සියලු ම හිමිකම් ඇවිරිණි / முழுப்பதிப்புரிமை உடையது / All Rights Reserved]



අධ්‍යාපන අමාත්‍යාංශය/கல்வி அமைச்சு/Ministry of Education

අධ්‍යාපන පොදු සහතික පත්‍ර (උසස් පෙළ) පෙරහුරු ප්‍රශ්න පත්‍රය 2022

கல்விப் பொதுத் தராதரப் பத்திர (உயர்தர) பரீட்சை 2022

General Certificate of Education (Adv. Level) 2022

භෞතික විද්‍යාව I/பௌதிகவியல் I (Physics I)

01 E I

පැය දෙකයි

இரண்டு மணித்தியாலம்

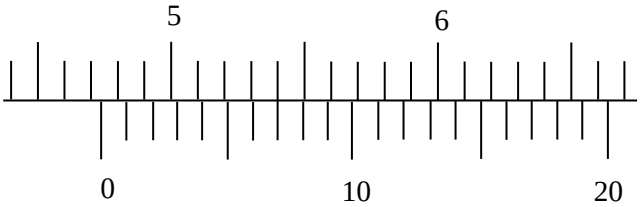
Two hours

**Answer all the questions.**

01. What are the dimensions of efficiency?
(1) $ML^{-1}T^{-1}$ (2) $ML^{-3}T^{2}$ (3) $ML^{2}T^{-3}$ (4) $ML^{2}T^{-1}$ (5) $L^{2}T^{-1}$

02. From the following physical quantities, the units of Impulse equals to the units of,
(1) work. (2) efficiency (3) momentum (4) moment of force (5) pressure

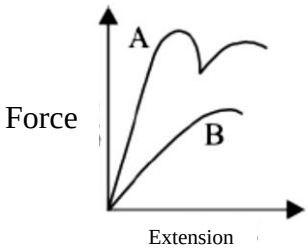
03. The part of the scale of the vernier caliper is given below. It's one part of the main scale is 1mm. What is the reading of the measurement of the caliper?
(1) 4.77 mm (2) 4.735 mm
(3) 47.07 mm (4) 47.35 mm
(5) 47.70 mm



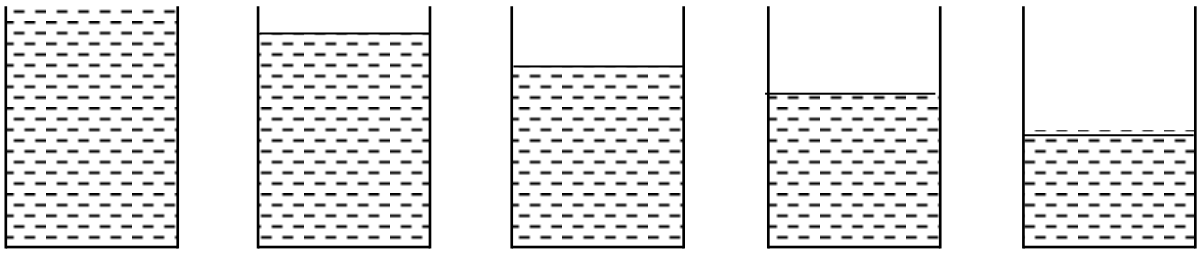
Figure

04. When the meniscus of the liquid inside the capillary tube is convex, its contact angle is
(1) greater than $90^0$ (2) smaller than $90^0$ (3) equals to $90^0$
(4) equals to $45^0$ (5) equals to $0^0$

05. The force-extension diagram for two materials A and B is shown in the given graph. From those two curves, it is assumed that
(1) A is brittle but B is ductile
(2) A is ductile but B is brittle
(3) Both A and B are ductile
(4) Both are brittle
(5) Both A and B are not ductile or not brittle



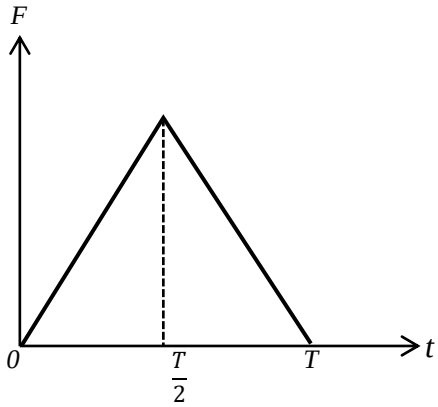

06. Which of the following diagrams shows the correct amount of liquid that should be filled in to the calorimeter of about 10 cm height to find the specific heat capacity of the liquid using cooling method?



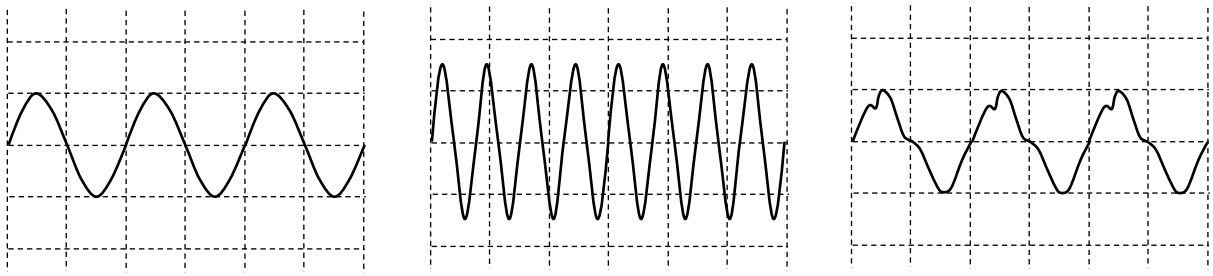
(1) (2) (3) (4) (5)

07. The ball of mass $m$ moves in a velocity $u$ bounces perfectly elastic manner after colliding on the wall. The reaction between the wall and the ball varies with time as shown in the following graph. The value of $F_0$ will be,

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




08. The following P, Q and R diagrams show the wave forms of three types of sounds obtaining from cathode ray Oscilloscope which is adjusted to the same scale.



P Q R

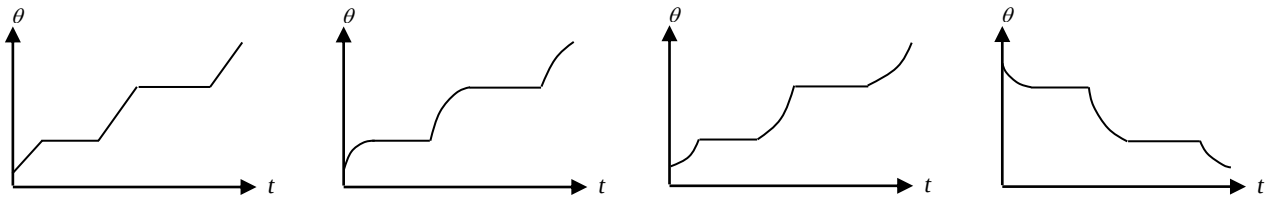
Consider the following statements on those waveforms.

(A). P and Q have different loudness and same pitch.
(B). P and R have different quality of sounds and same pitch.
(C). P and R have same loudness and different pitches.

The correct statements of the above are,

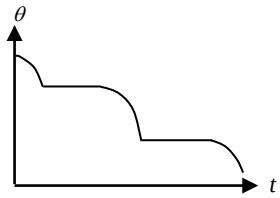
(1) Only (A) (2) Only (B) (3) Only (C) (4) (A) and (B) only (5) (B) and (C) only

09. A solid is heated until evaporating using a constant heat supply at normal environment. Then it is let to cool. Select the correct answer which shows the variation of temperature with time for the above mentioned process.




(a) (b) (c) (d)

| | When heating | When cooling |
|---|---|---|
| (1) | Graph (a) | Graph (d) |
| (2) | Graph (b) | Graph (d) |
| (3) | Graph (c) | Graph (d) |
| (4) | Graph (b) | Graph (e) |
| (5) | Graph (c) | Graph (e) |

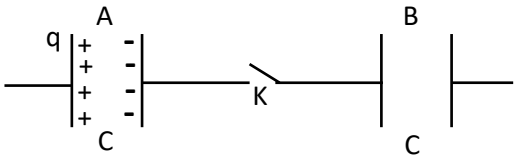



(e)

10. A hot air balloon of mass $M$ is moving down in *'a'* acceleration. After removing $m$ mass from the balloon, that balloon starts to move up with *'a'* acceleration. What would be the correct expression for $m$?

(1) $\frac{aM}{a+g}$ (2) $\frac{2aM}{a+g}$ (3) $\frac{(a+g)M}{a}$ (4) $\frac{(a+g)M}{2a}$ (5) $\frac{gM}{2a}$

11. An identical two capacitors A and B are connected using an open switch K. Initially A is given a charge $q$ and B is not charged. Now K is closed and kept for a sufficient time, what are the charges of A and B ?

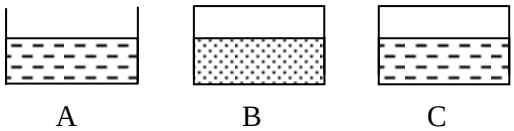



| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| A | q | q/2 | 0 | q | 0 |
| B | q | q/2 | q | 0 | 0 |

12. The box of mass $M$ is slightly kept on a belt which is moving with '$v$' velocity. The frictional coefficient between the floor and the box is $\mu$. How far does the box slip until obtaining the speed of the belt?

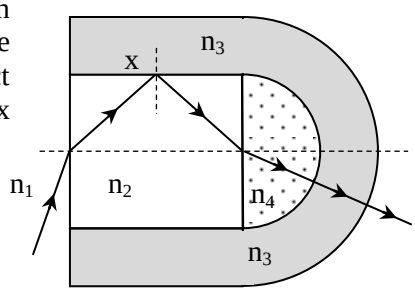
(1) $\frac{v}{\mu g}$ (2) $\frac{v^2}{\mu g}$ (3) $\frac{v}{2\mu g}$ (4) $\frac{v^2}{2\mu g}$ (5) $\frac{v}{g}$

13. Three identical vessels A, B and C contain water , alcohol and water respectively and kept inside the laboratory in a dry day of less relative humadity. A is opened and B and C are closed. Assuming that the atmosperic temperature ($\theta_1$) is constant, the temperatures of the vessels A, B and C are $\theta_2$, $\theta_3$ and $\theta_4$ respectively after sometimes. What are the correct relationships among those temperatures?




(1) $\theta_1 = \theta_2 = \theta_3 = \theta_4$ (2) $\theta_1 > \theta_4 > \theta_3 > \theta_2$ (3) $\theta_1 = \theta_4 > \theta_3 > \theta_2$ (4) $\theta_1 > \theta_4 > \theta_2 > \theta_3$ (5) $\theta_1 = \theta_4 = \theta_3 > \theta_2$

14. The given figure shows the path of a ray which is refracted through several media of absolute refractive indices $n_1$, $n_2$, $n_3$ and $n_4$. At the point X, there is a total internal reflection. What is the correct relationship among the refractive indices? ($n_1$ is the refractive index of air)




(1) $n_1<n_3<n_2<n_4$ (2) $n_1<n_2<n_3<n_4$
(3) $n_4<n_3<n_2<n_1$ (4) $n_1<n_3=n_4<n_2$
(5) $n_1<n_2=n_3=n_4$

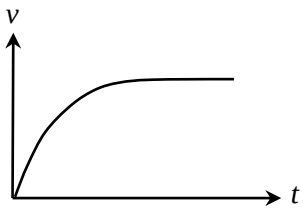
15. When vibrating the tuning fork A of frequency 255 Hz with the tuning fork B, the beat frequency is 3 Hz. Then a small metal ring is connected to the prong of the tuning fork B and again vibrated with A. At that moment, the beat frequency is 2 Hz. What would be the frequency of B after connecting the metal ring?

(1) 258Hz (2) 257 Hz (3)253 Hz
(4) 258 Hz or 252 Hz (5) 257 Hz or 253 Hz

16. The maximum speed which the motor car of mass 2000 kg can obtain on the inclined road of inclination $6^0$ to the horizontal when climbing up is 36 km $h^{-1}$.If the frictional coefficient of that road is 1/6, what is the efficiency of the car ? (Consider that sin $6^o$ = 0.1, cos $6^o$ = 0.99)

(1) 36 kW (2) 53 kW (3) 60 kW (4) 72 kW (5) 106 kW

17. The graph shows the velocity – time graph for the motion of the object and the given statements are about the motions of several objects.

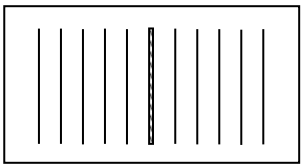


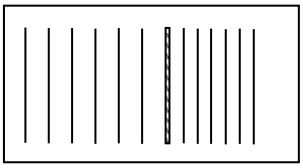

(A). The motion of a metal sphere which comes down from the rest through the viscous fluid.
(B). The motion of a car which moves in maximum efficiency from the rest on the rough uniform road.
(C). When moving the meteoroid from space until colliding on earth's surface.

Among the above given motions, which statement /s represent the given graph ?

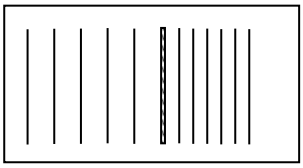
(1) Only (A) . (2) Only (B). (3) Only (A) and (B) .
(4) Only (A) and (C) . (5) (A), (B) and (C) .

18. The given figure shows the wave fronts of a ripple tank which are generated due to the vibration of a pointer of constant frequency. The system is used to demonstrate the Doppler Effect. When a pointer is moving right side with constant acceleration, which diagram shows the correct behavior of water wave fronts ?

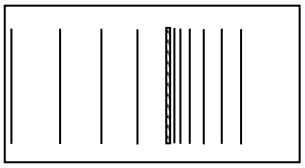




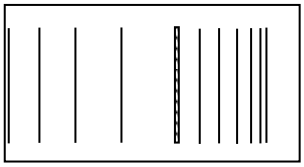
(1)

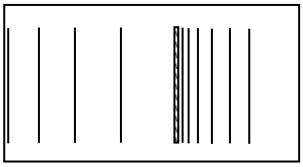


(2)



(3)





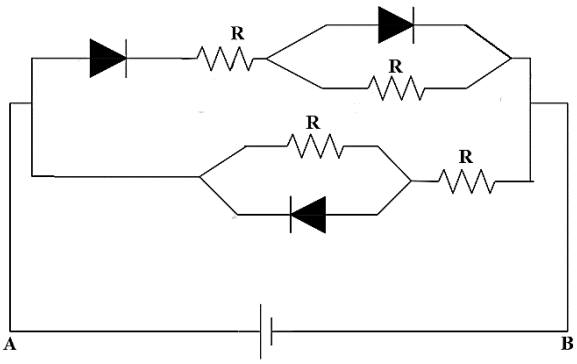
19. An object is projected along the direction of the coordinates (0, 1) to (4,9) which is on the vertical plane of the Earth's surface. After 1 s from the projectile, it comes to the X axis. What are the coordinates of that point?

(1) (3,0) (2) (4,0) (3) (2,0) (4) $(2\sqrt{5}, 0)$ (5) (1,0)

20. A pointing charge $Q$ is kept on the center of the equilateral triangle in order to be equilibrium when keeping three $+q$ pointing charges at vertices. Find the value of $Q$.

(1) $+q$ (2) $-q$ (3) $\frac{+q}{3}$ (4) $\frac{-q}{3}$ (5) $\frac{-q}{\sqrt{3}}$

21. In the given circuit, the values of resistors are $R$ and all diodes are ideal. Internal resistance of the cell is negligible and its emf is $E$, what are the current supplied to the circuit by the cell ?

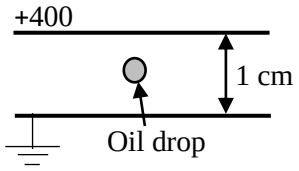



(1) $\frac{2E}{R}$ (2) $\frac{3E}{2R}$

(3) $\frac{E}{R}$ (4) $\frac{2E}{3R}$

(5) $\frac{E}{2R}$

22. Two conducting plates are kept parallel 1 cm apart from each other and +400 V potential is supplied to the upper plate while the lower plate is grounded. An oil drop of mass 0.16 mg is in between two plates in equilibrium position. If the charge of an electron is $-1.6\times10^{-19}$ C, how many electrons are there in an oil drop?




(1) $2.5\times10^{8}$ (2) $2.5\times10^{9}$ (3) $2.5\times10^{10}$ (4) $2.5\times10^{11}$ (5) $2.5\times10^{12}$

23. An electron of mass $m_e$ is initially at rest in a uniform electric field and then it moves a particular distance with $t_1$ time period. A proton of mass $m_p$ is also moves the same distance with $t_2$ time period inside the same electric field. Which of the following expressions give the ratio of $\frac{t_1}{t_2}$? Here the gravitational forces are negligible.

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

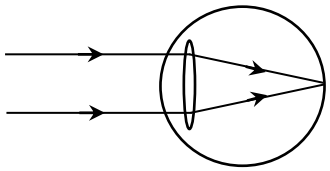
24. The terminal velocity of a gold sphere inside the viscous fluid of density 1.5 g $cm^{-3}$ is 0.2 m $s^{-1}$. What is the terminal velocity of the silver sphere of same radius? (The densities of gold and silver are 19.5 g $cm^{-3}$ and 10.5 g $cm^{-3}$ respectively.)

(1) 0.10 m $s^{-1}$ (2) 0.13 m $s^{-1}$ (3) 0.20 m $s^{-1}$ (4) 0.30 m $s^{-1}$ (5) 0.40 m $s^{-1}$

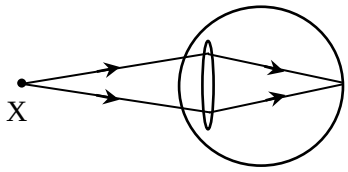
25. The distance between two real images of magnifying power formed by the convex lens of focal length 60 cm is,

(1) 240 cm (2) 180 cm (3)120 cm (4)60 cm (5)30 cm

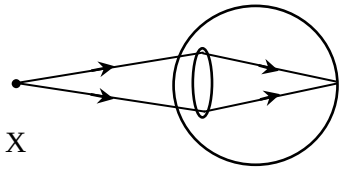
26. The given figure shows the formation of the image of a distinct object of the person who is having hypermetropia (long sightedenes). The correct ray diagram when he looks at an object X which is at his near point which can see the objects easily and the ray diagram when a healthy person looks at an object (Y) which is at the least distance of distinct vision are represented by the follwing ray diagrams.The correct diagrams are,



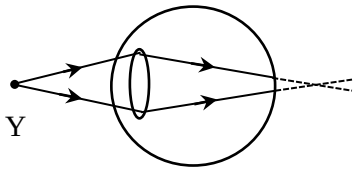
(1) A and C
(2) A and D
(3) B and C
(4) B and D
(5) B and E



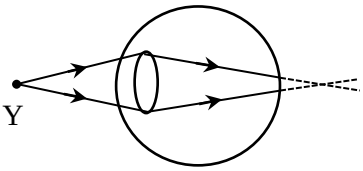

A




B



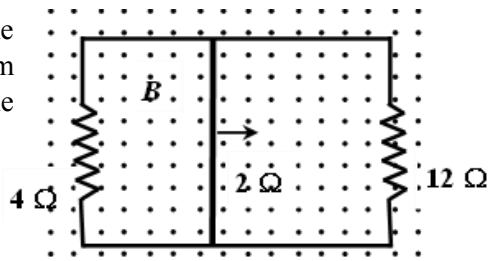

C




D

27. A uniform magnetic field 0.5 T is perpendicular to the plane of the circuit as shown in the figure. The sliding rod of length 0.25 m moves uniformly with constant speed 4 $ms^{-1}$. If the resistance of the slider is 2 Ω, then what is the current through the sliding rod?

(1)0.01A (2) 0.08A (3) 0.1A
(4) 0.17A (5) 0.18A



28. The maximum wavelength of an electromagnetic wave which can do photo electric effect for the given metal surface is 250 nm. If the incident wave of wave length is 200 nm, what is the maximum kinetic energy of the emitted electron ?($h$ = 6.62 × $10^{-34}$J s, $c$ = 3.0 × $10^{8}$ m $s^{-1}$ )

(1) 89.61 ×$10^{-20}$ J (2) 69.81 ×$10^{-20}$ J (3) 18.96 ×$10^{-20}$ J (4) 19.86 ×$10^{-20}$ J (5) 89.81 ×$10^{-20}$ J

29. What fundamental particles make up a Tritium ($^{3}_{1}H$)?

(1) 5 up-quarks , 4 down-quarks and1 electron

(2) 4 up-quarks , 5 down-quarks and1 electron

(3) 2 up-quarks , 4 down-quarks and1 electron

(4) 4 down-quarks, 4 up-quarks and1 electron

(5) 5 down -quarks, 2 up-quarks and1 electron

30. A Copper wire of length 50 cm and area of cross section $10^{-6}$ $m^2$ carries 0.5 A current. If the resistivity of Copper is 1.8×$10^{-8}$ Ω m what the electric field across the wire?

(1) 90 V $m^{-1}$ (2) 9 V $m^{-1}$ (3) 0.9 V $m^{-1}$ (4) 0.09 V $m^{-1}$ (5) 0.009 V $m^{-1}$

31. The two ways of projecting a uniform rod with an inclination to the horizontal are described as follows. In the first method initial velocity is given at one end of the rod and in the second method its initial velocity is given from the center of the rod. Consider the following statements about the above mentioned incidents.

A - The rod is moving while rotating in the first method while the rod is not rotating in the second method.
B - The center of mass of the rod moves in a parabolic path in both ways.
C - The center of mass of the rod does not move in a parabolic path in the first method while it moves in the parabolic path in the second method.

The correct statements from the above are,

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

32. A geostatic satellite is orbited at *6R* height from the Earth's surface. Here *R* denotes the radius of the Earth. What is the time period of another satellite which is orbited at *2.5R* height from the Earth's surface in hours?

(1) $4\sqrt{2}$ (2) 6 (3)$6\sqrt{2}$ (4) 10 (5) 12

33. A hollow sphere of internal radius 3a and external radius 4a is immersing ¾ $^{th}$ of its total volume in water. When the hollow part of the sphere is fully filled with wax, the sphere is fully immersed in water. What is the relative density of wax?

(1) 48/37 (2) 27/37 (3) 27/48 (4) 16/27 (5) 16/37

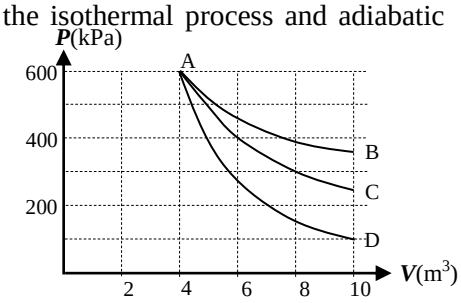
34. In order to read the readings clearly from the thermometer which is made with minimum length, the least distance between two consecutive scale lines should be 0.5 mm. Such a Mercury in glass thermometer has a least count 0.1 $^{0}$C and the range is 0 $^{0}$C to 50 $^{0}$C. If the volume expansion coefficient of Mercury is 2 x $10^{-4}$ $^{0}C^{-1}$, cross sectional area of the capillary tube is 0.02 $mm^2$ what is the volume of Mercury inside the thermometer at 0 $^{0}$C?

(1) 0.25 $cm^3$ (2) 0.50 $cm^3$ (3) 1.00 $cm^3$ (4) 2.00 $cm^3$ (5) 5.00 $cm^3$

35. A well insulated vessel contains 600 g of water at 30 $^0$C and its heat capacity is 830J K$^{-1}$. 450 g of ice at 0 $^0$C is added to that vessel, after sometimes what amount of maximum water can be remained inside the vessel? (Specific heat capacity of water is 4200 J kg$^{-1}$ $^0$C$^{-1}$, Specific latent heat capacity of fusion of ice is 335 kJ kg$^{-1}$ and the density of water is 1000 kg m$^{-3}$)

(1) 750 ml (2) 775 ml (3) 850 ml (4) 900 ml (5) 1050 ml

36. An ideal gas is set to three thermodynamic processes and the obtained curves related to the process are shown in the figure. Among them which curves are best explained the isothermal process and adiabatic process respectively?




(1) From AB curve and AC curve
(2) FromAB curve and AD curve
(3) FromAC curve and AB curve
(4) FromAC curve and AD curve
(5) FromAD curve and AB curve

37. The minimum energy to roll the given cylinder of mass *M* and radius *R* from the step of height '*h*' as shown in the figure is,

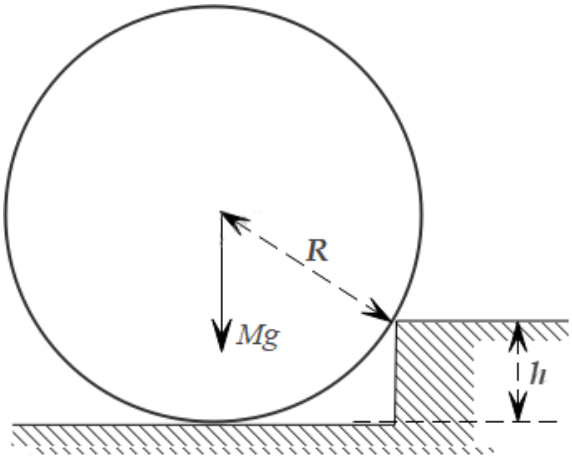
(1) $\frac{Mg\sqrt{(R^2-(R-h)^2)}}{2R}$

(2) $\frac{Mg\sqrt{(R^2-h)}}{R}$

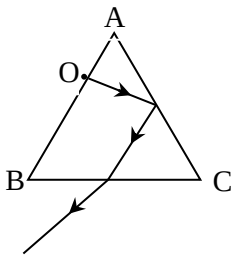
(3) $\frac{Mg\,R}{2}$

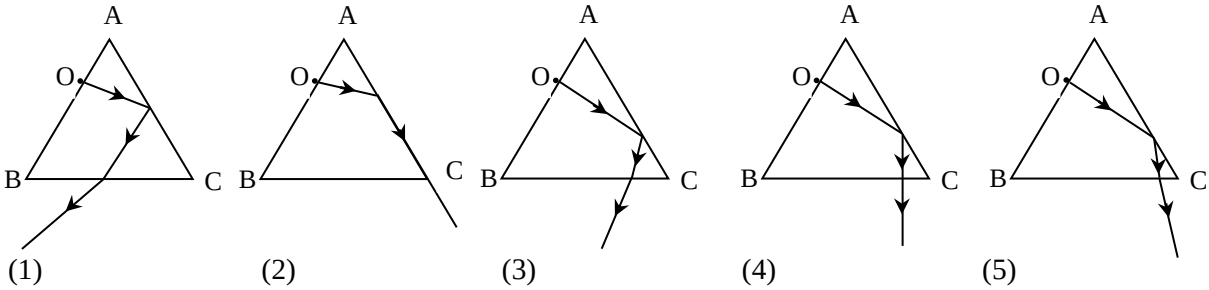
(4) $\frac{Mg\sqrt{(R^2-(h)^2}}{2R}$

(5) $\frac{\sqrt{(R^2-h)^2)}}{2R}$




38. The pin ' O' is fixed to touch the side AB of the equilateral prism ABC. The given figure shows the light ray which is incident on AC with critical angle and emerge from BC after the total internal reflection. Then the glass slide is pasted using a small water drop on AC side. Which diagram shows the correct ray diagram which the light ray incident on AC with critical angle related to glass – water interface and emerges from BC after the total internal reflection. (The critical angle for the glass-water interface is 63$^o$.)




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

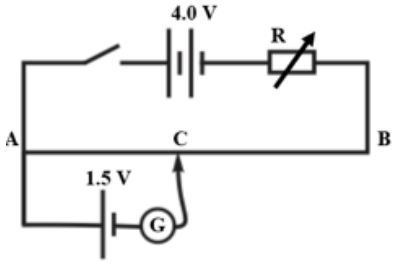
39. The masses of Sun, Earth and moon are $M_S$, $M_E$ and $M_m$ respectively. The distance between sun and the Earth is $d$ and the distance between moon and the Earth is $r$. If the universal gravitational constant is G, which of the following expression represents the resultant gravitational force on moon at full moon eclipse?

(1) $\frac{GM_SM_m}{(d+r)^2}+\frac{GM_EM_m}{r^2}$ (2) $\frac{GM_SM_m}{(d+r)^2}-\frac{GM_EM_m}{r^2}$

(3) $\frac{GM_SM_m}{d^2}+\frac{GM_EM_m}{r^2}$ (4) $\frac{GM_SM_m}{(d-r)^2}+\frac{GM_EM_m}{r^2}$

(5) $\frac{GM_SM_m}{(d-r)^2}-\frac{GM_EM_m}{r^2}$

40. A uniform metal string of length (AB) 1 m and resistance 2 Ω is connected to the given potentiometer. The resistance of the lead – acid accumulator of electro motive force (emf) 4 V is negligible. If 2.4 Ω is given to the variable resistor, what would be the length of AC in order to give zero deflection from center zero galvanometer?

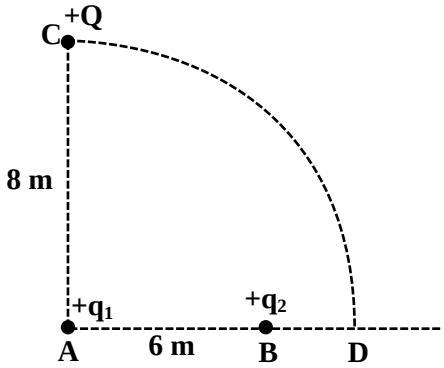



(1) 8.2 cm (2) 8.5 cm (3) 67.5 cm (4) 82.5 cm (5) 85.0 cm

41. A photon of energy $E$ and work function $\emptyset_o$ is incident on the metal surface. At that moment, the emitted electron has the mass $m$ and charge $e$ enters the uniform magnetic field of magnetic field intensity $B$ perpendicularly and goes on a circular path. What expression gives the maximum radius of the path?

(1) $\frac{\sqrt{2m(E+\emptyset_o)}}{eB}$ (2) $\sqrt{\frac{2m(E+\emptyset_o)}{eB}}$ (3) $\sqrt{\frac{2m(E-\emptyset_o)}{eB}}$ (4) $\frac{\sqrt{2m(E-\emptyset_o)}}{eB}$ (5) $\frac{2m(E-\emptyset_o)}{eB}$

42. The $q_1$ and $q_2$ point charges are kept 6 m away from each other at A and B points. The $+Q$ charge which is at C is taken from C to D along a circular path of radius 8 cm as shown in the figure. Which of the following expression gives the change of the potential energy of the system?

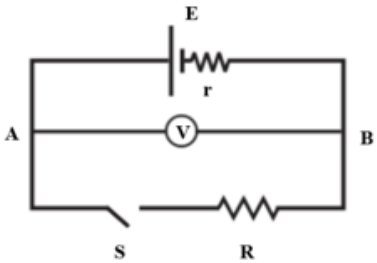



(1) $\frac{1}{4\pi\epsilon_0}\left[\frac{Qq_2}{8}-\frac{Qq_2}{2}\right]$ (2) $\frac{1}{4\pi\epsilon_0}\left[\frac{Qq_1}{8}-\frac{Qq_1}{2}\right]$

(3) $\frac{1}{4\pi\epsilon_0}\left[\frac{Qq_2}{2}+\frac{Qq_2}{10}\right]$ (4) $\frac{1}{4\pi\epsilon_0}\left[\frac{Qq_2}{2}-\frac{Qq_2}{10}\right]$

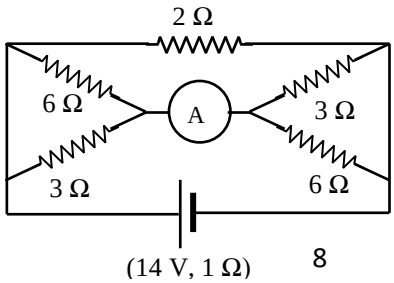
(5) $\frac{1}{4\pi\epsilon_0}\left[\frac{Qq_1}{8}-\frac{Qq_2}{8}\right]$

43. The internal resistance of the dry cell in the given circuit is r and its electro motive force (emf) is $E$. The external resistance ($R$) is 4 Ω. When its switch 'S' is open the ideal voltmeter reads 10 V while 'S' is closed its reading is 8 V. What would be the value of the internal resistance of the cell?



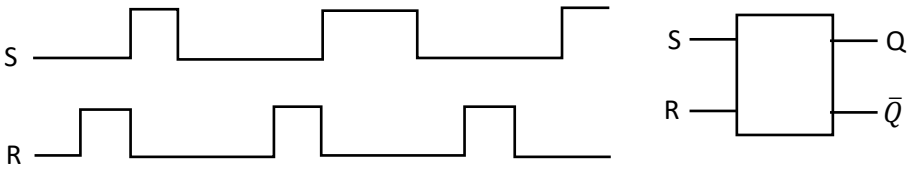

(1) 0.05 Ω (2) 0.1 Ω (3) 0.5 Ω (4) 1.5 Ω (5) 1 Ω

44. What is the correct reading of the given ideal ammeter in the given diagram of resistor system?

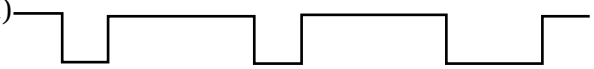



(1) 2.0 A (2) 2.5 A (3) 3.5 A (4) 4 A (5) 6.0 A

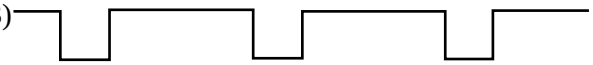
45. The timing diagrams of input signals for S and R input terminals of S-R flip-flop are given below.

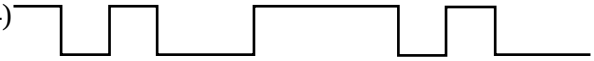



Which of the following diagrams correctly represent the output signal $Q$?

(1)


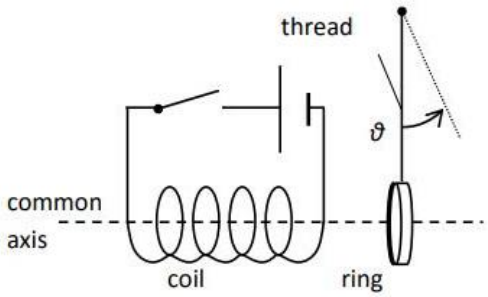
(2)

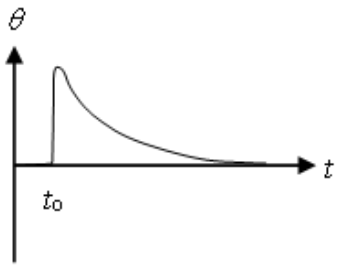
(3)


(4)


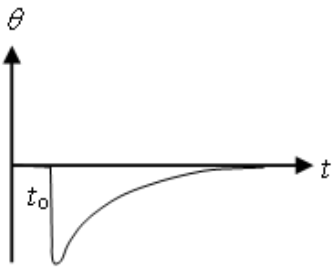
(5)

46. A soft iron ring hangs vertically from a thread and has its axis aligned with a coil. The current in the coil is switched on at time $t_0$. Which of the following graphs shows a possible variation of the angular displacement that the thread makes with the vertical, $\vartheta$, with time?

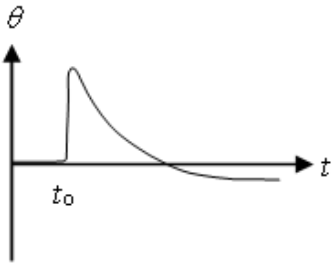


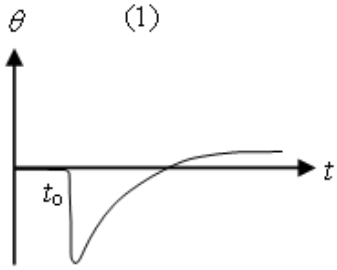

(1)



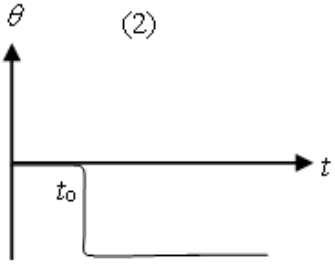

(2)




(3)

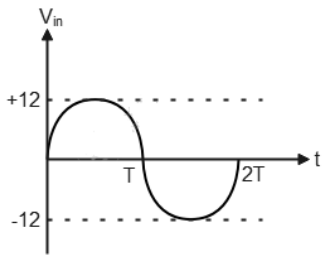


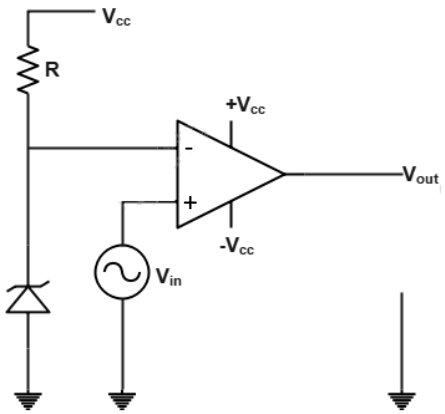

(4)



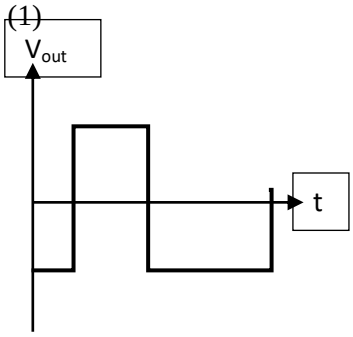

(5)

47. Given below is a voltage comparison circuit with operational amplifier (Op-Amp). The Zener voltage ($V_z$) of the Zener diode is 3V. When the input signal $V_{in}$ is given to non – inverted input, what would be the output signal from the following.

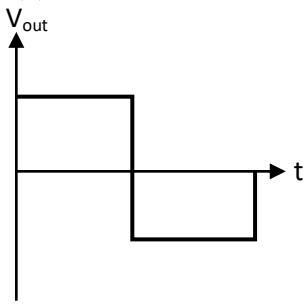


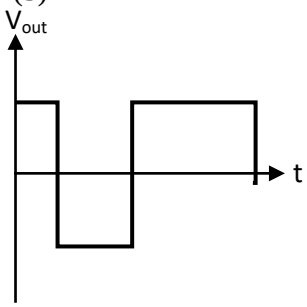

(1)



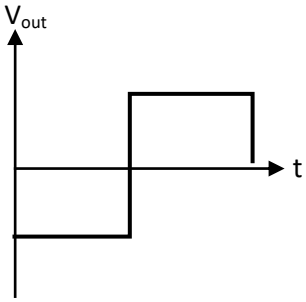

(2)



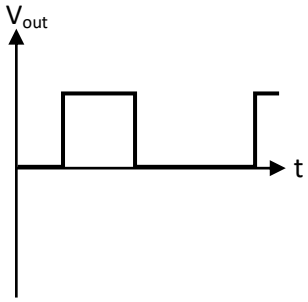

(3)



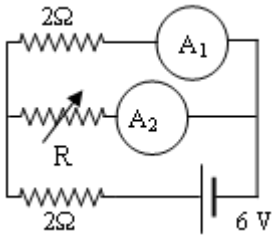

(4)

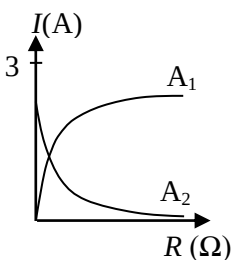



(5)

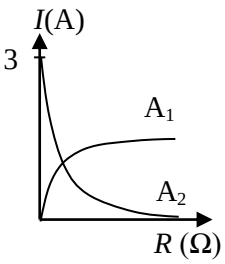



48. In the given circuit, $A_1$ and $A_2$ are ideal ammeters. $R$ is a variable resistor. When changing the resistance of $R$ from zero to infinity the readings of ammeters $A_1$, $A_2$ $(I)$ changes with the resistor value ($R$). Which of the following graphs best represent it?

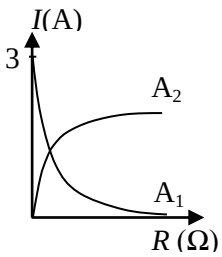



(1)




(2)

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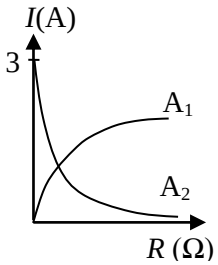


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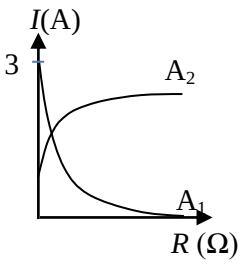
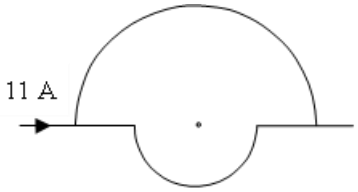


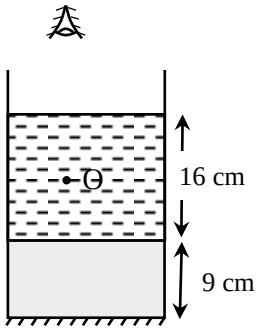

(5)

49. Two semicircular conducting coil loops of radius r and 2r are connected as shown in the diagram. 11 A current is also supplied to the system. Loops are made of same material. What is the value and the direction of the magnetic flux density of the circuit at the common center?
(Take as $\pi = 3$ )




(1) In to the paper $5\mu_0/8r$ (2) Out of the paper $7\mu_0/8r$
(3) In to the paper $7\mu_0/8r$ (4) Out of the paper $7\mu_0/4r$
(5) In to the paper $17\mu_0/8r$

50. In the glass cylinder given in the diagram has glass bottom of thickness 9 cm. A plane mirror is connected to bottom of it. Water is poured in to it. Its water height is 16 cm. A pointing object 'O' is in 8 cm below the water surface. When observing 'O' from the right above it in air, what are the distances for the two bright images from the water surface? (The refractive indices of water and glass relative to air are 4/3 and 3/2 respectively.)




(1). 6 cm, 24 cm (2). 6 cm, 27 cm (3). 6 cm, 30 cm
(4). 12 cm, 27 cm (5). 12 cm, 30 cm

# Advanced Level Examination 2022

## Physics Seminar

## Part A – Structured Essay

01. The figure shows a U - tube with water and an immiscible liquid in balance in the experiment for determining the relative density of a liquid. **XY is the initial horizontal common inter surface.**

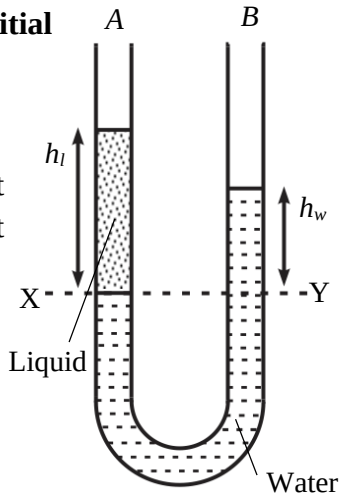


Figure (i)

(a) (i) Four liquids arranged in order of their densities from highest to lowest are aniline, water, coconut oil and alcohol. What liquid/ liquids cannot be used as the liquid labelled in this experiment?

.....

.....

(ii) Give reasons

.....

.....

(b) If the densities of the liquid and water are $\rho_l$ and $\rho_w$, write $\frac{\rho_l}{\rho_w}$ in terms of $h_l$ and $h_w$

.....

.....

(c) You have to find $\frac{\rho_l}{\rho_w}$ by a graphical method. Draw the graph you expect by labelling axes.

(d) Initially $h_l$= 10 cm and $h_w$ = 8 cm. What will be the new value of $h_w$ if 10 $cm^3$ of the liquid is put into the arm A. Area of cross section of the tube is 2 cm².

.....

……

……

(e) In the experiment a student carries out two extra steps ahead **<u>by reducing the height of the liquid back to 10 cm</u>.** As shown in figure (ii), a smooth and light piston (area of cross section 2 cm²) is inserted into the arm A and the liquid is compressed until the upper levels of the liquid and water come to the same level.

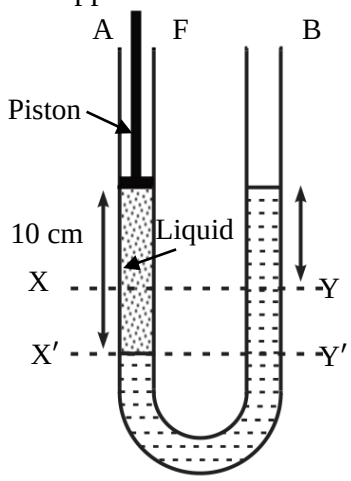


Figure (ii)

(i) What is the force (F) applied to the piston? (Density of water is 1000 kg$m^{-3}$)

……

……

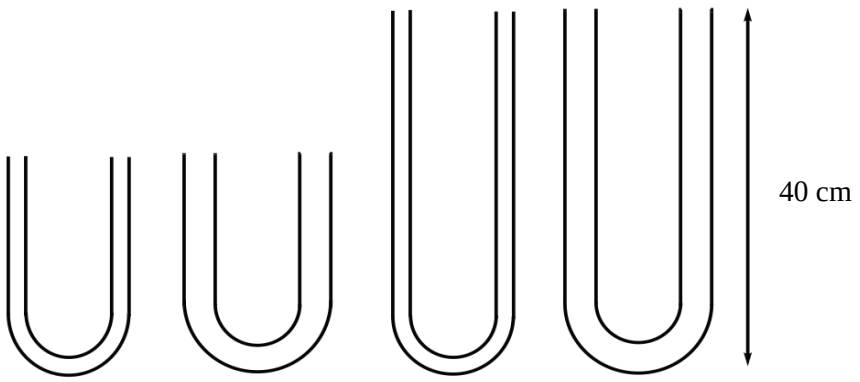
……

(ii) What is the gap between xy and x′y′?

……

……

(f) Several U tubes with different cross section areas and different heights are given.




(i) What is the most suitable U tube for the above practical from the given list?

……

(ii) Give two reasons for your answer.

(1) ……

(2) ……

(02) The following setup is used by a student to find the specific heat capacity of lead shot by the method of mixture in a school laboratory.

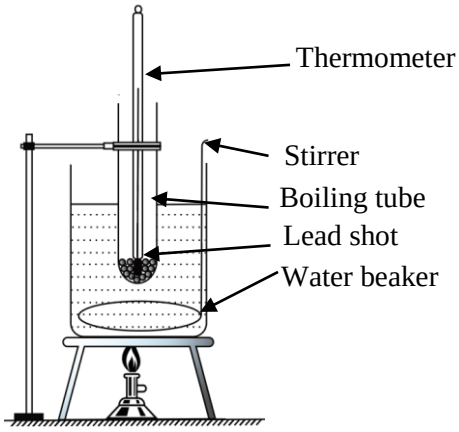



Figure 1

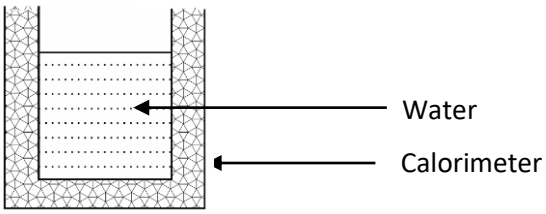



Figure 2

As shown in figure 1, the boiling tube with lead shot are heated up to 95°C by placing in a water bath. The heated lead shot are mixed to the water in the calorie meter.

(a) (i) How do you confirm that the lead shot in the boiling tube have reached 95°C?

.....

.....

(ii) A student suggests that a tube made out of metal is more suitable than a boiling tube to heat the lead shot. Do you agree with this statement? give the reason why.

.....

.....

(iii) Name two other apparatus required for this practical?

1. ..... 2. .....

(iv) What are the points that should be considered when adding heated lead shot to the calorimeter?

1) .....

2) .....

(b) (i) Write down the measurements taken by the student during the above experiment in correct order.

1) .....

2) .....

3) .....

4) .....

5) .....

(ii) The readings relevant to the measurements taken above are given in the below table in SI units.

| Measurements | reading |
|---|---|
| (1) | $100 \times 10^{-3}$ |
| (2) | $220 \times 10^{-3}$ |
| (3) | 30 |
| (4) | 40 |
| (5) | $720 \times 10^{-3}$ |

(Specific heat capacity of water is 4000 $Jkg^{-1} K^{-1}$, Specific heat capacity of the calorimeter is 400 $Jkg^{-1} K^{-1}$)

Calculate the specific heat capacity of lead.

.....

.....

.....

.....

.....

(c) In an experiment to find the specific capacity of a metal from the method of mixture is it suitable to use coconut oil instead of water? Justify your answer.

.....

.....

.....

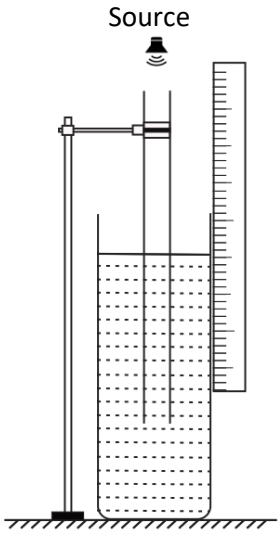
03. A student has arranged a practical setup to find molar mass in the laboratory. He uses a tall glass beaker of water, a meter ruler, a resonance tube open at both ends and a signal generator for this practical.

(a) Obtain an expression for the velocity of sound (V) using the absolute temperature (T) of air in the tube and molar mass of air (M).

……

……

(b) Describe the other physical quantities in the above expression.




…….
…….
…….

(c) The student has decided to do the practical in a room that the temperature can be changed and set up the apparatus as shown in the figure, and kept the vibrating signal generator just above the open end of the tube and obtained the fundamental resonance position. What is the correct method of obtaining the fundamental resonance?

…….
…….
…….

(d) If the fundamental resonance length is $l$, the end correction of the tube is $e$, and the frequency of the tube is f. Write an expression for the velocity ($v$) of sound in air.

……

……

(e) It is required to find the molar mass (m) of air by drawing a graph. For this the student has taken the fundamental resonance lengths by considering room temperatures. The student has taken the gradient of the graph as $2.5 \times 10^{-3}$ $m^2$ $k^{-1}$ and $\gamma$ = 1.4, R = 8.3 $JK^{-1}$ $mol^{-1}$, 100Hz. Calculate the molar mass of air (**neglect the end correction of the tube**

……
……
……
……
……....

(f) To do the above practical accurately, two students have selected two different temperature ranges.

student A –15℃, 20℃, 25℃, 30℃, 35℃

student B –20℃, 30℃, 40℃, 50℃, 60℃

(i) What range would you select from the above two ranges.

……

(ii) Give the reason why.

……

(g) When the temperature of air is constant, value and humidity is increased. What will happen to the velocity of sound in air?

……

……

04. (a) The figure (A) shows a solenoid connected to a centre zero galvanometer and the movement of the magnet

(i) What is the direction of the deflection of the galvanometer?

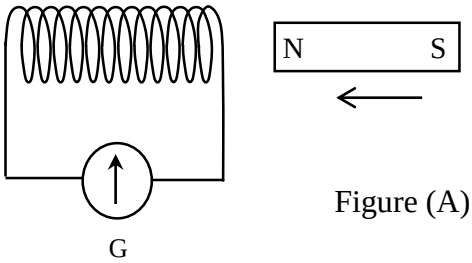



Figure (A)

……..

(b) The figure (B) shows a conducting rod AB of length l moving perpendicular to a uniform magnetic field of flux density B with velocity $v$.

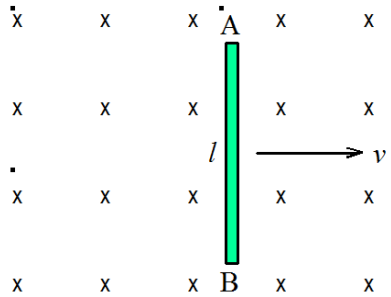



Figure (B)

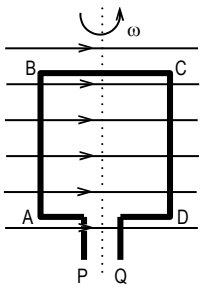
(i) Write an expression for the electromotive force induced on the conductor.

.....
.....

(ii) Mark the polarity of the EMF in the rod in the given figure (B)

c) A wire frame of cross sectional area A and number of turns N rotates in a magnetic field with uniform angular velocity $\omega$. The axis of rotation is perpendicular to the field. Two positions of the frame are shown in figure (C) & (D). In the figure (C) the frame is parallel to the field and in the figure (D) the frame is inclined at angle $\theta$ to the field.

Figure (C)



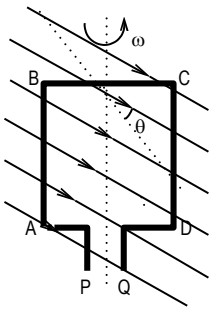




Figure (D)

(i) Write expressions for the EMF at each position.

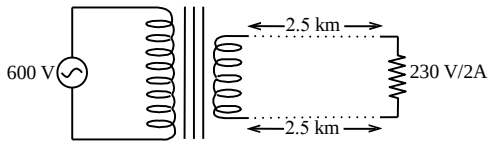
.....
……..

(ii) Show the changes necessary to the figure (C) & (D) to convert them to a D. C. generator and an A.C. generator respectively.

(ii) The cross section area of the frame is 100 $cm^2$, the number of turns is 300, magnetic flux density is 0.2 and the frequency of rotation is 50 Hz. Calculate the root mean square EMF induced across P and Q ($\pi$ = 3)

.....
.....

f) A. C. voltage produced by a dynamo is 600 V. It is required to supply 230 V and 2A to a factory which is at a distance 2.5 km from the dynamo. A transformer is used for this purpose. Linear resistance of the transmission cables is $10^{-3}\ \Omega\ m^{-1}$




(i) What type of transformer is used for this?

.....

(ii) Find the ratio of the number of turns between the primary and secondary coils.

.....

(iii) The efficiency of the transformer is 60%. Calculate the current through the primary coil.

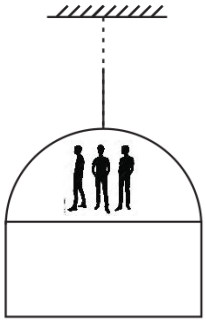
.....

.....

****

## Part B
## Essay Questions

05. Figure shows a diving chamber which is used to collect ruins of a ship sunk in the bed of the sea. If consists of half of a hollow sphere of radius 2 m and a hollow cylinder of 2 m height. When considering the volume of the chamber, the volume of the metal can be neglected. Mass of the diving chamber is 20000 kg and the total mass of 3 divers is 200 kg. ($\pi$ = 3)



(a) When the diving chamber is in water, how much volume of the chamber is inside the water? (Density of sea water is 1200 $kgm^{-1}$)

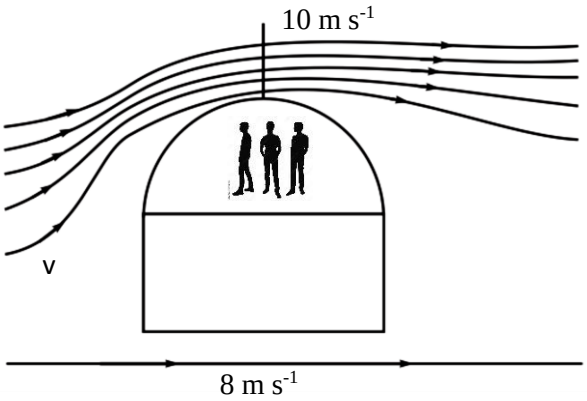
(b) Find the upthrust when the diving chamber is completely immersed in water.

(c) To immerse the diving chamber completely, sea water is filled in to the cylindrical part of the air chamber. If the cylindrical chamber is filled completely, find the tension of the string to keep the chamber stationary and completely immersed in water.

(d) If the string is not taut, find the acceleration of the chamber in the downwards direction.

(e) The chamber is kept at rest at a position where the bottom of the chamber will be at 100m depth from the sea surface. At that time there is no tension on the string. Find the force exerted on the curved surface of the diving chamber due to the water pressure and mark the directions.

(f) When the chamber is at 100 m depth it is affected by a sea current. Because of that, the velocity of water above the chamber is 10 $ms^{-1}$ and velocity of water below the chamber is 8 $ms^{-1}$ Find the resultant upwards force due to the pressure difference $0.48 \times 10^5$ Pa (Consider the flow is laminar and steady.)




(g) If at that time the string is 60° to the vertical, what is the horizontal force acting on the diving chamber due to the collision with water?

(h) At 120 m depth, the diving chamber comes to rest on the seabed and there is no water layer between the seabed and the chamber. A diver collects objects of 4000 kg mass into the chamber. Find the minimum volume of water needed to be removed from the cylindrical part to lift diving chamber.

06. (a) The Simple or compound microscopes are used to magnify and observe tiny objects.

(i) When an object is being moved towards the eye, its magnification seems to increase. State the reason for this.

(ii) Draw two ray diagrams to show that the image becomes larger and smaller respectively when an object is at two positions at close proximity and far away from the eye.

(iii What is meant by the normal adjustment of the microscope ?

(iv) What is the reason for selecting the normal adjustment?

(v) What is meant by angular magnification of a microscope?

(b) Two lenses having focal lengths of 5 cm and 2 cm have been used as the eye piece and the objective piece respectively in a compound microscope. This microscope is used to observe objects at 3cm away from the objective lens.

(i) If the final image is formed 25 cm away from the eye piece. Draw the ray diagram for this situation.

(ii) Calculate the angular magnification of this compound microscope.

(iii) Find the distance between the two lenses.

(c) (i) Generally, compound microscopes form inverted images. In order to obtain an "erect magnified final image", the eye piece of the above compound microscope is replaced by a concave lens of focal length 3 cm, and it was adjusted so that the final image is formed at 25 cm away from the eye piece. Draw the ray diagram for the newly adjusted compound microscope.

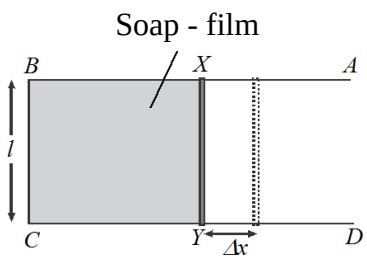
(ii) Find the distance between two lenses.

(iii) In order to obtain an "erect magnified final image", a student decided to introduce another convex lens to the compound microscope mentioned in (b) (i) without using a concave lens as in (c) (i), but another student says that, the method in (c) (i) is more suitable. What is your decision on this? Explain with reasons.

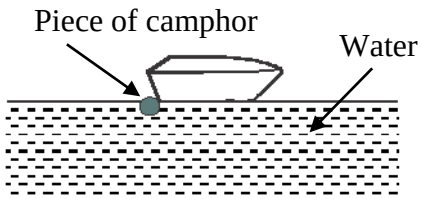
07. (a) (i) Write the dimensions of the co-efficient of surface tension.

(ii) What is meant by the surface energy?

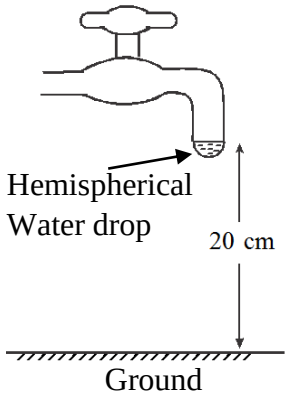
(iii) ABCD is a wire frame consisting of a thin soap-film which is kept horizontally. XY is a rod connected to the soap-film which can slide along the AB and CD arms. The co-efficient of surface tension of soap is 'T'. Obtain a relation between the work done on the rod and the additional energy stored in the soap-film, when the rod is moved by ΔX distance. (Neglect the frictional forces)




(iv) Explain the following incident using surface tension. "A toy boat is staying at rest on the surface of a stagnant body of water, as shown in figure. When a piece of camphor is connected to the back side of the boat so that it contacts with water, it proceeds to move forward"



(b) The figure shows an incident which happens after closing a tap. The water remaining in the vertical portion of the tube gets collected at the open end and the collected amount increased with the time, forming a hemispherical water drop, and then it gets released from the tap and falls under gravity. Assume, it falls as a spherical water drop, having a constant radius. The diameter of the open end of the tap is 9.2 mm. The density of water is 1000 $kgm^{-3}$. ($\pi$-3)




(i) Find the maximum amount of water mass that can be collected in the drop under the above conditions.

(ii) Calculate the coefficient of surface tension of water.

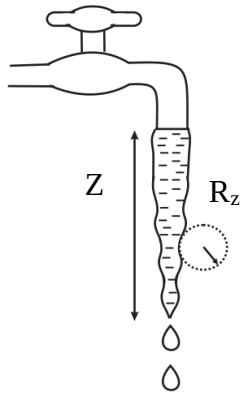
(iii) Find the radius of the water drop which falls under gravity (Consider $2^{4/3}$ = 2.5)

(iv) The water drop then hits on the ground and breaks into 100 identical water droplets with equal kinetic energies. The energy dissipations on the collision is negligible.

(I) Find the radius of one droplet after collision on the ground. (consider $10^{8/3} \sim 500$)

(II) Is the total maximum kinetic energy gained by small droplets equal to the initial kinetic energy of the water drop? (consider surface energy is negligible)

(c) When the tap opens smoothly the water falls downward as a thin stream as shown in the figure. At the beginning the shape is linear and later it forms sinusoidal pattern. The radius of the curvature of a wave is $R_Z$ , given by the following equation. At a certain value of $R_Z$ the stream breaks into water drops.




$R_Z = R_O + A_K \cos(k \times z)$

Where,

$R_O$ = radius of the tube of the steam

$A_k$ = the amplitude of a loop of a wave

$_k$ = wave number (the number of Crests and troughs per centimeter)

$_z$ = the distance from the mouth of the tap to the point of breaking. (In meters)

When AK = $\frac{R_O}{Z}$ and $R_Z = 1.25\ R_O$, it begins to break. At this time the number of crests and troughs which appear within 10 cm is 100.

(i) Find the wave number (k) of the water stream.

(ii) Find the distance from mouth to the point when the stream starts to break.

8. (a) (i) Write Newton's law of gravitation.

(ii) Define the gravitational potential at a point in a gravitational field.

(iii) Write an expression for gravitational potential V at a point at distance r from the centre of an object of mass M in terms of G, M and r. Where G is the universal gravitational constant.

(iv) Draw a rough graph to show how the gravitational potential V, varies with distance r.

(v) Why is the gravitational potential always a negative value?

(b) When a mass falls towards earth, its potential energy will be lost. Explain what happens to this energy lost under each of the following scenarios.

(i) When the mass free falls above the atmosphere

(ii) When the mass is moving with uniform velocity through the atmosphere

(c) An object of mass 1 kg is projected upward with a kinetic energy of 32 MJ from earth's surface.

(i) Calculate the velocity of the object.

(ii) Obtain an expression for the escape velocity of an object on earth's surface in terms of G, M and R. Where, M and R are the mass of earth and radius of earth respectively.

(iii) If the mass and radius of earth are $6\times10^{24}$ kg and 6400 km respectively, and G = $6.67\times10^{-11}$ N $m^2$ $kg^{-2}$, calculate the escape velocity of the object at earth's surface and hence show that the object does not leave the gravitational field.

(iv) How much kinetic energy must be imparted to the object at earth's surface so that it just leaves the gravitational field?

(v) If the mass of moon is $7.5\times10^{22}$ kg and the distance between the centres of earth and moon is $4.0\times10^{5}$ km, calculate the minimum velocity required to project a planetary object of mass 400 kg into infinity from the mid-point of the distance between earth and moon.

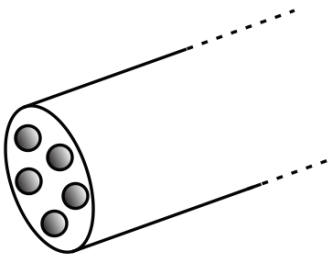
(**Hint: consider the mass of moon with compared to earth is negligible for this calculation**)

(vi) What will happen to the velocity of the planetary object if its mass is doubled?

09.A. The electric energy generated in power stations is distributed to distant villages using high voltage transmission. In this method the electric energy generated in the power station is converted in to a very high voltage and low current using a step-up transformer for transmission and at the sub stations a stepdown transformer is used to reduce the voltage and distribute it to factories and houses.

(a) Transmission of electric energy is done using a low current at high voltage. Explain the reason for this.

(b) Five parallel wires bundled together as a single cable as shown in the figure is used to transmit electricity to 40 km distance. Each wire is at room temperature (20°C), having resistivity 2 x $10^{-8}$ $\Omega m^{-1}$ and cross-sectional area 2 $cm^2$. During transmission the current flowing is 0.5 A.



(i) Find the resistance of the transmission cable.

(ii) Find the potential difference between the two ends of the transmission cable.

(iii) Find the power loss during electricity transmission.

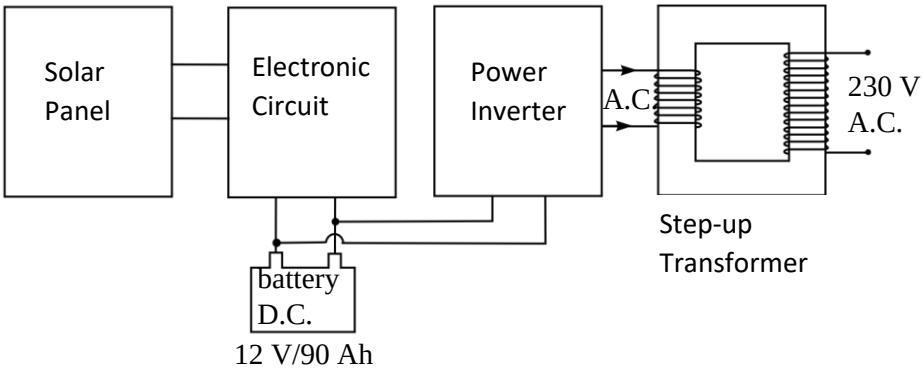
(iv) When a 0.4A current is transferred during a period of one hour, the potential difference between the 2 points of transfer is constant. The temperature of the wire also remains at a constant 40°C. Find the thermal coefficient of resistance.

c) (i) A DC motor is run by passing alternating current through a 12V full wave rectification. The maximum safe current flow through the motor coil is 2A. The resistance of the motor coil is 2$\Omega$, calculate the resistance to be connected in series when operating the motor.

(ii) Calculate the back EMF when the motor is running at the maximum power and find the efficiency.

(d) If the motor rotates at a speed of 600 revolutions per minute and the area of the coil is 40 $cm^2$ and the number of turns of the coil is 100, find the magnetic flux density of the field acting on the coil.

(e) A certain country has implemented rolling blackouts in order to conserve energy. In order to provide basic lighting during the blackouts, Power inverters are used in many households. Below is a basic schematic of such a power inverter. A power inverter operates by converting a DC voltage source to an AC current and passing it through a step up transformer to output mains power. The batteries are energised by solar power during the day and the charge thus stored is used to drive the inverter.




A certain house uses a power inverter of output power 1000W at 230 Volts to operate the following apparatus. The battery supplied is 12V and 90Ah capacity.

| **Apparatus** | **Quantity** | **Power (W)** |
|---|---|---|
| Bulb (LED) | 04 | 5 |
| Electric fan | 01 | 40 |

(i) If all the apparatus are used at the same time, what is the operating time of the inverter?

(ii) If a refrigerator of power 750W is used with the above apparatus. What is the operating time of the inverter?

(iii) For the above inverter, what is the output power through a load resistor of 10 $\Omega$?

09.B (a) Draw the characteristic curve of a diode

(b) Explain the action of a Zener diode.

(c) In the circuit given, a Zener diode of voltage 12 V is used. The resistances $R_S$ and $R_L$ are 120 Ω and 200 Ω respectively, supply voltage $V_{in}$ = 25 V

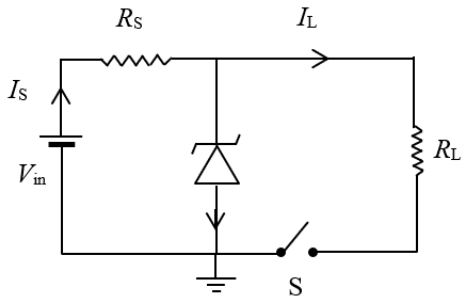



Figure (1)

(i) Calculate the currents through $R_S$, $R_L$ and the zener diode, $I_s$, $I_L$ and $I_Z$ respectively.

(ii) What is the power of the diode?

(iii) What is the possible maximum power of the diode?

(iv) What should be the minimum power rating of the diode used for proper operation of the circuit?

(d) The transistor shown in the circuit is biased to cut off region, and saturated region respectively by applying input voltages 0V and 5V respectively. Transfer characteristic ($I_C$ vs $I_B$) of the transistor is shown in the graph. The dc current gain, β of the transistor is 100.

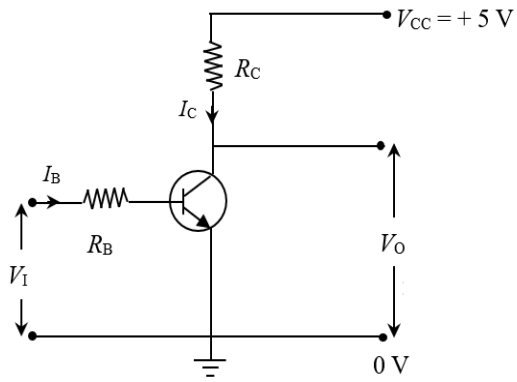



Figure (2)

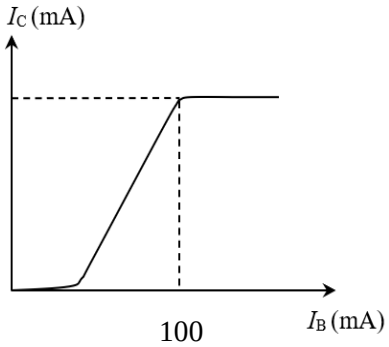



Figure (3)

(i) Calculate the maximum current of the $I_c$

(ii) Calculate the maximum resistance for $R_B$.

(iii) Calculate the resistance the $R_C$

(iv) Copy the table below and complete it giving the outputs for input 0 V and 5 V.

| **Input (A)** | **Output (F)** |
|---|---|
| 0 V | |
| 5 V | |

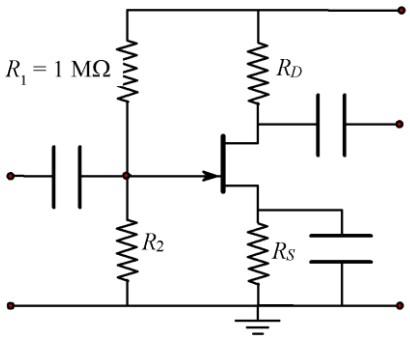
(v) What is the equivalent logic gate which gives the same output and give its truth table.

(e) (i) Draw the characteristic curve for $V_{DS}$ vs $I_D$ for a junction field effect transistor (JFET) for 3 different constant values of one parameter.

Mark the cut-off region, saturated region, and the Ohmic region.

(ii)Explain why the $V_{DS}$- $I_D$ graph has a linear variation for small values of $V_{DS}$ in the Ohmic region.

(iii) Draw the variation of $V_{DS}$ against $I_D$ when $V_{GS}$=0 and mark the pinch-off point, pinch off voltage ($V_P$) on the graph.



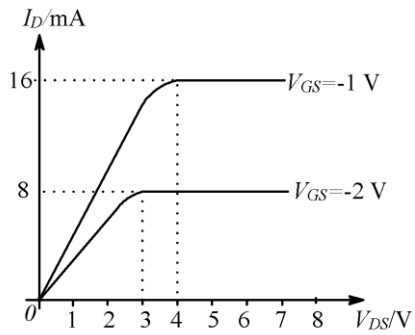



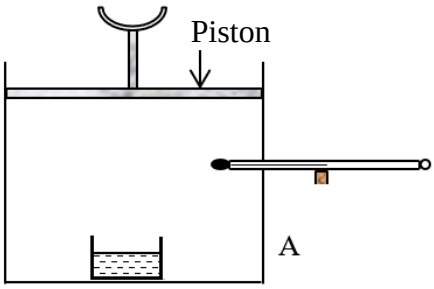

Figure shows a JFET amplifier and $I_D$ vs $V_{DS}$ graph.

(i) Find the minimum $V_{DS}$ for the device to operate in pinch –off

(ii) Find the Gate current when $V_{GS}$=-2V and when $V_{DS}$ =5V

(iii) If $V_G$=5V, $I_D$=4mA, $V_D$=8V and $V_{GS}$=-2V find the values of $R_2$,$R_D$,$R_S$

10. A. By moving the piston, the volume in the cylinder can be changed. A small quantity of water is placed inside.




(a) When the volume inside is slowly increased by moving the piston, water in vessel completely evaporated. The volume is further increased.
Draw a rough sketch to show the variation of vapour pressure with volume when the volume is increased by keeping the temperature constant.

(b) Keeping the volume constant, the temperature inside the cylinder is gradually increased until all the water in the vessel is evaporated. Now the temperature is further increased. Draw a rough sketch to show the variation of vapour pressure with temperature $\theta$ measured in $^0$C.

(c) The water vessel is removed from the cylinder. Then the relative humidity of air becomes 60% when the volume is 0.2 $m^3$ and the temperature is 27 $^0$C.

(i) Calculate the partial pressure of water vapour. (Saturated vapour pressure at 27 $^0$C is 27 Hg mm).

(ii) Calculate the absolute humidity inside the cylinder. Molar mass of the water is 18 g, density of mercury 13600 kg $m^{-3}$, R = 8 J $K^{-1}$ $mol^{-1}$)

(iii) By how much must the volume in the cylinder be decreased to start condensing the water?

(iv) Variation of density of saturated water vapour with temperature is given below. Calculate the dew point.

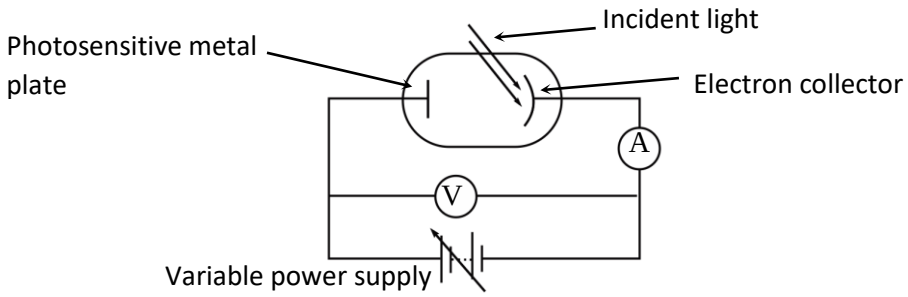
| Temperature ($^0$C) | 14 | 16 | 18 | 20 | 22 |
|---|---|---|---|---|---|
| Density of saturated water vapour (g $m^{-3}$) | 12.00 | 13.50 | 15.30 | 17.10 | 19.20 |

(v) Calculate the saturated vapour pressure of water at the dew point.

(d) There is another cylinder (B) similar to the former one (A). Relative humidity inside B is 80% when the volume is 0.2 $m^3$ and at temperature is 7 $^0$C.
Now A and B are connected by a tube of negligible volume. In what direction will water vapour flow? (Saturated vapour pressure at 7 $^0$C is 7.5 Hg mm)

(e) Calculate the relative humidity of B after they come to equilibrium. (Temperature of the system at the equilibrium is 22 $^0$C).

10) B. An apparatus used to study the photoelectric effect is shown in the diagram below. When light falls onto the photosensitive metal plate, electrons are ejected.




(a) Describe how the apparatus can be used to determine the maximum kinetic energy of ejected electrons for a given metal and a particular wavelength of light.

(b) Light of wave length $5.14\times10^{-7}$ m is incident on the photosensitive metal plate. The work function of the metal plate is 2.14 eV. Calculate the minimum potential difference required to stop all the ejected electrons in the apparatus.

(c) (i) Sketch a graph of stopping voltage (Vs) against frequency (1), showing typical results of an experiment using the apparatus. Label this graph A.

(ii) Using the axes in part (i), sketch a graph showing the results for a different photosensitive metal of higher work function, label this graph as B.

(d) Explain how you could use the apparatus above to determine Plank's constant. You have the ability to change the frequency of the incident light.

(e) When sunlight ejects electrons from the silver coating on the outer surface of a satellite, the satellite can become charged by the photoelectric effect. Assume the outer surface is initially uncharged.

(i) Calculate the longest wave length of sunlight that can eject an electron from the satellite's outer surface. The work function of silver is 3.83 eV.

(ii) Explain why a satellites with a platinum coating charges more slowly than one with a silver coating. The work function of platinum is 5.32 eV.

(f) Production of X rays can be considered to be the inverse of the photoelectric effect. The accelerating potential applied across an X rays tube is 3x $10^4$ V.

(i) Calculate both the kinetic energy and speed of electrons just before it hits the target.

(ii) Calculate the De Broglie wave length associate with an electron just before it hits the target.

(iii) Calculate the maximum frequency of the X radiation emitted (h = 6.63 x $10^{-34}$Js)