

G.C.E. (A. L.) Support Seminar - 2016

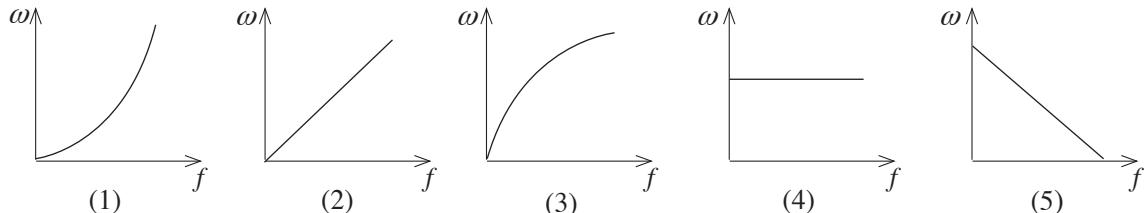
Physics I

Two hours

Instructions :

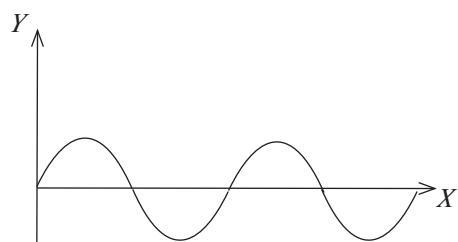
- * Answer **all** the questions.
- * Select the correct or the most suitable answer.

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

1. The SI unit of coefficient of viscosity,
(1) N m^{-1} (2) N m^{-2} (3) $\text{N m}^{-2}\text{s}$ (4) $\text{N m}^{-1}\text{s}^{-1}$ (5) N m s^{-2}
2. Angular displacement θ is given by $\theta = k\alpha t^2$. If α is the angular acceleration and t is time the dimensions of k is,
(1) T^{-1} (2) LT (3) LT^2 (4) LT^3 (5) No dimensions
3. Centripetal acceleration of a particle, which is moving in a circular path with a uniform angular velocity of ω is f . The graph between ω and f is correctly represented by,

4. A washing machine is operated with a motor of 320 W and the rotating disc of it has a moment of inertia 5 kg m^2 . Starting from rest, how long will it take to acquire a frequency of 240 rpm under the above power? ($\pi^2 = 10$)
(1) 2 s (2) 3 s (3) 5 s (4) 8 s (5) 10 s
5. The image of an object, which is 5 cm away from a convex lens is virtuous. An image which is real and equal in size to the earlier image is formed when the object is moved another 5 cm away from the lens. The focal length of the lens is.
(1) 5 cm (2) 10 cm (3) 15 cm (4) 20 cm (5) 25 cm
6. The distance between the eye lens and the retina of a person is 2.6 cm. If his near point is located 28.6 cm away from the eye lens, the minimum focal length of the eye lens,
(1) 0.07 cm (2) 2.1 cm (3) 2.2 cm (4) 2.4 cm (5) 2.9 cm
7. One end of a resonance pipe is opened and the other end is opened or closed. The resonant frequency of the new air column is 125 Hz. Which one would **not** be one of the natural frequencies of it?
(1) 250 Hz (2) 375 Hz (3) 500 Hz (4) 625 Hz (5) 900 Hz
8. Speeds of five air molecules are 0 km s^{-1} , 3 km s^{-1} , 5 km s^{-1} , 5 km s^{-1} and 6 km s^{-1} . The root mean square speed of these five molecules is,
(1) 95 km s^{-1} (2) 70 km s^{-1} (3) $\sqrt{19} \text{ km s}^{-1}$ (4) $\sqrt{21} \text{ km s}^{-1}$ (5) $\sqrt{14} \text{ km s}^{-1}$
9. The temperature coefficient of resistance of a metal by which a wire has been made is $1.25 \times 10^{-3} \text{ K}^{-1}$. The resistance of it is 1Ω at 300 K. At which temperature the resistance of it would be 2Ω ?
(1) 1154 K (2) 1400 K (3) 1127 K (4) 1100 K (5) 600 K

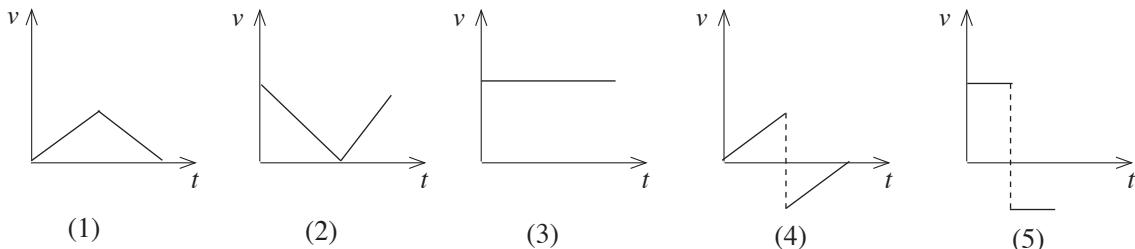
10. The frequency of oscillation of a string, which is tied at both ends is 1000 Hz. The frequency of oscillation of it when the tension is increased by 21%,
 (1) 1021 Hz (2) 1100 Hz (3) 1210 Hz (4) 420 Hz (5) 790 Hz

11. The relationship between 2 variables X and Y of a sound wave is represented by sinusoidal graph as shown in the figure. If X is the distance towards the direction of energy transfer, what is represented by Y out of the followings?
 A - displacement of the particle at a moment
 B - acceleration of the particle at a moment
 C - pressure at a moment
 (1) A (2) A and B (3) A and C
 (4) B and C (5) A, B and C

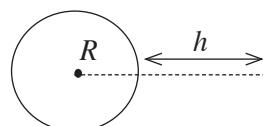


12. A boat travels at a uniform velocity of 10 m s^{-1} . The resistive force against the motion of the boat is 400 N. The power of the engine of the boat,
 (1) 40 W (2) 400 W (3) 2000 W (4) 3000 W (5) 4000 W

13. A ball moving on a smooth horizontal plane at a uniform velocity collides against a vertical stationary wall, and bounces back perpendicularly to the wall. If the collision is elastic the graph between the speed of the ball and time is,

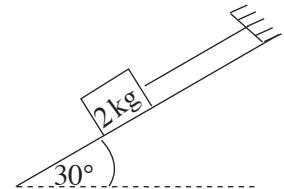


14. Consider earth as a spherical object with a radius R . At which value for h the gravitational acceleration is half of the gravitational acceleration at the surface of the earth?



(1) $h = \frac{R}{2}$ (2) $h = \frac{R}{\sqrt{2}}$ (3) $h = (\sqrt{2} - 1)R$
 (4) $h = \sqrt{2}R$ (5) $h = (\sqrt{2} + 1)R$

15. An object of 2 kg is kept on a rough plane which is inclined at 30° to the horizontal as shown in the figure. The object is fixed to a point at the top of the plane by a light inextensible string parallel to the plane. If the coefficient of friction between the inclined plane and object is $\sqrt{3}/2$. The tension in the string,



(1) 0 N (2) $5\sqrt{3}$ N (3) 10 N
 (4) $10\sqrt{3}$ N (5) 25 N

16. Relative humidity of the atmosphere is 50% at 30°C . The temperature is increased instantly up to 35°C and addition or removal of water vapour was not occurred. If the saturated vapour pressure at 30°C and 35°C are P_{30} and P_{35} respectively, relative humidity of the atmosphere at 35°C ,

(1) Little more than $\frac{50 P_{30}}{P_{35}}\%$ (2) Little less than $\frac{50 P_{30}}{P_{35}}\%$ (3) Equal to $\frac{50 P_{30}}{P_{35}}\%$
 (4) Little more than $\frac{50 P_{35}}{P_{30}}\%$ (5) Equal to $\frac{50 P_{35}}{P_{30}}\%$

17. An electron of mass m is accelerated under a potential difference of V . The De Broglie wave length of it is λ . To which value the De Broglie wave length is equal, when a proton of mass M is accelerated under the same potential difference of V ,

(1) $\frac{m}{M} \lambda$ (2) $\frac{M}{m} \lambda$ (3) $\frac{M}{M+m} \lambda$ (4) $\lambda \sqrt{\frac{M}{m}}$ (5) $\lambda \sqrt{\frac{m}{M}}$

18. Due to which reason, out of the followings a glass container is cracked when hot water is poured in to it?

(1) Low heat conductivity of glass
 (2) Low specific heat capacity of glass
 (3) Low volume expansivity of glass
 (4) High heat conductivity of glass.
 (5) High specific heat capacity of glass

19. The ice point of a thermometer has been marked as -10°C . 60°C is obtained when the temperature of a liquid in 50°C is measured. The reading obtained by this thermometer when the boiling point of water is measured,

(1) 90°C (2) 110°C (3) 120°C (4) 130°C (5) 140°C

20. An object, heated up to 80°C and kept in an environment of 30°C , the rate of temperature fall of initial temperature is 5°C s^{-1} . If the environmental temperature is reduced by 10°C , What is the rate of temperature fall of initial temperature,

(1) 3°C s^{-1} (2) 4°C s^{-1} (3) 5°C s^{-1} (4) 6°C s^{-1} (5) $12^{\circ}\text{C s}^{-1}$

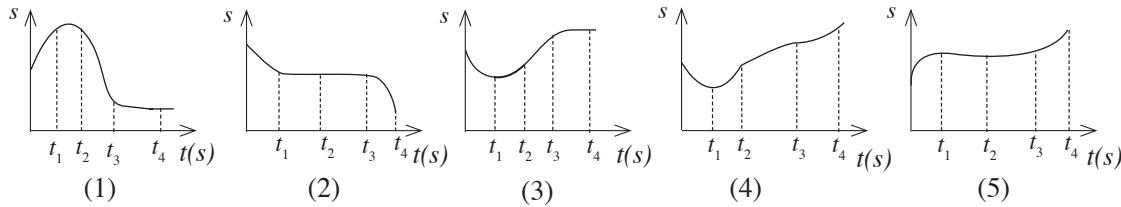
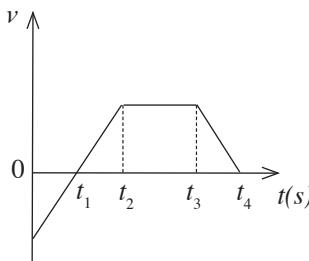
21. A phenomenon, which can be observed only in transverse waves.

(1) Refraction (2) Diffraction (3) Interference
 (4) Superposition (5) Polarization

22. A violin play is broadcasted through a live radio programme. The type of waves that transmit energy from the violin to listeners are,

(1) Transverse, longitudinal, longitudinal, transverse
 (2) Transverse, Longitudinal, Electromagnetic, longitudinal
 (3) Transverse, transverse, Electromagnetic, longitudinal
 (4) Electromagnetic, transverse, longitudinal, transverse
 (5) Longitudinal, transverse, Electromagnetic, longitudinal

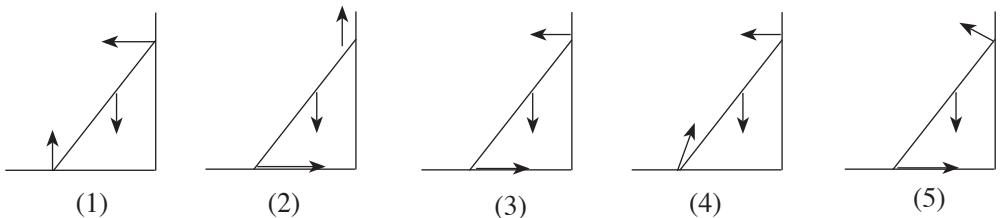
23. The corresponding displacement (s) time (t) graph for the given velocity (v) time (t) graph is,



24. The diameter of moon is 20 times through the astronomical telescope as as it is observed by the naked eye. If the focal length of objective is 1 m the focal length of the eyepiece is,
 (1) 1 cm (2) 2 cm (3) 5 cm (4) 20 cm (5) 50 cm

25. Element X, which is radioactive is converted in to another stable element called Y. The half life of the element is 8 days. The percentage of the number of X atoms converted in to Y after 24 days is,
 (1) 25 % (2) 50 % (3) 75 % (4) 87.5 % (5) 93.75 %

26. A Ladder is in an equilibrium on a vertical plane which is perpendicular to the wall as shown in the figure below. One end of the ladder is on the rough horizontal ground and the other end is resting against a smooth vertical wall. The correct free body diagram for the forces acting on the ladder is,



27. The figure shows the way that a beam of monocromatic light incidents on to a optical system and emerges. The instrument combination which can be present in this optical systems are as follows.



A - two convex lenses
 B - one convex lens and one concave lens
 C - rectangular, isosceles prism

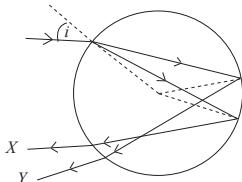
The correct combinations would be

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

28. A clear image of a remote object is focused on to a screen. Then the distance between the lens and the image is 20 cm. Now another lens L_2 is kept in contact with L_1 and a clear image of the object was obtained on to the screen. Then the distance between the screen and the lens combination was 25 cm. The focal length and the type of L_2 is,

(1) 5 cm, convex (2) 5 cm, concave (3) 50 cm, concave
 (4) 100 cm, convex (5) 100 cm, concave

29. Incidence of sunlight on to a spherical rain drop with an angle of i is shown in the figure.



Consider the following statements.

A - X can be red and Y can be blue.
 B - X and Y rays are subjected to total internal reflection for all the values of i .
 C - The deviation of X is greater than the deviation of Y.

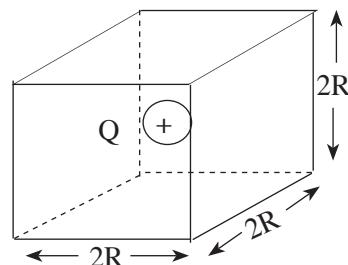
True statement/ statements out of the above

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

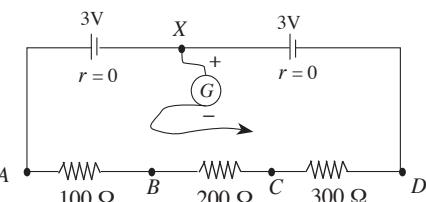
30. A person at 100 m away hears a sound broadcasted by a loudspeaker with a uniform intensity. Now the power output of the loudspeaker was brought up to $\frac{1}{10}$ of the earlier value. The distance that must be travelled towards the loudspeaker in order to increase the new intensity level by 10 dB is,
 (1) 10 m (2) 20 m (3) 50 m (4) 90 m (5) 100 m

31. The length of a sonometer wire under a certain tension is 80 cm, A knife edge is placed at the middle of the sonometer wire without affecting the tension. Due to the knife edge the wire has been divided in to 2 parts with the lengths 39.5 cm and 40.5 cm. 10 beats per second were heard when these two parts of wire are vibrated simultaneously. The vibration frequencies of each part of wire are,
 (1) 200 Hz, 210 Hz (2) 400 Hz, 410 Hz (3) 395 Hz, 405 Hz
 (4) 295 Hz, 305 Hz (5) 390 Hz, 400 Hz

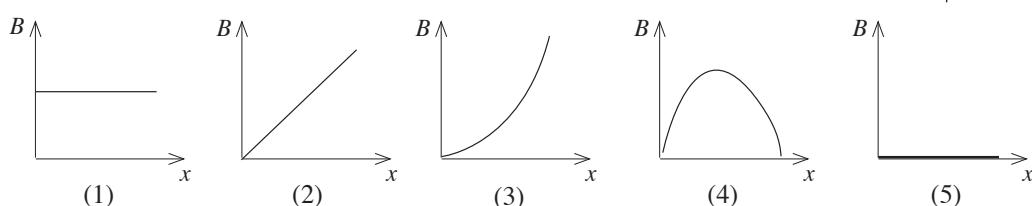
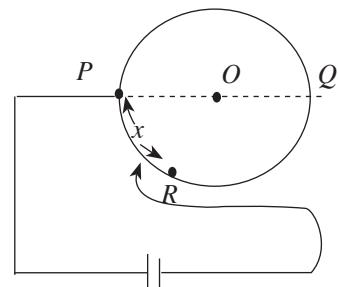
32. A $+Q$ point mass is kept in the middle of a cube with a length of a side is $2R$. The net flux through the surface of the cube is ϕ . What is the **incorrect** statement out of followings?
 (1) The net flux is zero when the charge is taken out from the cube.
 (2) The net flux through the surface is $\frac{\phi}{8}$ when the charge is kept at a vertex of the cube.
 (3) The net flux through the surface is twice when the magnitude of the charge is doubled.
 (4) The net flux through the surface is not changed when $-2Q$ charge is kept in addition to the $+Q$ charge inside the cube.
 (5) The net flux is less than ϕ when to change the charge Q is kept in the center of a sphere with a radius R , instead of the cube.



33. The internal resistance is zero in all 3 V cells in the diagram. G is a centre zero voltmeter. The (+) end of it is connected to X and the (-) end is touched with A , B , C and D respectively. Then the voltmeter readings are in order,
 (1) 3V, 2V, 0V, -3V (2) 6V, 5V, 3V, 0V
 (3) -6V, -5V, -3V, 0V (4) -3V, -2V, 0V, 3V
 (5) 1V, 2V, 3V, 6V



34. A circular loop of conducting wire has been connected to a circuit as in the diagram below. P and Q are two points at the ends of a diameter. Point P is permanently fixed and the key R can be slid from P to Q . Change in magnetic flux density at centre O due to the current in circular loop, with the distance x from P to Q is very well represented by,



35. The diagram shows the shapes of two liquid drops A and B consider the following statements.

A - the density of liquid A is greater than the density of liquid B.

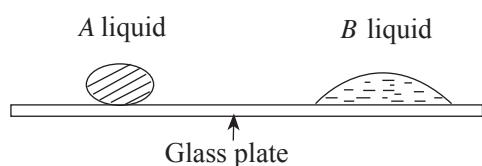
B - the surface tension of liquid A is greater than the surface tension of liquid B.

C - the angle of contact of liquid A is greater than the angle of contact of liquid B.

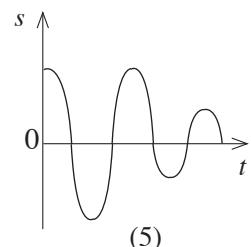
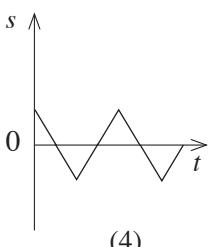
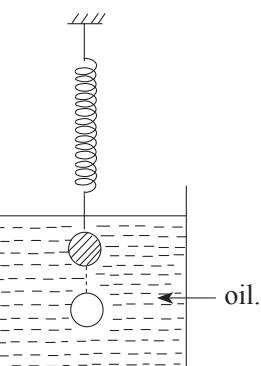
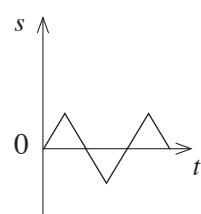
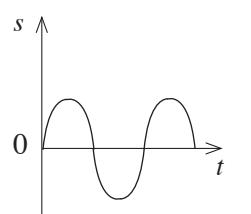
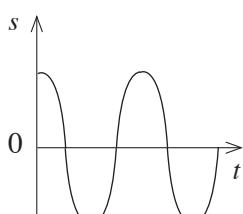
The statement/ statements which is/ are always true,

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

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



36. An iron ball hanged by a helical steal spring has been immersed in a container of oil. What is the displacement (s) time (t) graph for the motion when the ball is dragged down at $t = 0$ and released?



37. A roof of 500 kg has been mounted on 4 steal pillars with H shaped cross sectional area. Cross sectional area of a pillar is 25 cm^2 and the young's modulus of steal is $2 \times 10^{11} \text{ Nm}^{-2}$. If the weight of the roof is equally beared by the pillars, the contraction in length of a pillar due to the roof is,

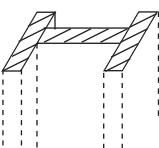
(1) $1 \times 10^{-2} \text{ mm}$

(2) $2 \times 10^{-2} \text{ mm}$

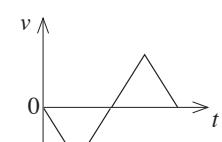
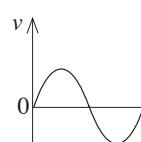
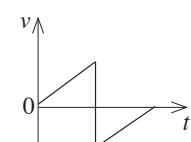
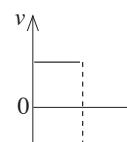
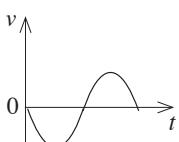
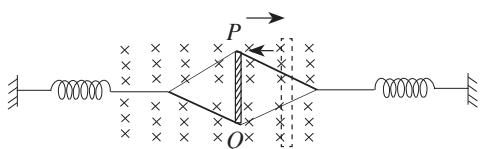
(3) $2.5 \times 10^{-2} \text{ mm}$

(4) $5 \times 10^{-2} \text{ mm}$

(5) $8 \times 10^{-2} \text{ mm}$

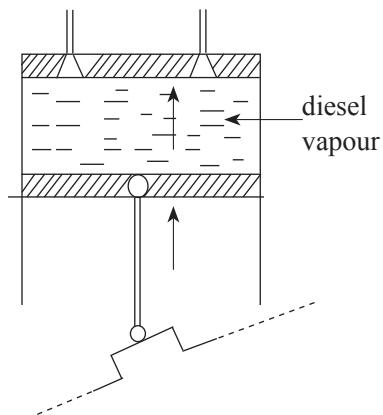


38. A conducting rod has been attached to two helical springs and held stationary as shown in the figure. A uniform magnetic field is there perpendicular to the rod in to the plane. PQ rod is dragged towards right hand side and released. Which graph represents the variation in potential of Q in one oscillation relative to P ?



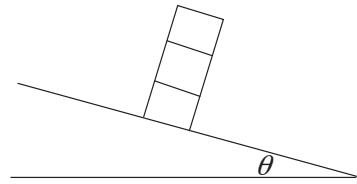
39. A cylinder in a diesel engine is shown in the figure. The most suitable expression for the known symbols ΔT , ΔQ , ΔU and ΔW , for the contraction process from situation the cylinder is filled with diesel vapour to burned out,

- (1) $\Delta T > 0$, $\Delta U > 0$, $\Delta Q = 0$, $\Delta W < 0$
- (2) $\Delta T = 0$, $\Delta U = 0$, $\Delta Q > 0$, $\Delta W > 0$
- (3) $\Delta T < 0$, $\Delta U < 0$, $\Delta Q > 0$, $\Delta W < 0$
- (4) $\Delta T > 0$, $\Delta U > 0$, $\Delta Q > 0$, $\Delta W < 0$
- (5) $\Delta T = 0$, $\Delta U = 0$, $\Delta Q = 0$, $\Delta W < 0$



40. There are uniform cubes on a toy box. A child makes a pillar using these cubes on a rough plane, which is inclined to the horizontal at an angle of θ . The cubes do not slide on each other. If $\tan \theta = \frac{1}{8}$ the maximum number of cubes that can be stacked without falling are,

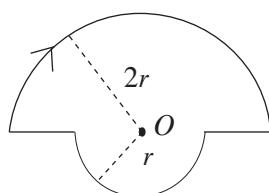
- (1) 2
- (2) 4
- (3) 5
- (4) 8
- (5) 16



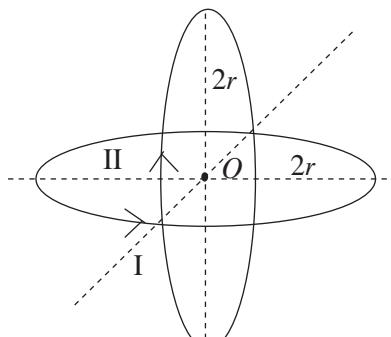
41. A hydrometer floats in a liquid of density 750 kgm^{-3} as the $\frac{1}{5}$ of the total volume is above the liquid level. The density of the liquid in which the hydrometer floats as $\frac{2}{5}$ of the total volume is above the liquid level.

- (1) 600 kgm^{-3} .
- (2) 800 kgm^{-3} .
- (3) 1000 kgm^{-3} .
- (4) 1200 kgm^{-3} .
- (5) 1500 kgm^{-3} .

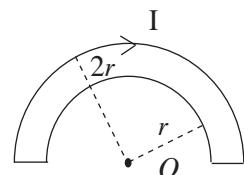
42.



(A)



(B)



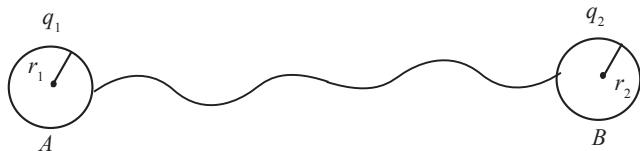
(C)

If B_A , B_B and B_C are net magnetic flux densities due to currents in the conductors, the correct relationship among those.

- (1) $B_A = B_B > B_C$
- (2) $B_A > B_B > B_C$
- (3) $B_B > B_A > B_C$
- (4) $B_C > B_B > B_A$
- (5) $B_A = B_C > B_B$

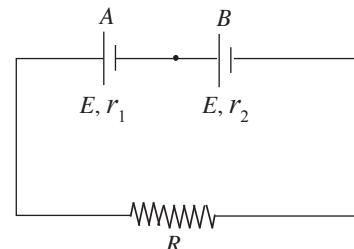
43. A and B spherical conductors with radii r_1 and r_2 respectively are kept apart by a distance which is extremely greater than their radii and connected by a long conducting wire. If the charges on A and B at the equilibrium are q_1 and q_2 respectively, the ratios between potential and field intensities are, (The potentials of A and B are V_A and V_B and the field intensities are E_A and E_B respectively.)

	V_A / V_B	E_A / E_B
(1)	r_1 / r_2	r_1^2 / r_2^2
(2)	1	r_2 / r_1
(3)	r_1 / r_2	r_2 / r_1
(4)	1	r_1 / r_2
(5)	1	r_1^2 / r_2^2



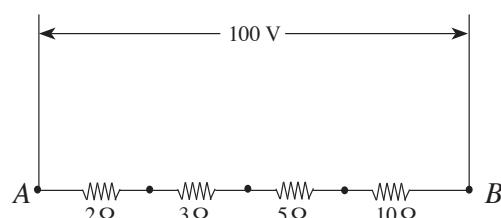
44. If the potential difference of the ends of cell B is zero, R is equal to

(1) $\frac{r_1 + r_2}{2}$ (2) $r_2 - r_1$ (3) $r_1 - r_2$
 (4) $\frac{r_2 - r_1}{2}$ (5) $3r_2 - r_1$



45. When the potential difference between AB is 100 V, power dissipation of the 5Ω resistor,

(1) 25 W (2) 75 W
 (3) 100 W (4) 125 W
 (5) 250 W



46. Sensitivity of a moving coil galvanometer can be increased by,

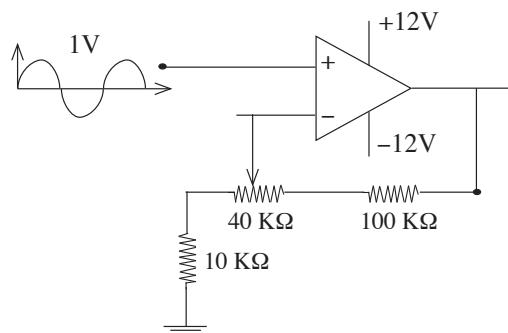
A - increasing the number of turns
 B - increasing the strength of magnetic poles.
 C - winding the coil around a smooth iron cylinder with a large diameter.
 D - connecting to a hair spring with a high torque constant
 (1) A and B only. (2) A and D only. (3) A and C only.
 (4) A, B and C only. (5) B, C and D only.

47. A frequency generator and an equipment which can detect the incident frequency and the reflected frequency to give the beat frequency is mounted inside a Jeep. The detected beat frequency by the detector, when the jeep moves towards a big barrier with a speed of 20 ms^{-1} emitting a frequency of 60Hz. (the speed of sound in air is 320 ms^{-1})

(1) 0 Hz (2) 2 Hz (3) 4 Hz (4) 6 Hz (5) 8 Hz

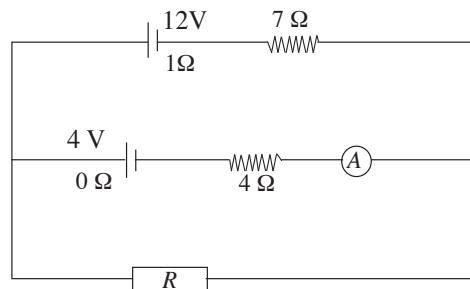
48. As shown in the figure the maximum and minimum output voltage of the operational amplifier circuit V is,

(1) 3, 15 (2) -3, 15
 (3) 3, 12 (4) -3, 12
 (5) 2, 12



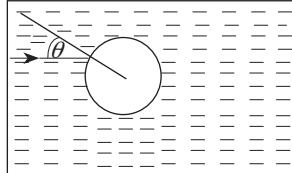
49. As shown in the figure the value of the resistance of R in Ω for the ammeter reading to be zero,

(1) 0 (2) 4
 (3) 6 (4) 8
 (5) 12



50. A ray of light incidents on to an air bubble inside the water as shown in the figure. If the refractive index of water is $\frac{4}{3}$ and $\sin\theta = \frac{3}{8}$, the deviation of the emergent ray is,

(1) θ^0 (2) $30^0 - \theta^0$
 (3) $\theta^0 - 30^0$ (4) $2\theta^0 - 60^0$
 (5) $60^0 - 2\theta^0$



* * *

G.C.E.(A. L.) Support Seminar - 2016

Physics II

Three hours

Instructions :

- * **Part A** : Answer **all** the questions.
- * **Part B** : Answer **only four** questions.

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

Part A - Structured Essay

1. A metal sheet with a circular hole of radius d is shown in the figure. a , b and d are lengths of a few centimeters ($< 10 \text{ cm}$). Thickness it is of several millimeters.

(a) What is the most suitable measuring equipment to measure the thickness t of the sheet?

.....

(b) What is the important experimental step to be practiced before the use of above equipment?

.....

(c) The above measurements were taken by using a vernier caliper. Which parts of the measuring equipment are used to obtain the each measurement?

a -

b -

c -

(d) What is the most suitable laboratory equipment to measure the mass (m) of the metal sheet?

.....

(e) Write an expression for the density of metal using the above measurements and standard formulae.

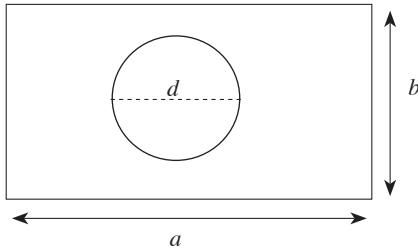
.....

(f) The measurements obtained at several places for the thickness of the metal sheet are given below.
3.50 mm, 3.51 mm, 3.52 mm, 3.51 mm, 3.53 mm

(i) What is the least count of the equipment?

.....

.....



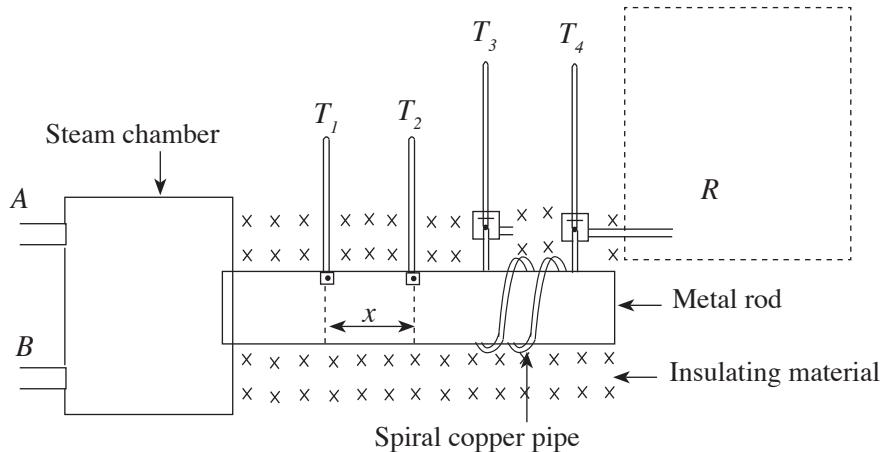
(ii) Calculate the mean thickness of the sheet.

.....

(iii) How many decimal places can be included in your answer? Explain the reason.

.....

2. A diagram of a complete laboratory set up, which uses to determine the heat conductivity of a metal is shown in the figure. One end of the cylindrical metal rod is heated by steam and the heat conducted along it is absorbed by the water, flowing in the pipe at the other end.



(a) Name the steam in - let and out - let of the steam chamber. (A and B)

in - let ::

out - let :

Give the reasons for your answer.

(b) Can hot water be used instead of steam? Explain your answer.

.....

.....

(c) Here, water should be flown in the copper spiral at a constant rate. Draw a diagram of the equipment to be used. Show the way to connect that equipment to the tube in the diagram at the correct place. (Shown by the broken lines).

(d) The temperatures in the thermometers T_1 and T_2 which are at the separation x are θ_1 and θ_2 at steady state. If the amount of heat flow across the cross section of the rod during time t is Q ,
$$\frac{Q}{t} = Ak \frac{(\theta_1 - \theta_2)}{x}$$
 A here is the cross sectional area of the rod and k is thermal conductivity of the material used to make the rod. Introduce the following quantities.

$$\frac{Q}{t} \text{}$$

$$\frac{(\theta_1 - \theta_2)}{x} \text{}$$

(e) How do you confirm that it has come to the steady state?

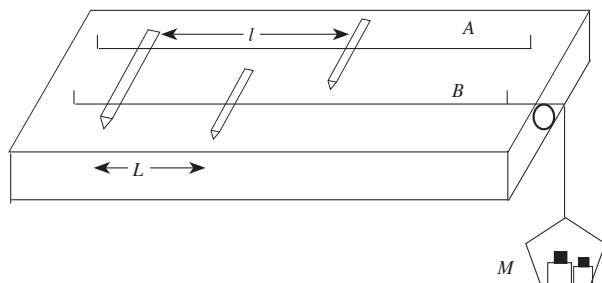
(f) The readings of thermometers T_1 , T_2 , T_3 and T_4 are θ_1 , θ_2 , θ_3 and θ_4 at steady state. Mention the other readings that you must obtain except these readings to find k .

(g) Write an expression for k in terms of the above measurements.

(h) If the flow rate of water through the copper tube is very high what is the practical problem to be faced?

(i) Can this method be used to find heat conductivity of weak conducting materials? Explain the reason.

3. A laboratory set up to investigate the variation of vibrating frequency (f) of a stretched string with the tension (T) in the string, using a sonometer is shown in the figure.



You are provided with a meter ruler, a tuning fork with a known frequency, a set of weights from 100 g to 500 g and paper mounts. The sonometer wire A is under a certain tension. Wire B has a smooth pulley with a scale pan attached to its free end. The tension in the wire B can be changed by adding the weights to the scale pan.

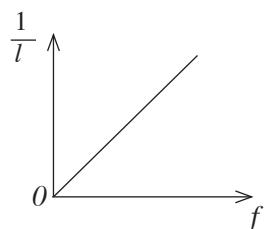
(a) Write an expression for the fundamental frequency f , of the wire B in terms of T : tension in the wire, L : vibrating length and m : mass per unit length.

(b) Taking T as the independent variable, re-arrange the above expression to plot a linear graph of the form $y = mx$.

(c) Wire A should be graduated according to the frequency to find the fundamental frequency of B under a given tension.

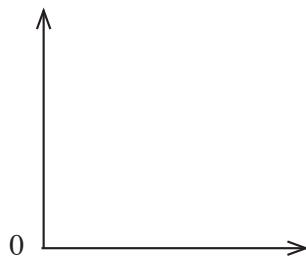
(i) Explain briefly the way to find the fundamental vibrating length of A for a tuning fork of known frequency.

(ii) Think that the following graph is obtained by measuring l for all the tuning forks.



Describe the method to use the above graph and wire A to find (f) frequency of wire B by vibrating a length L .

(d) Having found f , draw a rough sketch of the graph between f and T on the given pair of axis, considering the statement in above (b).

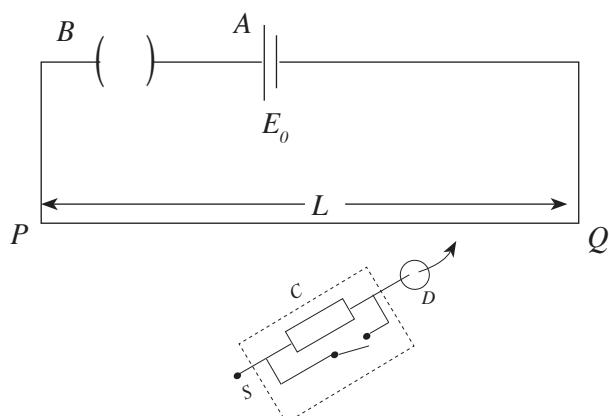


(e) (i) Using the graph drawn in above (d) write the method to find the value of m .

(ii) In order to obtain fundamental resonant lengths for all the tuning forks, the tension in A should be adjusted. For that will you choose the tuning fork with the minimum frequency or tuning fork with the maximum frequency? Explain your answer.

(f) Wire B vibrates at 480 Hz under a certain tension. The minimum length of wire A under the resonance with wire B is 23.7 cm. If the length of A is increased slightly and both the wires are vibrated, together a beat frequency of 6 Hz was heard. What is a new length of A ?

4. A circuit diagram of a potentiometer using in the laboratory is shown below.



(i) Name the items *A*, *B*, *C* and *D* correctly.

A -

B -

C -

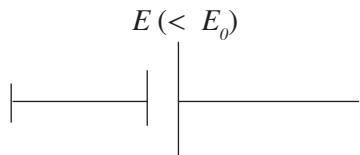
D -

(ii) Mention an essential property of each item *A* and *D*.

A -

D -

(iii) Express the ends to connect the following cell in to the potentiometer using the symbols on it, to find the electromotive force of the cell.



(iv) $E_0 = 2$ V and internal resistance is negligible in the above cell. Resistance of the wire *PQ* is 10Ω , if $L = 200$ cm find the potential drop per unit length.

.....

(v) If the above potentiometer can balance a thermocouple of 4 mV, find the balancing length.

.....

(vi) Are you satisfied by noting down the above balancing length in (v) as a reading? (Yes/ No)
 Give the reasons.

.....

(vii) What is the alteration that will be done to avoid the error identified by you in above (vi).

(viii) What is the value of the resistance of the item used for the alteration in above (vii) in order to maintain a potential difference of 10 mV across the ends of the potentiometer?

(ix) Find the new balancing length when the thermocouple is balanced using the altered potentiometer.

(x) Compare the fractional errors of measuring the balancing lengths at both the situation. Take the fractional error of the first balancing length as F_1 and fractional error of the second balancing length as F_2

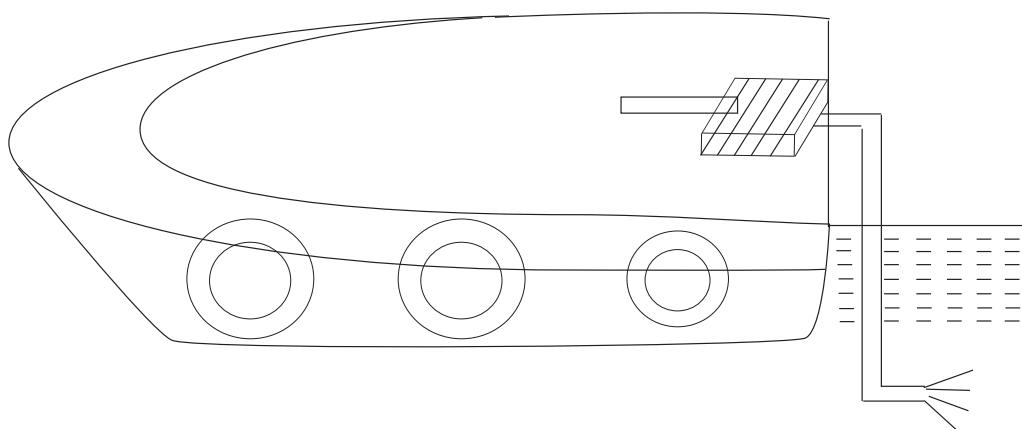
* *

Part B - Essay

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

* Answer **four** questions only.

5. Boat services are there on the waters, where the tourism activities are done for the entertainment of tourists. There are tubes filled with air, hanged around the boats. The engine fixed at the back generates the power to move the paddle, by burning the fuels. The mass of a boat without passengers is 600 kg. 8 people each weigh 70 kg can be loaded maximum. The air filled tubes immerse in water to provide the ability to load additional people on to the boat. The paddles attached to the engine of the boat push the water backward, and obtain the force to move the boat forward. An extra work should be done when the paddles are rotated to push the water, due to the hydrostatic pressure. The effective area of the paddles is 0.05 m^2 . Density of the water is 1000 kg m^{-3} .



- (a) What are the requirements to be fulfilled to float the boat on the water?
- (b) Sketch the forces acting on the empty boat.
- (c) Find the upthrust on the boat when 8 people are in it.
- (d)(i) Find the minimum force to start the motion, if there is an extra resistive force of 0.6 N kg^{-1} on the boat.
 - (ii) Find the speed of the water pushed back to obtain the above minimum force.
- (e)(i) Find the rate of work done by the paddles.
 - (ii) If the efficiency of the engine is 40% find the energy should be given to it during a unit time.
- (f)(i) The boat rides safely by immersing all 6 tubes hanged around the boat up to the water level when the boat comes to an area with air bubbles. If the effective density of the water in that region is 800 kg m^{-3} , find the extra volume needed to be sunk.
 - (ii) If tubes give 60% of the extra volume, find the volume of a tube.

6. The magnification power of the compound microscope which is used in the medical laboratory is between $X 5000$ and $X 100000$. A bulb or a mirror is used to illuminate the object in such microscopes. Consider as the focal length of objective is f_o , focal length of the eyepiece is f_e and least distance of distinct vision is $D = 25$ cm.

- A clear enlarged image is formed when an object is kept at the near point of the eye. Explain this using a ray diagram.
- What is meant by magnifying power of the compound microscope?
- Draw the ray diagram for the normal adjustment of the compound microscope and build up an expression for the magnifying power. Consider the distance from the objective to the image as l .
- If $l = 20.2$ cm, find the magnification for the normal adjustment. The focal lengths of eyepiece and the objective are 2 mm and 2.5 cm respectively.
- (i) The above image is invisible for an observer B , who looks through the eyepiece what is the eye defect of him?
(ii) The eyepiece should be moved by $175 / (81 \times 11)$ cm in order to observe correctly. Find the distance to the near point of the observer.
(iii) The above patient moves the eyepiece to obtain not normal adjustment. What is the distance between eyepiece and objective now?

7. Transformers are used to raise the electricity generated in power house to a higher potential. The electricity transmitted under a high potential is brought to a lower potential again using transformers. The energy requirements of factories are fulfilled through that.

- Plot the variation of potential in electricity generated in power houses with time.
- Write two features of the transformer, which uses to increase the potential.
- Plot the variation of the out put potential with time.
- The potential 11000 V, transmitted using step - up transformers, supplied to houses as a 250 V potential using transformers.
 - Find the ratio between the primary and secondary turns of the transformer which is used to fulfill the above requirement.
 - Find the V_p value of the current supplied to houses.
 - Write three ways of energy dissipation in a practical transformers.
 - Why the soft iron medium is used in the transformers?
- A potential with a maximum value of 20 V is used to operate an alternate current motor. The plane of rectangular coil with the dimensions a and b , is kept parallel to a uniform magnetic field of flux density B . If the number of turns of it is N ,
 - What is the maximum magnetic moment in the coil? Consider current through the coil as I .
 - What is the magnetic moment in the coil when it is inclined by an angle θ to the magnetic field?
 - If the resistance of the coil is 100Ω , What is the maximum magnetic moment? $N = 400$, $B = 0.2$ T, $a = 20$ cm, $b = 10$ cm
 - What are the alterations to be done in order to convert the above alternate current motor into direct current motor.
- A student says that the armature can rotate at outside to obtain direct current from the above altered direct current motor. Plot the variation in induced direct current with the time at that instance.

8. A set up prepared to find the viscosity of a fluid using small spheres made of same material but with different radii, falling in the fluid is shown in the figure. Each sphere attached to the string is released carefully from the position A. The string attached is long enough to reach B. The position of sphere is read by using the stop watch and the scale. Then having identified the terminal velocity, it is plotted with the radius of the sphere.

(a) Write the equation for the viscous force in a viscous medium on a sphere of radius r , when it is falling at a velocity of V . Prove that it is dimensionally correct.

(b) Build up an equation for the terminal velocity of a sphere, if the density of the material used to make the sphere is d , density of oil is ρ and coefficient of viscosity of oil is η .

(c) Plot variation of the terminal velocity with the radius of the sphere.

(d) (i) Plot the variation in terminal velocity with the square of the radius.

(ii) If the gradient of the above graph is m , build up an expression for the coefficient of viscosity.

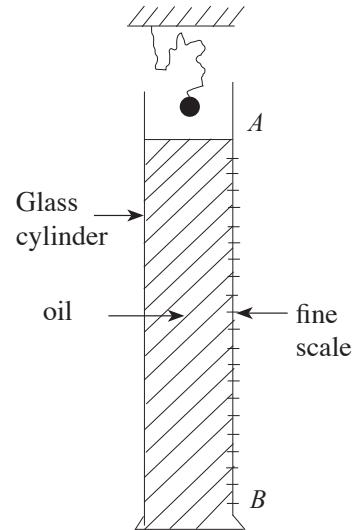
(iii) If $m = 800 \text{ m}^{-2}\text{s}^{-1}$, density of oil is 700 kgm^{-3} density of the material used to make spheres is 1240 kgm^{-3} , find the value of η .

(iv) What is the terminal velocity of the sphere of radius 10 cm ?

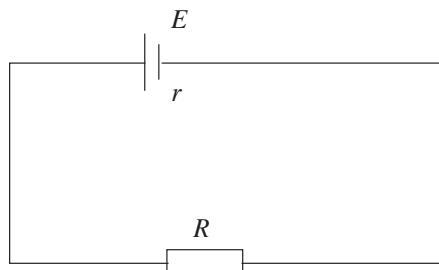
(e) Plot the variation in viscosity with the temperature.

(f) (i) Find the minimum force needed, when the above oil is spread over a thickness of 1 mm and a cube of surface area 400 cm^2 and velocity of 8 ms^{-1} on it.

(ii) Plot the variation in velocity of oil layers from top to bottom



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



(i) Prove that the power dissipation in the external resistor is $P_0 = \frac{E^2 R}{(r + R)^2}$.

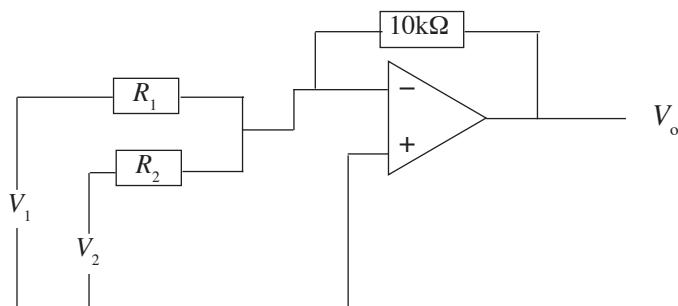
(ii) If the maximum power dissipation of the external resistor is P_{\max} , having written the relationship between R and r , obtain an expression for P_{\max} in terms of E and r .

(iii) Plot the graph to show the variation of P . Power dissipation against R resistance of the external resistor.

9. (B) Draw a diagram of operational amplifier (741 IC) and number the pins.

(a) Draw the characteristic curve between V_{in} and V_{out} of an operational amplifier at open loop configuration. $V_{\text{out}} / V_{\text{in}} = A$.

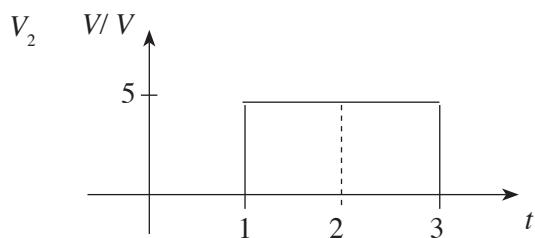
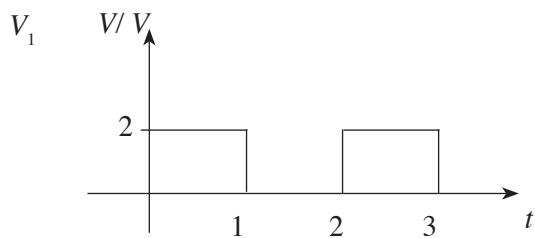
(b) A circuit diagram with independent input voltages V_1 and V_2 is shown in the figure. The supply voltage is ± 15 V.



Build up an expression for the output voltage of this circuit.

(c) Find the values for R_1 and R_2 for output voltage to be $V_o = -(5V_1 + 0.2V_2)$.

(d) Plot the variation in V_o output voltage relevant to the supply voltage and input voltages V_1 and V_2 with time.



(e) (i) Build up the truth table to identify the decimal numbers three, five and seven in a series on binary numbers.

(ii) Write down Boolean Expression.

(iii) Draw a suitable logic circuit.

10. (A) Air conditioners are used to cool the closed chambers when the hotness is high. When cooling the space, done by maintaining the absolute humidity at a low value and keeping the relative humidity at a higher value.

- What is absolute humidity?
- What is relative humidity?
- How the absolute humidity is maintain at a lower value and relative humidity is maintain at a higher value in an air conditioned room?

(d)

Temperature °C	0	2	4	6	8	10	12	14	16	18
Saturated vapour pressure Hg mm	4.08	5.29	6.10	7.01	6.04	9.21	10.50	12	13.6	15.5
Temperature °C	20	22	24	26	28	30	32	34	36	38
Saturated vapour pressure Hg mm	17.5	19.8	22.3	25.10	28.30	31.70	35.50	39.80	44.4	47.50

The room temperature was 30 °C and relative humidity is 80 % in a certain day. If the volume of the room is 60 m³.

- What is the absolute humidity in the room?
- Find the dew point.
- Find the mass of water vapour condensed, when the relative humidity is brought down up to 50 % at 24 °C room temperature. (Density of mercury 13600 kgm⁻³, R = 8.3 Jmol⁻¹k⁻¹.)

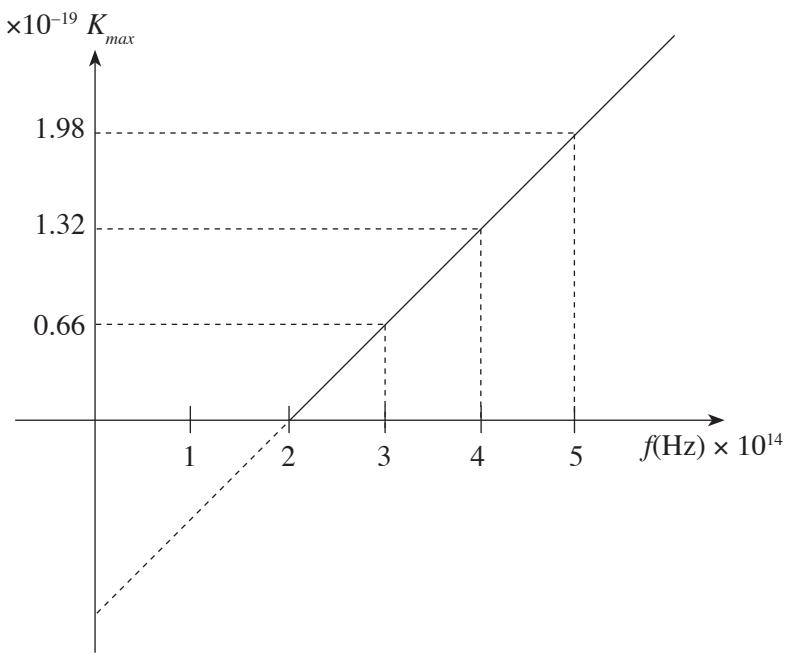
(e) It is important to drink more water when staying in an air conditioned room. Explain the reason.

10.(B)(a) Draw a tabled diagram of a photoelectric cell which can be used to show the photoelectric effect. How is the circuit altered to change the negative voltage? Draw the curves for each instances below to show the variation in the photoelectric current (i) due to the incident photons, with the potential difference between the electrodes. Draw the variation with the negative voltage also.

- When the frequency of incident photons is f_1 and intensity is I label as A.
- When the frequency of incident photons f_1 kept constant and intensity is doubled (2I) label as B.
- When the intensity of photons is I and frequency is f_2 ($f_2 > f_1$) label as C.
- When the intensity of photons is kept constant and wave length is increased (this wave length is greater than the wave length relevant to frequency f_1) label as D.

(b) Calculate the energy in photons when the wave length is 660 nm.
If the work function of the metal is 1 eV find the maximum kinetic energy and the stopping potential.

(c) The variation in the maximum kinetic energy (K_{max}) with the frequency of incident photons is shown below.



Using the graph,

- (i) Find the threshold frequency for the metal.
- (ii) Find the work function of the metal.
- (iii) Obtain a value for the Plank constant.
- (iv) Draw the curve for a metal with a work function of 2.64×10^{-19} on the above graph.

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