G.C.E. (Advanced Level) Examination - August 2012
PHYSICS - I
Two hours

Important :
- This question paper includes **60** questions in **6** pages.
- Enter 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 **60**, pick one of the alternatives (1), (2), (3), (4), (5) which is **correct or most appropriate** and mark your response on the answer sheet **in accordance with the instructions given therein.**

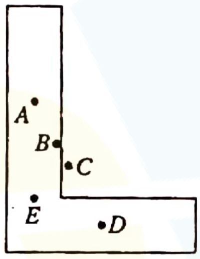
Use of calculators is not allowed.

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

01. Which of the following **does not** represent a fundamental unit in the SI system?
(1) m (2) N (3) kg (4) s (5) K

02. If the distance between two masses is doubled the gravitational force between them will decrease by a factor of
(1) 2 (2) 4 (3) 6 (4) 8 (5) 12

03. Figure shows a thin uniform L - shaped metal sheet. The centre of gravity of the sheet is most likely to be found at the point
(1) A (2) B (3) C
(4) D (5) E



04. The minimum amount of work that has to be done in order to fix a light elastic string of initial length l_0 between two parallel walls separated by a distance d ($d > l_0$) with a tension T is
(1) $\frac{1}{2}T(d - l_0)$ (2) $\frac{Td}{l_0}$
(3) $T(d - l_0)$ (4) $\frac{1}{2}\frac{T}{(d - l_0)}$
(5) $\frac{1}{2}\frac{(d - l_0)^2}{T}$

05. A vessel contains an ideal gas at 27 °C. If the temperature of the gas is increased to 127 °C. the ratio.
$\frac{\text{mean kinetic energy of the gas atoms at 127°C}}{\text{mean kinetic energy of the gas atoms at 27°C}}$ will become
(1) $\frac{127}{27}$ (2) $\frac{16}{9}$
(3) $\frac{4}{3}$ (4) $\frac{3}{4}$
(5) $\frac{27}{127}$

06. The mass of body A is twice that of body *B*. The specific heat capacity of the material of body *A* is three times that of body *B* They are supplied with equal amounts of heat. If the body *A* experiences a temperature change of ΔT, then body B will experience a temperature change of
(1) $\frac{\Delta T}{2}$ (2) $\frac{2}{3}\Delta T$ (3) ΔT
(4) $\frac{3}{2}\Delta T$ (5) $6\Delta T$

07. Consider the following statements made about laser light.
(A) The energy of a photon in a laser beam of certain frequency is higher than the energy of a photon of the same frequency in a normal light beam.
(B) A laser beam cannot be refracted by a glass prism
(C) All the photons in a laser beam have the same energy. the same phase. and the same direction
Of the above statements.
(1) only (B) is true
(2) only (C) is true
(3) only (A) and (B) are true
(4) only (B) and (C) are true
(5) all (A). (B) and (C) are true

08. A noisy workplace has a noise level of 90 dB This was reduced to a less uncomfortable level of 70 dB
The ratio $\frac{\text{new intensity of the noise}}{\text{old intensity of the noise}}$ is equal to
(1) 0.9 (2) 0.5 (3) 0.1
(4) 0.01 (5) 0.001

09. A monochromatic ray of light is incident on a glass prism and suffers minimum deviation while going through the prism. The emergent ray most likely will go through the point
(1) A (2) B (3) C (4) D (5) E

10. Which of the following statements made about electric field lines is false?
(1) Electric field lines can be either straight or curved.
(2) Electric field lines can be parallel to one another.
(3) Electric field lines can form closed loops.
(4) Electric field lines begin on positive charges and end on negative charges
(5) Electric field lines can never intersect with one another

11. A spherical Gaussian surface surrounds a point charge q. The following changes were made to the system.
(1) (A) (2) (A) and (B)
(3) (C) and (D) (4) (A). (B) and (D)
(5) all (A). (B). (C) and (D)

12. An ideal transformer operates at V_p 12.0 ac on the primary side and supplies electricity to a number of nearby houses at $V_s = 240V$, ac. The turns ratio,

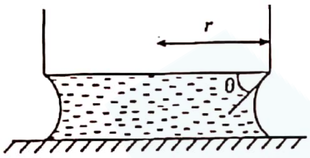
$$\frac{\text{number of turns in the primary}}{\text{number of turns in the secondary}}$$ of the trans former is

(1) 0.02 (2) 0.2 (3) 25
(4) 50 (5) 100

13. Two copper wires have the same volume, but wire 2 is 20% longer than wire 1. The ratio, $\frac{\text{resistance of the wire 2}}{\text{resistance of the wire 1}}$ is

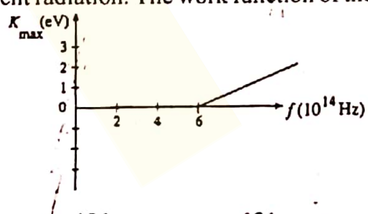
(1) 0.83 (2) 0.91 (3) 1.11
(4) 1.20 (5) 1.44

14. A water layer exists between the bottom of a cylindrical bottle and a glass plate as shown in the figure. The radius of the bottom of the bottle is r. When the bottle is raised slowly, at one instant the contact angle between water and the bottom of the bottle becomes θ. (see figure)
The magnitude of the force on the bottom of the bottle at that instant due to surface tension T of water, is
(1) $2\pi rT\sin\theta$
(2) $2\pi rT\cos\theta$
(3) $\pi r^2 T\sin\theta$
(4) $\pi r^2 T\cos\theta$
(5) $4\pi rT\sin\theta$



15. Which of the following is not true regarding the rate at which a body emits radiant energy?
(1) It is proportional to the surface area of the body.
(2) If is proportional to the 4th power of the absolute temperure of the body.
(3) It is proportional to the emissivity of the surface of the body.
(4) It depends on the temperature of the surrounding.
(5) It **does not** depend on the thermal capacity of the body.

16. The graph shows the variation of the maximum kinetic energy (K_{max}) of emitted photo-electrons from a metal, with the frequency (f) of the incident radiation. The work function of the metal is
(1) 6.0eV
(2) 4.0eV
(3) 2.5eV
(4) 2.0eV
(5) 1.0eV



17. A radioactive isotope of iodine, $^{131}_{53}I$ decays to $^{131}_{54}Xe$. What type of particle is emitted in this decay?
(1) α (2) β^- (3) β^+ (4) p (5) n

18. Consider the following statements made about the information that can be obtained from dimensional analysis.
(A) Numerical values of constants of proportionality that may appear in a physical equation can be determined by dimensional analysis.
(B) Numerical signs of constants of proportionality that may appear in a phyear in a physical equation can be determined by dimensional analysis.
(C) The units of constants of proportionality that may appear in a physical equation can be determined by dimensional analysis

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

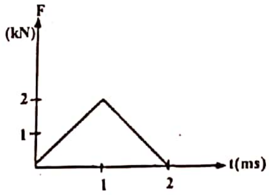
19. Equal masses of three liquids of densities d_1, d_2 and d_3 are added together. If the liquids mix together without causing any chang, then the density of the composite liquid will be

(1) $\frac{d_1 + d_2 + d_3}{3}$ (2) $\frac{d_1 d_2 d_3}{3}$

(3) $\frac{3d_1 d_2 d_3}{d_1 d_2 + d_2 d_3 + d_3 d_1}$ (4) $\frac{d_1 d_2 + d_2 d_3 + d_3 d_1}{3}$

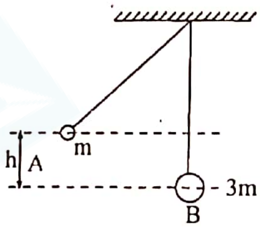
(5) $\frac{d_1 d_2 d_3}{d_1 d_2 + d_2 d_3 + d_3 d_1}$

20. A ball of mass 0.5 kg which is initally at rest, is struck by a bat. The variation of the force (F) on the ball with time (t) is shown in the figure. The speed of the ball when it leaves the bat is



(1) $10ms^{-1}$ (2) $8ms^{-1}$ (3) $6ms^{-1}$
(4) $4ms^{-1}$ (5) $2ms^{-1}$

21. Two small spheres A and B of putty of mass m and $3m$ respectively are suspended from a ceiling by means of strings of equal length. Sphere A is drawn aside so that it is raised to a height h as shown, and then released. Sphere A collides with sphere B which is at rest, and they stick together. The maximum height to which the composite body swings is



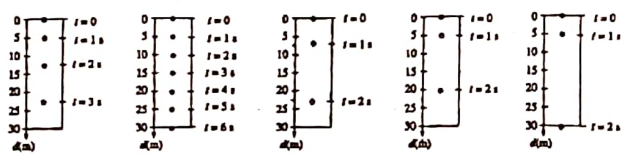
(1) $\frac{1}{16}h$ (2) $\frac{1}{8}h$ (3) $\frac{1}{4}h$ (4) $\frac{1}{3}h$ (5) $\frac{1}{2}h$

22. A car of mass m manoeuvres a circular bend of radius of curvature r in a horizontal flat road with a speed υ. If the car skids then (μ is the coefficient of friction between the road and a tyre).

(1) $\upsilon > \sqrt{\mu rg}$ (2) $\upsilon < \sqrt{\frac{\mu rg}{4}}$ (3) $\upsilon > \sqrt{\frac{\mu rg}{m}}$

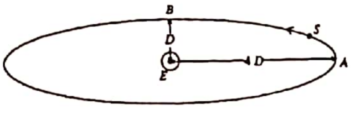
(4) $\upsilon < \sqrt{\mu rmg}$ (5) $\upsilon < \sqrt{\frac{\mu mg}{r}}$

23. Photographs of an object that starts falling freely from rest at $t = 0$ are taken by a camera, first at $t = 0$, and thereafter at the end of each second. Which of the following diagrams correctly indicates the location of the object at the end of each second? The vertical axes of the diagrams represent the distance (d) travelled by the object.



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

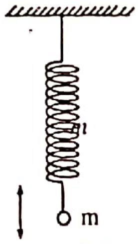
24. A satellite (S) moves in an elliptical orbit about the earth (E). If the speed of the satellite at point A is υ, then its speed at point B will be



(1) $\frac{\upsilon}{8}$ (2) $\frac{\upsilon}{4}$ (3) υ

(4) 2υ (5) 4υ

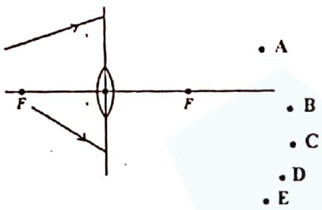
25. Consider the following statements made about a particle of mass m attached to a light spring and performing simple harmonic motion as shown in the figure.



(A) The acceleration of the particle is always towards the centre of motion.
(B) The force on the particle is proportional to the square of the displacement from the centre.
(C) The period of oscillation depends on the mass of the particle.

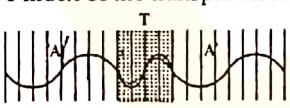
Of the above statements,
(1) only (A) is true. (2) only (C) is true.
(3) only (A) and (B) are true. (4) only (A) and (C) are true.
(5) all (A), (B) and (C) are true.

26. Consider two rays moving towards a thin converging lens as shown in the figure. After passing through the lens, the two rays are most likely to be met at the point



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

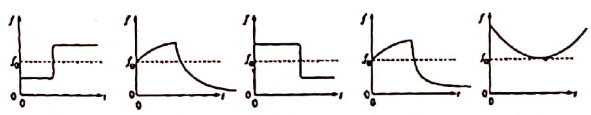
27. Figure shows the changes occurred to a waveform of a monochromatic ray of light travelling in air (A) when incident normally and transmitted through a transparent medium (T). The refractive index of the transparent medium is



(1) 1.5 (2) 2.0 (3) 2.5 (4) 3.0 (5) 3.5

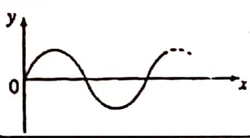
28. The human vocal tract (larynx) can be considered as a tube that is open at one end. If the length of this tube is 17 cm, the frequencies of the lowest two harmonics produced are given by (the speed of sound in air = 340 ms^{-1})
(1) 500 Hz, 1500Hz (2) 500 Hz, 1000Hz
(3) 1000 Hz, 2000 Hz (4) 1000 Hz, 3000 Hz
(5) 1500 Hz, 2500 Hz

29. A train travelling at a constant velocity while continuously sounding its horn with a frequency f_0 moves towards an observer standing on a platform and then moves away from him. The variation of the frequency (f) of the horn as heard by the observer with time (t) is best representes by



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

30. The graph shows the variation of a quantity y with another quantity x. Consider the following statements.



(A) If the graph reperesents a wave travelling in a stretched string, along the x direction, y could be the displacement of a particle of the string in a direction perpendicular to the motion of the wave, at a given instant.
(B) If the graph represents a wave travelling in water x could be the time and y could be the time and y could be the displacemen of a water molecule along the direction of the wave.
(C) If the graph represents a vibration of a tuning fork, x could be the time and y could be the velocity of the tip of one prong of the fork.

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

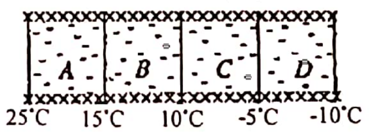
31. A planet is observed by an astronomical telescope in normal adjustment, having an objective of focal length 14m and an eyepiece of focal length 2cm. Consider the following statements.
(A) The distance between the objective and the eye piece is 1402 cm.
(B) Angular magnification of the planet is 700
(C) The image of the planet is formed at the near point of the observer.

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

32. Consider a process where air is quickly leaking out of a balloon. which of the following is true for this process?

	ΔQ	ΔW	ΔU
(1)	+	+	+
(2)	-	-	-
(3)	0	0	0
(4)	0	-	-
(5)	0	+	-

33. The figure indicates the face and interface temperatures of a lagged composite slab consisting of four materials A, B, C and D of identical thickness and surface area through which the heat transfer is steady. If k_A, k_B, k_C and k_D are the thermal conductivities of materials A, B, C and D respectively then

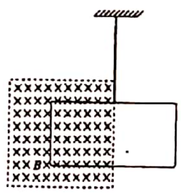


(1) $k_A > k_B > k_C > k_D$ (2) $k_A < k_B < k_C < k_D$
(3) $k_B = k_D > k_A > k_C$ (4) $k_B = k_D < k_A < k_C$
(5) $k_B = k_D = k_A > k_C$

34. Consider the following statements made about the capability of a given thermometer to produce an accurate value for a temperature measurement.
(A) In situations where quick changes of temperature with time have to be measured, the given thermometer must be a one having large variation of the thermometric property with temperature.
(B) Thermal capacity of the thremometer must be negligible when compared to the thermal capacity of the environment of which the temperature is measured.
(C) Thermometric property must have a linear variation with the temperature.

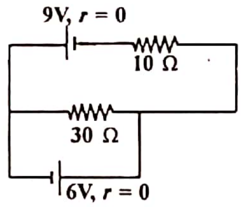
Of the above statemenst
(1) only (B) is true (2) only (A) and (B) are true
(3) only (B) and (C) are true (4) only (A) and (C) are true
(5) all (A), (B) and (C) are true.

35. A light, conducting loop is suspended freely, and a half of the loop is inserted into a magnetic field as shown in the figure. If the magnetic field begins to increase repidly in strength,



(1) the loop begins to move in the direction of the magnetic field.
(2) the loop begins to move against the direction of the magnetic field.
(3) the loop begins to move (to the left) into the field.
(4) the loop begins to move (to the right) out of the field.
(5) the loop does not move at all

36. Current through the 10Ω resistor is



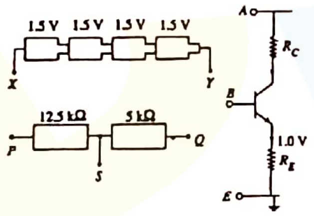
(1) 0
(2) 1.5A
(3) 3.0A
(4) 5.0 A
(5) 6.0A

37. A metal wire has resistances R_1 and R_2 at temperatures θ_1 and θ_2 respectively. The temperature coeffietient of resisitivity of the metal, is given by

(1) $\dfrac{(\theta_1 - \theta_2)}{(R_1 - R_2)}$ (2) $\dfrac{(R_1 - R_2)}{(\theta_1 - \theta_2)}$ (3) $\dfrac{(R_1 - R_2)}{(\theta_1 - \theta_2)(R_1 + R_2)}$

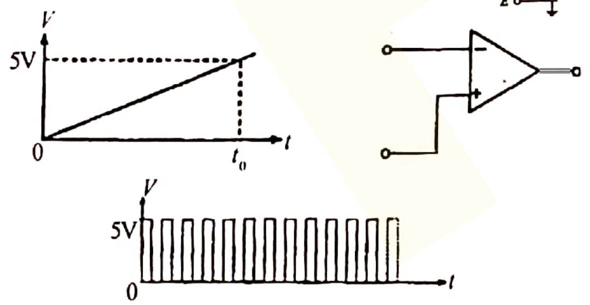
(4) $\dfrac{(R_1 - R_2)}{(R_2\theta_1 - R_1\theta_2)}$ (5) $\dfrac{(R_2\theta_1 - R_1\theta_2)}{(R_1 - R_2)}$

38. Which of the following connections will have to be made in order to operate the transistor (Si) circuit give in the figure as a common emitter amplifier?

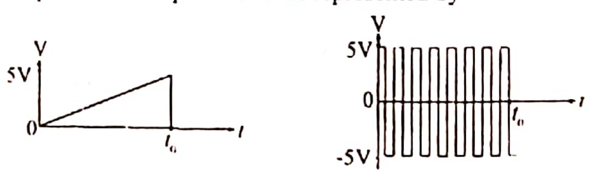


(1) *XE, YB, AP, BQ, SE*
(2) *PA, YE, XP, BS, QE*
(3) *SB, YA, AQ, BQ, SE*
(4) *XE, YB, AQ, BP, SA*
(5) *YA, XE, AP, BS, QE*

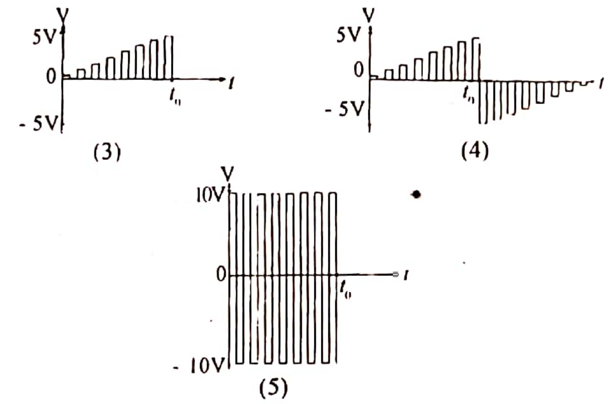
39.



The inverting input of a 741 operational amplifier operating with ±10V power supply voltages is provided with a voltage signal which increases linearly with time (t) as shown in the figure.
The non-inverting input is provided with a rectangular voltage waveform of amplitude 5V as shown. The output waveform of the operational amplifier is best represented by

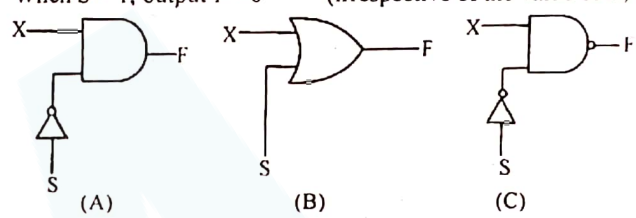


(1) (2)



(3) (4) (5)

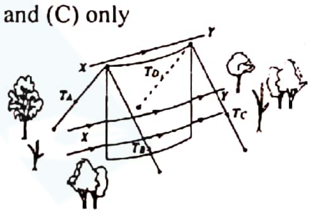
40. Which of the logic circuits shown will operate in the following manner?
When S = 0, output $F = X$ (value of X can be either 1 or 0)
When S = 1, output F =0 (irrespective of the value of X)



(A) (B) (C)

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

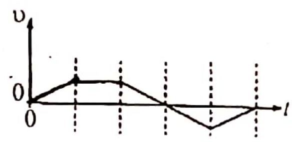
41. A large metal sheet **bent into the shape** shown in the figure is kept upright on the ground by means of four stretched ropes fixed to the ground.

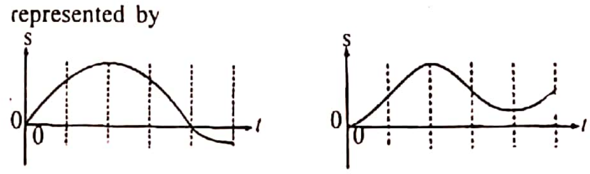


Magnitudes of the tensions in all ropes, T_A, T_B, T_C and T_D in still air are equal. When wind blows through the sheet in the direction XY

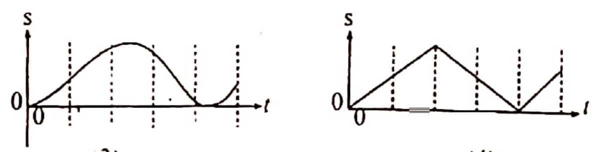
(1) $T_A < T_B$ and $T_D < T_C$ (2) $T_A > T_B$ and $T_D > T_C$
(3) $T_A = T_B$ and $T_C = T_D$ (4) $T_A > T_B$ and $T_C > T_D$
(5) $T_A < T_B$ and $T_C < T_D$

42. The variation of the velocity (υ) with time (t) of a particle is shown in the figure. The corresponding displacement (s) - time (t) curve is best represented by

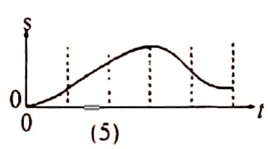




(1) (2)



(3) (4)



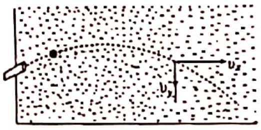
(5)

43. A grain of sand is stuck to a tyre of a vehicle at a distance r from its centre. The radius of the tyre is R. When the tyre is rotating at an angular speed of ω, the sand grain detaches suddenly from the tyre. If the air resistance is neglected, the **horizontal component** of the velocity of the grain **relative to the vehicle** immediately after detachment could have a value between

(1) 0 and $(R - r)\omega$ (2) 0 and $(r + R)\omega$
(3) 0 and $r\omega$ (4) $-r\omega$ and $r\omega$
(5) $(R = r)$ and $(r + R)\omega$

44. A lead ball of radius a is fired from a toy gun in water in a large swimming pool as shown in the figure. The densities of water and lead are ρ_w and ρ_{pb} respectively and the viscosity of water is η.

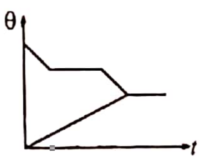
If the x and y components of the velocity of the ball at a certain instant are υ_x and υ_y respectively then the magnitudes of the corresponding acceleration components at that instant would be



	x (horizontal)	y (vertical)
(1)	$\dfrac{9\eta\upsilon_x}{2a^2\rho_{pb}}$	$\left(1 - \dfrac{\rho_w}{\rho_{pb}}\right) g - \dfrac{9\eta\upsilon_y}{2a^2\rho_{pb}}$
(2)	0	$\left(1 - \dfrac{\rho_w}{\rho_{pb}}\right) g - \dfrac{9\eta\upsilon_y}{2a^2\rho_{pb}}$
(3)	$\dfrac{9\eta\upsilon_x}{2a^2\rho_{pb}}$	$\left(1 - \dfrac{\rho_w}{\rho_{pb}}\right) g$
(4)	$\dfrac{9\eta\upsilon_x}{2a^2\rho_{pb}}$	g
(5)	0	$\left(1 - \dfrac{\rho_w}{\rho_{pb}}\right) g$

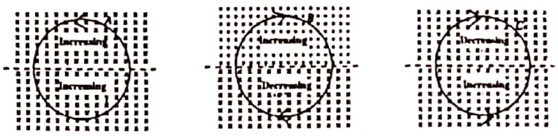
45. Water is found to condense on the outer surface of a cooled glass bottle of soft drink when kept in the atmosphere.
The **total** amount of water condensed before it reaches the atmospheric temperature will **not** depend on
(1) initial temperature of the cooled bottle of soft drink.
(2) thermal capacity of the bottle of soft drink.
(3) rate of increase of temperature of the bottle of soft drink.
(4) dew point of the atmosphere.
(5) the thermal conductivity of glass

46. Small amounts of water and ice of identical masses are placed in a thermally insulated container and allowed to come to thermal equilibrium. The variations of the temperature (θ) of water and ice are recorded with time (t) and are shown in the same graph.



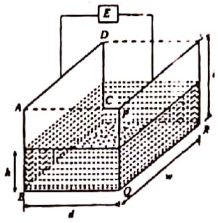
Which of the following conclusions can be drawn about the behaveiour of water and ice from the given graph?
(1) Water has fully frozen and on ice has melted.
(2) Water has partly frozen and on ice has melted.
(3) Water has partly frozen and ice has fully melted
(4) Water has fully frozen and ice has fully melted.
(5) Water has fully frozen and ice has partly melted.

47.



Three identical wire loops A, B and C are placed in uniform magnetic fields as shown in figures. Magnetic fields are either increasing or decreasing in magnitude at the same rate. If i_1, i_2 and i_3 are the magnitudes of the induced currents in loops A, B and C respectively then
(1) $i_1 > i_2 > i_3$ (2) $i_1 < i_2 < i_3$ (3) $i_1 = i_2 = i_3$
(4) $i_1 = i_2$; $i_3 = 0$ (5) $i_1 = i_2 = i_3 = 0$

48. A fuel ganuge in a vehicle uses a parallel plate capacitor made of two rectangular metal plates to determine the height of the fuel level in the tank. Each of the metal plates ($ABCD$ and $PQRS$) has a width w and a height l. The height of the fuel level between the plates is h.



(see figure) Appropriate electronic circuity E determines the effective capacitance of the combined air and fuel capacitors. The effective capacitance of this system is given by (k = dielectric constant of fuel)

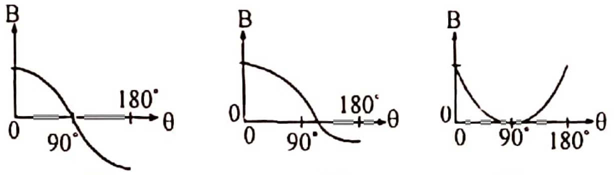
(1) $\dfrac{w\varepsilon_0}{d}\left[l + h(k-1)\right]$ (2) $\dfrac{(l - h)kh\varepsilon_0 w}{d\left[l + h(k-1)\right]}$

(3) $\dfrac{w\varepsilon_0}{2d}\left[l + h(k-1)\right]$ (4) $\dfrac{(l-h)kh\varepsilon_0 w}{2d\left[l + h(k-1)\right]}$

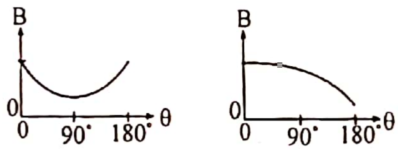
(5) $\dfrac{k\varepsilon_0 lw}{d}$

49.

A current carrying wire loop in figure (1) lies in plane of the paper and consists of two concentric semicircles of radii $2R$ and R and two radial lengths. The smaller smicircle is bent out of the plane gradually until the loop is flipped over and lies entirely on the same plane as shown in figure (2). An intermediate situation of the system when the loop is bent through an angle θ is shown in figure (3). The variation of the component of the magnetic flux density (B) directed into the page at the center (O) of the loop with angle θ is best represented by

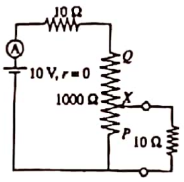


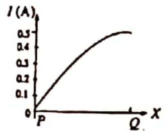
(1) (2) (3)



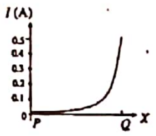
(4) (5)

50. In the circuit shown PQ is a variable resistor of 1000 Ω, and the resistance between the terminals P and X varies linearly as terminal X moves from P to Q. As the terminal X moves from p to Q the variation of the ammeter reading (I) is best represented by

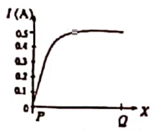




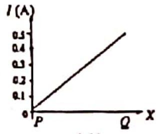
(1)



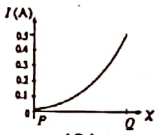
(2)



(3)



(4)



(5)

G.C.E. (Advanced Level) Examination - August 2012
PHYSICS - II
Three hours

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

01. A student has decided to measure the density of a stone with a smooth surface but having an irregular shape, at home using the following items.

A rectangular container

A 30 cm ruler (foor ruler) with mm scale

Assume that he has access to the following items too.

A household glass measuring cylinder capable of measuring liquid volumes upto nearest 5ml.

Electronic balance at a nearby retail shop.

(a) He started the experiment by determining the volume of the container using the 30 cm ruler.

(i) What are the measurements he has to take?

(1) .... (say x_1)

(2) .... (say x_2)

(3) .... (say x_3)

(ii) When an ordinary 30cm ruler (foot ruler) is used to take the above three measurements one measurements may be less accurate,

What is that measurement ? ....

What is the reason for that ? ....

....

(b) He washed the stone thoroughly, dried it, and kept it inside the container as shown in figure (1). Then he filled the remaining volume of the container upto the brim with a measured amount of water using the measuring cylinder.

figure (1)

Let the volume of water measured and added to the cylinder be V.

(i) Write down an expression for the volume of the stone (V_0) in terms of V, x_1, x_2, and x_3

V_0 = ...

(ii) If he has the option to choose a container with the same volume but having a narrow brim as shown in figure (2), explain as to why it is advantageous to select such a container?

....

....

figure (2)

(c) (i) What is the other measurement that he should take in order to determine the density of the stone?

.... (say P)

(ii) Hence write down an expression for the density (d_0) of the stone in terms of the symbols defined above.

d_0 = ...

(d) Suppose you want to estimate the mass of a huge rock that is situated on a flat land as shown in figure (3), using the knowledge that you have gained from the above experiment.

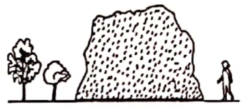


figure (3)

Assume that you have ability and provisions to construct wooden boxes of any known volume, or wooden structures of known size, and access to sufficient quantity of fine sand instead of water.

(i) Write kind of measuring device can be constructed to measure the volume of sand using the materials given under (d) above?

....

....

....

(ii) What kind of meusuring device can be constructed to measure the volume of sand using the materials given under (d) above?

....

(iii) What is the other physical quantity that is needed to estimate the mass of the rock?

....

(iv) Suggest a method to measure the quantity mentioned in (*d*) (iii) above.

....

....

02. You are asked to perform an experiment to verify that the value of the specific latent heat of fusion of ice is 3.3 x 10^5 J kg^{-1} using the method of mixtures.

Some of the items given to you are listed below.

(1) a copper calorimeter

(2) A beaker containing water heated to 45 °C

(3) A block of ice

(a) Prepare a list of other items needed to perform this experiment.

....

....

(b) When performing this experiment, what steps would you take to minimize the heat absorbed from the surroundings?

....

....

....

(c) If the room temperature is 30°C and the dew point of the atmosphere is 25°C what values would you suggest for

(i) initial temperature of water : ....

(ii) minimum temperaturwe of water : ....

Give reasons.

....

....

(d) List all the experimental measurements that you would take before adding ice.

....

....

....

(e) What procedures would you follow when preparing ice, adding it, and mixing with water?

Preparing : ....

Adding : ....

Mixing : ....

(f) Write down the rest of the experimental measurements that you would take after adding ice.

....

....

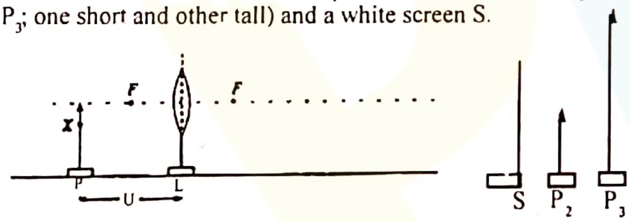
(g) In this experiment the measurements that are used to determine the mass of ice have to be taken more carfully and accurately. Explain why.

....

....

....

03. You are asked to verify the lens formula by plotting a suitable graph, and to determine the focal length of a convex lens. A partly assembled set-up that can be used for this purpose is shown in the following diagram. U is the object distance. You are provided with an object pin P_1, lens L, locating pins (P_2 and P_3; one short and other tall) and a white screen S.



(a) Considering two light rays coming from point X marked on P_1, draw a suitable ray diagram to locate the image of the object pin P_1.

(b) (i) Draw the screen S at an appropriate place in the abve diagram.

(ii) What is the purpose of keeping S at the place where you have drawn it?

....

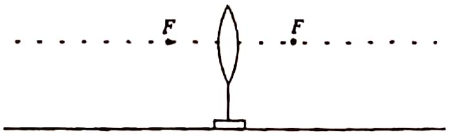
....

(c) (i) To determine the image distance (V) of the objcet pin P_1, the locating pin P_2 has to be used and you have to place your eye at a suitable position. Label this poition as E in the above diagram.

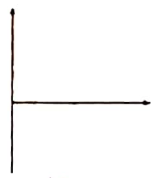
(ii) How do you make sure that the image of P_1 coincided with P_2?

....

(d) Suppose you want to take a few readings with virtual images too. Draw the object pin and the locatng pin at appropriate places for taking such a reading and label them as P_1, P_2, or P_3 in the following diagram (positioning them at exact locations is not necessary).



(e) (i) Draw a graph that you would expect to obtain on the following grid. Your graph must contain data points for real images as well as virtual images. Label the axes.



(ii) What is the expected gradient of the graph?

....

(iii) How do you determine the focal length of the lens from the graph?

....

(f) A student says that in the case of real images when one pair of U and V values are obtained, two data points could be plotted, on the graph. Would you agree with this? Give reasons for your answer

....

....

04. Figure (1) shows an incomplete diagram of a potentiometer arrangement used for measuring the internal resistance of a cell.

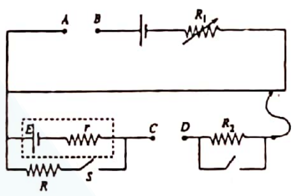
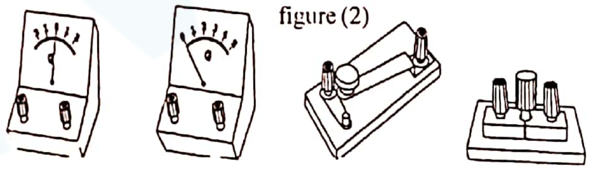


figure (1)

(a) In addition to the items corresponding to the symbols shown in figure (1), if you are provided with the items shown in figure (2) to preform this experiment.

figure (2)



Item (1) Item (2) Item (3) Item (4)

(i) Which item would you connect between AB? ....

(ii) Which item would you connect between CD? ....

(b) In this experiment, after the apparatus is setup properly. two balance lengths must be taken. What are they?

(i) ....

(ii) ....

(c) If the balance lengths taken by a student were 90cm and 80cm. calculate r. (The value of R was 5Ω during these measurements)

....

....

....

....

....

(d) For maximum accuracy, the potentiometer must be adjusted so as to give largest possible values for the balance lengths.

(i) Which of the two balance lengths mentioned in (b) above must be used for this adjustment?

Give reasons for your answer.

....

....

(ii) With what item do you perform this adjustment?

....

(e) If an R value much larger than 5 Ω, is used in the circuit when taking measurements under (b) above, would you expect a more accurate or less accurate value for r? Give reasons for your answer

....

....

....

(d) For maximum accuracy, the potentiometer must be adjusted so as to give largest possible values for the balance lengths.

(i) Which of the two balance lengths mentioned in (b) above must be used for this adjustment?

Give reasons for your answer.

....

....

(ii) With what item do you perform this adjustment?

....

(e) If an R value much larger than $5\,\Omega$ is used in the circuit when taking measurements under (b) above, would you expect a more accurate or less accurate value for r? Give reasons for your answer.

....

....

....

PART B

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

05. In this question, you will investigate a few basic movements of a robotic arm shown in figure (1).

The arm segments A and B of the robot have the ability to rotate in either direction around joints 1 and 2 in horizontal planes.

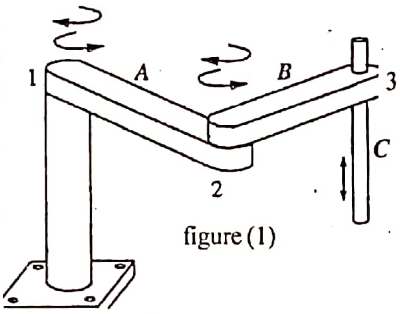


figure (1)

Joint 3 allows segment C to move up and down. All three joints are operated by electric motors. Assume that only one movement around or across a joint is allowed at a given time and that there is no friction in any of the joints.

(a) First consider an upward motion of segment C. This motion is described by the velocity (υ) - time (t) graph in figure (2). Mass of segment C is 0.1 kg.

(i) calculate the acceleration of segment C during the first 2 seconds.

figure (2)

(ii) The force acting on C are its weight, and the force applied by the motor for the motion of C. Calculate the force applied by the motor during the first 2 seconds.

(iii) What are the magnitude and direction of the force applied by the motor on C during the last 2 seconds of motion?

(iv) Suppose the magnitude of the maximum force the motor can exert on C is 1.2 N. If starting from rest, C moves up under this maximum force for 0.5s. how far will it move?

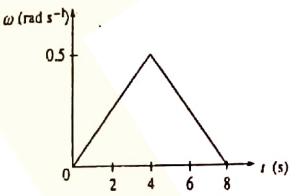


figure (3)

(b) Next consider a rotation of segment B (together with segment C) occuring around joint 2. The angular velocity (ω) - time (t) graph in figure (3) shows this rotation. Assume that segment A is held fixed during this rotational motion.

The moment of inertia of the combined system of segments B and C around the axis of joint 2 is $0.01 kg\ m^2$.

(i) Calculate the torque applied by the motor on B during the first 4 seconds of motion shown in figure (3).

(ii) Calculate the angular displacement of B during the 8 s period shown in figure (3).

(iii) If the magnitude of the maximum torque that can be applied by the motor is 0.002 N m, what is the minimum time that will take for B to start from rest and come to rest again after an angular displacement of 3.2 radians?

(c) Now if segment A is allowed to rotate freely around joint 1, what would be the direction of rotation of segment A, when segment B, starting from rest, rotates clockwise around joint 2? Give reasons for your answer.

06. Read the following passage and answer the questions given below.

The Doppler effect for sound waves depends on three velocities, namely the velocities of sound, the source, and the observer with respect to the air. Normally air is considered to be stationary relative to the ground and therefore these velocities can be measured relative to the ground.

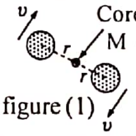
However, this is not the situation with regard to light waves. Light as well as other electromagnetic waves require on medium, and they are capable of travelling even through a vacuum. The Doppler effect for light waves depends on two velocities, namely the velocity of light (c) and the relative velocity (υ) between the source and the observer, as measured from the reference frame of either source or the observer.

If a certain light source is at rest relative to us, we would detect light from it with the same frequency (f_0) as that of the source, and it is known as the proper frequency. If it is moving away form us with a speed υ ($\upsilon \ll c$), then the light we detect has a frequency f that is shifted from f_0 due to the Doppler effect and f is given by the following formula.

$$f = f_0(1 - \beta) \quad \text{where } \beta = \frac{\upsilon}{c}$$

However, measurements involving light are usually made in wavelengths rather than frequencies, and the above formula can be rewritten in terms of wavelengths in the following from.

$$\upsilon = \frac{\Delta\lambda}{\lambda_0}c \quad \text{where } \Delta\lambda = \lambda - \lambda_0$$



Core of M 87

The quantity $\Delta\lambda$ is called the Doppler shift. figure (1)

If the light source is moving away from us, is longer than 0 is positive, and the Doppler shift is called a red shift. If the light source moving toward us, then λ is shorter than λ_0, $\Delta\lambda$ is negative, and the Doppler shift is called a blue shift

Using astronomical observations of stars, galaxies and other sources of light, scientists can determine how fast the sources are moving, either directly away from us or directly towards us by measuring the Doppler shift of the light that reaches us.

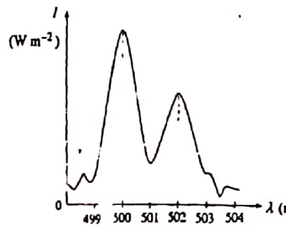


figure (2)

Two regions of interstellar gas orbiting the core of a galaxy known as M87 at a radius $r = 100$ light years is shown in figure (1). One region is moving towards us with a speed and the other region is moving away from us with the same speed. Figure (2) shows the variation of intensity (I) with wavelength (λ) of light reaching us from those two regions.

The gas is under the influence of the gravitational force due to the mass M of the core of the galaxy. This mass of the core is about two billion times the mass of our sun, strongly suggesting that a super massive black hole occupies the core.

(a) (i) Doppler effect for sound waves depends on three velocities. Name them

(ii) These velocities are normally measured relative to the ground. What is the reason for this?

(b) Why does the Doppler effect for light depends only on two velocities?

(c) Starting from $f = f_0(1 - \beta)$, derive the relationship $\upsilon = \frac{\Delta\lambda}{\lambda_0}c$
[Hint : When $\beta \ll 1$, $\frac{1}{1-\beta} = 1 + \beta$]

(d) (i) From figure (2), determine the values of two wavelengths at which the intensities are peaked.

(ii) Which peak corresponds to the gas moving towards us?

(iii) If the gas were not moving relative to the core, what is the wavelength λ_0 (proper wavelength) of the light that would be detected by us?

(iv) What is the Doppler shift ($\Delta\lambda$) of the light from the gas moving away from us?

(v) Hence determine the speed υ of the gas. Round off your answer to the nearest integer ($c = 3.0 \times 10^8\ ms^{-1}$).

(vi) Is $\beta \ll 1$? justify your answer.

(e) (i) Determine the mass M of the core of the galaxy. ($G = 6.0 \times 10^{-11}\ Nm^2\ kg^{-2}$)

(ii) What is believed to be occupying the core of the galaxy?

07. Figure (1) shows the stress-strain curve for a uniform steel rod. Identify the points A, B and C

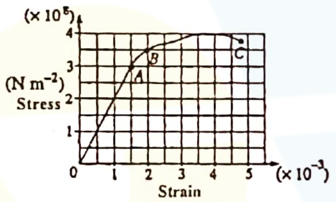


Figure (1)

An underground storage (S) of length 150m, and width 6m is to be constructed at a depth of 20 m from the ground level. Figure (2) shows the side view and figure (3) shows the front view of the storage. The weight of the soil existing above the roof of the storage is to be supported entirely by 30cm x 30cm square steel columns (C). The soild has a uniform density of $3.0 \times 10^3 kg\ m^{-3}$.

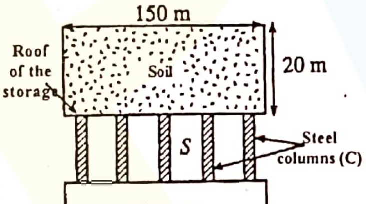


Figure (2)

(a) (i) Calculate the total weight of the soil that the columns must support.

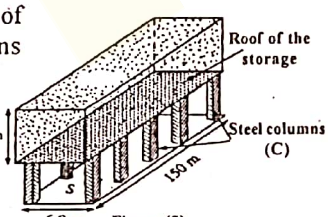


Figure (3)

(ii) What is the number of columns needed to keep the compressive stress on each column at $2 \times 10^8\ Nm^{-2}$?

Assume that the weight of the soil is equally distributed among the columns. Neglect the mass of the roofing material.

(b) (i) Determine the Young's modulus of steel from the curve given in figure (1) above.

(ii) If the height of a steel column is 4.995m what was its original uncompressed height?

(c) If the columns have a circular cross-section of radius 15cm instead of the square cross- section of 30 cm x 30cm mentioned above, does the number of columns calculated in a (a) (ii) above would be less, same or more? Give reasons for your answer.

08. Two metal plates A and B kept parallel to each other in a vacuum are connected to a voltage source as shown in figure (1). A molecular ion of mass m and charge +q, starting from rest from the plate A accelerates towards the metal plate B under the influence of the voltage V maintained between the plates.

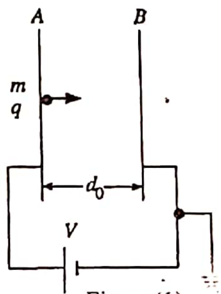


Figure (1)

(a) (i) Write down an expression for the kinetic energy gained by the ion when it reaches the plate B.

(ii) Derive an expression for velocity acquired by the ion when it reaches the plate B.

(iii) If d_0 is the distance between the plates derive an expression for the time (t) taken by the molecular ion to reach the plate B.

(b) Suppose the metal plate B is now replaced with a metal wire mesh so that the ions moving through the region AB could enter a field free region and move towards an ion detector D placed at a distance S from the wire mesh B as shown in figure (2).

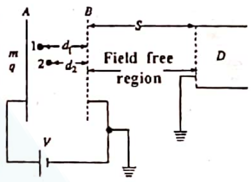


figure (2)

Consider two molecular ions 1 and 2 of mass m and charge $+q$ suddenly being formed at time $t = 0$ at distances d_1 and d_2 from the wire mesh B as shown in figure (2). If they start from rest and move towards B under the electric field.

(i) derive expressions for times t_1 and t_2 taken by the ions 1 and 2 to reach the mesh B, and indicate which ion reaches the mesh first.

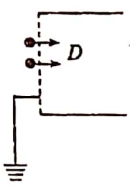


figure (3)

(ii) derive expressions for velocities υ_1 and υ_2 of ions 1 and 2 when they reach the mesh B. Indicate which ion has the higher velocity when they reach B.

(iii) Derive an expression in terms of t_1, t_2, υ_1 and υ_2 for the suitable value for the distance S at which the detector D has to be placed so that it detects both ions 1 and 2 at the **same time** as shown in figure (3)

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

(A) (a) Figure (1) shows a circuit powered by a 12V battery with negligible interanl resistance. The two bulbs A and B are rated at 3V, 0.1A and 12V, 2A respectively.

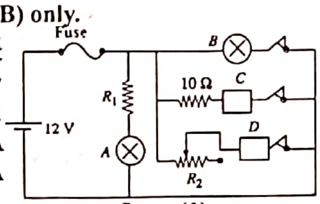


figure (1)

C and D are two devices having internal resistance 6Ω each.

(i) Calculate the value of resistor R_1 that would provide the rated voltage to buld A.

(ii) Calculate the voltage across C and the power dissipated in the 10 Ω resistor.

(iii) In order to be able to limit the current I ... ugh D between 0.5A and 2A, what should be the value of the variable resistor R_2?

(iv) Suppose three fuses with current ratings 4A, 5A and 10A are given. In order to make it opssible to operate all devices simultaneously, under the above conditions, which fuse would be most suitable to be connected to this circuit?

(b) Electrical circuits such as the one above are constructed by mounting electrical components on insulated boards, and joining the terminals of the components by copper wires. In modern circuits, however, such connections are made by thin copper strips printed on insulated boards.

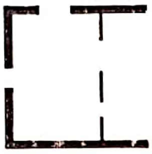


figure (2)

A part of a printed circuit board is shown in figure (2), and an enlarged diagram of one copper strip is shown in figure (3)

For all calculations below, take the thickness of copper strip, h, as 0.3 mm.

(i) Calculate the resistance of a 10mm long copper strip of width

w = 1 mm. (Resistivity of copper is $1.8 \times 10^{-8}\ \Omega$m)

(ii) Calculate the voltage across this strip and its power dissipation, when a current of 0.1 A passes through it.

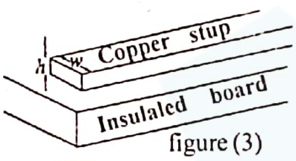


figure (3)

(iii) If all the heat dissipated in one second is accumlated in the strip without being lost to the environment, what will be its increase in temperature? (Specific heat capacity and density of copper are 400 J kg^{-1} K^{-1} and 9×10^3 kgm^3 respectively.)

(iv) Copper strips carrying large currents are normally made wider than those carrying small currents. Give two reasons for this.

B) (a) Write down the truth table for a 2-input AND gate. Use symbols A and B for inputs and F for output.

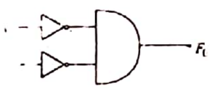


Figure (1)

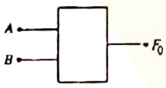


Figure (2)

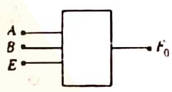


Figure (3)

(b) The block diagram of the circuit shown in figure (1) is given in figure (2)

(i) Write down the truth table for the circuit shown in figure (1)

(ii) Hence, show that the circuit shown in figure (1) operates as follows

F_0 = 1 only when A = 0 and B = 0

and F_0 = 0 otherwise.

(c) Suppose now you use a 3-input AND gate in the circuit shown in figure (1) above instead of a 2-input AND gate. Let the third input be E. Then the block diagram will take the form shown in figure (3)

(i) Draw the circuit diagram corresponding to the block diagram in figure (3).

(ii) By filing the two truth tables shown, show that the circuit will operate similar to the circuit given in figure (1) when $E = 1$, and the output F_0 = 0 when $E = 0$ irrespective of the values of A and B.

A	B	E	F_0
0	0	1	
0	1	1	
1	0	1	
1	1	1	

A	B	E	F_0
0	0	0	
0	1	0	
1	0	0	
1	1	0	

(d) Now draw a circuit diagram using a 3-input AND gate and one NOT gate to operate as follows.

The output $F_1 = 1$ only when $A = 0$, $B = 1$ and $E = 1$

$F_1 = 0$ when $E = 0$

(e) Similarly draw two separate circuits using 3-input AND gates and NOT gates, to operate as follows.

(i) Output $F_2 = 1$ only when A = 1 and B = 0 and E = 1

$F_2 = 0$ when E = 0

(ii) Output $F_3 = 1$ only when A = 1 and B = 1 and E = 1

$F_3 = 0$ when E = 0

(f) Now combine all four **circuits** drawn under (c) (ii), (d), (e) (i) and (e) (ii) and draw a single circuit so that it will have only 3 common inputs A, B and E four outputs F_0, F_1, F_2 and F_3.

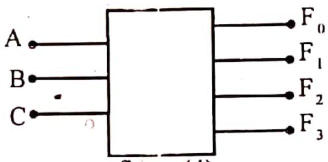


figure (4)

The circuit that you have drawn should conform with the block diagram given in figure (4)

(g) Suppose you are given four devices, an electric fan, an electric heater, an electric kettle and an electric motor which can be switched ON and OFF with logic signals 1 or 0 respectively.

(i) Draw a block diagram to show how you would connect the devices shown in figure (5) to the block diagram given in figure (4) so that any one of them can be selected and operated, one at a time.

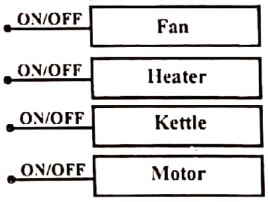


figure (5)

Write down the combination of appropriate lagic signals that you would apply to the inputs A and B to select each device.

(ii) How would you keep all the devices in ono operative condition using logic signals?

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

(A) (a) Consider a pond of cross section 2m x 2m, and containing pure water constantly being exposed to direct sunlinght. (see figure 1) The amount of solar heat radiation falling on the pond is 1000W m^{-2} and assume that it is constant for the calculations below.

Furthermore assume that solar heat is incident normal to the water surface at all times, no heat transfer occurs between water and the walls of the pond and that on **heat is absorbed by water directly from sunlight.** All the heat is absorbed by a blackened metal sheet placed at the bottom of the pond and then transferred to water near the bottom by conduction

(i) If the amount of heat absorbed by the metal sheet over a 7 minute period entirely contributed to raise the temperature of a thin layer of water of mass 40kg just above the metal sheet, how much will be the temperature rise in water? (Take specific heat capacity of water as 4200J $kg^{-1} K^{-1}$)

(ii) Let densities of water at 0 °C and at θ°C be ρ_0 and ρ_θ respectively. Obtain an expression for ρ_θ in terms of ρ_0, θ and the volume expansivity of water γ.

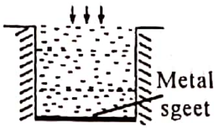


figure (1)

(iii) Explain why convection currents will occur when water is heated as mentioned in (a) (i) above.

(b) A solar pond is a pond used to collect and store solar energy as heat. Solar heat reaching the bottom of such a pond is trapped by suppressing convection currents.

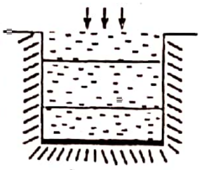


figure (2)

A very simple model of a solar pond with a 2m x 2m area is shown in figure (2). It has three distinct layers. The top layer has relatively pure water. The bottom layer has a very high salt concentration resulting a high density. The density is uniform throughout that layer. In the middle layer, the salt concentration and densit decreases gradually with height.

For the following parts, assume that the initial temperature of water throughout the pond is 30 °C.

(i) In a practical solar pond, the temperature of the bottom layer can reach about 90 °C. If the mass of water in this layer is 6000 kg and if it receives heat radiation at the constant rate of 1000 W m^{-2}, how long will water take to reach 90 °C? Assume that this heat is entirely used to increase the temperature of water, and that salt water has the same specific heat capacity as pure water.

(ii) Taking ρ_0 = 1554 kg m^{-3} for salt water, calculate the density of salt water at 90 °C. (Volume expansivity of salt water is 4 x 10^{-4} K^{-1})

(iii) If the top layer remains at 30 °C, can there be convection currents from the bottom to the top layer under the above condition? Justify your answer. (Take density of pure water at 30 °C as 1000kg m^{-3}.)

(iv) (1) When the temperature of the bottom layer increase from 30 °C to 90 °C, calculate the amount of heat stored in that layer.

(2) Suggest a method to use this energy for a practical purpose.

(v) In a practical solar pond, heat loss through the walls must be minimised. If a styrofoam layer of thickness 10 cm is used as an insulation between water and walls of the pond, and if the temperature of the walls stays at 40 °C while water is at 90 °C, what will be the rate of heat loss per m^2 through styrofoam? (Heat conductivity of styrofoam is 0.01 $Wm^{-1} K^{-1}$.)

(B) In 1924 Louis de Broglie proposed that a particle having a linear momentum p can be described by a matter wave known as a de Broglie wave.

(a) (i) Write down an expression for the de Broglie wavelength (λ), in terms of the Planck copstant h and p.

(ii) For a particle of mass m and kinetic energy E, rewrite the above expression in terms of h, m and E.

(b) A vessel is filled with helium gas at temperature T and atmospheric pressure of 10^5 Pa.

(i) Write down an expression for the mean kinetic energy E of helium atoms in terms of the Boltzmann constant k and T.

(ii) Using the expression derived in (a) (ii) above write down an expression for the mean de Broglie wavelength λ of helium atoms in terms in terms of h, k, T and mass m of a helium atom.

(iii) Calculate λ at T = 27 °C. (The numerical values of the constants are given at the end of the question.)

[Take $\sqrt{8.4} = 3$]

(iv) If a is the mean distance between helium atoms, by taking the total volume of helium gas to be Na^3, where N is the number of helium atoms present in the vessel, determine a. Consider helium to be an ideal gas.

[Take $\sqrt[3]{60} = 4$].

(v) Can the helium atoms be treated as particles under these conditions? Give reasons for your answer.

(vi) If the volume of the gas could be decreased without changing its pressure by cooling in down, at a certain temperature T' the mean de Broglie wavelength of helium atoms can be made equal to the mean distance between helium atoms. Derive an expression for T', in terms of h, m and k.

(Planck constant h = 6.6 x 10^{-34} Js: Mass of a helium atom m = 6.0 x 10^{-27} kg:

Boltzman constant k = 1.4 x 10^{-23} J K^{-1})

G.C.E. (Advanced Level) Examination - August 2012

PHYSICS - I

Provisional Scheme of Marking

2012 - Answers

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

G.C.E. (Advanced Level) Examination - August 2012

PHYSICS - II

Provisional Scheme of Marking

A - PART

01.(a) (i) length (x_1)
Width OR Breatth (x_2)
Depth OR Height (x_3)

All three correct 01

(ii) Depth OR Height OR X_3 or any other opporpriate variable There is a gap between the zero mark and the edge of ruler OR the zero mark of the rular does not Coincide with its edge.
OR
frictional / Percentage error / error of the height measurement is large. 01

(b) (i) $V_0 = X_1X_2X_3 - V$

(ii) Error OR frictional error in V measurement OR in V_0 is low volume of water occupied above the brin level is less. 01

(c) (i) Mass of the stone OR its weight 01

(ii) $d_0 = \frac{P}{X_1X_2X_3 - V}$ OR $d_0 = \frac{P}{V_0}$

[(P is Mass of the stone, given as the answer

$d_o = P/10\ (X_1X_2X_3 - V)$, $d_o = \frac{P}{10V_0}$ $d_o = P/V_{0}g$]

(d) (i) (1) Consturct a box (OR frame OR rec tangular structure)
enclosing the rock (Astructure drawn on the fig (3) canbe accepted)
(2) Measure its diamensions OR volume.
(3) fill in the remain volume with a measured amount of sand.
(4) Volune of the rock = Volume enclosed by the structre - Volume of sand

(slep 1, 2, 3 -01)

(ii) Construct a small woodern box with known volume 01
(iii) Density of the rock (material) 01
(iv) take a small sample / piece or part of the rock material and do the experiment (a) to find the density of the rock maferial. (OR any other acceptable method ex. upthrust method)

02 (a) Thermometer
Three beam balance / four beam balance / Electronic balance / chemical balance

(b) Start the experiment with water having a temperature higher than the room temperature by a few degrees, (OR 5°C) and add ice until the temperature drops below. the room temperature by the same number of degrees.
01

(c)(i) 34.5 °C OR 34°C (OR 34°C ≤ θ < 35°C)
(ii) 25.5 °0C OR 26°C (Or 25°C < θ < 26°C) 01

reasons
heat absorbed from surroundings = the heat out to surroundings.
OR no net absoption of heat from the surroundings.
OR to avoid the formation of dew.

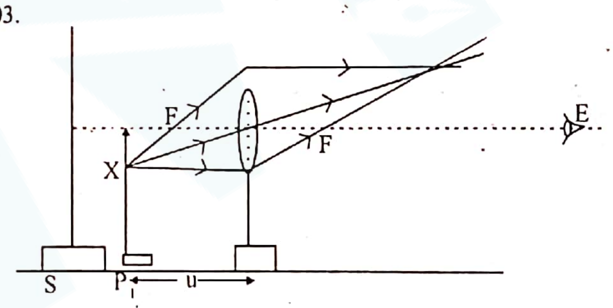
(d) Mass of the empty calorimeter + stirrer
Mass of the calorimeter with stirrer + water
Initial temperture of water. 01

(e) Preparing : Break the ice cube into small pieces and mop (OR dry/ wipe) them with a blotting paper (filter paper) 01
Adding : Add and dissolve one piece at a time 01
Maixing : Mix with a stirrer having a mesh
OR keep the piece of ice under water all time
(Disregard any overlaps between answer) 01

(f) Minimum temperature of water / mixture / system
Mass of the calorimeter and its contents 01

(g) latent heat of ice is large (3.3×10^5 Jkg^{-1}), the amount of ice needed will be small and therefore error (frictional error) associated with the mass measurement of ice is large.

03.



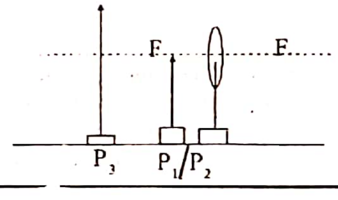
(a) At least any tow rays as drawn above 01
(An arrow should be marked at least on one of the rays)

(b) (i) Screen placed to the left of P_1 as shown. 01
(ii) To obtain a clear view/ To aroid obstructions from other objects / To view the image of P_1 clearly/ To veiw only P_2 and the image of P_1 01

(c) (i) Position of the eye marked (E) / the symbol of eye drawn on the principal axis and of the right of the image of P_1,
OR to right of the position where the two rays intersect.
01

(ii) When the eye is moved there should not be any relative movement between P_2 and the image of P_1.
OR P_2 and the image of P_1 move together. 01

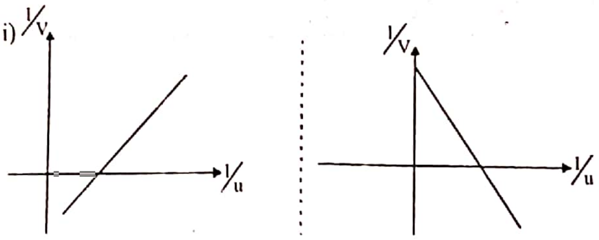
(d)



Placing P_1 (or P_2) and P_3 as shown 01

[P_1 or P_2 placed between F and the optical center. P_3 should be placed to the left of P_1 or P_2)

(e) (i)



(the straight graph as shown ; labling the axies corretly)

(ii) 1 OR (-1) 01

(iii) $1/\text{intercept}$ OR $1/C$

f) Yes.
For real imges u and v values can be interchanged with each other, Due to the principle of reversiblity of light,
OR when a certain V value becomes U, the corresponding U value Become V 01

04.(a) (i) Item 4 01

(ii) Item 1 01

(b) (i) Balance length with S open OR
balance length when current is not flowing from cell E
01

(ii) Balance length with S closed
OR balance length when current is flowing from cell E
01

(c) $E = kl_1$ OR $E \propto l_1$ OR $E \propto 90$ 01

$\frac{ER}{R+r} = kl_2$ OR $\frac{ER}{R+r} \times \alpha\, l_2$ OR $E \propto 80$ 01

[OR $\frac{E}{ER/_{R+r}} = \frac{90}{80}$ - 02]

$$\frac{R+r}{R} = \frac{90}{80}$$

$$1 + r/5 = \frac{90}{80}$$

$$r/5 = \frac{90}{80} - 1$$

$$r/5 = \frac{90-80}{80}$$

$$r = \frac{10}{80} \times 5$$

$$r = 0\ 625\ \Omega$$

(d) (i) The balance length with open
This is the larger balance length 01

(ii) R_1 OR (Variable resistance) 01

(e) A less accurate value
Because the error (frictional error) in the $(l_1 - l_2)$ measurment is large OR the measurments of l_1 and l_2 will be almost the same. OR the measurment of l_1 will be approximately equal to that of l_2 OR the difference between the measurments of l_1 and l_2 will be small. 01

PART - B

05.(a) (i) acceleranion $= \frac{0.1}{2}$

$= 0.05\ ms^{-2}$ 01

(ii) Using $F = ma$ 01

$F - 0.1 \times 10 = 0.1 \times 0.05$ 01

$F = 1.005\ N$ 01

(iii) acceleration $= -0.05\ ms^{-2}$

$\uparrow$ $F - 0.1 \times 10 = -0.1 \times 0.05$

$F = 0.995N$ 01

Direction in upward OR $\uparrow$ 01

(iv) Using $F = ma$

$1.2 - 0.1 \times 10 = 0.1\ a$ 01

$$a = \frac{0.2}{0.1}$$

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

Using $S = Ut + 1/2at^2$

$S = 1/2 \times 2 \times (0.5)^2$

$S = 0.25$ m 01

(b) (i) angular acceleration $(\propto) = \frac{0.5}{4}$ 01

$= 0.125\ rads^{-2}$

$J = I \propto$

$J = 0.01 \times 0.125$

$J = 0.00125Nm$ $(1\ 25 \times 10^{-3}\ Nm)$ 01

(ii) Angle of rotation = Area of graph (fig(3))

$= \frac{1}{2} \times 0.5 \times 8$ OR $(2 \times \frac{1}{2} \times 0.125 \times$

$[2 \times \frac{1}{2} \propto t^2]$

$= 2rad$

(iii) Angular accleration under maximum torque $= J/I$

$\propto_{max} = 0.002\ /\ 0.01$

$= 0.2 rads^{-2}$

To perform the required operation at a minimum time to be rotated at an angular acceleration of 0.2 $rads^{-2}$ during the first half of the time and at a deceleration of 0.2 $rads^{-2}$ during the second half.
(Identification of this as the minimum time) 01

$\Delta\theta = 2 \times \frac{1}{2} \times (t/2)^2$ OR $\Delta\theta = 2 \times \frac{1}{2} \propto t_1^2$

$t_1 = \sqrt{\frac{4\Delta\theta}{\propto}}$ $\quad t_1^2 = \frac{P\theta}{\propto}$

$t = \sqrt{\frac{4 \times 3.2}{0.2}}$ $\quad t_1 = \sqrt{\frac{3.2}{0.2}}$

$t = 8s$ $\quad t_1 = 4s$

$t = 2t_1$

$t = 8s$

(c) The arm A will rotate anti clock wise.
This is due to conservation of angular momentum 01

06\. (a) (i) Velocityof sound (relative to air)
Velocity of the source (relativeto air)
Velocity of the observrer (relative to air) 01

(ii) Air is Considerd to be Stationary relative to ground/ earth 01

(b) light does not need a medium to travel OR
light travels even in vacceum 01

(c) $f = f_0 (1-\beta)$

$\frac{c}{\lambda} = \frac{c}{\lambda_0}(1-\beta)$ (For Applying $C = f\lambda$) 01

$\lambda_0 = \lambda(1-\beta)$

$\lambda = \frac{\lambda_0}{1-\beta}$

$\lambda = \lambda_0(1+\beta)$

$\lambda = \lambda_0(1+V/C)$

$\lambda = \lambda_0 + \lambda_0 V/C$

$\lambda - \lambda_0 = \lambda_0 V/C$ 01

$\Delta\lambda = \lambda_0 V/C$

$V = C\frac{\Delta\lambda}{\lambda_0}$

(d) (i) 500nm and 502 nm

(ii) Peak with $\lambda = 500$nm OR left peak
OR peak with smaller wavelenght 01

(iii) $\lambda_0 = 501$ nm 01

(iv) $\Delta\lambda = 1$nm 01

(v) $V = \frac{1\text{nm}}{501\text{ nm}} \times 3 \times 10^8 = 5.988 \times 10^5\ \text{ms}^{-1}$

$V = 6 \times 10^5\ \text{ms}^{-1}$ [$5.988 \times 10^5\ \text{ms}^{-1}$ 01
[598800 - 600000) ms^{-1}]
[$\lambda_0 = 501$ nm]

(vi) $\beta = V/C$

$\beta = \frac{6 \times 10^5}{3 \times 10^8}$

$\beta = 2 \times 10^{-3}$ (0.001996 - 0.002) 01

$\beta <<< 1$ is Justified

(e) (i) m = mass of gas

$\frac{mv^2}{r} = \frac{GMm}{r^2}$ 01

$M = \frac{V^2 r}{G}$

$r = 100 \times 3 \times 10^8 \times 24 \times 3600$ 01
(For converting light years to m)

$M = \frac{(6 \times 10^5)^2 \times 100 \times 3 \times 10^8 \times 365 \times 24 \times 3600}{6.0 \times 10^{-11}}$

$M = 5.68 \times 10^{39}$kg [$(5.65 - 5.70) \times 10^{39}$ kg] 01

(ii) Super massive black hole. 01

07\. A - Proportional limit 01
B - Elastic limit 01
C - Breaking point 01

(a) (i) Volume of the soil (v) $= 6 \times 150 \times 20\ \text{m}^3$ 01
Mass of the soil (m) $= \rho V$
m $= 3 \times 10^3 \times 6 \times 150 \times 20$ 01
Weght of the soil (mg) $= 5.4 \times 10^8$ N 01

(ii) let n be the number of columns needed then the stress on a single column $= \frac{5.4 \times 10^8}{n \times 30 \times 30\ 10^{-4}}$ 01

$\frac{5.4 \times 10^8}{n \times 30 \times 30 \times 10^{-4}} = 2 \times 10^8$ 01

$n = \frac{5.4 \times 10^8}{2 \times 10^8 \times 30 \times 30 \times 10^{-4}}$

$n = 30$ 01

(b) (i) Young's modulus = gradient of the stress Vs strain Curve 01

$= 2\text{x } 10^{11}\ \text{Nm}^{-2}$ 01

(ii) The Corresponding strain for a stress of 2×10^8 is 0.001 from the graph)

Let L be the uncompressed height of the column, then

$e/L = 0.001$

$\frac{L - 4.995}{L} = 0.001$ OR $\frac{2 \times 10^8}{L - 4.995} \times L = 2 \times 10^{11}$ 01

$0.999L = 4.995$
$L = 5$m 01

Let e be the compressed of the column.

$\frac{e}{4.995 + e} = 0.001$

$e = (4.995 + e) \times 10^{-3}$

$e(1 - 0.001) = 4.995 \times 10^{-3}$

$e \times 0.999 = 4.995 \times 10^{-3}$

$e = \frac{4.995 \times 10^{-3}}{0.999}$

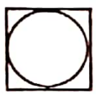
$e = 5 \times 10^{-3}$ m

$L = 4.995 + 5 \times 10^{-3}$

$L = 5$m 02

(c) Area of cross section of the circular Column
$= \pi R^2 = \pi(15)^2$
$= 707\ \text{cm}^2$

This area is less than 900 cm^2
OR
Area of crosa section of a circular column is less than that of a square column OR



for a diagran drawn as showr

OR Area of cross section of a square column is more then that of a circular column. 01

$\therefore$ Need more columns 01

08. (a) (i) Kinetic energy gained = qV 01

(ii) $qv = \frac{1}{2} m\upsilon^2$ 01

$\upsilon = \sqrt{\frac{2qV}{m}}$

(iii) Applying $S = Ut + \frac{1}{2} at^2$

$a = \frac{qv}{md_0}$ 01 $d_0 = \frac{1}{2} \times \frac{qv}{md_0} \times t^2$ $t = d_0\sqrt{\frac{2m}{qV}}$ 01	$F = qE$ $F = q\, v/d$ $F = ma$ $\frac{qv}{d_0} = ma$ $a = \frac{qV}{md_0}$

(b) (i) $d_1 = \frac{1}{2}\left(\frac{qv}{md_0}\right) t_1^2$

$\therefore t_1 = \sqrt{\frac{2md_1d_0}{qv}}$

Similary $t_2 = \sqrt{\frac{2md_2d_0}{qv}}$

Since $d_1 > d_2$, $\therefore t_2 < t_1$
ion 2 reaches the mash first 01

(ii) Applying $qv' = \frac{1}{2} mv^2$

$qv \frac{d_1}{d_0} = \frac{1}{2} mv_1^2$

$\therefore V_1 \sqrt{\frac{2qVd_1}{d_0 m}}$

Similary $\upsilon_2 = \sqrt{\frac{2qVd_2}{d_0 m}}$ 01 Since $d_1 > d_2$, $\therefore \upsilon_1 > \upsilon_2$ ion 1 has higher velocity	Applying $V^2 = u^2 + 2as$ $V_1^2 \; \frac{2qv\, d_1}{md_0}$ 01

(iii) The detector will detect both ions simultaneously if

$t_1 + S/\upsilon_1 = t_2 + S/\upsilon_2$ 01

$S\left(\frac{1}{\upsilon_2} - \frac{1}{\upsilon_1}\right) = t_1 - t_2$

$S = (t_1 - t_2)\frac{\upsilon_1\upsilon_2}{\upsilon_1 - \upsilon_2}$ 01

09. (A) (a) (i) $V = IR$
$12 - 3 = 0.1\, R_1$ 01
$R_1 = \frac{9}{0.1}$
$R_1 = 90\ \Omega$ 01

(ii) $V = IR$
$12 = i(10 + 6)$
$i = 0.75A$ 01
Power dissipation $= I^2 R$
$= (0.75)^2 \times 10$
$= 5.625W$ 01

Voltage across C $= IR$
$= 0.75 \times 6$
$= 4.5\ V$ 01

(iii) $V = IR$
$12 = 0.5 \times (R_2 + 6)$
$R_2 = 18\Omega$

(iv) Maximum total current = 4. 5 A
Therefore the 5A fuse is suitable 01

(b) (i) Using $R = \rho\, l/A$ 01

$R = \frac{1.8x10^{-8} \times 10 \times 10^{-3}}{0.3 \times 10^{-3}\ \ 1 \times 10^{-3}}$ 01

$= 6 \times 10^{-4}\Omega$ 01

(ii) Voltage across the strip $= IR$
$= 0.1 \times 6 \times 10^{-4}$
$= 6 \times 10^{-5}V$ 01

Power dissipation $= VI$
$= 6 \times 10^{-5} \times 0.1$
$= 6 \times 10^{-6}\ W$ 01

(iii) Dissipated power (Q) $= ms\Delta\theta$
$6 \times 10^{-6} = 10 \times 10^{-3} \times 0.3 \times 10^{-3} \times 1 \times 10^{-3} \times 9 \times 10^3 \times 400 \times \Delta\theta$ 01

$\Delta\theta = 5.5 \times 10^{-4}$ °C (OR K) 01

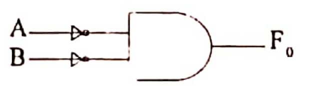
(iv) (1) larger width resistance (and therefore reduced power dissipation)
(2) Larger width increases heat transfer to the environment OR larger width increases area exposed to air 01

(B) (a)

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

01

(b) (i)

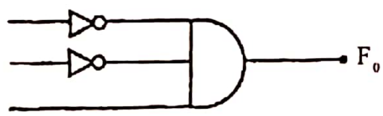


A	B	F_0
0	0	1
0	1	0
1	0	0
1	1	0

01

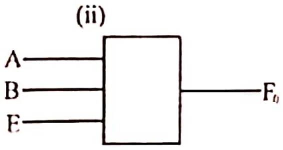
(ii) Truth table shows that $F_0 = 1$ only when A = 0 and B = 0 and it is zero under all other combinations. 01

(C) (i)



01

(ii)

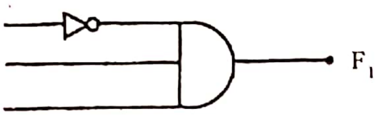


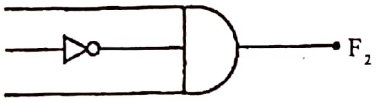
A	B	E	F_0
0	0	1	1
0	1	1	0
1	0	1	0
1	1	1	0

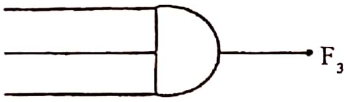
truth toble (1)

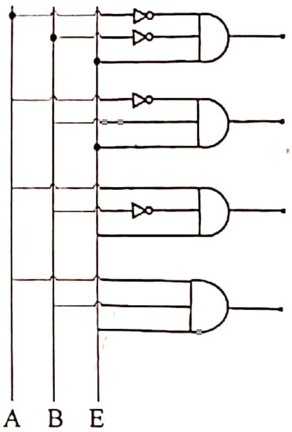
A	B	E	F_0
0	0	0	0
0	1	0	0
1	0	0	0
1	1	0	0

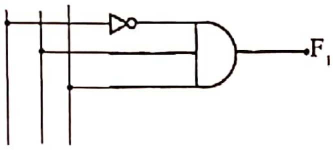
truth table (2)

(d)  01

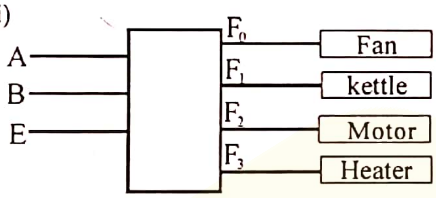
(e) (i)  01

(ii)  01

(f)  02



Accept the conections shown above also as correct

(g) (i)  01

Input conditions to operate the Fan, A = 0 , B = 0 , E = 1
Input Conditions to operate the kettle, A = 0 B = 1, E = 1
Input Conditions to operate the Motor A = 1, B = 0 E = 1
Input Conditions to operale the Heater A = 1, B = 1 , E = 1
(Devices can be conneated to block diagram in any order). 02

(ii) Keep E = 0 01

10. (A) (a) (i) $\Delta Q = ms\,\Delta\theta$ OR $Q = ms\theta$

$40 \times 4200 \times \Delta\theta = 1000 \times 7 \times 60 \times 4$ 01

$$\Delta\theta = \frac{1000 \times 7 \times 60 \times 4}{40 \times 4200}$$

$\Delta\theta = 10^0C$ 01

(ii) $V_\theta = V_0(1 + \gamma\theta)$ 01

Using $\rho = m/_v \Rightarrow V = m/_\rho$

$$\frac{m}{\rho_\theta} = \frac{m}{\rho_0}(1 + \gamma\theta)$$

$$\rho_\theta = \frac{\rho_0}{1 + \gamma\theta}$$

(iii) $\rho_\theta < \rho_0$, Water will rise 01

(b) (i) $ms\theta = \frac{Q}{t} \times t$

$$t = \frac{6000 \times 4200 \times (90 - 30)}{1000 \times 4}$$ 01

t = 378000 s OR 6300 min OR 105 h 01

(ii) $$\rho_0 = \frac{1554}{1 + 4 \times 10^{-4} \times 90}$$

$= 1500\,kgm^{-3}$

(iii) This den sity is greater than the density of pure water at 30⁰C. Therefore , water will not rise to the top layer. 01

(iv) (1) Amout of heat stored $= ms\Delta\theta$

$= 6000 \times 4200 \times (90 - 30)$

$= 1.5\ 12 \times 10^9\ J$ 01

(2) To produce hot water by circulating water through copper tubes which are laid in the bottom water

OR

To geneate electricity by operating thermoelectric devices using the temperature difference between bottom and the top layers. 01

(v) $\frac{Q}{t} = KA\,\frac{\Delta\theta}{l}$ 01

Rate of heat loss per unit area $= \frac{0.01 \times (90 - 40)}{0.1}$

$= 5\,Wm^{-2}$

(with corret unit) 01

10. (B) (a) (i) $\lambda = h/_p$ 01

(ii) $E = P^2/_{2m}$ 01

(or $E = \frac{1}{2}mV^2$ and $P = mv$)

$$\lambda = \frac{h}{\sqrt{2mE}}$$

(b) (i) $E = \frac{3}{2}KT$

(ii) $$\lambda = \frac{h}{\sqrt{3mkT}}$$

(iii) $$\lambda = \frac{6.6 \times 10^{-34}}{\sqrt{3 \times 6 \times 10^{-27} \times 1.4 \times 10^{-23} \times 300}}$$

$$\lambda = \frac{6.6 \times 10^{-34}}{\sqrt{9 \times 8.4 \times 10^{-48}}}$$

$$\lambda = \frac{6.6 \times 10^{-34} \times 10^{24}}{\sqrt{9 \times 8.4 \times 10^{24}}} \quad \text{OR} \quad \frac{6.6 \times 10^{-10}}{9}$$

$\lambda = 7.3 \times 10^{-11}m$ $(7.3 - 7.6 \times 10^{-11})$

(iv) $PV = NKT$ 01

$10^5 \times Na^3 = NkT$ 01

$$a^3 = \frac{kT}{10^5}$$

$$a^3 = \frac{1.4 \times 10^{-23} \times 300}{10^5}$$

$a = \sqrt[3]{42} \times 10^9$ m

$a = 3.5 \times 10^{-9}$ m

(v) yes 01

$\lambda < a$ (de Broglie wave length is less than the distance between the atoms) 01

(vi)
$$\frac{h}{\sqrt{3mkT'}} = \left(\frac{KT'}{10^5}\right)^{\frac{1}{3}}$$

$$\frac{h}{\left(3mkT'\right)^{\frac{1}{2}}} = \frac{K^{1/3}\,T'^{1/3}}{10^{\frac{5}{3}}}$$

$$T'^{\frac{5}{6}} = \frac{10^{5/3} \times h}{\sqrt{3m}\,K^{5/3}}$$

$$T' = \left[\frac{h \times 10^{5/3}}{\sqrt{3m}\,K^{5/6}}\right]^{\frac{6}{5}}$$

$$T' = \left[\frac{h^6 \times 10^{10}}{27m^3\,k^5}\right]^{\frac{1}{5}}$$