Royal College - Colombo 07

Grade 13

Final Term Test – November 2023

Physics I

01 E I

Time : 2 hours

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

Answer all questions.

Part I

(01) The unit of current density is,

1) $A\ m^{-2}$ 2) $A\ m^{-3}$ 3) $I\ m^{-2}$ 4) $I\ m^{-3}$ 5) $A\ m^{-1}$

(02) The main scale of a vernier caliper is marked in 1mm divisions. The length of 49 divisions of main scale is equal to 50 vernier divisions. The measurement, which is not taken by this instrument would be,

1) 8.00mm 2) 10.23mm 3) 18.78mm 4) 7.822cm 5) 12.062 cm

(03) The length of the string of a simple pendulum is *l* and the radius and the mass of the pendulum bob is **r** and **m** respectively. The periodic time of the pendulum is T. Now the pendulum bob is replaced by another bob of same material of mass **8m.** The periodic time of new pendulum is,

1) T 2) $T\sqrt{\frac{l+r}{l+2r}}$ 3) $T\sqrt{\frac{l+2r}{l+r}}$

4) $T\sqrt{\frac{l+4r}{l+r}}$ 5) $T\sqrt{\frac{l+8r}{l+r}}$

(04) Consider the following statements regarding the traveling microscope,

A) Both eye piece and the objective piece are convex lenses.

B) The distance between the eye piece and the objective piece should be adjusted to focus an object.

C) The final image is virtual and magnified.

The correct statement is/are?

1) A only. 2) B only. 3) A and B only.

4) A and C only. 5) All A, B and C are correct.

(05) The displacement (x) of a particle which follows a simple harmonic motion gives as $x = A\sin(\omega t + \frac{\pi}{2})$. The diplacement at t = 0 is given by,

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

(06) Same masses of two liquids P and Q are in two identical calorimeters of negligble heat capacity. When these two calorimeters are kept in a refrigerator, liquid P is cooling faster than the liquid Q. Consider the following statements.

A) Liquid P is most suitable than Q, to make a liquid – glass thermometer.

B) Liquid P is most suitable than Q, for using as a refrigerator liquid.

C) Liquid P is most suitable than Q to make a liquid resovour of constant temperature in the laboratory.

The correct statement(s) is/are?

1) A only. 2) B only. 3) C only. 4) A , B only. 5) All A , B , C

(07) The figure shows that a strong wind is blowing above a roof of a house which is having a horizontal ceiling. Following are the suggestions given by students to protect the roof removing by the wind.

A) Keeping the doors and windows are opened during the wind is blowing.

B) Keeping the doors and windows are closed duting the wind is blowing.

C) Reducing the inclination of the roof to the horizontal.

D) Increasing the inclination of the roof to the horizontal.

The correct suggestion(s) from the above is/are,

1) A only. 2) B only. 3) C only. 4) A and C only. 5) A and D only

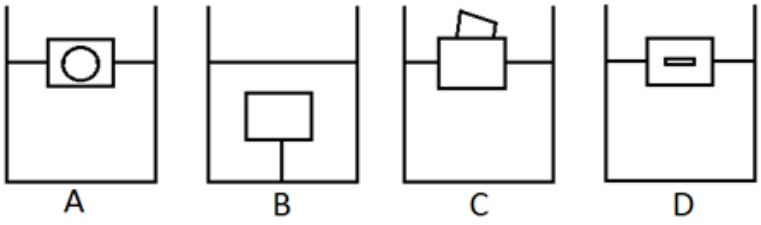
(08) Four possibilities of floating of an ice – cube in the water breaker are shown in following figures.

Figure A - Ice cube is floating on the water with an air hole.

Figure B – Ice cube is attached to the bottom of the vessel using a string.

Figure C – Ice cube is floating on the water with a cork.

Figure D – Ice cube is floating with a metal coin.



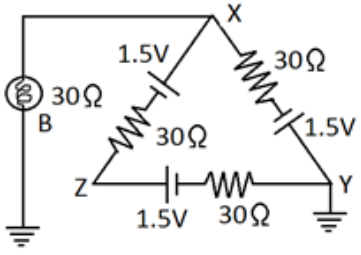
The situations which are not changed the water level when ice is melted is,

1) A and C only 2) B only

3) C and D only 4) B , C and D only

5) All A , B , C and D.

(09) The three cells in the circuit are having zero internal resistance. Three resistances of 30Ω are connected to them. Another bulb of having 30Ω resistance is connected externally as shown in the figure. The potential difference across the bulb is,



1) 0 V 2) 0.375 V 3) 0.75 V

4) 1.5 V 5) 3 V

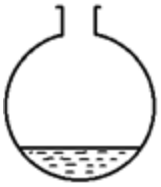
(10) Two opened vessels of volumes 0.2 m^3 and 0.3 m^3 are kept in a same environment. Room temperature is 30^0 C. Now a packet of silica gel is inserted in the vessel of volume 0.3 m^3 and seal it. The other vessel is sealed without inserting silica gel. While decreasing the temperatures of both vessels, it is found that the dew points of 0.2 m^3 vessel and 0.3 m^3 vessel are 15^0 C and 5^0 C respectively. The saturated vapour densities at 5^0 C and 15^0 C are 6.8 g m^{-3} and 12.7 g m^{-3} respectively. The amount of mass of water vapour which absorbed by silica gel is,

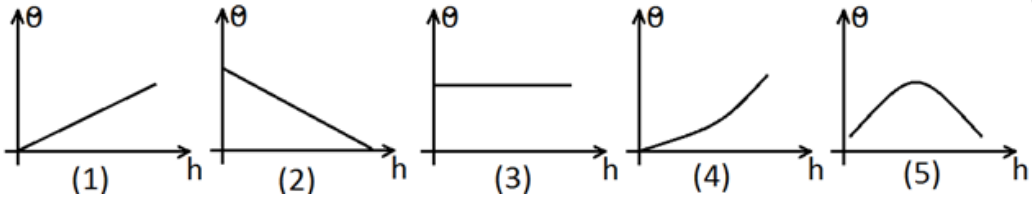
1) 6.8 g 2) 3.81g 3) 2.04 g 4) 1.77 g 5) 0.50 g

(11) By applying an unbalanced horizontal force, a bus which is at rest obtained velocity v within 8 s time duration. The mass of the bus is increased in 50% due to loading the passengers. Now the time taken to obtain the same V velocity by the same force F is,

1) 4 s 2) 8 s 3) 12 s 4) 16 s 5) 32 s

(12) The variation of the contact angle with the liquid height(h) of the given cleaned vessel when adding a pure liquid is given by,



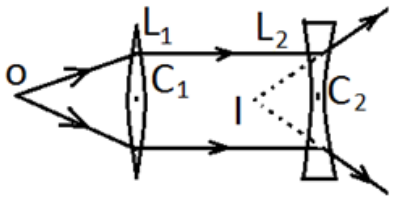


(13) The phenomenans which cannot be explained by resonance,

A) Action of swinging a swing as increasing the amplitude.
B) For high pitch sounds, tall glass vessels are damaged.
C) Vibrating a tuning fork by hammering a prong of it.
D) A bridge may be damaged by the soldiers who are marching on the bridge.

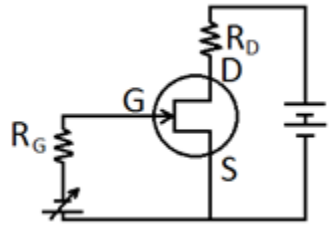
1) A only 2) A and B 3) C only 4) B and D only 5)A , B , D only

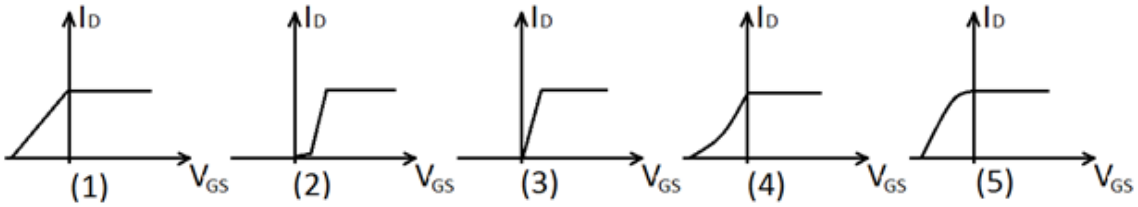
(14) L_1 and L_2 are convex and concave lenses. The final image of the point object O is formed at I. The position of the final image when the convex lens L1 is slightly moved towards the point O, is



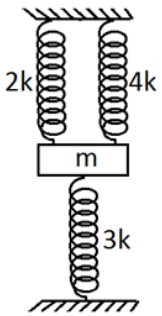
1) Between I and C_2 2) Between I and C_1
3) Right side at C_2 4) Between O and C_1
5) No change

(15) Following figure shows that an N-channel transistor is biased to flow DC- current by applying a dc voltage. The variation of drain current (I_D) with the voltage of G with respective to S (V_{GS}) is best represented by"





(16) Following figure shows that a mass m is under equilibrium with three springs of spring constants 2K, 4K and 3K. The periodic time of mass m, when it is vertically oscillated,

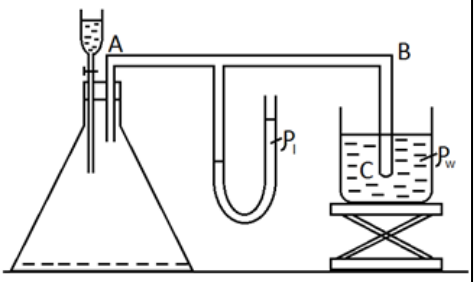


1) $T = 2\pi\sqrt{\frac{m}{K}}$ 2) $T = 2\pi\sqrt{\frac{2m}{K}}$

3) $T = 2\pi\sqrt{\frac{m}{4K}}$ 4) $T = 2\pi\sqrt{\frac{m}{6K}}$

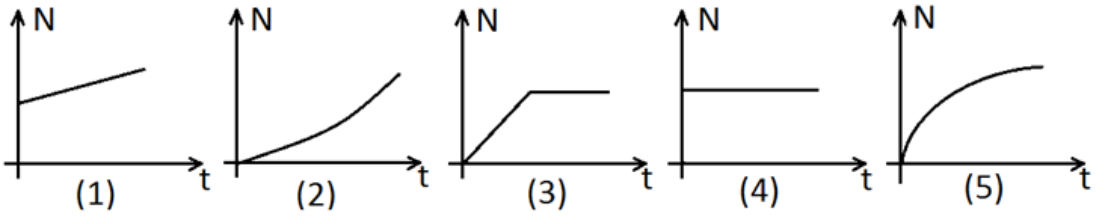
5) $T = \frac{2\pi}{3}\sqrt{\frac{m}{K}}$

17) The figure shows the Jegger's apparatus which is used to determine surface tension. hen an air bubblel is formed at the end C of the tube ABC, the maximum difference of water levels in the manometer liquid is 8 cm. The density of the liquid in the manometer is 800 Kgm^{-3}. The density of the water is 1000 Kg m^{-3}. The length of the part of the tube ABC, which is inside the water is 5.4 cm. The surface tension of the water (T) = 5.4 x 10^{-2} $Nm^{-1.}$ The minimum radius of the air bubble which is formed at the end C is in mm,



1) 1.44 2) 2.44 3) 2.88 4) 2.78 5) infinite

18) The variation of number of stable nuclei (N) which are formed by decaying a sample of unstable radioactive nuclei with time (t) is best represented by,



19) A uniform rod AB of mass m and length l is pivoted at point A at the ground and it is free to rotate on the verticle plane. Initially the rod is kept verticaly and released it. The linear velocity at point B when it is reached to the ground is, ($I = 1/3ml^2$)

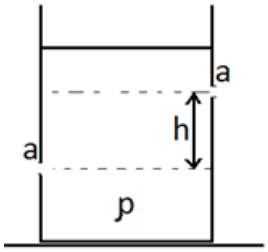
1) $\sqrt{\frac{gl}{3}}$ 2) $\sqrt{\frac{gl}{2}}$ 3) $\sqrt{3gl}$ 4) $\sqrt{2gl}$ 5) $\sqrt{gl}$

20) A particle is projected at velocity U with θ inclination to the horizontal. The range of θ to be satisfied, that may be possible to have equal vertical and horizontal velocity components at a certain time along the path is,

1) $0 \leq \theta \leq \frac{\pi}{4}$ 2) $\frac{\pi}{4} \leq \theta \leq \frac{\pi}{2}$ 3) $\theta \leq \theta \leq \frac{\pi}{6}$

4) $0 \leq \theta \leq \frac{\pi}{2}$ 5) $\frac{\pi}{4} \leq \theta \leq \pi$

21) A liquid of density ρ is in a vessel as shown in the figure. Two small holes of area 'a' are on it's walls at h seperation. If the vessel is on a rough floor at rest, the friction force acting on the bottom surface of the vessel by the floor is,



1) 0 2) $a\rho gh$ 3) $\sqrt{a\rho gh}$
4) $2a\rho gh$ 5) $\sqrt{2a\rho gh}$

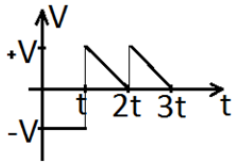
22) A sphere and a cube which are having same surface area and same meterial are heated upto a some temperature and allowed to cool in same environment. The ratio odf rate cooling at the starting is"

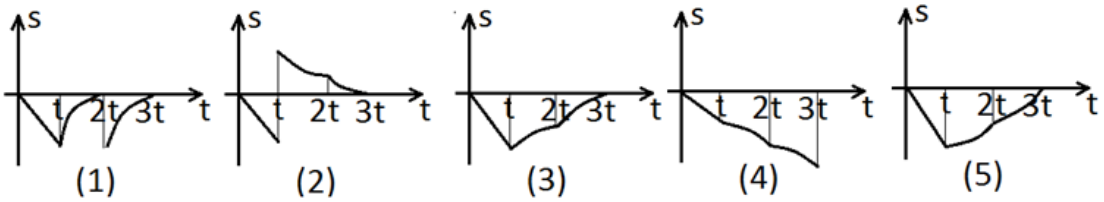
1) $\sqrt{\frac{\pi}{6}} : 1$ 2) $\sqrt{\frac{6}{\pi}} : 1$ 3) $\frac{\pi}{\sqrt{6}} : 1$ 4) $\frac{\pi}{\sqrt{3}} : 1$ 5) 1 : 1

23) Sixteen metal wires are connected in equal distance to the circumference of a metal wheel through it's centre. The wheel is rotating about it's axis with constant angular velocity ω. A perpendicular constant magnetic field of density B is applied perpendicular to the plane of the wheel. The induced electromotive force between the centre and the circumference of the wheel is,

1) $\omega r^2B/2$ 2) ωr^2B 3) $4\omega r^2B$ 4) $8\omega r^2B$ 5) $16\omega r^2B$

24) The velocity time graph for an object which is moving along a straight line is given in the figure. The respective displacement time graph is,





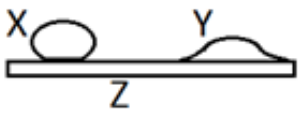
25) The masses of two objects A and B are m_A and m_B respectively and $m_A < m_B$. The kinetic energies of two objects are equal. The correct statement from following is,

1) The momentum of B is larger than that of A.
2) The momentum of A is larger than that of B.
3) The velocity of A is less than that of B.
4) If both objects are moving vertically upward, they will reach to a same height.
5) If both objects are moving vertically upward, the object A is reached to larger height than the object B.

26) A bullet of velocity 150 ms^{-1} is collided on a wooden pallet and moving out from the pallet with 125 ms^{-1} velocity. If another bullet of velocity 90 ms^{-1} is collided on the same pallet, the velocity of the bullet which moving out is (The resistamnce forces for both situations are same)

1) 20 ms^{-1} 2) 25 ms^{-1} 3) 35 ms^{-1} 4) 45 ms^{-1} 5) 50 ms^{-1}

27) Two liquid bubbles X and Y are on a plate as shown in the figure. Consider the following statements.



A) The density of liquid X is greater that that of liquid Y.

B) The surface tension of liquid X is greater than that of liquid Y.

C) The angle of contact between X - Z is larger than that of Y-Z.

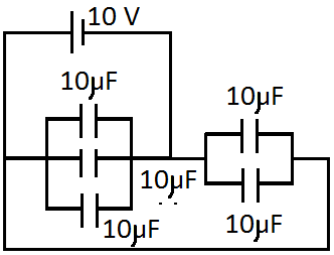
The true statement(s) is/are?

1) A only. 2) B only. 3) C only.
4) B , C only. 5) All A , B , C

28) The values should be given to the inputs A, B and C to obtain the value of the output Q as zero for given logic circuit,

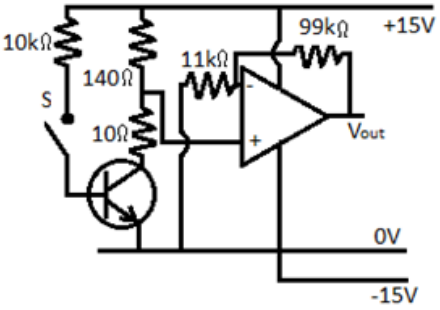
1) A=0 , B=0 , C=0 2) A=0 , B=0 , C=1
3) A=0 , B=0 , C=1 4) A=1 , B=1 , C=0
5) A=1 , B=0 , C=1

29) The capacitance of each and every capacitor is 10 µF. 10 V supply is given to the circuit as shown in the figure. The stored energy of all capacitor is,



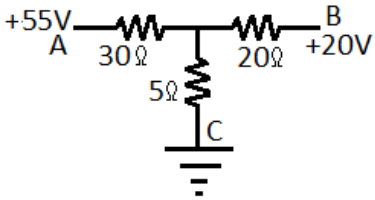
1) 2.5×10^{-3}J 2) 5×10^{-3}J
3) 10×10^{-3}J 4) 2.5×10^{-2}J
5) 5×10^{-2}J

30) If the switch S is closed, the transistor is become saturated. The output voltage (V_{out}) is,



1) 0 V 2) +1 V 3) +9 V
4) 10 V 5) 15 V

31) The voltages at point A, B and C are +55 V, +20 V and 0 V respectively. The values of current which are flowing through 30Ω , 20Ω, 5Ω are respectively given by,



1) 1A, 1A, 2A 2) 1.5A, 0.5A , 2A
3) 1.5A, 1A, 2.5A 4) 2A ,1.5A, 3.5A
5) 1.5A, 2A, 3.5A

32) The relative humidity of a given air sample is increased up to 80% by reducing its volume in 60%. The initial relative humidity of the air sample before compressing it is given by,

1) 64% 2) 50% 3) 40% 4) 32% 5) 20%

33) Two liquid-glass thermometers are calibrated within the range of 0^0c and 100^0C. Their stems are identical and the sizes of bulbs and the types of liquids in the bulbs are different. The volume of the small bulb is half of the large bulb. A liquid of volume expansion 2×10^{-4} K^{-1} is existed in the small bulb. The linear expansivety of glass is $\frac{4}{3} \times 10^{-5} K^{-1}$ The volume expansivety of the liquid which is in the large bulb is,

1) 3.6×10^{-4} K^{-1} 2) 3.2×10^{-4} K^{-1} 3) 1.2×10^{-4} K^{-1}
4) 0.8×10^{-4} K^{-1} 5) 4×10^{-4} K^{-1}

34) A sound source of frequency f_o is moving with u velocity towards an observer who is at rest. The velocity of sound is V. The wave length of sound wave in air is λ. Consider the following statements.

A) The frequency of sound heard by the observer is greater than f_0.

B) The velocity of sound heard by the observer is greater than V.

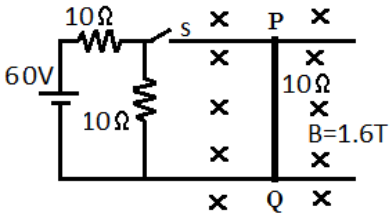
C) The wavelength of sound heard by the observer is less than λ.

The correct statement(s) is/are?

1) A only. 2) B only. 3) A and B only.

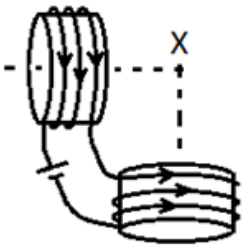
4) A and C only. 5 All A , B , C

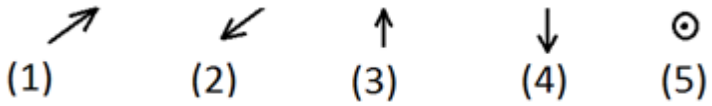
35) A metal rod of mass 0.16 kg and length 150 cm is kept on a smooth metal rail as shown in the figure. This setup is kept in a magnetic field of 1.6 T which is perpendicular to the paper. The resistance of the metal rod is 10 Ω. The acceleration of the metal rod just after the switch is closed is,



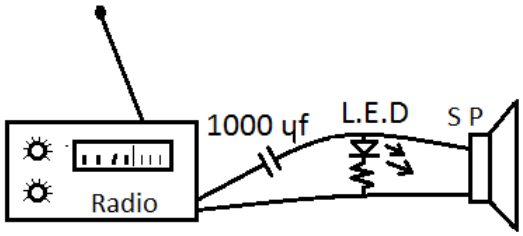
1) 30 ms^{-2} 2) 20 ms^{-2} 3) 5 ms^{-2} 4) 3 ms^{-2} 5) 1 ms^{-2}

36) There are two identical current carrying coils as shown in the figure. The direction of the magnetic flux density at point X , when an current is flowing through the coils towards the given dirrection is,





37) A student tries to operate the speaker of his radio at outside from the radio. For this, he is using a capacitor of 1000 μF capacity, a Light emitting diode (LED) and a resistor. Consider the following statements regarding the circuit.



A) A continuous sound cannot be heard by the speaker due to inserting the capacitor.

B) The intensity of light emitting diode is varied according to the intensity of sound.

C) Light emitting diode is not glowing due to inserting the capacitor

The correct statement(s) is/are?

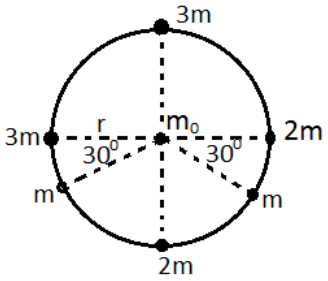
1) A only 2) B only 3) C only

4) A and B only 5) A and C only

38) An spectrometer should be adjusted before taking readings using it. For this,

1) Prism table should be adjusted first.
2) The objective lens of the telescope should be adjusted first.
3) The eye piece of the telescope should be adjusted first.
4) The slit of collimator should be adjusted first.
5) The collimator should be adjusted first until recieving the parrallel rays.

39) The various point masses are kept on the circumference of a circle of radius r as shown in the figure. There is a mass m_o at the centre of the circle. The system is in an isolated area which is not affected by other gravitational fields. The resultant force which is acting on mass m_o is ,



1) 0 2) $\frac{Gmm_0}{r^2}$

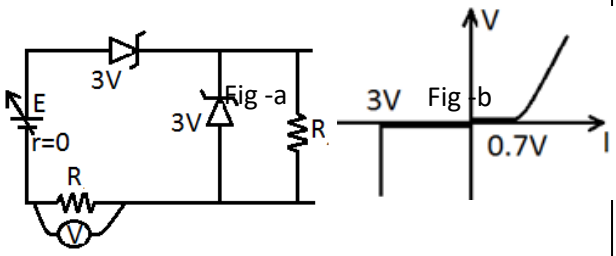
3) $\sqrt{2}\frac{Gmm_0}{r^2}$ 4) $\sqrt{2}\frac{Gmm_0}{r}$ 5) $\frac{2Gmm_0}{r^2}$

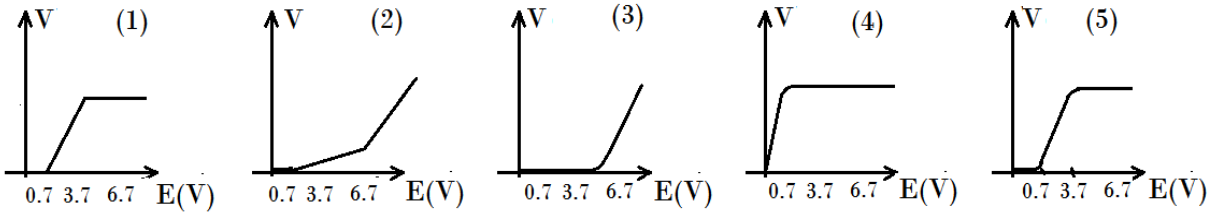
40) Two masses m and 2m are kept on a smooth plane. A velocity V is given to mass m to just reached up to the maximum height of mass 2m. The value of V would be,

1) $\sqrt{\frac{gh}{3}}$ 2) $\sqrt{gh}$

3 $\sqrt{2gh}$ 4) $\sqrt{3gh}$ 5) $\sqrt{6gh}$

41) The two diodes in the circuit are identical and the chracteristic curve of a diode is shown in the graph. An ideal voltmeter is connected across R. The variation of the reading of the voltmeter with electromotive force of the cell (E) is best represented by, (The internal resistance of the cell is negligible)





42) Masses of two objects A and B are m_A and m_B respectively. Each of these objects are given a charge Q. The objects B is moving under constant angular velocity along a circular path of radius r, as the object A is at the centre at rest. The angular velocity of object B is,

1) $\frac{Gm_A}{r^3}$ 2) $\left[\left(\frac{1}{4\pi\epsilon_0}Q^2 - Gm_Am_B\right)\frac{1}{r^3m_B}\right]^{\frac{1}{2}}$

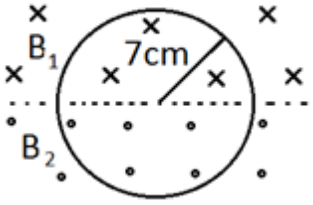
3) $\left[\left(\frac{1}{4\pi\epsilon_0}Q^2 - Gm_Am_B\right)\frac{1}{r^3m_A}\right]^{\frac{1}{2}}$ 4) $\left[\left(Gm_Am_B - \frac{1}{4\pi\epsilon_0}Q^2\right)\frac{1}{r^3m_A}\right]^{\frac{1}{2}}$

5) $\left[\left(Gm_Am_B - \frac{1}{4\pi\epsilon_0}Q^2\right)\frac{1}{r^3m_B}\right]^{\frac{1}{2}}$

43) The resistance of a platinum wire at 30^0C and 100^0C are 56 Ω and 70 Ω respectively. The value of the current flowing through this wire when it is kept on melting ice and giving a 50 V potential difference for a short time period across it is,

1) 0.6 A 2) 0.8 A 3) 0.9 A 4) 1 A 5) 1.2 A

44) Two magnetic fields of densities B_1 and B_2 are applied through a circular loop of metal wire of radius 7cm as shown in the figure. The resistance of the loop is 0.1 Ω.The magnetic field B_1 is reducing at a rate of 0.5 T s^{-1} and B_2 is reducing at a rate of 0.3 T s^{-1}. The current through the loop in mA is,



1) 7.7 2) 15.4 3) 30.8 4) 61.6 5) 123.2

45) A light of wave length λ is incident on to a metal surface which is having a threshold wave length λ_o . Plank constant is *h* and the velocity of light is C. consider the following statements.

A) If $\lambda > \lambda_0$, the elctrones are emitted from the metal.

B) If teh energy of the incident ray is greater than $\frac{hc}{\lambda_0}$ the electrons are emitted from the metal.

C) If the light rays which are having less wave lengths than λ are incident on the metal surface, the number of electrons which are emmiting from the metal surface are increased.

The correct statement(s) is/are? "

1) A only 2) B only 3) A , B only
4) B , C only 5) All A , B , C

46) The temperature of a given black body which is kept in 0 K environment is T_o K. Now it's temperature is increased up to 2 T_o K. Consider the following statements.

A) The rate of energy of radiation emmited is doubled due to the increment of the temperature in two times.

B) The frequency relevant to the maximum intensity of radiation is doubled due to the increment of the temperature in two times.

C) The number of radiation which are emitted by atomic nuclei are doubled due to the increment of the temperature in two times.

The true statement (s) is/are

1) A only. 2) B only. 3) A and B only.
4) B and C only. 5) A and C only

47) There is one α emission, one β emission and two γ emission from the radioactive element $^{220}_{80}X$ and it becomes another element $^{Q}_{P}Y$ The values of P and Q are,

1) P = 79 , Q = 216 2) P = 80 , Q = 216
3) P = 79 , Q = 220 3) P = 79 , Q = 218
5) P = 78 , Q = 216

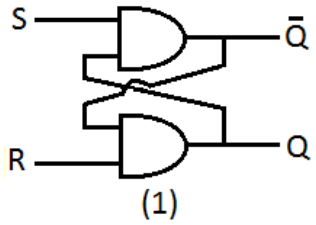
48) A particle is moving with constant V velocity along a circular path of radius R. When the particle is displaced by $\frac{\pi}{3}\ rad$ angular displacement, the change of velocity is given by,

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

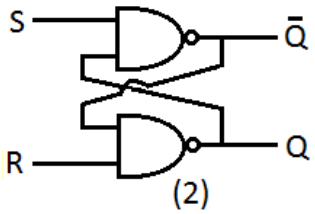
49) X number of identical wires of 0.6 mm^2 cross sectional area and 12m length are fixed parallely as shown in the figure. The young's modules of the material of wire is 2 x 10^{11} Nm^{-2}. Horizontal force of 900 N is given to the combined wire. If one wire is removed, the rest of wires are extended in 1mm each. The value of X would be (all wires are under proportional limit)

1) 8 2) 9 3) 10 4) 11 5) 12

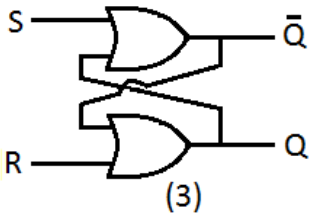
50) The correct circuit for SR flip-flop is given by,



(1)



(2)



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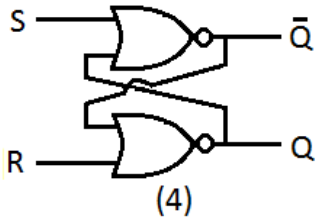
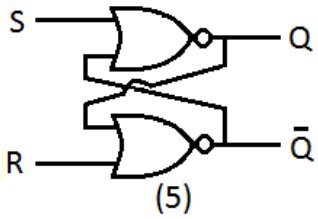


(4)



(5)

Royal College - Colombo 07
Grade 13
Final Term test – November 2023
Physics II

01 E II

Time : 3 hours and 10 minutes

Name :- ..... class : -..... Index no :- .....

Important :

(iii) *The question paper consists of **22** pages*

(iv) *The question paper comprises **PartA** and **Part B.** The time allotted for both part in **3hours and 10minutes.***

(v) *Use of calculators is **not**allowed*

Part A - Structured Essay

(09pages)

Answer all the questions on this paper itself.Write your answers in this spaces provided is sufficient for your answers and that extensive are not expected.

Part B - Essay

(13 pages)

*This part contains three questions. Use the papers supplied for this purpose. At the end of the time allotted for this paper, tie the two papers so that **Part A** is on top of **Part B** before handing them over to the Supervisor.*

*You are permitted to remove **onlyPart B**of the question paper from Examination hall.*

g = 10 Nkg^{-1}

For Examiner's use only

For the second paper		
Part	Question nos.	Marks
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
	8	
	9(A)	
	9(B)	
	10(A)	
	10(B)	
Total		

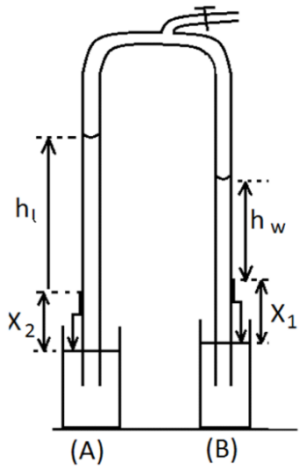
Final Marks

In numbers	
In words	

Part A – Structured Essay

Answer all the question.

1. An experimental setup of a hare's apparatus in a school laboratory is shown in the figure.



(a) Left beaker (A) contains oil, and the right beaker (B) contains water. X_1 and X_2 are indicators. If the height of the water column from the top of the indicators is h_w, and the height of the oil column is h_l, and the heights of the indicators are X_1 and X_2 , obtain an expression for h_w in terms of X_1,X_2 density of oil ρ_l, density of water ρ_w and acceleration of gravity g.

.....

.....

.....

(i) The readings obtained are shown in the table below.

h_l cm	9.0	13.4	16.2	19.8	23.0	27.0
h_w cm	7.2	10.8	13.0	15.8	18.4	21.6

(ii) Which value of h_w has the largest fractional error from these readings?

.....

(iii) Mark the coordinates which can be marked on the given coordinate plane.

(iv) Find the relative density of the oil using the graph.

.....

.....

(v) Is it necessary to equalize the liquid levels in the beakers during the experiment? Explain the answer.

.....

.....

.....

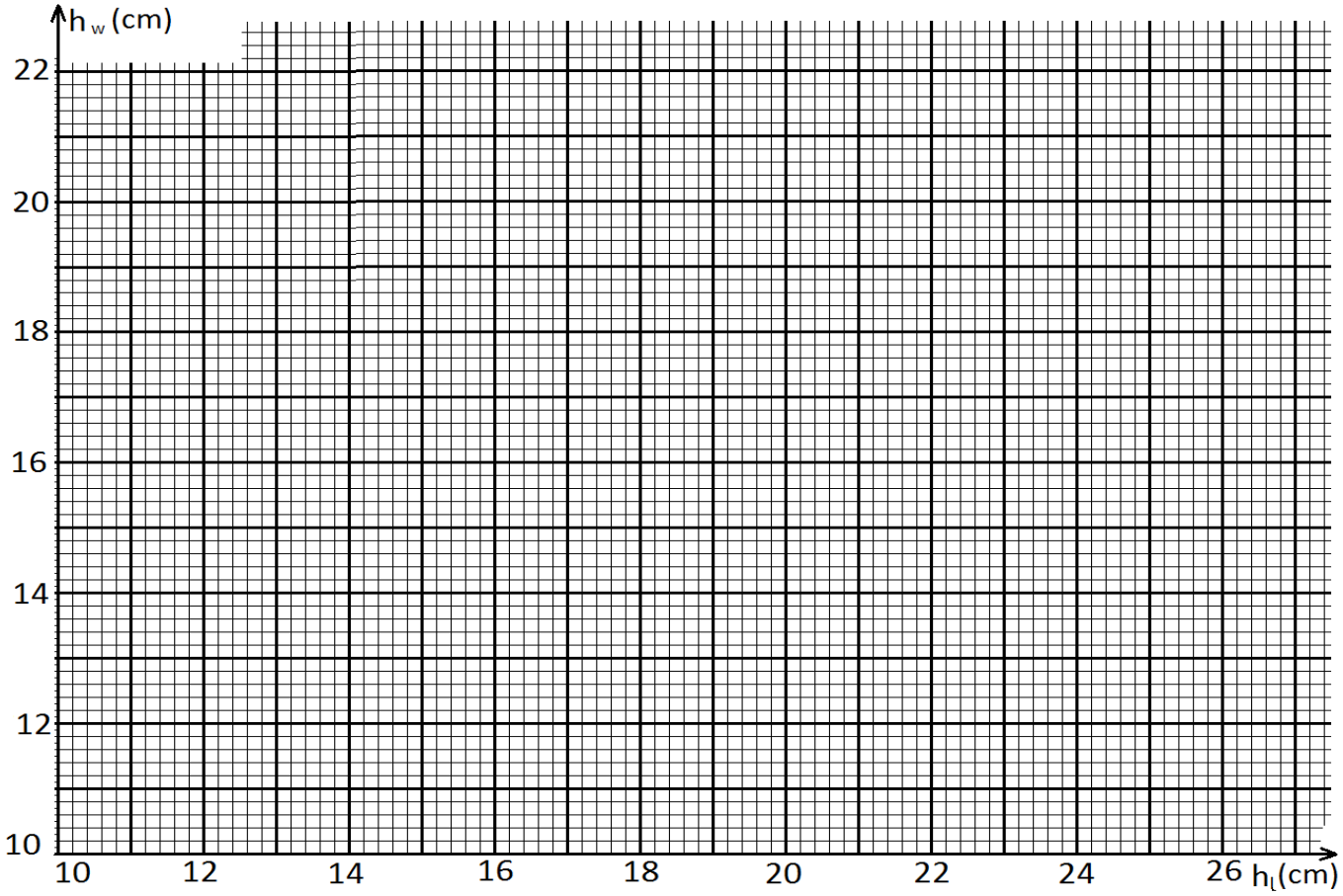
(vi) Are the cross-sectional areas of the two arms required to be the same? Give reasons.

.....

(vii) In this experiment there is another instrument which is required for taking readings correctly. Name the instrument and state the advantage of using that instrument.

Instrument :- .....

Advantage :-. .....



(viii) In order to perform the experiment in a short period of time, the readings are taken by moving both liquids to the top of the hare's apparatus and then dropping the liquid levels gradually. How can the readings be inaccurate now?

.....

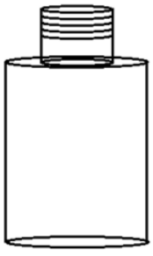
(ix) State whether the hare's apparatus can/cannot be used to find the relative density of liquids having the following properties.

(a) Highly volatile liquids: .....

(b) Miscible liquids : .....

(c) Immiscible liquids : .....

(b) A stock of oil of density measured by this hare's apparatus is filled into cylindrical glass bottles of uniform thickness as shown in figure. When the outer diameter of the bottle was measured with a vernier caliper which has not a zero error, a reading was obtained as shown in figure P. When the thickness of a small piece of glass taken from

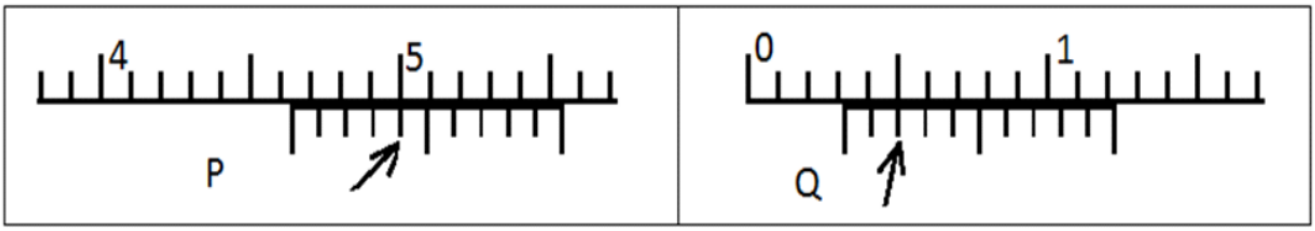


such a bottle was measured with a vernier caliper, readings were obtained as shown in figure Q.

(i) What is the reading of figure P? .....

What is the reading of figure Q?.....

What is the internal diameter of the bottle?.....



(ii) If the height of the oil placed in the bottle is 5.00 cm, what is the volume of oil filled in the bottle in ml? take as $\pi = 3$

.....

.....

(iii) The oil in this bottle is meant to be applied to a sore leg. Consider that the diameter of the leg is 10 cm, oil is applied to a height of 20 cm and consider the leg as cylindrical.

(a) If the thickness of the oil applied at one time is 0.1 mm, find the volume of oil required at one time in ml

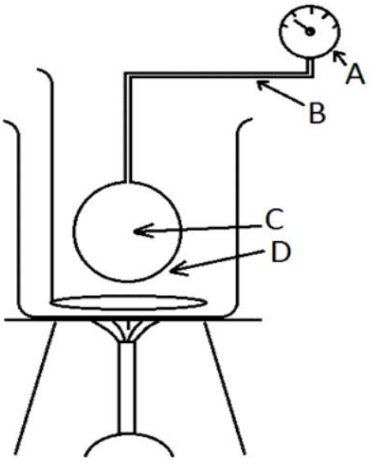
.....

.....

(b) If oil is applied twice a day, how many days will one bottle of this oil last?

.....

2. A student designs an experiment in a laboratory to verify the relationship between the pressure and absolute temperature of a gas at constant volume. An incomplete diagram of the experimental setup is shown in the figure.



(a) (i) Mark the amount of water to be poured into the beaker in the diagram.

(ii) D is a round bottom flask. C is the air contained in it. How should the air be?

.....

.....

(iii) (a) What is B?

.....

(b) Compare the amount of gas contained in B with the amount of substance contained in C. Why should it be so?

.....

.....

(b) The setup was prepared in a laboratory with temperature 27 ^{0}C and pressure conditions of 760 mmHg. The gas in C is also initially in these conditions. The reading obtained at 27 ^{0}C as the initial reading and the reading obtained at 87 ^{0}C as the final reading and it is expected to take six readings.

(i) Obtain the possible value for the pressure of the gas in C at 87 ^{0}C by a calculation.

.....

.....

.....

(ii) As a suitable pressure gauge for this experiment could not be found in this country, 3 pressure gauges which could be imported from another country were found on the internet.

X- manometer 750-1000 mmHg
Y- manometer 500-1000 mmHg
Z - manometer 0-1000 mmHg

Which of the above X, Y, Z pressure gauges would you choose for this experiment and give reasons.

.....

.....

.....

(iii) As six readings are to be taken with good dispersion in this experiment , state the temperatures at which readings should be taken respectively in the table below. You have to mark only four temperatures.

θ °C	27					87
P mmHg	760					

(iv) In this experiment, before taking the readings, the temperature should be maintained at the same temperature for a long time.

(a) Why should it be maintained like this?

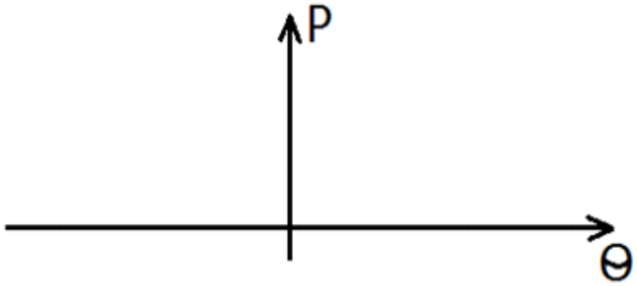
.....

(b) Mention the experimental steps for this.

.....

.....

(v) Draw the expected graph on the axes.



(vi) What should be the temperature in ^{0}C, where the graph you drew intersects the temperature axis

.....

(vii) Is it suitable to use an electric heater instead of a Bunsen burner for this experiment ? Give reasons.

.....

.....

(viii) If this apparatus is used as a constant volume gas thermometer, state whether the following qualities are lower or higher and state the reason.

(a) Sensitivity ;- .....

reason ;- .....

.....

(b) Accuracy ;- .....

reason ;- .....

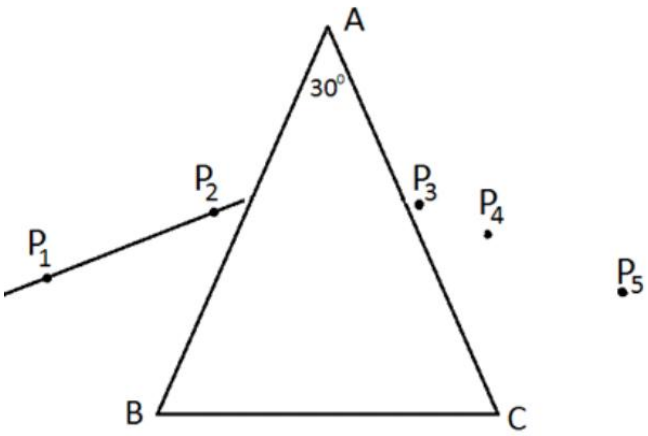
.....

(c) Quick responses ;- .....

reason ;- .....

.....

3. The figure shows an incomplete diagram used for the experiment of finding the minimum angle of deviation of a prism using a prism and pins. Pins P_1 and P_2 are mounted on the drawing board.



(a) (i) Explain how the emergent rays are found.

.....

.....

(ii) As shown in the above figure, to find the emergent ray, at which position should the third pin be located in the experiment from the locations of the pins P_3 , P_4 , P_5 ?

.....

(iii) Which is the best place to position the fourth pin

.....

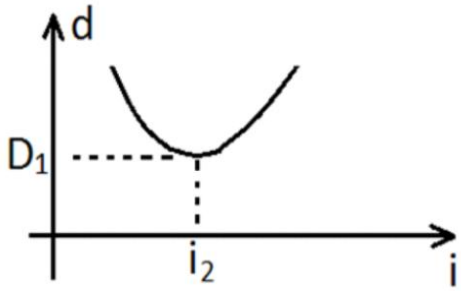
(iv) Complete the ray diagram in the figure and show the angle of deviation

(v) Which pins would you choose if there are thin pins and thick pins in the lab?
Give the reason.

.....

.....

(vi) A graph for a glass prism of prism angle 30° is drawn by taking readings as in figure



(a) If a glass prism 60° is used instead of 30° prism, is angle of minimum deviation less or more than in Prism 30°

.....

(b) If a glass prism 60° is used instead of 30° prism, angle of incidence corresponding to angle of minimum deviation is less than or greater than that of relevant to 30° prism?

.....

(c) Taking readings to draw the graph of i vs. d for the corresponding prism 60° could not take readings for 10°, 15°, 20°, 25°. Mention the reason for not being able to take such readings.

.....

.....

(vii)(i) Write an expression for the refractive index n of a prism if the minimum angle of deviation is D and the prism angle is A.

.....

(ii) If D = 30° and A = 60°, find the refractive index.

.....

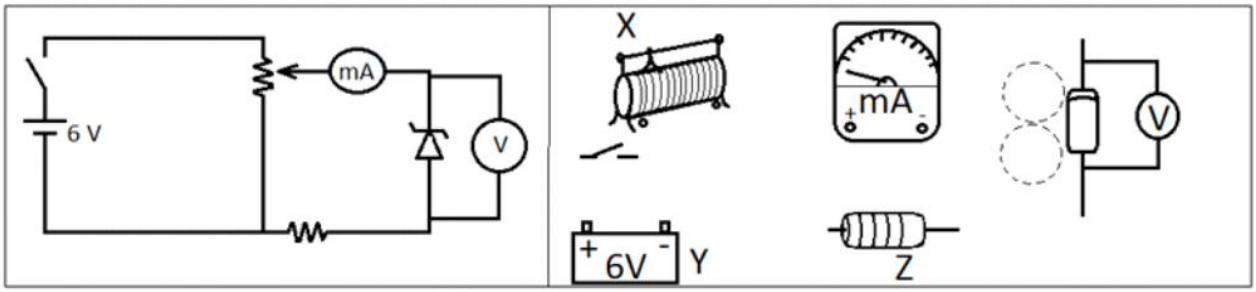
.....

(iii) Suppose there are two prisms with the same prism angle. How does the angle of minimum deviation change as the refractive index of the prism material increases?

.....

.....

4. A student designs a circuit to find the Zener voltage of a silicon Zener diode. According to the circuit diagram in the figure in left side below, the equipment in the figure in right side should be identified and installed.



(a) (i) Name X, Y, Z in the right figure.

X :- .....

Y :- .....

Z :- .....

(ii) Draw the wire to complete the circuit in the right figure.

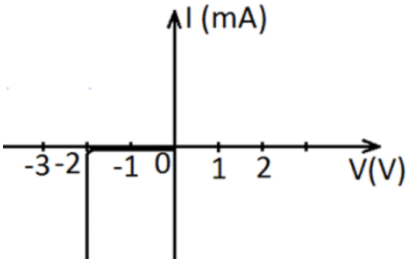
(iii) Draw the p side and n side of the Zener diode in the circle.

(iv) Is an analog voltmeter or a digital voltmeter most suitable for this experiment? Give the reason.

.....

.....

(v) The experiment is done for the reversed biased case and the graph was drawn as shown in figure.

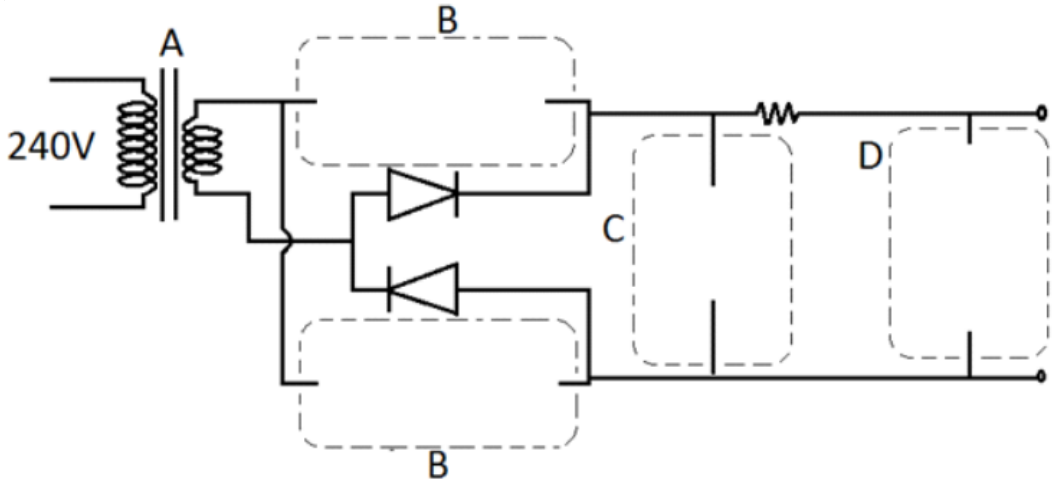


(1) If the power of the Zener diode is 800 mW, find the maximum current in mA.

.....

(2) Draw the graph in the same figure that would be expected if the experiment was repeated for the Zener diode's forward-biased case.

(b) Now the student uses the above Zener diode to obtain a constant voltage of 2 v from a 240 v supply. An incomplete circuit related to it is shown below.



(i) What type of instrument is indicated as A?

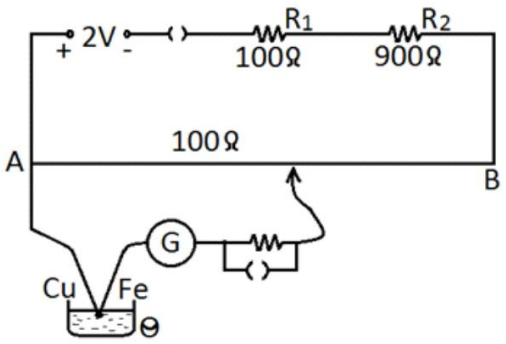
.....

(ii) Which instrument should be fitted in B? Draw how it should fit in both gaps B. (by symbols)

.....

(iii) Draw how the symbol of the Zener diode examined above should fit in D.

(c) The student plans to test the voltage of a thermocouple by making a potentiometer which is made by using a regulated 2 v power supply . The relevant circuit for that is shown in the diagram in right side. The resistance box used to obtain the resistance 900 Ω which is marked as R_2 is on the right side. The resistance of potentiometer wire is 100Ω. The potential difference across the potentiometer wire is 100 mV. Potential gradient of the wire k = 1 x 10^{-3} V $cm^{-1}$is



(i) How long must AB be to k = 1 x 10^{-3} V cm^{-1}

.....

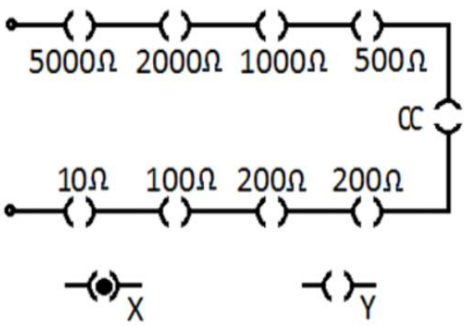
(ii) What is the constant current in the potentiometer wire?

.....

(iii) What should be the value of resistance R_1?

.....

(iv) If the resistor box shown in the figure on the right is used to obtain the resistance R_2 = 900 Ω, draw the way that the keys fix. (X-type key is fixed. Y-type key is not fixed)



(v) If the balanced length is 60.0 cm at $\theta = 27\ ^0C$ and the balanced length is 74.6 cm at $\theta = 100\ ^0C$, find the voltages generated in the thermocouple in each case.

(1) At $\theta = 27\ ^0C$ ..... ඝ

(2) At $\theta = 100\ ^0C$ ..... ඝ

(vi) If the voltage generated in the thermocouple is directly proportional to the absolute temperature, what is the maximum temperature in K that can be measured by this potentiometer ?

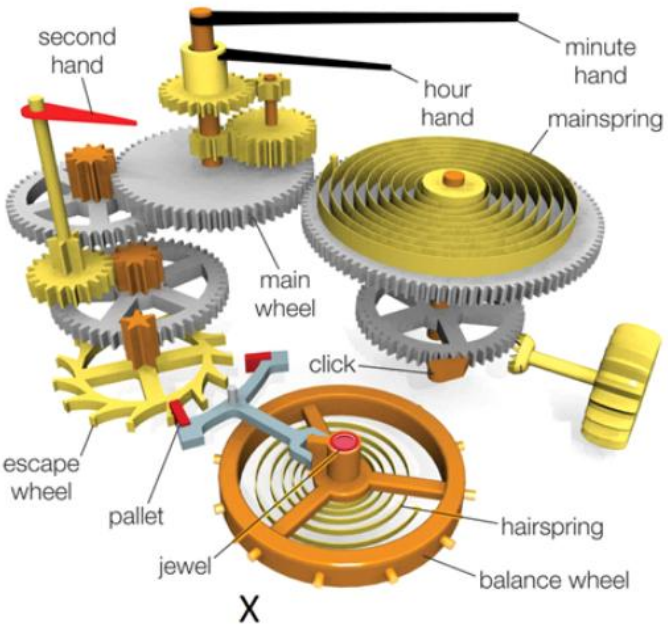
.....

.....

Part B – Essay

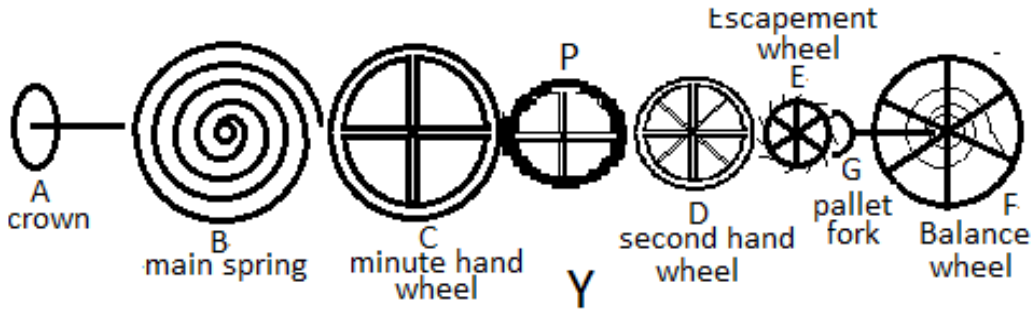
Answer four questions only

05) Time is a basic physical quantity. Various types of clock are used to measure time but all of them have same internal parts and same internal activities. Due to the different methods of energy supplied to their internal activities there are different types of clocks. The energy source for the mechanical clock is main spring (B). By rotating the crown (A), the main spring is wound up. Then the energy stored in the spring is transmitted to balance wheel (F) through the set of sprocket wheels. Initially, the energy supplied, is stored in the hair springs on which the balance wheel is placed and the balance wheel is continuously vibrated side to side by the energy stored.



X

Then the pallet fork (G) connected to it is vibrated side to side. When it vibrates to the left and right directions, a "tik" sound can be heard. Then, the Escape wheel connected to the pallet fork is rotated in a specific direction and transmits energy to other wheels. Second hand, minute hand and hour hand are connected to these sprocket wheels (which has different radii) separately and they are rotated to a specific period of time.



Y

Figure X shows the actually position of parts of a clock and the figure Y shows how some parts are connected.

a) i) Mention S.I unit for measuring time.
ii) What is the periodic time of the second hand?
iii) What is the angular speed of the second hand?

iv) If the sprocket wheel D connected to the second hand obtains a 0.20 rad angular displacement to reach uniform velocity from rest, calculate the angular acceleration.

v) Calculate the time taken for the sprocket wheel D to reach the uniform angular velocity.

vi) If the radius of sprocket wheel D is 2mm and the mass is 10 mg, calculate it's moment of inertia.

(The moment of inertia (I) of a sprocket wheel of mass M and radius R is given by $I = MR^2$)

vii) What is the torque acting on sprocket wheel D intially?

b) i) Write down the S.I unit of periodic time and the angular velocity of the minute hand.

ii) Write down the S.I unit of periodic time and the angular velocity of the hour hand. (Only the values substitution is enough)

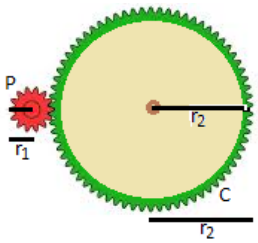
iii) When 1 hour and 10 minutes is spent, calculate the angular displacement obtained during that time by the following:

1) Second hand
2) Minute hand
3) Hour hand

iv) The moment of inertia of the balance wheel is $I = 3.8 \times 10^{-10}$ kgm^2 and "tik" sounds are heard 5 times per second. If the frequency of this wheel is given by the equation, $f = \frac{1}{2}\sqrt{\frac{K}{I}}$ calculate the value of K. K is the torque constant.

v) Write down a method that sprocket wheels have applied in order to rotate the second hand, minute hand and hour hand in the same direction.

vi) Angular velocity of sprocket wheel P equals to the angular velocity of sprocket wheel D to which the second hand is connected. Radii and masses of P and D wheels are equal to r_1. C is the sprocket wheel connected to minute hand and it's radius is r_2. Obtain a relationship between r_1 and r_2.



vii) Cogs in P and C wheels are N_1 and N_2 respectively. Obtain a relationship between N_1 and N_2.

c) i) Which type of energy is stored in the spring when energy is created by rotating the crown?

ii) Figure shows the main spring, and the angular displacement of it is θ (rad). The energy stored in the spring is given by the equation $E = \frac{1}{2}A\theta$. A is the torsion elasticity modules and the value of it is 0.02 Nm rad^{-1}. If this spring is wound up 5 turns, calculate the energy stored in it.

iii) If the energy stored by winding 5 turns is enough to work the clock 40 hours, what is the power of the clock? (Neglect the energy lost due to friction)

d) When a wall clock is hanging on a wall and is working, it's sprocket wheels and hands are rotated in a vertical plane.

i) Write down an expression for the maximum value of the change in potential energy when rotating its minute hand. The mass of the minute hand is M, length is L and the distance to the centre of gravity of the hand from the centre of the clock face is $\frac{L}{3}$.

ii) To which value on the clock face should the hand be aligned with, to rotate the hand with constant average angular velocity by preventing the torque created due to the weight of the hand of the wall clock?

iii) When comparing with the other hands, the second hand could be stopped by applying even a small force due to the weight of it. Write down the special arrangement (used when the wall clock is assembled) by which the second hand is arranged in order to avoid stopping it due to its weight. (Use diagrams if needed.)

06) Music is a medicine for releasing the peoples' stress. Musical instruments contributes towards this. String instruments are special among these. These string instruments are based on the vibration patterns of these stretched strings.

a) i) Write down an exporession for the velocity (V) of the transverse waves using the length (L), mass (M) and tension (T) of it.

ii) A string of length *l* has a linear density m. This string has a tension T. Consider an instance of obtaining the fundemental state by vibrating the stringin the middle.

i) Which type of wave created in this?

ii) Write down an expression for the wave length λ of a wave using the lenghth (*l*) of the string.

iii) Obtain an expression for the fundemental frequency f_0 using *l*, m and T.

iii) Draw the wave patterns for the first two overones when the string is vibrated in the middle.

iv) If the frequencies for the first two overtones are f_1 and f_2.

i) Obtain an expression for f_1 using T, m and *l*.

ii) Obtain an expression for f_2 using T, m and *l*.

iii) Write down harmonic numbers respectively for the four overtones after the fundemental when vibrating from the middle of the string.

b) A sithar is a music instrument used streched string. There are two types of streched strings for emitting a note. The wires in the upper side of the instrument are consisted with seven wires and these wires are vibrated. The wires in the lower side of the instrument are known as sympathetic strings consisted with 13 wires which is vibrated with relevant to the frequency

of the upper side of the instrument. The diameters, lengths and the fundamental frequencies of a certain sithar are given in below table.

Wire	Type of wire	Diameter(mm)	Length(cm)	Frequency(Hz)
1	Steel	0.30	88	174
2	Bronze	0.40	88	130
3	Bronze	0.50	88	98
4	Bronze	0.71	88	65
5	Steel	0.28	88	392
6	Steel	0.25	50	800
7	Steel	0.60	40	1046

Consider the density of steel is 8000 kg m^{-3}, density of bronze is 3000 kg m^{-3} and $\pi = 3$

i) Íf the vibrating frequency of the fundemental is f_0, obtain an expression for f_0 using the tension of the stretched string is T, the diameter is d (m), the density of the material of the wire is ρ (kg m^{-3}) and the length of the string is l (m).

ii) When the 6th string of the upper side of the sithar is vibrated with fundamental mode, what is the value of the tension of the wire should be maintained to obtain the given frequency?

iii) When the tension of the third string is 32.4 N, where do you place your finger from the end A as shown in the figure, to tune the fundemental frequency as 300 Hz?

iv) The lengths of the wires in the lower part are shown in the table. All the wires have 0.2 mm diameter. All the wires are made of steel and kept at equal tension.

Wire	Length(cm)
1	65
2	60
3	58
4	55
5	48
6	46
7	43
8	40
9	38
10	35
11	33
12	28
13	23

a) Is the variation of frequency of the wires from 1 to 13 would be in ascending or descending order?

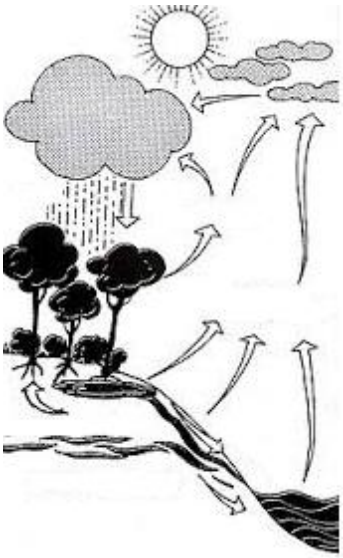
b) If the 8th wire is resonated at fundemental state with a frequency of 500 Hz, calculate the tension of the wire.

c) A musical instrument is playing with a power of 4.32×10^{-2} W.

i) What is the sound intensity having a distance of 6 m from this musical instrument? ($\pi = 3$)

ii) What is the sound intensity level with the distance of 6 m?

07) Some of the ways in which water moves from one place to another are natural. Others are artificial.



The water cycle is a wonderful way of moving water from one place to another. It is a fact that we know that the water in the reservoirs and the ocean evaporates from the solar energy and moves upwards and is cooled by the wind to different areas and rain occurs. Some of the things that happen there can be explained in terms of physics principles. Because the speed of water particles in warm water compared to cool water is higher and the surface tension is low ,The evaporation rate is high. Even though the water is colorless, we see many small water droplets that form in clouds in the sky as white or gray. The pressure inside a small water droplet is slightly higher than atmospheric pressure due to surface tension. The surface tension energy (E) of a small water droplet is given by TA. T is surface tension. A is surface area. Small water droplets in the cloud combine to form large water droplets. If a water droplet fell to the ground under gravity without atmospheric resistance, it would attain large speed, but due to the viscosity of the air, it would fall to the ground with terminal velocity.

Domestic water transport in urban areas can be considered as an artificial way of transporting water. Even if the diameter of the water pipes is determined and connected to meet the water demand in the city, later on the increase in the number of houses and shops in the city also increases the demand for water. In order to supply water according to the water demand, it is necessary to replace the old water pipes with new water pipes of larger diameter or to apply additional water pipes.

a) i) I) Write down two factors which affects for the evaporation as mentioned in the (A)

II) What is the source which is supplied energy for the water circle?

ii) Draw the graph of variation of the surface tension with temperature. (B)

iii) A is a water molecule in the water surface. B is a water molecule inside the body of water. Draw the inter molecular forces acting on a water molecule by other water molecules. (Draw the water molecule on to your answer script)

iv) What is the colour of water vapour?

v) I) The radius of a water droplet inside a cloud isr. The surface tension of water is T. If the inside pressure of the water droplet is $P_1$and the external pressure isP_2 , obtain an expression for the excess pressure ($P_1 - P_2$) using T and r.

II) Calculate the excess pressure of the droplet if the surface tension (T) = 7×10^{-2} Nm^{-1} and radius r = 1 mm.

vi) I) Claculate the surface tension energy if the radius r = 1 mm, surface tension= 7×10^{-2} Nm^{-1}.

II) What is the amount of energy released when a single water droplet is made by eight water droplets of radius 1mm?

vii) Consider a water droplet of mass m and radius r falls to the earth which is in a cloud at 2km height.

I) If there is no air resistance what is the velocity of water droplet when it reaches the earth?

II) If the coefficient of viscosity of air is η, radius of the droplet is rand the terminal velocity of the water droplet reaches to the earth is V_0Write down an expression forηin terms ofm, r, v_0, g,π.

III) Claculate the coefficient of viscosity of air if m = 3.2 mg, r = 2 mm and the terminal velocity of falling water droplet is 10 ms^{-1}. (Take π = 3 and neglect the upthurst force of air).

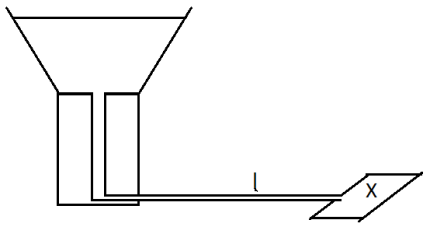
IV) Draw the variation of it's acceleration with time until the water droplet falling from a cloud obtain the terminal velocity.

b) Poissel's equation is used to solve problems when water is moved through pipes by man using artificial methods.

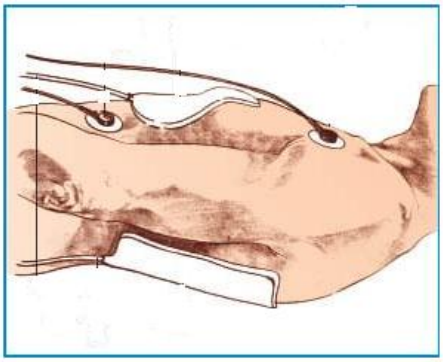
i) If the rate of volume of a flowing liquid in a tube is $\frac{\Delta V}{\Delta t}$then write poissel's equation for$\frac{\Delta V}{\Delta t}$.

ii) Illustrate with a diagram the variation of velocity of liquid practicles across a diameter of the pipe when a liquid flows through a pipe according to poissel's equation.

iii) Here is a figure related to supply of water at a rate Q through a pipe of length *l* and radius r to a village of 10 houses named X. Find the radius of the pipe required to supply water with same rate Q when the number of houses in the village is 160.



08) Transcutaneous Pacing is a method of providing external electrical stimulation of the heart through a set of electrode pads. This device works by sending an electrical impulse from the pulse generator to the patient's heart by the way of two electrodes which are placed on the front and the back of the patient's chest. The patient can be provided a continuous pulse from this device. This device consists of capacitors, resistors and transistors. The period of time of the pulses are increased when increasing the capacitance of the capacitor.



a) i)Write down an expression for the capacitance (C) of a capacitor in terms of the charges stored in plates of this capacitor (Q) and the potential difference (V) across the capacitor.

ii) Derive an expression for capacitance (C) of the capacitor in terms of plate area A, permittivity of free space ε_0 and the separation between the plates (d) of this capacitor by using Gauss's law.

iii) Draw the graphs of a charging capacitor by showing how the charges and the current vary with time.

iv) Draw the graphs of a discharging capacitor by showing how the charges and the current vary with time.

b) i) If a charged capacitor mentioned in above (a)(1) is a parallel plate capacitor with plates area of 100 cm^2 and the separation between the plates is6 x 10^{-8} m, what is the capacitance of the capacitor?$\varepsilon_0 = 9 \times 10^{-12}$ Fm^{-1}

ii) Calculate the amount of charge stored in the above (b) (i) capacitor when 800 V potential difference is supplied across it.

iii) Most patients require a current in the range of 20 – 140 mA. Assuming the above b (ii) calculated charge was sufficient to pass a constant current of 60 mA through the body, calculate the relevant time period.

iv) What is the emitting pulse rate per minute using the given graph?

v) What is the effective resistance of the path of the current mentioned in above b (iii)?

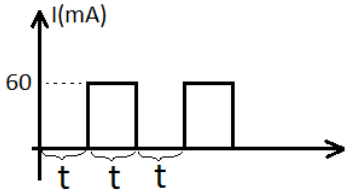
vi) What is the average power of this device?

c) The Transcutaneous Pacing delivers energy to the patient by discharging the capacitor.

i) Write down an expression for the energy stored (W) in a capacitor in terms of capacitance C and potential difference V.

ii) Calculate the energy stored in the above b (i) capacitor.

iii) If capacitance you calculated in the above b (i), is not available in the market, by using three 1 μF capacitors, draw a diagram of the connection to obtain the above b (i) capacitance.



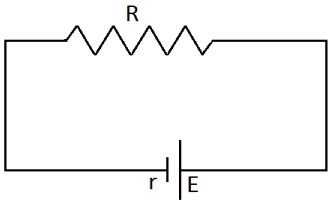
iv) The prices in the market for 1 μF, 450 V capacitor is Rs.30/=,1 μF, 850 V capacitor is Rs.40/=,1 μF, 250V capacitor is Rs.20/=,1 μF, 200 V capacitor is Rs.15/= . How do you obtain the above c (iii) connection with the lowest cost and highest safety? (Draw a diagram and mention the potential difference)

d) The pulse rate of the above patient is very low. What should be done to the instrument to increase this pulse rate?

09) Answer either Part A or Part B only.

A) Considerable amount of electrical energy is required to start a car and operate other electronic devices, and if the required energy is obtained from an ordinary battery, it will be discharged quickly. But a car has a rechargeable battery and a system to charge it. The recharging process starts as soon as the car is started and this is done by an engine powered alternator. Also, electricity is supplied to all devices in the car electrical circuit through fuses. By means of a fuse, the devices are prevented from being damaged by the current flowing in excess of the required current.

(a) Consider a case where a resistance R is connected externally to a battery, where the electromotive force is E and the internal resistance is r.



(i) Write an expression for the rate at which electrical energy is produced in the cell when a current I flows through the cell.

(ii) Derive an expression for the potential difference (V) across the cell in terms of E, I, r using the principle of conservation of energy.

(iii) Write an expression for R in terms of r so that 50% of the cell's rate of electric energy generation is dissipated by the resistance.

(b) The figure shows a part of a circuit that supplies power to several electrical devices in a car.

S_1, S_2, S_3switches.

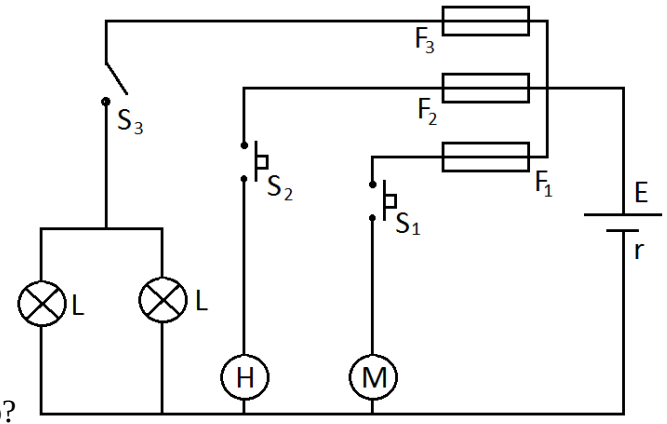
F_1, F_2, F_3fuses.

L- Headlamp

H- Horn

M- Starting motor

A headlamp's (L)rated values are 60 W, 12V. The rated value of the horn (H)is 12V. The Starting motor(M) rated values are 800 W, 12V.



(i) What is the resistance of a headlamp?

(ii) The potential difference across the battery with all switches open when the engine is not running is 13.0 V as measured by a digital voltmeter. When only the switch S_3 is closed the voltmeter reading was 12 V.

(a) Find the current in the circuit.

(b) Find the internal resistance of the cell.

(iii) When only the switch S_2 was closed, the potential difference across the cell was 12.5 V. Then find the current flowing in the circuit. Then find the power of the horn.

(iv) What is the current in the circuit when only the switches S_3 and S_2 are closed?

(v) Now Open the switches , S_3 ,S_2 and When S_1 is closed the voltmeter reading drops immediately and shows more than 13 V. Explain the reason for this observation.

(c) On a certain night, the car was parked with the headlights on. The next morning the vehicle would not start. The potential difference across the terminals of the battery was measured to be 10 V. A battery from another car had to be connected to start the car.

(i) a) If the discharged battery is X and the other is Y, show with a diagram how the two batteries should be connected.

b) Explain what can happen if the two batteries are not connected properly.

c) Why is the wire of a larger cross section used to connect the two batteries?

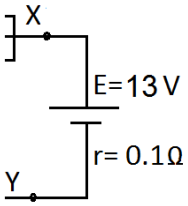
(ii) The external (new) battery has a emf of 13 V and an internal resistance of 0.3 Ω. A discharged battery has an electromotive force of 10 V and an internal resistance of 0.6 Ω.

(a) Find the electromotive force of the combined battery.

(b) Find the maximum current flowing when only S_1 is closed .

d) (i) Low melting point tin and lead alloys are used for making fuses. Due to some tracking in the headlight circuit, at 30^0C, the wire is heated up and melted, breaking the circuit. Resistance of the wire is $2 \times 10^{-2}\Omega$. The mass of the wire is 1×10^{-5} kg. The specific heat capacity of the material is 4×10^{2} J kg^{-1} K^{-1} The melting point of the wire is 230^0C If a current of 20 A flows through the fuse, how long will it take for the fuse to burn out?

(ii) Find the current flowing through the battery shown if the battery is caught between X and Y due to a car accident and explain the importance of having a fuse near the battery. (Note that there is no heat exchange with the environment)



B) a) Digital electronic circuits can be devided into two types as combinational logic circuits and sequential logic circuits.

i) Write down the main difference between a combinational and a sequential circuits.

ii) Name two types of fundemental electronic items which are used to construct these circuits.

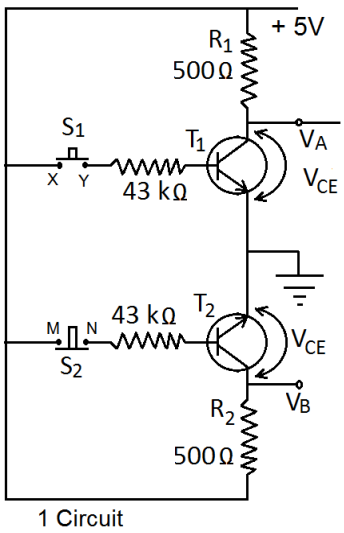
iii) Draw a circuit diagram ofNOR gate.

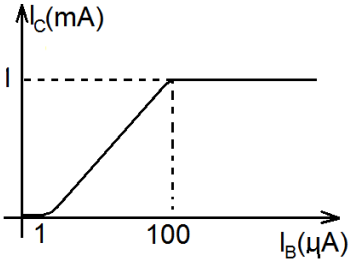
iv) Draw a circuit diagram using two NOR gates to obtain the function of SR flip flop.

v) Below shows an incomplete truth table of a SR flip flop. Draw the given table on your answer script and fill in the blanks.

S	R	Q	$\overline{Q}$
0	0		
0	1		
1	0		
1	1		

b) Below circuit (1) is constructed by using two identical transisitors T_1 and $T_2$to study in simply, the function of a bipolar transistor and SR flip flop. Graph (1) shows the transition characteristics of the transistors which are used.S_1 andS_2 are two button switches. The button switches are constructed as, when the switch S_1 press, X and Y are connected with each other and when the switch S_2 press M and N are disconnected with each other.When the potential of Y and N points are5 V, transistors T_1 and $T_2$are slightly saturated respectively. The relevant V_{BE} values for the transistors are 0.7 V each.





i) Mention the used transistor for the above circuit is npn and pnp.
   (a) Transistor T_1
   (b) Transistor T_2

ii) What is the configuration of the transisitor which is applied in the above circuit?

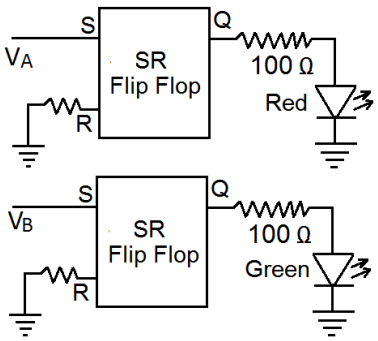
iii) What are the three main regions which can exist in the transistor according to the above graph?

iv) Consider an instance of pressing only the S_1 button switch.
   I) Then, what is the potential of Y?
   II) Claculate the base current (I_B) flowing through T_1 transisitor.
   III) What is the current flowing through R_1 resistor?
   IV) Calculate the Collector Emitter voltage (V_{CE}) of T_1 transistor.

V) Hence, calculate the potential of A(V_A).

v) Obtain a value for the potential of B, when pressing the button switch S_2.

vi) A student has an idea to investigate the function of a SR flip flop. For this, the output terminals A and B of above circuit (1) are connected to S input terminals of two SR flip flops seperately and Q outputs of SR flip flops are connected to 100 Ω resistor for each as shown in circuit (2) and connected red or green light emitting diode (LED) for each. Then the student observes the function of LED by pressing and releasing S_1 and S_2 buttons at once.
   (1) Draw the below table on your answer script and
   mention the relevant LED on or off for each instance. (If the LED is on put '1' and the LED is off put '0' in the table)



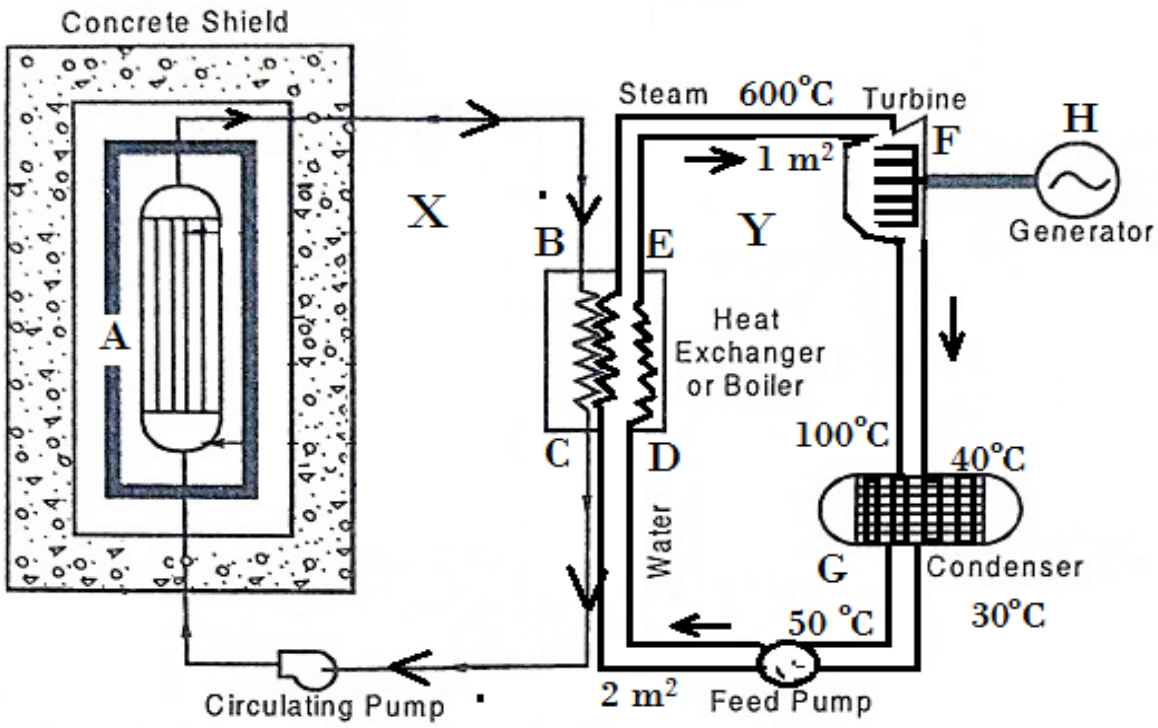
	Two switches are released	Two switches are pressed for first time	Two switches are for first time
Red LED			
Green LED			

10) Answer either Part A or Part B only.

A) Figure shows a rough sketch of a nuclear power station for generating electricity using nuclear energy.

The vast amount of heat energy is generated, due to a nuclear reaction of nuclear reactors in compartment A. This energy is absorbed by the water in the system X and flowing along the direction showed by the arrows. The steam at 1000^0C is entered to the steam generator from B and the heat energy of that steam is transmitted to the system Y inside the steam generator. The water at 50^0C is entered from D to the steam generator and is released from E

as 600^0C steam. Due to the high speed of that steam, the turbine which is in F compartment is rotated. The efficiency of the turbine is 75%. Then the elctricity is produced with an efficiency of 50% due to the rotation of the elecric generator which is connected to the turbine. The output power of the electric generator is 600 MW.



1) i) What is the output power of the turbine?
ii) What is the power given by the steam inside F compartment?
iii) Write down a suitable thermometer to measure the temperature inside F compartment.
iv) Write down the energy transformation from the nuclear reactor compartment (A) to the generator (H).

2) The steam at 600 ^{0}C which is produced by the steam generator, releases from the lower part of F compartment as 100 ^{0}C steam. This steam is entered into the condenser as 100 ^{0}C water. This water leaves out from the condenser as 50^0C water. The rate of water entering the condenser is 2×10^3 kg s^{-1}. Specific heat capacity of steam is 4000 J kg^{-1} K^{-1}, Specific heat capacity of water is 4200 J kg^{-1} K^{-1} and the specific latent heat of vaporization of water is 350×10^3 J kg^{-1}.

i) If the temperature of the steam enters compartment F is 600^0C, what is the decrease of heat energy of steam in the compartment F?
ii) What is the rate of decrease of heat energy of water inside compartment F?
iii) The water is moving to the downward through tubes inside the condenser. The average temperature of the external surface of the tube is 40^0C and the average temperature of the internal surface of the tube is 75^0C. The external outside temperature of the air is 30^0C. The emissivity of the surface of the tubes is 21×10^4 Wm^{-2} K^{-1}.
a) Obtain a value for the external surface area of the tubes.
b) If the thickness of the tubes is 1 cm (Radius of the tube >> 1 cm) What is the thermal conductivity of the tube.

3) The total efficiency of the power station is 20%.unstable nuclei are used to generate energy inside the nuclear compartment (A). This one nucleus reacts and generates 200 MeV energy.

i) Claculate the rate of reaction of $^{225}_{92}U$ nuclei inside the nuclear reactor compartment (A).

ii) It is highly dangerous the releasing of wasted materials of this power station to the environment. Explain.

4) Assume there is no leakage of water or steam inside the system Y, the molar mass of water is 20 $gmol^{-1}$, the cross-sectional area of the tube from G to D is $2m^2$, the cross sectional area of the part of the tube from E to F is $1m^2$ the temperature of steam E to F is 627^0C, the pressure of the steam is 1×10^8 Pa, the density of water is 1000 kgm^{-3} and the universal gas constant R =8,

i) calculate the velocity of flowing water from G to D.

ii) calculate velocity of flowing steam from E to F.

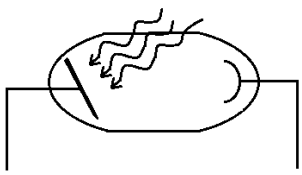
B) the photoelectric effect is the phenomenon of the release of electrons from certain metal surfaces when electromagnetic radiation falls on them. If the sun's surface temperature increases and the frequency of the sun's rays increases and those rays reach the earth, the photoelectric effect can also occur in metals such as aluminum. In such a case, electricity cables, communication equipment, cars made using aluminum may be destroyed and cause great damage.

(Planck's constant h = 6.6×10^{-34}Js ,Wien's constant c = 3×10^{-3} mK
Charge of an electron = -1.6×10^{-19} C , Velocity of light c = 3×10^{8} ms^{-1})

a) (1) Write down the photoelectric equation if $\varnothing$ is the work function of a metal, λ is the wavelength of the radiation incident on the metal surface, and $K_{max}$is the maximum kinetic energy of the photoelectrons.

(2) Write down an expression for work function $\varnothing$in terms of threshold wavelength λ_0,h,c

(3) A circuit which consists of a variable cell, suitable micro-ammeter and voltmeter is used to study the photoelectric effect.



i. Copy this figure and draw the appropriate circuit using symbols. Connect the positive terminal of the cell to the anode. Use the symbol for the variable cell.

ii. Name the anode as A and the cathode as C of the photoelectric cell.

iii. If the experiment is carried out by interchanging the terminals as required.

Plot the potential of anode relative to the cathode($V_{C,A}$) versus photocurrent (I) for each of the following cases

I) Keep the frequency of the incident radiation constant and name the occasion that intensity (number of photons) of the radiation is I as **a** and the occasion that intensity of the radiation is 2I as **b**.

II) Draw graphs on another graph for rays with equal intensities and name the ray with frequency(f_1) as c and frequency ($f_2 > f_1 > f_0$) f_2 as d. f_0 is the threshold frequency.

iv. Select the appropriate metal/metals from this table for the corresponding terminal of the cell to produce a photocurrent when electromagnetic waves of 450 nm are incident on a cell.

metal	Work function(eV)
Sodium	2.4
Calcium	2.9
Zinc	3.6
silver	4.5

(5) If 495 nm photons are incident on a photocell with a rate of 0.1 W, the ratio between the number of incident protons and the detached electrons is 10^3:1 and all the detached electrons contribute to the photocurrent.

(6) Suppose the satellite made of silver orbitsaround the earth. What must be the wavelength of the solar radiation falling on the satellite to release photoelectrons from the satellite? If that wavelength is the wavelength related to the maximum intensity emitted by the solar surface, what is the temperature of the solar surface in Kelvin (K)?

b) The solar cell can be considered as an instance of generating a current when solar radiation incidents on photo sensitive semi conductor materials. Solar panals are made of set of solar cells. Below equation shows the efficiency (η_{max}) of the conversion of the radiation energy gained by the solar panal to electrical energy.

$$\eta_{max} = \frac{P_{max}}{ExA} x100\%$$

P_{max} = Maximum power of the solar panal

E = Solar energy incidents on an unit area per second.

A_c = Area of solar panal.

Radius of the sun $r_1 = 7 \times 10^8$ m

The distance from the sun to the earth $r_2 = 1.5 \times 10^{11}$ m

C = 3×10^8 ms^{-1} Stefan constant $= \sigma = 5.6 \times 10^{-8} W\, m^{-2} K^{-4}$, $\pi = 3$

Taker$_2$ >> r_1

i) If the temperature of the surface of the sun is 6000 K and the sun is a black body, calculate the rate of emission of solar energy incident on earth atmosphereper unit area per second.

ii) If the solar energy incidents on an unit area of the earth's surface during 1 second is 1000 W, calculate the percentage of the absorption of energy by the atmosphere.

iii) If the area of the solar panel is 2 m^2 and efficiency is 20% ,what is the maximum power of the solar panel?

c) UV rays which are coming to the earth with high frequency are absorbed by the slightly spreaded ozon layer. Consider a beam of UV with thickness t and the intensity of perpendicularincidence on it is I_0. Due to the absorption of this ray, it's intensity decreases upto I, the relationship between I_0 andI are below given

$$\log_{10}\frac{I}{I_0} = 52t$$

i) If the intensity is decreased by half, calculate the thickness t of the ozone layer.

ii) Write down an effect if the ozone layer is destroyed.