G.C.E. (Advanced Level) Examination - August 2007
PHYSICS - I
Two hours

Important:
- This question paper includes 60 questions in 7 pages.
- **Answer all the questions.**
- Write your Index Number in the space provided in the answer sheet.
- Instructions are given on the back of the answer sheet. Follow them carefully.
- In each of the questions 1 to 60, 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 (×) on the number of the correct option in accordance sith instructions given on the back of the answer sheet.

Use of calculators is not allowed.

($g = 10N\ kg^{-1}$)

01. SI unit of surface tension is
(1) N (2) Nm^{-1} (3) Nm (4) Nm^{-2} (5) Nm^2

02. Dimensions of a certain physical quantity when multiplied by $[L]^3$ yield the dimensions of work. The physical quantity would be
(1) force. (2) momentum (3) pressure
(4) mass (5) velocity

03. If the absolute temperature of a body is doubled, the rate at which the energy is radiated will
(1) remain the same (2) increase two times
(3) increase four times (4) increase eight times
(5) increase sixteen times

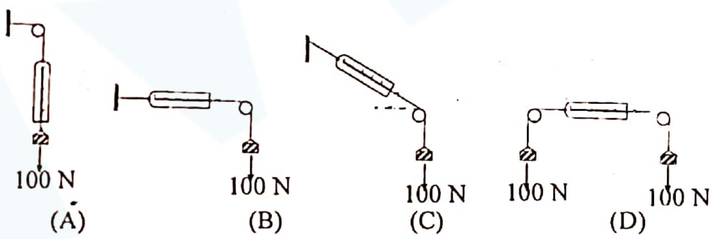
04. An e. m. f. is induced across the length of a wire when it is moving in a uniform magnetic field. This e.m.f. **does not** depend on
(1) velocity of the wire.
(2) radius four wire.
(3) length of the wire.
(4) flux density of the magnetic field
(5) the angle that the wire makes with the magnetic field.

05. Consider the following statements made regarding the photoelectric effect.
(A) This effect can be explained by assuming light as energy packets.
(B) For a given incident monochromatic light, the energy of emitted electrons **does not** depend on the material.
(C) Rate of emission of electrons depends on the intensity of the incident light.
Of the above statements,
(1) only (A) and (B) are true.
(2) only (B) and (C) are true.
(3) only (A) and (C) are true.
(4) all (A), (B) and (C) are true.
(5) all (A), (B) and (C) **are false.**

06. A sound emitted by a source of intensity I reaches a certain point. The change in the sound intensity level at the same point when the sound intensity is increased to 2I is (log 2 = 0.3)
(1) 0.3 dB (2) 3dB (3) 6dB (4) 9dB (5) 15dB

07. Consider the following statements made regarding a monochromatic light ray refracting through a glass prism placed in air.
(A) The speed of the light ray inside the prism is lower than that outside the prism.
(B) The frequency of the light ray inside the prism is lower than that outside the prism.
(C) The wavelength of the light ray inside the prism is lower than that outside the prism.
Of the above statements,
(1) only (A) is true (2) only (C) is true
(3) only (A) and (B) are true (4) only (A) and (C) are true
(5) all (A), (B) and (C) are true.

08. Figures A, B, C and D show four ways in which a light spring balance can be loaded with a weight of 100N using frictionless pulleys.

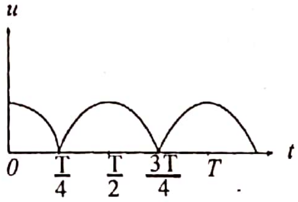


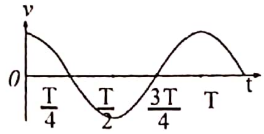
The scale readings of the spring balances in the four cases would be

	A	B	C	D
(1)	100 N	100 N	100 N	100 N
(2)	100 N	0 N	200 N	100 N
(3)	100 N	100 N	100 N	200 N
(4)	100 N	0 N	200 N	200 N
(5)	100 N	100 N	200 N	200 N

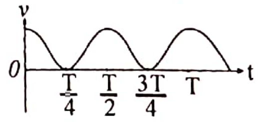
09. Consider the following statements made about the linear expansivity of a material.
(A) Its SI unit is K^{-1}
(B) Its value changes when the temperature is measured in Celsius instead of Kelvin.
(C) Its value changes when the temperature is measured in Fahrenheit instead of Kelvin.
Of the above statements,
(1) only (A) is true
(2) only (A) and (C) are true.
(3) only (A) and (B) are true
(4) only (B) and (C) are true
(5) all (A), (B) and (C) are true.

10. The variation of the speed u with time t of a simple harmonic oscillator is shown in the figure. The variation of its velocity u with time t is best represented by

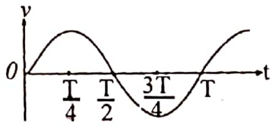




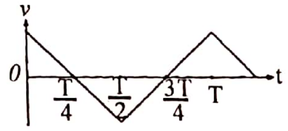
(1)



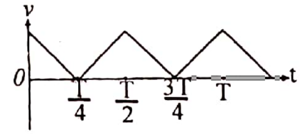
(2)



(3)

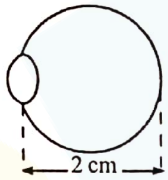


(4)



(5)

11. A normal eye ball has a diameter of 2 cm as shown in the figure. The magnitude of the minimum power of the eye lens is
(1) 0 (2) 10D (3) 25D
(4) 50D (5) 100D

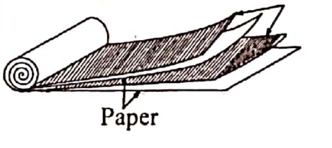


12. The size of the image of an object placed at a distance of 10cm from a convex lens is twice that of the object. If the image is erect, the focal length of the lens is
(1) 7 cm (2) 10cm (3) 20cm (4) 30cm (5) 40cm

13. The focal length of the lens of a simple microscope is 10cm. If the near point of an eye is 25cm, the **approximate value** of the object distance required to obtain the maximum angular magnification is
(1) 5cm (2) 6cm (3) 7cm (4) 8cm (5) 9cm

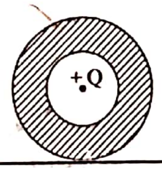
14. An object weighs 100N on the earth surface. When it is carried to a height equal to the radius of the earth, from the earth's surface, its weight becomes.
(1) 10N (2) 25N (3) 50N (4) 75N (5) 100N

15. A cylindrical capacitor is formed by inserting two sheets of paper of dielectric constant 4 and thickness 10^{-4} m, alternately between two rectangular sheets of metal foils, each of length 1 m and breadth 10^{-2}m, and rolling them as shown in the figure.



($\varepsilon_0 = 9 \times 10^{-12}$ Fm^{-1})

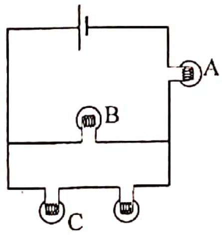
The capacitance of the capacitor is
(1) 3600 pF (2) 360 pF (3) 36 pF
(4) 18 pF (5) 3.6 pF

16. 

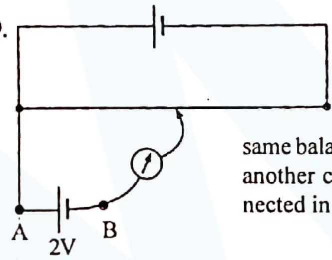
The figure shows a spherical conducting shell. A point charge +Q is placed at the centre of the shell and a charge -q is given to the shell. Finally the shell will have
(1) zero charge on the inner surface, -q on the outer surface.
(2) -Q charge on the inner surface, -q on the outer surface.
(3) -Q charge on the inner surface, -q + Q on the outer surface.
(4) +Q charge on the inner surface, -q - Q on the outer surface.
(5) $-Q-\frac{q}{2}$ on the inner surface, $+Q-\frac{q}{2}$ on the outer surface.

17. If a wire of resistance R and length l is used to form another wire of length $2l$ without changing its volume, the resistance of the new wire is
(1) 4R (2) 3R (3) 2R (4) R (5) $\frac{R}{2}$

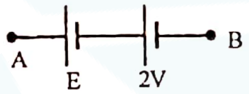
18. Four identical electric bulbs are connected to a bettery as shown in the figure. If all the bulbs are lit, and the intensities of the bulbs A, B and C are I_A, I_B and I_C respectively then



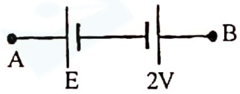
(1) $I_A > I_C > I_B$ (2) $I_A > I_B = I_C$
(3) $I_B > I_C > I_A$ (4) $I_A > I_B > I_C$
(5) $I_A = I_B = I_C$

19. 

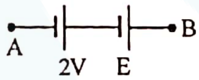
A potentiometer is balanced by connecting a cell of e.m.f. 2V across A and B, as shown in the figure. The same balanced length can be obtained of another cell E of suitable e.m.f. is connected in series with the 2V cell as



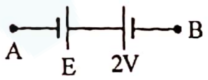
(1)



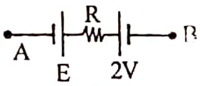
(2)



(3)



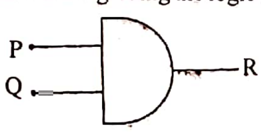
(4)



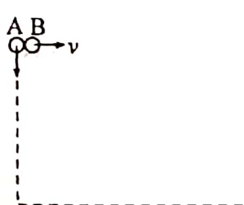
(5)

20. An archeologist extracted 100mg of carbon from an ancient wooden tool and found that it is $\frac{1}{4}$ as radioactive as 100 mg of carbon extracted from a live tree. Half-life of carbon -14 is 5730 years. How old is the wooden tool?
(1) 1432.5 years (2) 5730 years (3) 10162.5 years
(4) 11 460 years (5) 22 920 years

21. Consider the following statements made regarding the logic gate shown in the figure.
(A) When P = 1, R = Q
(B) When Q = 0, R = P
(C) When P = 0, R = 0

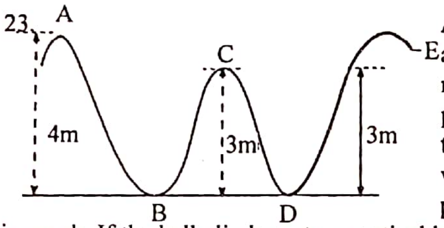


Of the above statements,
(1) only (C) is true (2) only (A) and (B) are true
(3) only (A) and (C) are true (4) only (B) and (C) are true.
(5) all (A), (B) and (C) are true.

22. 

A ball B is projected horizontally with speed u and a ball A is dropped vertically from rest at the same instant as shown in the figure. Which of the following statements is true? (Neglect air resistance)

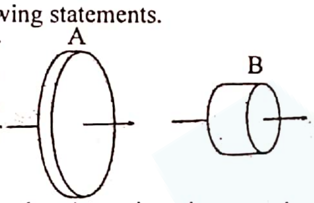
(1) A reaches the ground first with a higher speed than B.
(2) B reaches the ground first with a higher speed than A.
(3) A reaches the ground first with a lower speed than B.
(4) Both A and B reach the ground at the same instant with the same speed.
(5) Both A and B reach the ground at the same instant but B with higher speed than A.

23. 

As shown in the figure a ball of mass 6kg released from rest at point A on a smooth track ABCD slips without rolling. The portion DE of the track is rough. If the ball climbs upto a vertical height of 3 m along the rough surface, the energy lost due to friction is

(1) 240J (2) 180J (3) 120J (4) 60J (5) 0

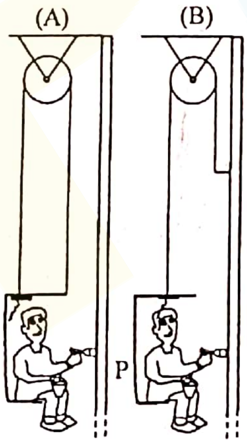
24. The two uniform disks A and B shown in the figure are made of the same material and have equal masses. The radius of the disk A is greater than that of B. The disks are kept in isolation at outer space. Consider the following statements.



(A) The disk A takes a longer time than B to gain a given speed under an external force acting through the centres of the disks.
(B) The disk B takes a longer time than A to gain a given angular speed under an external torque about the axis of the disks.
(C) The disk B has a higher rotational inertia about the axis of the disk than disk A.

Of the above statements,
(1) only (A) is true
(2) only (A) and (B) are true
(3) only (B) and (C) are true
(4) all (A), (B) and (C) are true
(5) all (A), (B) and (C) are **false.**

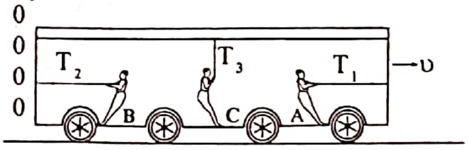
25. Figures A and B show two ways in which a painter could use a system consisting of a platform P, a pulley and a rope in painting tall buildings. The total weight of the painter and the platform is 400N. If the rope is light then the tensions of the rope in the two cases are.



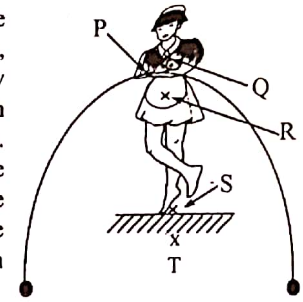
	A	B
(1)	400 N	400 N
(2)	400N	200 N
(3)	200 N	400 N
(4)	200 N	200 N
(5)	100 N	200 N

26. A trolley is moving with a constant velocity υ. Three men, A, B, and C, are pulling three strings in such a way that their tensions are T_1, T_2, and T_3 respectively, as shown in the figure. When the trolley moves a distance L, the work done by the men are

	A	B	C
(1)	T_1L	T_2L	T_3L
(2)	$-T_1L$	T_2L	0
(3)	T_1L	$-T_2L$	0
(4)	T_1L	T_2L	0
(5)	0	0	0



27. A toy in the form of a child-figure holding a section of a thin ring, which carries two identical heavy metal balls, is made from a thin metal sheet as shown in the figure. If the toy can be balanced in stable equilibrium from the toe of the child-figure, most probably the centre of gravity of the system can be found close to a point.



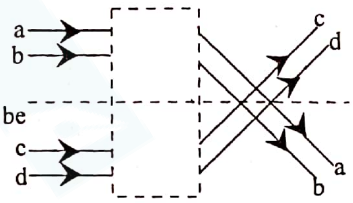
(1) P (2) Q (3) R (4) S (5) T

28. Starting from rest, a sphere takes a time t to roll down a rough inclined plane. If the plane is made frictionless, the time taken by the sphere to slip down will be
(1) t.
(2) higher than t.
(3) lower than t.
(4) determined by the mass of the sphere
(5) determined by the radius of the sphere.

29. An organ pipe filled with O_2 has a fundamental frequency f_0. If the pipe is filled with H_2 at the same temperature and pressure, the new fundamental frequency of the pipe is (relative molecular masses of H_2 and O_2 are 2 and 32 respectively),

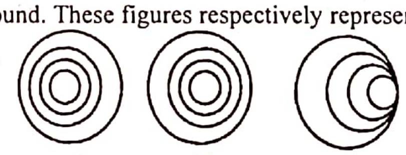
(1) $\frac{1}{4}f_0$ (2) $\frac{1}{2}f_0$ (3) f_0 (4) $2f_0$ (5) $4f_0$

30. Rays from a monochromatic source of light are deviated by an optical element as shown is the figure.



This optical element is likely to be
(1) a convex lens
(2) a concave lens.
(3) a single prism.
(4) a combination of two prisms.
(5) a combination of a prism and a convex lens.

31. Figures A, B and C show wave fronts emitted from three sources of sound. These figures respectively represent sources



A B C

(1) moving to the right, moving to the left, and stationary.
(2) moving to the left, moving to the right, and stationary.
(3) stationary, stationary, and moving to the right.
(4) moving to the left, moving to the right, and moving to the left with the speed of sound.
(5) moving to the left, moving to the right, and moving to the right with the speed of sound.

32. A student vibrated a tuning fork and listened to its sound while keeping it in air. Then he vibrated this tuning fork again with the same amplitude and listened to the sound while holding its handle against a large wooden board.
(1) Sound intensity heard by him in both cases in the same.
(2) Sound intensity heard when the tuning fork is in air is larger than when it is held against the wooden board.
(3) The time during which the tuning fork goes on vibrating is the same in both cases.
(4) The time during which the tuning fork goes on vibrating is higher when it is kept on the board than in air.
(5) The time during which the tuning fork goes on vibrating is higher when it is kept in air than on the board.

33. A tuning fork is at resonance with a sonometer wire. Consider the following statements
(A) A Standing wave is set up in the wire.
(B) If the tension of the wire is increased its resonance length will decrease.
(C) The amplitude of vibrations would be maximum if it resonates in the fundamental mode of vibration.
Of the above statements,
(1) only (C) is true
(2) only (A) and (B) are true.
(3) only (A) and (C) are true.
(4) only (B) and (C) are true.
(5) all (A), (B) and (C) are true.

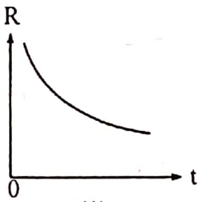
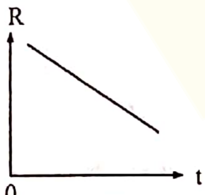
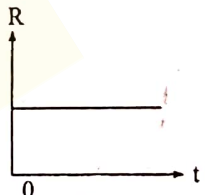
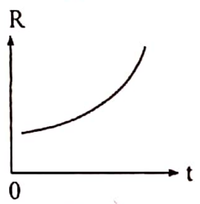
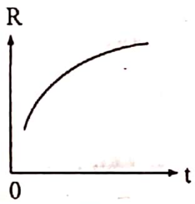
34. Which of the following statements is true for a mixture of ideal gases at a given temperature?
(1) All the gas molecules in the mixture have the same speed.
(2) Molecules of each component of the gas mixture have the same average kinetic energy.
(3) Lighter gas molecules have a lower average kinetic energy.
(4) Heavier gas molecules have a lower average kinetic energy.
(5) Root mean square velocities of gas molecules of each component of the gas mixture are the same.

35. A volume V_1 of air at 100% relative humidity is mixed with volume V_2 of completely dry air at the same temperature and pressure so that the final volume becomes $V_1 + V_2$. The relative humidity of the mixture is

(1) $\left[\frac{V_1}{V_2}\right] \times 100\%$ (2) $\left[\frac{V_1 - V_2}{V_1 + V_2}\right] \times 100\%$ (3) $\left[\frac{V_1}{V_1 + V_2}\right] \times 100\%$

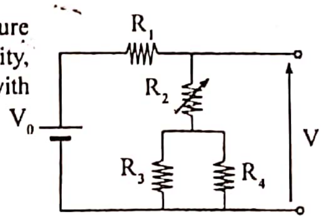
(4) $\left[\frac{V_2}{V_1}\right] \times 100\%$ (5) $\left[\frac{V_2}{V_1 + V_2}\right] \times 100\%$

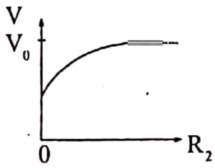
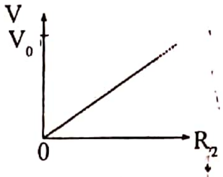
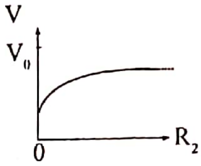
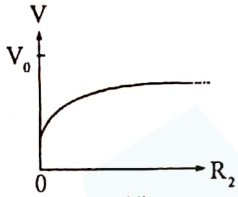
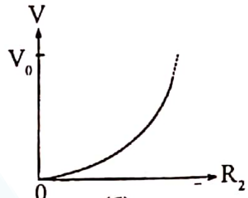
36. Consider a situation where a layer of ice is being formed on Arctic sea water due to a constant temperature difference between sea water and the atmosphere. The variation of the rate (R) at which the heat is extracted from a unit area of ice-atmosphere interface by the atmosphere with time (t) is best represented by


(1)

(2)

(3)

(4)

(5)

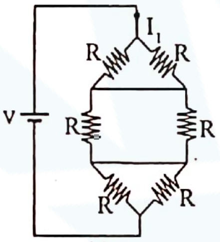
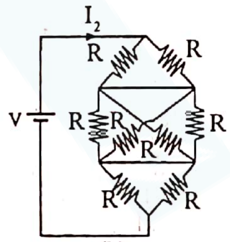
37. A Particle with charge q and mass m travels perpendicular to a uniform magnetic field along a circular path of radius R with frequency f. The magnitude of the magnetic flux density is given by
(1) $\frac{mf}{q}$ (2) $\frac{2\pi fm}{q}$ (3) $\frac{m}{2\pi fq}$ (4) $\frac{mf}{qR}$ (5) $\frac{af}{2\pi R}$

38. When the value of R_2 in the figure shown is varied from 0 to infinity, the corresponding variation of V with R_2 is best represented by



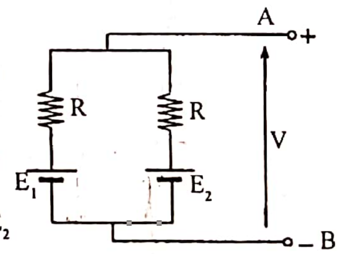

(1)

(2)

(3)

(4)

(5)

39. If the currents passing through networks shown in figures (a) and (b) are I_1 and I_2 respectively then the ratio $\frac{I_2}{I_1}$ is equal to (Neglect the internal resistance of the cell)

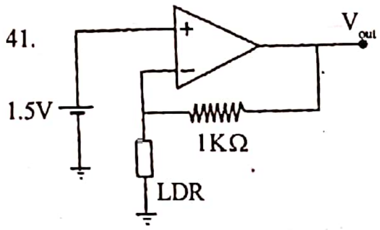

(a)

(b)

(1) $\frac{4}{3}$ (2) $\frac{5}{3}$ (3) $\frac{7}{4}$ (4) $\frac{6}{5}$ (5) 2

40. The cells E_1 and E_2 shown in the figure have zero internal resistance. The voltage V across the terminals A and B is



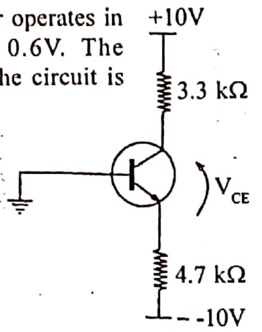
(1) $E_1 - E_2$ (2) $E_1 + E_2$
(3) $\frac{E_1 + E_2}{4}$ (4) $\frac{E_1 - E_2}{2}$ (5) $\frac{E_1 + E_2}{2}$

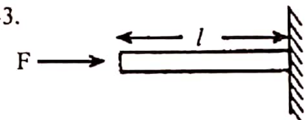
41.


The figure shows an operational amplifier circuit with a light dependent resistor (LDR) and a 1 kΩ resistor.
The supply voltage to the operational amplifier is ±16.5V and its saturation voltage is ±15V. The resistance of the LDR is 1 MΩ at complete darkness and 100Ω at bright light.
The approximate values of the output voltage of the circuit V_{out} at complete darkness and bright light will be respectively
(1) 1.5 V and 15V (2) 1.5V and 16. 5 V
(3) -1.5mv and -15V (4) -1.5V and -16.5V
(5) 1.5mV and 15V

42. In the circuit shown, the transistor operates in the active mode with $V_{BE} = 0.6V$. The collector-emitter voltage V_{CE} in the circuit is approximately

(1) 0 (2) 2V (3) 4V
(4) 6V (5) 10V



43. 

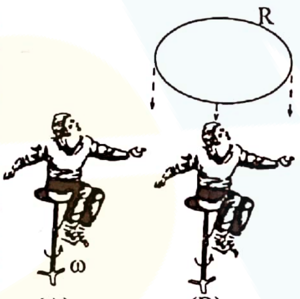
As shown in the figure, a device is made to measure the magnitude of a force by applying it to a uniform metal rod of length l and area of cross-section A, and measuring the resultant compressing (Δl). E is the Young's modulus of the material of the rod.

The smallest value of the compression that can be measured with a measuring instrument attached to the rod is Δl_0. If the smallest value of F that can be measured with the device is F_0, then the legth l of the rod should be such that

(1) $l \geq \frac{EA}{F_0}\Delta l_0$ (2) $l \geq \frac{F_0}{EA}\Delta l_0$ (3) $l \leq \frac{F_0}{EA\Delta l_0}$

(4) $l \geq \frac{F_0 A}{E\Delta l_0}$ (5) $l \leq \frac{EA}{F_0}\Delta l_0$

44. As shown in figure A, a child sitting on a rotating chair, rotates with an angular speed ω. The moment of inertia of the system with the child around the axis of rotation is 2kg m². As shown in figure B, while rotating, the child catches a thin ring R of mass 4kg and diameter 1m, which is falling vertically with its plane horizontal, and with no angular momentum. The final angular momentum of the whole system would be



(A) (B)

(1) 0 (2) $\frac{2}{3}\omega$ (3) ω (4) $\sqrt{\frac{2}{3}}\omega$ (5) $\sqrt{\frac{1}{3}}\omega$

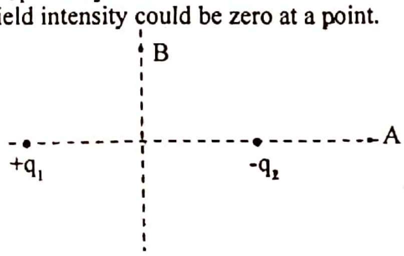
45. A boat made of metal floats in water with one fifth of its volume submerged. If a second boat is made with a volume five times bigger than the first using the same mass of the same metal that has been used to construct the first boat, then the ratio,

$\frac{\text{the maximum load that can be carried by the second boat}}{\text{the maximum load that can be carried by the first boat}}$ is equal to

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

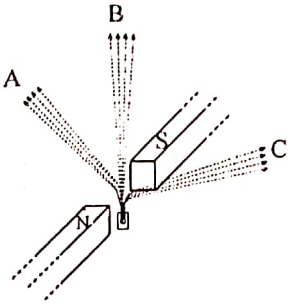
46. Two point charges $+q_1$ and $-q_2$ are placed as shown in the figure. Resultant electric field intensity could be zero at a point.

(1) A, if $q_1 = q_2$
(2) A, if $q_1 > q_2$
(3) A, if $q_1 < q_2$
(4) B, if $q_1 = q_2$
(5) B, if $q_1 > q_2$

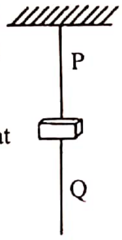


47. A radioactive source is placed at the bottom of a hole in a lead block. The beam of radiation emanating through the hole is allowed to pass through a magnetic field as shown in the figure. Three separated beams A, B and C could be, respectively

(1) α, β^- and γ
(2) β^-, γ and α
(3) γ, α, and β^-
(4) α, γ and β^-
(5) γ, β^- and α



48. A metal block is hung from a support by a string P as shown in the figure. An identical piece of string Q is attached underneath the block



Consider the following statements,

(A) If Q is taut the tension in P is greater than that of Q
(B) If Q is pulled with slowly increasing tension, then P has a tendency to break before Q.
(C) If Q is pulled with a jerk, then Q has a tendency to break before P.

Of the above statements

(1) only (A) is true. (2) only (A) and (B) are true.
(3) only (A) and (C) are true. (4) only (B) and (C) are true.
(5) all (A), (B) and (C) are true.

49. A decoration consists of four independently rotating sets of small lanterns P, Q, R and S which are fixed to a rotating central pole as shown in the figure (A). All the rotations take place around vertical axes. Which of the following modes of rotations provides the best stability to the entire decoration?

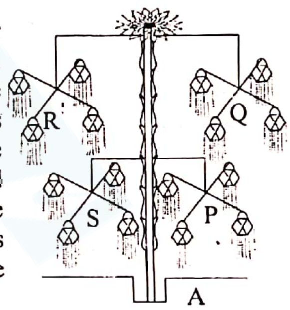
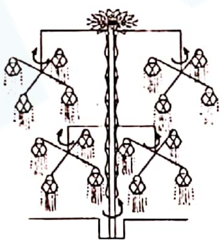
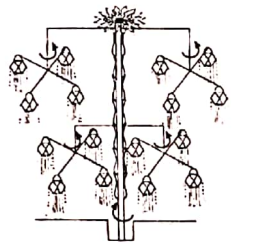
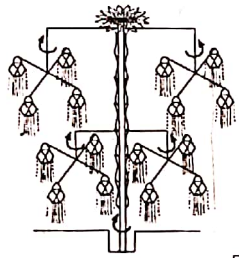
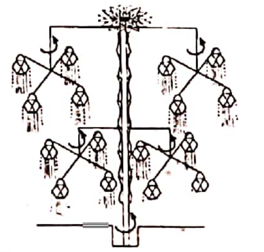


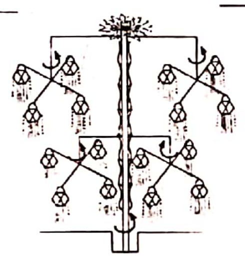
Figure (A)


(1)

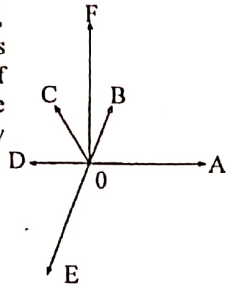

(2)


(3)


(4)

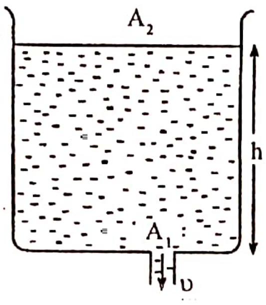

(5)

50. A system of coplanar forces OA, OB, OC, OD, OE and OF acts on an object as shown in the figure. Magnitude of $OA = 2\ CD$ and $OE = 2\ OB$. The resultant force on the object is most likely to be



(1) along the direction of OC.
(2) along the direction of OE.
(3) along the direction of OF.
(4) along the direction of OA
(5) zero

51. Water drains through an opening of area A_1 in a container of cross-sectional area A_2 as shown in the figure. If the motion of the water surface in the container is **not** ignored the speed u at which the water drains is given by



(1) $\upsilon = \sqrt{\dfrac{2gh}{1 - \dfrac{A_1^2}{A_2^2}}}$

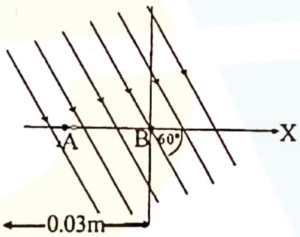
(2) $\upsilon = \sqrt{2gh}$

(3) $\upsilon = \sqrt{\dfrac{gh}{\dfrac{A_1^2}{A_2^2} + 1}}$

(4) $\upsilon = \sqrt{\dfrac{2gh}{\dfrac{A_1^2}{A_2^2} - 1}}$

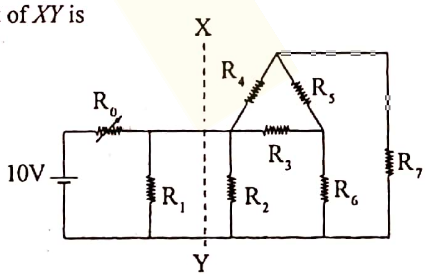
(5) $\upsilon = \sqrt{\dfrac{gh}{\dfrac{A_1^2}{A_2^2} - 1}}$

52. A uniform electric field of magnitude 400Vm^{-1} is acting in the direction as shown in the figure. If V_A and V_B are the electric potentials at points A and B respectively, then $V_B - V_A$ is equal to



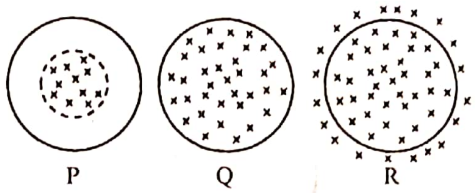
(1) -6V (2) -3V (3) 0 (4) 3V (5) 6V

53. The internal resistance of the battery shown in the circuit is zero. The value of R_0 is adjusted until the voltage across it becomes 5V. The equivalent resistance of the part of the network to the right of XY is



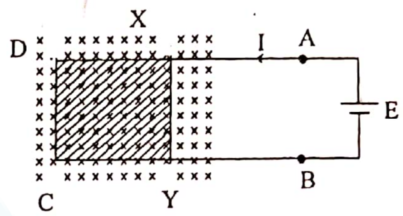
(1) R_0
(2) $R_0 + R_1$
(3) $\dfrac{R_0R_1}{R_1 - R_0}$
(4) $\dfrac{R_0R_1}{R_1 + R_0}$
(5) R_1

54. Three identical circular wire loops are placed perpendicularly to uniform magnetic fields of flux density B. The extent of the magnetic fields are different from one another in situations P, Q and R as shown in figures. The extent of the magnetic field in Q is equal to the area of the loop. When the flux density B varies with time at the same constant rate, the induced e. m. f. s of the respective wire loops are E_P, E_Q and E_R. Which of the following is true regarding the magnitude of E_P, E_Q and E_R?



(1) $E_P = 0,\ E_Q = E_R$
(2) $E_P = 0,\ E_R > E_Q$
(3) $E_P = E_Q = 0,\ E_R \neq 0$
(4) $E_P < E_Q,\ E_Q = E_R$
(5) $E_P < E_Q < E_R$

55. A rectangular wire frame made from a smooth resistive wire is connected to a battery of e.m.f. E with negligible internal resistance as shown in the figure. XY is a piece cut from the same wire, which can slide along the wire frame. A non conducting liquid film of surface tension T is formed in the region $CDXY$, and the entire structure is placed in a uniform magnetic field of flux density B acting in the direction shown.

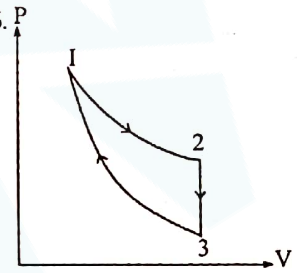


If $XY = XD = CD = CY$, and the current through AX is I, then the wire XY will tend to move to the right when

(1) $B > \dfrac{8T}{3I}$ (2) $B > \dfrac{4T}{I}$ (3) $B < \dfrac{8T}{3I}$

(4) $B > \dfrac{4T}{3I}$ (5) $B < \dfrac{4T}{3I}$

56. An ideal gas is taken through a thermodynamic cycle as shown in the figure. Process $1 \rightarrow 2$ is isothermal and during the process 60 J of heat enters the system. Process $2 \rightarrow 3$ takes place at constant volume and during this process 40J of heat leaves the system.



The change in internal energy (ΔU) of the system during process $3 \rightarrow 1$ is

(1) -40J (2) -20 J (3) 0 (4) + 20J (5) + 40 J

57. Thermometers must possess good sensitivity as well as good accuracy. In this connection which of the following is true regarding a mercury-in-glass thermometer?

	To increase accuracy	To increase sensitivity
(1)	Reduce the radius of the capillary.	Increase the volume of mercury in the glass bulb.
(2)	Increase the volume of mercury in the glass bulb.	Reduce the radius of the capillary
(3)	Reduce the volume of the glass bulb.	Reduce the radius of the capillary
(4)	Increase the radius of the capillary.	Reduce the volume of the glass bulb.
(5)	Reduce the volume of the glass bulb.	Increase the volume of mercury in the glass bulb.

58. Two bulbs, A (110V, 40W) and B (110V, 100W) are connected in series with an electric supply of 220V. Which of the following statements is **false**?

(1) The current through A is the same as the current through B.

(2) The potential drop across A is greater than the potential drop across B.
(3) The current through B is less than its rated current.
(4) The power dissipation of A is greater than the power dissipation of B.
(5) There is a higher probability of burning the bulb B.

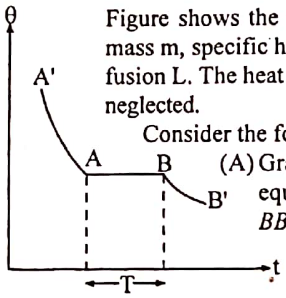
59. 

Figure shows the cooling curve of liquid wax of mass m, specific heat capacity S_l and latent heat of fusion L. The heat capacity of the container can be neglected.

Consider the following statements.

(A) Gradient of the curve AA' at A is equal to the gradient of the curve BB' at B.

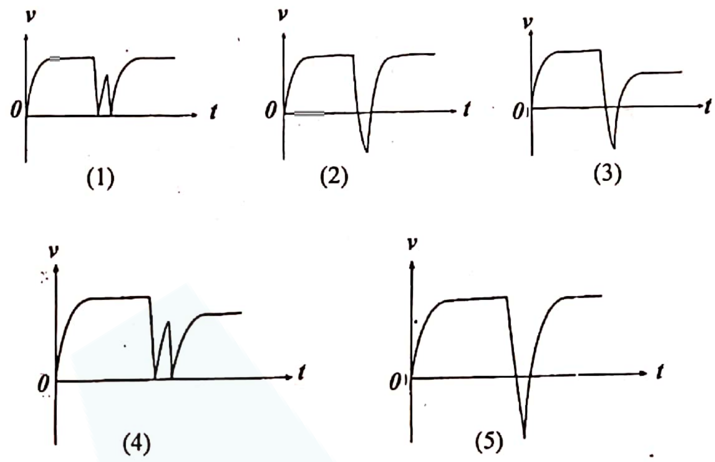
(B) The rate of heat released to the surrounding during the time T is $\frac{mL}{T}$

(C) Gradient of the curve AA' at A = $\frac{I}{S_l} \cdot \frac{L}{T}$

Of the above statements,
(1) only (A) is true.
(2) only (A) and (B) are true.
(3) only (B) and (C) are true.
(4) all (A), (B) and (C) are true.
(5) all (A), (B) and (C) are **false.**

60. A tiny sphere with a static charge $+q$ starts to fall through air under gravity at $t = 0$. After the sphere has reached terminal velocity, a vertically upward electric field E of constant magnitude is applied. A short time after the sphere changes direction of its motion, the electric field is removed.

The variation of the velocity (υ) of the sphere with time (t) is best represented by



G.C.E. (Advanced Level) Examination - August 2007
PHYSICS - II
Three hours

Answer all four questions. **PART A - Structured Essay** $[g = 10\ N\ kg^{-1}]$

01. You are to determine the density of the material used to make a A-4 size (30 cm x 21 cm) photocopy paper.

(a) You are provided with a spring balance, a triple-beam balance and a chemical balance which are available in a school laboratory. What is the most suitable measuring instrument that you would select to determine the mass (m) of the sheet of paper?

....

(b) In order to determine the volume of the paper you have to take three measurements. Indicate below the most suitable and appropriate measuring instrument you would use to measure each of them.

Measurement	Instrument
(1) Length of the paper (say l)	....
(2) Width of the paper (say w)	....
(3) Thickness of the paper (say t)	....

(c) Write down an expression for the density (d) of the material used to make the paper. in terms of m, l, w and t.

d = ...

(d) When measuring the thickness, it is more appropriate to take several readings at different places of the paper. What is the reason for this?

....

(e) (i) Once the most appropriate measuring instruments are used by a student to measure l and t, the values he obtained are given below. Determine the fractional error of each of the measurements l and t. (It is **not** necessary to simplify your answers.)

	Fractional error
(1) l = 30.0 cm	....
(2) t = 0.15 mm	....

(ii) In order to achieve the fractional error of t same as that of l, a student suggested to measure the thickness of a bundle of papers. How many papers does he need to make the bundle?

....

(f) In practice, a unit called gsm is used to measure the thickness of papers. gsm stands for grams per square metre, i.e. the mass of 1 m² area of a given paper.
Assuming that in (a) and (b) above, m was measured in grams and the l and w were measured in centimetres, write down an expression for the gsm value of the paper.
gsm value = ...

02. You are asked to design and perform an experiment in the school laboratory to determine the specific heat capacity of a metal using the method of mixtures. Water, a thermally insulated calorimeter with a stirrer, a thermometer and small metal balls heated to 100 °C are provided.

(a) What is the other instrument you need in this experiment?

....

(b) What is the advantage of using a thermally insulated calorimeter?

....

(c) List the measurements you will obtain in this experiment in the order that you perform the experiment.
(1) ....
(2) ....
(3) ....
(4) ....
(5) ....

(d) The amount of water used in the calorimeter should not be too small or too large.

(i) Give a reason as to why it should **not** be too sm

....

(ii) Give a reason as to why it should **not** be too large.

....

(e) Suppose the following values were calculated from your experimental results.

Heat gained by calorimeter, stirrer and water	= 2400 J
Mass of metal balls	= 0.3kg
Decrease in temperature of metal balls	= 64 °C

Calculate the specific heat capacity of the metal.

....
....

(f) Why is it **not suitable** to heat the metal balls in a water bath at 100 °C in order to obtain the 'metal balls heated to 100 °C required for this experiment?

....
....

(g) Instead of small metal balls, is it possible to use metal powder in this experiment? (Yes/No) Give **two** reasons for your answer.
(1) ....
(2) ....

03. A student is asked to design an experiment using the resonance phenomenon to determine the speed (υ) of transverse waves in a sonometer wire being kept under constant tension. The student is supposed to use a graphical method. A set of tuning forks is provided for this purpose.

(a) If resonance at the fundamental mode was obtained with a tuning fork of frequency f, write down an expression for υ in terms of resonance length l, and f.

.... υ = ...

(b) Rearrange the expression in (a) above to take the form $y = mx$, where y is the dependent variable. In this experiment choose y in such a way that it is not a reciprocal of a measurement. Identify x.

....

....

(c) State whether you would start the experiment with the tuning fork having the highest frequency or with the tuning fork having the lowest frequency first. Give the reason for your answer.

....

....

(d) How would you identify the tuning fork with the highest frequency from the given set of tuning forks, only considering their physical dimensions?

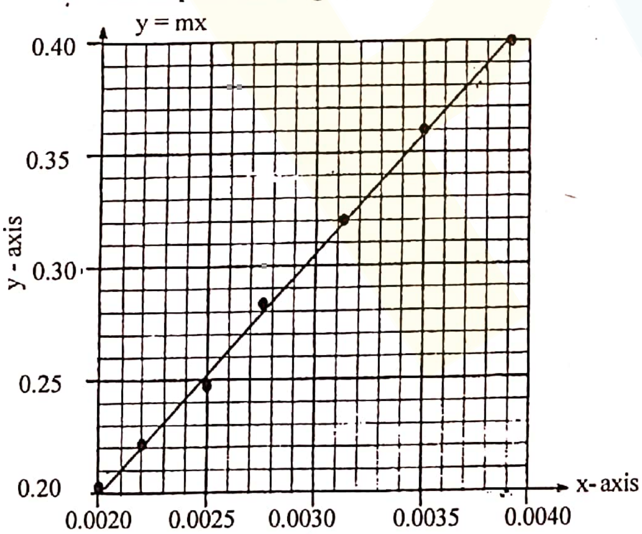
....

....

(e) why is it easier to observe the resonance state of the wire at its fundamental mode of vibration than at an overtone?

....

(f) The graph, y against x, obtained by the student is shown below. All quantities are given in SI units.



(i) Label the axes of the graph with units.

(ii) Calculate υ from the graph. Clearly indicate the **two** points which you have used to calculate υ.

....

....

(g) The error Δl of the resonance length l has two components; i.e. the reading error (Δl_1) of the instrument used to measure l, and the error due to the uncertainty in obtaining the resonance state (Δl_2). How would you experimentally determine Δl_2?

....

....

....

04.

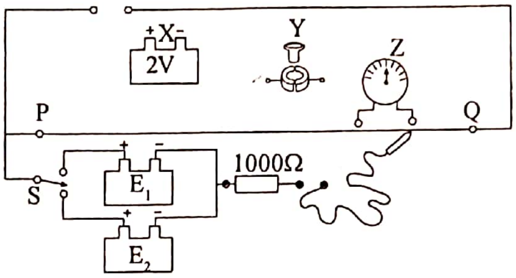


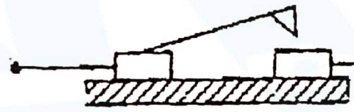
Figure shows an incomplete diagram of an experimental set-up of a potentiometer arrangement used to compare the e.m.f E_1 and E_2 of two cells. PQ is a wire of length 1 m and resistance of 20 Ω. X, Y and Z represent a 2V accumlator, a switch, and a centre zero galvanometer respectively. S is a two-way key.

(a) Complete the arrangement by connecting the items X, Y and Z to the circuit with lines.

(b) In order to perform this experiment the magnitudes of E_1 and E_2 must satisfy a certain requirement with e.m.f. of X What is it?

....

(c) Do you suggest a tap-key (T) shown in the figure to the accumulator circuit? (yes/ No). State the reason.



....

....

(d) Give a reason as to why a much thicker wire of the same material should **not** be used as the potentiometer wire.

....

(e) List the essential steps that you would perform when obtaining a balanced length.

....

....

....

....

(f) Write down an expression relating E_1, E_2 and their corresponding balanced lengths l_1 and l_2.

....

....

(g) If you want to determine the value for the ratio $\frac{E_1}{E_2}$ by plotting a suitable graph, state what modification you would propose to the circuit.

....

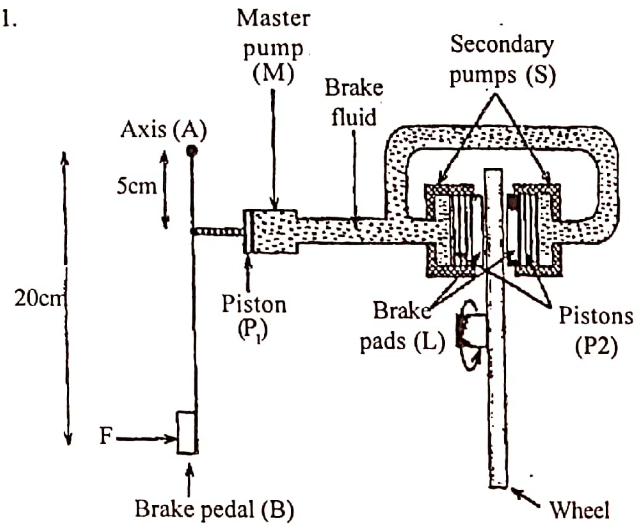
(h) When a student began to perform the experiment as mentioned in (g) above, he found that the lowest pair of values that he could obtain for l_1 and l_2 were closer to 100cm. As a result he was unable to obtain a good set of measurements to plot a graph. How would you overcome this problem experimentally?

....

Physics II PART B

Answer four questions only. [g = 10 N kg^{-1}]

01.



The figure shows a hydraulic braking system which could be used to stop a rotating wheel. A force F is applied perpendicular to the brake pedal (B). The pedal rotates freely about a fixed axis through (A) and perpendicular to the plane of the paper as shown in the figure, and causes a force to be applied perpendicularly to the piston (P_1) of the master pump (M). The resulting pressure is transmitted by the brake fluid to the two identical pistons (P_2) of the secondary pumps (S). Then the brake pads (L) attached to the pistons move a little distance and press against both sides of the rotating wheel. Assume that the brake fluid is incompressible. Cross-sectional area of the master pistion (P_1) is 1 cm^2, and the croos-sectional area of the secondary piston (P_2) is 3 cm^2.

(i) When a certain force is applied to the master piston it moves a distance of 0.6 cm to the right in this process. How far does a single brake pad (L) move?

(ii) If F = 10 N,

(a) what is the force applied on the piston (P_1) of the master pump? The required distances are marked in the figure.

(b) Calculate the pressure exerted by master piston (P_1) on the brake fluid in pascal.

(c) Calculate the force exerted on the brake pads due to the pressure created on the secondary pistons (P_2).

(d) If the coefficient of dynamic friction between the brake pads and the wheel is 0.5, calculate the frictional force acting on the wheel due to each pad when they are pressed against the wheel.

(iii) Before applying the brakes, the wheel was rotating freely at 600 revolutions per minute. If the distance from the rotating axis of the wheel to the line of action of the frictional force is 5cm, how long does it take to stop the wheel when brakes are applied with $F = 10N$ as above? The moment of inertia of the wheel about its axis of rotation is 0.1 kg m^2. Assume that the frictional force remains constant throughout the motion.

How many revolutions does the wheel make before coming to rest? (Take $\pi = 3$)

02. Figure (a) shows a cross section of a human eye. Although it is normally considered that the eye lens is responsible for the formation of the image on he retina, actually it is the combination of the cornea and the eye lens that forms the image.

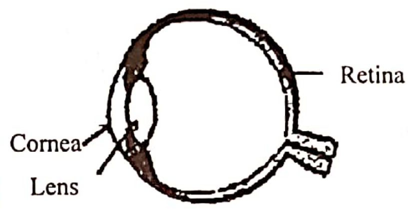


Figure (a)

The cornea can be considered as a convex lens with a fixed focal length while the focal length of the eye lens can be adjusted through muscle movements.

(i) Assume that the cornea and the eye lens can be considered as a composite lens consisting of two thin lenses in contact. The distance from the composite lens to the retina is 2 cm.

(a) Calculate the power in dioptres, of the composite lens when it is adjusted for (1) far point (infinity) (2) near point (25 cm.) (Take the power of a convex lens as positive.)

(b) Is the image on the retina real or virtual, and erect or inverted?

(c) If the power of the cornea is 40 dioptres, calculate the power of the eye lens for the two cases mentioned in part (a) above.

(ii) Consider two tiny dots, with a small separation d, on a paper placed at the near point of the eye as shown in figure (b).

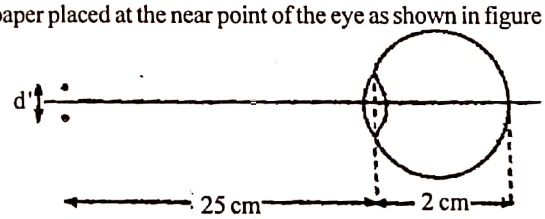


Figure (b)

(a) Obtain an expression for the distance s between the two images formed by the two dots on the retina in terms of d.

(b) Letters and images printed by some computer printers consist of many closely spaced tiny dots which are not visible to normal eye. For example,

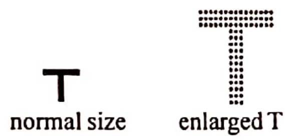


Figure (c)

the enlarged letter **T** in figure (c), formed by many dots, appears without dots when viewed at normal size. For this to happen, the separation of the images on the retina formed by any tow adjacent dots must be less than a certain value S_{max}.
If the value for S_{max} is 8 μm, show that a dot separation of 0.08 mm (300 dots per inch) is sufficient for a letter to be seen without dots.

(c) If it is necessary to see the dots contained in a letter printed with 0.08 mm dot separation with a magnifying glass, what is the maximum focal length of the magnifying glass that should be used?

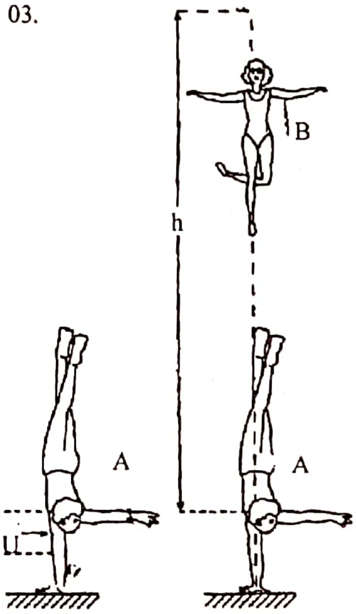
03. 

Figure (a) Figure (b)

An acrobat A stands on one hand as shown in figure (*a*). Assume that the bone of the upper arm *U* of the acrobat is a solid cylinder with an inner cylindrical cavity. When not subjected to stress the length of this cylinder is 0.3m. Its outer radius and that of the inner cylindrical cavity are 10^{-2} m and 4×10^{-3} m respectively. The weight of the acrobat excluding the arm is 600N. Young's modulus and the breaking stress of a human bone are 1.4×10^{10} Nm and 9.0×10^{7} Nm^{-2} respectively.

(i) What is the compressional strain of the upper arm bone when he is standing as shown in figure (*a*)? By how much is the bone compressed?

(ii) What is the elastic energy stored in a unit volume of the bone?

(iii) Starting from rest, another acrobat *B* of mass 50 kg now jumps vertically on to A from a height h as shown in figure (*b*). After landing on the shoulder of *A*, which is right above his upper arm bone. *B* takes a time of 0.02s to come to rest.

(a) Once landed on A and came to rest, what is the change in momentum of *B* in terms of *h*?

(b) Find the average value of the force in terms of *h* exerted on *A* by *B* due to the change in momentum.

(c) Calculate the maximum height from which *B* can jump on to *A* without breaking the upper arm bone of *A*. (Assume that Hooke's law is applicable until the breaking stress is applied.)

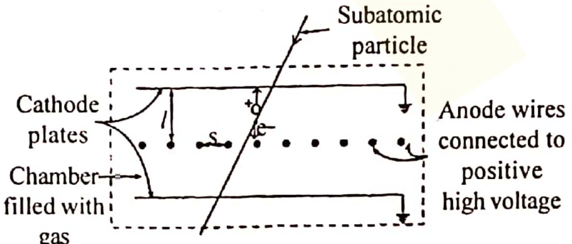
04. 

Figure (a)

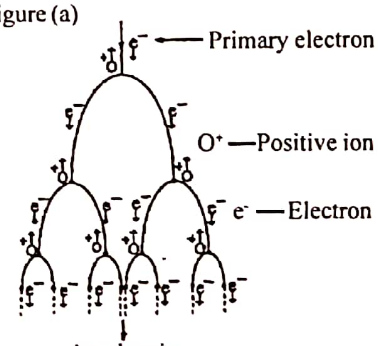


Figure (b)

Detection of photons and other subatomic particles is important in high energy particle physics. The multiwire proportional chamber (MWPC) is one of the detectors that is used for such purposes. Applications of MWPC can be found in a variety of fields such as nuclear medicine, protein crystallography, and particle track detection in high energy physics experiments. In its basic configuration, an MWPC consists of thin (~20 μm diameter) parallel and equally spaced anode wires symmetrically placed between two thin metallic cathode plates as shown in figure (a). For proper operation, the gap *l* is normally three or four times larger than the wire spacing s (~2mm). The cathodes are earthed and the anode wires are maintained at a positive high voltage (~3kV) to produce an extremely large electric field around the wires. The chamber is filled with a gas mixture of 90% argon and 10% of molecular gas such as CO_2 or CH_4.

When a high energy charged subatomic particle passes through the detector it collides and ionizes the gas molecules (mainly argon atoms) along its path in the chamber producing a certain number of electron-positive ion pairs. This ionization is called the primary ionization. In the process of creating one electron-ion pair, the high energy particle loses about 30eV from its kinetic energy. The primary electrons thus created move towards the anode wires and the positive ions to cathode Plates due to the electric field present inside the chamber. when these Primary electrons move closer to anode wires, the strong electric field that exists around the wires will accelerate them increasing their kinetic energies. Such energetic electrons, while moving towards the anode wires will collide with argon atoms producing more electron-ion pairs close to the wires. This process, called secondary ionization, is repeated many times producing a large number of electron-ion pairs. This will continue until all the electrons are collected by the anode wires. Figure (*b*) shows how a single primary electron will give rise to a large number of secondary electronion pairs through secondary ionization. This number is 10^3 in pure argon and its value can be about 10^6 in a mixture of argon and CO_2. The anode wires will finally collect all the electrons in a very short time leaving a cloud of positive ions around the wires, which slowly migrates towards the cathodes.

Electrons collected by anode wires can be observed as a current pulse which can later be converted to a voltage pulse. The pulse amplitude by MWPC is a measure of the energy loss by the particle during its passage through the detector. In addition the amplitude of the pulse depends on the detector properties such as the gas used, voltage applied to anode wires, the gap between cathode plates, wire spacing and wire diameter.

(i) Give **two** areas in which MWPC finds applications.

(ii) Which region of the detector has the highest electric field?

(iii) How does a primary electron acquire energy to produce a secondary electron-positive ion pair?

(iv) If the secondary ionization takes place according to the diagram given in figure (*b*) how many electron-atom collisions are necessary for one primary electron to produce 4 secondary electrons (including the primary electron)?

(v) Where in the detector are the majority of positive ions being produced?

(vi) Give **two** reasons as to why positive ion cloud takes a longer time to migrate to the cathode.

(vii) Give **three** properties of the detector that determine the amplitude of the pulse.

(viii) Use Gauss' theorem to find an expression for the electric field intensity E at a distance r ($r > a$) from the axis of a long straight wire of radius 'a' carrying a charge per unit length λ.

(ix) What would happen to the amplitude of the pulse if the radius of the anode wires is reduced? Give reasons for your answer.

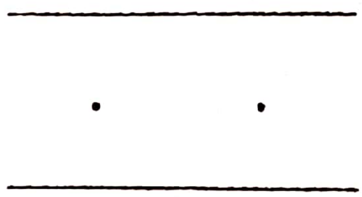


Figure (c)

(x) The figure (c) shows a section of an MWPC with two anode wires. Copy this diagram on to your answer sheet and draw the pattern of electric field lines inside this section.

(xi) If a high energy charged particle entering the detector with a kinetic energy of 100 keV passes through the detector creating 100 primary electron-ion pairs, calculate the energy of the particle when it leaves the detector.

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

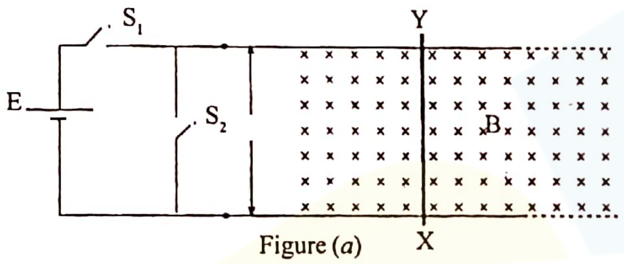


Figure (a)

(A) The figure (a) shows an arrangement that consists of a bar XY of mass m and resistance R placed on two parallel smooth horizontal conducting rails with negligible resistance, separated by a distance l. A uniform magnetic field with a flux density B is applied perpendicular to the plane of the rails (into the paper) and throughout the region between the rails. A battery of e.m.f. E with negligible internal resistance connected to the rails produces a current through the bar.

(i) When the bar XY is at rest on the rails, the switch S_1 is closed, while keeping the switch S_2 opened. Write down an expression using the given symbols for the force experienced by bar XY at this instant, due to the magnetic field. What is the direction of this force?

(ii) Consider an instant at which the bar is moving at a speed υ which is less than its maximum speed.

(a) Write down an expression for the magnitude of the back e.m.f. induced across the bar at this instant.

(b) Obtain expressions for the current through the bar, the force on the bar, and the power drawn from the battery at this instant.

(c) Hence show that the maximum speed that the bar XY can attain is given by $\frac{E}{Bl}$. What is the current through the bar when it is moving at the maximum speed?

(iii) Using the Lenz's law show that the bar can be decelerated it the switch S_1 is opened and the switch S_2 is closed at any instant while it is moving. What is the mechanism through which the kinetic energy of the bar is converted to heat during this process?

(iv) The above principle is used in the device known as linear motor which has many applications. One such application is launching of an aircraft from a ship. As shown in figure (b), the aircraft is mounted on the moving bar and when it reaches the required speed, the aircraft is detached from the bar and allowed to take-off. The bar is then decelerated as mentioned in part (iii) above.

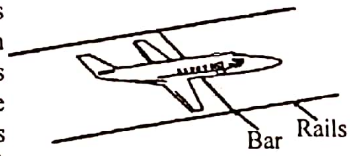


Figure (b)

Suppose the combination of the bar and the aircraft has a mass of 20 000kg, the separation between the rails is 10m, the magnetic flux density is 2T, and the resistance of the bar is 100Ω.

(a) Calculate the e.m.f. that should be provided by the battery to achieve a maximum speed of $100 ms^{-1}$.

(b) Hence calculate the initial acceleration of the aircraft.

(B) Draw the I-V characteristics of an ideal diode and a real diode.

In answering the following questions assume that the voltage across the diodes, when conducting is 0.7V.

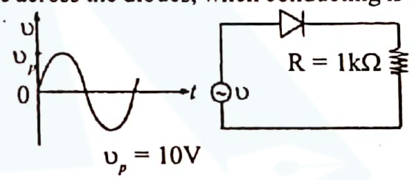


Figure (a) Figure (b)

(i) Input signal (υ) to the circuit given in figure (b) is shown in figure (a). Calculate the values of positive and negative peak currents in the circuit.

(ii)

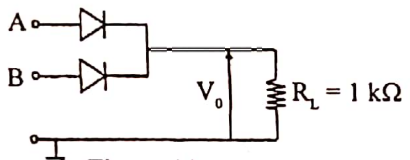


Figure (c)

V_A(V)	V_B(V)	V_0(V)	Logic Level
0	0		
0	5		
5	0		
5	5		

In the given table V_A and V_B are voltages applied to inputs A and B of the circuit shown in figure (c). Inputs A and B are connected to combinations of 0 and 5V as shown in the table. Copy the table on to your answer script and fill in the columns for the output voltage V_0 and the corresponding logic levels (1 or 0).

(iii) In the circuit shown in figure (c) above if $V_A = 5V$ and $V_B = 3V$, calculate the current through R_L.

(iv)

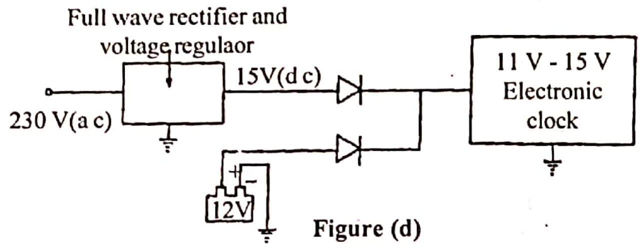


Figure (d)

Figure (*d*) shows the power connection to an electronic clock which needs a dc (direct current) voltage in the range 11V - 15V for proper operation.

(1) Describe the operation of the circuit when

(a) ac (alternating current) power is present,

(b) ac power fails.

(2) What is the current drawn from the 12V battery when the ac power is present?

(v) Draw a suitable circuit for the full wave rectifier and voltage regulator shown in figure (*d*) above.

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

Figure (a)

(A) An electronic device *P* is mounted on a thermally insulated base of a metal casing as shown in the figure (*a*). The device dissipates heat at the rate of 50W and this heat flows out **only through the upper plate of** the casing which is a rectangular metal plate of thickness 2mm and area 2cm². The entire system is kept in a room of temperature 30 °C.

(i) At the steady state, the temperatures of the inner and outer surfaces of the upper plate of the casing are 100 °C and 98°C respectively. Calculate the thermal conductivity of the material of the casing.

(ii)

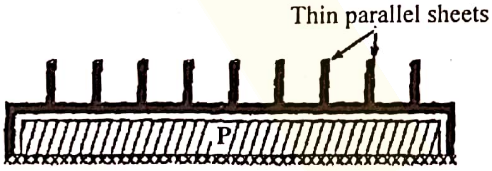


Figure (b)

For efficient and safe operation of the device the temperature of the **inner surface** of the upper plate of the casing should be maintained at 40 °C by means of a suitable mechanism.

(*a*) Under this condition, what should be the temperature of the **outer surface** of the upper plate?

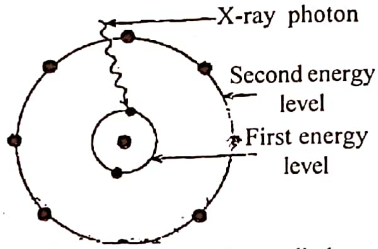
(*b*) As a mechanism to remove heat efficiently, the effective outer surface area of the upper plate is increased by mounting thin parallel sheets, made of casing material, perpendicular to the outer surface of the upper plate as shown in the figure (*b*). Assuming that the temperature of the entire outer surface including the thin parallel sheets is maintained at the value calculated in part (ii) (*a*) above, calculate the new effective surface area of the upper plate using the Newton's Law of cooling. The room temperature is given above.

(c)

Figure (c)

As an alternate method, the outer surface of the upper plate of the casing is cooled by passing water through a metal jacket which is in contact with the outer surface of the upper plate as shown in the figure (c). At the steady state the temperature of the water at the inlet and the outlet of the jacket are 30 °C and 35 °C respectively. If heat is not lost to the surrounding, calculate the rate at which watch water flows through the jacket in kilograms per second. (Specific heat capacity of water = 4.2×10^3 J kg^{-1} °C^{-1}).

(B) When an X-rey photon collides with an inner electron of an atom, (see the figure) the electron could be detached from the atom by absorbing the energy of the X-ray photon.



This process of removal of electrons could be studied using the usual **photoelectric equation.** The minimum energy needed to remove an electron can be taken as the work function appearing in the photoelectric equation. At the threshold wavelength of the incident X-ray photon, the electron is just removed without imparting any kinetic energy to it.

(i) An X-ray photon of wavelength 2.2Å could barely remove an electron at the first energy level in a Ca atom. Determine the minimum energy required (ϕ_1) to remove an electron at the first energy level in a Ca atom.

(ii) (a) When another X-ray photon with the same wavelength as in (i) collides with an electron at the second energy level in a Ca atom and gives all its energy to it, the electron is ejected with a kinetic energy of 6.0×10^{-16}J. Calculate the minimum energy (ϕ_2) required to remove an electron at the second energy level in a Ca atom.

(iii) Consider the situation described in (i) above. Following the removal of an electron at the first energy level, a vacancy is created in it. An electron from the second energy level drops to the first energy level to occupy this vacancy. This transition yields a photon with energy equal to the difference between ϕ_1 and ϕ_2. Determine the wave length of this photon. (Detection of such X-rays is used to identify heavy elements).

(iv) The energy (E) of a photon is related to its momentum (p) by the equation $E = pc$, where c is the velocity of light.

(a) Determine the momentum of the incident X-ray photon mentioned in (i) above.

(b) Since the electron is just removed without any momentum in (i) above, the Ca atom should recoil to conserve linear momentum. Calculate the speed of the recoiling Ca atom. (The mass of Ca atom is 6.0×10^{-26} kg).

(c) Calculate the kinetic energy of the recoiling Ca atom.

(d) Hence show that this kinetic energy is negligibly small compared to the energy of the incident X-ray photon.

($h = 6.6\ 10^{-34}$ Js, $c = 3.0 \times 10^8$ ms^{-1}, 1 Å = 10^{-10}m)

G.C.E. (Advanced Level) Examination - August 2007
PHYSICS - I
Provisional Scheme of Marking

2007 - Answers

Q	1	2	3	4	5	Q	1	2	3	4	5	Q	1	2	3	4	5
01	1	☒	3	4	5	21	1	2	☒	4	5	41	☒	2	3	4	5
02	1	2	☒	4	5	22	1	2	3	4	☒	42	1	2	☒	4	5
03	1	2	3	4	☒	23	1	2	3	☒	5	43	☒	2	3	4	5
04	1	☒	3	4	5	24	1	2	3	4	☒	44	☒	☒	☒	☒	☒
05	1	2	☒	4	5	25	1	2	☒	4	5	45	1	2	☒	4	5
06	1	☒	3	4	5	26	1	2	3	4	☒	46	1	☒	3	4	5
07	1	2	3	☒	5	27	1	2	3	4	☒	47	1	2	3	☒	5
08	☒	2	3	4	5	28	1	2	☒	4	5	48	1	2	3	4	☒
09	1	☒	3	4	5	29	1	2	3	4	☒	49	1	2	3	☒	5
10	☒	2	3	4	5	30	1	2	☒	☒	5	50	1	2	☒	4	5
11	1	2	3	☒	5	31	1	2	☒	4	☒	51	☒	2	3	4	5
12	1	2	☒	4	5	32	1	2	3	4	☒	52	☒	2	3	4	5
13	1	2	☒	4	5	33	1	2	☒	4	5	53	1	2	☒	4	5
14	1	☒	3	4	5	34	1	☒	3	4	5	54	1	2	3	☒	5
15	☒	2	3	4	5	35	1	2	☒	4	5	55	☒	2	3	4	5
16	1	2	☒	4	5	36	☒	2	3	4	5	56	1	2	3	4	☒
17	☒	2	3	4	5	37	1	☒	3	4	5	57	1	2	☒	4	5
18	1	2	3	☒	5	38	☒	2	3	4	5	58	1	2	3	4	☒
19	1	☒	3	4	5	39	☒	☒	☒	☒	☒	59	1	2	☒	4	5
20	1	2	3	☒	5	40	1	2	3	4	☒	60	1	☒	3	4	5

G.C.E. (Advanced Level) Examination - August 2007

PHYSICS - II

Provisional Scheme of Marking

A - PART

01. (a) Chemical balance. 01

(b) (1) Meter Ruler / Half meter ruler 01

(2) Meter Ruler / Half Meter ruler 01

(3) Micrometer Screw Gauge 01

(c) $d = \frac{m}{lwt}$ 01

(d) Thickness may not be uniform OR

Thickness may not have the same value everywhere.

Thickness can be different at various places 01

(e) (i) (1) l = 30.0 cm $\frac{1}{300}\left(\text{or} \frac{0.1}{30} \text{ or} \frac{0.05}{30}\right)$

(2) t = 0.15 mm $\frac{1}{15}\left(\text{or } \frac{0.01}{0.15} \text{ or } \frac{0.005}{0.15}\right)$

(ii) 20

(f) $\frac{m}{l\,W \times 10^{-4}}$ or $\frac{m \times 10^{4}}{l\,W}$

02. (a) Triple beam balance/ chemical balance / four beam balance OR electronic balance. 01

(b) Heat lost to the surrounding can be neglected OR
No heat exchange with the surrounding OR
Heat loss to the surrounding is minimized 01

(c) 1. Mass of calorimeter with the stirrer
2. Mass of calorimeter, stirrer and water
3. Initial temperature of water
4. Maximum temperature of the water
5. Mass of calorimeter, stirrer, water and metal balls.
or mass of calorimeter and the mixture. 02
(All 02 any correct three 01)

(d) (i) Water may not cover the metal balls completely OR
Water may vaporize (evaporate) due to high temperature it gains.
OR metal balls will not mix properly with water.
OR Heat in metal balls will not completely absorbed by water.
OR Heat loss to the surrounding will be higher. 01

(ii) Water may spill over when stirring
OR water may spill over when balls are transferred
Increase in temperature may be too small
Increase in temperature of water may not be deflectable.

(e) Heat lost by metel balls = 0.3 x S x 64
Heat lost by metal balls = heat gained by calorimeter, stirrer and water

$0.3 \times S \times 64 = 2400$ 01

$S = 125 Jkg^{-1}\,^{0}C^{-1}$ 01

(f) Water will be added to the mixture along with the metel balls.
Dry balls can not be obtained from this method
Temperature of metel balls will be reduced when water is wiped off from the balls.
Heat lost to the surroundings will be high while transferring the balls. any correct 01

(g) No

(1) Metel power may float in water

(2) Metel power may stick on to the wall of the calorimeter.

(3) During the transfer of metel powder of the calorimeter amount of heat lost from the powder is high because of its high surface area. OR

Temperature of metel powder will be less than 100°C when it is transferred to the calorimeter because of higher cooling rate due to large surface area.

Any correct two 01

03. (a) $V = f\lambda$ and $\lambda = 2l$

$V = 2fl$ 01

(b) $l = \frac{V}{2f}$

$l = \left(\frac{V}{2}\right)\frac{1}{f}$ 01

$y = l$

$x = \frac{1}{f}$

(c) (i) first use the tuning fork with the lowest frequency and check the resonance length.

reason :- To make sure that the wire is long enough to get the resonance lengths for all frequencies.

(ii) Start taking data with the tuning fork with highest frequency

Reason :- To make sure that the fundamental mode of resonance is taken in increasing the resonance length for successively decreasing frequencies.

Correct Answer and reason 01

(d) The smallest tuning fork (Shortest tuning fork) 01

(e) Vibration amplitude is highest at the fundamental mode 01

(f) (i) Y axis - l cm

X axis - $\frac{1}{f}$ (H_z^{-1}) or S 01

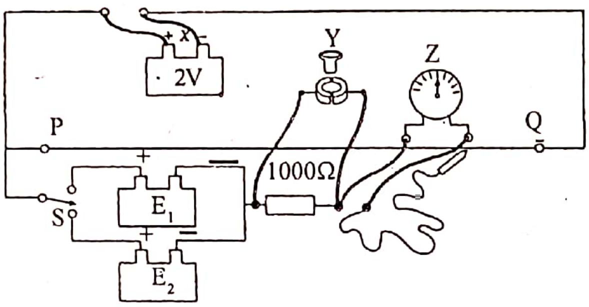
(ii) (Selecting the two point in graph) 01

$m = \frac{0.39 - 0.21}{0.0038 - 0.0021} = \frac{0.18\ ms^{-1}}{0.0017} = 105.88\ ms^{-1}$

$V = 211.76\ ms^{-1}$

($210 - 213\ ms^{-1}$)

(g) Repeat obtaining the resonance state several times by adjusting the peg and estimate Δl_2
OR by slowly moving the position of the peg within the resonance region and detecting its limits. 01

04. 

(a) Connection of the 2V accumulator as shown 01
Connection of the key (Y) and Galvanometer Z 01

(b) E_1 and E_2 < e.m.f x
OR Magnitude of the e.m.f. of x must be greater than E_1 and E_2 OR $2V > E_1$ and E_2

(c) No
Reasons :- Wire does not come to stady state OR voltage across the wire can not be kept constant OR Temperature of the wire will vary
Any reason 01

(d) Accumulater will be discharged rapidly OR
E.m.f of the accumulater can not be maintained at 2V OR the potential drop per unit length of the wire will vary OR wire will be heated up excessively.
Any reason 01

(e) (i) Momentarily touch the wire with the jockey and find the approximate balance - point 01
(ii) close the switch y and take the exact balance point 01

(f) $E_1 = kl_1$

$E_2 = kl_2$

$\frac{E_1}{E_2} = \frac{l_1}{l_2}$ 01

(g) Add a resistance box in series with the poteitiometer wire
01

(h) Replace the 2V accumulator with another accumulator (battery) having a larger e.m.f. OR
Connect another accumulator is series with the accumulater.
OR connect another 2V accumulater is series with the first

PART B

01. (i) If x is the displacemant of each brake pad then
$1 \times 0.6 = 2 \times 3 \times$
$x = 0.1$ cm 01

(ii) (a) Let F be the force on the master piston
G_A $10 \times 20 = F \times 5$
$F = 40N$ 01

(b) Pressure on the Master piston (P) = F/A
$P = \frac{40}{10^{-4}}$
$P = 4 \times 10^5$ Pa 01

(c) Force on a Second piston $= PA$ (F = PA)
$= 4 \times 10^5 \times 3 \times 10^{-4}$
$= 120N$

(d) Force exerted on the wheel due to a single brake pad.
$F = \mu R$ 01
$= 0.5 \times 120$
$F = 60N$ 01

(iii) Let α be the angular deceleration of the wheel
$\tau = I\alpha$ 01
$2 \times 60 \times 0.05 = 0.1\alpha$ 02
$\alpha = -60$ rads^{-2} 01
Initral angular velocity ω_0 of the wheel.
$\omega_0 = 2\pi f$
$\omega_0 = 2\pi \times \frac{600}{60}$ ($2\pi \times 10$ or 20π or 60π) 01

$\omega = \omega_0 + \alpha t$
$0 = 20\pi - 60t$
$60+ = 20 \times 3$
$t = 1$ S 01

Applying $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ or $\omega^2 = \omega_0^2 + 2\alpha\theta$ or $\theta = \frac{(\omega + \omega_0)}{2}$
or $\tau\theta = \frac{1}{2} I\omega_0^2$

$\theta = 20\pi \times 1 - \frac{1}{2} \times 60 \times 1$ or $0 = (20\pi)^2 - 2 \times 60\theta$ or $\theta \frac{(20\pi \times 0)1}{2}$

OR $6 \times \theta = \frac{1}{2} \times 0.1 \times (60)^2$
$\theta = 30$ rad

Number of revolutions $= \frac{\theta}{2\pi}$
$= \frac{30}{2\pi}$

$=$ 5 revolutions 01

[take $\pi = \frac{22}{7}$, t = 1.05s (1.04 , 1.05) 01

Nuber of revolutions = 5.24 rev
(5.23 - 5.25) 01

02. (i) (a) (1) When focused to infinity, the focal leagth mast be equal to the distance from the lens to the retina.
focal length = 2cm = 0.02m

$P = \frac{1}{f}$
$P = \frac{1}{0.02}$ 01
$P = 50$ D 01

$\frac{1}{V} - \frac{1}{u} = \frac{1}{f}$.
$\frac{-1}{0.02} - \frac{1}{\infty} = \frac{1}{f}$
$f = 0.02$m
$P = \frac{1}{f} = \frac{1}{0.02\text{ m}}$ 01
$P = 50$ D 01

(2) focused to near point
using the lens formula

$\left.\begin{array}{l} \frac{1}{V} - \frac{1}{U} = \frac{1}{f} \\ \frac{-1}{0.02} - \frac{1}{0.25} = \frac{1}{f} \end{array}\right\}$ or 10

$\frac{1}{f} = \frac{-27}{0.5}$

$\frac{1}{f} = \frac{-270}{5}$

$P = 54$ D 10

(b) The image is real and 01
inverted 01

(c) For thin lenses in contact $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ | $P = P_1 + P_2$ -01

When focused to infinity $50 = 40 + \frac{1}{f_{Lens}}$ | $50 = 40 + P_2$

| $P_2 = 10D$ -01

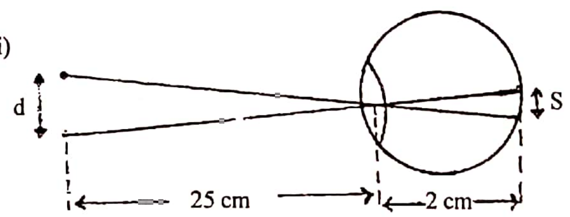
$$\frac{1}{f_{Lens}} = 10\text{ D}$$

$$P = 10\text{ D}$$

When focused to near point $54 = 40 + \frac{1}{f_{Lens}}$ | $54 = 40 + P_2$

The power of the lens $= 14D$ | $P_2 = 14D$

(ii)



(a) $\frac{S}{d} = \frac{2}{25}$

$S = \frac{2d}{25}$ $S = 0.08\text{ d}$ 01

(b) When d = 0.08 mm $S = 0.08 \times 0.08 = 0.0064$ mm

$= 6.4\ \mu\text{m}$ 01

This value is lessthan 8μm. Therefore this separation is sufficient 01

(c) for 0.08 mm dot separation the image separation is 0.0064 mm. Using the lens, the image separation must be increased to 0.008mm. Therefore the required magnification is $\frac{0.008\text{ N}}{0.0064}$

$= 1.25$ 01

Using lens formula

$$\frac{1}{V} - \frac{1}{u} = -\frac{1}{f}$$

$$\frac{1}{D} - \frac{1}{u} = -\frac{1}{f}$$

$$\left(M = \frac{D}{u}\right) = 1 - \frac{D}{u} = \frac{D}{f}$$

$$M = 1 + \frac{D}{f}$$

$1.25 = 1 + \frac{25}{f}$ 01

$$\frac{25}{f} = 0.25$$

$f = 100$ cm (1D) 01

03. (i) Compressional stress of the upper arm bone $= \frac{60 \times 10}{\pi(1-0.4^2)10^{-4}}$

young's modulus $= \frac{\text{stress}}{\text{strain}} = \frac{F/A}{e/l}$

Compressional strain $= \frac{600}{\pi(1-0.4^2)10^{-4}} \times \frac{1}{1.4 \times 10^{10}}$

$= 1.6 \times 10^{-4}$ 01
(1.60 - 1.63)

Compressoinal strain $= e/l \left(\frac{\text{decrease in tength}}{\text{Intial length}}\right)$ 10

Compressional of the bone $= 1.6 \times 10^{-4} \times 0.3$
$= 4.8 \times 10^{-5}$ m 01
(4.80 - 4.90)

(ii) Elastic energy stored per unit length.

$= \frac{1}{2}$ Stress x strain 01

$= \frac{1}{2} \times \frac{600}{\pi(1-0.4^2)10^{-4}} \times 1.6 \times 10^{-4}$

$= 1.8 \times 10^2\ Jm^{-3}$ 01
(1.80 - 1.86)

Energy Stored $= \frac{1}{2}$ force x Compression 01

$= \frac{1}{2} \times 600 \times 4.8 \times 10^{-5}$

Energy sfored per unit volume $= \frac{1}{2} \times \frac{600 \times 4.8 \times 10^{-5}}{\pi(1-0.4^2)\,10^{-4} \times 0.3}$

$= 1.8 \times 10^2\ Jm^{-3}$ 01

(iii) (a) $V^2 = u^2 + 2as$
$V^2 = u^2 + 2gh$

Velocity of B when falls on to A $\left(\sqrt{2 \times 10 \times h} / \sqrt{20h} / 2\sqrt{5h}\right.$ or $\left.4.47\sqrt{n}\right)$

$V^2 = 2gh$

$V = \sqrt{2gh}$

Change in momentum of B after falling on to A

$= \left(\sqrt{2 \times 10 \times h} - 0\right) \times 50$ $\left[or\ 100\sqrt{5h} / 223.5\sqrt{h}\right]$

$= 50\sqrt{20h}$ 01

(b) Average force $= \frac{\text{change in momentum}}{\text{time}}$

$F = \frac{\Delta mv}{t}$ or $25 \times 10^2 \sqrt{20h}$

$= \frac{50\sqrt{20h}}{0.02}$ $\left(5 \times 10^3 \sqrt{5h}\ or\ 111.8 \times 10^2 \sqrt{h}\right)$

(c) maximum stress $= 9 \times 10^7\ Nm^{-2}$

Total force on the upper arm bone =

$600 + 25 \times 10^2 \sqrt{2 \times 10 \times h} + 500$ 01

$\left(600 + 5 \times 10^3 \sqrt{5h}, or\ 600 + 118.8 \times 10^2 \sqrt{h}\right)$

If h_{max} is maimum height then

$\frac{500 + 600 + 25 \times 10^2 \sqrt{2 \times 10 h_{max}}}{\pi \times \left(1 - 0.4^2\right) 10^4} = 9 \times 10^7$ 01

$h_{max} = 4.3$ m
(4.10 - 4.53) 01

04. (i) Nuclear Medicine
Protein crystallography
Talking detectors in high energy physice
any one 01

(ii) Near the anode wire 01

(iii) Due to the acceleration in the electric field 01

(iv) Three (3) 01

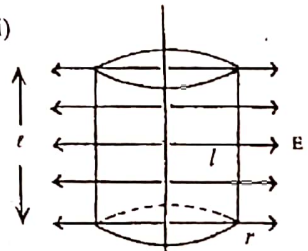
(v) Near the anode wire

(vi) Speed of the positive ions is low.
Positive ions are heavier than electrons or lower acceleration.
Any one 01

Positive ions have to travel a longer distance weaker electric field away from the wires.
Any one 01

(vii) Gas used, anode voltage, separation between the cathode plates, separaton between wirrles, diameter or radius of wires.
Any one 01

(viii)



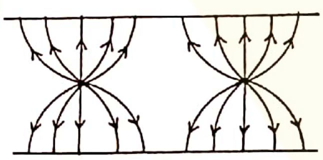
or Consider the cylindrical Gauss surface of length and radius r symmetrically
01

Applying Gouss law $2\pi r l E = \frac{\lambda l}{\varepsilon_0}$

$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

(ix) Amplitude of the pulse increase.
reason : More secondary ionizations being produced
OR
More electrons would be collected by the anode wire
OR stronger electric field closer to the wire. 01

(x)



Correct Shape 01
line perpendicular to the Cathode plate 01
Correct direction of the field with arrows 01

(xi) Energy of outgoing particle $= 100 - \frac{100 \times 30}{1000}$
$= 97 \times 10^3$ or 97keV 01

05. (A) (i) $F = BIl$

$$F = \frac{BEl}{R} \quad (I = E/R)$$

direction of the force right or → 01

(ii) (a) $E = Blv$
the back emf $= Blv$ 01

(b) Current through the bar; $i = \frac{E - BlV}{R}$ $(v = E - Blv)$
01

$F = BIl$
Force on the Bar $= \frac{Bl(E - Blv)}{R}$ 01

Power delivered by the battery (w) $= VI$
$= E\left(\frac{(E - BlV)}{R}\right)$
$= \frac{E^2}{R} - \frac{EBlV}{R}$ 01

(c) Due to the force F, the bar is accelerated, Then because E is constant, the force is decreases. The speed v does not increase after the force becomes Zero OR current becomes Zero
Therefore the maximum speed is reached when
$E = Bvl$

$V = \frac{E}{Bl}$ correct orgument 01

When the speed in maximum current through the bar is Zero 01

(iii) When is S is open and S_2 is closed the only emf present in the system is the induced emf due to the motion of the bar. This emf produces a current which creates a force that opposes the motion of the bar. Therefore, the bar is decelorated. 01

The kinetic energy is converted to heat the induced current flows through the resistance of the bar OR through i^2R type heating OR through Joule heating. 01

(iv) (a) Maximum speed is given by $v = \frac{E}{Bl}$ $(E = Blv)$

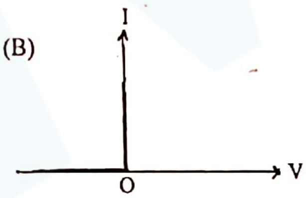
required E is given by $= 2 \times 10 \times 100$ $(E = Blv)$
$= 2000V$ 01

(b) The initial acceleration $= \frac{BlE}{mR}$

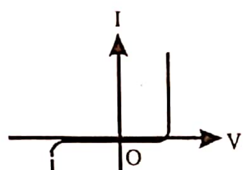
$$\begin{bmatrix} F & = ma \\ BIl & = ma \\ a & = \frac{BEl}{R} \end{bmatrix} \quad a = \frac{BEl}{mR}, \quad a = \frac{2 \times 10 \times 2000}{20000 \times 10}$$ 01

$a = 0.02\ ms^{-2}$ 01

05. (B)



01



notl required
01
not labled in both diagrams deduct 1 mark

(i) When forward biased
Peak currend (i_D)
$V = IR$
$10 - 0.7 = 1 \times 10^3 I_D$
$i_D = \frac{9.3}{10^3}$ 01

$I_D = 9.3 \times 10^{-3}$ A (9.3mA) 01

When reverse biased peark current of $I_D = 0$ 01

(ii)

V_A (V)	V_B (V)	V_o (V)	logic level
o	o	o	o
o	5	4.3	1
5	o	4.3	1
5	5	4.3	1

Correct V_0 column 01
Correct logic level Column
01

(iii) $V_A = 5V$ and $V_B = 3V$

$$I_{R_L} = \frac{5 - 0.7}{1 \times 10^3}$$

$= 4.3\,A\ (4.3 \times 10^{-3}A)$ 01

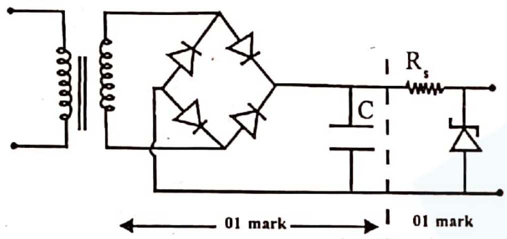
(iv) (1) (a) When ac power is present upperdiode is forward based and its cathode will be at 14.3 v which makes lower diode reverse biased 01
Clock will have 14.3V at its supply input and function normally 01

(b) When ac power fails, lower diode becomes forward biased and upper diode becomes reversed biased. 01

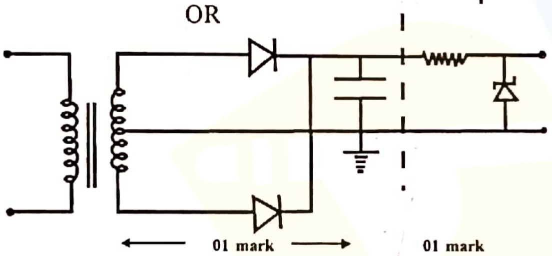
∴ Clock will bave 11.3v at its supply input and continue to function normally 01

(2) When ac power is present the lower diode is reverse biased and therefore current drawn from the 12v supply is zero. 01

(v)



OR



06. (A) (i) At the steady state, rate of heat how through the upper plate = 50w 01

Applying $\overset{\circ}{Q} = kA \frac{(\theta_1 - \theta_2)}{d}$ 01

$$50 = \frac{k \times 2 \times 10^{-4} \times (100 - 98)}{2 \times 10^{-3}}$$

$K = 250 Wm^{-1}k^{-1}$ 02
(Corret unit 01 mark)

(ii) (a) $\overset{\circ}{Q} = KA\,(\theta_1 - \theta_2 /d)$

$$50 = \frac{250 \times 2 \times 10^{-4} \times (40 - \theta)}{2 \times 10^{-3}}$$ 01

$\theta = 38\ ^0C$ 01

(b) From Newton's low of cooling rate of heat loss

$\overset{\circ}{Q}\ \alpha\ A\,(\theta - \theta_R)$ 01
$50\ \alpha\ A \times (38 - 30)$ Ⓐ 01
$50\ \alpha\ 2 \times 10^{-4}\,(98 - 30)$ Ⓑ 02
From the above proportionalities

Ⓐ/Ⓑ $1 = \frac{A \times 8}{2 \times 10^{-4} \times 68}$

$A = \frac{2 \times 10^{-4} \times 68}{8}$ 01

$A = 17 \times 10^{-4}\ m^2$ 01

(c) Rate of heat absorbed by water $= ms\theta = m \times s \times (35 - 30)$
$50 = m \times 4.2 \times 10^3 \times 5$ 01
$m = 2.3 \times 10^{-3}\ kgs^{-1}$ 01
$= (2.3 - 2.4)$

06. (B) (i) Energy of the incident x - ray photon $= \frac{hc}{\lambda}$

Energy of the incident x - ray photon $= \phi_1$

$$\phi_1 = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{2.2 \times 10^{-10}}$$

$\phi_1 = 9 \times 10^{-16} J$ 01

(ii) (a) Apply the photo - electric equation

$\phi_1 - \phi_2 = E_k$
$9 \times 10^{-16} - \phi_2 = 6 \times 10^{-16}$ 01
$\phi_2 = 3 \times 10^{-16}\ J$ 01

(b) $\phi_2 = \frac{hc}{\lambda}$

$\lambda = \frac{hc}{\phi_2}$

$$\lambda = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{6 \times 10^{-16}}$$

$\lambda = 6.6 \times 10^{-10} m\ (6.6\ ^0A)$ 01

(iii) $\phi_1 - \phi_2 = 9 \times 10^{-16} - 3 \times 10^{-16}$ 01
(Award the mark for taking the difference)

$$\lambda = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{6 \times 10^{-16}}$$

$\lambda = 3.3 \times 10^{-10} m\ (3.3\ ^0A)$ 01

(iv) (a) $P = E/C = \frac{9 \times 10^{-16}}{3 \times 10^8}$

$= 3 \times 10^{-24}\ kgms^{-1}\ (Jms^{-1})$
(01 mark for the unit)

(b) Let V be the Speed of the recoiling atom then
$P = mV$
$3 \times 10^{-24} = 6 \times 10^{-26}\ V$ 01
$V = 50 ms^{-1}$ 01

(c) Kinetic energy of the atom $= \frac{1}{2} mV^2$
$= \frac{1}{2} \times 6 \times 10^{-26} \times 50^2$
$= 7.5 \times 10^{-23}\ J$ 01

(d) Kinetic energy as a fraction $= \frac{7.5 \times 10^{-23}}{9 \times 10^{-16}}$
$= 8.3 \times 10^{-8}\ (8.0 - 8 \cdot 4)$ or

indicatmg that 10^{-23} is very small compared to 10^{-16} 01

∴ the kinetic energy of the recoiling atom is negligibly small compared to the energy of the incident X - ray photon.