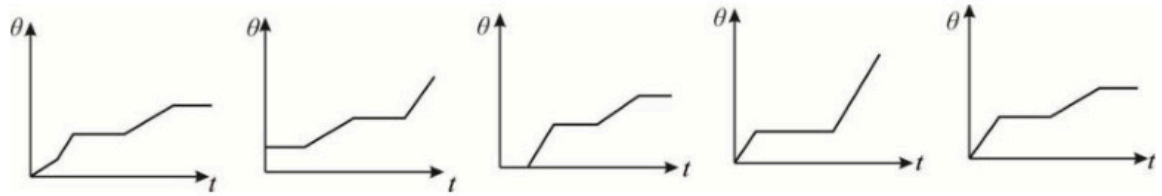
32. Consider the circuit given in the figure. The battery has zero internal resistance. First, the switch S_1 is closed and let the capacitor charge fully. Then S_1 is opened and S_2 is closed at $t = 0$. The Zener voltage of the zener diode is 6 V. The variation of voltage across the load resistor R is best represented by





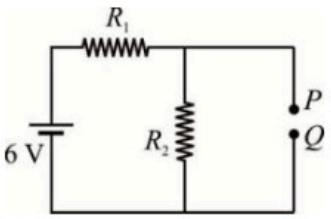
(1) (2) (3) (4) (5)

33. A block of ice at -10 °C is slowly heated until it is completely become steam at 100 °C. Which of the following graph best represent the above incident qualitatively?



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

34. Consider the given circuit. When an ideal voltmeter is connected between P and Q, it shows a 4 V reading. If an ideal ammeter is connected, it shows 0.6 A reading. If the internal resistance of the battery is zero and emf is 6 V, the resistance of R_1 and R_2 respectively are.

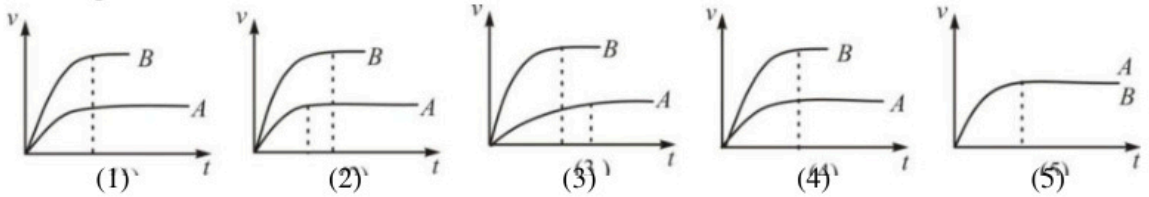


(1) 10 Ω , 10 Ω (2) 10 Ω , 20 Ω (3) 20 Ω , 10 Ω
(4) 30 Ω , 20 Ω (5) 20 Ω , 40 Ω

35. For the photoelectric effect, which of the following is the correct relationship between the energy E of a photon, the work function w of the surface which it strikes, and the maximum kinetic energy K of the emitted photoelectron?

(1) $E = w + K$ (2) $E = w - K$ (3) $E = K - w$
(4) $K = 2(w + E)$ (5) $w = ½(K + E)$

36. Two spheres, A of mass m and B of mass $2m$ but of the same volume, are released from rest at time $t = 0$ at the surface of a deep pond. Which of the following graphs best represents the variation of the speed of two masses from $t = 0$ until they reach the bottom of the pond.



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

37. An astronomical telescope is adjusted to view a distant object under normal adjustment. Which of the following statement is/are correct?

(A) The first image formed by the objective is real and is smaller than the object.

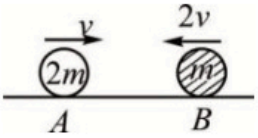
(B) The final image formed by the eyepiece is at the least distance of distinct vision from the eye.

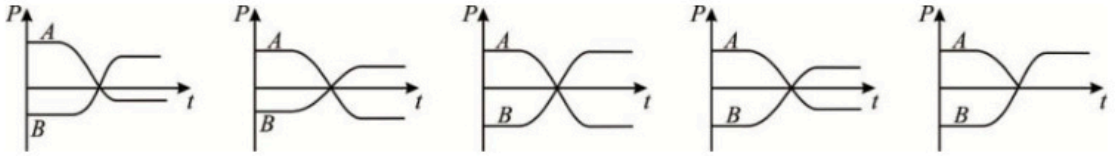
(C) If part of the objective is blocked by an opaque obstacle, part of the final image could not be viewed.

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

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

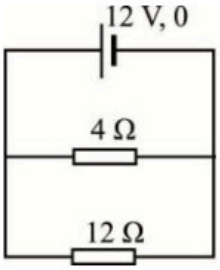
38. Two spheres A and B as shown in the figure are moving towards each other with velocities v and $2v$ respectively on a smooth horizontal floor. Which of the followings can best represent the variation of momentum of A and B if the collision is head-on and inelastic?





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

39. In the circuit above, an electron travelling through 4 Ω loses energy E_1, and an electron travelling from through 12 Ω loses energy E_2. Then

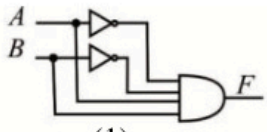


(1) $E_1 = \frac{E_2}{3}$ (2) $E_1 = 3\,E_2$ (3) $E_1 = 4\,E_2$

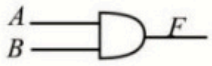
(4) $E_1 = \frac{E_2}{4}$ (5) $E_1 = E_2$

40. Identify the logic circuit that satisfies the given truth table.

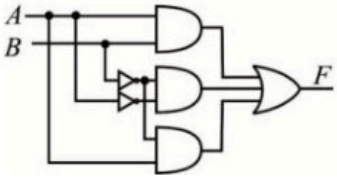
A	B	F
0	0	1
0	1	0
1	0	0
1	1	1



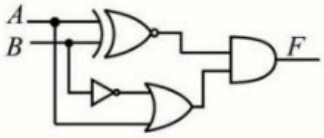
(1)



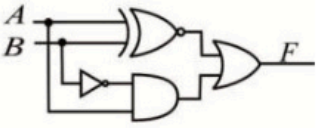
(2)



(2)



(4)

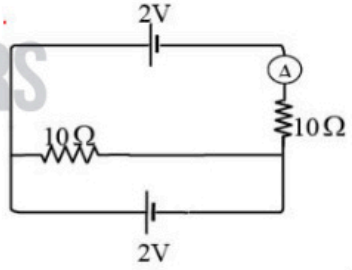


(5)

41. The internal resistance of cells shown in the circuit is negligible. The ammeter reading is

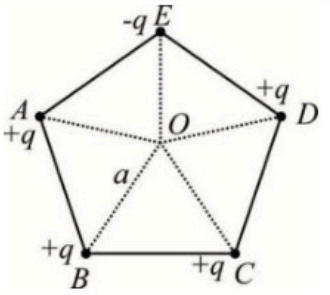
(1) 0.4 A (2) 0.3 A (3) 0.2 A

(4) 0.1 (5) zero



PAST PAPERS WIKI

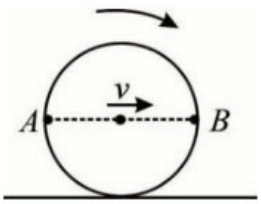
42. $ABCDE$ is an equilateral pentagon. Its center is O which is at a distance from each corner. + q charge is place on each corner except at E. if There is a -q charge at E, the magnitude and the direction of the electric field intensity at O.



(1) $\frac{q^2}{4\pi\varepsilon_0 a^2}$, $\overrightarrow{OE}$ (2) $\frac{q}{4\pi\varepsilon_0 a^2}$, $\overrightarrow{EO}$

(3) $\frac{2q}{4\pi\varepsilon_0 a^2}$, $\overrightarrow{EO}$ (4) $\frac{2q}{4\pi\varepsilon_0 a^2}$, $\overrightarrow{OE}$ (5) $\frac{q}{4\pi\varepsilon_0 a^2}$, $\overrightarrow{OE}$

43. A wheel is rolling on a horizontal surface with a velocity v. A and B are two points at the edge of horizontal diameter. The respective velocities of points A and B and their directions with respect to ground are



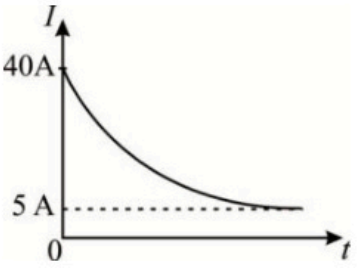
(1) $\sqrt{2}\,v$ ↗, $\sqrt{2}\,v$ ↘, (2) v ↑ , v ↓ (3) $\sqrt{2}\,v$ ↑, $\sqrt{2}\,v$ ↓

(4) v →, v → (5) $\sqrt{2}\,v$ ↖, $\sqrt{2}\,v$ ↙,

44. Three occasions where forces are acting between objects are given here.
(A) Two equal masses joined by a rubber band under tension.
(B) Two long straight parallel conducting wires carrying steady electric currents.
(C) The earth and a satellite in its orbit.
For which of the above does the force between two objects vary inversely as the square of the distance between their centres of masses?

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

45. The graph indicates how the current through an electric motor changes with time after switch on. This motor has no initial current control mechanism. The switch is on at $t = 0$. If the motor is powered by a 240 V supply, its **mechanical power** once it reach the maximum speed is

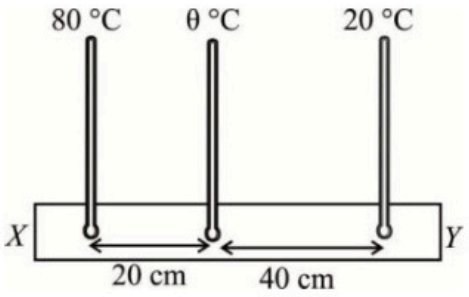


(1) 105 W (2) 1050 W (3) 1200 W
(4) 1000 W (5) 9600 W

46. A mass m of an ideal gas initially has volume V_0 and temperature T_0. When it is kept at constant volume V_0, heat Q is required to increase its temperature to $T_0 + \Delta T$. If the same mass of gas at V_0 and T_0 is given heat, the volume was expanded from V_0 to $3V_0$ and temperature was increased from T_0 to $T_0 + 2\Delta T$, then the heat supplied must be

(1) less than 2 Q. (2) equal to 2 Q. (3) more than 2 Q.
(4) more than 3 Q. (5) more than 6 Q.

47. The diagram shows an **open** meal bar XY whose ends are maintained at different temperatures. Three thermometers, register steady 80 ºC, θ ºC and 20 ºC at after a while. (The room temperature is below 20 ºC.) Which of the following statements is correct?



(A) The rate at which heat energy crosses any cross section of the bar decreases from X to Y.

(B) $(80 - \theta)$ is greater than $\frac{1}{2}(\theta - 20)$

(C) θ must be less than 40°C .

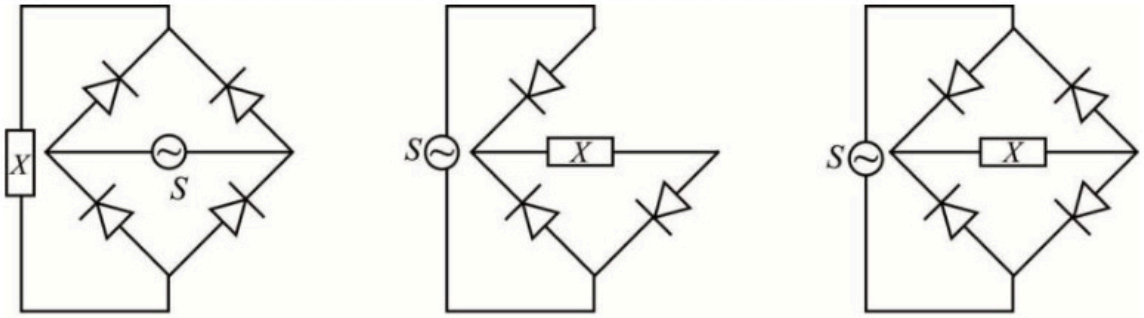
(1) (A) only. (2) (C) only. (3) (B) and (C) only.

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

48. A near-sighted person's greatest distance of distinct vision is 0.9 m. After wearing certain pair of spectacles, his greatest distance of vision increases to 18 m. What is the magnitude of the focal length of the spectacle lenses?

(1) 0.86 m. (2) 0.90 m. (3) 0.95 m. (4) 17.1 m. (5) 18.9 m.

49. S is a source of alternating voltage. In which of the following circuits will the current flowing through component X be rectified, i.e. flowing in one direction only?

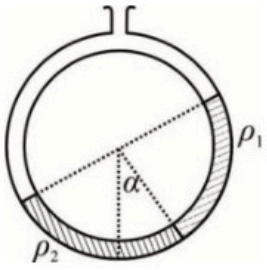


(A) (B) (C)

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

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

50. A Circular instrument is made of a narrow glass tube as shown in the figure. Two immiscible liquids of density ρ_1 and ρ_2 as shown are added to the tube. At the equilibrium, the interface shows an angular displacement of α from vertical. Then the ratio $\frac{\rho_1}{\rho_2}$ is



(1) $\frac{\tan\alpha - 1}{\tan\alpha + 1}$ (2) $\frac{\tan\alpha + 1}{\tan\alpha - 1}$ (3) $\tan\alpha$

(4) $\frac{1 + \tan\alpha}{1 - \tan\alpha}$ (5) $\frac{1 - \tan\alpha}{1 + \tan\alpha}$

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Third Term Test - Grade 13 - 2026

01 E II

Examination No.: .....

PHYSICS - II

Time : 03 hours

Extra reading time 10 minutes

Part - A

Structured Essay

- **Answer all four questions on this paper itself.**
  (Acceleeration due to gravity g = 10NKg^{-1})

---

(01) Using the principle of momentum, we need to find the value of an unknown mass of M approximately 60 g, using a graphical method. For this, you have been provided with a tall wooden block, a uniform meter ruler and pieces of twine.

(a) (i) Underline the mass you choose from the masses given below as the unknown mass

10 g 50 g 100 g 150 g

(ii) Give a reason for your choice.

.....

(iii) At the beginning we can find some data to by balancing the meter ruler on the kinfeedge what is it ?

.....

(iv) What is the reason, important it for the experiment ?

.....

(b) (i) Using above balanced situation, Draw a diagram of the arranged experimental setup.

Mark the balanced lengths from the balanced point to the mass as larger length l_1 and shote length l_2. Name the items.

(ii) Get the expression for l_2 in terms of m, M and l_1 when the system is balanced.

.....

.....

(iii) What is the reason for choosing indipendent veriable as l_1 ?

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(iv) When take a different set of reading for l_1 and l_2, what should not be changed in the meter ruler ?

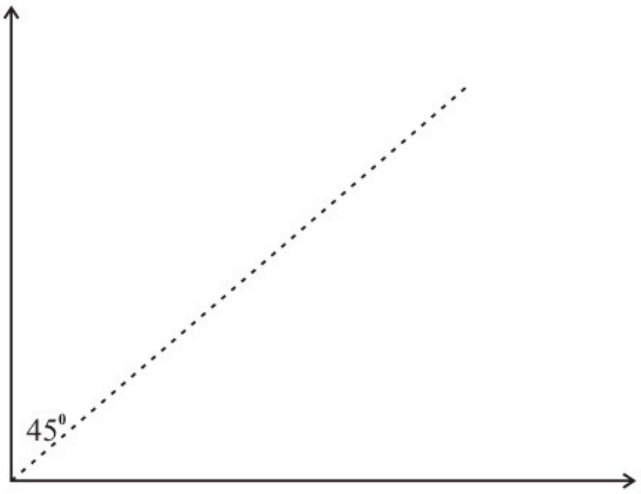
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(v) Why should we not take readings for small values for l_1 and l_2 ?

.....

.....

(C) (i) Draw the rough shape of the graph you can obtain based on the readings you obtained on the axes given.



(ii) Two points taken from the relevand graph are shown below.

(19, 14) (45, 34) Find the value of M in grams.

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(iii) Keeping 60 cm mark of the metre rule on the knife edge and balance it m, is hanging first part of the ruler and M is last part of the ruler which same distance from the knife edge. What is the hanging distance from the balance point. mass of the meter ruler is 30 g and center of gravity is located at the 50 cm position.

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(02) To find the speed of air, you are provided both ends open tube with 2.5 cm diameter and about 50 cm long tube, Known frequency tuning fork, meter rule, tall Jar, water, supporter.

(a) (i) Draw the equipment setup for do the experiment, in the figure

(ii) What is the need to immerse the tube in water ?

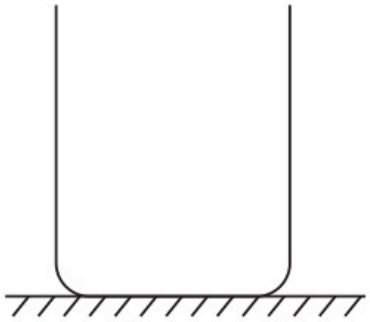
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(iii) What type of wave is formed inside the tube at resonance ?

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(b) (i) You are provided known frequency tuning fork and told to get the first harmonic length l_0 . What is the procedure to follow for this.

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(ii) How to get second harmonic length l_1 ?

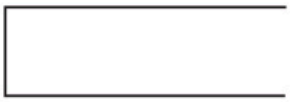
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(iii) Show and mark in the figure above, how to obtain the resonance length l neglecting the end correction.

(iv) Draw the vibration pattern of the first harmonic in the figure below. Mark the end correction e.

Below that to draw the second harmonic vibration pattern, draw the tube properly and draw the vibration patten.



(v) If the wave length of the first harmonic is λ_1 and second harmonic is λ_2 underline the correct answer.

(1) $\lambda_1 < \lambda_2$ (2) $\lambda_1 = \lambda_2$ (3) $\lambda_1 > \lambda_2$

(vi) The intensity of the first harmonic is I_1 and second harmonic is I_2 underline the correct answer.

(1) $I_1 > I_2$ (2) $I_1 = I_2$ (3) $I_1 < I_2$

(C) (i) If λ is the wave length corresponding to the first harmonic , write down an expression for λ in terms of l_0 and e.

.....

(ii) Write down a similar expression for the wave length corresponding to the second harmonic in terms of l_1 and e.

.....

(iii) If V is the speed of sound in air, derive an expression for V in terms of known and measurd quantities f, l_1 and l_0

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(iv) Frequency of the used tuning fork is f = 512 Hz. If corresponding resonance lengths of two 20.5 cm and 55. 5 cm. Calculate the speed of sound in air.

.....

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(v) What additional quantity is needed to express the result meaningfully ?

.....

(vi) If the speed of the sound in air at 27^0C room temperature is 240 ms^{-1}. Find the speed of the sound when the room temperature rises to 37^0C

Take as $\sqrt{\frac{31}{30}} = 1.02$

.....

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(03) The figure shows an apparatus used to study how the pressure of a gas changes with temperature while keeping the volume constant.

(a) (i) Complete the setup with other essential items needed.

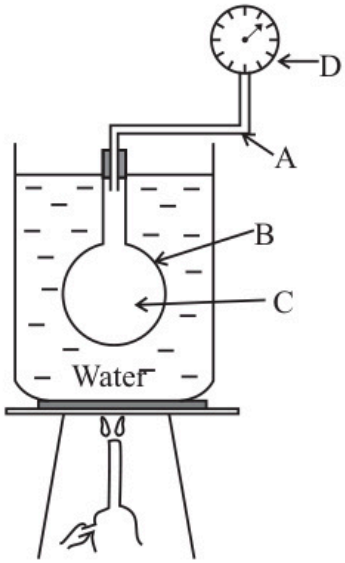
(ii) Name the following parts.

A - .....

B - .....

C - .....

D - .....



(iii) Write the expected rule to be confirmed here.

.....

.....

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(iv) What is the reason part B to sink in water ?

.....

(v) Why should the walls of the beaker be thin ?

.....

(vi) What should the form of the tube be like. What is the reason for that ?

.....

(b) (i) Here you are taking what quantity as the independent variable.

.....

(ii) Give two important steps to follow in obtaining it.

.....

.....

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(iii) What is taken as the dependent variable ?

.....

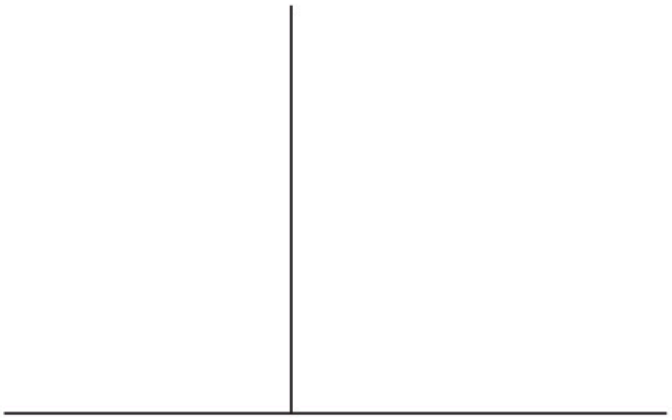
(iv) When will we get it ?

.....

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(C) Use the following axes to draw the relevant graph **based on the readings obtained.**

(i) Name the axes with the units.

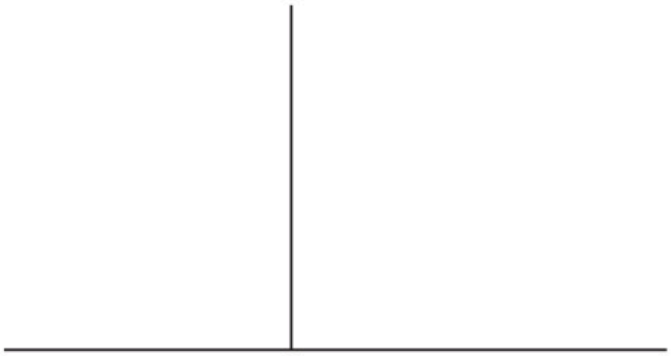


(ii) Draw the outline of the graph.

(iii) Mark the point, where the graph is cut horizontal line and write its value with units.

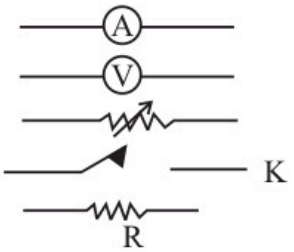
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(iv) Draw the outline of the graph, that would be obtained if the independent variable is taken in SI units. labeling the axes with units.



(04) You are provided with the following, to find the e. m. f (E) and internal resistance r of the dry cell.

A milli ammeter
A digital voltmeter
(0 - 100) Ω rivastat
Tap key
10 Ω resistance
Connecting wire



(A) (i) Complete the circuit diagram using the symbols above.



(ii) What is the reason for using a digital voltmeter here ?

.....

.....

(iii) If the e. m. f of the cell is E and internal resistance is r, currant in the circuit is I, terminal potential difference of the cell is V, write down the expression for E.

.....

(iv) What will you use as the independent variable in the experiment ?

.....

Explain how it varies

.....

What is used as the dependent variable ?

.....

(v) Arrange the above relation as appropriate to draw a graph.

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(b) (i) After set up the equipment as above explain how to obtain a pair of initial readings.

.....

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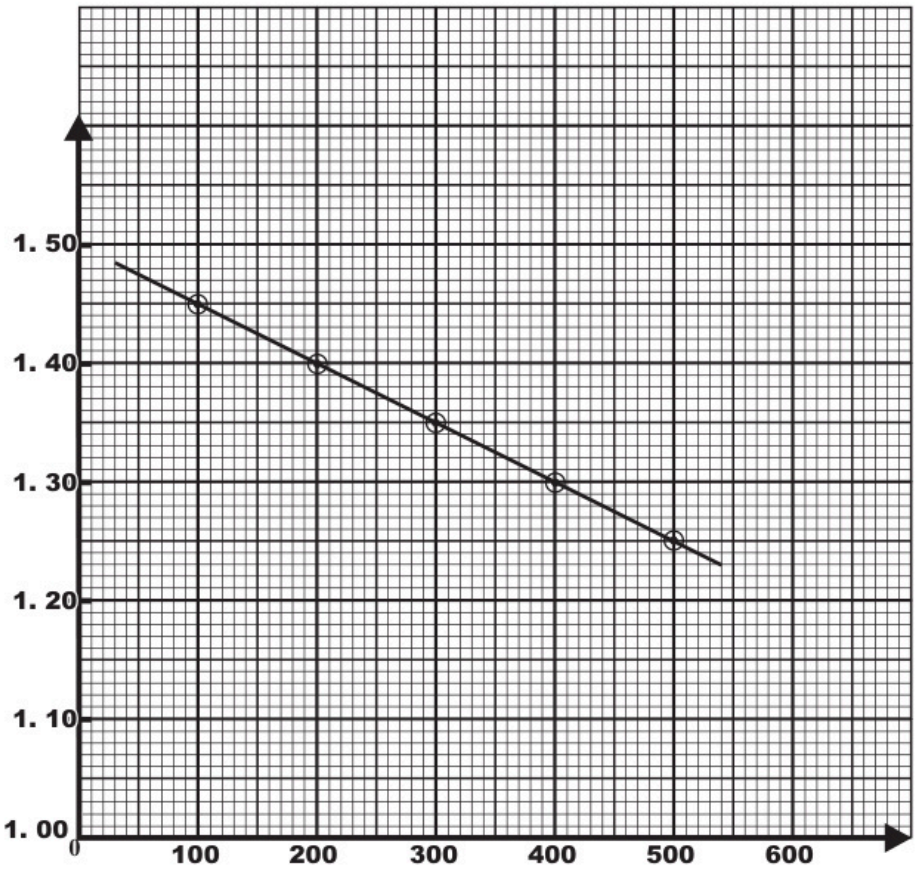
(ii) How to experimentally confirm cell was not discharged, during the experiment ?

.....

.....

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(C) A graph drawn based on the readings obtained is shown below.



(i) Label the axes with units.

(ii) Mark the **more suitable** two point to find the gradient.

(iii) By this find the internal resistance of the cell.

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(iv) By using the graph, find the e. m. f of the cell.

.....

(v) Find the short circuit current of the cell.

.....

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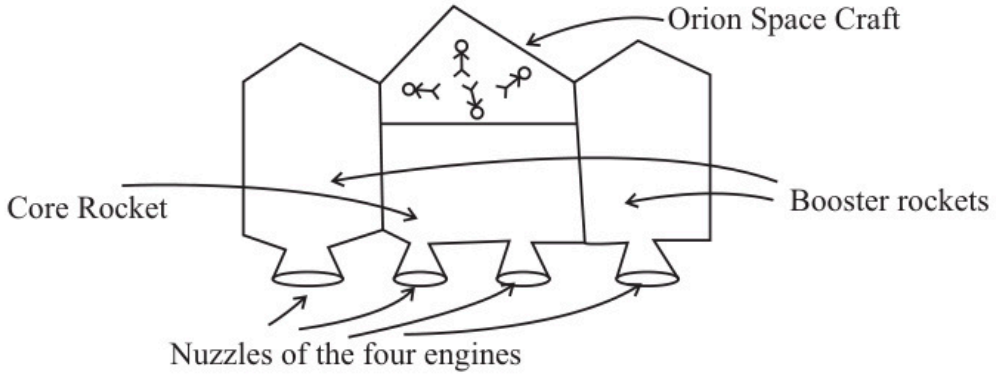
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Essay

(05) Below figure shows Space Launch System (SLS) of Artemis II program, designed to send astronauts around the Moon and safely return them to Earth. This Space Launch System consists of two booster rockets, core rocket and Orion space craft as shown in the below figure. The purpose of SLS is to carry the Orion space craft to a higher altitude. For all the calculations assume that all the motions are vertical and gravitational acceleration g = 10 m s^{-2} and constant. Neglect the air resistance.



(a) The initial mass of the SLS is 4 x 10^6 kg and it has four engines that provide equal and constant thrust at all the time. Initial acceleration of the SLS is 2 m s^{-2}.

(i) What is the initial thrust provided by the four engines to leave the launching pad ?

(ii) The thrust necessary for the upward motion is obtained by burning the fuel and expelling the hot gas by the nuzzles of the engines. If the hot gas is expelled with the velocity 4 x 10^3 m s^{-1} relative to the nuzzles, find the rate of burning of fuel by the four engines.

(iii) Find the initial resultant force acting on the SLS.

(iv) Find the resultant force acting on the rocket 2 minutes after the take off.

(v) Assume that the resultant force acting on the SLS increases linearly with time. Plot the variation of resultant force (F) acting on the SLS with time (t) for the first two minutes.

(vi) If the initial velocity of the SLS is zero, find the velocity of SLS after 2 minute from the take off.

(b) Two minutes after the take off, the fuel in the booster rockets ran out and engines of the booster rockets stopped. Therefore, at the instant when booster engines stopped, two booster rockets are detached from SLS.

(i) If the mass of a booster rocket without fuel is 6.4 x 10^5 kg, find the acceleration of SLS immediately after the booster rockets are detached.

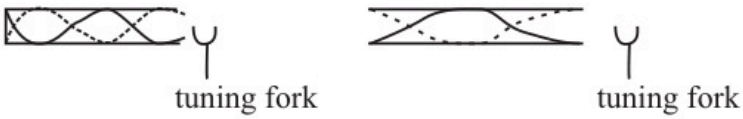
(ii) Find the acceleration of SLS 1 minute after the booster rockets are detached. (Find the answer to the first decimal place in scientific notation.)

(iii) If the acceleration increases linearly with time, plot the acceleration (a) - time (t) graph for the period of 1 minute after the booster rockets are detached and find the velocity of SLS after 1 minute from the detachment of booster rockets.

(c) 1 minute after booster rockets are detached, the fuel in the core rocket ran out. At that instant, Orion space craft is projected vertically up from the core rocket. The mass of Orion space craft is 2×10^5 kg. If the core rocket moves up with the velocity 1200 m s^{-1} immediately after the Orion space craft is projected up, find the velocity of the Orion space craft immediately after it is projected.

(06) When a sound source is placed near the open end of a tube of uniform cross-section and it's frequency is varied, at a certain point the tube will resonate with the source. When the frequency of the source is changed, the intensity of the sound produced in the tube changes. At the point of resonace, it will vibrate with maximum intensity. Thus, let us consider the standing waves produced in the tube.

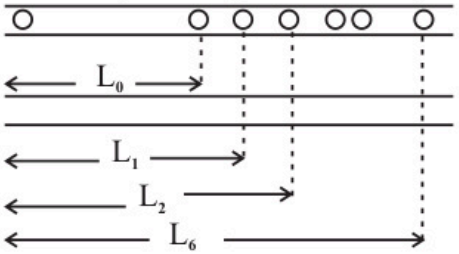
When sound source such as a tuning fork vibrates near the open end, the resulting sound waves travel forward through the tube and are reflected, the super position of incident and reflected waves produces standing waves. standing waves are formed in both closed and open tubes, as shown in the below figure.



More important is that the waves generated in a tube by the air layers vibrating in a transverse motion reflected at both ends of the tube. A sound wave traveling through a one end closed tube is reflected at its closed end. This is similar to the echo of a voice when a sound wave is reflected off a wall in front of it. A sound wave does not undergo inversion when it is reflected by a rigid reflection. There is no 180^0 phase difference. A pressure compression is reflected while remaining as a pressure compression during reflection. A sound wave travelling through an open tube towards an open end is reflected near the open end.This is known as partial reflection in which only about 1 % of the energy generated in the tube is released to the environment. If not the sound produced by a musical instrument such as flute should not spread to the surrounding area. Most of the sound wave is reflected back into the tube at the open end as follows in a both end open tube.

The pressure near the open end of the tube is initially at atmospheric pressure and when a displacement antinode reaches the open end of the tube, the pressure around it immediately drops below atmospheric pressure. To balance the pressure drop the air molecules around the open end moves into the tube with a high momentum and compress the air molecules inside the tube near open end. Thus, the compression near the open end causes the wave to reflect back along the tube. A sound wave reaching an open end is not only reflected but also inverted.

A standard six-hole flute is shown in the figure below. In it's simplest form, this flute can be considered equivalent to a set of two open - ended pipes. The corresponding lengths of the open ended tubes equivalent to flute also shown in the figure. when all the holes are open it is equal to the open tube. When the first hole is closed the length inside the tube becomes L_1 ,and when the first two holes are closed at the same time, the length becomes L_2. When all the holes are closed, the length becomes. L_6.

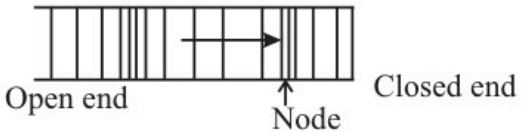


Following shows the note, the player is playing the number of holes they are closing, and the corresponding frequencies.

note	Closed hole ⊗	fundamental frequency
A4	⊗ ⊗ ⊗ ⊗ ⊗ ⊗	440 Hz
B4	O ⊗ ⊗ ⊗ ⊗ ⊗	493.88 Hz
C5	O O ⊗ ⊗ ⊗ ⊗	523.25 Hz
D5	O O O ⊗ ⊗ ⊗	587.33 Hz
E5	O O O O ⊗ ⊗	659.25 Hz

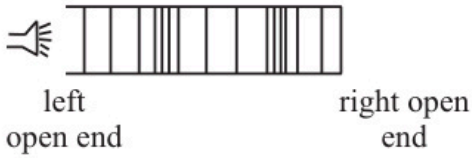
(a) State the principle of superposition.

(b) Draw the reflected wave in a closed tube for the incident wave given below and express it using the leading node.



(c) Sketch the variation of pressure with distance for the incident wave shown above.

(d) Draw the reflected wave of the incident wave given for a tube open at both ends.



(e) (i) Draw the pressure variation along the pipe regarding to fundamental tone.

(ii) Draw the displacement variation regarding to fundamental tone.

(f) Draw the fundamental wave form and wave forms of first two over tones generated by both end open tubes seperately. Mark nodes as N and antinodes as A for the fundamental tone. Obtain an expression for fundamental tone f_o in terms of length of tube l_1, velocity of sound V.

(g) (i) If velocity of sound is $340 ms^{-1}$, find the effective length of A_4 and E_5.

(ii) Mention the 1st overtone of A_4.

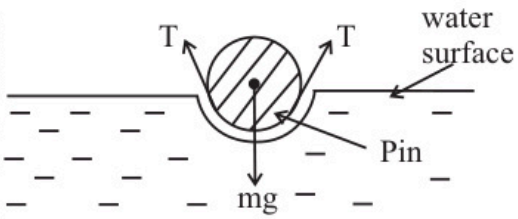
(h) At a location where the speed of sound in air is $330 ms^{-1}$, A flute maker manfactures a tube so that when A_4 switch is played it produces the exact fundamental frequency corresponding to it. At another location where the speed of sound is $333 ms^{-1}$, this flute plays the note A_4 and simultaneously sounds a tuning fork of note 440 Hz. Find the number of beats hears in one second.

(i) The flute player plays the flute by closing four holes. The sound travels into a closed tube closed at one end and resonates at the fundamental frequency. calculate the length of this closed tube. Speed of sound is $330 ms^{-1}$.

(j) Two tube closed at one end each with lengths l_1 and l_2 and same radii vibrates fundamentally. They produce n pulses with in time t seconds. If the difference of the lengths of the tube is x, show that the speed of sound in air $V = \frac{4nl_1l_1}{tx}$

(Neglect end error of the tubes)

(07) (A) Small insects like water striders walk on the surface of still pond. similarly, when a small pin is placed on the surface of the water, it floats on the surface of the water, it floats on the surface with out sinking. As shown in the figure, since the pin is not submerged in the water, no upward thrust acts on it. It's weight is balanced by an upward force exerted by the free surface of the water.



From the above phenomena, it is clear that the surface of a liquid is streched like an elastic membrane. It is considered as surface tension.

(i) Explain how the phenomenon of surface tension occurs on a liquid using intermolecular forces of attraction.

(ii) Define surface tension.

(iii) Write down the dimensions of the coefficient of surface tension.

(iv) Sketch the variation between surface tension and temperature.

(B) (i) When a both end open capillary tube is immersed vertically in a container of water the water level in the tube rises, while when it is immersed vertically in a container of mercury the liquid level in the tube drops. Explain above phenomena by considering surface tension forces and draw appropriate diagrams with forces for this purpose.

(ii) Obtain an expression for capillary rise h using pressure if the radius of capillary tube is r, the surface tension is T, contact angles for glass and water is θ , the density of water is ρ.

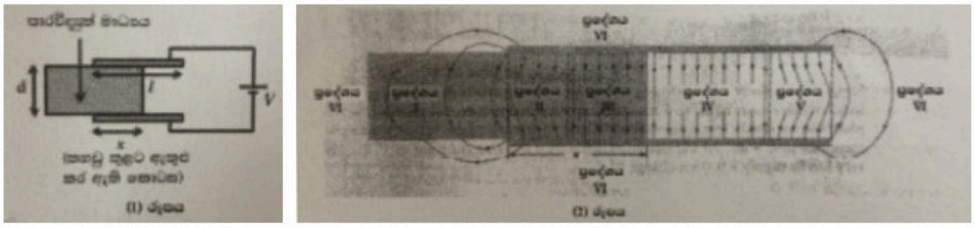
(iii) A capillary tube with a well-cleaned inner surface of radius 0.7mm is immersed vertically in distilled water of density 1000kgm^{-3} and coefficient of surface tension 7 x 10^{-2} kgs^{-2} The tube is in 30 mm height above the water surface. If the contact angle between distilled water and pure glass is zero, Find the capillary rise.

(iv) Now, the capillary tube break from a certain place such that, remaining portion above the water surface is 15mm. Draw the water meniscus in the tube at that instance. calulate the contact angle and radius of meniscus [Cos $41^0 25^1 = 0.7500$ and Sin $48^0 35^1 = 0.7500$]

(v) Internal radius of tube of a mercury barometer which used to measure atmospheric pressure is 1. 00 mm. The observed reading is 759. 8 mm. calculate the atmospheric pressure in (Hgmm) mercury millimeters by considering surface tension forces. The density of mercury is 13600 kgm^{-3}, coefficient of surface tension is 19.2 x 10^{-3} kg s^{-2}. The contact angle between glass and mercury is 135^0. (Take $\sqrt{2} = 1.414$)

Hint $|\cos(180 - \alpha)| = \cos\alpha$ Take $\frac{192 \times 1.414}{136} = 2$

(08) (1) A capacitor is created by keeping two plates of fength "*l*" and breadth 'b' parallelly with a gap "d" between them. It is connected to a battery of potential difference "v" then a dielectric medium of dielectric constant "k" and thickness "d" with the same breath as the Aforementioned plates is slowly inserted between them. consider an instance where the medium is inserted by a length "x" as shown in figure.(l)



The figure (2) differentiates six regions in this instance and the force lies in each of these. regions are represented

(1) Region I - The region of the dielectric medium from its left end, up to the front end of the plates.

(2) Region II - The region in the dielectric medium from the right end of the region I where the electric field does not remain constant

(3) Region III - The region of the dielectric medium between the plates. where a uniform electric field exists

(4) Region IV - The region containing free space where the electric field is uniform.

(5) Region V - The remaining free region where the electric field is not uniform.

(6) Region VI - The two regions on either side of the plates and the dielectric medium in the region past them.

Now the dielectric medium is pushed slightly by a distance (Δx) into the plates, from the given instance. The electric energy in the regions I, II, V and VI do not change due to this. However, the region III undergoes a volume increase of (bd) Δx while the region IV undergoes an equal volume decrease. Answer the following using the given information.

(A) (i) The quantity obtained when the electric energy (w) stored parallel plate capacitor is divided by the volume between the plate is know as its 'energy density'. Accordingly, if the energy density when the above capacitor is connected to the battery while in free space (the permittivity of free space is ε_0) is U_0 show that.

$$U_0 = \frac{1}{2}\,\varepsilon_0 \left(\frac{V}{d}\right)^2$$

(ii) Now if gap between the plates is completely filled by a medium of dielectric constant 'k' while maintaining the battery connection, show that the energy density U1 can be given by

$$U_1 = \frac{1}{2}\,K\varepsilon_0 \left(\frac{V}{d}\right)^2$$

(iii) Using the above answer, show that the increase of the stored energy when the dielectric medium which had initially been inserted upto a distance, x travels an additional distance (Δx) into the plates is given by

$$\frac{(K - 1)\,\varepsilon_0\, bV^2\,(\Delta x)}{2d}$$

(B) (i) If the increase of the capcitance of the capacitor due to the additional motion of the dielectric medium by a distance (Δx) given by (ΔC), show that,

$$U_0 = \frac{\varepsilon_0\, b}{d}\,(K - 1)\,\Delta x$$

(ii) Show that the charge of the plates will increase due to this (Δx) motion.

(iii) Show that this increase of charge $(\Delta Q) = \frac{\varepsilon_0\, b}{d}\,(K - 1)\,\Delta x\ V$

(iv) What is the additional work, $(\Delta W)_b$ which must be done by the battery in order to move the additional charge ΔQ between the plates ?

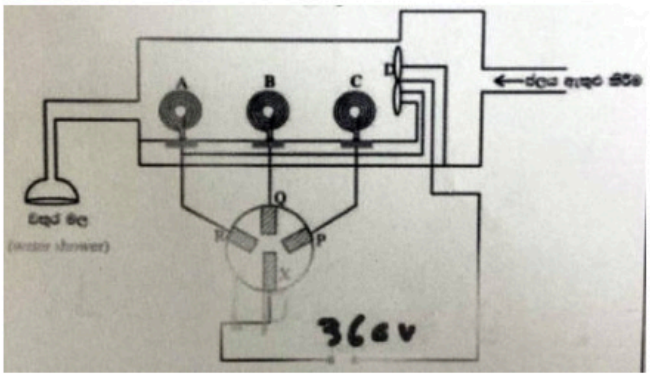
(C) (i) Consider the attraction force 'F' is exerted on the dielectric medium by the field. if so, obtain an expression for the magnitude of the external force 'F' required to move the dielectric medium by a distance (Δx) with a uniform speed and state its direction.

(ii) What is the work $(\Delta W)_c$ which must be done in order to move the dielectric by a distance (Δx) ?

(iii) By equating the sum of $(\Delta W)_c$ and $(\Delta W)_b$ to the increase of the electric energy of the capacitor, show that

$$F = \frac{\varepsilon_0\, bV^2\,(K - 1)}{2d}$$

(09) (A) A hot water shower system is designed as shown. A coils A, B, C are each 60 Ω resistors connected to the power supply. D is a 60 Ω resistor connected to a motor. The cross sectioned area of pipe is 1 cm^2.



The figure shows component P, Q, R connected to 'X', with a 360 V supply.

(a) When the "X" is connected to point "P".

(i) What is the maximum current that can flow through the circuit?

(ii) Find the maximum power output of the heating coils.

(iii) Find the maximum power consumption of motor "D"

(iv) Find the initial velocity of water being. pushed out through the pipe when "D"s motor operates of full power ant it gives total power as kinetic energy of water.

(v) Is that the flow velocity of water remain constant. Explain.

(vi) To increase the temperature of water entering the between per. $0.01^0C\ S^{-1}$. Find the volume of water in ml that can be heated per unit time (density of water = $1000kg\ m^{-3}$ $1l = 10^{-3}m^{-3}$, specific heat capaciy = $4000\ J\ kg^{-1}\ k^{-1}$)

(b) When the "x" connected to point Q.

(i) Find the maximum power cut put of heating coils.

(ii) Find the maximum power consumption of "D".

(c) When X is connected to point R, what is the maximum total power consumption of the healing coils and motor ?

(B) (a) The amplifier shown in the figure is biased so that $V_{CE} = \frac{V_{CC}}{2}$. The transistor is in the active region and Its DC current gain is β. the base current is I_B.

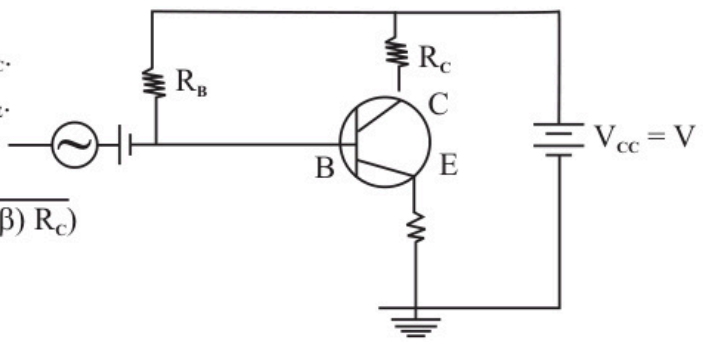
Write an expression for the,

(i) Collector current I_C.

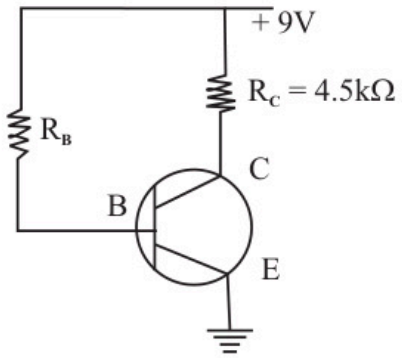
(ii) Potential difference accross R_C.

(iii) Potential difference accross R_E.

(iv) Show that $I_B = \frac{V}{2\,(\beta R_C + (1+\beta)\,R_C)}$



(b) NPN transistor shown is the figure is biased to active region.



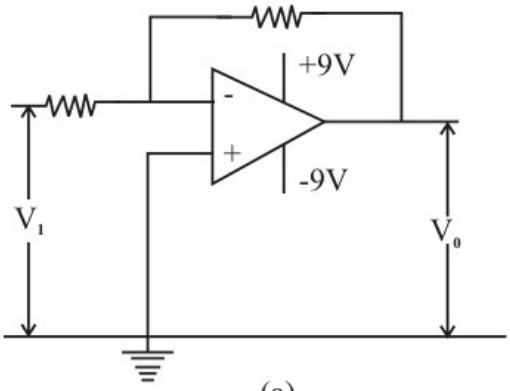
The current gain of this transistor is 200. Take $V_{CE} = 0.5V_{CC}$, $V_{BE} = 0.7V$. Find

(i) the base current I_B

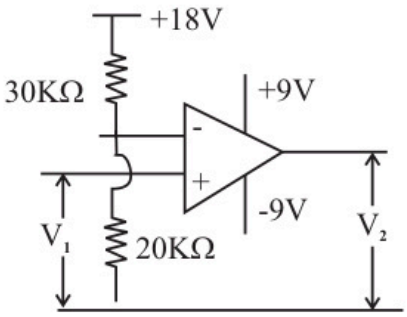
(ii) the collector current I_C

(iii) the base resistor R_B.

(c)



(a)



(b)

(i) Two op-amps (a) and (b) circuits are shown above which one operates as,

(1) Voltage comparator

(2) Inverting amplifier

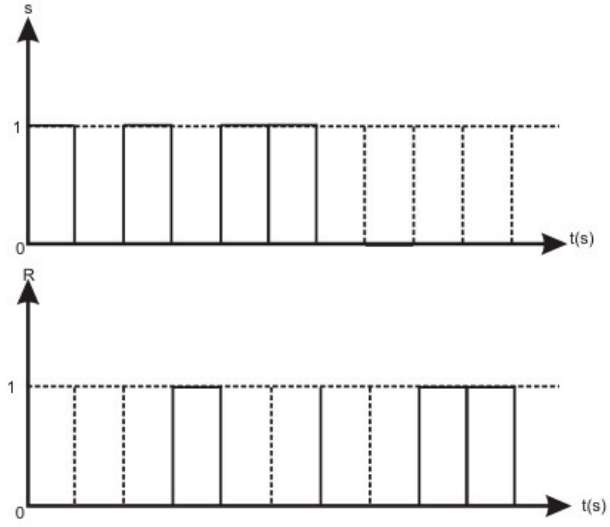
State with explanation.

(d) A flip-flop is a basic sequential logic circuit.

(i) Draw the S-R flip flip circuit using NOR logic gate and name the terminalis R, S, Q and Q.

(ii) Give the truth table of S - R flip flop

(iii) Draw the graph for out put Q which time when the following signals are provided. to S, R of S - R flip flop ?



(10) (A) Two solid spheres A and B are made of the same material with identical surface properties. The radius of sphere A is r and that of sphere B is 2r. They are heated to the same temperature and then allowed to cool in the same environmental conditions. The initial rates of loss of heat of A and B are R_A and R_B respectively. The initial rates of cooling of A and B are x_A and x_B respectively.

(a) Write down Newton's law of cooling.

(b) Define the term specific heat capacity of an object.

(c) Find the ratio of $\frac{R_A}{R_B}$. That is the ratio of initial rates of loss of heat of A and B.

(d) Find the ratio of $\frac{x_A}{x_B}$. That is the ratio of initial rates of cooling of A and B.

(e) Sphere (A) cool from 62^0C to 50^0C in a steady air flow in 10 minutes. Room temperature is 26^0C. Find its temperature at the end of the next 10 minutes.

(f) Then the sphere (B) is heated up to 100^0C and dropped in to a copper vessel of mass (0.04 kg) containing water of mass 0.2kg at a temperature of 16^0C . The mass of the sphere B is 0. 1kg. The final temperature of the mixture is 24^0C. Calculate the specific heat capacity of the metal B. Specific heat capacity of copper is 400 J kg^{-1} C^{-1} and specific heat capacity of water is 4200 J kg^{-1} C^{-1}.

(10) (B) Consider the decay of radioactive ^{210}Po (Polonium) atom which is at rest into a daughter atom ^{206}Pb (lead) and an $^4\alpha$ particle.

$$^{210}Po \rightarrow {}^{206}Pb + {}^4\alpha + \text{Energy (E)}$$

A radioactive sample contains 0.21g of polonium (^{210}Po). Half life of polonium is 160 days.

(a) What is the SI unit of activity.

(b) Write down the law of radioactivity in words.

(c) Define the half - life of a radioactive sample.

(d) Find the initial number (N_0) of ^{210}Po atoms in the sample.
(Take Avogadro constant $= 6 \times 10^{23}$ mol^{-1}, Molar mass = 210 g mol^{-1})

(e) Find the decay constant (λ) of Polonium.

(Take $\lambda = \frac{0.7}{T_{½}}$)

(Take $\frac{7}{16 \times 24 \times 36} = 5 \times 10^{-4}$)

(f) Find the initial activity of the sample. ($A = \lambda N_0$)

(g) Find the number of radioactive ^{210}Po atoms in the sample after 480 days.

(h) Find the activity of the sample after 480 days.

(i) Calcium has a work function of 2.7 eV. calculate the following.

(i) What is the work function of calcium expressed in J ? (1 eV = 1.6×10^{-19} J)

(ii) What is the maximum wave length that will cause emission from calcium.
(Plank constant (h) = 6.6×10^{-34} Js, speed of light in vaccum (C) = 3×10^8 ms^{-1}).

(iii) Calculate the maximum kinetic energy in joules, of the electrons emitted when calcium is illuminated with ultra violet radiation of frequency 1.7×10^{15} Hz

(iv) What is the stopping potential for these electrons
(electronic charge (e) = 1.6×10^{-19}C)

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Provincial Department of Education - NWP

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Third Term Test - Grade 13 - 2026

Physics (Answer Paper)

1. (5)	11. (2)	21. (3)	31. (5)	41. (5)
2. (4)	12. (1)	22. (2)	32. (1)	42. (4)
3. (1)	13. (5)	23. (4)	33. (5)	43. (1)
4. (4)	14. (3)	24. (3)	34. (2)	44. (2)
5. (1)	15. (2)	25. (4)	35. (1)	45. (2)
6. (4)	16. (2)	26. (1)	36. (2)	46. (3)
7. (2)	17. (5)	27. (5)	37. (1)	47. (4)
8. (2)	18. (4)	28. (2)	38. (4)	48. (3)
9. (4)	19. (5)	29. (4)	39. (3)	49. (5)
10. (2)	20. (4)	30. (5)	40. (4)	50. (5)

Part - A - Essay

(01) Using the principle of momentum, we need to find the value of an unknown mass of M approximately 60 g, using a graphical method. For this, you have been provided with a tall wooden block, a uniform meter ruler and pieces of twine.

(a) (i) Underline the mass you choose from the masses given below as the unknown mass

50 g (01 m.)

(ii) Give a reason for your choice.

To get more readings or to obtain a good spread between the readings. (01 m.)

(iii) At the beginning we can find some data to by balancing the meter ruler on the kinfeedge what is it ?

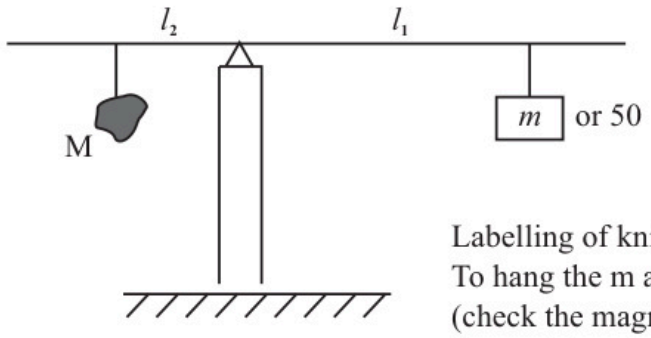
Center of gravity of the Meter ruler (01 m.)

(iv) ☺What is the reason, important it for the experiment ?

To avoid the mass of the Meter ruler in the calculations. (01 m.)

(b) (i) Using above balanced situation, Draw a diagram of the arranged experimental setup.

Mark the balanced lengths from the balanced point to the mass as larger length l_1 and shote length l_2. Name the items. (01 m.)



l_1 m = l_2 m (01 m.)

Labelling of knife edge and meter ruler. (01 m.)
To hang the m and M (01 m.)
(check the magnitude of l_1 and l_2)
To mark l_1 and l_2 correctly. (01 m.)

(ii) Get the expression for l_2 in terms of m, M and l_1 when the system is balanced.

l_1 m = l_2 M (01 m.)

$l_2 = \frac{m}{M} l_1$ (01 m.)

(iii) What is the reason for choosing indipendent veriable as l_1 ?

to confirm that to set all the dependent variables for the selected independent variables (since $l_1 > l_2$) (01 m.)

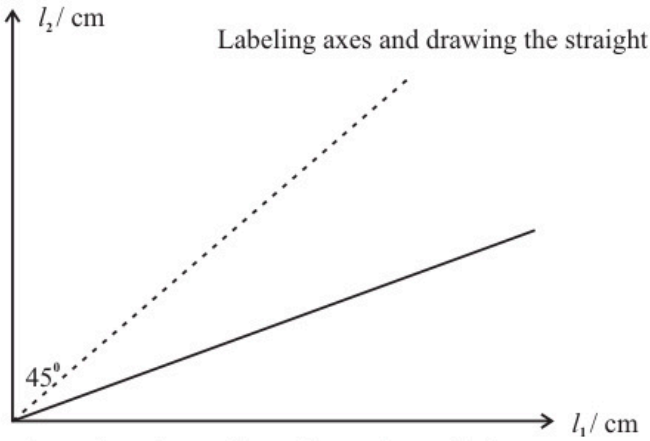
iv) When take a different set of reading for l_1 and l_2, what should not be changed in the meter ruler ?

position of the Center of gravity of the Meter ruler in the Knife age (01 m.)

(v) Why should we not take readings for small values for l_1 and l_2 ?

to reduce the fractional / percentage error of the Length measurement (01 m.)

(C) (i) Draw the rough shape of the graph you can obtain based on the readings you obtained on the axes given.



Labeling axes and drawing the straight line. (01 m.)

(ii) Two points taken from the relevand graph are shown below.

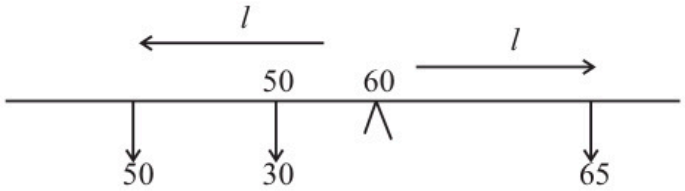
(19, 14) (45, 34) Find the value of M in grams.

gradient = $\frac{34 - 14}{45 - 19} = \frac{20}{26} = \frac{10}{13}$ (01 m.)

$\frac{m}{M} = \frac{10}{13}$ (01 m.)

$M = \frac{13}{10} \times 50 = 65$ g (01 m.)

(iii) Keeping 60 cm mark of the metre rule on the knife edge and balance it m, is hanging first part of the ruler and M is last part of the ruler which same distance from the knife edge. What is the hanging distance from the balance point. mass of the meter ruler is 30 g and center of gravity is located at the 50 cm position.



$50l + (30 \times 10) = 65l$ (01 m.)

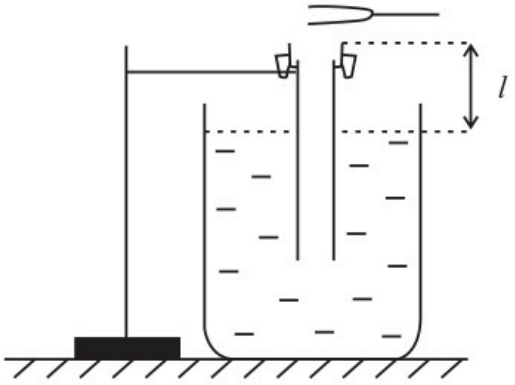
$15l = 300$

$l = 20$ cm (01 m.) (Total 20 m.)

(02) To find the speed of Air, you are provided both ends open tube with 2.5 cm diameter and about 50 cm long tube, Known frequency tuning fork, meter rule, tall Jar, water, supporter.

(a) (i) Draw the equipment setup for do the experiment, in the figure

Correct diagram with the stand and tube. (01 m.)
The ends of the prongs of the tunning fork should lie in the middle of the tube (01 m.)



(ii) What is the need to immerse the tube in water ?

to produce a closed end tube with variable length. (01 m.)

(iii) What type of wave is formed inside the tube at resonance ?

Stationary wave. (01 m.)

(b) (i) You are provided known frequency tuning fork and told to get the first harmonic length l_0. What is the procedure to follow for this.

fully immersed the Tube and increase the length of the Air column until maximum sound is heard first time. (01 m.)

(ii) How to get second harmonic length l_1?

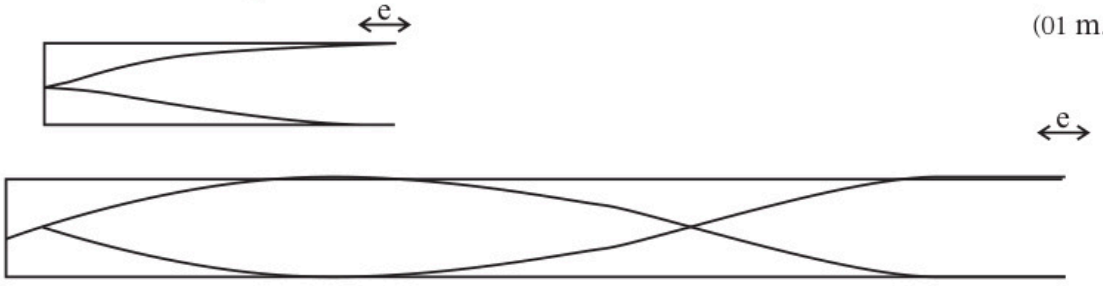
after getting l_0, then increase the Length of the Air column until maximum sound is heard again. (01 m.)

(iii) Show and mark in the figure above, how to obtain the resonance length l neglecting the end correction.

correctly mark the l (01 m.)

(iv) Draw the vibration pattern of the first harmonic in the figure below. Mark the end correction e.

Below that to draw the second harmonic vibration pattern, draw the tube properly and draw the vibration patten.



(01 m.)

Length of the tube (in the second tube) would be three times compaired to the first tube. (02 m.)

(v) If the wave length of the first harmonic is λ_1 and second harmonic is λ_2 underline the correct answer. (01 m)

(1) $\lambda_1 < \lambda_2$ (2) $\lambda_1 = \lambda_2$ (3) $\lambda_1 > \lambda_2$

(vi) The intensity of the first harmonic is I_1 and second harmonic is I_2 underline the correct answer. (01 m)

(1) $I_1 > I_2$ (2) $I_1 = I_2$ (3) $I_1 < I_2$

(C) (i) If λ is the wave length corresponding to the first harmonic , write down an expression for λ in terms of l_0 and e.

$\lambda = 4 (l_0 + e)$ (01 m.)

(ii) Write down a similar expression for the wave length corresponding to the second harmonic in terms of l_1 and e. (01 m.)

$\lambda = \frac{4}{3} (l_1 + e)$

(iii) If V is the speed of sound in air, derive an expression for V in terms of known and measurd quantities f, l_1 and l_0

$2\lambda = 4 (l_1 - l_0)$

$\lambda = 2 (l_1 - l_0)$ (01 m.)

$V = f\lambda$

$V = 2f_0 (l_1 - l_0)$ (01 m.)

(iv) Frequency of the used tuning fork is f = 512 Hz. If corresponding resonance lengths of two 20.5 cm and 55. 5 cm. Calculate the speed of sound in air.

$V = 2 \times 512 (55.5 - 20.5) \times 10^{-2}$

$= 358.4 \text{ ms}^{-1}$ (01 m.)

(v) What additional quantity is needed to express the result meaningfully ?

Room temperature (01 m.)

(vi) If the speed of the sound in air at 27^0C room temperature is 240 ms^{-1}. Find the speed of the sound when the room temperature rises to 37^0C

$\sqrt{\frac{31}{30}} = 1.02$

$V \alpha \sqrt{T}$

$\frac{240}{V} = \sqrt{\frac{273 + 27}{273 + 37}}$ (01 m.)

$V = 240\sqrt{\frac{310}{300}} = 240 \times \sqrt{\frac{31}{30}}$

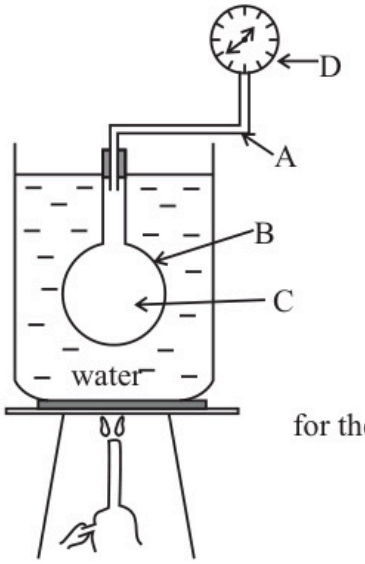
$= 240 \times 1.02$

$= 244.8 \text{ ms}^{-1}$ (01 m.)

(Total 20marks)

(03) The figure shows an apparatus used to study how the pressure of a gas changes with temperature while keeping the volume constant.

(a) (i) Complete the setup with other essential items needed.



for the stirrer and thermo meter (02 m.)

(ii) Name the following parts.

A - Capillary tube

B - Round bottomed flask

C - Fix mass of dry gas

D - Pressure guage (02 m.)

(iii) Write the expected rule to be confirmed here.

The Pressure of a given Mass of a Gas is directly proportional to it's absolute Temperature, provided that the Volume remains constant ($P \alpha T$) (02 m.)

(iv) What is the reason part B to sink in water ?

To heat the Gas uniform. (01 m.)

(v) Why should the walls of the beaker be thin ?

To equal the temperature of the Gas and the temperature of Water. (01 m.)

(vi) What should the form of the tube be like. What is the reason for that ?

Thin (01 m.)

to minimize / neglect the amount of Gas outside the Bulb (not in the required temperature.) (01 m.)

(b) (i) Here you are taking what quantity as the independent variable.

Reading of the Thermometer (01 m.)

(ii) Give two important steps to follow in obtaining it.

- Heat the Water in the Beaker while stirring and when the temperature has risen by about 10^0C remove the Burner and when the temperature become still note down the temperature reading. (02 m.)

(iii) What is taken as the dependent variable ?

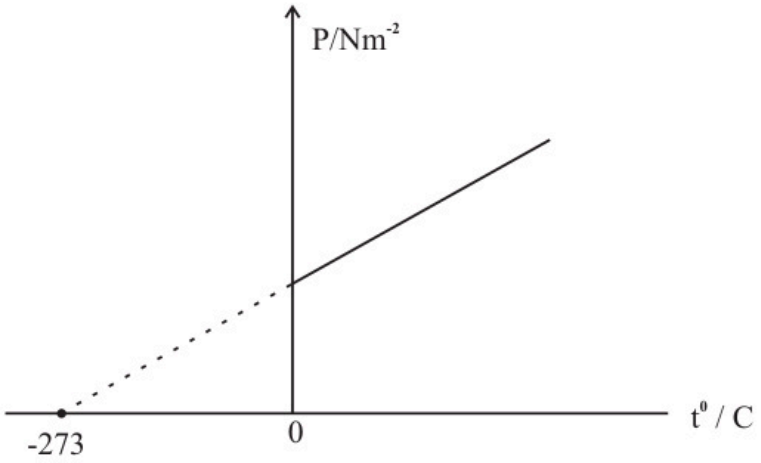
Reading of the Pressure guage. (01 m.)

(iv) When will we get it ?

Get the reading of the Pressure guage just after getting the Thermometer reading. (01 m.)

(C) Use the following axes to draw the relevant graph **based on the readings obtained.**

(i) for labeling the axes with unit. (01 m.)



(ii) Draw the outline of the graph. To the graph (01 m.)

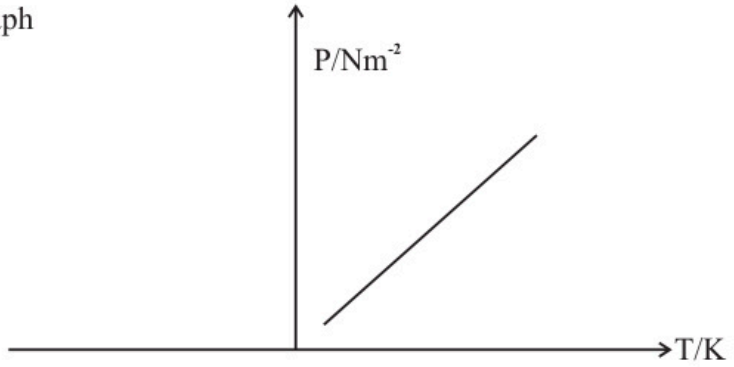
(iii) Mark the point, where the graph is cut horizontal line and write its value with units.

To mark the -273 value (01 m.)

(iv) Draw the outline of the graph, that would be obtained if the independent variable is taken in SI units. labeling the axes with units.

For labeling the Axes with Unit. (01 m.)

For the Graph (01 m.)



(Total 20 marks)

(04) You are provided with the following, to find the e. m. f (E) and internal resistance r of the dry cell.

A Milli ammeter — (A)

A Digital voltmeter — (V)

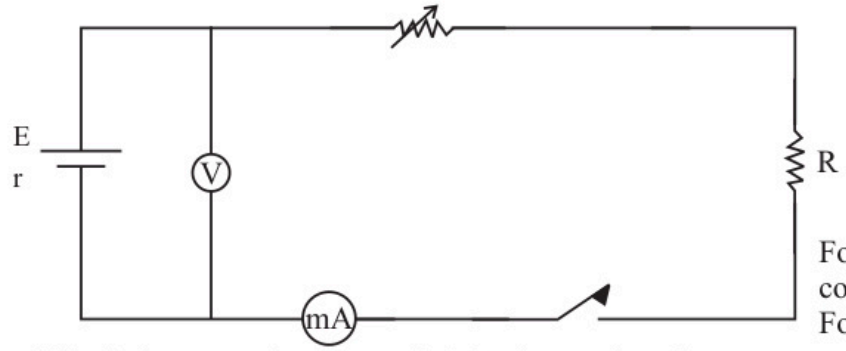
(0 - 100) Ω Rivastat

Tap key — K

10 Ω Resistance — R

Connecting wire

(a) (i) Complete the circuit diagram using the symbols above.



For the connection of (V) (01 m.)
For the other connections (01 m.)

(ii) What is the reason for using a digital voltmeter here ?

It has a high Internal resistansce. we can neglect the current flowing through it. (01 m.)

(iii) If the e. m. f of the cell is E and internal resistance is r, currant in the circuit is I, terminal potential difference of the cell is V, write down the expression for E.

$E = V + Ir$ (01 m.)

(iv) What will you use as the independent variable in the experiment ?

Independent variable (I) (01 m.)

Explain how it varies

By changing the value of Rheostat (01 m.)

What is used as the dependent variable ?

Reading of (V) (01 m.)

(v) Arrange the above relation as appropriate to draw a graph.

$V = -rI + E$ (01 m.)

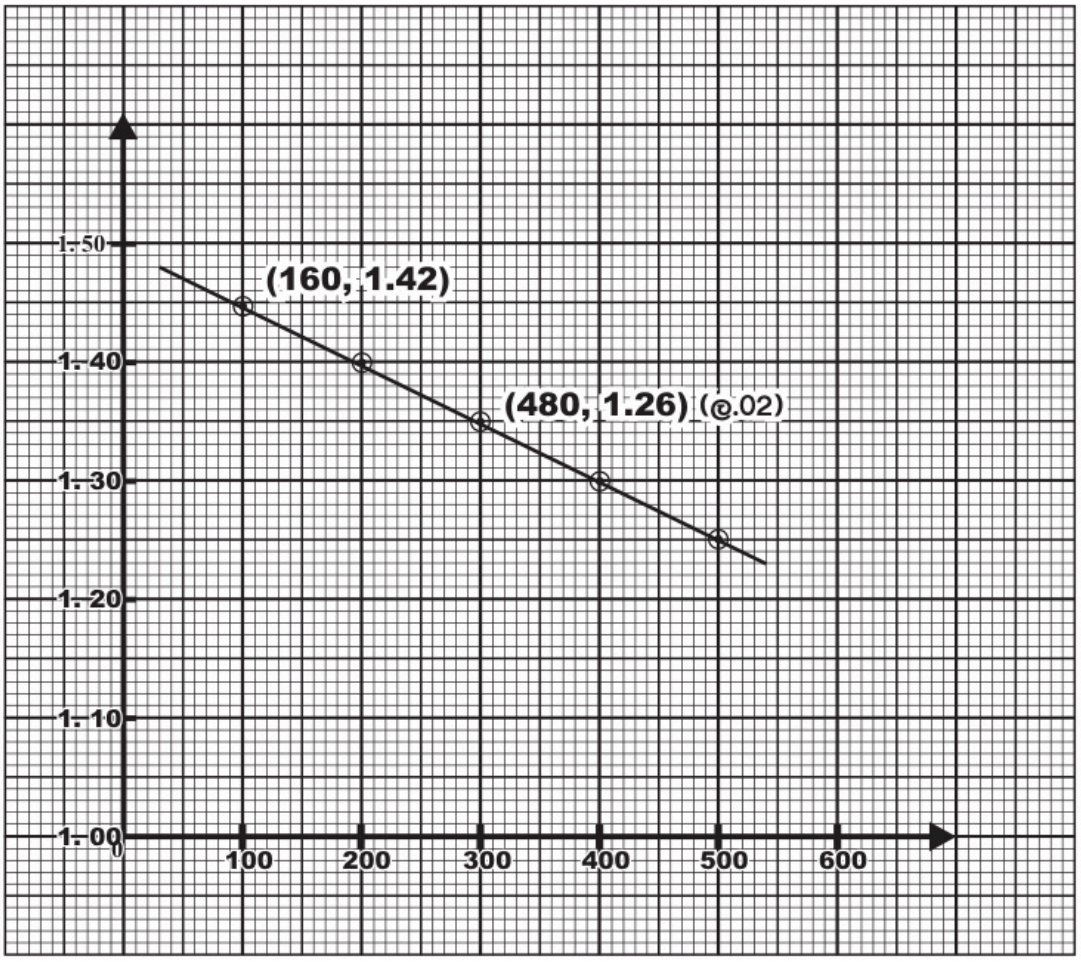
(b) (i) After set up the equipment as above explain how to obtain a pair of initial readings.

- Keep the Resistance of the Rheostat at the maximum value (switch K open)
- Taking the (V) reading (01 m.)
- Taking the (A) reading (01 m.)

(ii) How to experimentally confirm cell was not discharged, during the experiment ?

After taking the final reading go back to the first reading and check it's value again. to see if it is different (01 m.)

(C) A graph drawn based on the readings obtained is shown below.



(i) Label the axes with units. x axis $\rightarrow$ I / mA (01 m.) y axis $\rightarrow$ V / V (01 m.)

(ii) Mark the **more suitable** two point to find the gradient. (01 m.)

(iii) By this find the internal resistance of the cell.

$$r = \frac{1.42 - 1.26}{(160 - 480)\ 10^{-3}} \quad \text{(01 m.)}$$

$$= \frac{0.16}{-320 \times 10^{-3}} = \frac{160}{320} = \frac{1}{2}$$

$$= 0.5\Omega \quad \text{(01 m.)}$$

(iv) By using the graph, find the e. m. f of the cell.

1.5V (01 m.)

(v) Find the short circuit current of the cell.

$$I = \frac{5}{r} \quad \text{(01 m.)}$$

$$= \frac{1.5}{0.5} \quad \text{(01 m.)}$$

$$= 3\ A \quad \text{(01 m.) (Total 20 marks)}$$

Part - B - Essay

(05) (A) (i) $F = ma \uparrow$

$F - 4 \times 10^6 \times 10 = 4 \times 10^6 \times 2$ (01 m.)

$\underline{\underline{F = 4.8 \times 10^7 \text{ N}}}$ (01 m.)

(ii) $F = \dfrac{mv - mu}{t}$ (01 m.)

$F = \dfrac{m}{t}(v - u)$

$4.8 \times 10^7 = \dfrac{m}{t}(4 \times 10^3 - 0)$ (01 m.)

$\dfrac{m}{t} = \underline{\underline{1.2 \times 10^4 \text{ kg s}^{-1}}}$ (01 m.)

(iii) $F = ma$

$F = 4 \times 10^6 \times 2$

$\underline{\underline{F = 8 \times 10^6 \text{ N}}}$ (02 m.)

(iv) Mass of fuel burnt in 2 minutes $= 1.2 \times 10^4 \times 120$

$= 1.44 \times 10^6$ kg (01 m.)

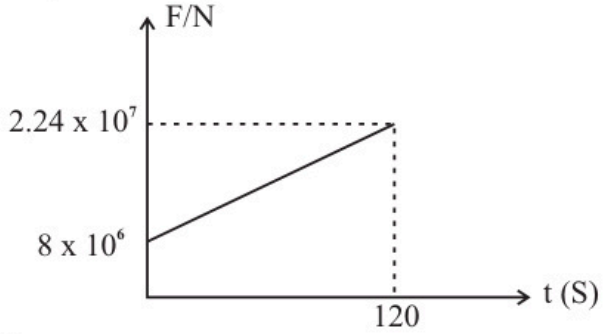
Mass of SLS $= 4 \times 10^6 - 1.44 \times 10^6$ kg

$= \underline{\underline{2.56 \times 10^6 \text{ kg}}}$ (01 m.)

$F = 4.8 \times 10^7 - 2.56 \times 10^6 \times 10$

$= \underline{\underline{2.24\ 10^7 \text{ N}}}$ (02 m.)

(iv)



(02 m.)

(vi) $Ft = mv - mu$

$\dfrac{(8 \times 10^6 + 2.24 \times 10^7) \times 120}{2} = 2.56 \times 10^6 \text{ V} - 0$ (02 m.)

$\underline{\underline{V = 712.5 \text{ ms}^{-1}}}$ (01 m.)

(b) (i) Mass of SLS $= 2.56 \times 10^6$ kg $- 2 \times 6.4 \times 10^5$ kg

$= 2.56 \times 10^6 - 12.8\ 10^5$

$= 1.28 \times 10^6$ kg (02 m.)

$\uparrow F = ma$

$\dfrac{4.8 \times 10^7}{2} - 1.28 \times 10^6 \times 10 = 1.28 \times 10^6 \text{ a}$ (01 m.)

$\underline{\underline{a = 8.75 \text{ ms}^{-2}}}$ (02 m.)

(ii) Mass of SLS $= 1.28 \times 10^6 - \dfrac{1.2 \times 10^4}{2} \times 60$ (01 m.)

$= 1.28 \times 10^6 - 36 \times 10^4$

$= \underline{\underline{0.92 \times 10^6 \text{ kg}}}$ (01 m.)

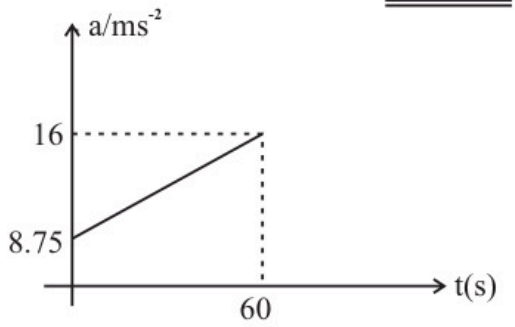
↑ F = ma

$\frac{4.8}{2} \times 10^7 - 0.92 \times 10^6 \times 10 = 0.92 \times 10^6 a$ (01 m.)

$14.8 \times 10^6 = 0.92 \times 10^6 a$

$a = 16\ ms^{-2}$ (01 m.)

(iii)



(01 m.)

Velocity increase $= \frac{(8.75 + 16)}{2} \times 60$

$= 742.5\ ms^{-1}$ (01 m.)

final velocity $= 712.5 + 742.5$

$= 1455\ ms^{-1}$ (01 m.)

(C) ↑ Conservation of liner momentum

$0.92 \times 10^6 \times 1455 = (9.2 \times 10^5 - 2 \times 10^5) \times 1200 + 2 \times 10^5 V$ (01 m.)

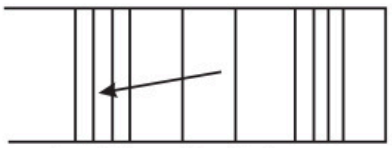
$13386 = 8.64 \times 10^3 + 2V$

$V = 2373\ ms^{-1}$ (01 m.)

(Total marks 30)

(06) (a) Waves super position (01 m.)

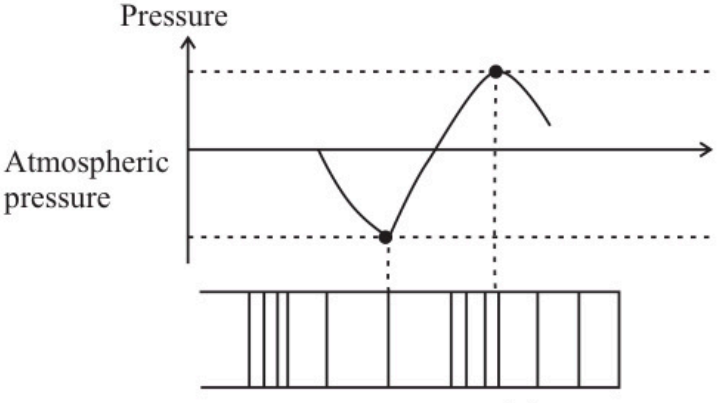
(b)



reflection of compresson as a compresson

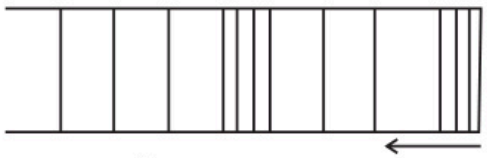
node of the reflected wave. (01 m.)

(c)



(02 m.)

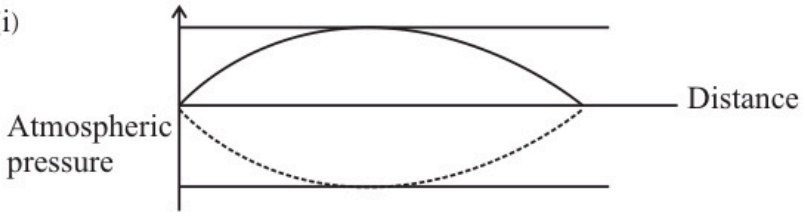
(d)



Pressure

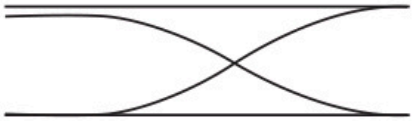
reflection of rare fraction as a compression (01m.)

(e) (i)



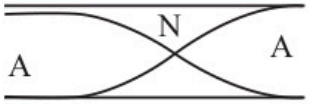
(02m.)

(ii)

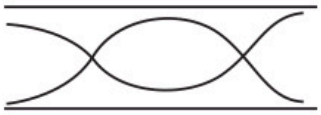


(02m.)

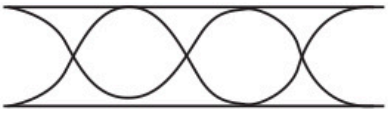
(f)



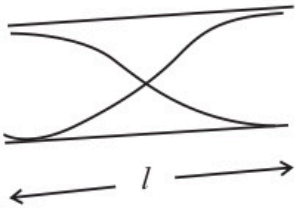
fundamental (01m.)



1st overtone (01m.)



2nd overtone (01m.)



$V = f_0 \lambda$

$\frac{\lambda}{2} = l$

$\lambda = 2l$ (01m.)

$V = f_0 . 2l$

$f_0 = \frac{V}{2l}$

(g) (i) $A_4 / f_0 = \frac{V}{2l}$

$440 = \frac{340}{2 \times l}$ (01m.)

$l_1 = 0.386$ m

$= \underline{38.6 \text{ cm}}$ (01m.)

$E_5 / f_0 = \frac{V}{2l}$

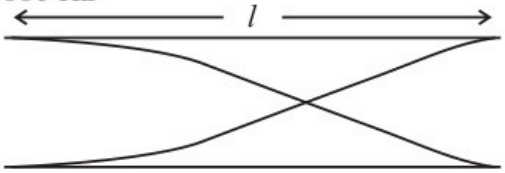
$659.25 = \frac{340}{2l_2}$ (01m.)

$l_2 = \frac{340}{2 \times 659.25}$

$= 0.257$ m

$= \underline{25.7 \text{ cm}}$ (01m.)

(ii) 880 Hz



(f)

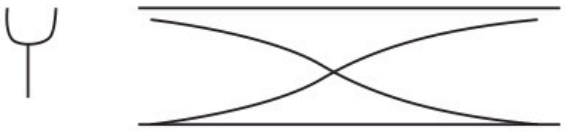
$V = 330 \text{ ms}^{-1}$

$f_0 = 440$ Hz

$V = f\lambda = f . 2l$ (01m.)

$300 = 440 \times 2l$ (01m.)

$\frac{330}{880} = l$ (01m.)



$V = f\lambda$ (01m.)

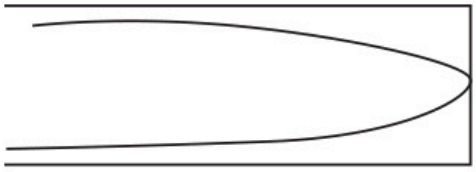
$333 = f_1 \times \frac{330}{880} \times 2$

$f_1 = 444$ Hz (01m.)

V = 333

Beat frequency = 4 Hz (01m.)

(i)



$V = f\lambda$

$V = f_0 \cdot 4l$ (01 m.)

$330 = 523.25 \times 4l$

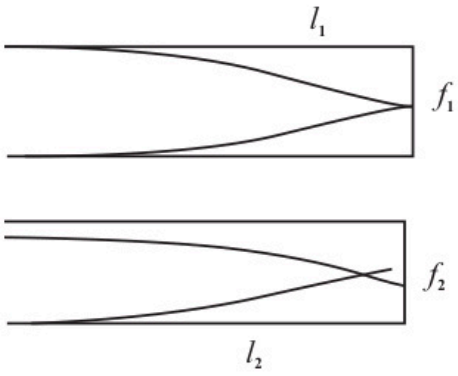
$l = \dfrac{330}{523.25 \times 4}$

$= 15.7$ cm (01m.)

$\dfrac{\lambda}{4} = l$

$\lambda = 4l$ (01m.)

(j)



$V = f_1\ 4\ l_1$

$V = f_2\ 4\ l_2$

$f_b = \dfrac{n}{t}$ (01m.)

$f_1 - f_2 = \dfrac{V}{4l_1} - \dfrac{V}{4l_2}$ (01m.)

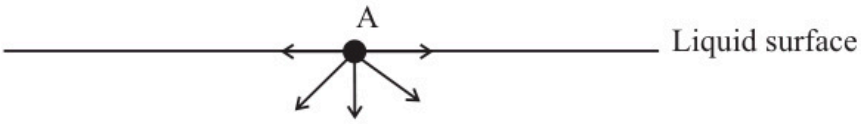
$\dfrac{n}{t} = \dfrac{V}{4}\left[\dfrac{l_2 - l_1}{l_1 l_2}\right]$ (01m.)

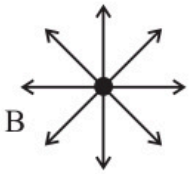
$\dfrac{n}{t} = \dfrac{V}{4}\left[\dfrac{x}{l_1 l_2}\right]$

$V = \dfrac{4n\, l_1 l_2}{tx}$ (01m.)

(Total mark 30)

(07) (A) (i)





Liquid

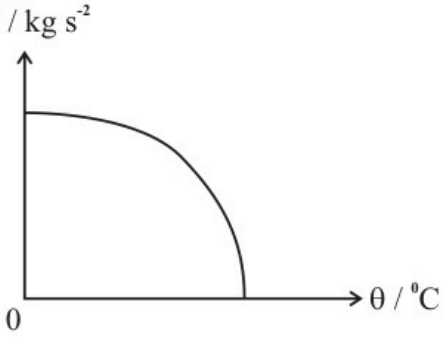
The resultant force on a Molecule such as B is zero (due to intermolecular forces). However when considering molecule A on the liquid surface the resultant force act vertically downwards. Hence the liquid surface behave as a stretched string. This arises the surface tension. (02m.)

(ii) The surface tension of a Liquid is define as the force acting alone the surface of a Liquid on a unit length of an imaginary line drawn on the surface of the Liquid normal and towards one side of the line. (02m.)

(iii) $T = \frac{F}{l}$

$[T] = \frac{[F]}{[l]} = \frac{MLT^{-2}}{L}$

$T = MT^{-2}$ (01m.)



Labeling the axes (01m.)

Shape of the curve (01m.)

(01m.)

(B) (i)

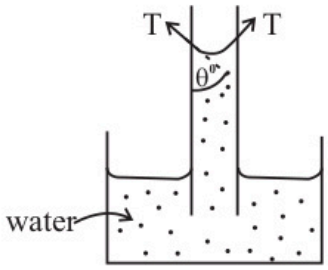


figure (I)

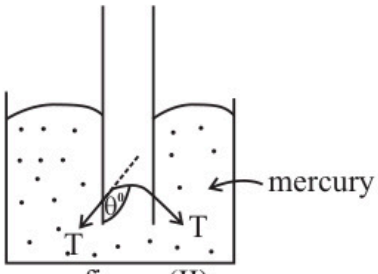


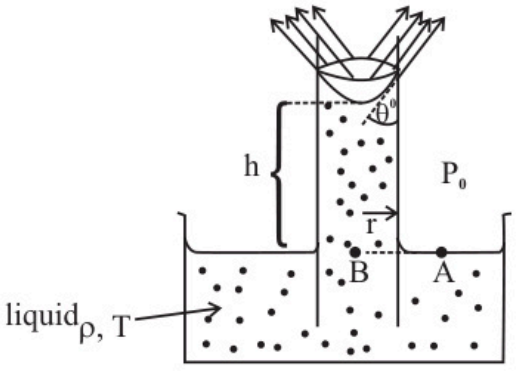
figure (II)

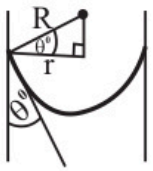
For the diagrams (02 m.)

The contact angel for Water is an acute angel ($\theta < 90^0$). The adhesive force between Water and Glass is stronger than the cohesive force between Water molecules , so Water spread in to a Glass plate.

The force acting on the upward component of the surface tension force pulls the Liquid upwards. The cohesive force between Mercury Atoms is stronger than the adhesive force between Mercury Glass. The downward component of the surface tension force pull the Liquid downwards. (02 m.)

(ii)





$\text{Cos}\ \theta = \frac{r}{R}$

$R = \frac{r}{\text{Cos}\ \theta}$

P_0 = Atmospheric presure

r = Internal radius of the tube.

R = Radius of the meniscus for the picture (01 m.)

$P_A = P_B$

$P_0 = P_0 - \frac{2T}{R} + h\rho g$ ⟶ For the expression (02m.)

$h\rho g = \frac{2T}{R}$

$h\rho g = \frac{2T}{r / \text{Cos}\ \theta}$ ⟶ Substitution (01m.)

$h\rho g = \frac{2T \text{ Cos } \theta}{r\rho g}$ ⟶ Snswer (02m.)

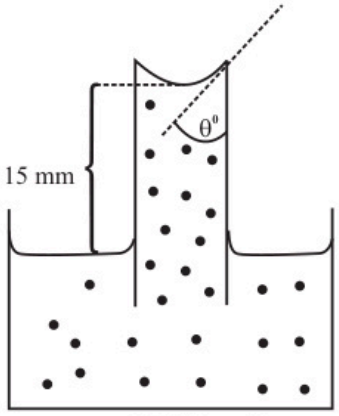
(iii) $h = \frac{2T \text{ Cos } \theta}{r\rho g}$

$= \frac{2 \times 7 \times 10^{-2} \times \text{Cos } 0^0}{0.7 \times 10^{-3} \times 1000 \times 10}$ ⟶ Substitution (01m.)

$h = 2 \times 10^{-2}$ m / 20 mm

Answer (02m.)

(iv)



⟶ For the correct picture (01m.)

$h = \frac{2T \text{ Cos } \theta}{r \rho g}$

$\text{Cos } \theta = \frac{h \rho g r}{2T}$

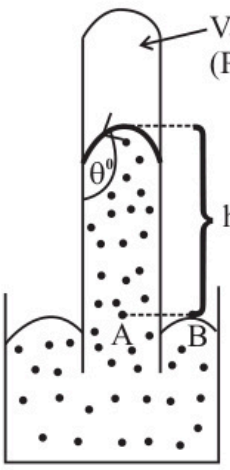
$= \frac{15 \times 10^{-3} \times 1000 \times 10 \times 0.7 \times 10^{-3}}{2 \times 7 \times 10^{-2}}$ ⟶ Substitution (01m.)

$\text{Cos } \theta = 0.7500$

$\theta = \text{Cos}^{-1}\ 0.7500$

$\theta = 41^0\ 25^1$ ⟶ For the answer (02m.)

(v)



Atmospheric Pressure = P_0

$P_0 = H\rho g$

$$P_A = P_B$$

$$P_0 = 0 + \frac{2T\,\text{Cos}\,\theta}{r} + h\rho g \xrightarrow{\text{Substitution}} \quad (01\text{m.})$$

$$H = \frac{2T\,\text{Cos}\,\theta}{r\,\rho g} + h \xrightarrow{\text{Substitution}} \quad (01\text{m.})$$

$$= \frac{2 \times 19.2 \times 10^{-3} \times \text{Cos}\,135^0}{1 \times 10^{-3} \times 13600 \times 10} + 759.8 \times 10^{-3}$$

$$H = \frac{2 \times 19.2 \times 10^{-3} \times \text{Cos}\,45^0}{136} + 759.8 \times 10^{-3}$$

$$= \left(\frac{2 \times 19.2}{136 \times \sqrt{2}} + 759.8\right) \times 10^{-3}\ \text{m}$$

$$= \left(\frac{1.414 \times 19.2}{136} + 759.8\right) \times 10^{-3}\ \text{m}$$

$$= (0.2 + 759.8) \times 10^{-3} \longrightarrow \quad (01\text{m.})$$

$$= 760.0 \times 10^{-3}\ \text{m}$$

$$H = 760.0\ \text{mm} \xrightarrow[\text{Answer}]{} \quad (02\text{m.})$$

(Total marks 30)

(08) (A) (i) Let the Energy stored in the Capacitor is E.

$$E = \frac{1}{2} CV^2$$

$$C = \frac{\varepsilon_0 A}{d}$$

$$E = \frac{1}{2} \times \frac{\varepsilon_0 A}{d} \times V^2 \quad (02\text{m.})$$

Let the Energy stored per unit volume be U_0

$$U_0 = \frac{E}{Ad}$$

$$U_0 = \frac{\frac{1}{2}\left(\frac{\varepsilon_0 A}{d}\right) V^2}{Ad}$$

$$U_0 = \frac{1}{2} \quad \frac{\varepsilon_0 A}{d\,Ad} V^2$$

$$U_0 = \frac{1}{2} \varepsilon_0 \frac{V^2}{d^2} \quad (03\text{m.})$$

(ii) When the Capacitor filled with a dielectric material $(\varepsilon_0 = K\varepsilon_0)$

$$U_0 = \frac{K\varepsilon_0}{2} \quad \frac{V^2}{d^2} \quad (02\text{m.})$$

(iii) Increase in Energy

$$U_1 - U_0 = \frac{K\varepsilon_0}{2} \quad \frac{V^2}{d^2} - \frac{1}{2} \varepsilon_0 \frac{V^2}{d^2}$$

$$= \frac{1}{2} \varepsilon_0 \quad \frac{V^2}{d^2} (K - 1) \quad (02\text{m.})$$

Increase in the volume when it move Δx

$$\Delta y = bd\,\Delta x \quad (01\text{m.})$$

$\therefore$ Energy increas $= (U_1 - U_0) \times bd\,\Delta x$

$$= \frac{1}{2} \varepsilon_0 \quad \frac{V^2}{d^2} (K - 1) \times bd\,\Delta x$$

$$= \frac{(K - 1)\,\varepsilon_0\, bV^2\,\Delta x}{2d} \quad (02\text{m.})$$

(B) (i) $\Delta c = \frac{\varepsilon_0 b (l - x)}{d} + \frac{K \varepsilon_0 bx}{d}$

$c = \frac{\varepsilon_0 b}{d} (l + (K - 1)x)$ (01m.)

$\Delta c = \frac{\varepsilon_0 b}{d} (K - 1) bx$ (02m.)

(ii) $Q = CV$

V constant $\Delta c > 0$

$\therefore \Delta Q = V\Delta C > 0$ (01m.)

$\therefore$ Charge is increased (01m.)

(iii) Let the increase of charge is ΔQ

$\Delta Q = V \Delta C$

$= V \left[\frac{\varepsilon_0 b}{d} (K - 1) \Delta x\right]$

$\therefore \Delta Q = \underline{\underline{\frac{\varepsilon_0 b}{d} (K - 1) \Delta xy}}$ (03m.)

(iv) Work done by the battery

$\Delta W_b = V \Delta C$

$= V \times \frac{\varepsilon_0 b}{d} (K - 1) \Delta xV$

$= \underline{\underline{\frac{\varepsilon_0 b (K - 1)V^2}{d} \Delta x}}$ (03m.)

(C) (i) electric force should be equal to the external force. (02m.)

(ii) $\Delta W_e = F\Delta x$ (02m.)

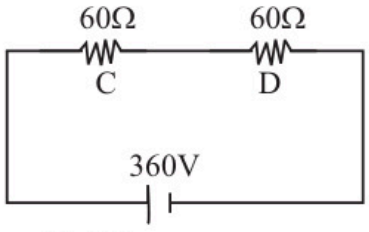
(iii) $\Delta W + \Delta W_b + \Delta W_e = 0$

$\frac{(K - 1) \varepsilon_0 bV^2 \Delta x}{2d} + \frac{\varepsilon_0 b(K - 1) V^2 \Delta x}{d} - FA x = 0$

$F = \underline{\underline{\frac{\varepsilon_0 bV^2 (K - 1)}{2d}}}$ (03m.)

(Total marks30)

(09) (A) (a) (i)



(i) $V = IR$

$360 = 120 \times I$

$I = \frac{360^0}{120} = \underline{\underline{3A}}$ (02m.)

(ii) $P = I^2R$

$P = 3^2 \times 60$

$P = \underline{\underline{540\ W}}$ (03m.)

(iii) $P = I^2R$

$P = 3^2 \times 60$

$P = \underline{\underline{540\ W}}$ (03m.)

(iv) $P = \frac{1}{2} A\rho V^3$

$540 = \frac{1}{2} \times 1 \times 10^{-4} \times 10^3 \times 3$

$V^3 = 10800$

$V = 22.10\ ms^{-1}$ (03m.)

(v) No (01m.)

When the current flow through the Coil Resistance increases. Power of the motor change. Velocity change. (02m.)

(vi) Assumption

Total Heat Energy dissipated (540w) used to increase the temperature of Water. (02m.)

$Q = mc\Delta\theta$

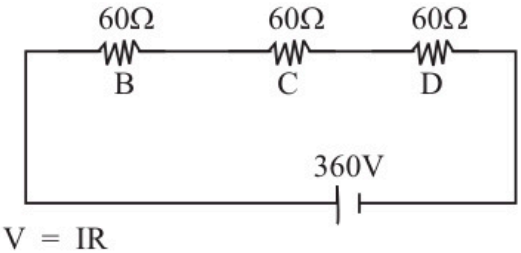
$540 = \rho V \times C\Delta\theta$

$540 = 10^3 \times V \times 4000 \times 0.1$ (02m.)

$V = 1.35 \times 10^{-3}\ m^3$

$V = 1350\ ml$ (01 m.)

(b)



$V = IR$

$360 = I \times 180$

$I = 2A$ (02m.)

(1) $P = I^2R$

$P = 2^2 \times 120$

$P = 480\ W$ (02m.)

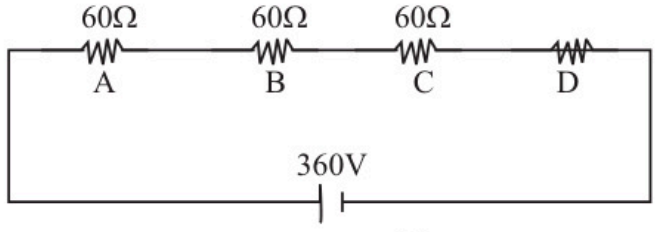
D

$P = I^2R$

$P = 2^2 \times 60$

$P = 240\ W$ (02m.)

(c)



$V = IR$

$360 = I \times 240$

$I = \underline{\underline{1.5A}}$ (01m.)

$P = I^2R$

$P = 1.5^2 \times 180$

$P = \underline{\underline{405\ W}}$ (02m.)

$P = I^2 R$

$P = 1.5^2 \times 60$

$P = \underline{\underline{135\ W}}$ (02m.)

(Total marks 30)

(09) B (a) (i) $\beta = \dfrac{I_C}{I_B}$

$I_C = \underline{\underline{\beta I_B}}$ (02m.)

(ii) $V_{CC} = I_C R_C + V_{CE} + I_E R_E$

$I_C R_C = V_{CC} - V_{CE} + I_E R_E$

$I_C R_C = V_{CC} - \dfrac{1}{2} V_{CE} - I_E R_E$

$I_C R_C = \underline{\underline{\dfrac{V_{CC}}{2} - I_E R_E}}$ (02m.)

(iii) $V_{CC} = I_C R_C + V_{CE} + I_E R_E$

$V_{CC} - I_C R_C - V_{CE} = I_E R_E$

$I_E R_E = V_{CC} - \dfrac{V_{CC}}{2} IR_C$ or (03m.)

$I_E = I_C = \beta I_B$

$I_E = I_C + I_B \Rightarrow I_E = \beta I_B + I_B$

$V_{RE} = I_E R_E$

$V_{RE} = \underline{\underline{I_B (1 + \beta) R_E}}$

(iv) $V_{CC} = I_C R_C + V_{CE} + I_E R_E$ (02m.)

$V - \dfrac{V}{2} = \beta I_B R_C + (1 + \beta) I_B R_E$

$\dfrac{V}{2} = I_B (\beta R_C + (1 + \beta) R_E)$

$I_B = \underline{\underline{\dfrac{V}{2[\beta R_C + (1 + \beta) R_E]}}}$ (02m.)

(b) (i) $V_{CE} = \dfrac{1}{2} V_{CC} = \dfrac{1}{2} \times 9V$

$= 4.5V$

$V_{CC} - V_C = I_C R_C$

$9V - 4.5V = I_C \times 4.5 \times 10^3$ (01m.)

$I_C = \dfrac{4.5}{4.5 \times 10^3} = 1 \times 10^{-3}$

$I_C = \underline{\underline{1mA}}$ (01m.)

(ii) When, $\beta = \frac{I_C}{I_B}$

$$200 = \frac{I_C}{I_B}\ 1 \times 10^{-3}$$

$$I_B = \frac{1 \times 10^{-3}}{200} = 5 \times 10^{-6}\ A$$

$$I_B = \underline{\underline{5\ \mu A}}$$ (02m.)

(iii) $V_{CC} = I_B R_B + V_{BE}$

$9 = 5 \times 10^{-5} \times R_B + 0.7$

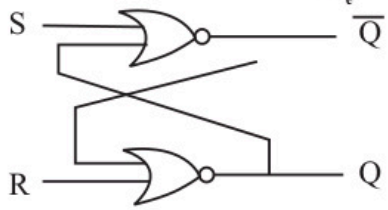
$8.3 = 5 \times 10^{-5} R_B$

$$\underline{\underline{1.66 \times 10^6 = R_B = 1.66M\Omega}}$$ (02m.)

(c) (i) Can be used the circuit (b) as Voltage comparator. (no feed back) it is in the open loop condition. (02m.)

(ii) Can be used the Circuit (a) as non inverting amplifire, negetive feed back, face change is 180^0. (02m.)

$$\text{gain} = \frac{R_f}{R_e}$$

(d) 

(02m.)

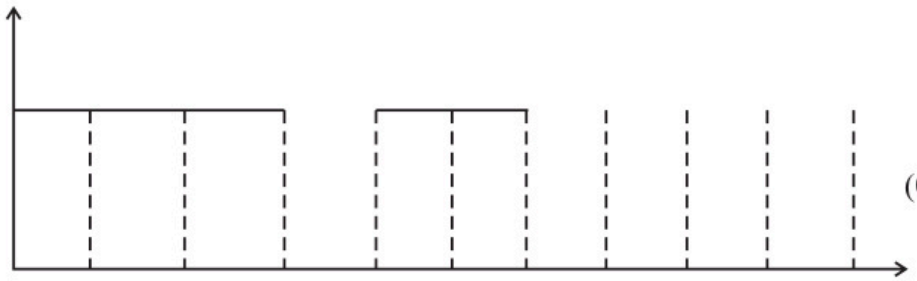
S	R	Q	$\overline{Q}$
1	0	1	0
0	0	1	0
0	1	0	1
0	0	0	1
1	1	-	-

or

S	R	Q	$\overline{Q}$
0	0	no change	
0	1	0	1
1	0	1	0
1	1	not defined	-

(03m.)

(iii) out put



(04m.)

(Total marks 30)

(10) (A) (a) When all other environmental factors are kepts constant, the rate of loss of Heat at a given moment from a heated object cooling under a steady flow of Air is directly propertional to the excess temperature between the object and the environment. (03m.)

(b) Definition (03m.)

(c) $\frac{\Delta Q}{\Delta t} = EA(\theta - \theta_R)$

$R_A = E \times 4\pi r^2 (\theta - \theta_R)$ (02m.)

$$\underline{\underline{R_B = E \times 4\pi (2r)^2 (\theta - \theta_R)}}$$ (02m.)

(20)

$$\frac{R_A}{R_B} = \frac{E \times 4\pi r^2 (\theta - \theta_R)}{E \times 4\pi (2r)^2 \times (\theta - \theta_R)}$$

$$\frac{R_A}{R_B} = \frac{1}{4} \quad \text{(02m.)}$$

(d) $$\frac{\Delta Q}{\Delta t} = mc\left(\frac{\Delta \theta}{\Delta t}\right)$$

$$\frac{\Delta Q}{\Delta t} = \frac{4}{3} r^3 \rho c \left(\frac{\Delta \theta}{\Delta t}\right)$$

$$R_A = \frac{4}{3} \pi r^3 \rho c \, x_A \quad \text{(02m.)}$$

$$R_B = \frac{4}{3} \pi (2r)^3 \rho c \, x_B \quad \text{(02m.)}$$

$$\frac{R_A}{R_B} = \frac{\frac{4}{3} \pi r^3 \rho c \times x_A}{\frac{4}{3} \pi (2r)^3 \rho c \times x_B}$$

$$\frac{R_A}{R_B} = \frac{1}{8} \times \frac{x_A}{x_B}$$

$$\frac{x_A}{x_B} = 2 \quad \text{(02m.)}$$

(e) $$mc\left(\frac{d\theta}{dt}\right) = E_A (\theta - \theta_R)$$

$$mc\left(\frac{62 - 50}{10 \times 60}\right) = EA\left(\frac{62 + 50}{2} - 26\right) \quad \text{(02m.)}$$

$$mc\left(\frac{7}{600}\right) = EA\,(30)$$

$$mc\left(\frac{50 - \theta}{10 \times 60}\right) = EA\left(\frac{50 + \theta}{2} - 26\right) \quad \text{(02m.)}$$

$$\frac{mc\left(\frac{7}{600}\right)}{mc\left(\frac{50 - \theta}{600}\right)} = \frac{E_A\,(30)}{EA\left(\frac{50 + \theta}{2} - 26\right)} \quad \text{(02m.)}$$

$$\theta = 44.99\ C^1$$

$$\theta = 45\ C^1 \quad \text{(02m.)}$$

$$0.1 \times C \times (100 - 24) = 0.04 \times 400 \times (24 - 16) \quad \text{(02m.)}$$

$$+$$

$$0.2 \times 4200\,(24 - 16)$$

$$C = 459\ J\ kg^{-1}\ C^{-1} \quad \text{(02m.)}$$

(Total marks 30)

(10) (B) (a) Bq or Becqueral (01m.)

(b) The rate of decay (A) of a given radio active sample is directly proportional to the number of unstable Radio Active Atoms. (02m.)

(c) Time taken to reduce the number of Radio Active Atoms (or unstable nuclei or activity) of a given Radio Active sample to one half of it's initial value. (02m.)

(d) $No = \frac{0.21}{210} \times 6 \times 10^{23}$ (02m.)

$= \underline{\underline{6 \times 10^{20}}}$ (01m.)

(e) $\lambda = \frac{0.7}{160 \times 24 \times 3600}$ (01m.)

$= \underline{\underline{5.00 \times 10^{-8}\ s^{-1}}}$ (02m.)

(f) $A = \lambda No$

$= 5 \times 10^{-8} \times 6 \times 10^{20}$ (02m.)

$= \underline{\underline{3 \times 10^{13}}}$ (01m.)

(g) $\frac{N}{N_0} = \frac{1}{2^n}$

$n = \frac{480}{160}$

$\underline{\underline{n = 3}}$ (01m.)

$\frac{N}{N_0} = \frac{1}{2^n}$

$\frac{N}{6 \times 10^{20}} = \frac{1}{2^3}$

$N = \underline{\underline{7.5 \times 10^{19}}}$ (02m.)

(h) $A = \lambda N$

$= 5 \times 10^{-8} \times 7.5 \times 10^{19}$ (02m.)

$= \underline{\underline{3.75 \times 10^{12}\ Bq}}$ (01m.)

(i) (i) $\phi = 2.7\ eV$

$= 2.7 \times 1.6 \times 10^{-19}$

$= \underline{\underline{4.32 \times 10^{-19}\ J}}$ (02m.)

(ii) $\phi = \frac{hc}{\lambda_{max}}$

$\lambda_{max} = \frac{hc}{\phi}$

$= \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{4.32 \times 10^{-19}}$ (02m.)

$= 4.58 \times 10^{-7}\ m$

$= \underline{\underline{458\ nm}}$ (01m.)

(iii) $hf = \phi + KE_{max}$

$6.6 \times 10^{-34} \times 1.7 \times 10^{15} = 4.32 \times 10^{-14} + KE_{max}$ (02m.)

$KE_{max} = \underline{\underline{6.90 \times 10^{-19}\ J}}$ (01m.)

(iv) $KE_{max} = eV_s$

$6.90 \times 10^{-19} = 1.6 \times 10^{-19} \times V_s$ (01m.)

$V_s = \underline{\underline{4.3125V}}$ (01m.)

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