G.C.E. (Advanced Level) Examination - April 2006

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 with instructions given on the back of the answer sheet.

Use of calculators is not allowed.

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

01. Which of the following is **not** an SI unit?
(1) kg (2) m (3) s (4) A (5) k

02. If $(n - 1)$ number of main scale divisions of a certain measuring instrument is divided into n vernier scale divisions, then the least count of the instrument i main scale divisions is
(1) 1 (2) $\frac{1}{n}$ (3) $\frac{n}{n-1}$ (4) $\frac{n-1}{n}$ (5) $\frac{1}{n-1}$

03. The refractive indices of water and glass are $\frac{4}{3}$ and $\frac{3}{2}$ respectively.
The refractive index of water relative to glass is
(1) $\frac{1}{4}$ (2) $\frac{1}{2}$ (3) $\frac{8}{9}$ (4) $\frac{9}{8}$ (5) 2

04. For an object undergoing simple harmonic motion
(1) the magnitude of the acceleration is maximum when the displacement is maximum.
(2) the displacement is maximum when the speed is maximum.
(3) the magnitude of the acceleration is maximum when the speed is maximum.
(4) the maximum potential energy is greater than the maximum kinetic energy.
(5) the acceleration is always constant.

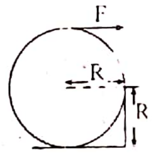
05. A black body of temperature T K radiates energy at a rate of 10mW. At temperature $2T$ K it will radiate energy at a rate of
(1) 10mW (2) 20mW (3) 40mW
(4) 80mW (5) 160mW

06. A radioactive nucleus $^{A}_{Z}X$ decays to a nucleus $^{A-4}_{Z-1}Y$ in two stages. The radiations emitted in the two stages would most likely be

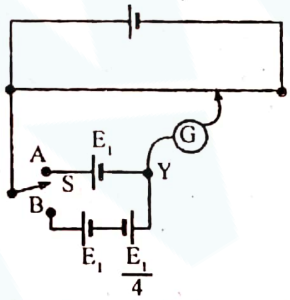
	First stage	Second stage
(1)	α	β
(2)	β	γ
(3)	β	α
(4)	α	γ
(5)	β	γ

07. Light of wavelength 5000Å is incident on a sodium surface whose work function is 2.28 eV. The maximum kinetic energy of the emitted photoelectrons is ($hc = 12.4 \times 10^3$ eVÅ)
(1) 0.03eV (2) 0.20eV (3) 0.60eV
(4) 1.30eV (5) 2.00eV

08. A circular coin of radius R and mass M is placed so that it touches a step of height R as shown in the figure. The minimum value of the horizontal force F required to pull the coin over the step is



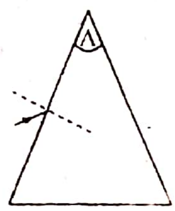
(1) $\frac{Mg}{2}$ (2) $\frac{Mg}{\sqrt{2}}$ (3) Mg
(4) $\sqrt{2}$ Mg (5) 2 Mg

09. 

In the potentiometer circuit shown when switch S is connected to A the balance length is l. When S is connected to B the balance length will be
(1) $\frac{l}{4}$ (2) $\frac{l}{2}$ (3) $\frac{3l}{4}$
(4) $\frac{4l}{3}$ (5) $\frac{5l}{4}$

10. An astronomical telescope consists of two convex lenses of focal lengths 50 mm and 650mm. The moon subtends an angle of 0.5° on an unaided eye. If the telescope is used in normal adjustment to view the moon. the angle subtended by the final image of the moon on the aye is
(1) 6.5° (2) 5.5° (3) 4.5° (4) 3.5° (5) 2.5°

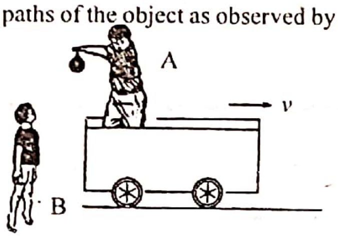
11. A ray of light incident on a glass prism is shown in the figure. Consider the following statements.

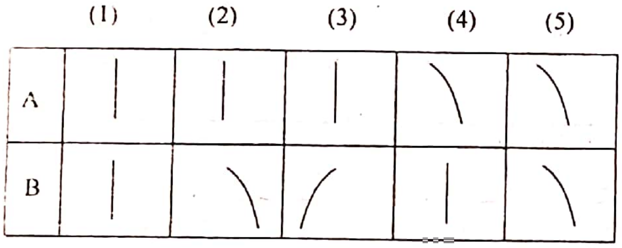


(A) Irrespective of the value of angle A the incident ray always emerges from the opposite face.
(B) For a certain value of the angle of incidence the deviation of the emergent ray is minimum.
(C) There is an angle of incidence for the ray for which the angle of emergence is equal to the angle of incidence.

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

12. A person A standing on a trolley moving with a constant speed v on a straight horizontal track drops an object as shown in the figure. B is an observer standing on the ground. If the air resistance is negligible, the paths of the object as observed by A and B are represented by





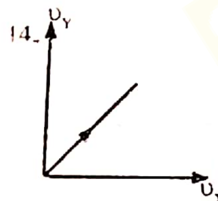
13. Refractive indices for red light and blue light in crown glass are 1.51 and 1.53 respectively. Consider the following statements.

(A) The speeds of red light and blue light in vacuum are the same.

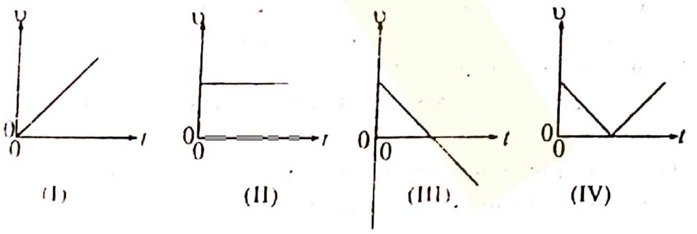
(B) The speed of red light is greater than that of blue light in crown glass.

(C) Critical angle of red light is greater than that of blue light for crown glass

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

14. 

A stone is thrown at a certain angle with the horizontal in the direction shown by the arrow. If air resistance is ignored, which of the following velocity (v) - time (t) graphs best represent the variations of v_x with t, and v_y with t?



(I) (II) (III) (IV)

	v_x with t	v_y with t
(1)	II	III
(2)	II	I
(3)	I	IV
(4)	II	IV
(5)	II	II

15. Consider the following statements made regarding a transformer

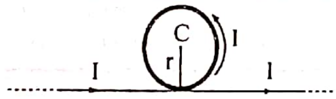
(A) The core of a transformer is usually made of soft iron in order to maintain a better flux linkage

(B) The wire diameter of the secondary coil of a step-down transformer is usually larger than that of the primary coil

(C) When winding transformers, wires without insulated coating must be used.

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.

16. A long insulated wire carrying a current I is bent to form a flat circular coil of N turns and radius r. The two straight ends of the wire extend to a large distance as shown. The magnitude of the magnetic flux density at the centre C of the coil is

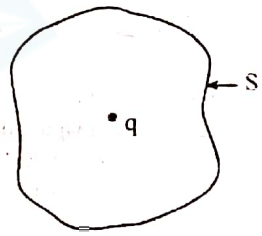


(1) 0 (2) $\frac{N\mu_0 I}{2\pi r} + \frac{\mu_0 I}{2r}$ (3) $\frac{N\mu_0 I}{2r} - \frac{\mu_0 I}{2\pi r}$

(4) $\frac{N\mu_0 I}{2r} + \frac{\mu_0 I}{2\pi r}$ (5) $\frac{N\mu_0 I}{2r} + \frac{\mu_0 I}{2r}$

17. As a mechanical wave propagates in a medium, the energy of the wave dissipates gradually. This will gradually
(1) decrease the speed of the wave
(2) decrease the amplitude of the wave
(3) decrease the frequency of the wave
(4) decrease the wavelength of the wave
(5) increase the wavelength of the wave

18. S is a Gaussian surface and q is a charge inside it. Consider the following statements made about the net electric flux Φ through the surface S.



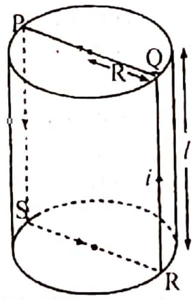
(A) If the volume enclosed by the surface S increases, than Φ increases

(B) If the charge q is moved close to the surface S, then Φ increases

(C) Even if the shape of the surface S is changed, Φ remains the same.

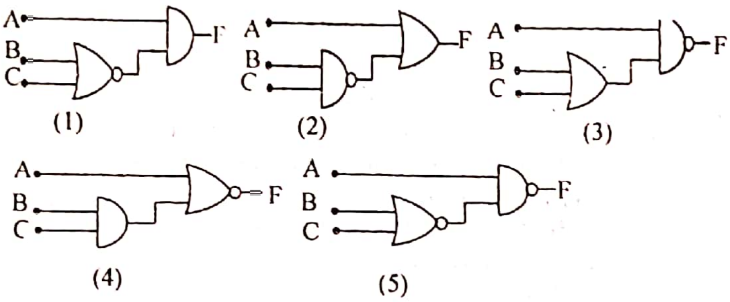
Of the above statements,
(1) only (A) is true. (2) only (B) is true.
(3) only (C) is true. (4) only (A) and (B) are true
(5) only (B) and (C) are true

19. The figure shows a cylindrical satellite with radius R and length l and a wire $PQRS$ wrapped around it in a rectangular shape. If a current i is made to flow through $PQRS$ at an instant when the direction of the earth's magnetic field of flux density B is along PQ.

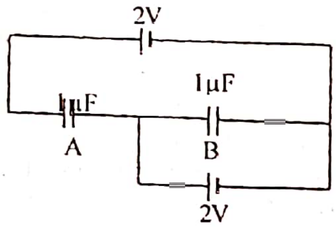


(1) a net force of 2RiB and a torque of 2RliB will act on the satellite.
(2) a net force of 2liB and a torque of 2RliB will act on the satellite
(3) there will be no net force but a torque of RliB will act on the satellite
(4) there will be no net force but a torque of 2RliB will act on the satellite
(5) neither a net force nor a net torque will act on the satellite

20. The circuit corresponding to the logic expression $F = A.\overline{B+C}$ is

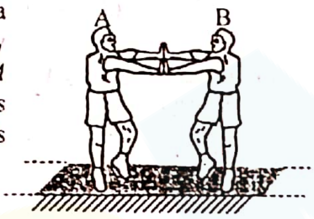


21. In the circuit shown, charges of the capacitors A and B respectively are



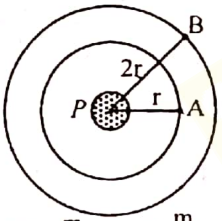
(1) 2μC, 2μC
(2) 1μC, 2μC
(3) 1μC, 3μC
(4) 0, 2μC
(5) 0,4μC

22. Tow boys, A and B, standing on a horizontal ice surface move apart by pushing each other. The weight of A is twice that of B. By the time A has moved 4 m the distance moved by B is



(1) 0 (2) 2m (3) 4m
(4) 8m (5) 12m

23.



As shown in the figure, two satellites A and B of masses m_A and m_B move around a planet P in circular orbits with speeds V_A and V_B respectively. The radii of the orbits are r and $2r$ respectively. The ratio $\frac{V_A}{V_B}$ is

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

24. Suppose the times taken for a large airplane to accelerate uniformly from 500kmhr^{-1} to 505kmhr^{-1}, a car from 50kmhr^{-1} to 55kmhr^{-1} and a bicycle from 5 kmhr^{-1} to 10kmhr^{-1} are the same. Consider the follwing statements.

(A) All have the same acceleration

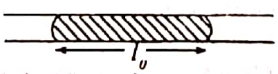
(B) All travel the same distance during the above time period.

(C) The accelerating force on each is the same.

Of the abve 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.

25.

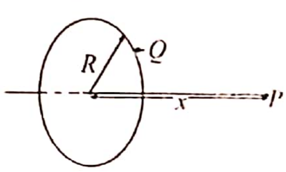


A liquid of volume expansivity γ forme a liquid thread of length l_0 inside a tube made of a material of linear expansivity α as shown in the figure. If the temperature is increased by an amount θ, the length of the liquid thread will become

(1) l_0 (2) $l_0\frac{(1+\gamma\theta)}{(1+\alpha\theta)}$ (3) $l_0(1+\gamma\theta)(1+2\alpha\theta)$

(4) $\frac{l_0(1+\gamma\theta)}{(1+2\alpha\theta)}$ (5) $\frac{l_0(1+\gamma\theta)}{(1+3\alpha\theta)}$

26. A thin conducting ring of radius R has a charge Q uniformly distributed over it. P is a point on the axis passing perpendicular to the plane of the ring and through its centre. The electric potential at the point p is given by

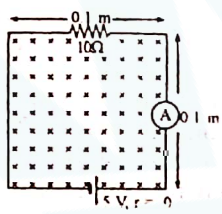


(1) $\frac{Q}{4\pi\varepsilon_0 x}$ (2) $\frac{Q}{4\pi\varepsilon_0 (R^2+x^2)^{\frac{1}{2}}}$ (3) $\frac{QX}{4\pi\varepsilon_0(R^2+x^2)}$

(4) $\frac{QX}{4\pi\varepsilon_0(R^2+x^2)^{\frac{1}{2}}}$ (5) $\frac{QR}{4\pi\varepsilon_0(R^2 \times x^2)}$

27. If two cylinders one containing argon gas and the other containing neon gas are kept at the same temperature, then
(1) the pressures of the gases must be equal.
(2) the mean speeds of the gas atoms of the two gases must be equal
(3) the gas atoms of the two gases must have the same root mean square speed.
(4) the masses of the gases must be equal.
(5) the gas atoms of the two gases must have the same mean translational kinetic energy.

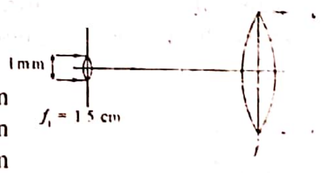
28.



The circuit shown is placed in a uniform magnetic field that is acting into the page. This magnetic field is decreasing in magnitude at a rate of 150Ts^{-1}. The reading of the ammeter is
(1) 0.15A (2) 0.35 A
(3) 0.50 A (4) 0.65 A
(5) 0.80 A

29. A laser beam of 1 mm diameter has to be converted into a beam of 10mm diameter using two convex lenses as shown. What is the value of the focal length f_2 of the second lens and the distance d at which it should be placed from the first lens?

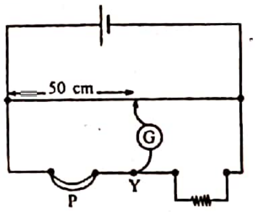
	f_2	d
(1)	4.5 cm	6.0 cm
(2)	10.0 cm	10.0 cm
(3)	10.0 cm	11.5 cm
(4)	15.0 cm	15.0 cm
(5)	15.0 cm	16.5 cm



30. The near point of a defective eye is 50cm. The lens that should be worn to correct the near point to 25cm is
(1) a converging lens of focal length 50cm.
(2) a diverging lens of focal length 50cm.
(3) a converging lens of focal length 25cm.
(4) a diverging lens of focal length 25cm
(5) a converging lens of focal length 75cm

31. An earthquake which occurred at a certain location generates a transverse wave (S - wave) and a longitudinal wave (P-wave). Both waves travel through the earth, and the P - wave arrives 3 minutes before the S - wave at a certain point on the earth. The average speeds of the S and P waves between the point and the location of the earthquake are 4kms^{-1} and 8kms^{-1} respectively. How far away from the point did the earthquake occur?
(1) 40km (2) 540km (3) 720km
(4) 1440km (5) 2400km

32. The diagram shows a balanced metre bridge. P indicates a pair of identical resistive wires connected in parallel. When one resistive wire is removed, the new balance length is approximately equal to



(1) 22 cm
(2) 44 cm
(3) 55 cm
(4) 67 cm
(5) 92 cm

33. Two small plastic spheres, A and B of which A is hollow and B is solid, made of the same material and having the same external radii are released from rest from a tall building. Both spheres reach their terminal velocities before hitting the ground. When the spheres reach the ground
(1) the speed of A is greater than the speed of B.
(2) the viscous force on A is less than that on B
(3) the viscous force on B is less than that on A
(4) A has taken a shorter time than B.
(5) both spheres gain the same speed.

34

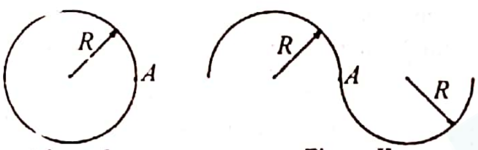


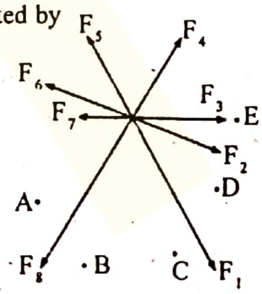
Figure I Figure II

The moment of inertia of a ring of mass M made of a uniform thin wire about an axis through the point A (figure I) perpendicular to the plane of the ring is $2MR^2$. When the ring is bent to a S shape as shown in figure II, the moment of inertia about the same axis is

(1) 0 (2) $\frac{1}{2}MR^2$ (3) MR^2

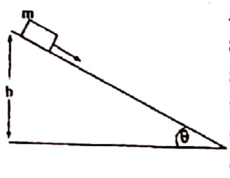
(4) $\frac{3}{2}MR^2$ (5) $2MR^2$

35. A system of coplanar forces F_1 to F_8 drawn to scale act on a point object O as shown. The resultant force will most probably be a vector represented by



(1) $\overrightarrow{OA}$
(2) $\overrightarrow{OB}$
(3) $\overrightarrow{OC}$
(4) $\overrightarrow{OD}$
(5) $\overrightarrow{OE}$

36.



A wooden block of mass m is sliding down an inclined plane at **constant speed** from a height h above the ground as shown in the figure. The total energy dissipated due to friction by the time the block reaches the bottom of the plane is

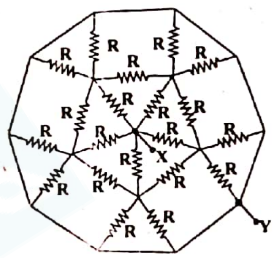
(1) $\frac{mgh}{\cos\theta}$ (2) $\frac{mgh}{\sin\theta}$ (3) $mgh\tan\theta$
(4) mgh (5) 0

37. Two identical conducting spheres A and B carry equal charges. The spheres are separated by a distance which is much larger than their diameters. The electrostatic force acting between them is F. Now a third identical uncharged conducting sphere is first made to touch A and secondly B, and then removed. The new value of the force acting between A and B is
(1) 0 (2) $\frac{F}{16}$ (3) $\frac{F}{4}$ (4) $\frac{3F}{8}$ (5) $\frac{F}{2}$

38. The standard length of the filament of a 60w, 230V electric bulb has shortened due to a certain defect. When this bulb is glowing,
(A) it will glow brighter and consume more power than a standard 60W bulb.
(B) the wavelength corresponding to the maximum intensity of the light emitted will be lower than that due to a standard 60 w bulb.
(C) surface temperature of the glass envelope of the bulb will be at a higher temperature than that of a standard 60w bulb.
Of the above statements,
(1) only (A) is true. (2) only (A) and (B) are true.
(3) only (B) and (C) are true. (4) only (A) and (B) are true.
(5) all (A), (B) and (C) are true.

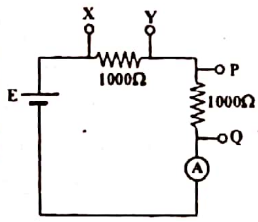
39. A long uniform wire of resistance R is cut into n number of pieces of equal length. These pieces are bundled together to make a composite wire of length that is equal to the length of a piece. The resistance of the composite wire is
(1) R (2) nR (3) n^2R (4) $\frac{R}{n}$ (5) $\frac{R}{n^2}$

40. Resistance across XY of the network shown is
(1) 2R
(2) $\frac{3}{2}R$
(3) R
(4)
(5)



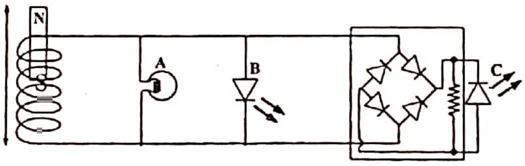
41. A point source of sound emits sound equally in all directions. For such a situation the sound intensity at a point is inversely at a point is inversely proportional to the square of its distance from the source. If the intensity level at a distance of 5 m from the source is 70 dB then the intensity level at a distance of 50 m from the source is
(1) 30dB (2) 40dB (3) 50dB
(4) 60dB (5) 80dB

42 In the circuit shown the cell E and the ammeter A have negligible internal resistances. When a voltmeter having internal resistance of 2000Ω is connected across XY,



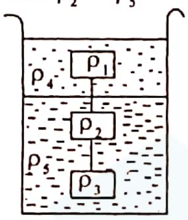
(1) the voltage across XY drops and the ammeter reading decreases.
(2) voltage across PQ increases and the ammeter reading drops.
(3) voltages across XY and PQ remain the same.
(4) both the voltage across PQ and the ammeter reading increase.
(5) voltage across PQ remains the same and the ammeter reading increases.

43. In the figure shown, A is a torch bulb, B and C are light emitting diodes. If a strong bar magnet is moved up and down continuously at a high rate through the coil and generates an ac voltage of peak amplitude 4v.

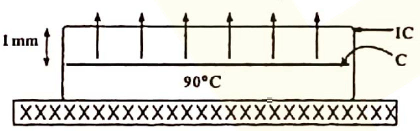


(1) only A will light up
(2) only A and B will light up.
(3) only B and C will light up
(4) only A and C will light up
(5) all A, B and C will light up.

44. Three masses made of materials having densities ρ_1, ρ_2 and ρ_3 and of equal volumes are connected together with light strings. The system floats in a vessel containing two immiscible liquids of densities ρ_4 and ρ_5 with strings taut as shown in the figure.
Consider the following conclusions made about the system.
(A) $\rho_1 < \rho_5$
(B) $\rho_1 < \rho_5$
(C) If the tensions of the strings are equal, then $\rho_2 = \rho_5$.
Of the above conclusions
(1) only (A) is true.
(2) only (C) is true.
(3) only (A) and (B) are true.
(4) all (A), (B) and (C) are true.
(5) all (A), (B) and (C) are **false.**

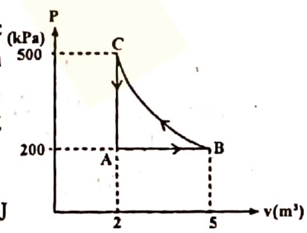


45. The figure shows a cross section of an integrated circuit (IC) mounted on a circuit board. The core (C) of the IC (The electronic circuit) dissipates 60 W of power as heat. The core is covered with a material of thermal conductivity $6 Wm^{-1} K^{-1}$. The direction of heat flow is shown by the arrows. The top surface of the IC is cooled by forced convection. The top surface has an area of 10 cm² and the distance from the core to the top surface is l mm. At what temperature the top surface be kept in order to maintain the core at 90°C? (Assume that no heat flows through the bottom surface and the sides.)

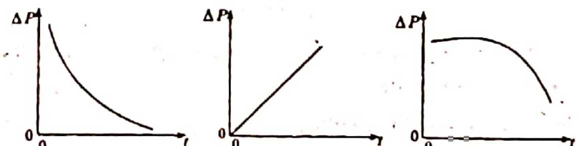


(1) 70°C
(2) 80°C
(3) 89.9°C
(4) 91°C
(5) 100°C

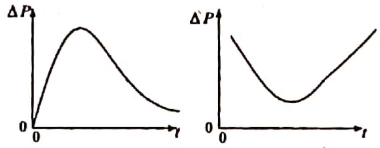
46 An ideal gas undergoes the cyclic process $ABCD$ in the PV diagram shown. BC is an isothermal path. The work done by the gas during one cycle is nearly equal to
(1) 600 kJ
(2) 300 kJ
(3) 0
(4) -300 kJ
(5) -600 kJ



47. A soap bubble is formed gradually at one end of a glass tube from time $t = 0$ by slowly blowing air from the other end. The variation of excess pressure (ΔP) inside the bubble with time (t) is best represented by

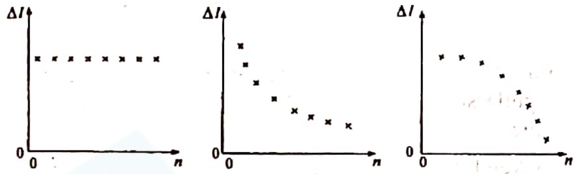


(1) (2) (3)

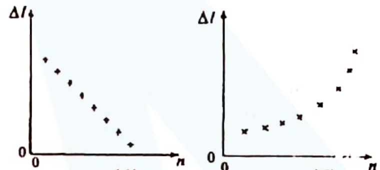


(4) (5)

48. A heavy metal box is to be supported by n number of uniform identical legs of the same material in such a way that the entire weight of the box is equally distributed among all legs. In this situation, the variation of the contraction Δl of each leg with the number of legs n, due to the weight of the box, is best represented by

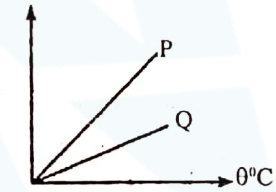


(1) (2) (3)



(4) (5)

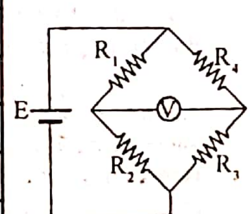
49. Graph shows the variation of the length (l) of the liquid columns of a certain mercury-in-glass thermometer (P) and an alcohol-in-glass thermometer (Q) with temperature (θ).



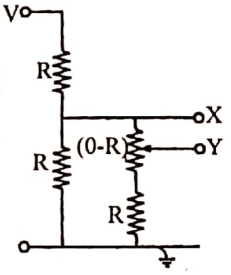
A student draws the following **general** conclusions solely based **only** on the graph.
(A) Mercury thermometers are more sensitive than alcohol thermometers.
(B) Mercury thermometers are longer than alcohol thermometers.
(C) Volume expansivity of mercury is greater than of alcohol.
He can truly conclude
(1) only (C).
(2) only (A) and (B).
(3) only (A) and (C).
(4) all (A), (B) and (C).
(5) **none** of (A), (B) and (C).

50. The following table indicates five different sets of resistance values that can be allocated for R_1, R_2, R_3 and R_4 of the bridge circuit shown. Which of the following sets produces the **largest** deflection in the voltmeter (V)?

	Set	$R_1 \Omega$	$R_2 \Omega$	$R_3 \Omega$	$R_4 \Omega$
(1)	1	30	5	30	5
(2)	2	20	15	10	25
(3)	3	25	10	10	25
(4)	4	10	25	25	10
(5)	5	30	5	5	30



51. The circuit shown consists of three fixed resistors and variable resistor which can be varied from *0* to *R*. The maximum voltage that can be obtained across *XY* is

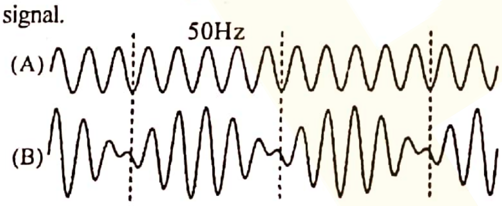


(1) $\frac{1}{5}$ V (2) $\frac{1}{3}$ V (3) $\frac{2}{5}$ V
(4) $\frac{2}{3}$ V (5) $\frac{4}{5}$ V

52. A particle is moving in a circular orbit of radius 10m. At one instant, the speed of the particle is $10ms^{-1}$ and is increasing at a rate of $10ms^{-2}$. The angle between the velocity vector and the resultant acceleration vector of the particle at that instant is
(1) 0° (2)30° (3) 45° (4) 60° (5) 90°

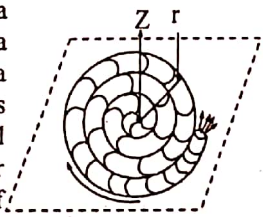
53. Consider the following statements made regarding the weightlessness experienced inside a satellite orbiting around the earth?
(A) Weightlessness is due to the negligibly small gravity at such an altitude.
(B) Due to weightlessness, the momentum of a person moving inside the satellite is zero.
(C) Due to weightlessness, natural thermal convection currents cannot occur inside the satellite.
Of the above statements.
(1) only (A) is true.
(2) only (C) is true
(3) only (A) and (C) are true
(4) all (A), (B) and (C) are true.
(5) all (A), (B) and (C) are **false.**

54. An oscilloscope is connected to a microphone which receives simultaneously a 50Hz signal and another signal of frequency *f*(*f*> 50Hz). The figure *A* shows the trace with the 50Hz signal alone while the figure *B* shows the trace due to the combined signal.



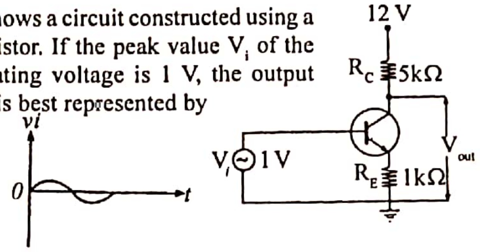
The value of f is
(1) 50Hz (2) 55Hz (3) 60Hz
(4) 65Hz (5) 70Hz

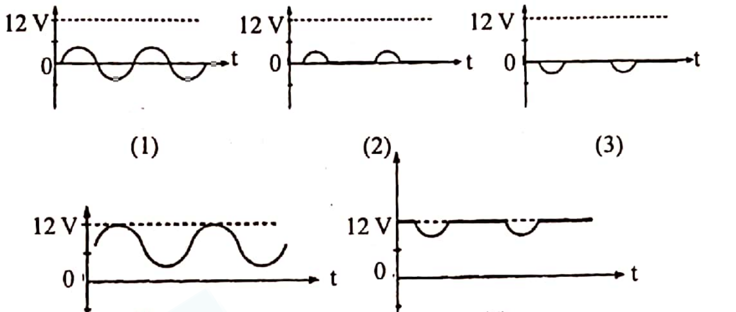
55. A circular disc shaped pin wheel type firework shown in the figure performs a rotational motion about the Z-axis on a horizontal smooth floor due to a constant reaction force generated by its burning. Assume that the pin wheel retains the shape of a uniform circular disc throughout and its moment of intertia $I = \frac{1}{2}mr^2$ about the Z-axis. If m,r, ω and α are the values of mass, radius, angular velocity and angular acceleration respectively of the burning pin wheel at a certain instant, then



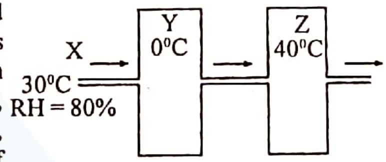
(1) $m\,r\,\alpha$ is constant (2) $mr^2\alpha$ is constant
(3) $r\,\omega$ is constant (4) $mr^2\,\omega$ is constant
(5) $mr^2\omega^2$ is constant

56. The figure shows a circuit constructed using a silicon transistor. If the peak value V_i of the input alternating voltage is 1 V, the output voltage V_{out} is best represented by





57. Atmospheric air at 30°C and having 80% relative humidity is made to flow slowly through two large chambers, *Y* and *Z*, maintained at 0 °C and at 40°C, as shown in figure. Densities of saturated water vapour in the atmosphere at 0 °C, 30°C and 40°C are 4.8 x 10^{-3} kg m^{-3}, $30x10^{-3}$kg m^{-3} and $48x10^{-3}$kg m^{-3} respectively. Which of the following tables correctly represents the relative humidities (RH), and the absolute humidities (AH) of air in the atmosphere (X), and in the chambers Y and Z?



(1)

	X	Y	Z
RH	80	10	90
AH(kg m^{-3})	30×10^{-3}	4.8×10^{-3}	35×10^{-3}

(2)

	X	Y	Z
RH	80	100	10
AH(kg m^{-3})	24×10^{-3}	4.8×10^{-3}	4.8×10^{-3}

(3)

	X	Y	Z
RH	80	0	40
AH(kg m^{-3})	24×10^{-3}	4.8×10^{-3}	4.8×10^{-3}

(4)

	X	Y	Z
RH	80	100	100
AH(kg m^{-3})	24×10^{-3}	4.8×10^{-3}	4.8×10^{-3}

(5)

	X	Y	Z
RH	80	100	100
AH(kg m^{-3})	24×10^{-3}	4.8×10^{-3}	4.8×10^{-3}

58. In the circuit shown in figure (a), the supply voltage (E) increases linearly with time (t) as shown in figure (b).

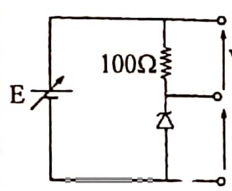


figure (a)

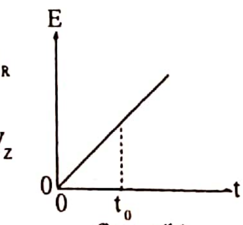
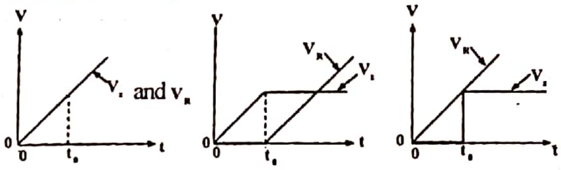


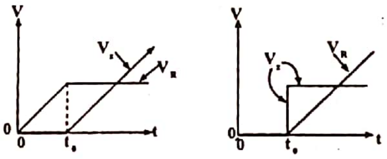
figure (b)

At time t = t_0, supply voltage surpasses the breakdown voltage of the Zener diode.
The variation of the voltage (V_R) across

100Ω resistor, and the voltage (V_Z) across the Zener diode with time (t) is best represented in

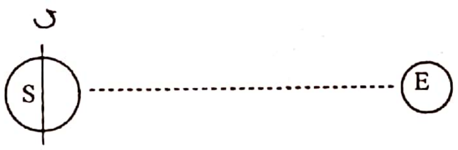


(1) (2) (3)

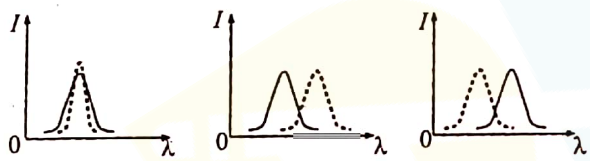


(4) (5)

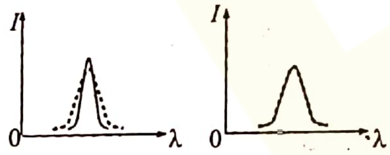
59.



A star (S) rotates about its own axis as shown in the figure. Which of the following graphs best represents the observed distribution of intensity (I) as a function of wavelength (λ) of a spectral line emitted by a certain gas in the star, when viewed from the earth (E)? The broken lines represent the expected intensity distribution of the spectral line if the star does not rotate about its axis.

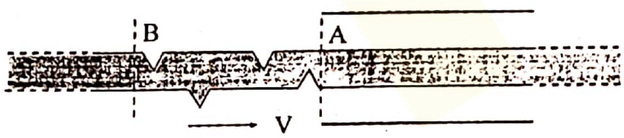


(1) (2) (3)

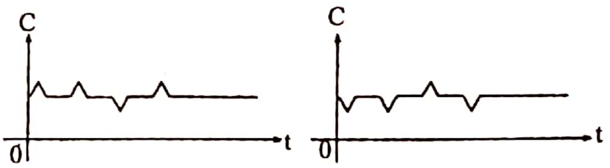


(4) (5)

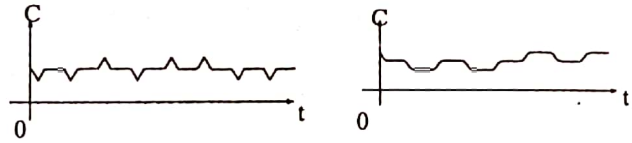
60.



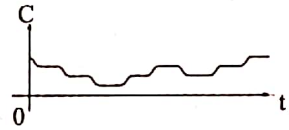
A uniform sheet of dielectric material is sent through two parallel metal plates as shown in figure at a constant velocity (v) to check for manufacturing defects. Some of such defects are shown in the figure. As the section AB of the sheet passes through the metal plates, variation of the capacitance (C) of the system with time (t) is best represented by



(1) (2)



(3) (4)



(5)

G.C.E. (Advanced Level) Examination - April 2006

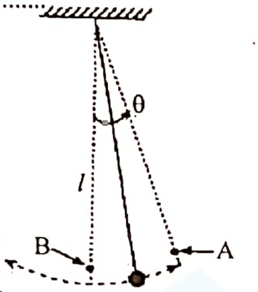
PHYSICS - II

Three hours

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

01. A student plans to find the acceleration due to gravity in the laboratory using a simple pendulum.

(a) (i) Write down an expression for the period of oscillations T of the simple pendulum is terms of the length l of the pendulum and the acceleration due to gravity g.



(ii) Rearrange the above expression in the most suitable manner in order to obtain a value for g by plotting a graph.

(iii When taking readings for T, the student keeps a reference pin directed at the point B as shown in the above diagram.. State why the directing of this pin at B gives a better accuracy for the time measurement than directing it at A.

(b)(i) When the student measured the time for only one oscillation, his reading was 2.0s. If the instrumental error in the time measurement is 0.1s, determine the percentage error of the value of the period of oscillations.

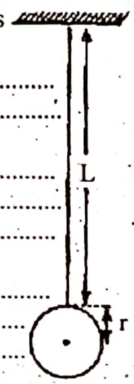
(ii) Instead of measuring the time for one oscillation he measured the time for 25 oscillations, and the value obtained was 50.2s. Determine the percentage error of the value of the time measurement. (Give your answer to the nearest first decimal place)

(c) The student used a uniform metal sphere of radius r as the pendulum bob. The length L he used as the length of the pendulum is shown in the diagram. After plotting the T^2 versus L graph he found that the gradient was 4.0s^{2}m^{-1} and the intercept was 0.04s^2.

(i) Rewrite the expression in part (*a*) (ii) in terms of L, r and g.

(ii) Determine g. (Take π as 3.1)

(iii) Determine the radius r of the sphere.

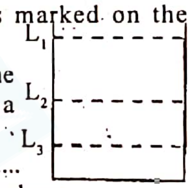


(d) The student observed that the amplitude of oscillations gradually decreases with time and the bob finally comes to rest due to air drag. He repeated the above experiment with a wooden sphere of the same radius. Which bob would take less time to come to rest? Give reasons for your answer.

02. A student wants to determine the specific heat capacity of a liquid using the method of cooling. For this he plans to obtain cooling curves for water and the liquid separately. All necessary equipment for the experiment have been provided.

(*a*) In this experiment it is important to use **equal volumes of water and liquid.** Give the reason for this.

(*b*) Figure shows three different levels marked on the calorimeter.

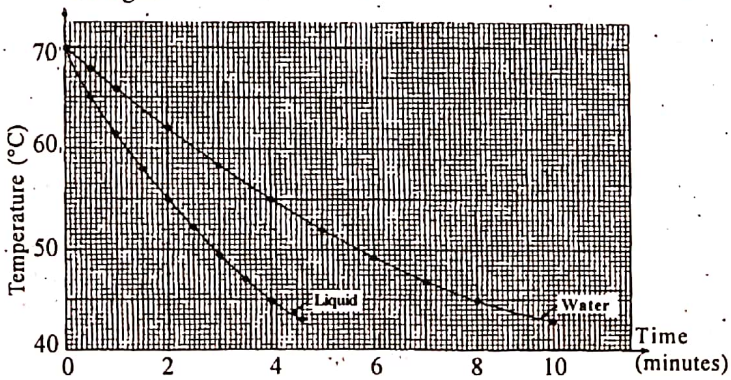


(i) Of these three levels, up to which level the student should fill water /liquid to obtain a more accurate result in this experiment.

(ii) Give the reason for your answer in (b) (i) above.

(c) What experimental step should the student follow in order to make sure that the thermometer immersed in water or liquid reads the temperature of the calorimeter surface?

(d) The tow cooling curves obtained by the student are shown in the figure.



Other date of the experiment are also given below.

Heat capacity of the calorimeter and the stirrer = 112 Jk^{-1}

Mass of water = 0.2 kg

Specific heat capacity of water = 4×103 Jkg^{-1} K^{-1}

Mass of the liquid = 0.172kg

(i) What is the average rate of heat loss of the calorimeter with water during the cooling from 55°C to 45°C?

....

....

....

(ii) Calculate the specific heat capacity of the liquid.

....

....

....

....

(e) Why is it **not** suitable to use a glass container in place of the calorimeter in this experiment?

....

....

03. A spectrometer, sodium lame/flame and a glass prism are provided to determine the refractive index (n) of glass for light emitted from sodium. Certain adjustments in the spectrometer have to be made before taking measurements.

(a) **Two parts** of the spectrometer can be rotated about the vertical axis through the centre of the spectrometer indepen dently of the other parts. List the **two** parts.

(1) ....

(2) ....

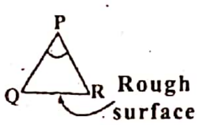
(b) Telescope of the spectrometer has been adjusted for parallel light by focusing to a distant object. As observed by a student through the telescope, is the image of the object erect or inverted?

....

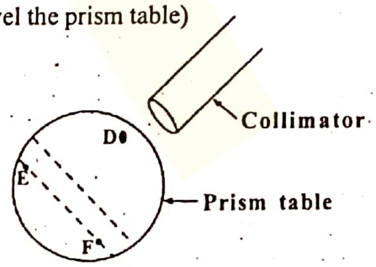
(c) In this experiment, the eyepiece, the telescope and the collimator have been adjusted for parallel light by one student. A second student whose near point is different from that of the first student is to continue the experiment. What is the only adjustment the second student has to repeat?

....

(d) The prism PQR shown in figure (a) is given to level the prism table. Draw on figure (b) how you would place the prism on the prism table. Label P, Q and R. (D, E and F are the three screws available to level the prism table)

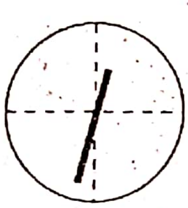


Figue (a)



Figue (b)

(e) Fig. (c) shows the cross-wires (broken lines) and the image of the slit (solid line) formed by the reflected light from one surface of the prism as seen through the telescope. It indicates two errors associated with the set-up.



Identify them.

(1) ....

(2) ....

(f) In this experiment, two measurements have to be taken to determine the angle of prism A.

(i) Draw on figure (d) the correct location of the prism, and the two positions of the telescope in order to obtain the two measurements.

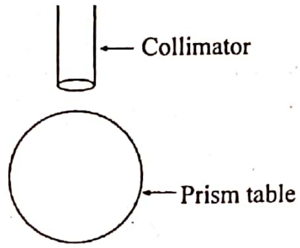


Figure (b)

(ii) scale readings for the two measurements are 197° 6' and 72° 52'. The scale did not pass through 360° mark when taking the measurements. Calculate the angle of prism.

....

....

....

(g) One student argues that a source of white light can be used instead of a sodium lamp in taking measurements for the determination of the angle of minimum deviation for the wave length of sodium light. Is this correct? Give reasons.

....

....

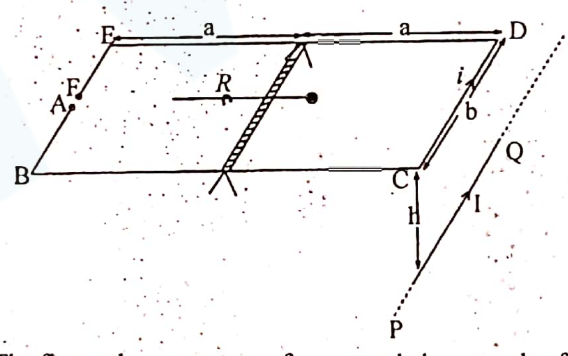
....

(h) If the angle of prism is A and the angle of minimum deviation for sodium light is D, write down an expression for the refractive index n.

....

....

04.



The figure shows a set-up of a current balance made of a rigid rectangular wire frame $ABCDEF$ made in such a way that the ends of the wire A and F are not in contact with each other. A light strip of insulating material which carries a rider arrangement is fixed to the wire frame at the middle as shown in the figure. The set-up is **first balanced horizontally** on two knife-edges by adjusting the position of the rider R. The knife-edges are in contact with the wire frame so that a current can be passed through the frame by connecting an external current source to the knife-edges. As shown in the figure a long straight wire PQ carrying a current I is now placed parallel to the wire segment CD at a distance h vertically below it.

Neglect the earth's magnetic field in answering the following questions.

(a) Write down an expression for the magnetic flux density B at a point on CD, due to the current I through PQ.

....

(b) A current i is now made to flow through the wire frame in the direction shown in the diagram. Obtain an expression for the magnitude of the force F acting on CD due to B above, once the wire frame is **rebalanced horizontally** by adjusting rider R.

....

(c) On the diagram, indicate with an arrow, the direction along which the rider R has to be moved from its initial position, in order to rebalance the wire frame in part (*b*) above.
Briefly explain why you need to move the rider in the direction indicated in order to rebalance the wire frame.

....

....

(d) In part (*b*) above, if the rider had to be moved by a distance Δx from its initial position to rebalance the wire frame, obtain an expression for I in terms of m, i, h, a, b, Δx, $\mu 0$, and g, where m is the mass of the rider.

....

....

....

(e) This set-up can be used for measuring an unknown current I passing through PQ, by connecting PQ and the wire frame in series. Rewrite your expression in part (*d*) above for this situation.

....

....

(f) The set-up in part (e) above can be used to check the calibration of an ammeter.
(i) How would you connect the ammeter to the set-up?

....

(ii) Briefly state the calibration procedure.

....

....

....

(g) The sensitivity of the current measurement carried out with the set-up mentioned in part (*e*) above can be increased by changing the magnitudes of h, m, a and b. By placing a ✓ in the appropriate column, indicate how you would increase the sensitivity of the current measurement.

Parameter	By increasing the magnitude	By decreasing the magnitude
h		
m		
a		
b		

Physics II PART B

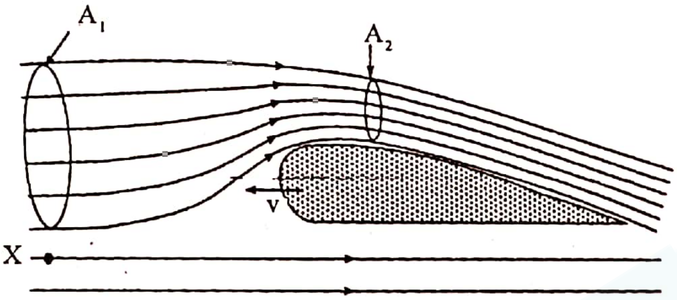
Answer four questions only. [$g = 10\ N\ kg^{-1}$]

01. (i) Bernoulli's equation for a fluid flow can be written as

$$P + \frac{1}{2}\rho V^2 + h\rho g = \text{constant, where all symbols have their usual meaning.}$$

Applying dimensional analysis only to the term $\frac{1}{2}\rho V^2$ show that it has the dimensions of pressure.

(ii) Figure shows a cross section of a wing of an aeroplane which is moving through air horizontally to the left at a constant velocity v relative to the ground.



(a) What is the magnitude and direction of the velocity of air at point X **relative to the plane**? Assume that air is at rest relative to the ground.

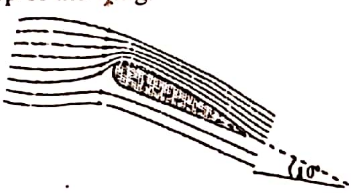
(b) As shown in the figure, the cross-sectional area of a tube of flow exists away from the wing is A_1, and the corresponding area of the same tube of flow over the top surface of the wing is A_2. If $\frac{A_1}{A_2} = 1.2$ write down an expression for the speed (✓) of air passing over the top surface of the wing relative to the aeroplane in terms of v.

(c) If the plane has a mass of 2.64×10^5 kg and total **effective** surface area of **both wings** is 250 m2, calculate the minimum value of v necessary for the aeroplane to just lift-off the ground. (The density of air is $1.20\ kg\ m^{-3}$.)

(d) The aeroplane starts at rest on the runway and applies a constant a horizontal driving force of 6.00×10^6 N from its engines. If the average drag force due to air is 7.20×10^5N, how far does the aeroplane have to travel along the runway in order to achieve the speed v, calculated in (ii) (*c*) above?

(iii) The cross section of a wing of the aeroplane which is moving 10° to the horizontal just after take-off, is shown in the figure.

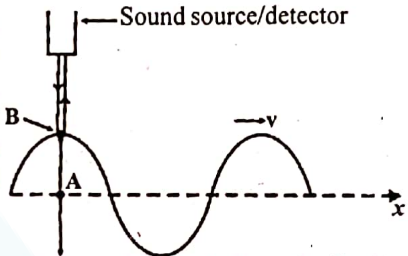
(a) Copy the cross section of the wing on to your answer paper and draw the direction of the net force acting on the wing due to the pressure difference between the bottom and top of the wing.



(b) Now the speed of air over the top surface of wings relative to the aeroplane has increased to $250ms^{-1}$. Assuming the speed of air below the bottom surface of the wings relative to the aeroplane remains the same as in (ii) (a), calculate the net vertical lifting force acting on the **wings** now.

(iv) Consider a situation where the plane is moving horizontally at an altitude of 10 km with a speed v_1. If the air is at rest relative to the ground at this altitude also, then the value v_1 should be greater than the value v, calculated in (ii) (*c*) above. Give a reason why this is so. Assume that the mass of the aeroplane has the same value given in (ii) (*c*) above.

02. The figure shows ripples moving in x-direction on the surface of a liquid. The liquid at the surface B performs simple harmonic motion in a vertical direction.



A stationary sound source/ detector is placed above the liquid surface to study the vertical motion at a given location of the liquid surface due to the propagation of the wave. The sound source sends sound signals vertically downwards as shown in the figure, and the reflected signal from the oscillating liquid surface is detected by the detector. The detector is also capable of determining the frequency of the beats produced by the waves emitted by the source and the waves received after being reflected from the liquid surface. The frequency of the sound waves produced by the source is 680 kHz and the speed of sound in air is $340ms^{-1}$.

(i) (a) At what position shown in the figure (*A* or *B*) is the speed of the liquid surface minimum? What is the value of the speed?

(b) What is the frequency of the reflected sound waves at the instant when the speed of the liquid surface is minimum?

(ii) (a) If the speed of sound in air and the frequency of the sound waves emitted by the source are u and f_0 respectively, write down an expression for the frequency f' as observed at liquid surface when the liquid surface is moving away from the sound source at speed v, in terms of v, f_0 and u.

(b) For the situation described in (ii) (a) obtain an expression for the frequency f'' measured by the detector in terms of v, f_0 and u.

(c) Using your expressions in (ii) (*a*) and (ii) (*b*) show that when $v << u$ the beat frequency measured by the detector is $\frac{2f_0 v}{u}$.

(d) At what position (A or B) of the liquid surface can the maximum beat frequency be detected? If this frequency is 600Hz, find the magnitude of the velocity of the liquid surface at this position.

(e) Sketch the value of the beat frequency measured by the detector as a function of time for a complete period of oscillation of the liquid surface for the situation $v << u$.

(iii) (a) If the time interval between two successive zero values of the beat frequency is 0.05s, what is the frequency of the ripples?

(b) For small wavelengths the speed V of the ripples on a liquid is given by $V = \sqrt{\dfrac{2\pi T}{\lambda\rho}}$

where T, λ and ρ are the surface tension of the liquid, wavelength of the ripples and the density of the liquid respectively. If $\lambda = 12$ mm and $\rho = 13\ 600 \text{kgm}^{-3}$, obtain a value for T. (Take $\pi = 3$.)

03. Read the following passage carefully and answer the questions given below.

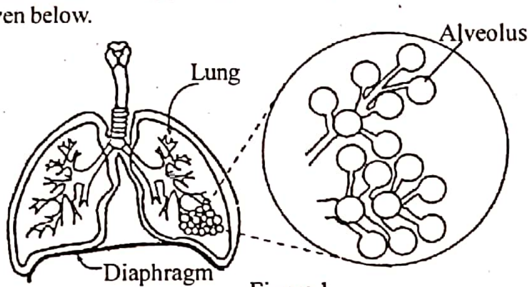


Figure 1

The exchange of oxygen and carbon dioxide in the lungs takes place across the surface membranes of small balloon-like structures (see the figure 1) called alveoli. there are about 150 million alveoli in each lung. The presence of a large number of alveoli increases the effective surface area and thereby the exchange of air takes place more efficiently.

Inflating these alveoli in the process of inhalation requires an excess pressure inside the alveoli relative to their surroundings. This pressure difference is achieved by making the pressure outside the alveoli less with respect to the atmospheric pressure by moving the diaphragm (see the figure 1) down. The maximum pressure difference that could be provided by this action is only 1.0 mm Hg.

During inhalation the radius of an alveolus normally increases form 0.05mm to 0.10mm. The fluid lining the inner surface of alveoli has a surface tension of $5.0 \times 10^{-2}\ \text{Nm}^{-1}$. The 1.0 mm Hg pressure change occurring due to the movement of the diaphragm is not sufficient to inflate an alveolus from 0.05 mm to 0.10mm. Therefore these alveoli are fully inflated by secreting a surface tension reducing liquid (surfactant) and thereby lowering the surface tension of the above mentioned fluid to about $\frac{1}{15}$. Once the surface tension of the fluid is reduced, a pressure change of 1.0mm Hg is sufficient to inflate the alveoli fully.

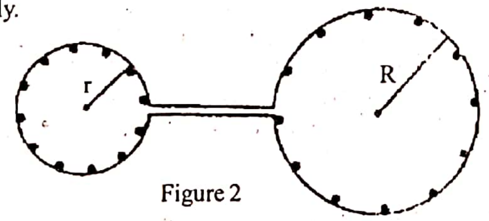


Figure 2

Another very important function of the surface tension reducing liquid is to avoid all small alveoli, being collapsed into one large alveolus.

All alveoli do not have the same size. If the surface tension of the fluid takes the same value everywhere, air from smaller alveoli would flow into larger alveoli. This process would continue till the entire lung is converted into one giant alveolus. But this does not happen because of the surface tension reducing liquid.

Consider tow alveoli, one with radius r and another with radius R ($r < R$) connected together like two bubbles as shown in figure 2.

The number of molecules of the surface tension reducing liquid, shown as black dots, is the same in both alveoli, but its distribution is more dense (more liquid molecules on a unit surface area) in the small alveolus. Therefore the reduction of the surface tension is more in the small alveolus than that in the large one. Due to this, the internal pressures could be maintained at the same value in both. alveoli and the smaller alveolus would not collapse into the larger one.

(i) What is the advantage of having a large number of small alveoli in a lung instea of one big alveolus?

(ii) (a) Taking the radius of a single inflated alveolus to be 0.1 mm, calculate the total surface area of 1.5×10^{8} number of such alveoli. (Take $\pi = 3$)

(b) If a lung is made of one large spherical alveolus, estimate the radius that the lung should have in order to achieve the surface area calculated in (ii) (a) above. (Take $\pi = 3$ and $\sqrt{1.5} = 1.22$)

(iii) (a) Take the excess pressure inside an alveolus to be $\frac{2T}{r}$ Here T is the surface tension of the fluid ($5.0 \times 10^{-2}\ \text{Nm}^{-1}$) **without surfactant,** and r is the radius of the alveolus. Calculate the excess pressure, (Δp_1) that should be inside the alveolus to make r = 0.05mm. Similarly calculate the excess pressure (Δp_2) that should be inside the alveolus to make r = 0.10 mm.

(b) Calculate the difference of these excess pressures ($\Delta p_1 - \Delta p_2$) in mm of Hg.
(1 Pa = 7.5×10^{-3} mm Hg)
Hence show that this pressure difference cannot be achieved only by moving the diaphragm.

(c) Show that with low surface tension $\left(\frac{5.0}{15} \times 10^{-2}\ \text{Nm}^{-1}\right)$ in the fluid due to secretion of the surface tension reducing liquid, 1.0 mm Hg pressure difference is sufficient to fully inflate the alveolus.

(iv) Now draw your attention to the figure 2 of the paragraph.

(a) Why is the reduction of surface tension is more in the small alveolus than that of the large alveolus due to the secreted liquid?

(b) If the effective surface tensions with the secreted liquid in the small alveolus and the large alveolus are T_r and T_R respectively, obtain an expression which should have for the ration $\frac{T_r}{T_R}$ in terms of r and R, in order to prevent air flowing from the small alveolus to the large alveolus. Assume that the pressure outside both alveoli is the same.

(c) (i) An expression for the effective surface tension, T_r, can be written as
$Tr = 5.0 \times 10^{-2} - \frac{k}{2}$ where k is a constant
Write down the dimensions of k.

(ii) Write down a similar expression for T_R

(d) Using these two expressions and the relationship obtained in (iv) (b) above determine values for T_r and T_R. (Take r = 0.5 mm and R = 1.0 mm)

04. Consider a hypothetical situation in which a point object of mass m carrying a charge +q is fixed at a point in space where there are no other objects and charges present except at infinity.

(i) Show that if $m = \frac{q}{2\sqrt{\pi G \varepsilon_0}}$ a second object having identical mass and charge can be brought from infinity towards the first object without doing any work. (Neglect the energy required to initiate the motion of the second object at infinity.) G is the universal gravitational constant and ε_0 is the permittivity of free space.

Show also that when bringing the second object from infinity,

(a) if $m > \frac{q}{2\sqrt{\pi G \varepsilon_0}}$ work is done by the object and

(b) if $m > \frac{q}{2\sqrt{\pi G \varepsilon_0}}$ work has to be done on the object

(ii) What is the total work that has to be done when bringing the second object from infinity to a point at a distance r from the first object under the condition stated in (i) (b) above?

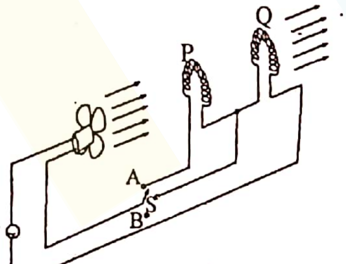
(iii) State under which condition given in (i) above, the second object has a capability of existing in a circular orbit around the first object.

(iv) If the second object moves in a circular orbit of radius r as stated in (iii) above with a speed v_0, write down an expression relating r and other quantities mentioned above.

(v) An asteroid of mass m located far away from a certain planet of mass M starts to move towards the planet due to the gravitational influence between them. Assume that the planet is stationary and there is no gravitational influence on the planet and the asteroid from other celestial objects. If the speed of the asteroid when it is at a distance R away from the planet is v, derive an expression for the magnitude of the charge that has to be placed on each of the objects at that instant. (i.e. at the instant when the separation is R) in order to stop the asteroid at a distance $\frac{R}{2}$ from the planet and reverse its motion.

05. **Answer either part (a) or part (b) only.**

(a) The figure represents the essential parts of a certain type of a hot air blower. It shows a way in which stream of hot air is produced by flowing air through two **identical heating elements P and Q, using a fan.**



(i) If each heating element is made of inchrome wires with area of cross section 10^{-8} m² and length 0.45m, calculate the resistance of **one** heating element at room temperature of 25°C. (Resistivity of inchrome at 25°C is $10^{-6}\Omega$m)

(ii) Assuming that the effective resistance of the fan motor is 10 Ω and that the heating elements are still at room temperature, calculate the following.

(a) The **total** power consumption of the heating elements when the switch S is at position A.

(b) The power consumption of the fan motor when the switch S is at position A.

(c) The **total** power consumption of heating elements when the switch S is at position B.

(d) The power consumption of the fan motor when the switch S is at position B.

(iii) (a) **What** are the **forms** to which the electrical energy consumed by the fan motor is converted?

(b) Considering your calculations in part (ii) above, make a qualitative comparison on the speeds and the temperatures of the air flow at switch positions A and B.

(Assume that the fan speed is proportional to the current through it)

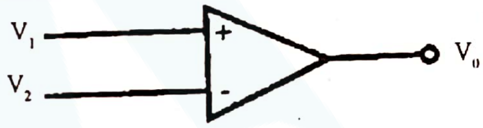
(iv) When the hot air blower is operating at switch position B, the temperature of the heating element Q rises to a steady value of 200 °C.

(a) Calculate the resistance of Q at the new temperature. (Temperature coefficient of resistance of nichrome is 0.002 Ω K⁻¹).

(b) Will this change in temperature cause an increase or decrease of the rate of heat generated by Q? If so, by how much? (Neglect any temperature changes of other parts of the circuit.)

(v) While the hot air blower is operating at switch position B, if the heating element Q is moved away from the air flow without disconnecting it from the circuit, will the fan speed increase or decrease? Give reasons for your answer.

(b) (i) If A is the open loop gain of the operational amplifier shown, write down an expression for V_0 in terms of V_1, V_2 and A.



(ii) If the saturation voltage of the output of the above operational amplifier is ± 5V, and A = 10^5, find the **minimum value** of the input voltage difference, $(V_1 - V_2)$, that is necessary to saturate the output.

(iii) Output saturation voltage of the operational amplifier shown in the circuit (see figure 1) is ±5 V.

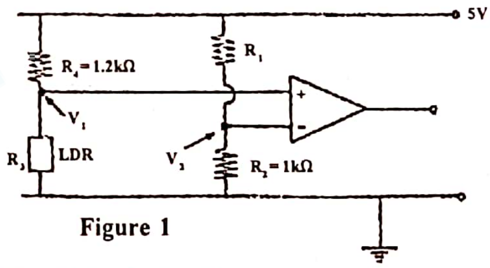


Figure 1

(a) If $R_2 = 1k\Omega$, calculate the value of R_1 which makes V_2 = +3V. Assume that no current flows into the input terminals of the operational amplifier.

(b) R_3 is the value of a light dependent resistor (LDR) whose resistance varies with the time (t) of day according to the curve shown in figure 2.

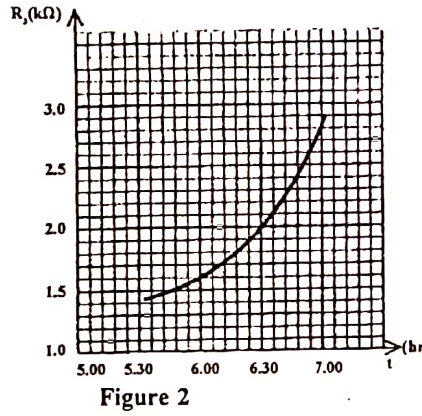
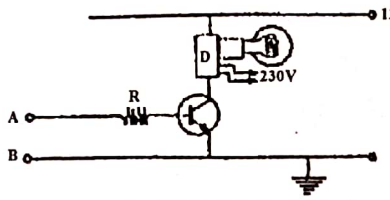


Figure 2

Show that the output voltage of the operational amplifier is -5V at 6.00 p.m and +5V at 6.30 p.m.

(iv) In the circuit shown the device) h ne capability of lighting a 230V lamp when the transistor is set to operate in the saturation mode. The input terminals AB of this circuit are to be connected to the output of the operational amplifier circuit shown if figure 1 above to light the 230V bulb when dark (i.e. at 6.30 p.m)



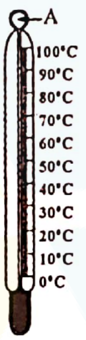
(a) If the base current needed to operate the transistor in the saturation mode is 100μA, Calculate a suitable value for R. ($V_{BE} = 0.7V$)

(b) If the effective collector resistance due to device *D* is 600 Ω, find the collector current through the transistor when the lamp is lit.

06. **Answer either part (a) or part (b) only.**

(a) The **internal** volume of the bulb of a mercury-in-glass thermometer is 1cm3 at 0°C. The linear expansivity of glass is 3×10^{-6} C^{-1} and the volume expansivity of mercury is 2×10^{-4} °C^{-1}. The volume of the capillary is negligible when compared to the volume of the glass bulb.

(i) The temperature of the bulb is increased from 0°C to 100°C.



(a) Find the final internal volume of the glass bulb.

(b) Find the increase in volume of mercury.

(c) Find the rise of mercury volume in the capillary tube.

(d) If this thermometer is made using a suitable capillary to have a sensitivity of 0.25cm rise per 1 °C, find the cross-sectional area of the capillary. Assume that the cross section of the capillary is uniform.

(ii) Thermometers are designed with a small cavity *A*, as shown in the figure, as a protection for accidental overheating of the thermometer. what would be the minimum volume of the cavity A in order to protect the above mentioned thermometer up to 300°C?

(iii) The 0°C and 100°C marks on the scale of an incorrectly calibrated thermometer correspond to temperatures of -0.3°C and 99.8°C respectively. Find the correct temperature when this thermometer reads 40°C.

(iv) Give **three** reasons as to why mercury is a suitable thermometric liquid for liquid-in-glass thermometers?

(b) (i) Consider the decay of a radioactive ^{210}P0 (polonium) atom which is at rest into a daughter atom ^{206}Pb (lead) and an $^{4}\alpha$- particle.

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

where *E* is the energy released in the decay. The atomic masses of ^{210}Po and ^{206}pb are $348.571554 \times 10^{-27}$kg, $341.917595 \times 10^{-27}$kg respectively, and mass of the α-particle is 6.644625×10^{-27}kg and the speed of light is (c) 3.0×10^{8}ms^{-1}.

(a) Calculate the sum of the masses of the ^{206}pb atom and the α - particle

(b) Find the loss of mass (Δm) due to decay.

(c) *E* is the energy created by the mass (Δm) lost in the decay. Calculate *E* (Take $E = \Delta mc^2$)

(d) If the α - particle is emitted in the direction *x* with momentum *p*, what would be the magnitude and the momentum P, what would be the magnitude and the direction of the momentum of the daughter atom.

Log tables may be used for the calculations of the following parts.

(e) The kinetic energy *K* of the emitted α - particle is given by

$$K = \frac{A_d}{A_d + A_\alpha} E$$

, where A_d and A_α are the mass numbers of the daughter atom and the α - particle respectively. Find K.

(ii) A radioactive sample contains 1g of polonium (^{210}Po). Decay constant (λ) of Polonium for the decay in (i) above is 5.6×10^{-8}s^{-1}.

Find the following.

(a) the initial number (N) of ^{210}Po atoms in the sample. (Take Avogadro constant = 6×10^{23} mole^{-1})

(b) the initial activity (A) of the sample ($A = \lambda N$)

(c) the initial rate of emission of α - particles.

(d) the initial rate of release of energy from the sample.

(e) (i) The half-life *T* of ^{210}Po in days.

(Take $T = \dfrac{0.7}{\lambda}$ and $1\text{ s} = 1.16 \times 10^{-5}$ days)

(ii) Approximately by what fraction, does the activity of a given ^{210}Po sample decrease in 2 years?

G.C.E. (Advanced Level) Examination - April 2006

PHYSICS - I

Provisional Scheme of Marking

2006 - Answers

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

G.C.E. (Advanced Level) Examination - April 2006
PHYSICS - II
Provisional Scheme of Marking

A - PART

(01) (a) (i) $T = 2\pi\sqrt{l/g}$ 01

(ii) $T^2 = \frac{4\pi^2 l}{g}$ 01

(iii) Bob has the highest (maximum) speed at B
OR Time measurement is sharp at B 01

(b) (i) $\frac{0.1}{2.0} \times 100 = 5\%$ 01

(ii) $\frac{0.1}{50.2} \times 100$

0.2 %

(c) (i) $T^2 \frac{4\pi^2}{g} (L + r)$ OR $T^2 = \frac{4\pi^2}{g} L + \frac{4\pi^2}{g} r$

(ii) L^2 = Versus L graph

Gradient $\frac{4\pi^2}{g}$ OR $\frac{g}{4\pi^2}$ 01

$\frac{4\pi^2}{g} = 4$

$g = 9.6 \text{ ms}^{-2}$

(iii) identification of the intercept 01
T^2 versus L graph

Intercept $= \frac{4\pi^2 r}{g}$

$= 0.04$

r $= 0.01\text{m}$ (1.0 cm)

(d) woodern bob
woodern bob has lesser inertia (rotational inertia/ moment of inertia)
(OR Metal bob has a higher inetia (rotational inertia / moment of inertia)
OR
Intial stored energy is high for Metal (law for wood)
OR
woodern bob has less mass (less energy) and high frctional energy loss. 01

02. (a) To maintain the same cooling conditions.
OR
To keep the exposed surface area of the calorimeter the same in both cases. 01

(b) (i) L_1 01
(ii) To minimize the exposed inside surface area of the calorimeter OR
To achive the temperature of the calorimeter uniform every where OR
To make the heat capacity of liqud/ water larger than that of the calorimeter OR
To minimize the heat loss by the inner surface area of the colorimeter. 01

(c) Stirring the water (liquid) well. 01

(d) (i) $(112 + 0.2 \times 4 \times 10^3) \times \frac{(55-45)}{4 \times 60}$ (with correct unit)

= 38w

OR $(112 + 0.2 \times 4 \times 10^3) \frac{(55-45)}{4}$
2280 J / m in

(ii) $(112 + 0.172 \times s) \frac{(55-45)}{2 \times 60} = 38$

OR $(112 + 0.172 \times 5) \frac{(55-45)}{2} = 2280$

OR $(112 + 0.1725) \frac{(55-45)}{2} = (112 + 0.2 \text{ X } 4 \text{ X } 103) \frac{(55-45)}{4}$

$S = 2 \times 10^3 \text{ Jkg}^{-1}\text{K}^{-1}$ 01

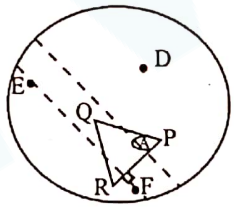
(e) There will be a appreciable temperature diffemce between the outer surface of the container and the water / liquid inside the container OR
Glass is a bad thermal conductor OR
Temperture of the surface of the container will not be uniform.

03. (a) (1) telescope 01
(2) prism table

(b) Inverted (↓) 01

(c) eyepiece 01

(d)

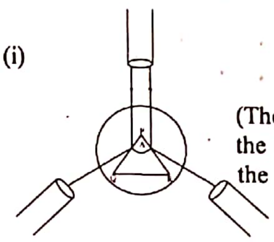


(PQ OR PR is perpendicular at to the dotted lines)

(e) (i) Prism table is not leveled
(ii) Slit is not vertical
(iii) The slit is too broad

any two 02
any one 01

(f) (i)



(The drawing of corect location of the prism and the two positions of the telescopc) 01

(ii) Prism angle A $= \frac{(197^\circ 6' - 72^\circ 52)}{2}$

A $= 62^\circ 7'$ 01

(g) Not correct
It is not possible to locate the position of the sodium wavelength / spectral line from the yellow band of the continuoces spectrum (or band) of white light 01

(h) $n = \dfrac{\sin\left(\frac{A+D}{2}\right)}{\sin(A/2)}$ 01

04. (a) $B = \dfrac{\mu_0 I}{2\pi h}$ 01

(b) $F = Bib$, $F = \dfrac{\mu_0 Ibi}{2\pi h}$ 01

(c) A arrow ($\leftarrow$) indicated in the diagram 01
Force on CD in downward ($\downarrow$). The creates a clock wise moment. To blance the system, an equal and opposite moment must be applied by moving the rider to left. 01

(d) $I = \dfrac{2\pi\Delta \times mgh}{\mu_0 bai}$ 01

(e) $I = \sqrt{\dfrac{2\pi\Delta \times mgh}{\mu_0 ba}}$ 01

(f) (i) In series with CD and PQ 01
(ii) For different readings of the ammeter, blance the system, calculate I and plot a graph of ammeter reading Vs Calculated I 01

(g)

Para meter	By inreasing the magnitude	By decreasing the magnitude
h		✓
m		✓
a	✓	
b	✓	

(Decrease h and m Increase a and b) all correct 02
any two correet 01

PART - B

01.(i) Dimensions of ρV^2 $= ML^{-3}[LT^{-1}]^2$
$= ML^{-1}T^{-2}$

Dimensions of Pressure $= \dfrac{MLT^{-2}}{L^2}$
$= ML^{-1}T^{-2}$

ρV^2 has the Dimensions of Pressure

(ii) (a) The velocity of air relative to the plane is V to the right $\vec{V}$ 01

$\left[\text{OR} \quad V_{AP} = V_{AG} + V_{GP} = 0 - V = -V\right]$ 01

(b) $A_1 V = A_2 V'$ [OR $A_1 V = \dfrac{A_1 V^1}{1.2}$]
$V^1 = 1.2\ V$

(c) Let P_1 and P_2 be the pressure underneath the wing and above the wing respestively.

$P_1 + \frac{1}{2}\rho V^2 = P_2 + \frac{1}{2}\rho V'^2 =$ OR $P_1 + \frac{1}{2}\rho V^2 = P_2 + \frac{1}{2}\rho(1.2V)^2$ 01

But $P_1 - P_2 = \dfrac{mg}{A} = \dfrac{2.64 \times 10^5 \times 10}{250}$ 01

$\frac{1}{2} \times 1.2 \times (1.2^2 V^2 - V^2) = \dfrac{2.64 \times 10^5}{25}$

$V^2 = \dfrac{2.64 \times 10^5}{0.44 \times 0.6 \times 25} = \dfrac{10^6}{25}$

$V = 200 ms^{-1}$ 01
$(224 - 225\ ms^{1})$

(d) Applying $F = ma$ to the plane
$6 \times 10^6 - 7.2 \times 10^5 = 2.64 \times 10^5\ a$ 01

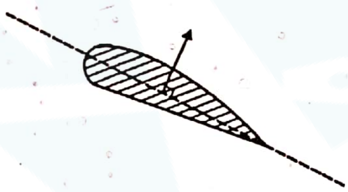
$a = \dfrac{52.8 \times 10^5}{2.64 \times 10^5}$

$a = 20\ ms^{-2}$

Applying $V^2 = u^2 + 2as$ to the plane
$200 \times 200 = 2 \times 20S$ 01
$S = 1000m\ (1km)$ 01
$(1258 - 1259m)$

[Applying $Fs = \frac{1}{2}mv^2$
$(6 \times 10^6 - 7.2 \times 10^5)\ S = \frac{1}{2} \times 2.64 \times 10^5 \times (200)^2$] 02
$S = 1000m$ 01
$(1258 - 1259m)$

(iii) (a)



01

(b) New lifting force $= \frac{1}{2} \times 1.2 \times (250^2 - 200^2) \times 250$ 01

New vertical lifting force $= \frac{1}{2} \times 1.2\ (250^2 - 200^2) \times 250\ \cos 10^\circ$
$= 3.32 \times 10^6 - 2.64 \times 10^6$ 01
$= 0.68 \times 10^6 N\ (0.7 \times 10^6 N)$

(c) At higher altitudes the density of air is less OR ρ is less OR air is thinner 01

02. (i) (a) B 01
Zero (o) 01
(b) 680 KH_z 01

(ii) (a) $F' = \dfrac{(u - v)}{u} F_0$

(b) $F'' = \dfrac{u}{u + v} F^1$

$F'' = \dfrac{u}{u + v} \dfrac{(u - v)}{u} F_0$

$F'' = \dfrac{u - v}{u + v} F_0$

(c) beat frequency $= F_0 - F''$ 01

$= F_0 - \frac{u - v}{u + v} F_0$

$= F_0 \left(\frac{u + v - u + v}{u + v} \right)$

$= \frac{2 F_0 v}{u + v}$

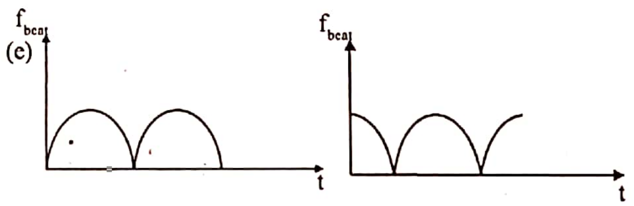
$= \frac{2 F_0 v}{u}$ $(v <<< u)$

(d) A 01

$600 = \frac{2 \times 680 \times 10^3\ v}{340}$ OR $600 = \frac{2 \times 680 \times 10^3 \times v}{340 + v}$

$V = 0.15\ ms^{-1}\ (15 cms^{-1})$

(e)



(iii) (a) time period $T = 0.05 \times 2 = 0.1 s$

Frequecy of ripples $f = \frac{1}{T} = \frac{1}{0.1}$

$= 10 Hz$ 01

(b) $V = f\lambda$

$f\lambda = \sqrt{\frac{2\pi T}{\lambda \rho}} \Rightarrow T = \frac{f^2 \lambda^3 \rho}{2\pi}$

$T = \frac{10^2 \times (12 \times 10^{-3})^3 \times 13600}{2 \times 3}$

$= 0.393\ (0.4)\ Nm^{-1}$ 01
$(0.39 - 0.40)$

03. (i) incrase of effective surface area OR exchange of air takes places more efficiently. 01

(ii) (a) Tolal surface area $= 4 \times 3 \times (0.1)^2 \times 1.5 \times 10^8\ [4\pi r^2 \times n]$
$= 1.8 \times 10^7\ mm^2\ [18 m^2]$ 01

(b) let R be the corresponding radius

$4\pi R^2 = 12 \times 1.5 \times 10^6$
$12 R^2 = 12 \times 1.5 \times 10^6$
$R = 1.22 \times 10^3\ mm\ (1.22 m)$ 01

(iii) (a) $\Delta p_1 = \frac{2 \times 5 \times 10^{-2}}{0.05 \times 10^{-3}}$ 01

$\Delta p_1 = 2.0 \times 10^3\ Pa$ 01

Simi larly $\Delta p_2 = \frac{2 \times 5 \times 10^{-2}}{0.1 \times 10^{-3}}$

$\Delta p_2 = 1.0 \times 10^3\ pa$ 01

(b) Therefore $\Delta p_1 - \Delta p_2 = 1.0 \times 10^3 \times 7.5 \times 10^{-3}$
$\Delta p_1 - \Delta p_2 = 7.5\ mmHg$ 01

The maximum Pressure difference that could be achieved by moving the diaphragm is 1mmHg. (Indentitifying maximum as 1mmHg) 01
Since 7.5 > 1 alveolus cannot be fully inflated

(c) with the surfactant $\Delta p_1 - \Delta p_2 = \frac{7.5}{1.5}$
$= 0.5\ mmHg$ 01

Now it is possible to inflate the alveolus by moving the diaphragm.

(iv) (a) The distrbution of the surfacfant is more dense in the small alveolus than that of the large alveolus OR the number of surfactant molecules is more in the small alveolus than thatofthe large alveolus. 01

(b) Pressure should be equal inside both alreolius.

$\frac{2T_r}{r} = \frac{2T_R}{R}$ OR $\frac{T_r}{r} = \frac{T_R}{R}$

$\frac{T_r}{T_R} = r/R$ 01

(c) (i) Dimensions of K $= MLT^{-2}\ L^{-1}\ L^2$
$= ML^2\ T^{-2}$ 01

(ii) $T_R = 5 \times 10^{-2} - K / R^2$

(d) $T_r - 5 \times 10^{-2} = K / r^2$ (A)
$T_R - 5 \times 10^{-2} = K / R^2$ (B)

$\frac{(A)}{(B)}$ $\frac{T_r - 5 \times 10^{-2}}{T_R - 5 \times 10^{-2}} = \frac{R^2}{r^2}$

$R^2 T_R - r^2 T_r = 5 \times 10^{-2} (R^2 - r^2)$ (C) 01

But $T_R = \frac{R}{r} T_r$

$(C) \Rightarrow T_r(\frac{R^3}{r} - r^2) = 5 \times 10^{-2} (R^2 - r^2)$

$T_r(1/0.5 - 0.5^2) = 5 \times 10^{-2} (1 - 0.5^2)$

$T_r = \frac{5 \times 10^{-2} \times 0.75}{1.75}$

$T_r \approx 2.1 \times 10^{-2}\ Nm^{-1}$ 01
$(2.1 - 2.2)$

$T_R = 4.2 \times 10^{-2}\ Nm^{-1}$ 01
$(4.2 - 4.4)$

04. (i) gravitfational force F_G between two objects When they are separated by a distance r

$= \frac{Gm^2}{r^2}$ 01

Similary the electric force $= \frac{q^2}{4\pi\varepsilon_0 r^2}$ 01

For Zero work done $\frac{Gm^2}{r^2} = \frac{q^2}{4\pi\varepsilon_0 r^2}$ 01

$\left[m = \frac{q}{2\sqrt{\pi\varepsilon_0 G}} \right]$

(a) $\frac{Gm^2}{r^2} > \frac{q^2}{4\pi\varepsilon_0 r^2}$, work will be done by the second object

[when $m > \frac{q}{2\sqrt{\pi\varepsilon_0 G}}$

(b) $\frac{Gm^2}{r^2} < \frac{q^2}{4\pi\varepsilon_0 r^2}$, work will be done by the second objec'

[i.e. when $m > \frac{q}{2\sqrt{\pi\varepsilon_0 G}}$

(ii) Consider the situation in which the second object is at a distance r from the first object

Gravitational potential energy of the 2nd object $= \frac{-Gm^2}{r}$

Electrical Potential energy of the 2 nd objeet $= \frac{q^2}{4\pi\varepsilon_o r}$ 01

Total work done when briging a seeand object

$$= \frac{-Gm^2}{r^2} + \frac{q^2}{4\pi\varepsilon_o r}$$ 01

(iii) (i) a (01)

(iv) Resultant force towards first mass $= \frac{Gm^2}{r^2} - \frac{q^2}{4\pi\varepsilon_o r^2}$

Second object will execute a rotaional motion around the first object if

$$\frac{Gm^2}{r^2} - \frac{q^2}{4\pi\varepsilon_o r^2} = \frac{mV_o^2}{r}$$ 01

(v) Let the charge to be placed on each object at R be Q. Total energy of the second object it is at R is

given by 01

$$\frac{1}{2}mv^2 - \frac{GmM}{R} + \frac{Q^2}{4\pi\varepsilon_o R}$$

Total energy at $R/2$ is given by

$$\frac{Q^2}{2\pi\varepsilon_o R} - \frac{2GmM}{R}$$ 01

$$\therefore \frac{1}{2}mv^2 - \frac{GmM}{R} + \frac{Q^2}{4\pi\varepsilon_o R} = \frac{Q^2}{2\pi\varepsilon_o R} - \frac{2GmM}{R}$$ 01

$$Q = 2\sqrt{2\varepsilon_o R\left(\frac{1}{2}mv^2 + \frac{GmM}{R}\right)}$$ 01

05. (A) (i) $R = \rho \ell / A$ 01

$$R = \frac{10^{-6} \times 0.45}{10^{-8}}$$

$= 45\ \Omega$ 01

(ii) (a) $220 = i(10 + 45 + 45)$

$i = 2.2A$ 01

Power dissipation by heating elements $= 2 \times 2.2^2 \times 45$
$= 435.6W$ 01

(b) Power disspation by motor $= 2.2^2 \times 10$
$= 48.4W$ 01

(c) $220 = i(10 + 45)$
$i = 4A$
Power disspation by heating elements $= 4^2 \times 45$
$= 720w$ 01

(d) Power disspation by motor $= 4^2 \times 10$
$= 160w$ 01

Alternative method
$W = V^2/R$

(a) $\dfrac{\left(\frac{220}{100} \times 90\right)^2}{90} = 435.6\ W$

(b) $\dfrac{\left(\frac{220}{100} \times 10\right)^2}{10} = 48.4\ W$

(c) $\dfrac{\left(\frac{220}{55} \times 45\right)^2}{10} = 720\ W$

(d) $\dfrac{\left(\frac{220}{55} \times 10\right)^2}{10} = 160\ W$

(If the student has assumed 220v as the peak voltage and used $\frac{220}{\sqrt{2}}$V as the r.m.s value award full marks)

(iii) (a) Kinetic energy / mechanical energy heat / sound.
for any two 01

(b) The current at switch posstion B is greater Therefore, the air speed is greater.

Therfore the temperature of air must be lower at switeh position B 02

(iv) (a) $R_\theta = R_0(1 + \alpha t)$

$R_{200} = R_0(1 + 0.002 \times 200)$ ——— ①

$45 = R_0(1 + 0.002 \times 25)$ ——— ②

$$①/② \quad \frac{R_{200}}{45} = \frac{(1 + 0.4)}{(1 + 0.05)}$$

$R_{200} = 60\ \Omega$ 01

(59.8 - 60.0)

(b) $i_{new} = \frac{220}{70}$ A

New power dissipation $Q = \left(\frac{22}{7}\right)^2 \times 60 = 592.6W$

Decrease $= 720 - 592.6 = 127.4$ W
Power dissipation will decrease by 127.4 W 01

(127.3 - 127.4)

(v) Fan speed will decrease 01

whlen Q is out of airflow its temperature will Increase. This will increase the resistance of Q reduce the current and decrease the fan speed. 01

05. (B) (i) $V_o = A(V_1 - V_2)$ 01

(ii) $(V_1 - V_2)\min = \frac{Vsat}{A}$

$= 5/10^5$

$= 50\ \mu V$ (OR 5×10^{-5} v) 01

(iii) (a) $V_2 = \left(\frac{5}{R_1 + R_2}\right)R_2$ OR $3 = \left(\frac{5 \times 10^3}{10^3 + R_1}\right)$

$R_1 = \frac{2}{3} \times 10^3$

$= 667\ \Omega$ (666 - 668) 01

(b) At 6.00 p.m

$R_3 = 1600\ \Omega$

$V_1 = \left(\frac{5}{R_3 + R_4}\right)R_3$ OR $V_1 = \left(\frac{5}{1600+1200}\right)1600$

$V_1 = \frac{80}{28}$

$V_1 = 2.86$ V

This value is less then 3V OR

$(V_1 - V_2)$ is negative (and its magnitude is $> 50\mu$ V) 01

$\therefore V_o = -5V$

At 6. 30 p.m

$R_3 = 2000\ \Omega$

$V_1 = \left(\frac{5}{1200 + 2000}\right)2000$

$= \frac{100}{32}$

$= 3.1\ V$ 01

This value is qreater than 3v OR

$(V_1 - V_2)$ is positive (and $>50\mu$ V) 01

$V_0 = +5V$

(iv) (a) $V_{AB} = I_B R + V_{BE}$ OR

$5 = 100 \times 10^{-6} R + 0.7$ 01

$R = \frac{4.3}{100 \times 10^{-6}}$

$= 43\ K\Omega\ (43000\ \Omega)$

(b) Collector current Ic

$Ic = \frac{12 - 0}{600}$ or $Ic = \frac{12 - 0.1}{600}$

$= 20$ mA or $Ic = 19.8$ mA 01

06. (A)

(i) (a) $V_\theta = V_0(1 + 3\alpha\theta)$ or

$V_{100\ glass} = 1\ (1 + 3 \times 3 \times 10^{-6} \times 100)$ 01

$= 1.0009 \times 10^{-6}\ m^3$ 01

$= (1.0009\ cm^3)$

(b) $V_{100\ Hg} = 1\ (1 + 20 \times 10^{-5} \times 100)$ 01

$= 1.02\ cm^3$

increase in volume of mercury $= 1.02 - 1.0$

$= 0.02\ cm^3$ 01

$(2.0 \times 10^{-8}\ m^3)$

OR

incrase Volume $= 1 \times 20 \times 10^{-5} \times 100$ 01

$= 0.02 cm^3$

$(2.0 \times 10^{-8} cm^3)$ 01

(c) Rise of mercury volume in the capilary tube

$= 1.02 - 1.0009 = 0.019 cm^3$ 01

$(1.9 \times 10^{-8} m^3)$

[OR mercury volume $= 1 \times (20 - 0.9) \times 10^{-5} \times 100$

$= 0.019 cm^3\ (1.9 \times 10^{-8} m^3)$ 01]

(d) Cross - sectional Area of the Capilay tube $= \frac{\text{rise of mercury volume}}{\text{length}}$

$= \frac{0.019}{25}$

$= 0.00076\ cm^2$

$= (7.6 \times 10^{-8}\ m^2)$

(ii) Rise of mercury volume at 300°C

$= 3 \times 0.019 = 0.057\ cm^3$ 01

Volume of the cavity $= 0.057 - 0.019$

$= 0.038\ cm^3$

(OR $3.8 \times 10^{-8}\ m^3$)

[OR can argue that Volume of the cavity]

$= 2 \times 0.019 cm^3$ 01

$= 0.038 cm^3$ 01

$(3.8 \times 10^{-8} m^3)$

OR V_{300} glass $= 1\ (1 + 3 \times 3 \times 10^{-6} \times 300)$

V_{300}Hg $\approx 1\ (1 + 20 \times 10^{-5} \times 300)$

These rise in mercury volume $= 1.06 - 1.0027$

$= 0.057 cm^3$

Volume of the cavity $= 0.057 - 0.019$ 01

$= 0.038 cm^3$ 01

$(3.8 \times 10^{-8} m^3)$

(iii) Correet temperture $= \left[\frac{[99.8 - (-0.3)] \times 40}{100}\right] - (03)$

$= 40.04 - 0.3$

$= 39.74^\circ C$ 01

(iv) Uriform expansion

opaque

large expansivity

Do not wet glass / large angle of contact

Higher boiling point

lower vapour parssure

High therma conductivity any thrce correct 02

any two 01

06. (B)

(i) (a) Sum of the masses $= (341.917595 + 6.644625) \times 10^{-27}$ Kg

$= 348.562220 \times 10^{-27}$ Kg 01

(b) loss of mass (Δm)

$= 10^{-27}(348.571554 - 348.562220)$

$= 0.009334 \times 10^{-27}$Kg 01

(c) Eerrgy Created (E) $= (0.009334 \times 10^{-27}) \times (3 \times 10^8)^2$

$= 8.4 \times 10^{-13}$ J 01

(d) magnitude = P & direetion -x (OR - P) 01

(e) $K = \frac{A_d}{A_d + A_x} E$

$= \left[\frac{206}{206 + 4}\right] \times (8.4 \times 10^{-13})$ 01

$= 8.2 \times 10^{-13}$ J 01

(8.2 -8.3)

OR $K = \frac{Ad}{Ad + A\alpha} E$

$= \left[\frac{341.917595}{(341.917595 + 6.644625)}\right] \times (8.4 \times 10^{-13})$ 01

$= 8.2 \times 10^{-13} J$ 01

(ii) (a) $N = \frac{6.0 \times 10^{23}}{210}$

$= 2.86 \times 10^{21}$ (2.8 - 2.9) 01

(b) $A = n\lambda$

$= (2.86 \times 10^{21})(5.6 \times 10^{-8})$

$= 1.6 \times 10^{14}$ Bq 02

(1.5 -1.7) (1 mark for the correct unit)

(c) Ratc of emisson of $\propto$ - Particle $= 1.6 \times 10^{14}$ (particals s^{-1})

(d) Rate cf release of energy $= (1.6 \times 10^{14}) \times (8.4 \times 10^{-13})$

$= 134.4$ W

(123W - 143W)

(e) (i) Half life $(T\frac{1}{2})$ $= \frac{0.7}{5.6 \times 10^{-8}} = (1.16 \times 10^{-5})$ S

$=$ 145 days 01

(ii) No of half lifes in 2 years $= \frac{2 \times 365}{145}$ 01

$= 4.9 \simeq 5$

Fractional dercrease in 2 years $= 1 - \frac{1}{2^5} \left(1 - \frac{1}{2^{5.034}}\right)$

$= 1 - \frac{1}{32}$ OR

$= \frac{31}{32}$ OR

OR (0.96 - 0.97)

01