G.C.E. (Advanced Level) Examination - August 2013

PHYSICS - I

Two hours

Instructions :
- This question paper consists **50** questions in **5** pages.
- Write your **Index Number** in the space provided on the answer sheet.
- Answer **all** the questions.
- Instructions are given on the back of the answer sheet. Follow them carefully.
- In each of the questions **1** to **50,** pick one of the alternatives (1), (2), (3), (4), (5) which is **correct** or **most appropriate** and **mark your response on the answer sheet witha cross (×) in accordance with the instructions given in the back of the answer sheet.**

Use of calculators is not allowed.

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

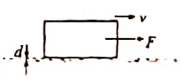
01. SI unit of Planck constant is
(1) $J\ s^{-1}$ (2) J s (3) $J\ K^{-1}$ (4) J K (5) $J^{-1}\ s^{-1}$

02. Which of the following waves requires a plysical medium for travelling?
(1) Light wavès (2) Radio waves
(3) Sound waves (4) X - rays
(5) Gamma rays

03. Electromgnetic radiation of frequency f is incident on a photosensitive surface of which threshold frequency for emis sion of photoelectrons is f_0.
Which of the following is **not true?**
(1) No photoelectrons are emitted when $f < f_0$.
(2) f_0 is a characteristic feature of the material of the photosensitive surface.
(3) When $f > f_0$, the rate of the emission of photoelectrons increases as the intensity of incident radiation increases.
(4) The stopping potential is directly proportional to f^2.
(5) The stopping potential is independent of the intensity of the incident radiation.

04. Consider the following statements made regarding the speed of sound.
(A) The speed of sound in air increases with the increase of temperature of air.
(B) At a given temperature the speed of sound in a metal is higher than that in air.
(C) The speed of sound depends on the frequency of the sound wave.
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

05. As shown in figure, a box is placed on an oil layer of viscosity η and thickness d. The area of the surface of the box in contact with the oil is A. What should be the horizontal force F to be applied non the box in order to move it at a constant velocity v?



(1) $F = \frac{\eta A d}{v}$ (2) $F = \frac{\eta A v}{d}$
(3) $F = \frac{\eta v}{dA}$ (4) $F = 6\pi\eta A v d$
(5) $F = 6\pi v A \eta$

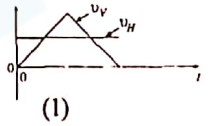
06. A slow neutron is absorded by a $^{235}_{92}U$ nucleus and results in a fission process as follows.

$$^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{139}_{56}Ba + {}^{94}_{36}Kr + x\ {}^{1}_{0}n$$

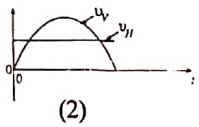
The value of x (number of neutrons produced) of the above fission process is
(1) 1 (2) 2 (3) 3 (4) 4 (5) 5

07. If the mean output pressure of the heart is 1.2×10^4 Pa and the mean blood flow rete is $5.0 \times 10^{-3}\ m^3$ per **minute**, the mean output power of the heart is
(1) 0.5 W (2) 1.0 W (3) 1.5 W (4) 2.0 W (5) 2.5 W

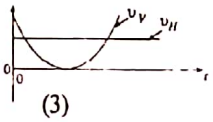
08. An object is projected under gravity with velocity , in a direction which makes an angle 0 with the horizontal as shown in the figure. Which of the following graphs correctly indicates the variation of the horizontal (υ_H) and vertical (υ_V) components of the velocity of the object with time (t)?



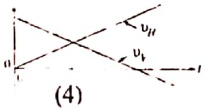
(1)



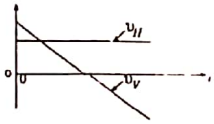
(2)



(3)



(4)



(5)

09. Two athletes run a 10 km race with constant speeds v_1 and v_2 in a circular track of radius 50 m. It has been observed that the athlete with speed v_1 completed 10 rounds when the other athlete completed 9 rounds. The ratio $\frac{v_1}{v_2}$ is
(1) $\frac{10}{9}$ (2) $\frac{9\pi}{10}$ (3) $\frac{18\pi}{10}$ (4) $\frac{10\pi}{9}$ (5) 9

10. Two wheels A and B of a machine rotate about a common axis in the same direction with angular speeds ω_1 and ω_2, respectively. See figure (a). Moment of inertia of wheel A about the axis of rotation is I_1 and that of wheel B is I_2. At a certain instant, two wheels are pushed towards each other until they are firmly pressed and the system rotates with a common angular speed ω, without slipping. See figure (b). The value of w is given by

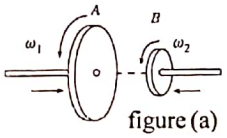


figure (a)

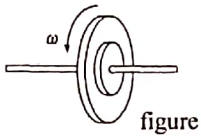


figure (b)

(1) $\omega = \frac{\omega_1 + \omega_2}{2}$ (2) $\omega = \frac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}$

(3) $\omega = \sqrt{\omega_1\omega_2}$ (4) $\omega = \frac{I_1\omega_1 + I_2\omega_2}{I_1 - I_2}$

(5) $\omega = \frac{I_1\omega_1^2 + I_2\omega_2^2}{\omega_1^2 + \omega_2^2}$

11. A block of mass m, kept on the horizontal truck-bed, is at rest with respect to the truck when it is moving horizontally with a constant acceleration a. The coefficient of static friction between the truck-bed and the mass is μ. The frictional force acting on the mass is given by
(1) ma (2) μma (3) $\mu m(g + a)$
(4) $\mu m (g - a)$ (5) mg

12. A simple pendulum is constructed by suspending a small metal bob with a fine wire of the same metal. The period of the pendulum at temperature θ_1 is T_1. When the pendulum operates at a higher temperature of θ_2 the period of the pendulum would be (Linear expansivity of the metal is α)

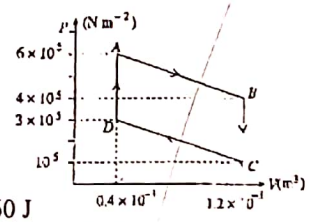
(1) $T_1\sqrt{1 + \alpha(\theta_2 - \theta_1)}$ (2) $T_1\sqrt{\frac{1}{1 + \alpha(\theta_2 - \theta_1)}}$

(3) $\frac{T_1}{1 + \alpha(\theta_2 - \theta_1)}$ (4) $[1 + \alpha(\theta_2 - \theta_1)]\frac{1}{T_1}$

(5) $T_1\sqrt{\alpha(\theta_2 - \theta_1)}$

13. The atoms of an ideal gas have a certain mean kinetic energy at 10 °C. Their mean kinetic energy will be twice at
(1) 20 °C (2) 100 °C (3) 293 °C
(4) 566 °C (5) 600 °C

14. A system undergoes a cyclic process according to the P - V diagram shown in figure. The work done by the system from A to B and from B to C, respectively are



(1) 400 J, 0 (2) 400 J, 360 J
(3) 480 J, 360 J (4) 480 J, 0 (5) 520 J, 0

15. A stretched string is vibrating with four loops. If the frequency of vibration is increased by a factor of 2, the number of loops formed would be
(1) 3 (2) 5 (3) 6 (4) 7 (5) 8

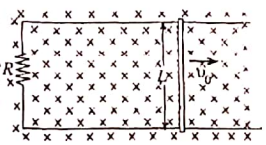
16. Consider the following statements made about a compound microscope
(A) The object should be placed just outside the focal poind of the objective.
(B) The eyepiece acts as a simple magnifier.
(C) The angular magnification is independent of the focal length of the objective.
Of the above statements
(1) only (A) is true (2) only (A) and (B) are true
(3) only (B) and (C) are true (4) only (A) and (C) are true
(5) all (A), (B) and (C) are true.

17. 

(A) Incandescent (B) CFL (C) LED
The figure shows three types of electric bulbs (A), (B) and (C) which produce the same brightness spproximately. The consumptions of electric power by (B) and (C) when compared with (A) are approximately.
(1) same as (A).
(2) $\frac{1}{10}$ and $\frac{1}{5}$ of (A), respectively.
(3) 10 times and 5 times of (A), respectively.
(4) $\frac{1}{6}$ and $\frac{1}{12}$ of (A), respectively.
(5) 6 times and 12 times of (A), respectively.

18. Consider the following statements made regarding a transformer.
(A) The core of the transformer is made out of laminated plates of soft iron.
(B) Both Joule heating and eddy currents contribute to the energy loss of a transformer.
(C) Power can be amplified using a transformer.
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.

19. A metal rod of mass M and length L is placed on a frictionless perallel horizontal rail in a magnetic field of flux density B directed into the paper as shown in figure. (The rail is a conductor and a resistor of value R is connected to the rail as shown.) If an initial velocity of υ_0 is given to the rod released as shown, it will begin to move in the direction of υ_0, with an acceleration of



(1) $-\frac{BL\upsilon_0^2}{MR}$ (2) $\frac{RB^2L^2\upsilon_0^2}{M}$

(3) $\frac{B^2L\upsilon_0}{MR}$ (4) $-\frac{B^2L^2\upsilon_0}{MR}$

(5) $-\frac{MBL\upsilon_0}{R}$

20. Sound that has an intensity level of 100 dB is how many times more intense than sound of mtensity level 20 dB?
(1) 5 (2) 8 (3) 10^3 (4) 10^5 (5) 10^8

21. The minimum velocity υ that a particle should have in order to escape from a planet of mass M and radius R is given by

(1) $\upsilon = \sqrt{\frac{2GM}{R}}$ (2) $\upsilon = 2\sqrt{\frac{GM}{R}}$

(3) $\upsilon = 4\sqrt{\frac{gM}{R}}$ (4) $\upsilon = \frac{GM}{R}$

(5) $\upsilon = \frac{2GM}{R}$

22. A child, swinging a swing, hears a sound from a stationary whictle loctated in the direction where he is facing as shown in figure. The minimum and maximum frequencies of the sound heard by him are 1314Hz and 1326 Hz respectively. If the speed of sound in air is 330 m s^{-1} and air remains still, what is the wavelength of the sound emitted from the whistle?

(1) 12.5 cm (2) 24.8 cm (3) 25.0 cm
(4) 25.2 cm (5) 50.0 cm

23. A person suffering from farsightedness has his near point located at 150 cm from the eyes. After wearing contact lenses, he could read clealy a book held at a distance of 25 cm. The used contact lenses are
(1) concave lenses with 21.7 cm focal length.
(2) convex lenses with 21.7 cm focal length.
(3) concave lenses with 30.0 cm focal length.
(4) convex lenses with 30.0 cm focal length.
(5) convex lenses with 60.0 cm focal length.

24. A prism is placed on the prism table of a properly adjusted spectrometer and the refracted image of the illuminated collimator slit is observed while rotating the prism table starting from a large angle of incidence towards smaller angles. As the prism table rotates.
(1) the image will move in a direction with continuously decreading angle of deviation.
(2) the image will move in a direction with continuously increasing angle of deviation.
(3) the image will move in a direction wing increasing angle of deviation, turn back, and move in a direction with decreasing angle of deveiation.
(4) the image will first move in a direction with decreasing angle of deviation, turn back, and move in a direction with increasing angle of deviation.
(5) the image will first move in a direction with decrasing angle of deviation and then stop.

25. A lighted candle is placed in front of a convex lens as shown in figure (a).

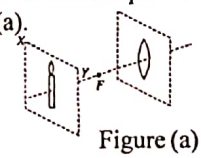


Figure (a)

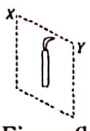
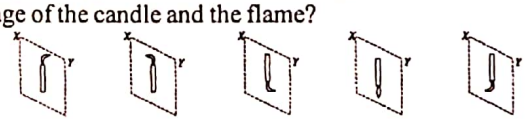


Figure (b)

If the flame bends towards the direction Y due to wind as shown in figure (b), which of the following shows the nature of the image of the candle and the flame?

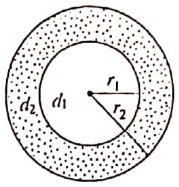


(1) (2) (3) (4) (5)

26. A man of mass 60 kg standing on a uniform wooden rafter hung horizontally by two identical ropes is painting a wall. The mass of the rafter is 20 kg. What is the **minimum** tension that should be wihheld by each rope so that the man can move safaly between A and B?

(1) 100 N (2) 400 N (3) 600 N
(4) 700 N (5) 800 N

27. The inner sphere of a composite solid spherical object is made of a material of density d_1 and the rest of the composite spgere is made of a material of density d_2 as shown in figure. The radius of the inner sphere is r_1 and the radius of the composite sphere is r_2. If the composite sphere floats fully immersed in a liquid of density d_3, then

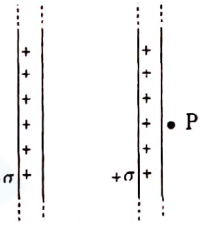


(1) $r_2^3 d_3 = r_1^3 d_1 + r_2^3 d_2 - r_1^3 d_2$ (2) $r_1^3 d_1 = r_2^3 d_2 + r_2^3 d_3 + r_1^3 d_2$

(3) $r_2^2 d_2 = r_1^2 d_1 + r_2^2 d_1 - r_2^2 d_2$ (4) $r_2^2 d_3 = r_1^2 d_1 + r_2^2 d_2 - r_1^2 d_2$

(5) $r_2^3 d_2 = r_1^3 d_1 + r_1^3 d_3 - r_1^3 d_2$

28. Two large non-conducting plane sheets, each having a uniform surface charge density $+\sigma$ on one side, are situated parallel to each other as shown. The electric field intensity at a point P is

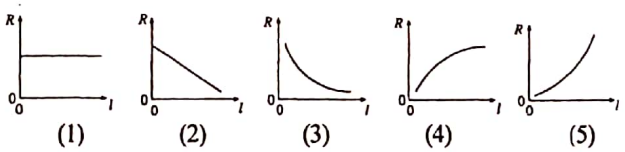


(1) $\frac{2\sigma}{\varepsilon_0}$ (2) $\frac{\sigma}{\varepsilon_0}$ (3) $\frac{\sigma}{2\varepsilon_0}$

(4) $\frac{\sigma}{4\varepsilon_0}$ (5) 0

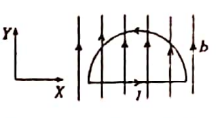
29. Consider the following statements made about electric fields and equipotential surfaces.
(A) Flectric field lines and equipotential surfaces are always perpendicular to each other.
(B) The magnitude of the electric field intensity should be same at all points on an equipotential surface.
(C) The magnitude of the electric field intensity cannot be zero at a point on an equipotential surface.
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

30. If a piece of uniform wire is stretched gradually, which of the following curves correctly indicates the variation of its resistance R with the length l?



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

31. A wire bent into the shape of a semicircle forms a closed loop and carries a current I as shown in figure. The loop lies in the XY plane and a uniform magnetic field is present along the Y direction. Which of the following is true regarding the forces acting on the circular and straight portions of the loop due to the magnetic field?

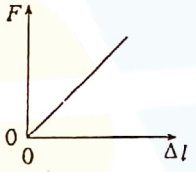


	Force on the circular portion	Force on the straight portion
(1)	zero	into the paper
(2)	zero	out of the paper
(3)	into the paper	into the paper
(4)	into the paper	out of the paper
(5)	out of the paper	into the paper

32. Small amount of powdered pepper was sprinkled on the surface of water in a cup and the water surface was touched with a clean ary finger tip. Then the finger tip was mbbed with a little soap and the same process was repeated. Which of the following observation is likely to be seen in the above processes?

	Cleaned and dried finger tip	Soapy finger tip
(1)	Pepper powder tend to move away from the finger tip.	Pepper powder tend to flock around the finger tip.
(2)	Pepper powder tend to move away from the finger tip.	Pepper powder tend to move away from the finger tip.
(3)	Nothing happens to the distribution of pepper powder.	Pepper powder tend to flock around the finger tip.
(4)	Nothing happens to the distri bution of pepper powder.	Pepper powder tend to move away from the finger tip.
(5)	Pepper powder tend to flock around the finger tip.	Pepper powder tend to flock around the finger tip.

33. The applied force F and extension Δl curve for a metal wire is shown in figure. Consider the following statements.



(A) If another wire of lower cross-sectional area is used without changing other parameters, the corresponding curve would fall above the curve shown in figure.

(B) If a wire having identical parameters but with a larger Young's Modulus is used then the corresponding curve would fall below the curve shown is figure.

(C) If a longer wire is used without changing the other parameters the corresponding curve would fall below the curve shown in figure.

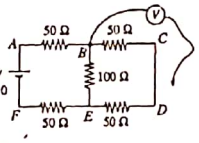
Of the above statements

(1) only (A) is true. (2) only (C) is true

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

(5) all (A), (B) and (C) are true.

34. One terminal of the voltmeter V shown in figure is connected to the point *B*. When the voltages of all the other points labelled with English letters are measured by connecting the free terminal of the voltmeter to those points, the **magnitudes** of the readings indicated by the voltmeter

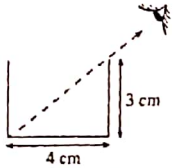


(1) 0, 2V, 8V (2) 4V, 6V

(3) 2V, 4V, 8V (4) 0, 6V, 8V

(5) 4V, 8V, 12V

35. By looking at an empty glass vessel along the path shown by the broken ling in figure, a person could see the left corner of the bottom of the glass vessel. After the glass vessel is filled with a clear liquid the person could see the **middle** of the bottom of the glass vessel when looking along the same path. The refractive index of the liquid is (Take $\sqrt{13} = 3.6$)



(1) 1.11 (2) 1.22 (3) 1.33 (4) 1.44 (5) 1.55

36. The initial relative humidity of a closed room of volume V at room temperature θ_0 is X%. The temperature and the relative humidity of the room are then reduced to θ_1 and Y% respectively using an airconditioner. If the absolute humidities of air at corresponding dew points of θ_0 and θ_1 are A_0 and A_1 respectively then the mass of water vapour that has been removed by the airconditioner is

(1) $\left(\frac{XA_0V - YA_1V}{100}\right)$ (2) $\left(\frac{XA_0}{V} - \frac{YA_0}{V}\right)100$

(3) $\left(\frac{X}{A_0V} - \frac{Y}{A_1V}\right)\frac{1}{100}$ (4) $\left(\frac{XV}{A_0} - \frac{YV}{A_1}\right)100$

(5) $\left(\frac{A_0V}{X} - \frac{A_1V}{Y}\right)100$

37. When a uniform rod of known length and area of cross-section was lagged, and the rate of rlow of heat and the temperature gradient were measured, it was found that value of the thennal conductivity calculared using those quantiries, is smaller than the expected value of the thermal conductivity for the material of the rod, This could occur if

(A) the measured value of the rate of flow of heat through the rod is lower than the expected valne.

(B) lagging of the rod is poor

(C) the measunred value of the temperature gradient in larger than the expected value.

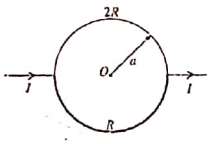
Of the reasons given above

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

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

(5) all (A), (B) and (C) are true.

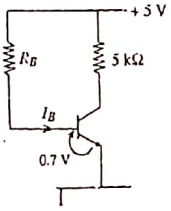
38. Lower half of the circular wire loop of radius a, shown in figure is made of a wire of resistance R and the upper half with a wire of resistance $2R$. The magnetic flux density at the center (O) of the wire loop is given by



(1) $\frac{\mu_0 I}{4\alpha}$ (2) $\frac{\mu_0 I}{6\alpha}$ (3) $\frac{\mu_0 I}{12\alpha}$

(4) $\frac{\mu_0 I}{16\alpha}$ (5) $\frac{\mu_0 I}{18\alpha}$

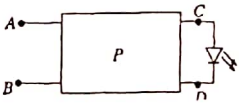
39. In the circuit shown I_B = 500 μA and the transistro has a current gain, β of 100. Current through the 5 kΩ resistor in approximately



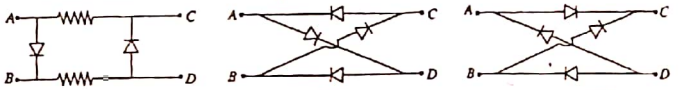
(1) 0.5mA (2) 1.0mA (3) 2.0mA

(4) 5.0mA (5) 50.0mA

40. The box *P* shown contains a circuit and when a battery is connected between *A* and *B*, the Light Emitting Diode (LED) connected to the circuit is lit.



Which of the following circuit/ circuits inside the box P enables/ enable the Light Emitting Diode to be lit even when the battery terminals are interchanged between A and B?

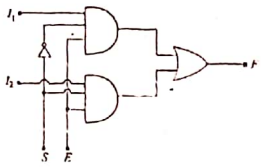


(X) (Y) (Z)

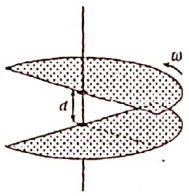
(1) Only X and Y (2) Only Y and Z (3) Only X and Z

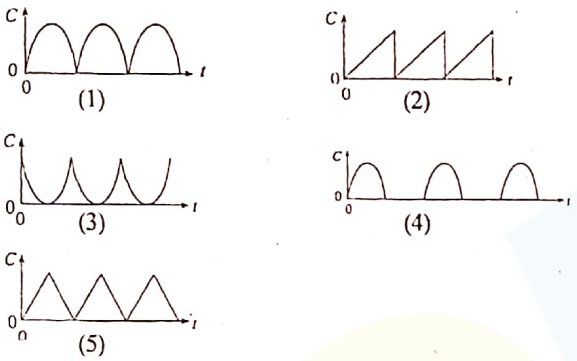
(4) Only Y (5) Only Z

41. Consider following statements made about the circuit shown in figure.
(A) When E = 1 and S = 0, the output F = I_1
(B) When E = 1 and S = 1 the output F = I_2
(C) When E = 0 the output F = 0 irrespective of the values of S, I_1 and I_2.
Of the above statements
(1) only (C) 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.



42. A variable parallel plate capacitor is made of two identical semi-circular matal plates that can be rotated about the common axis passing through the centres of each plat and perpendicular to them, as shown in the figure. If one plate rotates with constant angular speed ω, relative to the other, the variation of the capacitance C of the capacitor with time t is best represented by



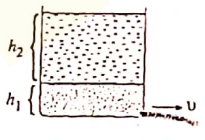


(1) (2) (3) (4) (5)

43. One end each of two identical, stretched springs are fixed to the two ends of a closed tube and the other ends of the springs are attached to a mass m, as shown in the figure. Which of the following motion/s of the system results in a displcement of mass m towards P from the centre of the tube?

(A) Uniform acceleration of the tube in the direction of PQ, keeping the tube in a horizontal.
(B) Rotation of the tube around a vertical axis passing through Q, keeping the tube in a horizontal plane.
(C) Vertical motion of the tube under gravity keeping Q below P.
(1) (A) only (2) (A) and (B) only
(3) (B) and (C) only (4) (A) and (C) only
(5) All (A), (B) and (C)

44. A cylindrical tank having a very large diameter contains two immiscible liquids of denities d_1 and d_2 ($d_1 > d_2$). The tank has a small hole closer to the bottom (see figure.)



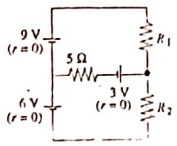
If the heights of the liquids at a certain instant, are h_1 and h_2 what will be the speed υ of the liquid ejecting out of the tank at that instant? Neglect the surface tension effects and assume that the liquids are **non**-viscous.

(1) $\upsilon = \sqrt{2gh_1}$ (2) $\upsilon = \sqrt{\frac{2gh_1d_1}{d_2}}$

(3) $\upsilon = \sqrt{2g\left(h_1 + h_2\right)}$ (4) $\upsilon = \sqrt{2g\left(\frac{d_1}{d_2}h_1 + h_2\right)}$

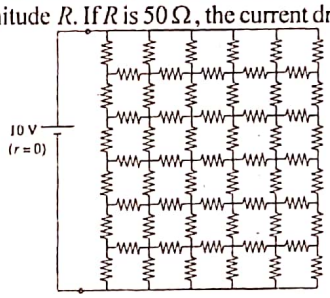
(5) $\upsilon = \sqrt{2g\left(h_1 + \frac{d_2}{d_1}h_2\right)}$

45. If **no** current flows through the 5 Ω resistor in the circuit shown, what is the value of ratio ?



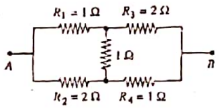
(1) $\frac{2}{5}$ (2) $\frac{3}{5}$ (3) $\frac{2}{3}$
(4) 1 (5) $\frac{3}{2}$

46. The network shown in figure consists of identical resistors each having magnitude R. If R is 50 Ω, the current drawn from the cell is



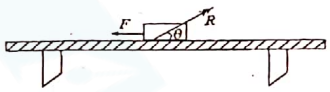
(1) 0.01A (2) 0.1A (3) 0.2A
(4) 0.5A (5) 1.0A

47. If a certain potential difference V is applied between A and B, a current of 3 A flows through R_1 and a current of 2 A flows through R_2.

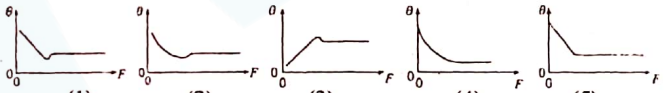


What is the equivalent resistance between A and B?
(1) $\frac{4}{3}\Omega$ (2) $\frac{7}{5}\Omega$ (3) $\frac{3}{2}\Omega$ (4) 6Ω (5) 7Ω

48. A box, which is placed on a rough, horizontal surface of a table is pulled by a variable, horizontal force of magnitude F.



For a given value of F the resultant force R exerted by the surface on the box makes an angle θ with the horizontal direction as shown in the figure. The variation of θ with F is best represented by

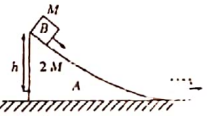


(1) (2) (3) (4) (5)

49. Four identical rectangular metal plates, P, Q, R and S have been arrenged parallel to each other so that the distance between two successive plates is d. Area of each plate is A. If the plates Q and S are connected by a thin metal wire, what will be the capacitance between platse P and R?

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

50. A body A of mass $2M$ shown in figure is placed on a smooth horizontal surface, and a small block B of mass M is placed at the top of the body. Staring from rest, block B sllides down on the smooth surface of A. At the instant when block B leaves A the speed υ of A is given by



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

G.C.E. (Advanced Level) Examination - August 2013

PHYSICS - II

Three hours

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

01. You are asked to determine the density of a given oil experimentally using Archimedes' principle. A set-up consisting of a **thin walled** glass test tube containing the oil, and a transparent glass vessel with water as shown in figure is provided to perform the experiment.

The test tube floats in up-right position in water as shown in the figure. A coloured ring is clearly marked around the wall of the tube at P and it can be used as a reference to measure heights. The following symbols are assigned to various parameters relevant to the set-up and use these symbols to answer the questions.

A - Area of cross-section of the tube above the ring

V - Volume of the tube below the ring

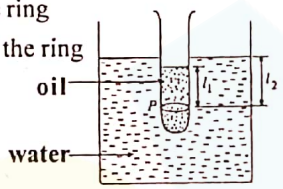
l_1 - Height of the oil column above the ring

l_2 - Height of the water column above the ring

M - Mass of the empty test tube

d - Density of the oil

d_w - Density of water (given)



(a) Writr down an expression for the weight of the oil inside the tube in terms of V, A, l_1, d, and g.

.....

(b) Write down an expression for the total weight W of the test tube with the oil.

W = ...

(c) Write down an expression for the upthrust U acting on the test tube.

U = ...

(d) (i) What relationship holds between W and U?

.....

(ii) In the relationship you have given in (d) (i) above, arrange the parameters in W and U, to obtain a relationship in the form $l_2 = ml_1 + c$.

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.....

(iii) If a suitable graph is plotted using the relationship obtained in (d) (ii) above, how would you determine the density of oil, d, using the graph?

.....

(e) The following measuring instruments are at your disposal.

A half metre ruler, a vernier calliper, and a travelling microscope.

(i) Of the given instruments what is the most suitable instrument to measure l_1 and l_2? You are not allowed to change the position of the test tube.

.....

(ii) How do you abtain the relevant readings to measure l_1 and l_2 using the instrument that you have mentioned under (e) (i)?

.....

.....

.....

(f) If the wall of the test tube is thick instead of thin, the corresponding expression for m in the expression that you have obtained in (d) (ii) above will yield $m = \dfrac{A_i d}{A_e d_w}$, where A_i and A_e are internal area of cross-section and external area of cross-section, respectively of the tube above the ring.

(i) To determine A_i and A_e what measurements do you have to take?

For A_i ..... (say x_i)

For A_e ..... (say x_e)

(ii) How do you use proper instrument selected out of the measuring instruments given in (e) above, to obtain the measurements x_i and x_e?

To measure x_i : .....

To measure x_e : .....

02. An experiment has been designed to find the linear expansivity of lead by using a thin perforated lead tube, closed at both ends. The temperature of the tube is increased in steps by pumping hot air at different temperatures. The temperature of the tube is measured by means of a thermocouple. In this experiment, a student is expected to measure the increase in length that occurs in the length of the tube, with the increase of temperature, by designing and implementing a suitable methodology.

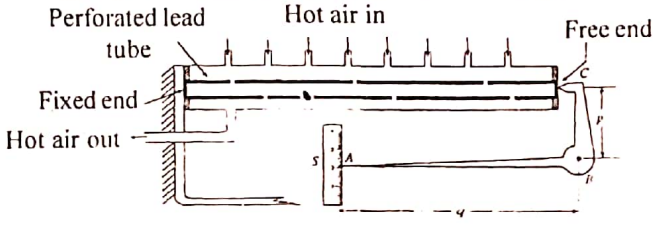

Figure (1)

(a) Let the length of the lead tube at the room temperature be l_0. The new length of the tube, when the temperature of the tube is increased by an amount θ°C from the room trmperature, is l_1. Write down an expression for the linear expasivity a of lead in terms of l_0, l_1 and 0.

.....

.....

(b) Student proposes to use a metre ruler for the measurement of length l_0. What is the minimum length l_0 must have in order for the percentage error of the l_0 measurement to be less than or equal to 0.2%?

.....

.....

.....

(c) State **two** advantages of using a thin perforated tube in this experiment?

(1) .....

(2) .....

(d) For the measurement of increase in length $(l_1 - l_0)$ of the tube, student has designed the arrangement shown in the figure (1) above. One end of the tube touches a rigid support. *ABC* is a lever system pivoted at *B*. The end *C* of the lever system firmly touches the movable end of the tube and the *ABC* structure can rotate about the fixed pivot at *B*. Scale *S* is calibrated in **millimetres.**

Let X_0 = Reading indicated by the pointer *A*, on the scale *S*, at the room temperature, and

X = Reading indicated by the pointer *A*, on the scale *S*, when the temperature of the tube is increased by an amount θ.

Then the relationship between $(l_1 - l_0)$ and $(X - X_0)$ is given by the equation.

$$(l_1 - l_0) = \frac{p}{q}(X - X_0) \quad \text{.....} ①$$

For this arrangement, $P = 2$ cm and $q = 10$ cm.

(i) What is the minimum value of increase in length $(l_1 - l_0)$, that can be measured using this arrangement?

.....

.....

(ii) Substitute the expression for $(l_1 - l_0)$ given is equation *1* in the expression you have written down for *a* in part (*a*) above and obtain a suitable equation to plot a graph of *X* with θ.

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(e) A graph of *X* plotted with θ from the reading obtained when the length l_0 = 80.0 cm is shown in the figur (2).

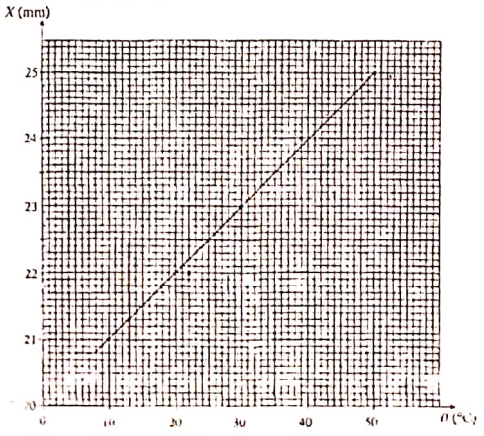

Figure (2)

(i) Find the gradient of the graph.

.....

.....

(ii) Hence determine the linear expansivity of lead.

.....

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.....

(f) Student has chosen a material with very low thermal conductivity to construct the arm *ABC*. Do you agree with his choice? Give reasons.

.....

.....

(g) In order to reduce the error in taking readings from the scale S, student proposes to fix a narrow strip of a plane mirror (*M*) colse to the scale S as shown in the figure (3). After this modification, what is the step that must be followed in taking readings from the scale *S*?

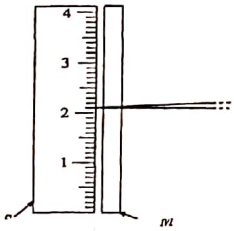

figure (3)

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03. A glass tube, a measuring cylinder with water, a metre ruler and a tuning fork of frequency (f) 512 Hz are provided to determine the speed of sound (v) in air and the end correction of the tube (e). When the glass tube is completely immersed in water and then raised gradually, resonances can be heard when the heights of the tube above the water level are l_1 = 0169 m and l_2 = 0.509 m, respectively.

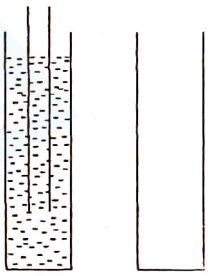

figure l

(a) (i) Draw the wave form for the resonance heard for the first time in figure l (a).

(ii) Draw the tube, water level and the wave form for the resonance heard for the second time in figure l (b).

(iii) Clearly mark the height l_2 that you would measure in figure 1 (b).

(b) (i) Obtain an expression for the speed of sound *v* in terms of *e*, f and l_1 by considering the resonance heard for the first time.

.....

.....

(ii) Write down an expression for the speed of sound v in terms of *e*, *f* and l_2, considering the resonance heard for the second time.

.....

.....

(iii) Using the resulte obtained in (*b*) (*i*) and (*b*) (*ii*) above, obtain an expression for *v* in terms of l_1, l_2 and *f*.

.....

.....

.....

.....

(iv) Hence calculate v and e.

.....

.....

.....

.....

.....

(c) A student suggested to use a graphical method to determine v and e taking measyrements of several resonance states of the tube with the tuning fork. Write down **two** difficulaties of different nature in preforming such an experiment to obtain sufficient number of measurements.

(1) .....

(2) .....

04. In the circuit shown in figure (1) R_1, R_2, R_3 and R_4 represent resistances and E represents the e.m.f of the cell.

(a) If the potential at B is same as that at D, **derive** and expression relating R_1, R_2, R_3 and R_4.

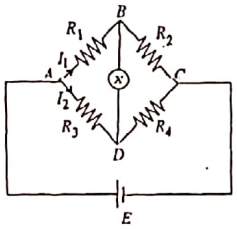

figure 1

.....

.....

.....

(b) The above circuit can be used to measure the value of an unknown resistor (say R_2) by replacing resistors corresponding to R_3 and R_4 with a uniform resistive wire as shown in figure (2).

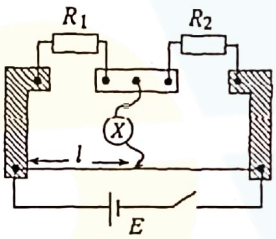

figure 1

All resistors and the resistive wire are connected using wide copper strips. The length of the resistive wire is **exactly 1m**.

What is the main reason for using wide copper strips instead of connecting wires when connecting the components?

.....

(c) Identify the item X in the circuit **precisely.**

.....

(d) If the unknown value of R_2 is to be determined by plotting a graph, state whether you would use a resistance box or a rheostat for R_1. Give reasons for your answer.

.....

.....

(e) (i)Write down an expression relating R_1, R_2 and balanced length l.

.....

.....

(ii) Rearrange the variables in expression given under (*e*) (*i*) above so that it is suitable to plot a graph with the reciprocal $\left(\frac{1}{R_1}\right)$ of the indepndent variable R_1 as X-axis.

.....

.....

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.....

(iii) How do you find R_2 from the graph?

.....

(*f*) Give **two** reasons for not selecting R_1 values which produce small values for l.

(1) .....

(2) .....

PART B

Answer **four** questions on this paper itself. $[g = 10\ N\ kg^{-1}]$

05. The vertical force (lift) required for the taking off of an airplane is provided by **two forces**, one arises due to the Bernoulli effect and the other due to the hitting of air molecules on the wings of the airplane. The orientation and the cross sectional view of a wing of an airplane when it is travelling along the runway for taking off are shown in the figure (1). Here the bottom surface of the wing makes an angle θ with the horizontal direction.

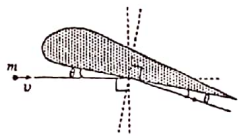


Figure (1)

Figure (2)

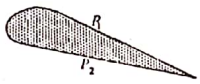


Figure (3)

(a) Take the speed of the airplane on the runway to be (ms^{-1}) at a certain instant and assume that air molecules remain still relative to the earth. Also assume that each air molecule has the same mass m. Consider a complete elastic collision of an air molecule with the wing. [see figure (1).] The speed of the air molecule relative to the airplane is shown in the figure.

(i) Write down an expression for the change in momentum of the air molecule in the direction **perpendicular** to the bottom surface of the wing in terms of *m*, υ and θ.

(ii) If the number of air molecules hitting the witg during one second is *N*, using the result in (*a*) (i) above obtain an expression for the **vertical** force generated by collisions of air molecules on the with in terms of *m*, υ, θ and *N*.

(b) When the airplane is moving , a wing sweeps an effective cross-sectional area *A* [figure (2)], and therefore molecules in a volume *A*υ hit the wing during one second period. Let the density of air be *d*.

(i) Write down the total mass of air molecules hitting the wing during one second in terms of *A*, υ and *d*.

(ii) Hence express *N* in terms of *A*, υ, *d* and *m*.

(iii) Obtain an expression for the total vertical force (take as F_c), generated due to the collisions of air molecules on **both wings** in terms of *A*, υ, *d* and θ.

(iv) If θ = 10°, $A = 25\ m^2$ and $d = 1.2\ kg\ m^{-3}$ obtain the value of F_c in terms of υ.

(Take sin θ = 0.2 and cos θ = 1 for θ = 10°)

(c) (i) Assume that, because of the shape of the wing, the average speeds of the air streams relative to the airplane just above and just below the wing are $\frac{7\upsilon}{6}$ and $\frac{5\upsilon}{6}$ respectively. Taking P_1 to be the pressure just above the wing and P_2 to be the pressure just below the wing [figure (3)], show that the pressure difference across the wing due to the Bernoulli effect is given by

$$(P_2 - P_1) = \frac{2}{5}\upsilon^2.$$

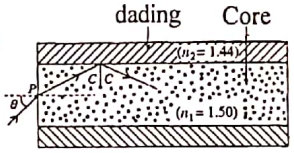
(ii) If the effective surface area of one wing is 120 m^2, find the total vetical force on **both wings** (Say F_b) due to the above pressure difference, in terms of υ. (Assume cos10° = 1)

(d) If the mass of the airplane is 4.32×10^4 kg, calculate the minimum speed required for the plane to take off.

(e) The maximum possible acceleration of the airplane on the runway is 0.9m s^{-2}. Assuming that the airplane accelerates uniformly, calculate the minimum length the runway must have for taking off.

(f) Pilots take off airplanes by accelerating against the direction of wind, whenever possible. Explain the reason for this.

06. In modern world optical fibres are used in numerous fields such as telecommunication and medicine. Figure (1) shows a crosssection of an optical fibre known as a 'step-index' fibre.



The inner part of the fibre known as the core in made of a transparent material of refractive index 1.50 and the outer layer of th fibre known as the cladding is made of another transparent material of refractive index 1.44.

(a) As shown in figure (1) a monochromatic ray of light travelling in air and entering one end of the fidre with an angle of incidence θ is refracted into the core. Then the ray is incident on the core-cladding interface at an angle corresponding to the critical angle C of that interface.
[sin 160 = 0.28; sin 25° = 0.42, sin74° = 0.96]

(i) Calculate the value of *C*

(ii) Hence calculate the value of θ

(iii) Find the range of values θ must have for the ray to be totally internally reflected from the core-cladding interface and transmit along the fibre.

(iv) Write down an important advantage of using such fibres in telecommunication.

(v) Draw the paths of emergent rays from the other end of the fibre for (1) odd number of reflections and (2) even number of reflections.

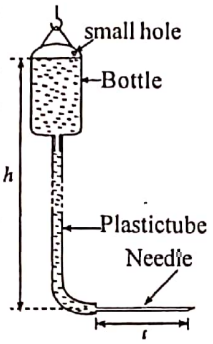
(vi) Copy the figure (1) onto your answer sheet with the existing incident ray and show the complete path of a ray incident at *P* and subsequently falls at the core-cladding interface but **does not** undergo total internal reflection.

(b) Two short red and blue light pulses are sent into one end of a straight optical fibre of 3km length simultaneously and perpendicular to it. Calculate the time interval between the red blue light pulses when emerging at the other end. The speed of light in air is 3.00×10^8 m s^{-1} and the refractive indices for blue and red light are 1.53 and 1.48 respectively.

(c) (i) To transmit light signals more efficiently some optical fibers are made so as to decrease its refractive index gradually and continuously from the middle (axis) of the fibre to the outer surface of the fibre. This type of optical fibre is called a 'graded-index' fibre. Draw the path of a monochromatic light ray transmitting along such a fibre in a span of two total internal reflections.

(ii) If the incident ray consists of blue and red colours instead of being monochromatic, will they travel along the same path inside the fibre? Explain your answer with a help of a diagram.

07. Treatment procedures adapted in hospitals very often require infusion of fluids such as saline, antibiotics, insulin, etc. into the venous sxstem of patients, over a long period of time. A common method used for this is to allow the fluid to be infused to the patient under the gravity. Here, the fluid to be infused is included in a bottle, and a metal needle in the form of a thin tube is connected to the bottle by a plastic tube as shown in figure (1). The fluid is allowed to be infused by inserting the needle to a vein of the patient.



(a) Suppose that it is required to infuse a saline solution to a patient using the set-up shown in figure (1).

(i) If r = Internal radius of the needle; l = Length of the needle; Q = Volume flow rate of the saline solution through the needle; η = Viscosity of the saline solution; ΔP = Pressure difference across the needle, write down an expression for ΔP in terms of r, l Q and η, when the needle is placed horizontally.

(ii) When a needle with $r = 2 \times 10^{-4}$m and $l = 3 \times 10^{-2}$ m is used, the volume flow rate through the needle, before it is inserted into the patient is $Q = 1.5 \times 10^{7}$ m^3 s^{-1}. Calculate the height h shown in figure (1) under these conditions. You are also provided with the following data.

Density of the saline solution
$= 1.2 \times 10^{3}$ kg m^{-3} ; $\eta = 2 \times 10^{-3}$ Pa s. Take $\pi = 3.0$.

(iii) If it is desired to maintain the **initial** volume flow rate through the needle at the same value given in (a) (ii) above, after inserting the neelde into a place where the venous blood pressure of the of the patient is 3×10^{3} N m^{-2} over and above the atmospheric pressure, by how much the height h must be increased?

(iv) If the length of the saline bottle is 0.2 m, by how much the volume flow rate through the needle will change when a completely filled saline bottle becomes almost empty?

(v) Hence, find the average value of the volume flow rate through the needle.

(vi) If a saline bottle contains $1.10^{4} \times 10^{-3}$ m^3 of saline solution, using the result obtained in (a) (v) above, find the time taken for the infusion of one bottle of saline completely to the patient.

(b) Infusion under the gravity is not a very good method when it is crucial to maintain a constant rate of infusion. In this situation use of infusion machines is appropriate. A schematic diagram of the relevant section of such an infusion machine is shown in the figure (2).

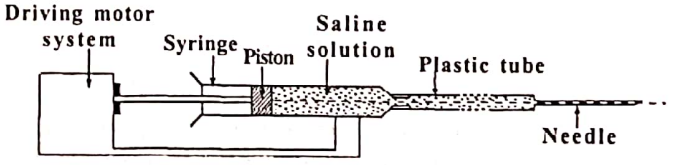


figure (2)

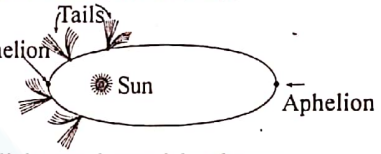
Here the fluid is filled to a syringe and is pressed using a piston which can be moved very slowly by a controllable motor system. Consider that the needle described in (a) (ii) above is connected to this machine horizontally as shown in the figure. The machine is used to infuse the saline solution to the patient as described in (a) (iii) above with the same volume flow rate of $Q = 1.5 \times 10^{-7}$ m^3 s^{-1}.

(i) If the internal cross-sectional area of the syringer is 1.2×10^{-3} m^2, how fast the piston must be moved?

(ii) Assuming that the pressure differences of the saline solution across the syringe and the plastic tube [see figure (2)] are negligibly small calculate the constant force exerted by the piston on the saline solution.

(iii) calculate the rate of work done by the driving motor systen on the piston.

08. Read the passage and answer the questions given below.



Comets are small astronomical objects typically moving in highly elliptical ordits around the sun. [see figure (1).]
Some orbits extend roughly one light-year beyond the planetary system. The main force acting on the comet is the gravitational attraction to the sun. The main components of a comet are the nucleus, coma and tails. While the solid body of the comet, the nucleus, is generally less than 50 km in extent, the coma may be larger than the sun, and the tails can extended over 150 million kilometres.

Comets mainly, compose of frozen carbon dloxide, methane, water (ice) with dust, and various types of minerals. When the comet reaches the inner planets and moving closer to the sun, its outer layer gets evaporated due to the radiation pressure from the sun. The dust and gases released from it form the extended atmosphere of the comet around its nucleus and is called the coma. The solar radiation pressure and the solar wind acting on the coma produce a bluish colour tail of ions which is straight and directed away from the sun as the gas is more strongly affected by the solar wind. The dust released from the comet forms another white coloured and slightly curved tail behind the comet.

The speed of the comet varies from its minimum value at furthest point from the sun (aphelion) to the maximum value at the closest point to the sun (perihelion). For example, the Halley's comet of mass 2.0×10^{14} kg at the aphelion which is at adistance of 5.0×10^{12}m from the sun, acquires its lowest speed of 12.0 km s^{-1}.

Debris those enter the atmosphere from the outer space are known as meteoroids. Most meteoroids burn out emitting light in the atmosphere due to heat generated through the friction with the expense of their kinetic energies, both linear and rotational. They are called meteors. When the Earth's atmosphere crosses the debris left along the path of a comet, meteor showers could be observed. Some meteoids fall onto the Earth's surface and they are called meteorites.

When a meteoroid is rapidly reaching its melting point, it becomes incandescent. When the surrounding atoms become ionized and rapidly recombined with the electrons causing the emission of light, the meteoroid produces a huge spherical air mass, appearing as a fire ball. Some meteoroids seen as fire balls could explode

into several pieces of meteors. Seconds after seeing the explosion, the shock waves produced by the fragments of the meteoroid could reach the ground making ground-breaking sonic booms as heard in the recent event in Russia.

(*a*) What are the main components of a come?

(*b*) Write down **three** main differences between the two types of tails of a comet.

(*c*) Calculate the gravitational force acting on the Hallry's comet when it is at aphelion.

(Mass $\frac{3}{5}$ of the Sun = 2×10^{30} kg, $G = 6.7 \times 10^{11}$ N m^2 kg^{-2})

(*d*) Find the speed of the Halley's comet when it is located at perihelion where its distance from the sun is 8.0×10^{10}m.
Note : The velocity of the comet is perpendicular to radial direction at both perihelion and aphelion. Assume that the mass remains undhanged.

(*e*) Why meteor showers are produced when the Earth's atmosphere crosses an orbit of a comet?

(*f*) What is the difference between meteors and meteorites?

(*g*) What energies are converted to heat energy in burning meteorids?

(*h*) What is the mechanism that generates the light for a meteoroid to appear as a fire ball?

(*i*) A meteoroid falling vertically downward with a speed of 200 m s^{-1} explodes into two pieces. If one piece having a mass of the meteoroid travels in the horizontal direction with the speed of 600 m s^{-1}, find the speed of the other piece.

(*j*) What should be the condition that must be satisfied by the speed of a piece of meteoroid to create a shock wave?

(*k*) Explain the formation of a shock wave using a diagram.

09. **Answre either part (A) or part (B) only.**

(A) The box P shown in the figure (1) comprises a complex electrical circuit containing only cells and resistances.

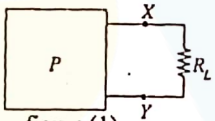


figure (1)

Assume that the entire circuit inside the box can be replaced with a series combination of a single cell with an e. m. f. E and a single resistance R_0 as shown in figure (2).

(a) Write down an expression for the current I drawn from the circuit in P when an external resistance R_L is connected across the terminals XY in figure (2) in terms of E, R_0, and R_L.

Values of E and R_0 mentioned above can be determined exprimentally be using the two methods indicated under (b) and (c) below.

(b) After removing the resistance R_L the voltage across the terminals XY is measured with a voltmeter having an internal resistance very much greater than R_0. Let the voltmeter reading be V_0.

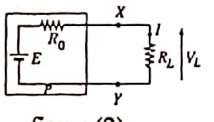


figure (2)

Then the terminals XY are short circuited for a short time and the current in the circuit is measured by an ammeter with negligible internal resistance. Let the ammeter reading be I_s.

Use the results obtained above to write down expressions for E and R_0.

(c) In order to find values of E and R_0 using the second method, two resistors having different values are used for R_L in figure (2), and the voltages V_L across R_L are measured with a voltmeter having an extremely high internal resistance compared to R_L values. Set of values obtained in such a measurement is given below.

When $R_L = 1$ kΩ, $V_L = 75$ mV

When $R_L = 100$kΩ $V_L = 5$ V

Use the above measurements and calculate E and R_0.

(d) (i) In general if R0 is extremely large compared to R_L, show that the current I in the circuit is almost independent of the value of R_L and it depends only on E and R_0. You may use the expression obtained for I under part (*a*) above for this. (Under this condition the circuit in P consisting of E and R_0 can be treated as a constant currant source)

(ii) If the voltage appearing across R_L under the conditions mentioned in (d) (i) above is V_L, draw a rough sketch to show how the current I varies with V_L. (Use V_L for x - axis.)

(e) Part of the output I - V characterictic of an npn transistor [see figure (3)] connected in the common emitter mode is almost similar to the rough sketch that you have drawn in (*d*) (ii).

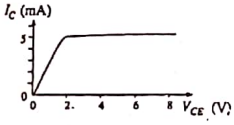


figure (3)

From this what can you infer about the magnitude of the resistance between the collector and the emitter of the transistor? Briefly explain your answer.

(B) A step-down transformer produces an output voltage of 18 V (peak value) from a 240 V, 50 Hz ac mains voltage.

(a) Draw a circuit diagram of a bridge rectifier connected to the appropiate terminals of the above transformer.

(b) Draw the voltage waveforms formed across a resistor connected across the outputs at the following output stages. Label the axes of the graphs and clearly mark the peak values of the voltage (in volts) and the period of the waveforms (in seconds). Assume that silicon restifier diodes used in the rectifier have a forward bias voltage of 1V.

(i) Transformer output

(ii) Rectifier output (without smoothing capacitor)

(iii) Rectifier output with the smoothing capacitor. Show the capacitor connection in the circuit, that you have drawn under (*a*).

(iv) Output after connecting a zener diode to regulate the voltage. Show the zener diode connection in the circuit that you have drawn under (*a*).

(c) (i) What is the advantage of choosing a large capacitance value for the smoothing capacitor than a small value?

(ii) When the smoothing capacitor is in place what is the maximum reverse-bias voltage that can appear across a diode?

(d) If the zener diode used in (b) (iv) above has following specifications, colculate the value of the safety resistor that has to be used in order to safeguard the zener diode.

Zener voltage = 10 V

Maximum permissible current through the zener diode = 200 mA

(Use the relevant peak values for your calculations.)

(e) A student has decided to use the rectifier sircuit with the smoothing capacitor (but without zener regulation) as the

dc power supply which is necessary to operate a common emitter amplifier.

(i) Draw a circuit diagram of a common emitter amplifier.

(ii) State changes that you would expect in voltages at the base and at the output of the amplifier due to the voltage variation (ripple voltage) of the power supply.

10. Answer either part (A) or part (B) only.

(A) Starting from ideal gas equation derive an expression for the density (ρ) of an ideal gas in terms of pressure (P), molar mass (M), absolute temperature (T) and universal gas constant (R).

As shown in figure (i) a volume of 1.0 m^3 of air at atmospheric pressure (1.0 x 10^5 Pa) and temperature 27°C (point A of the P - V curve). is compressed adiabatically to a pressure of 1.5 x 10^5 Pa and temperature of 64.5 °C (point B of the P-V curve).

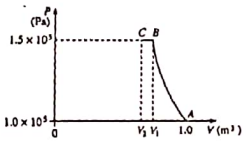


figure (1)

Then the air is cooled to the initial temperature of 27 °C under a constant pressure of 1.5 x 10^5 Pa (point C of the P - V curve).

[Assume that air behaves as an ideal gas; the molar mass of air = 3.0 x 10^{-2} kg mol^{-1}; R = 8.31 J k^{-1} mol^{-1}; **take** $\frac{1}{8.31} = 0.12$]

(a) Calculate the densities of air (i) at point A, (ii) at point B, and (iii) at point C.

(b) Calculate (i) volume V_1 of air at point B, (ii) volume V_2 of air at point C. (Give your answers to the nearest second decimal place.)

(c) Assuming the adiabatic curve to be linear, the above P - V diagram could be redrawn as shown in figure (2). During the compression process of air from A to B, calculate the following.

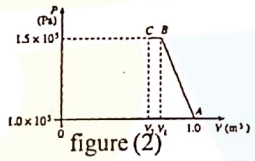


figure (2)

(i) Work done by air

(ii) The change in the internal energy

(d) During the compression process of oir from B to C, calculate the following.

(i) Work done by air.

(ii) The amount of heat given out from air.

(e) A process similar to the process shown in figure (1) takes place in some vehicle engines. The power output of an automobile engine is directly proportional to the mass of air that can be drawn into the engine to mix with a given mass of fuel. These vehicles have a unit called 'turbocharger' which compresses the air before it enters the engine, giving a greater mass of air per unit volume. This rapid, adiabatic compression heats the air. [Process A to B shown in figure (1).] To compress it further, the air is then passed through a unit called 'intercooler' in which the air gives out heat at constant pressure. [Process B to C shown in figure (1).] The air is then drawn into the engine.

Compared to the power output of an engine that takes in air at a pressure 1.0 x 10^5 Pa at 27°C, what percentage increase in power output can be obtained by using the 'turbocharger' and 'intercooler'?

[Hint : use the results obtained in (a) (i) and (a) (iii) above.]

(B) A photosensitive surface is illuminated by radiations of wavelength λ.

(a) (i) Write down the Einstein's photoelectric equation relating the maximum kinetic energy (K_{max}) of the ejected photoelecrons to λ and the work function (ϕ) of the photosensitive material.

(ii) Obtain an expression for ϕ in terms of the threshold wavelength (λ_0) of the photosensitive material.

(b) Intensity

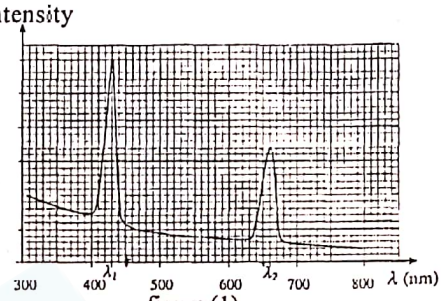


figure (1)

Plants can convert solar energy directly to chemical energy. This process is known as photosynthesis. In order to absord light, plants use pigments known as chlorophyll. A typical chlorophyll molecule absorbs two wavelengths (one of blue colour and the other of red colour) from sunlight. The wavelengths absorbed by chlorophyll are shown in the figure (1).

(i) Determine the two wavelengths, λ_1 and λ_2 absorbed by a chlorophyll molecule.

(ii) Which wavelength corresponds to blue colour?

(c) Chlorophyll molecules absorb the photons of the corresponding wavelengths shown in figure (1) above and get transferred to excited states. The minimum energy needed to excite the molecules is known as the excitation energy (ϕ) of the molecule. This excitation energy can be evaluated by the same expression obtained for the work function ϕ in (a) (ii) above. Determine the two excitation energies, ϕ_1 and ϕ_2 of the chlorophyll molecule, corresponding to the excitations occur due to the two absorptions, λ_1 and λ_2 respectively.
(Take hc = 1290 eV nm)

(d) (i) During the day time average rate of solar radiation incident on a unit area of the Earth's surface in Sri Lankd is 1200W m^{-2}. Assuming that out of this rate of energy, only 0.1% belongs to the energy of the photons corresponding to the wavelength λ_1 determined in (*b*) (*i*) above, calculate the rate of energy incident on a unit surface area of the Earth, which belongs to wavelength λ_1.

(ii) (1) If the effective surface area of chlorophyll molecules on a leaf of a plant is 4.0 x 10^{-4} m^2, determine the rate of energy incident on chlorophyll molecules, which belongs to wavelength λ_1.

(2) What is the rate of photons corresponding to the rate of energy in (ii) (1) above?

(1 eV = 1.6 x 10^{-19} J)

(iii) If only one chlorophyll molecule is excited for every 10^{14} photons incident on chlorophyll molecules, how many molecules are excited due to the incident photons calculated in (ii) (2) above?

(iv) If such six excited chlorophyll molecules are needed to make one glucose molecule, hoq much time is needed to make one glucose molecule?

G.C.E. (Advanced Level) Examination - August 2013

PHYSICS - I

Provisional Scheme of Marking

2013 - Answers

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

G.C.E. (Advanced Level) Examination - August 2013

PHYSICS - II

Provisional Scheme of Marking

A - PART

(01) (a) $(V + Al_1)\, dg$ 01

(b) $W = Mg + (V + Al_1)dg$ 01

(c) $U = (V + Al_2)d_w g$ 01

(d) (i) $W = U$

(ii) $Mg + (V + Al_1)dg = (V + Al_2)\, d_w g$

$M + Vd + Al_1 d = Vd_w + Al_2\, d_w$

$$l_2 = \frac{d}{d_w} l_1 + \frac{M + Vd - Vd_w}{Ad_w}$$ 01

(iii) $d = (\text{gradient}) \times d_w$

Mulitplying the gradient of graph by d_w/ density of water 01

(e) (i) Travelling mieroscope 01

(ii) Focus the horizontal cross wire of the travelling microscope to the ring / point p and take the reading.

Then focus the horizontal cross wire of the travelling microscope to the oil and water surface / levels and take corresponding readings. 02

(f) (i) internal diameter of the tube

Exteranl diameter of the tube 01

(ii) Using the inner Jaws of the vernier Calliper

Using the outer Jaws of the vernier Calliper 01

(02) (a) $\alpha = \frac{l_1 = l_0}{l_0\, \theta}$ 01

(b) $\frac{1mm}{(l_0)\min} \times 100\% = 0.2\%$ OR $\frac{0.5mm}{(l_0)\min} \times 100 = 0.2$ 01

$(l_o)\min =$ 500 mm $(l_o)\min = 250$ mm

50 cm $= 25$ cm

0.5 m $= 2.5$ m 01

(c) Tube reaches the thermal equilibrium state OR

equilibrium / stable temperature quickly/ with small amount of heat or it will have a small heat capacity.

Tube will heat up uniformly/ tube will achieve the same interanl and external temperatures or beter thermal contact to the inside and outside of the tube. 01

(d) (i) $(X - X_0) = \frac{10}{2}(l_1 - l_0)$

$1\ mm = 5(l_1 - l_0)$

minimum value of $(l_1 - l_0)$ that can be measured using the setup $= 0.2$ mm $= 0.02$ cm $= 2 \times 10^{-4}$m 01

OR $(X - X_0) = 5(l_1 - l_0)$

$0.5\ mm = 5(l_1 - l_0)$

$l_1 - l_0 = 0.1$ mm / 0.01 cm/ 1×10^{-4}m 01

$$\alpha = \frac{(X - X_0)}{5l_0\, \theta} \qquad X - X_0 = 5(l_1 - l_0)$$

$$X - X_0 = 5[\alpha l_0\, \theta]$$ 01

OR $X = 5x\, l_0\, \theta + X_0$

$$X = \frac{ql_0}{P} \times \theta + X_0$$

(e) (i) Gradient of the graph $= 0.1$ mm $^0C^{-1} = 10^{-4}$m $^0C^{-1}$ 01

(ii) $5\alpha l_0 = 10^{-4}$ OR $5\alpha l_0 = 0.1 \text{mm}\ ^\circ C^{-1}$ 01

$$\alpha = \frac{10^{-4}}{5 \times 80 \times 10^{-2}}\ ^\circ C^{-1}$$

$\alpha = 2.5 \times 10^{-5}\ ^\circ C^{-1}$ 01

(f) yes.

low thermal conductivity for the arm ABC is disired because;

Heat absorbed by the ABC arm will be small, OR

Expansion of the ABC Arm will be small negligible.

OR

Temperature rise of the arm ABC will be small,

OR

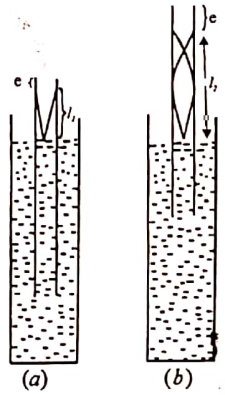
The ratio (p/q) will not be different from the given value.

OR

No additional contribution to the expansion will come from the heated arm 01

(g) looking from above and move until the indicator pears right in top of its own mirror image and take the reading. 01

03.



(a) (i) Correct diagram with the end correction 01

(ii) Correct diagram with the end correction as shown Length above the water level should be approximately three times compared fo the first case.

(iii) Correctly marked the height from the water level to the open end of the tube 01

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

$V = 4\,(l_1 + e)$ 01

$V = f\lambda$

$V = f4(l_1 + e)$

$V = 4f(l_1 + e)$ ——— Ⓐ 01

(ii) $\lambda = \frac{4}{3}\,(l_2 + e)$

$V = \frac{4f}{3}\,(l_2 + e)$ ——— Ⓑ 01

(iii) Ⓐ $\Rightarrow \frac{V}{4f} l_1 + e$ $\Rightarrow \frac{2V}{4f} = l_2 - l_1$

Ⓑ $\Rightarrow \frac{3V}{4f} = l_2 + e$ $V = 2f\,(l_2 - l_1)$ 01

(iv) $V = 2f\,(l_2 - l_1)$

$= 2 \times 512\,(0.509 - 0.169)$

$V = 348.16\ ms^{-1} = 348.2\ ms^{-1}$

Ⓐ $\Rightarrow e = \frac{V}{4f} - l_1$

$e = \frac{348.2}{4 \times 512} - 0.169$

$e = 0.001$ m 01

(c) The length of the tube or the height of the measuring cylinder equired would be too long OR

length of the tube or the measuring cylinder may not be sufficient.

The intensity of sound / loudness would be too low to hear sufficient number of overtones. OR (if would be difficult to hear sufficient number of overtones) 01

04. (a) $I_1 R_1 = I_2 R_3$ } 01

$I_1 R_2 = I_2 R_4$

$\therefore \frac{R_1}{R_2} = \frac{R_3}{R_4}$ 01

(b) To reduce the resistance between the interconnection of items OR

To reduce the contrrbution of connecting wires to be the resistances OR

To reduce errors associated with resistances due to conecting wires 01

(c) Centre - Zero Galvonometer with a Safety resistor 01

(d) Resistance box

Reasons

To obtain read the value of the resistance (R_1) to plot the graph OR

The resistance box will provide the value of resistance

OR

Numerical value of the resistance is needed to plot the graph

OR

Rheostatdoes not provide the value of the resistance (R_1) 01

(e) (i) $\frac{R_1}{R_2} = \frac{l}{1 - l}$ or $\frac{R_1}{R_2} = \frac{l}{100 - l}$ 01

(ii) $\frac{R_2}{R_1} = \frac{1 - l}{l}$ or $\frac{R_2}{R_1} = \frac{100 - l}{l}$

$\frac{R_2}{R_1} = \frac{1}{l} - 1$ $\frac{R_2}{R_1} = \frac{100}{l} - 1$

$\frac{1}{l} = (R_2)\ \frac{1}{R_1} + 1$ or $\frac{1}{l} = \left(\frac{R_2}{100}\right) \frac{1}{R_1} + \frac{1}{100}$ 01

(iii) Form the gradient OR gradient x 100

(f) If small l value are selected.

1. Fractional / percentage error due to end correction will be large.
2. Fractional / percentage error due to l measurment will be large.
3. Galvonometer is more sensitive when the readings are taken at the middle (or 30 cm - 70 cm) 02

PART - B

05. (a) (i) Change in momentum of the air molecule perpendicular fo the wing = 2 mv sin θ 01

(ii) Vertical force generated by the collisions

$= 2mv \sin\theta \times \cos\theta \times N$ 01

(b) (i) Mass of molecules hitting the wing in one second = Avd 01

(ii) Number of molecules hitting the wing in one second,

$N = \frac{Avd}{m}$ $[Nm = Avd]$ 01

(iii) Total vertical force on both wings due to collisions of air molecules on the wings,

$F_c = 2mv \sin\theta \cos\theta \times \frac{Avd}{m} \times 2$

$F_c = 4Adv^2 \sin\theta \cos\theta$ 01

(iv) If A = 25m², d = 1.2 kgm⁻³, cosθ = 1 sinθ = 0.2

$F_c = 4 \times 25 \times 1.2 \times V^2 \times 0.2 \times 1$

$F_c = 24V^2$

(c) (i) Bernullis eq; $P + \frac{1}{2}\rho v^2 + \rho gh = \text{Constant}$ 01

OR $P + \frac{1}{2}\rho v^2 = \text{Constant}$ 01

$P_1 + \frac{1}{2} d \left(\frac{7v}{6}\right)^2 = P_2 + \frac{1}{2} d \left(\frac{5v}{6}\right)^2$

$P_2 - P_1 = \frac{1}{2} d \left(\frac{49v^2}{36} - \frac{25v^2}{36}\right)$ 01

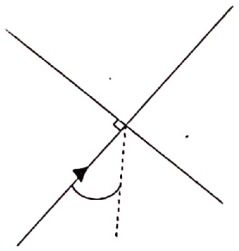
$= \frac{1}{2} \times d \times \frac{24V^2}{36}$

$= \frac{1}{2} \times d \times \frac{2V^2}{3}$

$P_2 - P_1 = \frac{dv^2}{3} = \frac{1.2V^2}{3}$

$P_2 - P_1 = \frac{2}{5}V^2$ 01

(ii) Total vertical force on both wings due to Bernulli's effect;



$\frac{F}{A} = P_2 - P_1$

$F = A\left(P_2 - P_1\right)$

$= A \frac{2V^2}{5}$

$F = 2 \times \frac{120}{5} \times 2 \times V^2$

$F_b = 2 \times \frac{120}{5} \times 2 \times V^2 \times \text{Cos } 10^0$

$F_b = 96V^2$ 01

(d) Total vertical force on the airplane;

$F_b + F_c = 96V^2 + 24V^2$

$= 120\ V^2$ 01

$F_b + F_c = mg$

$120\ V^2 = 4.32 \times 10^5$

$V^2 = \frac{4.32 \times 10^5}{120}$

$V^2 = 3600$

$V = 60\ ms^{-1}$ 01

(e) Initial velasity , U = O Final velocity = 60 ms^{-1}

$a = 0.9\ ms^{-2}$

$V^2 = U^2 + 2as$

$60^2 = 0 + 2 \times 0.9 \times 5$ 01

$S = \frac{3600}{1.8}$ m $\qquad S = 2000m$

Required minimum length of the runway = 2 km

(f) Pilots take off airplanes by accelerating in the direction against the wing in order to have a higher value of v OR to achive a higher lift

OR

Airplane can take off at a lower speed relative to the earth. 01

06. (a) (i) $n_1 \sin i = n_2 \sin r$

$1.5 \text{ Sin } C = 1.44$ 01

$\text{Sin } C = \frac{1.44}{1.5} = 0.96$

$C = 74^0$ 01

(ii) Angle of refraction of the first surface (r)

$r = 90^0 - C$ 01

$r = 90 - 74$

$r = 16^0$

$\text{Sin } \theta = 1.5 \times \text{Sin } r \text{ (sin } 16^0\text{)}$ 01

$\text{Sin } \theta = 1.5 \times 0.28 = 0.42$

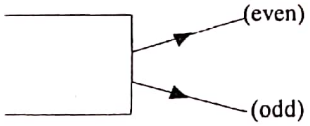
$\theta = 25^0$ 01

(iii) Range of θ : 0 to 25^0 or $O < \theta \leq 25^0$

$-25^0 \leq \theta \leq 25^0$ 01

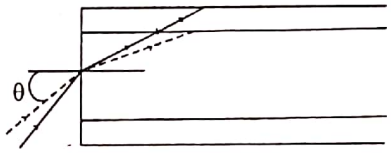
(iv) Advantages : - No interfences from external electromagnetic waves/ imterferences from external noises could be avoided OR Bandwidth is large OR low transmission loss OR Less heat dissipation OR No cross-talk 01

(v)



01 01

(vi)



01

(b) Speed of the blue light in the fibre $= \frac{3 \times 10^8}{1.53}$

OR

Speed of the Red light in the fibre $= \frac{3 \times 10^8}{1.48}$ 01

Time taken by the blue light $= \frac{3 \times 10^3}{\frac{3 \times 10^8}{1.53}}$

$t_b = \frac{3 \times 10^3}{3 \times 10^8} \times 1.53$

OR

Time taken by the red light $(t_R) = \frac{3 \times 10^3 \times 1.48}{3 \times 10^8}$

Time difference $t = t_b - t_R$

$t = \frac{3 \times 10^3}{3 \times 10^8}(1.53 - 1.48)$

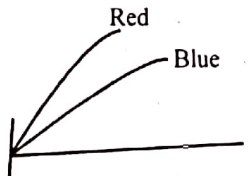
$t = 10^{-5} \times 0.05\ S$

$t = 5 \times 10^{-7} S\ (0.5\mu s)$ 01

(c) - (i)

01

(ii)



01

Speeds / refractive indices / Wavelengths of blue and red rays are diffrent inside the fibre

07. (a) (i) Presure differece $= \Delta P = \frac{8\eta l}{\pi r^4} Q$ 01

(ii) Give that $r = 2 \times 10^{-4}$m $\quad l = 3 \times 10^{-2}$m

$Q = 1.5 \times 10^{-7}\ m^3 s^{-1}$

$\Delta P = \frac{8 \times 2 \times 10^{-3} \times 3 \times 10^{-2}}{3x\left(2 \times 10^{-4}\right)^4} \times 1.5 \times 10^{-7}$ 01

$\Delta P = 1.5 \times 10^4$ Pa

∴ Value of h required to maintain this pressure diffrence is given by

$hdg = \Delta p$ (For equaling Δp to hpg)

$h \times 1.2 \times 10^3 \times 10 = 1.5 \times 10^4$

$h = 1.25$ m 01

(iii) If the pressure at the free end of the needle is increased by an amount $3 \times 10^3 Nm^{-2}$ over and above the atmospheric pressure, the height of the saline coloumn must be increased by an amount h' Where

$$h'dg = 3 \times 10^3 \quad 01$$

$$h' = \frac{3 \times 10^3}{1.2 \times 10^3 \times 10}$$

$$h' = 0.25 \text{ m} \quad 01$$

(iv) If the corresponding change in flow rate is ΔQ for a change in height of Δh, then.

$$(\Delta h)\, dg = \frac{8\eta l}{\pi r^4} \times \Delta Q$$

$$(\Delta h)\, dg = \frac{8 \times 2 \times 10^{-3} \times 10^{-2} \times \Delta Q}{3 \times \left(2 \times 10^{-4}\right)^4}$$

$$(\Delta h)dg = 10^{11}\, \Delta Q$$

$$\Delta Q = \frac{(\Delta h)dg}{10^{11}}$$

$$\Delta Q = \frac{20 \times 10^{-2} \times 1.2 \times 10^3 \times 10}{10^{11}} \quad 01$$

$$\Delta Q = 2.4 \times 10^{-8}\ m^3 S^{-1} \quad 01$$

OR Minimum volume flow rate Qmin which occurs when the bottle is almost empty

$h = (1.5E - 0.2)m = 1.3$m

$$1.3 \times 1.2 \times 10^3 \times 10 - 3 \times 10^3 = \frac{8 \times 2 \times 10^{-3} \times 3 \times 10^{-3}}{3 \times (2 \times 10^{-4})^4} \times Q_{min} \quad 01$$

$$Q_{min} = 1.26 \times 10^{-7}\ m^3\ S^{-1}$$

∴ Change in flowrate $= 1.5 \times 10^{-7} - 1.26 \times 10^{-7}$

$= 2.4 \times 10^{-8}\ m^3 S^{-1}$ 01

(v) maximum flow rate (when the bottle is full) $= 1.5 \times 10^{-7}\ m^3 S^{-1}$

minimum flow rate (when the bottle is emty)

$= (1.5 \times 10^{-7} - 2.4 \times 10^{-8})\ m^3 S^{-1}$

$= 1.26 \times 10^{-7}\ m^3 S^{-1}$

$$\text{Average flow rate} = \frac{(1.5 + 1.26)}{2} \times 10^{-7}$$

$$= 1.38 \times 10^{-7} m^3 S^{-1} \quad 01$$

(vi) Time required to infuse $1104 cm^3$ of saline

$$t = \frac{1104 \times 10^{-6}}{1.38 \times 10^{-7}} \text{ S}$$

$t = 8000$ S 01

(b) (i) If V is the speed of the piston with which it must be moved in order to maintain a volume flow rate of $1.5 \times 10^{-7}\ m^3 S^{-1}$. then [Q = AV]

V_x cross sectional area of the syringe $= 1.5 \times 10^{-7}$

$$V = \frac{1.5 \times 10^{-7}}{12 \times 10^{-4}}$$

$$V = 1.25 \times 10^{-4} ms^{-1} \quad 01$$

(ii) Required Pressure to maintain the given flow rate

[P = hρg]

$= 1.5 \times 1.2 \times 10^3 \times 10 = 1.8 \times 10^4\ Nm^{-2}$

∴ Force exerted by the piston on the saline solution,

$F = PA$

$F = 1.8 \times 10^4 \times 12 \times 10^{-4}$ 01

$F = 21.6$ N 01

(iii) Power $= F \times v$

$= 21.6 \times 1.25 \times 10^{-4}$

$= 2.7 \times 10^{-3}$W $= 2.7$mW 01

OR

Power $= P\ V$

$= 1.8 \times 10^4 \times 1.5 \times 10^{-7}$

power $= 2.7 \times 10^{-3}$ W

$= 2.7$ W

08. (a) Nucleus, Coma and Tails (All three)

(b)

	Ion tail	Dust tail
(i)	Straight	Slightly curved
(ii)	Bule Colour	White colour
(iii)	Mostly ione	Mostly dust
(iv)	Always directed away from the sun	Behind the comet 01

(c) $$F = \frac{GMm}{r^2}$$

$$F = \frac{6.7 \times 10^{-11} \times 2 \times 10^{30} \times 2 \times 10^{14}}{\left(5 \times 10^{12}\right)^2} \quad 01$$

$$F = 1.07 \times 10^9\ W \quad 01$$

(d) Apply $I_1\ \omega_1 = I_2\ \omega_2$ (Consevation of angular momontum)

$$mr_1^2 \frac{V_1}{r_1} = mr_2^2 \frac{V_2}{r_2} \qquad [mr_1v_1 = mr_2\ v_2]$$

$8.0 \times 10^{10} \times V = 5 \times 10^{12} \times 12.0 \times 10^3$

$V = 7.5 \times 10^5\ ms^{-1}$ OR $V = 7.5 \times 10^2\ kms^{-1}$ 01

(e) The debris left along the path of a comet enters the earth's atmosphere and burn out due to heat being genarated through friction, emitting light. 01

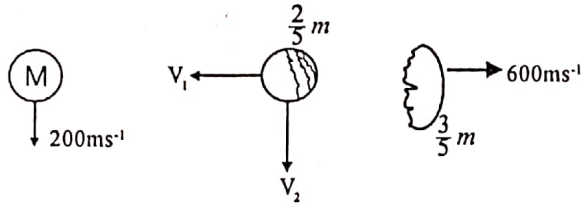
(f) Meteorltes - Metorids which burn out partially and the remains fall into the earth surface

Meteors - Meterids which burnt out completely in the atmosphere emitting light. 01

(g) linear (translational) and rotational kinetic energies.

(h) Fireballs are produced when the atoms surrounding the meteoroid ionize and rapidly recombine with the electrons, emitting light 01

(i)



Applying consevation of linear momentum,

$\rightarrow \odot = \frac{3M}{5} \times 600 - \frac{2M}{5} \times V_1$

$V_1 = 900\ ms^{-1}$

$\downarrow V_2 \times \frac{2M}{5} = 200\ M$

$V_2 = 500\ ms^{-1}$

$V = \sqrt{V_1^2 + V_2^2}$

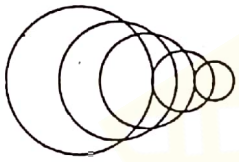
$V = \sqrt{900^2 + 500^2}$

$V = \sqrt{106} \times 10^2\ ms^{-1} = 1030\ ms^{-1}$ (1020 - 1040) 01

(j) Speed of the piece > the speed of saund. 01

[Mac Number > 1]

(k)



Correct diagram with the envelope (two lines) 01

The cone procluced by the envelope of spherical wave fronts is the shock wave OR labeling the envelope of the wave front as the shockwave. 01

09. (A) (a) $I = \frac{E}{R_0 + R_L}$ 01

(b) $E = V_0$ 01

$I_s = E/R_0$ 01

$\therefore R_0 = \frac{V_0}{I_s}$ 01

Ohms (e) and Kirchhoff's lows are apply to the eircuit,

$I = \frac{V_L}{R_L}$

$\therefore E = IR_0 + IR_L$ 01

(c) Applying $V = IR$

$V_L = IR_L$

$V_L = \left(\frac{E}{R_0 + R_L}\right) R_L$ 01

$R_L = 1 \times 10^3$ and $V_L = 75\ mV$

$75 = \times 10^{-3} = \frac{1 \times 10^3 E}{R_0 + 1 \times 10^3}$ 01

$75 \times 10^{-3} R_0 + 75 = 1 \times 10^3 E$

$E = 75 \times 10^{-6} R_0 + 75 \times 10^{-3}$ (A)

$R_L = 100 \times 10^3 \Omega$ and $V_L = 5V$

$5 = \frac{100 \times 10^3 E}{R_0 + 100 \times 10^3}$ 01

$5R_0 + 5 \times 10^5 = 100 \times 10^3 E$

$E = 5 \times 10^5 R_0 + 5$ (B)

(A) = (B) $75 \times 10^{-6} R_0 + 75 \times 10^{-3} = 75 \times 10^{-5} R_0 + 5$

$25 \times 10^{-6} R_0 = 4.925$

$R_0 = 0.197 \times 10^6\ \Omega$

$R_0 = 197\ k\Omega$ 02 (02 or 00)

(B) $\Rightarrow E = 5 \times 10^{-5} \times 197 \times 10^3 + 5$

$= 985 \times 10^{-2} + 5$

$E = 14.85\ V$ 02 (02 or 00)

(d) (i) Considering the eq $I = \frac{E}{R_0 + R_L}$ when $R_0 >>> R_C$

$\therefore I \approx E/R_0$ OR $I = E/R_0$ 01

OR Answer in words followed by a correct argument.

(ii)

01

(e) The nearly horizontal flat region of the output characteristic is similar to the above curve. 01

(the one corresponding to the active region)

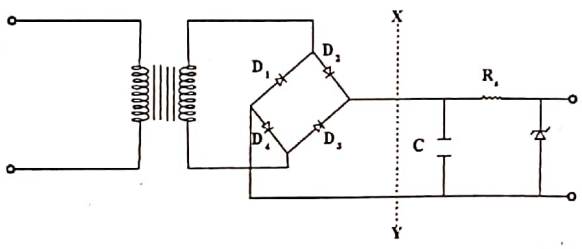
The above curre is produecd by a circuit baving a large internal resistance (R_0), **there fore** the internal resistance of the transistor is also large. OR

The qradient of the above curve is very small implying that the associated resistance $\left(\frac{\Delta V_L}{\Delta I}\right)$ is vey large.

Therefore the resistance, of the transistor is very large.

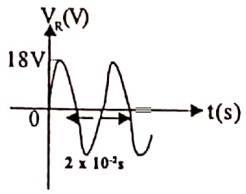
any one 01

(B)

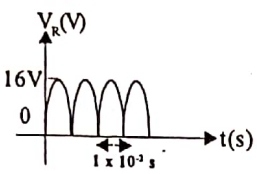


For correctdiagram up to the line xy from left 01

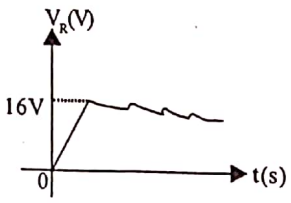
(b) (i)



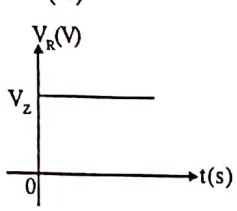
(ii)



(iii)



(iv)



01 mark each for the shapes and labeling of axes of above graphs 04

18V and 16V mark at least one graphs 01

Respective periods of the wave forms 2×10^{-2} S and 1×10^{-2} S 01

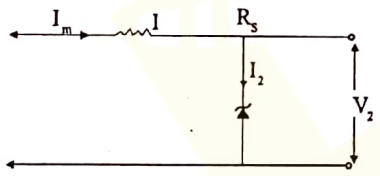
(ii) Smoothing capacitor connection shown in the diagram 01

(iii) Zenor diode connection shown in the diagram 01

(c) (i) The dc component bigger OR the voltage smoother OR A large capacitance will make ripple voltage smaller OR ripple factor smaller OR make the output more dc 01

(ii) Maximum reverse - bias voltage across a diode is 17 V 01

(d)

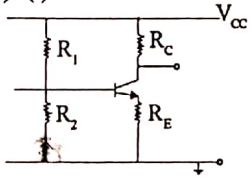


$\frac{16 - 10}{R_S} = 200 \times 10^{-3}$ OR $\frac{16 - 10}{R_S} \leq 200 \times 10^{-3}$

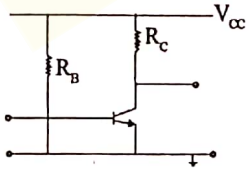
$R_S = \frac{6}{200 \times 10^{-3}}$ $R_S \geq 30\ \Omega$ 01

$R_S = 30\Omega$ 01

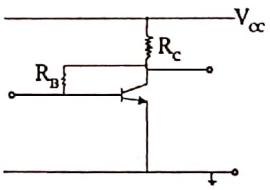
(e) (i)



OR



OR



Correct circuits 01

(ii) Base voltage would vary according to the ripple voltage. This will appear as a signal variation at the base and produce an amplified (inverted) signal at the collector. 01

10. (A) $PV = nRT$ OR $PV = \left(\frac{m}{M}\right)RT$ 01

$\rho = \left(\frac{m}{v}\right)\frac{RT}{M}$

$\rho = \frac{\rho RT}{M}$

$\rho = \frac{PM}{RT}$ 01

(a) (i) $\rho_A = \frac{10^5 \times 30\ 10^{-3}}{8.31 \times 300} = \frac{0.12 \times 10^5 \times 30 \times 10^{-3}}{300}$

$\rho_A = 1.2\ \text{kgm}^{-3}$ 01

(ii) $\rho_B = \frac{1.5 \times 10^5 \times 30 \times 10^{-3}}{8.31 \times 337.5} = \frac{0.12 \times 1.5 \times 10^5 \times 30 \times 10^{-3}}{337.5}$

$\rho_B = 1.6\ \text{Kgm}^{-3}$ 01

(iii) $\rho_C = \frac{1.5 \times 10^5 \times 30 \times 10^{-3}}{8.31 \times 300} = \frac{0.12 \times 1.5 \times 10^5 \times 30 \times 10^{-3}}{300}$

$= 1.8\ \text{kgm}^{-3}$ 01

(b) (i) $V_1 = \frac{1.2}{1.6}$ OR $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$;

$\frac{1.0 \times 10^5 \times 1}{300} = \frac{1.5 \times 10^5 \times V_1}{337.5}$

$V_1 = 0.75\ \text{m}^3$ 01

(ii) $V_2 = \frac{1.2}{1.8}$ OR $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{1.0 \times 10^5 \times 1}{300} = \frac{1.5 \times 10^5 \times V_2}{300}$

$V_2 = 0.67\text{m}^3$ 01

(c) (i) Work done from A to B $= \frac{-1}{2} \times 0.25 \times (1 + 1.5) \times 10^5$

$= -31250\text{J}\ (3.125 \times 10^4\text{J})$

(ii) For an adiabatic process $\Delta Q = 0$ 01

$\Delta Q = \Delta U + \Delta w$

$\odot = \Delta U + \Delta w$

$\therefore\ \Delta u = -\Delta w$ 01

Change in internal energy from A to B = 31250J 01

(d) (i) Workdone form B to C $= -1.5 \times 10^5 \times 0.08$

$= -12000\text{J}\ (1.2 \times 10^4\text{J})$

(ii) Since temperature at C is equal to the temperature at A, the internal energy of the air of C is same as that at A. Therfore the internal energy gained during the process from A to B has to be lost during the process from B to C

$\therefore$ Applying $\Delta Q = \Delta U + \Delta w$

$\Delta U = \Delta Q - \Delta w$

$-31250 = \Delta Q - (-12000)$ 01

$\Delta Q = -43250\text{J}\ (4.325 \times 10^4 J)$ 01

(e) Increase in efficienct $= \frac{(1.8 - 1.2)}{1.2} \times 100\%$

$= 50\ \%$

10. (B) (a) (i) $\frac{hc}{\lambda} - \phi = K_{max}$ 01

(ii) When $\lambda = \lambda 0$, $K_{max} = 0$ 01

$\phi = \frac{hc}{\lambda_0}$ 01

(b) (i) $\lambda_1 = 430$ nm $(430 \times 10^{-9} m)$ 01

$\lambda_2 = 660$ nm $(660 \times 10^{-9} m)$ 01

(ii) 430 nm OR λ_1 OR shorter wavelength 01

(c) (i) $\phi_1 = \frac{1290}{430}$ OR $\phi_1 = \frac{1290 \times 1.6 \times 10^{-19} J \text{ nm}}{430 nm}$

$\phi_1 = 3eV$ $\phi_1 = 4.8 \times 10^{-19}$ J 01

$\phi_2 = \frac{1290}{660}$ OR $\phi_2 = \frac{1290 \times 1.6 \times 10^{-19}}{660}$

$\phi_2 = 1.96$ ev $\phi_2 = 3.13 \times 10^{-19} J$ 01

$(1.95 - 1.96)$ $(3.12 - 3.12)$

(d) (i) Rate of energy incident on unit surface area due to λ_1

$= \frac{1200}{100} \times 0.1$

$= 1.2\ Wm^{-2}$ 01

(ii)(1) Rate of energy incident on chlorophgll molecules $= 1.2 \times 4 \times 10^{-4}$

$= 4.8 \times 10^{-4} W$ 01

(2) Number of photons incident per second

$= \frac{4.8 \times 10^{-4}}{3 \times 1.6 \times 10^{-19}}$ 01

$= 10^{15}$ Photons S^{-1} 01

(iii) Number of chlorophyll molecules excited Per Second $= \frac{10^{15}}{10^{14}}$

$= 10$ molecules S^{-1}

01

(iv) time taken to make on glucase molecule $= 6/10$

$= 0.6$ S

01