கல்விப் பொதுத் தராதரப் பத்திர(உயர் தர) முன்னோடிப் பரீட்சை - 2017
General Certificate of Education (Adv.Level) Pilot Examination - 2017

பௌதிகவியல் I Physics I	01	E	I	இரண்டு மணித்தியாலம் Two hours

Note:

- This paper contains **50 MCQs** in **12 pages**.
- **Answer all questions.**
- **Write your Index number** in given answer sheet.
- Choose the **correct** or **most suitable** answer from the answers numbered (1), (2), (3), (4), (5) for the questions **1** to **50.**
- **Mark (X) the answers in the answer sheet according to the given instructions.**

Do not use Calculator.
($g = 10\ N\ kg^{-1}$)

01. When a steel sphere of radius r moves in a liquid with speed v, the viscous force F acts on it is given by $F=krv$. The dimension of constant k?

(1) $M^0L^{-1}T^{-1}$ (2) $ML^{-1}T^{-1}$ (3) $ML^{-2}T^{-1}$ (4) $ML^{-1}T^{-2}$ (5) $M^2L^{-1}T^{-1}$

02. Kinetic energy of a particle,

(A) will change when resultant force acts on particle.

(B) is a scalar quantity.

(C) depends on the mass of this particle.

In the above statements,

(1) Only (A) is true (2) Only (B) is true (3) Only (C) is true

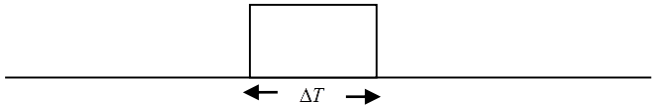
(4) Only (B), (C) are true (5) All (A), (B), (C) are true

03. If the sound intensity level at two points P, Q are 50 dB and 40 dB, the ratio between the sound intensity at P and sound intensity at Q is,

(1) 10:1 (2) 20:1 (3) 1:20

(4) 100:1 (5)1000: 1

04. Nowadays optical fibers are used for communication purpose. The communication is made by passing the laser ray pulse through the optical fibers. Such a laser ray pulse with wavelength 600nm is shown below.



The power of pulse observed in ΔT time is 500 mW. What is the number of energy photons existing in the pulse for ΔT = 30 ms? (Planck's constant h = $6x10^{-34}$ Js, velocity of light in air = $3x10^8\ ms^{-1}$)

(1) $5x10^{14}$ (2) $3x10^{15}$ (3) $5x10^{16}$ (4) $6x10^{16}$ (5) $8x10^{16}$

[see pg. 2

05. When the speed of a car is 108 kmh^{-1}, what is the angular speed of the wheel with 0.400 m diameter of car? (assume that the wheel doesn't slip on the floor)

(1) 75 $rads^{-1}$ (2) 150 $rads^{-1}$ (3) 270 $rads^{-1}$ (4) 540 $rads^{-1}$ (5) 1080 $rads^{-1}$

06. The factor/s in which the total energy of radiation released from a modern X ray tube depends on,

(A) Current flowing through the tube.

(B) Atomic number of target metal.

(C) Potential difference between cathode and anode.

(D) The distance between cathode and anode.

(1) Only (A), (B) & (C) are true
(2) Only (A), (C) are true
(3) Only (B), (D) are true
(4) Only (D) is true
(5) None of the above

07. A sonometer string creates sound at a certain frequency. Which of the following change will create a low frequency sound?

(1) Halve the length of string and double the tension.
(2) Halve the length of string and keep the tension unchanged.
(3) Keep the length of the string unchanged and double the tension in the string.
(4) Double the length of string and halve the tension of the string.
(5) Double the length of string and keep the tension unchanged.

08. In a resonance tube experiment, the 1st and 2nd resonance states for a certain tuning fork are obtained at 17 cm and 53cm. The end correction of this tube is,

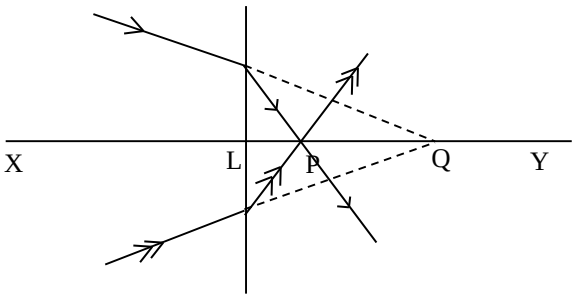
(1) 0.2 cm (2) 0.5 cm (3) 0.7 cm (4) 1 cm (5) 1.2 cm

09. Equal mass of O_2 gas and H_2 gas are in a closed vessel. The partial pressure of O_2 gas as of the total pressure is,

(1) $\frac{1}{2}$ part (2) $\frac{1}{4}$ part (3) $\frac{1}{8}$ part (4) $\frac{1}{16}$ part (5) $\frac{1}{17}$ part

10. The figure shows a light ray refracts in the lens with focal length f placed at L having XY as the principal axis. Which of the given statements is **wrong** when considering the given ray diagram?

(1) The given lens is a converging lens.
(2) Length LP < f
(3) Real image will form at P for the virtual object at Q.
(4) Real image will form at Q for the virtual object at P.
(5) Virtual image will form at Q for real object at P.



11. An uncharged capacitor of capacitance 4.7 nF is completely charged by connecting with 1.5 V power source. What is the number of electrons transferred to the negative plate of the capacitor during the charging process? (charge of an electron e = -1.6×10^{-19})

(1) 2.2×10^{10} (2) 3.3×10^{10} (3) 4.4×10^{10} (4) 8.8×10^{10} (5) 9.9×10^{10}

[see pg. 3

12. A Lithium nucleus joins with a proton and forms an unstable nucleus and then it undergoes nuclear reaction and forms two Helium nuclei. This reaction can be illustrated as follow.

$$^{7}_{3}Li + ^{1}_{1}P \rightarrow 2\left[^{4}_{2}He\right] + \text{ Energy}$$

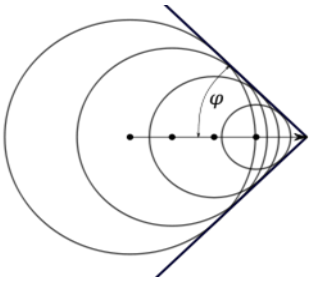
The initial kinetic energy of Lithium nucleus and proton are negligible. The mass loss in this nuclear reaction is Δm. What is the maximum kinetic energy of Helium nucleus released in this nuclear reaction?
(Velocity of light in air is C)

(1) $2\Delta mC^2$ (2) ΔmC^2 (3) $\frac{1}{2}\Delta mC^2$ (4) $\frac{1}{4}\Delta mC^2$ (5) $\frac{1}{8}\Delta mC^2$

13. A string with Young's modulus $5x10^{10}\,Nm^{-2}$ is under the tensile stress of $5x10^{8}\,Nm^{-2}$. The ratio between the velocity of longitudinal wave and the velocity of transverse wave in this string is,
(1) 2 (2) 5 (3) 10 (4) 50 (5) 100

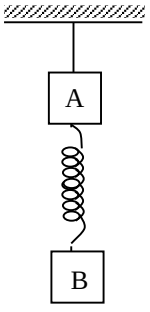
14. A bulb rated as 12V 60W glow with full brightness when connected to the secondary circuit of a step-down transformer. The primary circuit is connected to 230V power source. If the efficient of particular transformer is 75%, the current in the primary circuit is,
(1) 0.25 A (2) 0.35 A (3) 3.75 A (4) 5.0 A (5) 5.5 A

15. The figure shows the successive wave fronts formed when a supersonic jet with Mach number *k* flies horizontally. When a person in the floor hears the sonic boom, the angle subtended by the line joining the person and the jet with horizontal is,



(1) $Sin^{-1}(k)$ (2) $Sin^{-1}(\frac{1}{k})$ (3) $Cos^{-1}(k)$ (4) $Cos^{-1}(\frac{1}{k})$ (5) $Tan^{-1}(k)$

16. Two identical masses A and B are connected by a light spring and hung from the roof using a string. The acceleration of center of gravity of masses A and B and system at the moment of when the string is cut are g_A, g_B and g_S. The correct relationship between them is, (g- gravitational acceleration)



(1) $g_A > g_S > g_B > g$
(2) $g_A > g_S = g > g_B$
(3) $g_A = g_B = g_S = g$
(4) $g_A = g_B = g_S = g$
(5) $g_B > g_S = g > g_A$

17. A heating element with power P is kept in a vessel containing water placed in a surrounding with room temperature 30 °C and it's switched on. The temperature of water reached the boiling point and started to evaporate at the rate of $5gs^{-1}$. When the power of heating element is changed into 2P, the water evaporated at the rate of $15gs^{-1}$ at steady state. If a heating element with power P/4 is kept in the vessel containing water at the beginning, at the steady state, (heat loss occurs according to the Newton's Cooling law)

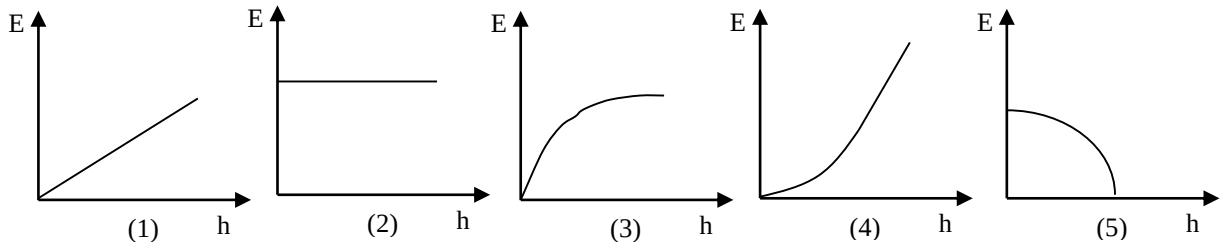
(1) won't change at 45 °C (2) won't change at 65 °C (3) won't change at 100 °C
(4) Water will evaporate at the rate of $1gs^{-1}$ at boiling point.
(5) Water will evaporate at the rate of $3gs^{-1}$ at boiling point.

[see pg. 4

18. A satellite of mass m is in the circular orbit which is at a height R from the surface of a uniform spherical planet with radius R and density ρ. What is the gravitational attractive force between the planet and the satellite?

(1) $\frac{\pi\rho GmR}{3}$ (2) $\frac{2\pi\rho GmR}{3}$ (3) $\frac{\pi\rho GmR^2}{3}$ (4) $\frac{2\pi\rho GmR^2}{3}$ (5) $\frac{4\pi\rho GmR^2}{3}$

19. When a particle of mass m is slowly released from points at different heights (h) from the floor, the Kinetic energy of the particle when it reaches the floor after traveling through the air resistance is E. The graph which possibly shows the correct variation of E with h is, (assume the density of air and the gravitational acceleration remain unchanged)



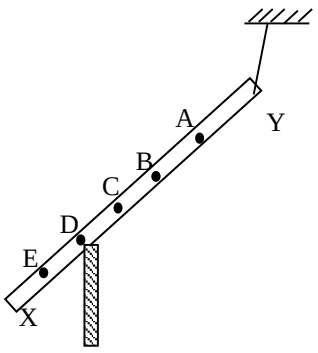
20. X and Y are the two strings made of same material and with equal cross-sectional area. But the length of string Y is little less than that of string X. One of the free ends of two strings are attached to the roof together and the other free ends are held together (At this state, the tensile force of X is negligible and Y has a considerable tensile force). When the tension for the string combination is gradually increased, which of the following qualitatively describes the behavior of tensions in strings X and Y?

(1) X will reach the proprtional limit first. Then the majority of the force will act in Y.
(2) Y will reach the proprtional limit first. Then the majority of the force will act in X.
(3) X will reach the proprtional limit first. Then the majority of the force will act in X.
(4) Y will reach the proprtional limit first. Then the majority of the force will act in Y.
(5) X will reach the proprtional limit first. Then the applied force will be divided equally to two strings.

21. A mass m is attached at the end of a light rigid string and the other free end is attached to the roof. The particle is held such that the string be horizontal and the particle is allowed to move. The minimum tension that the string should withstand, to prevent breaking in the whole motion is,

(1) mg (2) 2mg (3) 3mg
(4) 4mg (5) Depends on the length of the string

22.



A non-uniform, thin cylindrical rod XY is balanced by connecting to the roof by a light string when it is in contact with a smooth edge. The point where the center of gravity of rod may exist is,

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

[see pg. 5

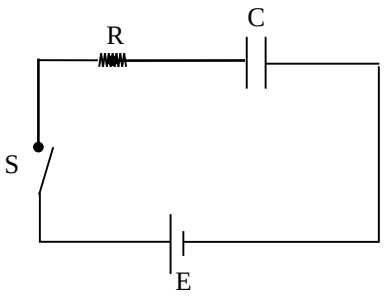
23. The magnetic force lines near the linear positive current carrying conductor are,
    (1) in spiral shape.
    (2) circles in the plane parallel to the conductor.
    (3) Parallel straight lines to the conductor.
    (4) perpendicular straight lines to the conductor.
    (5) circles in the plane perpendicular to the conductor.

24. The heat capacity of a liquid in S.I unit is K. The specific latent heat of vaporization of this liquid in terms of K is 100K. The needed heat quantity to completely evaporate the liquid of mass m at its boiling point 230 °C when the liquid is at 30 °C temperature in S.I unit, is
    (1) 300K (2) 100K (3) 300mK (4) 200mK (5) 100K(m+2)

25. Two concentric circular loops with radii *a*, 2*a* carry a current I in same plane but in opposite direction. At that time, the magnetic field intensity at the common center is 2×10^{-5}T. If the current through the smaller loop is stopped, now the magnetic field intensity at the common center is,
    (1) 1×10^{-5}T (2) 2×10^{-5}T (3) 4×10^{-5}T (4) 6×10^{-5}T (5) 8×10^{-5}T

26. When an astronomical telescope is under normal adjustment, a straight line of length *L* is drawn on the objective lens. If the length of the image of line formed by the eye piece is *x*, what is the angular magnification of this telescope
    (1) $\frac{L}{x}$ (2) $\frac{L}{x}+1$ (3) $\frac{L}{x}-1$ (4) $\frac{L+x}{L-x}$ (5) $\frac{x}{L}$

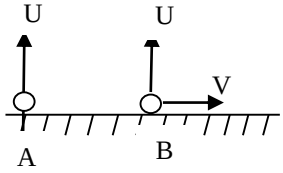
27. In the given electric circuit, the electromotive force of the battery is constant and the internal resistance is negligible. If the switching on scenario in the given state is X, the switching on scenario after doubling the resistance R of resistant is Y and the switching on scenario after doubling the capacitance C of capacitor is Z. The correct statement / statements about the given scenarios is / are, (consider that, in each scenario the capacitor doesn't have any charge before switching on and the capacitor is fully charged in each scenario)



    (A) The time taken to charge the capacitor in scenario Y is more than scenario X.
    (B) The amount of charge added in capacitor in scenario X and scenario Y are same.
    (C) In scenario Z, battery will lose four times of energy as the energy lost by battery in scenario X.

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

28. The figure shows two particles A, B thrown simultaneously from certain position in the horizontal floor. At the moment of throwing, A has velocity U vertically upwards and B has velocities U and V, horizontally and vertically respectively. The moving path of B relative to A in the motion before reaching floor.



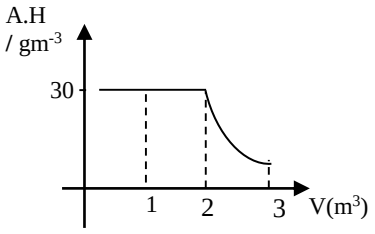
    (1)  (2)  (3)  (4) (5) 

[see pg. 6

29. A particle of mass *m* makes a circular motion with uniform speed in a circle with radius *a*. If the angular momentum about the axis through the center of the circle is *L*, the Kinetic energy of particle is,

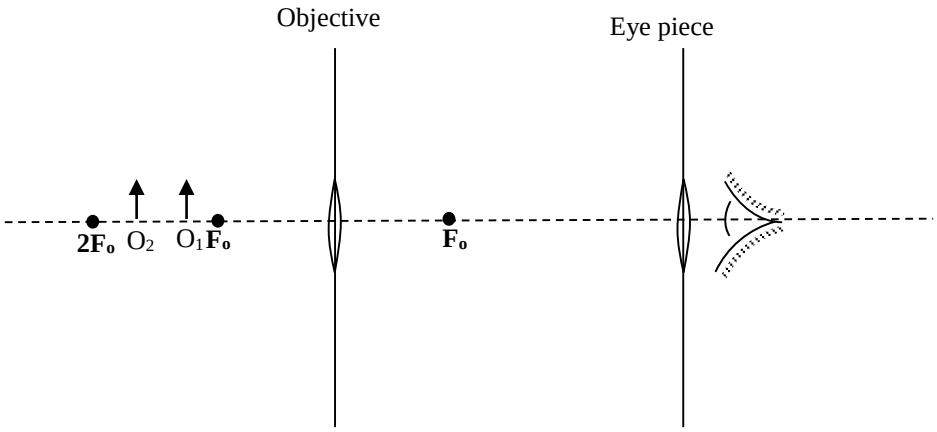
(1) $\frac{L^2}{am}$ (2) $\frac{L^2}{2am}$ (3) $\frac{L^2}{2a^2m}$ (4) $\frac{L^2}{a^2m}$ (5) $\frac{L}{2am}$

30. The absolute humidity (AH) inside a closed vessel varies as shown in the graph when the volume is changed without changing the temperature. When the volume of the vessel is $3m^3$, the approximate relative humidity inside the vessel is,



(1) 25% (2) 33% (3) 42%
(4) 67% (5) 73%

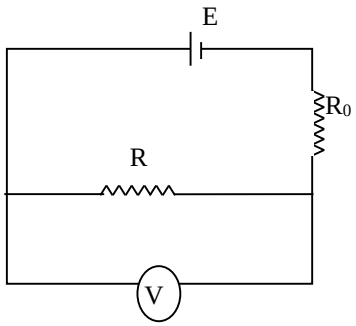
31.



An object is placed at positions O_1,O_2 seperately infront of the objective of compound microscope as shown in the figure and observed under normal adjustment. When the object is at O_1, the seperation between the two lens is d_1 and angular magnification is M_1. When the object is in O_2 the seperation between two lens is d_2 and angular magnification is M_2. Which of the following relationship between d_1, d_2 and M_1, M_2 is true?

(1) $d_1 > d_2$, $M_1 = M_2$
(2) $d_1 > d_2$, $M_1 > M_2$
(3) $d_1 > d_2$, $M_1 < M_2$
(4) $d_1 < d_2$, $M_1 > M_2$
(5) $d_1 < d_2$, $M_1 < M_2$

32. In the given electric circuit, the electromotive force E of the cell is 6V and the internal resistance is negligible. Voltmeter has R_v internal resistance. Its reading is 4V. Which of the following relationship about the quantities in the given circuit are correct?

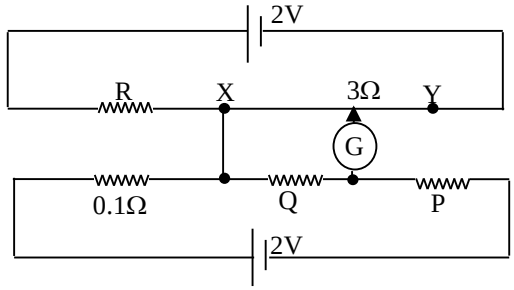


(A) $R_V = R_O$
(B) $R > R_O$
(C) $\frac{1}{R_0} > \frac{1}{R_V} + \frac{1}{R}$

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

[see pg. 7

33.

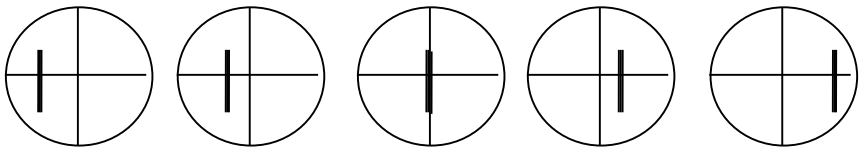


In the given circuit, when resistance Q and standard resistance 0.1Ω are interchanged within them, the equilibrium point is obtained at 50cm from X instead of 60cm from X. The value of resistance Q in Ω is,

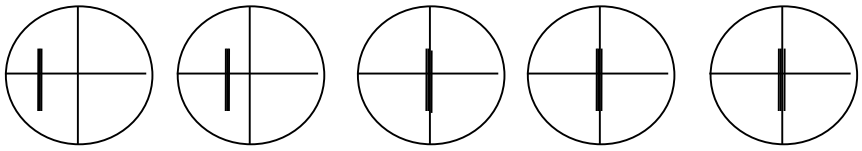
(1) 0.067 (2) 0.083 (3) 0.100 (4) 0.120 (5) 0.150

34. In an experiment to determine the minimum deviation of spectrum in spectrometer, the telescope is positioned after identifying the position of minimum deviation angle on the cross-wire of telescope. In order to confirm that, you are asked to rotate the prism table with small incident angle until it passes through the minimum deviation angle while observing the image of the slit continuously. During this rotation, the following five stages from left to right while the image of the slit is visible to observe are,

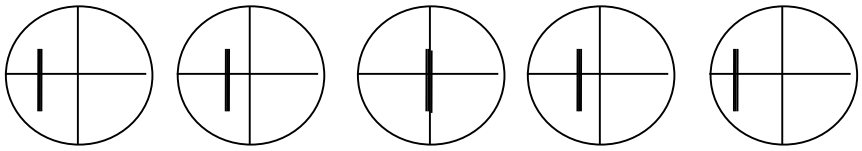
(1)



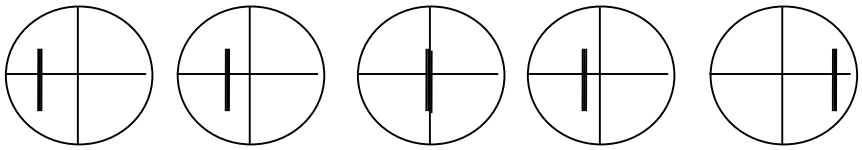
(2)



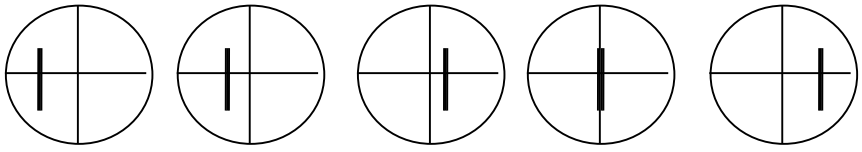
(3)



(4)

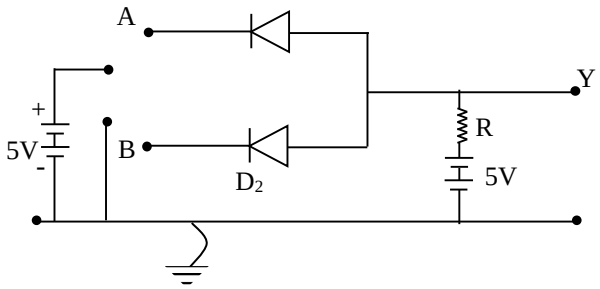


(5)



35. The given circuit is made of cells, diodes and resistor. A, B are input and Y is output. The gate denoted by this circuit is,

(1) OR
(2) AND
(3) NAND
(4) NOR
(5) NOT



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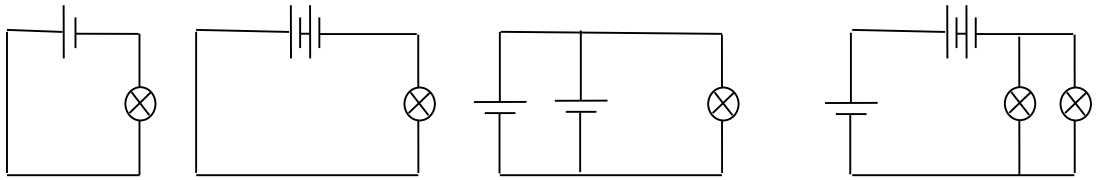
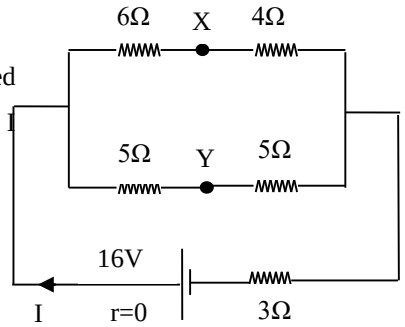
36. 

(A) (B) (C) (D)

In the given electric circuits, all cells are identical, their internal resistances are negligible and they have constant electromotive force and all electric bulbs are identical. In which circuit / circuits, the electric bulbs glow with same brightness?

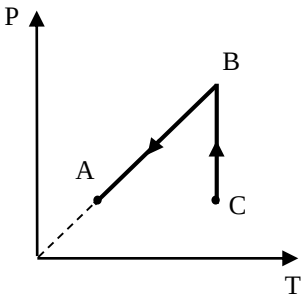
(1) Only in (A) & (C)
(2) Only in (B) & (D)
(3) Only in (A), (C) & (D)
(4) Only in (A) & (D)
(5) In all (A), (B), (C) & (D)

37. In the given electric circuit, when a cell with 1V electromotive force is connected between XY as positive terminal is with Y, what is the change in current I through the 16V cell?



(1) 0.1A (2) 0.5A (3) 1A
(4) 2A (5) zero

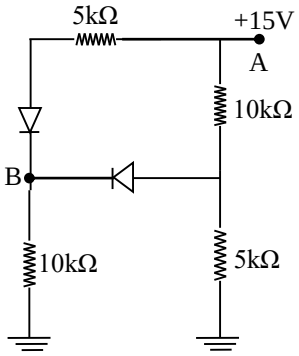
38. The graph shows the variation of Pressure (P) of a certain mass of ideal gas with absolute temperature (T). The correct statement / statements regarding this is / are?



(A) When move from B → A, the density of gas does not change.
(B) When move from B → A, the work is done on gas.
(C) When move from C → B, the work is done on gas.

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

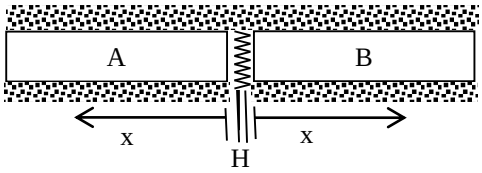
39. In the given ideal diode, resistance circuit, if the junction A is kept in +15V, what is the potential at junction B?

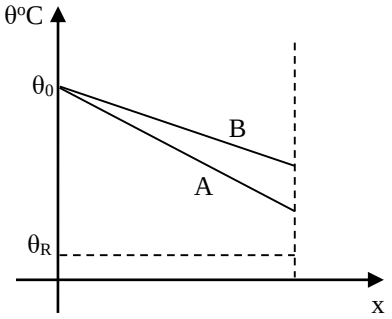


(1) + 2.5 V
(2) +5 V
(3) -5V
(4) +7.5 V
(5) +10V

[see pg. 9

40.





Two identical rods A, B with equal dimensions are lagged and kept in an environment with constant room temperature Q_R as shown in the figure. Heating coil H which produces heat at constant power P is kept in contact with the ends of rods as shown. The graph shows the variation of temperature (θ^0C) with distance x from the contact ends of rods in steady state. If the cooling constants for the surface of these two rods are same, consider the following statements.

(A) The heat conductivity of substance which rod B made is less than the heat conductivity of substance of rod A.

(B) The rate of heat flow through rod A is greater than that of rod B.

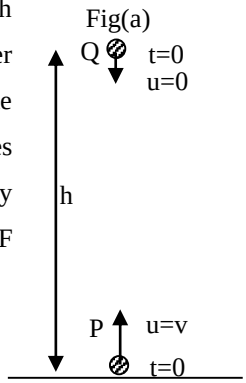
(C) If the cross-sectional areas of rods are decreased without changing the length, at steady state, the temperature at the two ends of rods will increase.

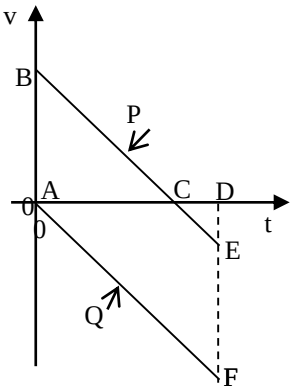
In the above statements,

(1) Only (A) is true (2) Only (A), (B) are true (3) Only (A), (C) are true

(4) Only (B), (C) are true (5) All (A), (B), (C) are true

41. Figure (a) shows the moment when a particle P is thrown with velocity V vertically upwards from floor at time t=0 and another particle Q is slowly released from a height h straight above the position of first particle. In the following motion, both particles meet each other. The above graph shows the variation of velocity (V) with time (t). If the areas of triangles, ΔABC, ΔCDE, ΔADF are A_1, A_2, A_3 respectively, the correct relation for h is,





(1) $h = A_1 + A_2 + A_3$

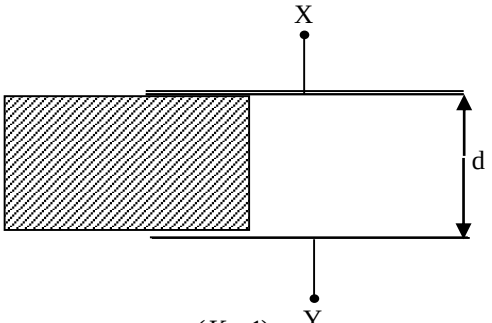
(2) $h = A_1 + A_3$

(3) $h = A_1 + A_3 - A_2$

(4) $h = A_1 + 2A_2 + A_3$

(5) $h = A_1 + A_2$

42. An air capacitor is made by placing square shape conducting plates of length *a* at a separation *d*. The figure shows dielectric substance with relative permittivity K is partially inserted. When the dielectric substance in the considered state is moved further t distance into the capacitor, the capacitance between XY is,



(1) increase by $\frac{at\varepsilon_0}{d}$

(2) decrease by $\frac{at\varepsilon_0}{d}$

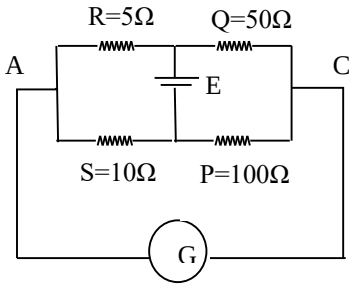
(3) decrease by $\frac{at\varepsilon_0(K-1)}{d}$

(4) increase by $\frac{at\varepsilon_0(K-1)}{d}$

(5) increase by $\frac{at\varepsilon_0 K}{d}$

[see pg. 10

43. Figure shows a Wheatstone Bridge circuit. The correct statement / statements about the given structure is /are,



(A) If resistance P is increased a little, electric current flow through the Galvanometer from C to A.

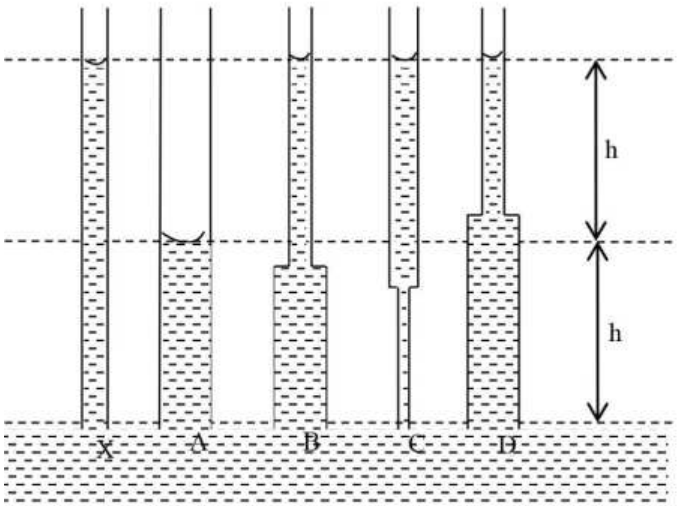
(B) Even the cell E and Galvanometer G are interchanged within them, G shows zero deflection.

(C) When the electromotive force of cell E with negligible internal resistance is increased by 3V, the potential difference across the resistance P will increase by 2V.

(1) (A) Only (2) (A) & (B) Only (3) (B) & (C) Only

(4) (A) & (C) Only (5) All (A) (B) (C)

44. Figure shows water is in equilibrium for a height 2h when a cleaned capillary tube X with radius r is kept perpendicularly in water. When combination tubes (A), (B), (C), (D) with capillary tubes of radii r, 2r, r/2 are kept normal to water, the possible equilibrium height / heights in the given amount is / are,



(1) (A) only

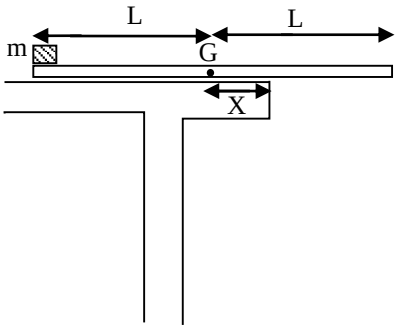
(2) (A),(B) only

(3) (A), (B), (C) only

(4) (B), (C), (D) only

(5) all (A), (B), (C), (D)

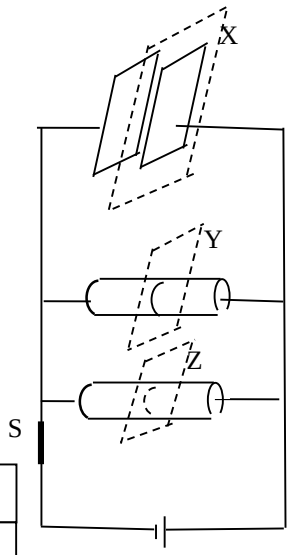
45. A uniform wood of mass M and length 2L is placed on a horizontal frictionless smooth table. The center of gravity of wood is at X distance from the edge of the table. A small block of mass m is placed on the end of wood as shown in the figure and velocity u is given along the length of the wood. If the co-efficient of dynamic friction between wood and block is μ, what is the minimum time taken for the wood to topple from the table since the velocity is given to block (let the block didn't come out of wood until the wood topples).



(1) $\frac{Lm+(M+m)X}{mU}$ (2) $\sqrt{\frac{2(l+X)m}{\mu g(M+m)}}$ (3) $\frac{L+X}{U}$ (4) $\frac{U^2}{2\mu g}$ (5) $\frac{(L+X)m}{(M+m)U}$

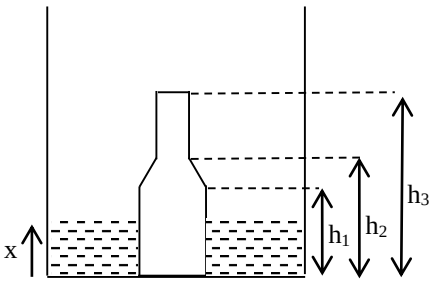
[see pg. 11

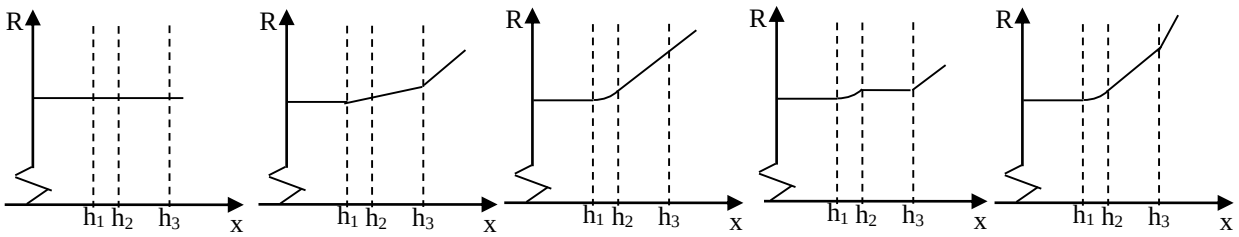
46. Figure shows a parallel plate condenser, a diode and a resistor are connected with battery in parallel state. In the given state, the switch S is closed. As shown in the figure, plane surfaces X, Y and Z are in the middle of the capacitor plates and parallel to plates, in the middle of diode and resistor and perpendicular to them respectively. Let the switch closed situation at the beginning as A and switch opened situation later as B. If the state where electric flux is present along the plane surfaces X, Y, Z is given by √ and no electric flux is along the plane surfaces X, Y, Z is given by ×, which of the following is true?



	X		Y		Z	
	A	B	A	B	A	B
(1)	√	√	√	×	×	×
(2)	√	√	√	√	×	×
(3)	√	√	√	√	×	×
(4)	√	×	√	×	√	×
(5)	√	×	√	√	√	×

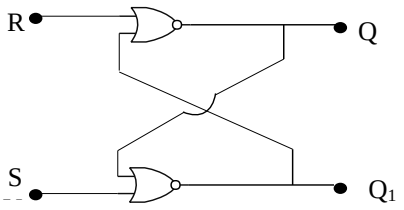
47. An iron solid in the given shape is kept inside a cylindrical tank without its bottom is wet. Now water is being poured into the tank. The graph which correctly shows the variation of the reaction (R) given by the bottom of tank to the iron solid with the height of water (X) is,





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

48. In the given flip-flop circuit, S and R had binaries 1, 0 respectively. Then S and R were involved to following changes (0,0) → (0,1) → (0,0) → (1,1). The truth table which correctly gives the Q and Q^1 for the respective changes is,



S	R	Q	Q1
1	0	1	0
0	0	1	0
0	1	0	1
0	0	0	1
1	1	1	1

(1)

S	R	Q	Q1
1	0	1	0
0	0	1	0
0	1	0	1
0	0	0	1
1	1	0	0

(2)

S	R	Q	Q1
1	0	1	1
0	0	0	1
0	1	0	1
0	0	1	0
1	1	1	0

(3)

S	R	Q	Q1
1	0	0	0
0	0	0	1
0	1	1	0
0	0	1	1
1	1	1	1

(4)

S	R	Q	Q1
1	0	0	1
0	0	0	0
0	1	1	0
0	0	1	0
1	1	1	1

(5)

[see pg. 12

49.

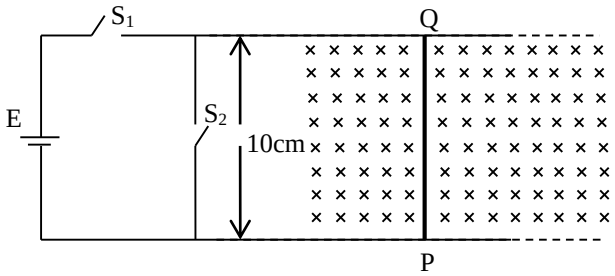


Figure shows a setup where a rod PQ with mass 10g and resistance 2Ω is placed on horizontal, parallel conducting rails with zero resistance which is kept at a separation of 10cm. A uniform magnetic field with field density 0.1T is applied to the whole area perpendicular to the plane (into the paper) between two rails. The e.m.f of cell connected to the two rails is 2V. Switch S_1 is closed while keeping switch S_2 is open. What is the instant deceleration of rod when switch S_2 is closed while keeping switch S_1 opened right after the rod reaches its maximum speed,

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

50.

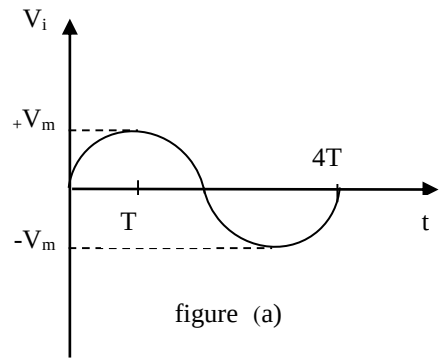


figure (a)

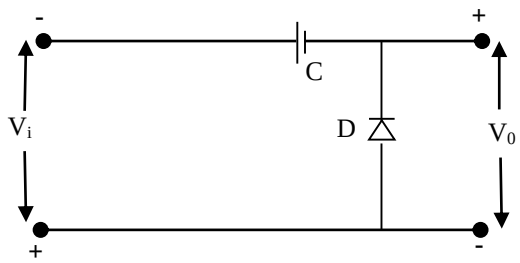
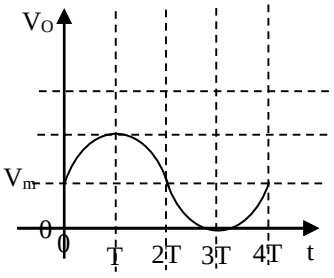
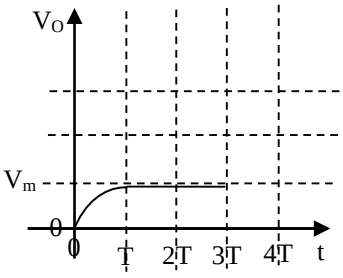


figure (b)

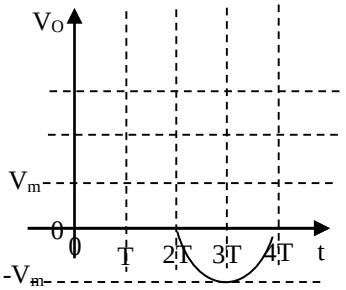
The voltage signal shown in figure (a) is given continuously to the input in figure (b). The correct potential wave pattern across the output in figure (b) is given by,



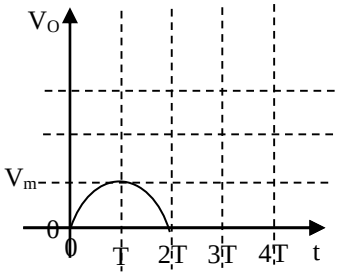
(1)



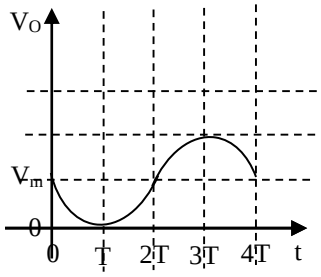
(2)



(3)



(4)



(5)

மொரட்டுவை பல்கலைக்கழக பொறியியற் பீட தமிழ் மாணவர்கள்

நடாத்தும் க.பொ.த உயர்தர மாணவர்களுக்கான 8வது முன்னோடிப் பரீட்சை - 2017

கல்விப் பொதுத் தராதரப் பத்திர(உயர் தர) முன்னோடிப் பரீட்சை - 2017
General Certificate of Education (Adv.Level) Pilot Examination - 2017

பௌதிகவியல் II Physics II	01	E	II	மூன்று மணித்தியாலம் Three hours

Index No. : ……..

Instructions :

- This question paper consists of 22 pages.
- This paper comprises of two parts **A and B.** The time allotted for the **two parts** is **three hours only**.
- **Use of calculators is not allowed.**

❖ **Part A – Structured Essay (Pages 2 - 9)**

- Answer all the questions on the question paper itself.
- Write your answers in the space provided for each question.
- Please note that the space provided is sufficient for the answer and that extensive answers are not expected.

❖ **Part B – Essay (Pages 11 - 22)**

- This part consists of **six** questions. Answer **four** questions only. Use the papers supplied for this purpose.
- At the end of the time allotted for this paper, tie the two papers together so that Part **A** is on top and hand them over to the Supervisor.
- You are permitted to remove only Part **B** of the question paper from the Examination Hall.

For Examiner's Use Only

Part	Question No.	Marks
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
	8	
	9(A)	
	9(B)	
	10(A)	
	10(B)	
Total		
Percentage		

Final Marks

In Numbers	
In Letters	

Code Numbers

Marking Examiner 1	
Marking Examiner 2	
Checked by :	
Supervised by :	

[see page two

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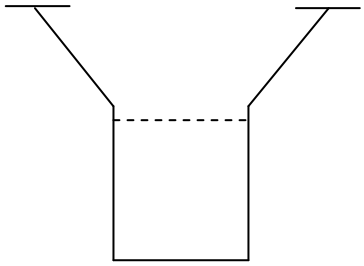
PART B – STRUCTURED ESSAY

*Answer **all** the questions **on this paper itself.***

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

01. Newton's cooling law needs to be verified using a small metal container having hot water to the shown level, which is suspended by strings as shown in the figure.



(a) What are the other instruments needed to carry out this experiment?

……

(b) What is the reason for hanging the container than not placing on the table?

……

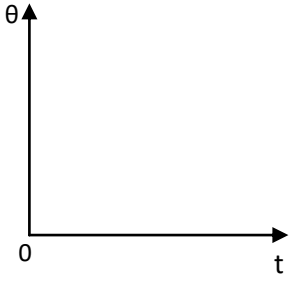
……

(c) For drawing the cooling graph, the surface temperature at different times should be known. What is the practical procedure that a student should carryon to ensure that the thermometer reading is the temperature of the surface?

……

……

(d) Draw the expected cooling curve in the following axis. (mention the room temperature θ_R in the graph)



(e) If another container made up of same material and same volume but with higher surface is used, then draw the cooling curve for this in the same figure above and name this graph as X. (Neglect the mass change of vessel comparing with water)

[*see page three*

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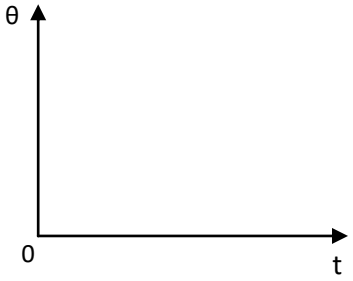
(f) What is the quantity you obtain from the graph drawn?

……

……

(g) Water is taken at room temperature in the same container and heating coil is placed inside. Though the coil is ON for a long time, the temperature of the water does not reach the boiling point.

i. Draw the variation of temperature (θ) with time (t) from the moment the heating coil is ON.



ii. What is the reason for a constant temperature, though the heating coil is ON?

……

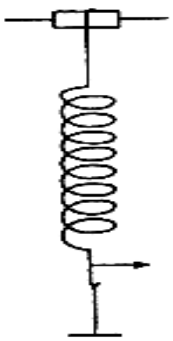
……

iii. The rate of heat loss R (in Watt) from the container at temperature θ is given by $R = 10 (\theta - \theta_R)$. Here θ_R is the room temperature. What is the steady temperature reached, when the heating coil is working at power 500W? (room temperature 30°C)

……

……

02.



A light spring whose one end is attached to the rigid support and a light indicator is attached at the bottom is shown in the figure.

[see page four

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(a) Draw the correct position of the meter ruler where it should be placed, when a standard mass is attached and the extension *e* is obtained.

(b) When a load M is attached at the bottom, the extension in the spring was found to be *e*. What is the force constant of the spring?

……

(c) Since the extension here is very small, measuring errors will be high. So a student suggested measuring the initial and final lengths of the string to find the extension in the string. Give the method, by how the length of the spring can be measured using a meter ruler?

……

……

(d) Another similar spring is attached end to end with the bottom end of this spring and a composite spring is made.

i. If a load M is attached to the bottom of the composite spring, what is the extension in the spring?

……

ii. What is the spring constant of the composite spring?

……,……

(e) A mass M is attached to the bottom and it is allowed to oscillate vertically by giving it a small displacement. The period of oscillation (T) is given by the equation $T = 2\pi\sqrt{\frac{M}{K}}$

i. Arrange the above equation in a proper manner, to find the spring constant K using a graph.

……

……

ii. What is the additional instrument needed to take readings in this experiment?

……

……

iii. What is the quantity extracted from the graph to determine the value of K?

……

……

[*see page five*

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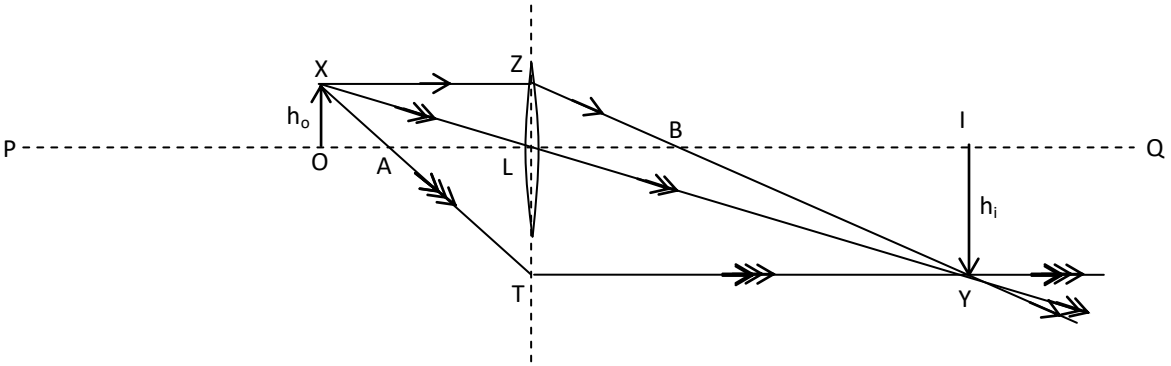
iv. How many oscillations have to be obtained to make the percentage error in measuring T to 1%? (the least count in measuring time is 0.1s. Assume T = 2s)

……

……

……

03. A student arranges a practical in a laboratory using lenses. The image IY produced by a lens having principal axis PQ for an object OX is obtained at first. The above figure shows three light rays travelling through the lens from a point X on the object to the point Y on the image. (XZ and TY are parallel to PQ)



i. Denote the place E where the student should place his eye to observe the image, in the above diagram.

ii. What is the position of focal of lens in the figure?

……

iii. Distance AO = x and BI = y, image and object heights are h_I and h_o respectively and the focal length of the lens is *f*. By considering prove that $xy = f^2$.

……

……

……

……

iv. Arrange the equation obtained in question (3), by substituting x, y in terms of image and object distance u, v and focal length f.

……

……

[*see page six*

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v. If the student wishes to obtain a virtual image, where should the object needs to be transferred?

……

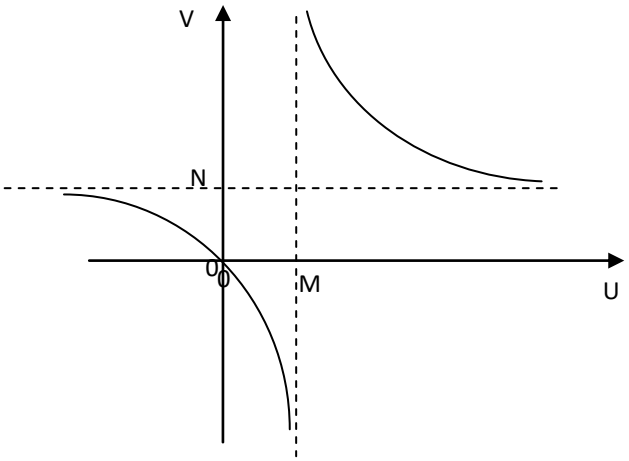
……

vi. When object OX is moved to the place mentioned in question (5), such that O is on the principal axis and OX is perpendicular to the principal axis, give the path of movement the vertex Y of the image.

……

……

vii. Student obtained various object distance u and image distance v for real object and virtual object and drew a graph for the variation of v with u and the graph is as below.



1. Give the coordinates of points M and N using the equation obtained in question 4.

   M :- ……

   N :- ……

2. Clearly mention the sign convention used for object distance (u) and image distance (v) while drawing the graph.

   ……

viii. Student places a concave lens in contact with the convex lens on the same axis. For the initial position of the object OX, again another real image is obtained.

1. Where the focal lens of the combined lens would be found on the object side?

   ……

[*see page seven*

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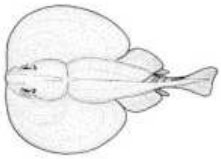
2. Compare the magnification of the image obtained now with the magnification obtained earlier. [Hint : Consider the position of focal in question viii(1) and the equation in question (iii)]

……

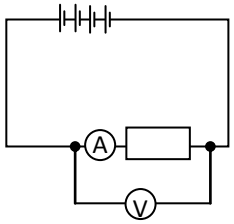
……

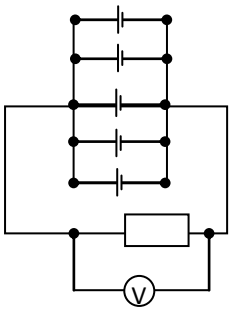
04. The following figure shows a type of electric ray fish which has the capability to produce electricity. These types of fish use these techniques to prevent them from enemies and to catch preys.



In the special electric organs of these types of fishes, structures similar to many electric cells can be found. These can be arranged in parallel or series according to the purpose is one of the significant properties.

(a) Two circuits arranged in series and parallel manner using 5 electric cells to understand the mechanism of these fishes is shown in the figure below. Load resistance R is connected across each circuits and Voltmeter and Ammeter are connected in such a way to measure the potential difference across them and the current flow through them respectively. The values are measured and tabulated as below. Here A and V are ideal.





Load resistance (Ω)	Current in series circuit (A)	Current in parallel circuit (A)
0.1	2.7	7.2
1	2.0	1.3
10	0.55	0.14

i. Pure water has higher resistivity than marine water. When these types of fishes live in pure water and marine water, what would you say regarding the arrangement of cells (series/parallel)? (producing high current is the special adaptation of these fishes)

[*see page eight*

Do not write in this column.

Pure water : - .....

Marine water : - .....

ii. Support your answer using the conclusions obtained from the table above.

.....

.....

.....

iii. When 5 cells are in series connection, the total electromotive force across the cells is 6.9V. Calculate the internal resistance of a cell using the data provided in the table below.

Load resistance (Ω)	Potential difference (V)	Current (A)
2.2	3.3	1.5

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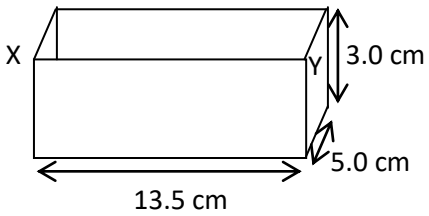
(b) A plastic container is completely filled with marine water, to determine the resistivity of marine water. To metal plates are kept inside the container such that it cover the ends X and Y of the container.



Ohm meter is connected to the metal plates and the resistance of marine water between XY is measured. (Resistance of marine water = 1.2 kΩ)

i. Calculate the resistivity of the marine water

.....

.....

.....

[see page nine

Do not write in this column.

ii. In this particular practical, pure water is taken and salt is added little by little and mixed. The mass of salt added in this practical is m. An approximate graph is drawn by a student for the variation of Ohm meter reading (Rs) with the mass of salt added (m). Draw that approximate graph drawn by that student. (Denote the axis clearly)

(c) i. One fish of this kind produces potential difference of 45V and 0.12A in a beat for 5 ms. During an attack, the number of beats made was 400, then calculate the energy transmitted by the fish.

……

……

……

ii. During this kind of attacks, what resistivity the fish should poses to prevent its body from damages? Give reason.

……

……

……

iii. During these attacks, the damage made to the prey is limited to one extent. What is the reason for it?

……

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மொரட்டுவை பல்கலைக்கழக பொறியியற் பீட தமிழ் மாணவர்கள்

நடாத்தும் க.பொ.த உயர்தர மாணவர்களுக்கான 8வது முன்னோடிப் பரீட்சை - 2017

கல்விப் பொதுத் தராதரப் பத்திர(உயர் தர) முன்னோடிப் பரீட்சை - 2017

General Certificate of Education (Adv.Level) Pilot Examination - 2017

பௌதிகவியல் II Physics II	01	E	II

PART B - ESSAY

*Answer **four** questions only.*

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

5.

(a) A jet plane which is at rest and ready to take off in the main runway is shown in the figure below. Though the engine of this plane is running, the motion is prevented by the applied brakes.

Draw a similar diagram on your answer sheet and denote the following forces using separate arrows. .

i. Weight of the jet plane (W)

ii. Force exerted by the engine (T)

iii. Total force given by the runway to the jet plane (F)

(b) Brakes are released. The maximum force given by the engine is 30kN. The takeoff speed of jet plane is 50ms^{-1} and the mass of jet plane is 6000kg.

i. What is the shortest distance traveled by the jet plane from rest to the point of takeoff?

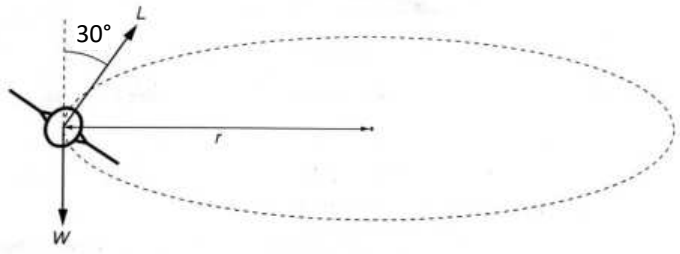
ii. What is the reason for the runway to be longer than the value calculated in the above question (i)?

(c) When this particular jet plane is about to perform an air show, the pilot has to fly in a horizontal circular path of radius r with a constant speed 80ms^{-1}. By tilting the wings of the plane at an angle 30° to the horizontal, this can be performed. During this, two forces acting on the plane, lifting force L and the weight of the plane W_a is shown in the figure. The air resistance effects can be neglected.

$\sqrt{3} \approx 1.7$

$\frac{1}{1.7} \approx 0.6$

[see page twelve

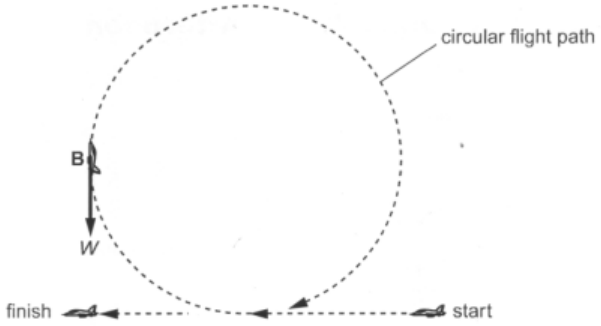


i. Find the value of the lifting force L.

ii. Calculate the radius r.

iii. Compare the speed V of the plane and the angle of tilt θ with initial speed 80ms^{-1} and initial tilt 30°, if the plane needs to perform a circular motion with less radius than mentioned above.

(d) As another part of a show, pilot flies the plane in a vertical circle with a constant speed as show in the figure.



i. At particular speed weightlessness is felt by the pilot at a particular point on the above circular path.

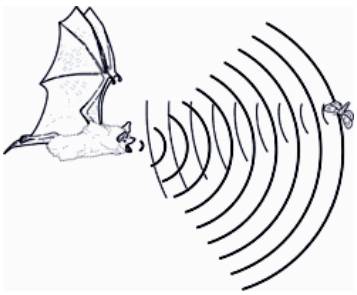
1. Copy the circular path and denote the point A where the above phenomenon is felt by using a cross.
2. Obtain a relationship between the radius of this circular path r, speed of plane V and gravitational acceleration g.

ii. During this, the motion of the plane can be explained using a constant weight W and a variable force P.

Here P is the force exerted by the engine. This is the resultant of the lifting force and the air resistance. At point B in the figure, plane flies vertically upwards. Here the force P is not directed towards the center. What is the reason for this? Explain.

[*see page thirteen*

6. Bat, flying mammals have sensory structures which uses echo to identify the environment and to detect any obstacles in the path during night times and also they are capable to find out the position of the prey and catch them. These insectivores are classified by the food they eat, some eat fruits and some eat flower nectar and blood.



The ultra sound (20 – 200kHz) produced by bats differs to every type, i.e. they differ according to the environment they live and the prey they search for. They calculate the distance (nearer or farer) between the prey and position (up/low/right/left) by the time taken for the echo to be heard back, by the part of the ear which the echo is heard (inside/outside/left/right ear), they calculate the size (big/small) by the concentration of echo and the movement (towards/away) by the frequency (Doppler Effect). These are the such information which a normal human eye obtain by seeing

They are capable to feel the sound with less frequency than the sound they produce. The reason for this is, loss in dispersion while sound leaves and enters the absorption by the medium in both travel and the absorption by the surface where the echo is formed.

Bats can produce constant frequency sound; frequency modulated sound and also mixed types of sound according to the purpose. Not only this, they can also form high and low frequency sounds.

The patterns how the sounds are formed by the bats are divided into two types.

i. Low duty cycle echolocation

(types of bats which has the ability to contract the middle muscles in the ear)

Bats that use this approach time their short calls to finish before echoes return. The time interval between the calls and echo allows them to relax these muscles, so they can clearly hear the returning echo. The delay of the returning echoes provides the bat with the ability to estimate the range to their prey.

ii. High duty cycle echo location - Calls with no time interval

(The bats whose ears are sharply tuned t a certain frequency)

They emit calls outside of this range to avoid self-deafening. They then receive echoes back at the finely tuned frequency range by taking advantage of the Doppler shift of their motion in flight. The Doppler shift of the returning echoes yields information relating to the motion and location of the bat's prey.

So a person, who does researches on bats, can identify the type of bat by the quality of sound and by the pattern in which it is produced and the need of them also can be identified.

(For the calculations speed of sound in air 340ms^{-1})

[*see page fourteen*

(a)

i.

1. Give three instances where bats use echo.
2. How the bats use echo to find the distance, position, size and motion of the prey?

ii.

1. The concentration of the received sound is always less than the frequency of the produced sound. Give three reasons for this.
2. Give three factors which determine the concentration of the echo produced.

iii. Bats use low frequency ultra sound to identify the objects approximately, but use high frequency ultra sound to clearly identify the object. Give the reason for it.

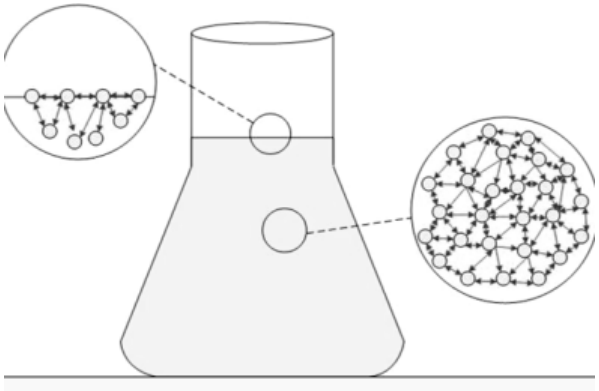
(b)

i. A bat in a cave produces sound and observes the continuous echoes. The first echo, started to hear in 1 second after the sound is produced. What is the minimum distance between the bat and the wall of the cave?

ii. A bat flies towards a stationary insect at a constant speed of 10m/s. In this motion it hears an echo with frequency 70 kHz.

1. What is the frequency of the sound produced by the bat?
2. The frequency of the echo heard now seems to be different by 5 kHz from the echo heard initially and bat feels that the insect moves away. What would be the velocity of the insect?
3. If the bat which chases the insect, hears the echo for the first time by its right ear, then what is the position of the insect? .

7. The energy required to break the bond between two liquid molecules is known as the bond energy (E_0). This energy is used for the separation of these molecules. i.e: it makes the potential energy among them to zero. Every molecule in a liquid is surrounded by n number of surrounding molecules. So the energy required to break the bond of a molecule from other molecule is nE_0



[*see page fifteen*

When a new liquid surface is produced, if we consider a molecule which come to the surface from the liquid, n/2 number of molecules are released from the bonding. (see the figure) So, during this the energy provided for a, molecule is $\frac{1}{2}nE_0$. If the new surface has N number of molecules in a unit area, N/2 number of pair molecules could be found there. So the energy required to produce a new surface with a unit area is

$$T = \frac{1}{2} N \times \frac{1}{2} nE_0$$

$$= \frac{1}{4} NnE_0$$

The energy given in such a way for the formation of a new surface is known as the surface energy. When temperature is constant, the energy required to increase the surface area by a unit is known as the surface tension of that liquid. When a liquid surface is increased without changing the temperature, then the process is an isothermal process.

(a)

i. What is the bond energy of the molecules?

ii. What is the potential energy of two molecules having E_0 as the bond energy?

iii. How many molecules are released from bonding when a molecule comes to surface from liquid in terms of number of adjacent molecules found when it was in the liquid?

iv. From the above data, what is the surface energy of a liquid surface, having surface area A?

(b) When liquid boils and evaporate, the bonds among the molecules are broke. The energy required for breaking of such L number of molecules is $\frac{1}{2}LnE_0$

i. The energy required for the conversion of 1kg water molecules as vapor molecules is 2.3×10^6J. The mass of one mole water molecule is 0.018 kg. Avogadro's constant $6 \times 10^{23} mol^{-1}$ for water n =10 Find the bond energy found among the molecules

ii. The number of water molecules in a unit surface area is $N = 2 \times 10^{18} m^{-2}$ and the energy required for the breaking of bond among water molecule is as calculated in question (b) (i), then find the surface tension of water by considering the definition of surface tension.

iii. Some insects can walk on the surface of water due to surface tension effect by pushing the water surface downwards. The bottom of the feet of these insects can be considered as a sphere. An insect in such a way has 6 legs and the radius of the circular area in contact is 3×10^{-5} m. In the above mentioned water, the angle which the contact areas make with the vertical is θ. If $\cos\theta = 0.8$, then find the mass of the insect in kg. ($\pi = 0.3$)

iv. The above mentioned insect is brought to another liquid. Though this liquid has greater surface tension than water, the insect seems to be drowning. What could be the reason for this?

[see page sixteen

8.

(a)

i. Give the equation for the gravitational potential energy of a particle of mass m which is at a distance r from the center. mass of earth M_E, radius R_E (here r> R_E)

ii. What do you understand by the term "Escape velocity of a planet (Ve)"?

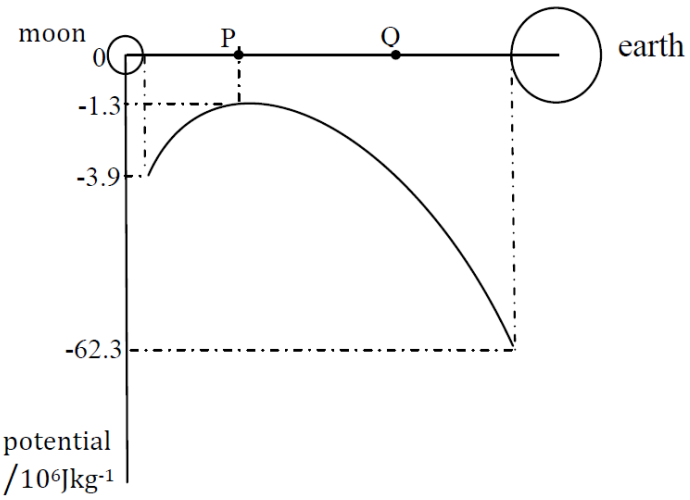
iii. If the final velocity of a particle, which is thrown with velocity V_0 (>V_e) from earth surface is V_f, then show that

$$V_0^2 = V_f^2 + V_e^2$$

iv. Draw the velocity (V) time (t) graph for the motion of the particle mentioned in question (iii)

v. The escape velocity of a planet is 3000ms^{-1}, then what is the final velocity of the particle which is thrown from the surface with a velocity 5000ms^{-1}?

(b)



The above figure shows the variation of the gravitational potential along the line joining the centers of earth and moon. The gravitational potential is high at point P. When answering the following questions, assume that the moon is still related to earth.

i. If a mass is kept at the point Q, then in which direction the resultant gravitational force will act on that object?

ii. If the particle at P starts to move slowly towards earth, then what would be the speed of that particle when it has reached the earth?

iii. With what minimum speed a particle has to be thrown from earth surface, to reach moon?

iv. If the rotation of moon related to earth is considered, will a particle thrown with the speed calculated in (b)iii reach the surface of moon? Explain your answer.

[*see page seventeen*

9. Answer either part (A) or part (B)

(A) Nowadays electric vehicles running on electric energy have come to use by running electric motors using refilling electric cells. The instant torque given by the electric motors in the electric cars helps for the stable and uniform acceleration. Electric cars are three times more effective than the normal internal combustion engine cars (fuel injected cars) The use of electric cars are started in the mid of 19th century and now it is becoming more popular. The reason for its popularity is less. They are, the motion does not depend on fuel or oil (0.1), the prevention of air and sound pollution and the availability of rechargeable cells. Also, the cost of travel and maintenance is less and easy, which attracts the people towards itself. Though, the cost of purchase, the time taken for recharging the cell is greater, the cell needs to be recharged after a short distance travel and the troubles due to the usage for the people traveling on the way are some opinions which pushes the users and drivers to a critical position. Though, the manufacturers try to decrease the cost of purchase, increase the lifetime of cell and reduce the time taken for recharging and some well developed countries install charging stations in required places and made facilities to recharge in parking areas increases the usage of electric cars.

(a) Give 2 advantages and 2 disadvantages of electric cars than normal fuel injected cars.

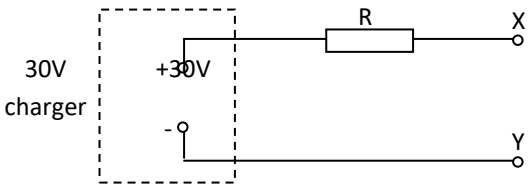
(b) The electromotive force of the cell of an electric car is 24V. This can provide 200A current to the motor for 4 hours, when it is completely charged.

i. Explain with respect to energy, what do you understand by the term electromotive force of a cell?

ii. Find the total charge Q that can be supplied by the cell.

iii. Find the total energy E that can be given by the cell at constant electromotive force 24V. 24V

(c) For any supply current (I), the charger of the cell has 30V output. In the figure the resistor R, represents the total resistance including the variable resistance in the circuit. The cell which needs to be charged is connected across XY and charged.



i. Draw the way, with polarities, how the cell mentioned in question (b) is connected in the above circuit. (the internal resistance of the cell is negligible)

ii. When a constant current 120A is supplied by the charger, the potential difference across the cell is maintained constant at 24V. What is the resistance R in this instance?

[*see page eighteen*

iii. Calculate the energy dissipated in the resistance R while charging?

iv. What is the time taken for the complete charging of a cell?

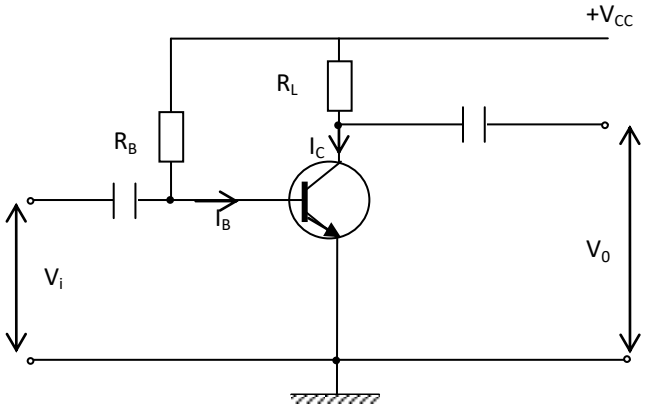
(d) This type of charging process has to be done in a house in Sri Lanka. The maximum current that can be obtained in the house electric supply is 40A. The supply voltage for the house is kept constant at 240V. A rectifier circuit is used along with a step down transformer to supply 30V dc to charge a cell mentioned in question (c).

i. What is the ratio of number of turns in input and output circuits?

ii. During the charging process at 120A as mentioned in question (c)(ii), what is the current in the input circuit?

iii. When this charging is taking place in a house, what could be the total maximum power for the devices which run in potential difference 240V, without burning the main fuse?

(B) (a) The figure shows a simple potential amplifier which runs according to plan characteristic while there is no alternative current in the input, with 3mA collector current. At bias state base emitter voltage (V_{BE}) is 0.6V and supply voltage (V_{CC}) is 6V.



The alternative current gain (β) of a transistor is the ratio between collector current (I_C) and base current (I_B). This can take any values from 10 to 1000 with respect to the type of transistor. For the transistor in the circuit (figure) β=100. The potential gain of a transistor is the ratio between the change in input potential (ΔV_i) and change in output potential (ΔV_0) and it's given by $\frac{\Delta V_0}{\Delta V_i}$. In the simple common emitter amplifier circuit, input resistance is, the ratio between the change in input potential (ΔV_i) and change in base current due to this (ΔI_B). In the circuit given above, the internal resistance is 2kΩ. So the potential change in output can be given by the following equation.

$$\Delta V_0 = \Delta I_C \times R_L$$

$$= \beta \Delta I_B \times R_L$$

$$= \beta \times \frac{\Delta V_i}{2 \times 10^3} \times R_L$$

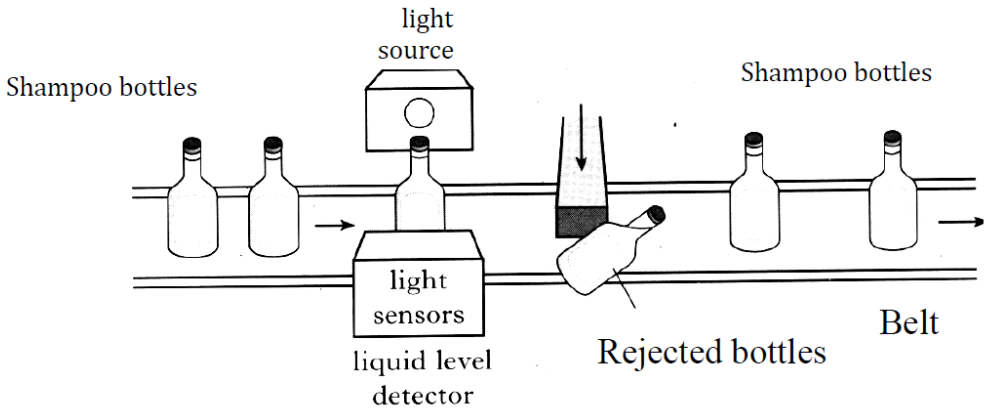
[see page nineteen

i. Find the load resistance (R_L)

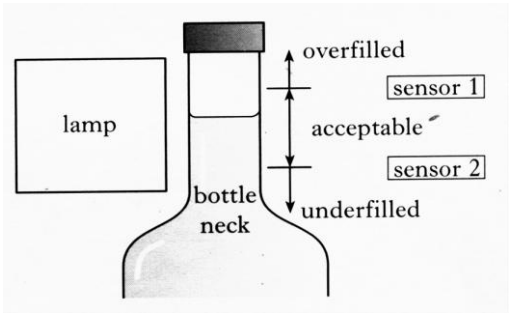
ii. biased base resistance (R_B)

iii. What is the maximum potential that can be matched with the input of transistor such that to obtain complete amplification?

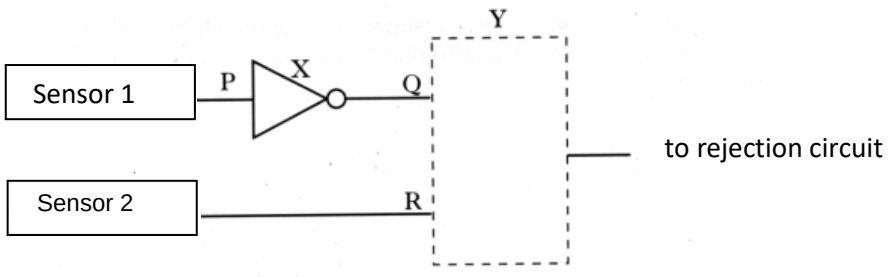
(b) In the production of shampoo bottles, they pass through a sensor which detects liquid column. Here bottles which are underfilled and overfilled are rejected. Only shampoo bottle which were filled to a certain level is allowed to pack. They are conveyed through the belt to the packing section.



Liquid column sensors consist of a lamp and a light sensor. The following figure shows the correct levels. The light has the ability to reach the sensor while there is no liquid in between lamp and light sensor.



Part of a logic circuit of liquid column sensor is shown in the figure.



[see page twenty

The table shows the logic relationship among the input and output of the light sensor.

Light level in the sensor	output logic level
Dark	0
Bright	1

i. Name the gate X

ii. Copy the following table on your answer sheet. When bottles filled with various levels are in the sensor, fill the logic levels of P, Q and R.

liquid level	P	Q	R	F
over filled				
acceptable level				
under filled				

iii. For the activity of reaction circuit, output needed is '1'. The Y should only give 1, when the bottle is not filled to the correct level. So

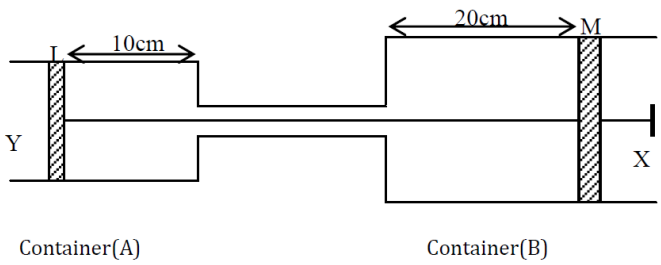
1. Fill the output of Y in the table
2. Give the output F in terms of Q and R in the Boolean equation form.
3. Prepare the logic circuit in Y only using NAND gates.

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

(A)

(a) State Boyle's law.

(b)



Rigid containers A and B have two airtight pistons L and M, which has the ability to move freely along the container. These are connected together by a light inelastic string and air is trapped inside the container. The cross sectional areas of pistons L and M are $1x10^{-3}m^2$ and $2x10^{-3}m^2$. The volume of the total air trapped inside the container at this state is $6 \times 10^{-4}m^3$ and the pressure is $2x10^5Pa$. Atmospheric pressure is $1x10^5Pa$.

[see page twenty one

i. Containers are held steady and by applying a force at X, the system is maintained at equilibrium.
   1. What is the force applied at X and what is the direction it is applied?
   2. What is the tension in the string?

ii. If the system is kept on a frictionless surface and the force applied at X is removed and allowed to move, what would you say about the motion of the system?

When answering the following questions, neglect the mass of the container and pistons.

In the following motion, the air inside the container A is removed.

1. What is the change of volume of the trapped air?
2. If the temperature of the trapped air does not change, then what is the pressure?
3. When attaining equilibrium from this, argue that the air inside the container (A) would be totally removed. (The system when attaining equilibrium returns to the initial temperature).

iii. What is the work done by the trapped air, when it reaches the final equilibrium in question (iii)(3)? (Hint: work is done against the atmospheric pressure)

iv. What is the energy absorbed by the system, when it reaches equilibrium after the force is removed?

v. "For heat transfer, there must be a temperature different among the system", by this concept explain the heat transfers in the above question (ii)(3).

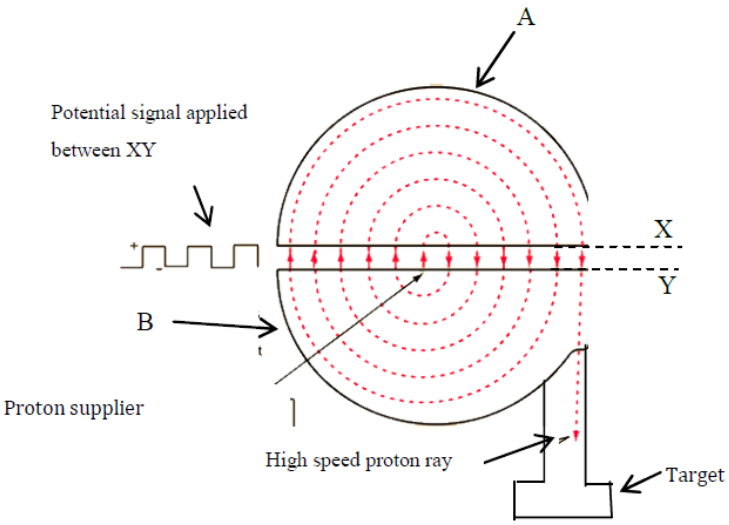
vi. Draw the approximate variation of the average temperature of the system with time, from the moment the system is released until it reaches the room temperature.

(B) Naturally found unstable nuclei of radioactive isotopes are artificially produced for medical purposes and also for physics research purposes. This process is done by colliding a nucleus by an ion having high kinetic energy.

18F is one of the most important isotopes which is used in medical field to do Pet scan. This nucleus has short lifespan and emits positron. These are created artificially by setup called Cyclotrons. This setup comprises of two major parts.

1. Ion accelerating part
2. Place where it hits the target

[*see page twenty two*



This is found in a completely empty place (vacuum). Only charged particles (ions) can be accelerated in a cyclotron and an electric field is also used for this purpose. The ion source is found in the middle of the cyclotron. A positive ion being accelerated in the gap in-between the two semicircular portions A and B known as DEE is shown in the figure. For this purpose, a constant potential difference is applied across X and Y and this potential difference changes into positive and negative potentials in a given time period. The positive ion (proton) which is released approximately from rest, from the center of the cyclotron and it is released from an edge of DEE. Due to the force by the strong and directed magnetic field on the positively charged particle its is directed to move in a path as shown in the figure.

The released proton with high kinetic energy is collided with $^{18}_{8}O$ isotope and a neutron is released and converted as ^{18}F. The activity A is measured as below

$$A = In\sigma(1 - e^{-\lambda t})$$

Here

I- The number of protons perform collision in a unit time (s) in a unit area (cm2) of a target having ^{18}O

n - Number of ^{18}O atoms

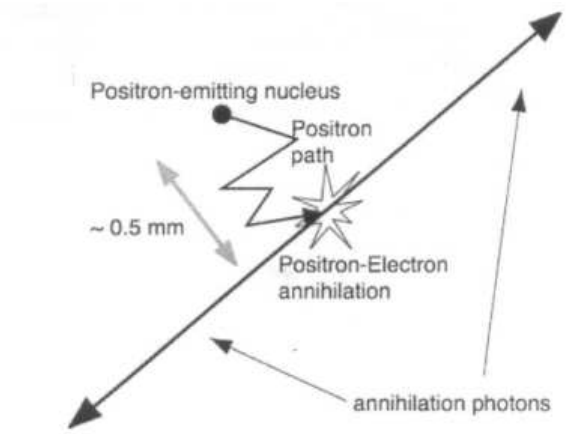
λ - Radioactive decay constant

σ - Area of target where collision takes place (cm^2)

t - Collision time (s)

At the target collision takes place in 300millibarn area and the half life time (t1/2) of ^{18}O is 110 minutes. (1barn=10-24cm2). ^{18}F is inserted into patients body where scanning needed. This inserted isotope travels some distance and joins with the electron in the scanning place and destroys and two photos (γ – rays) are also released as shown in the figure. When this is received by an instrument out of the body, PET image is created.

[*see page twenty three*



(a) i. In this particular structure, if the path of the accelerating positive ion as shown in the above diagram, then what is the direction of the magnetic field at that particular place?

ii. In the instance where a positive ion move from x to y, what is the sign of potential at y related to x?

iii. If the magnetic flux at the particular point is B, the potential difference is V_o, the mass of the ion is m and its charge is e,

1. In the motion in sides X and Y (in two DEE A and B), no work is done by the magnetic field on the charge, give reason for this.
2. What is the kinetic energy obtained by that charge, when it has traveled n times across X and Y?
3. What is the radius of motion of the charged particle, from it enters y from x with velocity V and again enters x from y? x
4. What is the time t taken for the motion of the ion in the above question (iii)?

(b) i. Write the nuclear reaction takes for the product formed when a proton collides with a nucleus of $^{18}_{8}O$.

ii. Calculate the number of protons in 30μA/cm2s. (charge of proton e = 1.6 x10-19C)

iii. Calculate the decay constant of produced ^{18}F. $\lambda = \frac{0.7}{t_{1/2}}$

iv. 1g $H_2{}^{18}O$, is collided with a proton beam of 30μA/cm2 for one hour. Calculate the activity of produced ^{18}F. (n=2.17 x1023, e-0.378 = 0.6852)

v. When produced ^{18}F in this method has activity 108Bq it is inserted into the patients' body. After 55 minutes, PET image is obtained. At this state, find the rate of formation of γ photons inside the body in terms of s^{-1}.

[*see page twenty four*

(Assume that all positrons which can produce γ from the emission of ^{18}F joins with the electrons in the body parts)

vi. What is the reason, the γ rays produced inside the body can be used to obtain PET image?

vii. What is the reason, the formed γ rays are produced in opposite directions, during the decay process when positron joins with electrons?

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