PRE-MEDICINE ASSOCIATION

2020/2021 Kurunagala

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கல்விப் பொதுத் தராதரப் பத்திர (உயர் தரப்) பரீட்சை, 2021
General Certificate of Education (Adv. Level) Examination, 2021

Physics I	01 E I	Two Hours

Instructions:

- *Answer all the questions.*
- *Write your **Index number** in the space provided in the answer sheet.*
- *Instructions are given on the back of the answer sheet. Follow them carefully.*
- *In each of the questions from 1 to 50, pick one of the alternatives from (1), (2), (3), (4), (5) which is correct or most appropriate and mark your response on the answer sheet with a cross (x) on the number of the correct option in accordance with the instructions given on the back of the answer sheet.*

1. In the equation $[F = A\cos Bx + C\sin Dt]$ x is displacement(m) and t is time(s). dimensions of D/B,

   1)$M^0L^0T^0$ 2) $M^0L^0T^{-1}$ 3) $M^0L^{-1}T^0$ 4) M^0LT^{-1} 5) MLT

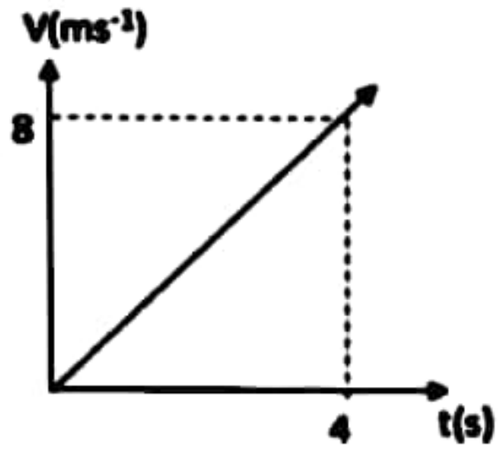
2. Consider the following statements about a micrometre screw gauge.
   A. Here screw principal is used.
   B. A negative zero error is formed due to deposition of rust in between anvil and the spindle.
   C. We must rotate the thimble head when the object is just in contact with the anvil and the spindle without rotating the thimble head.

   True statements are,

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

3. The most important property of mercury glass thermometer when compared to other thermometer types is,
   1) Ability to long term usage.
   2) Ability to get the readings directly.
   3) Ability to measure a large range temperature.
   4) Quickly changing temperature can be measured.
   5) Higher sensitivity.

4. The velocity-time graph of an object where its initial displacement is +10m is given below.
   Find its displacement at the 4th second.



   1) 16 m 2) 20 m
   3) 26 m 4) 48m
   5) 8m

10. A glass beaker is having a circular hole of 0.1mm radius at its bottom. To which height water can be filled such that water doesn't leak from the hole,
(Surface tension = $7.2\times10^{-2}\ Nm^{-2}$, Density = $1000kgm^{-3}$)

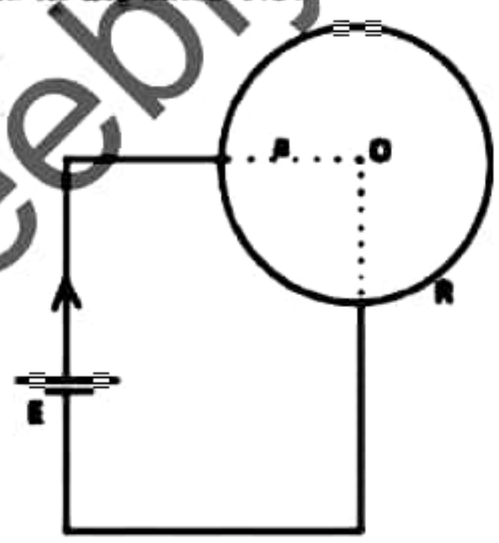
1) 0.288m
2) 0.1m
3) 0.144m
4) 0.2m
5) 0.072m

11. If the half of the mach angle of a super sonic jet is 30°, find the ratio of $\frac{\text{Speed of the jet}}{\text{Speed of sound in air}}$

1) 1/2
2) $\sqrt{3}/2$
3) $\sqrt{3}$
4) 2/3
5) 2

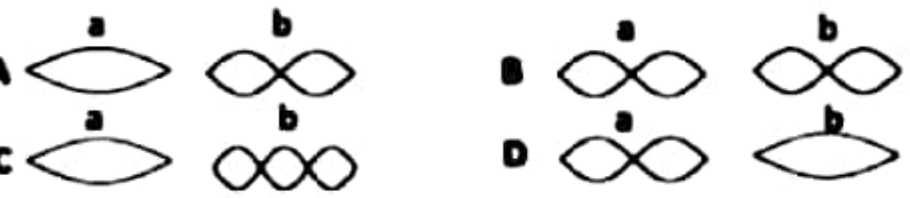
12. A battery of electro motive force E and zero resistance is connected to a uniform loop of radius "a" and resistance "R". The loop is connected such that it is divided into two segments in the ratio 1:3.
Magnetic flux density at the centre is,

1) $\frac{2\mu_o E}{Ra}$
2) $\frac{2\mu_o E}{2Ra}$
3) $\frac{\mu_o E}{Ra}$
4) $\frac{\mu_o E}{2Ra}$
5) 0



13. A and B are 2 identical strings. A is under a higher tension than B. Both strings are vibrating in the same frequency.
The correct vibrating stage is,

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



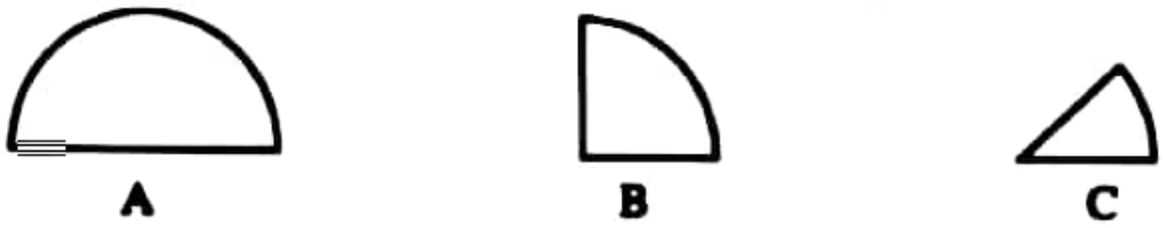
14. Poiseuille equation is given in standard symbols as below.

$$\frac{V}{t} = \frac{\pi P a^4}{8\eta \ell}$$

The correct statement about the condition in which it is valid are,
A. Must be in a laminar flow.
B. Flow must be in steady conditions.
C. Liquid is incompressible.
D. Tube is thin and straight.

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

5. Three plates having same masses are folded as given below. If their moments of inertia around the axis going through the centre are I_A, I_B, I_C respectively, the correct statement is,



1) $I_A > I_B > I_C$
2) $I_A < I_B < I_C$
3) $I_A = I_B = I_C$
4) $I_A > I_B = I_C$
5) None of the above

6. The ${}^{A}_{Z}X$ radio active nucleus release α and β particles by its decay.
If the formed daughter element is ${}^{A-1}_{Z}Y$, the number of α and β particles released are respectively,

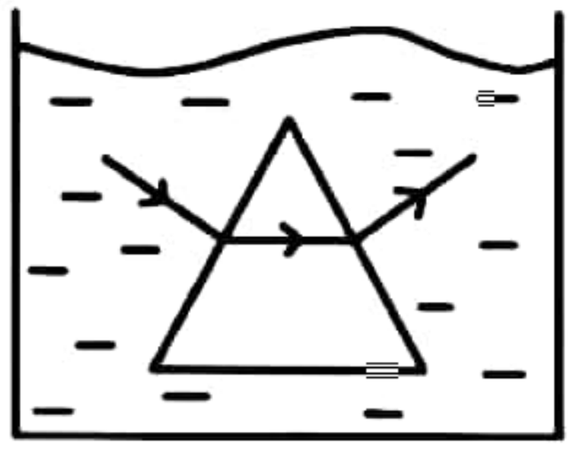
1) 1,0
2) 1,1
3) 1,2
4) 2,1
5) 2,2

7. Consider the following motions.
   A. Motion of moon around the earth.
   B. Motion of a mass connected to a spiral spring after given a slight displacement.
   C. Re-bounce of a ball repeatedly at the floor when released from above.
   D. Oscillation of a simple pendulum of length 50cm in a 60° range.

The simple harmonic motions are,

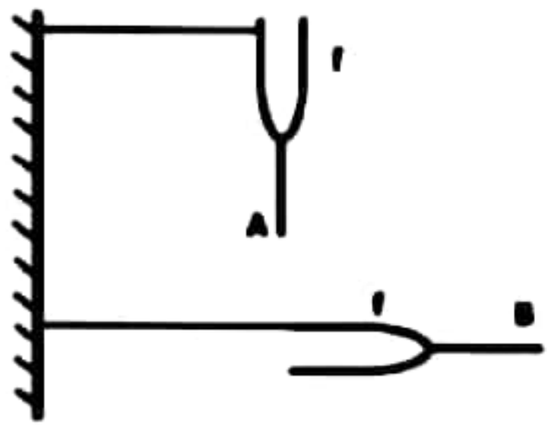
1) A, D only
2) B only
3) B, D only
4) B, C, D only
5) B, C only

8. An equilateral prism where incident angle and emergent angle are 24° is kept in a certain medium. The angle of minimum deviation of the prism in that medium is,



1) 24°
2) 48°
3) 12°
4) 36°
5) 30°

9. A stretched string and tuning fork are connected to a wall in 2 ways as below. If the tuning fork vibrates in frequency(f), the frequency of the strings are,



	A	B
1)	F/2	F/2
2)	F	F
3)	F/2	F
4)	F/4	F/2
5)	F/2	F/4

15. Consider the following statements.

A. When created a gaussian surface across the depletion region of a diode such that the p crystal is included, there is an electric flux towards the surface.

B. Reduction of resistance of a diode when heated is due to the amplification of minority carrier production.

C. As the free electrons or holes contribute for the operation of a FET, they are named unipolar and as both the free electrons and holes contribute to the operation in BJT, they are named bipolar.

Correct statements are,

1) All
2) B, C only
3) C only
4) B only
5) None of the above

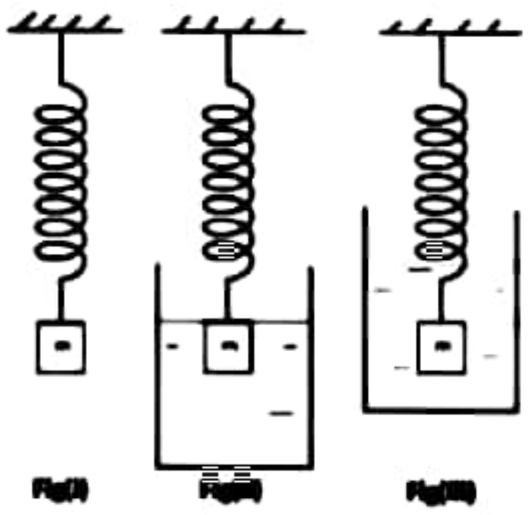
16. The given diagram shows 3 identical springs with 3 'm' masses connected and applied with same extensions which perform a simple harmonic motion.

i. The motion take place in air where the periodic time is T1.
ii. The motion takes place such that the centre of oscillation is at water-air interface where the periodic time is T2.
iii. The motion takes place completely inside the water bath where the periodic time is T3.

A. Periodic times are in the order of T1<T2<T3.
B. All periodic times are same and pendulum ii becomes rest in a short time.
C. T1=T3>T2

Correct statement is,

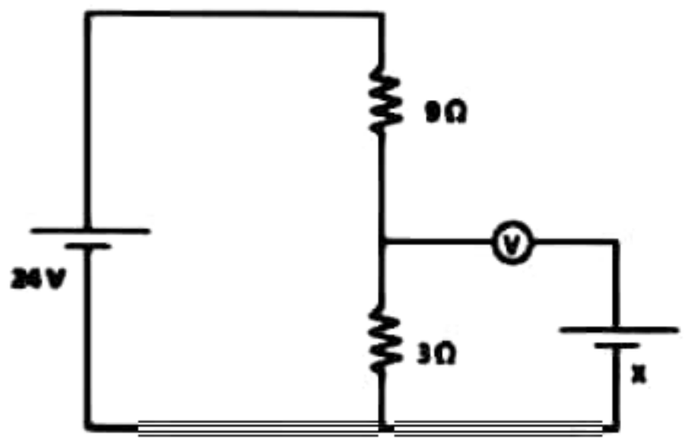
1) B, C only
2) B only
3) C only
4) A only
5) All are incorrect



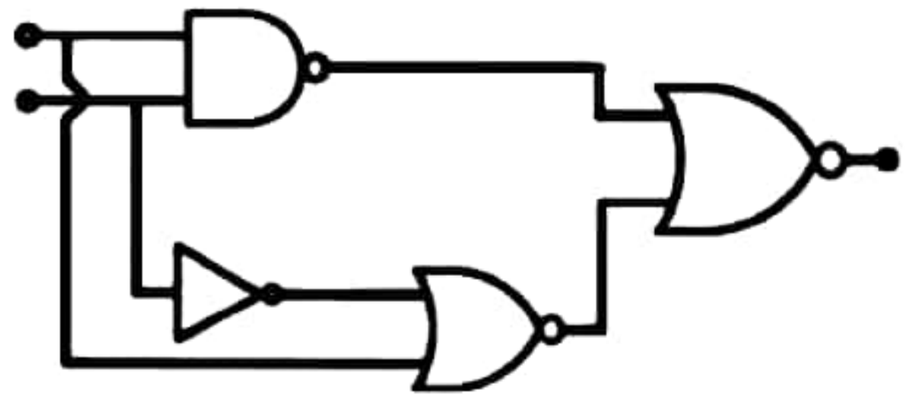
17. The internal resistance of the given cells is negligible. E.M.F of a cell is 6V. (V) is an ideal voltmeter.

What is the reading of the voltmeter?

1) 0V
2) 6V
3) 8V
4) -6V
5) -8V



18. What is the equivalent logic gate to the given system of logic gates.



1) OR
2) AND
3) XOR
4) NAND
5) NOR

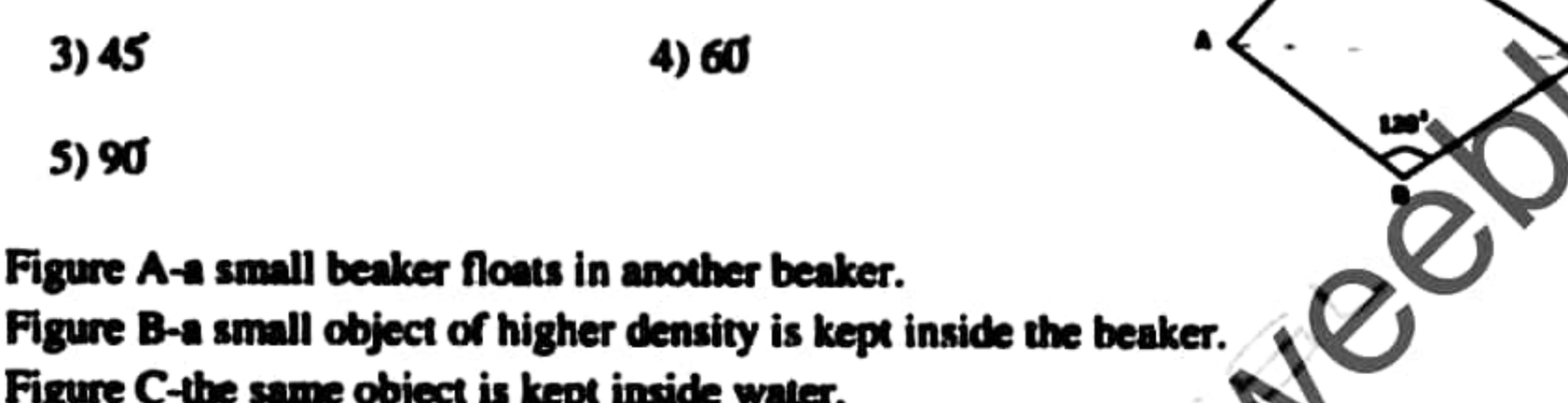
19. A uniform wire is bent as follows. AD = DB = BE = EC. If we hang the system from D, find the angle between the vertical and the AC.

1) 0°
2) 30°
3) 45°
4) 60°
5) 90°

20. Figure A-a small beaker floats in another beaker.
Figure B-a small object of higher density is kept inside the beaker.
Figure C-the same object is kept inside water.

Consider the following statements

A. h1=h3
B. h3>h2
C. h2>h1

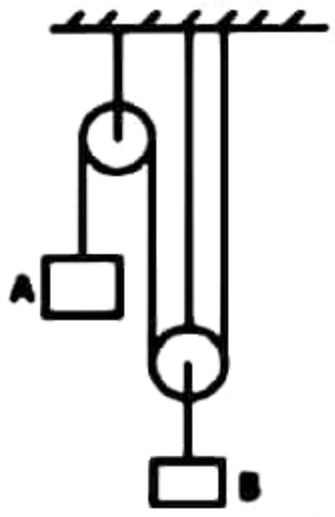


1) Only A is true
2) Only C is true
3) Only A, B are true
4) A, B, C are true
5) All A, B, C are false

21. A glass vessel of volume v is completely filled with a liquid of real expansivity γ_l. The volume expansivity of glass is γ_g. ($\gamma_l > \gamma_g$)
Find the remaining volume of liquid inside the beaker when increased the temperature by θ.

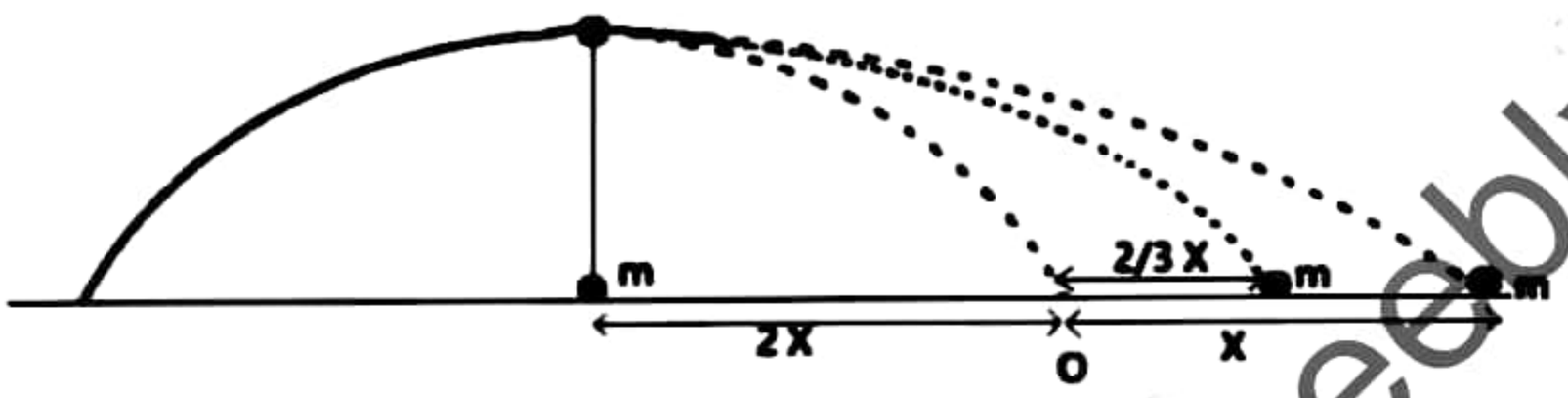
1) $V(\gamma_l - \gamma_g)\theta$
2) $V - V(\gamma_l - \gamma_g)\theta$
3) $V - V\gamma_l\theta$
4) $V - V\gamma_g\theta$
5) $V(\gamma_l - \gamma_g)\theta - V\gamma_l\theta$

22. A and B in the diagram are 2 masses of each 20kg. Pulleys are frictionless and light. P2 pulley can rotate freely. Acceleration and tension of A are respectively.



1) 2 ms^{-2}, 240N
2) 4 ms^{-2}, 120N
3) 2 ms^{-2}, 60N
4) 4 ms^{-2}, 240N
5) 2 ms^{-2}, 120N

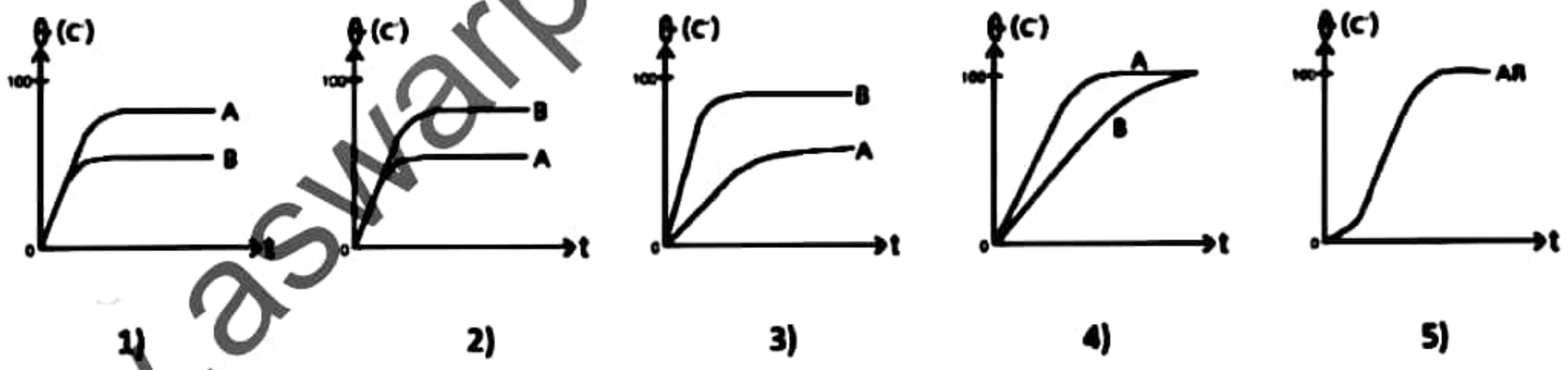
23. An object of mass involves in a projectile motion. At the highest position of its motion it divides into 4 pieces. Among those, 3 pieces falls as follows.



The distance from O to the other mass?

1) $\frac{2x}{3}$ 2) $\frac{x}{2}$ 3) $\frac{x}{3}$ 4) x 5) $\frac{4x}{3}$

24. 2 thin metal vessels A and B having equal volume of water are heated by 2 identical heaters. These 2 vessels are kept on a metal block and rigifoam block respectively. The variation of temperature of water with time is best represented by..

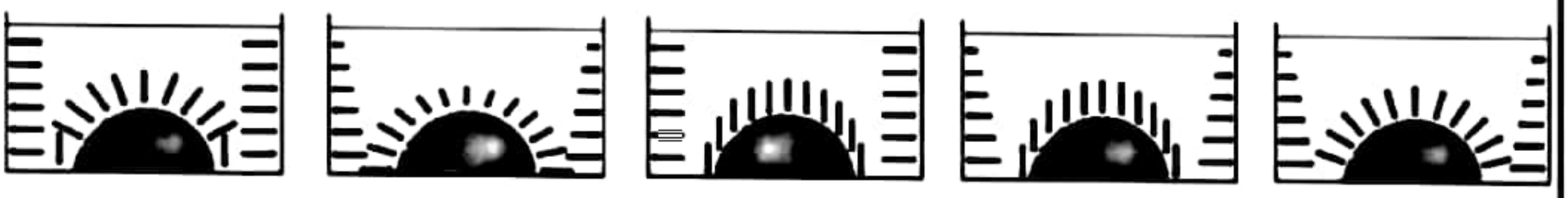


1) 2) 3) 4) 5)

25. The electro static attraction force between 2 charges at 3m away is 0.09N. The sum of the magnitude of two charges is 19μc. Magnitude of each charge is,

1) 10μC, 9μC
2) 12μC, 7μC
3) 15μC, 4μC
4) 16μC, 3μC
5) 18μC, 1μC

26. A hemispherical vessel is kept at the bottom of a beaker. The magnitude and the direction of force acting on the beaker wall are best represented by.



1) 2) 3) 4) 5)

27. There is a cavity of radius R/2 inside a solid lead ball of radius R such that its wall goes through the centre of the sphere. Mass of the sphere without the cavity is M. Find the gravitational force act on a mass (m) kept on the line joining centres of cavity and the ball which is at a d distance from the centre of sphere.

1) $\frac{GMm}{d^2}$

2) $\frac{GMm}{8(d-\frac{R}{2})}$

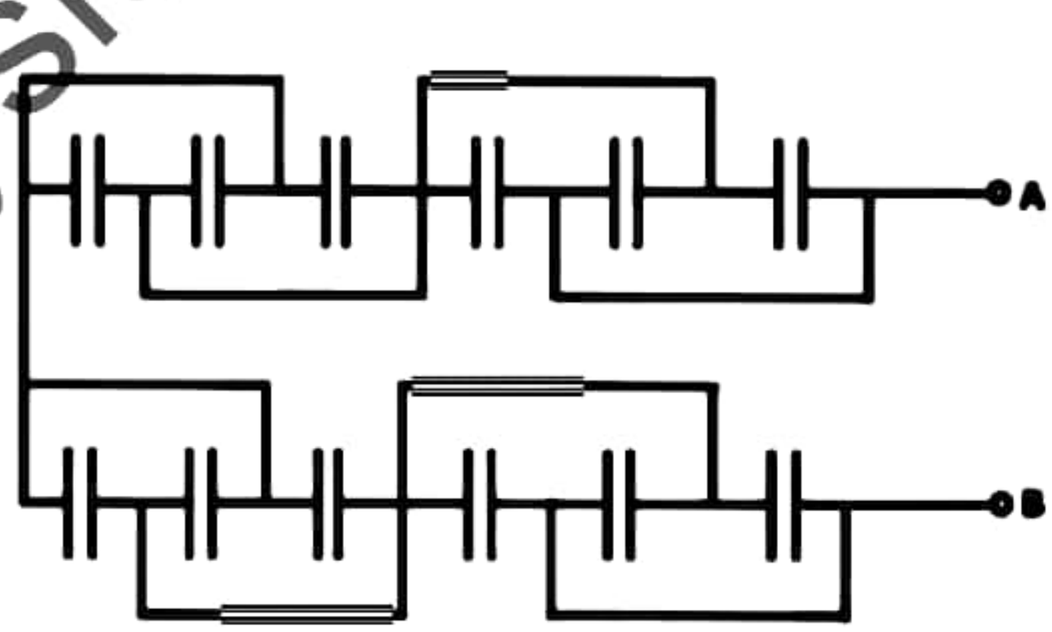
3) $\frac{GMm\,(7d^2+2R^2)}{8d^2(d^2-\frac{R^2}{2})^2}$

4) $\frac{GMm}{2d^2}$

5) $\frac{GMm\,(7d^2-8Rd+2R^2)}{8d^2(d+\frac{R}{2})^2}$

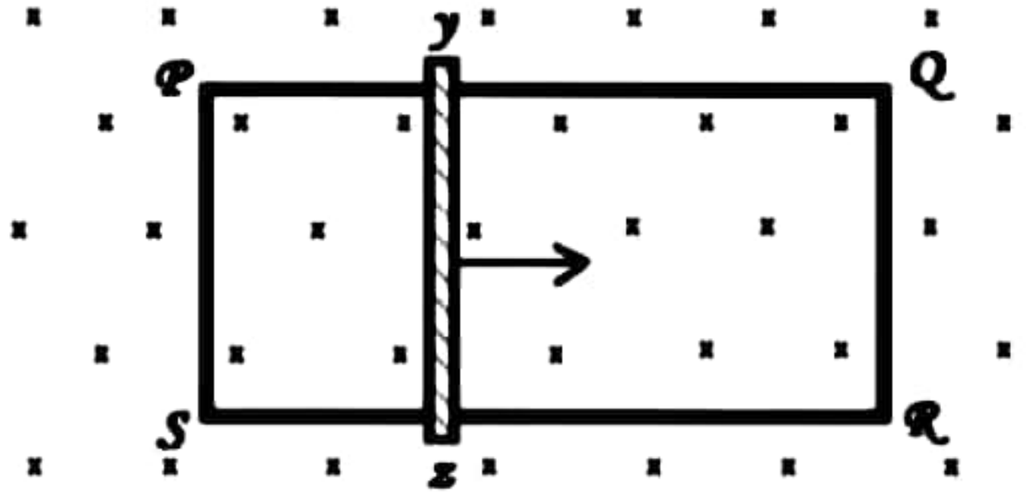
28. The figure shows a combination of 12 capacitors each having a capacitance C. Find the resultant capacity of the system.

1) 0.5C
2) 0.75C
3) 1.0C
4) 1.5C
5) 3.0C

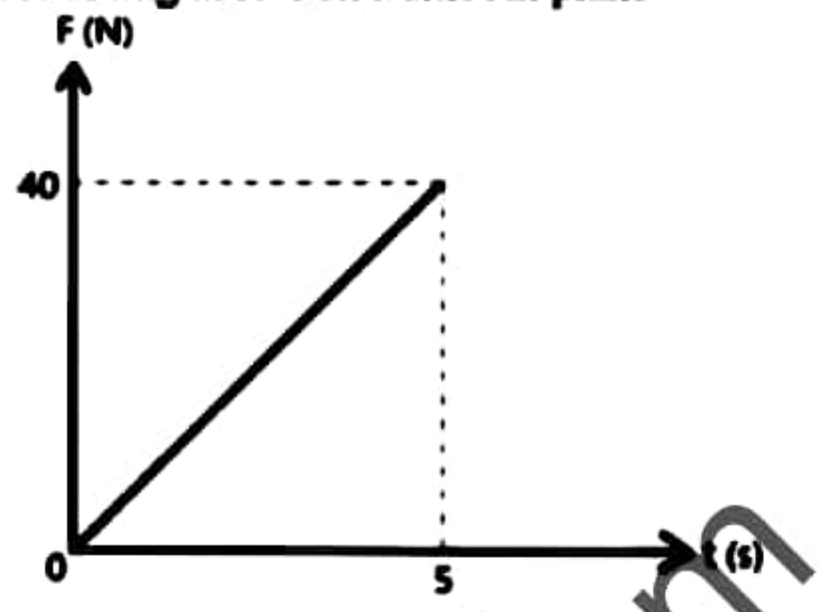


29. The plane of PQRS uniform wire loop is kept perpendicular to the B uniform magnetic field. The directions of current flowing through SP, YZ, QR conductors when YZ is moved right is given by.

1) $\vec{SP}$, $\vec{XY}$, $\vec{RQ}$
2) $\vec{SP}$, $\vec{YX}$, $\vec{QR}$
3) $\vec{YX}$, $\vec{PS}$, $\vec{QR}$
4) $\vec{RS}$, $\vec{YX}$, $\vec{QR}$
5) $\vec{PS}$, $\vec{XY}$, $\vec{QR}$



30. The graphical representation of variation of a force acting on an object of 2kg at rest on a smooth plane with time is given below. Velocity at 5th second?



1) 50 ms^{-2}

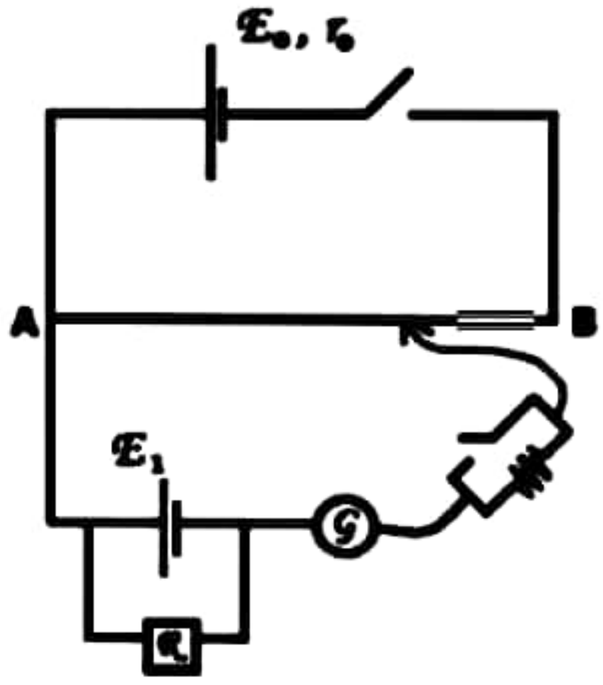
2) 10 ms^{-2}

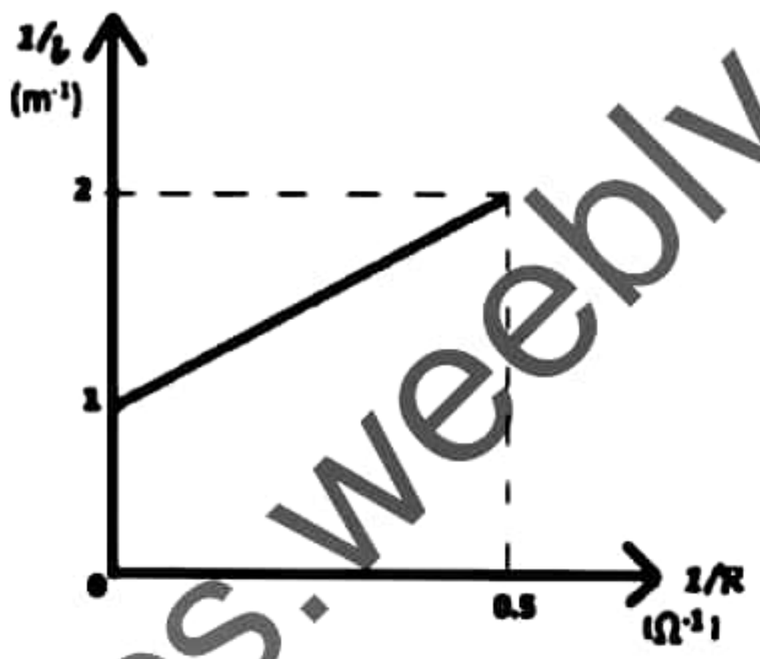
3) 100 ms^{-2}

4) 75 ms^{-2}

5) 25 ms^{-2}

31. A student uses a potentiometer to find the internal resistance of a cell. Here R is varied by resistor box and corresponding balance length is measured. The variation of 0/l with 1/R is given below.





1) 0.5Ω

2) 1Ω

3) 1.5Ω

4) 2Ω

5) 4Ω

32. Consider the following statements

A. The fundamental frequency of sonometer reduces when the weight is immersed in water.

B. 123 Hz beats can be heard when 2 tuning forks of frequency 256 Hz and 334 Hz are sounded together.

C. Sound waves can be refracted.

True statements are,

1) A, B only

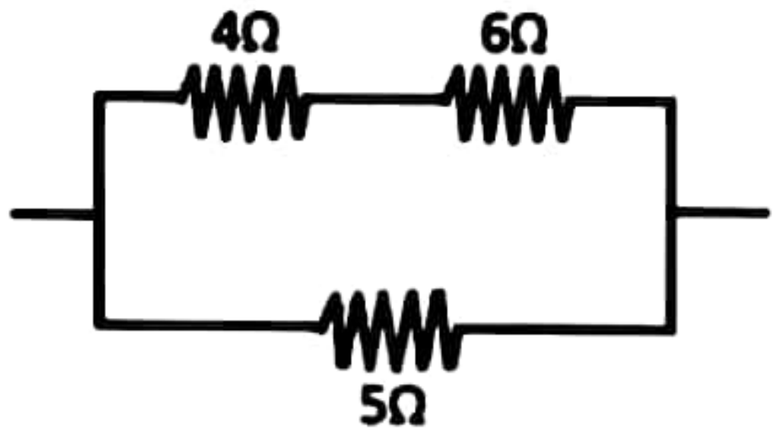
2) A, C only

3) B, C only

4) A, B, C only

5) All are incorrect

33. The power generation of 5Ω resistor is 10W. What is the power generation through 4Ω resistor and voltage drop across 6Ω resistor?



1) 1W, $\frac{3}{\sqrt{2}}$V

2) 2W, $\frac{6}{\sqrt{2}}$V

3) 22W, $\frac{3}{\sqrt{2}}$V

4) 4W, $\frac{6}{\sqrt{2}}$V

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

34. Consider a process where air rushes out from a rubber ball. Which of the following is correct?

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

35. A lead bullet going in 200ms^{-1} speed hits a wooden block and get stopped. Specific heat capacity of lead is 260Jkg^{-1}C^{-1}. Consider there is no heat loss to the surrounding. What is the increase in temperature?

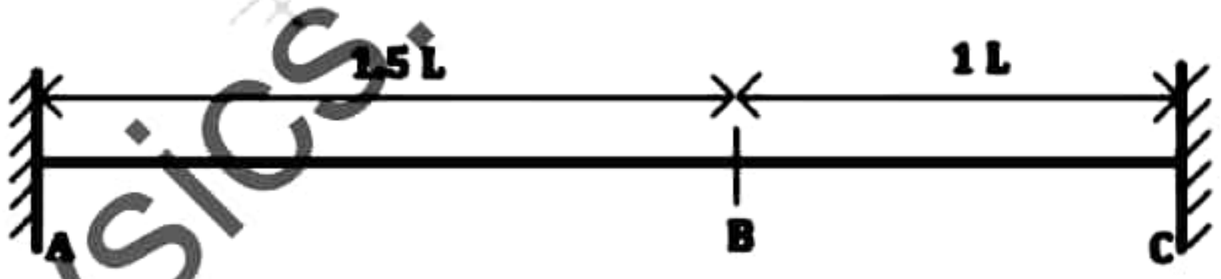
1) 75°C 2) 65°C 3)130°C 4) 260°C 5) 85°C

36. Rope AC which is a combine rope of 2 rope pieces AB and BC is stretched between 2 walls. The ratio of velocities of transverse waves along AB and BC is 1:2. At the minimum vibrating frequency stage of the combined rope, what is the ratio of number of loops in AB and BC?

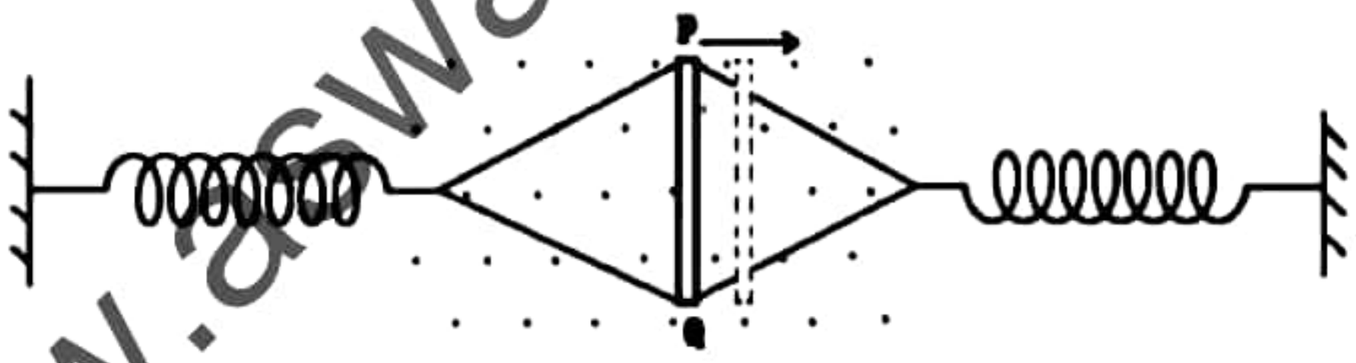
1) 2:1 2) 3:1

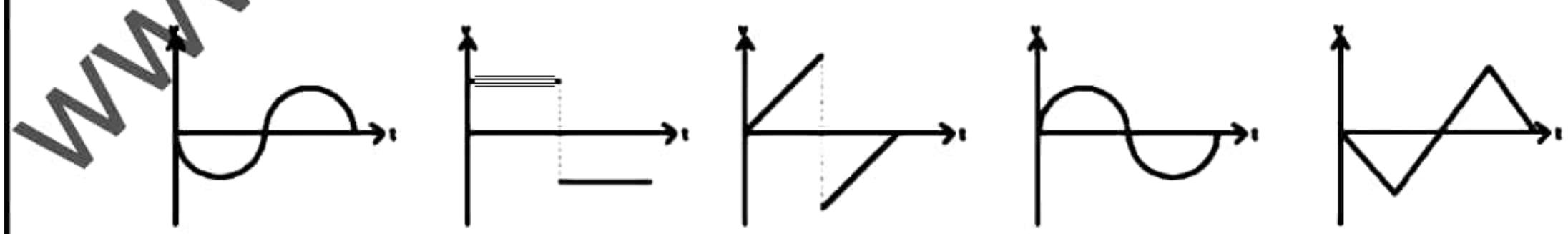
3) 1:2 4) 1:1

5) 1:3

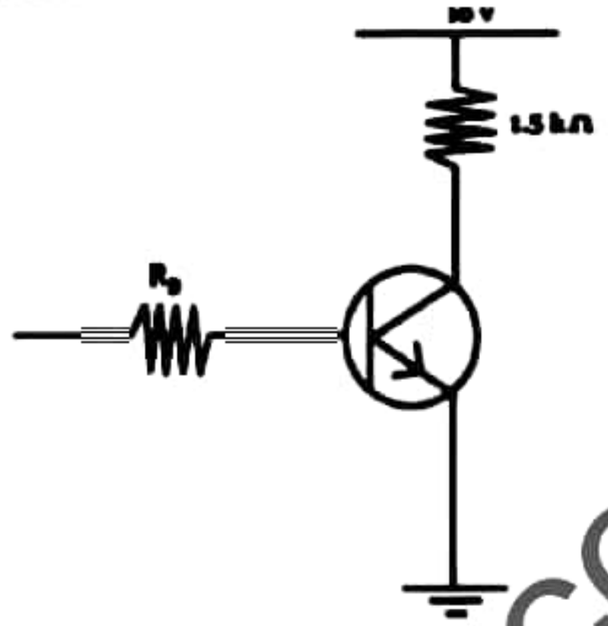


37. PQ conducting rod is kept at rest using 2 insulating threads and connected to 2 spiral springs. There is uniform magnetic field perpendicular to the plane of the rod. PQ is pulled towards the right and released. Which of the following best represents the voltage of Q with respect to P with time within a single period?





38. In the given npn transistor $\beta = 100$. If the base current is 100μA which is the collector current?



1) 0.66mA

2) 10mA

3) Depend on R_B

4) Zero

5) Can't calculate without knowing V_{BE}

39. An object which is at H height from the earth surface is projected such that it escapes the gravitational region. If the radius of earth is R, what is the minimum velocity that has to be projected?

1) $V_E = \sqrt{2g(R+H)}$

2) $V_E = \sqrt{2gH}$

3) $V_E = \sqrt{2gR}$

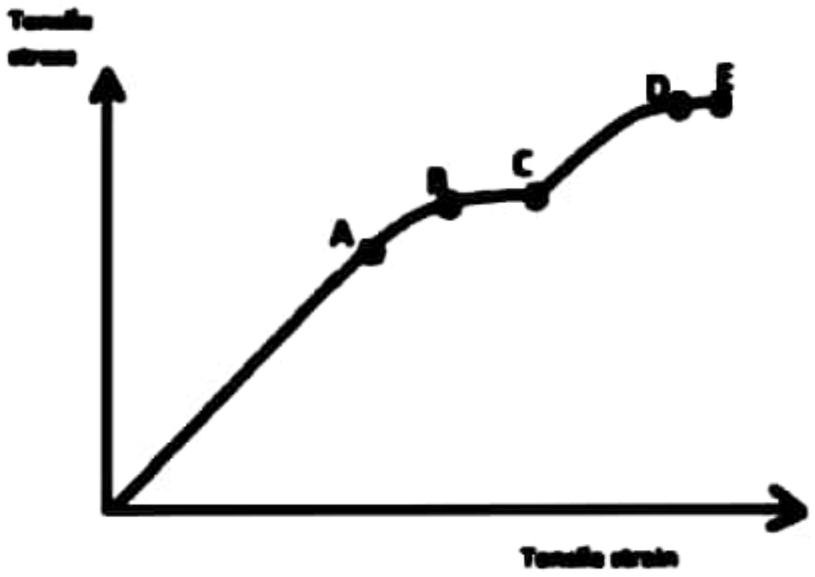
4) $V_E = \sqrt{2g(R-H)}$

5) $V_E = 2\sqrt{g(R+H)}$

40. In a space where 2 electric fields of magnitude $2NC^{-1}$ and $3NC^{-1}$ along x and y axis respectively are distributed, origin is having a zero-electric potential. What is the potential of a point having co-ordinates 3m, 2m?

1) 12V 2) -12V 3) 2V 4) -6V 5) -22V

41. Here C is,



1) Final point of proportionality limit

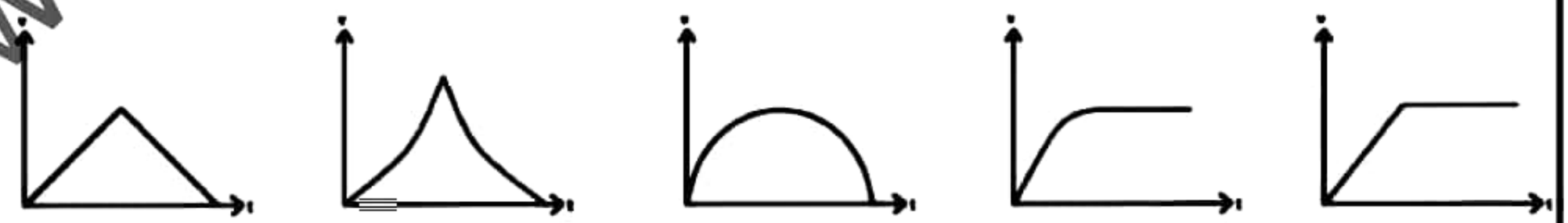
2) Breaking stress

3) Breaking point

4) Yield point

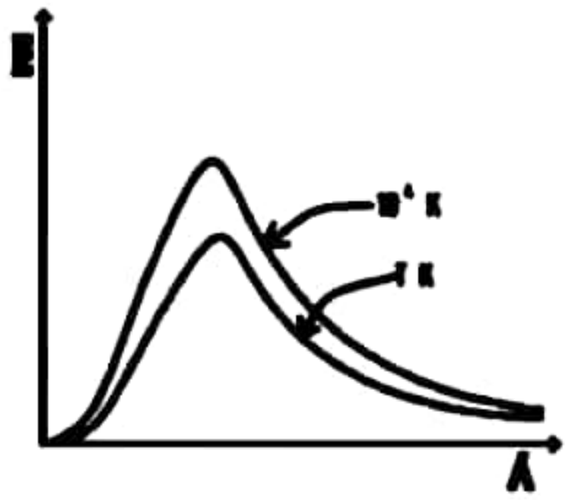
5) End point of elastic limit

42. A barrel where upper end is opened is pulled by a constant force along a rough floor. Here rain water is filled in to it at constant rate. The variation of velocity of the barrel with time,



1) 2) 3) 4) 5)

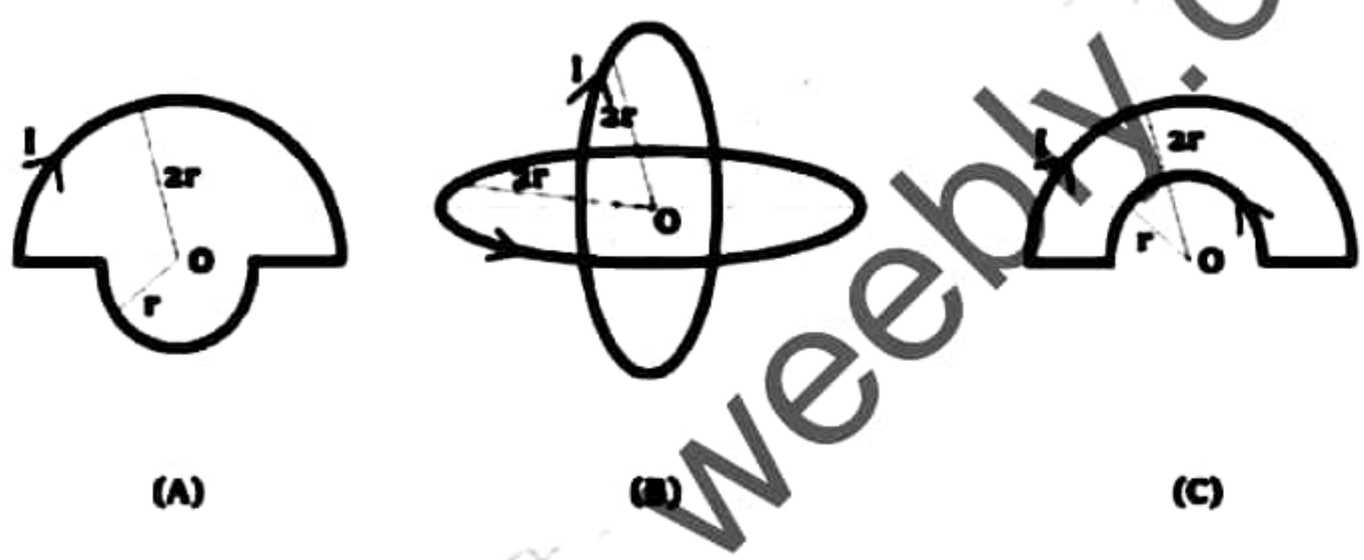
43. The variation of radiation intensities of a black body at 2 temperatures are as follows. Area of A is 16× that of B. Value of T may be,



1) 250K
2) 500K
3) 2500K
4) 5000K
5) 7500K

44. If B_A, B_B, B_C are magnetic flux densities at centre due to currents. The correct relationship between them is,

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



45. Correct statement about the contact angle is,

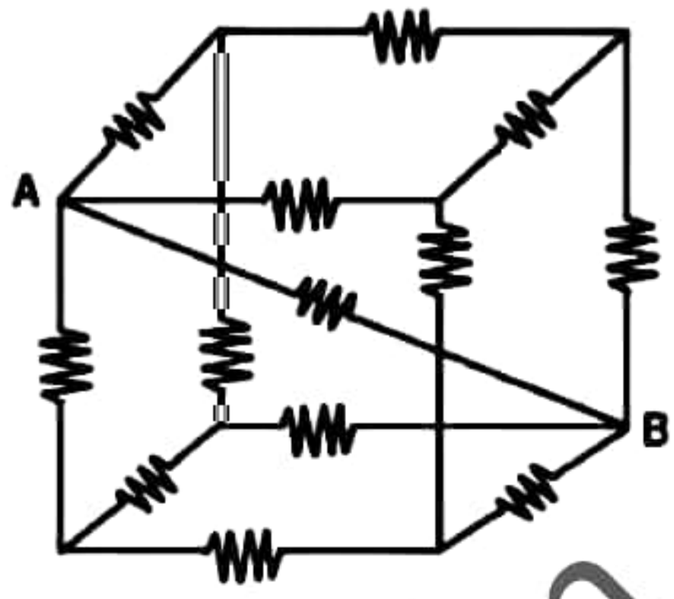
A. It is a constant specific to the liquid and the surface in contact.
B. The surface is wet when the angle of contact θ is θ<90°.
C. The surface is wet when the angle of contact θ is θ>90°.
D. The angle drawn through the liquid from the solid surface at the point of contact between 2 surfaces is the contact angle.

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

46. Sprinkling a little bit of water into an enclosed chamber causes slight decrease in temperature. This is caused mostly due to,

1) Temperature of water is less than that of the room.
2) Specific heat capacity of water being very high.
3) specific latent heat of vaporization of water being very high.
4) Water is a weak conductor of heat.
5) The coefficient of surface tension of water is very high.

47. If the resistance of each resistor is R, equivalent resistance between AB is,



1) $\frac{5}{6}R$

2) $\frac{6}{5}R$

3) $\frac{5}{11}R$

4) $\frac{11}{5}R$

5) R

48. Calculate the work done to convert a liquid ball of radius R to 8 liquid balls which are identical. (T=surface tension of the liquid)

1) $4\pi R^2T$

2) $4\pi R^2 \times T\left(\frac{1}{8}-1\right)$

3) $\frac{7\pi R^2T}{2}$

4) $\frac{7}{8}\pi R^2T$

5) $\frac{\pi R^2T}{2}$

49. An object is projected in v velocity such that it reaches maximum horizontal range. What is its angular momentum around the projection point at its maximum height?

1) $\frac{\sqrt{2}mv^2}{g}$

2) $\frac{\sqrt{2}mv^2}{2g}$

3) $\frac{\sqrt{2}mv^3}{g}$

4) $\frac{\sqrt{2}mv^3}{2g}$

5) $\frac{\sqrt{2}mv^2}{8g}$

50. Charge q at the infinity is ready to hit a steady charge Q. q comes with velocity v. But it comes towards Q and turns back at a r distance from Q. If q comes with a velocity of 2v, at which distance from Q it turns back?

1) r

2) 2r

3) $\frac{r}{2}$

4) $\frac{r}{4}$

5) $\frac{r}{8}$

♦♦♦

PRE-MEDICINE ASSOCIATION

2020/2021 Kurunagala

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கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2021
General Certificate of Education (Adv. Level) Examination, 2021

PHYSICS II	09 E I	three Hours

Instructions:

- *This question paper consists of 15 pages.*
- *This question paper comprises of two parts. part A and part B. The time allotted for both parts is three hours.*

PART A – Structured Essay:

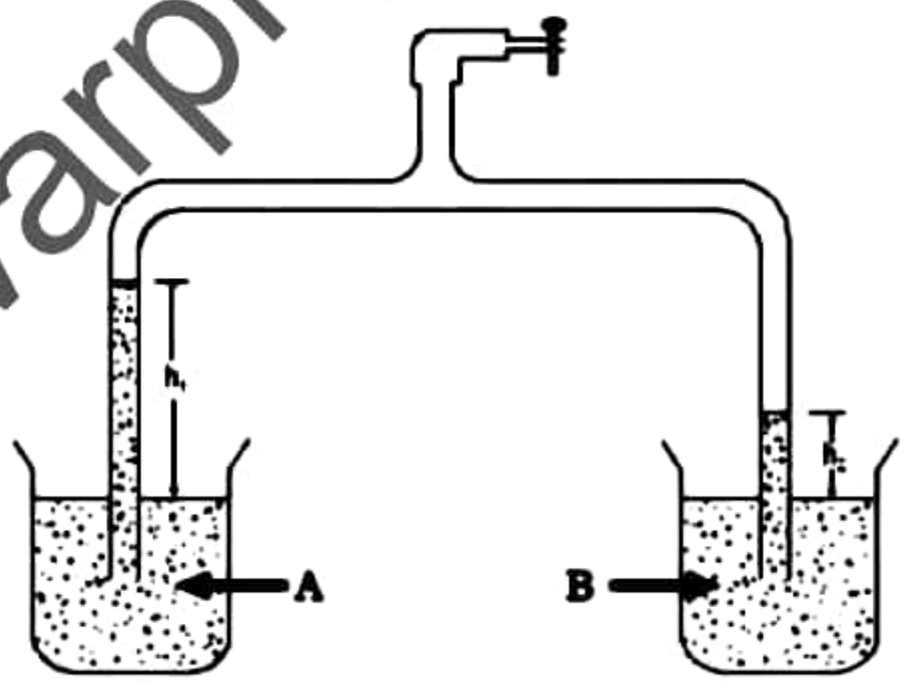
- *Answer the all questions on the paper itself .write your answers in the space provided for each questions.*

PART B – Essay:

- *This part contains six questions .of which, four are to be answered. Use the papers supplied for this purpose*

Part A

1) Hare's apparatus is arranged as below to compare the densities of distilled water and $cuso_4$ powder dissolved in distilled water.



a)

i. Identify above A and B solutions

1. A liquids……

2. B liquids……

ii. **What is the criteria you used to identify the 2 liquids separately?**

……

……

iii. **Take the density of $cuso_{4\,(aq)}$ as P_c and that of water as P_w. write down an equation to represent the relative density of $cuso_4$ using given data.**

……

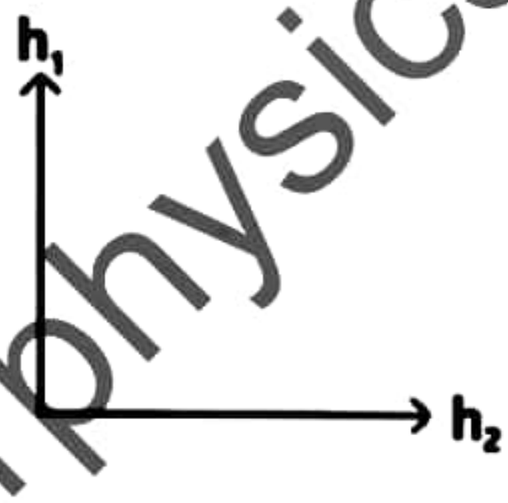
……

iv. **What is the law that you used to derive the above expression?**

……

……

v. **1) Draw the rough sketch of the graph and name it as x in the below graph.**



2) Draw the variations on the same graph, if coconut oil use instead of cuso4 solution name it as y.

b)

Now 2 solutions are poured into a U tube.

I. **What happens to the liquid levels of 2 arms at the equilibrium state?**

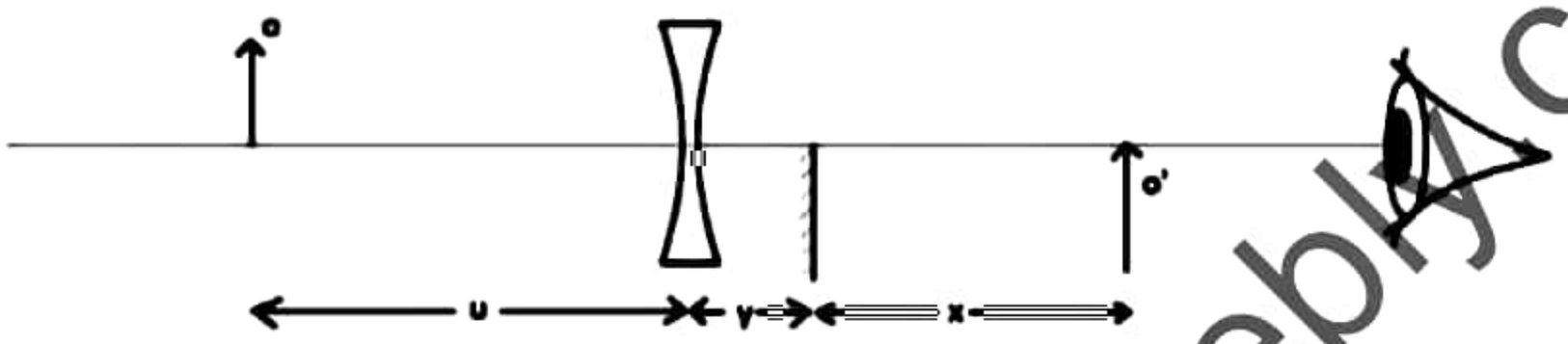
……

II. **Give the reason**

……

2)

An experimental setup is shown as given below to find the focal length (F) of a concave lens. Here the image of O pin formed via the lens gets coinsided with the image of O″ pin formed by the mirror.



a) Draw a ray diagram to show the position of final image in the given diagram

b) Show the distance from the lens to the final image using *x* and *y*.

……

……

c) Is the final image real/virtual?

……

d) Here the final image is having 2 parts (by the lens, mirror).what can you tell about the cross section of the final image? Is it uniform or not. Describe your answer.

……

……

……

e) What are the measurements taken in this experiment?

……

……

f) If you hope to obtain the focal length (F) using a straight line graph, what are its dependant and independent variables?

1. Independent variable .....
2. Dependant variable.....

g) How do you find the focal length (f) using the graph?

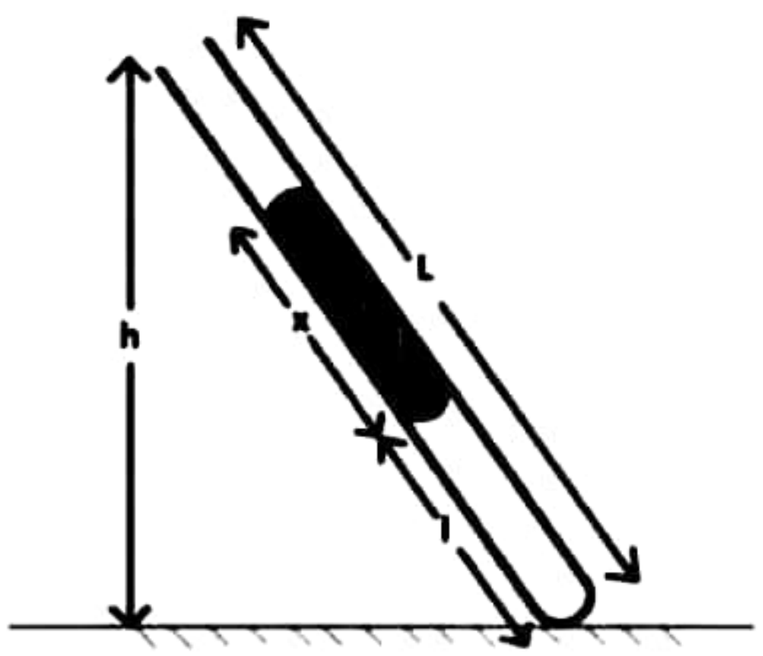
.....

h) At one position it was noticed that the image formed by the mirror is closer to the eye than the image formed by the lens. What is the direction we should move the mirror to make the 2 images coinsided?

.....

3

The below diagram show a setup which trapped on mass of air inside a thin uniform tube (cone end closed) of length L using a mercury column of length x.(length of air column is l).the atmospheric pressure is A and the air follows Boyle's law.



a) State Boyle's law.

.....

.....

.....

b) Write the relationship between h and L (h-vertical height)

.....

c) **Rearrange the equation to obtain a simple linear graph varying h and to obtaining readings for l.**

……

d) **What are the quantities chosen for x and y axis?**

x: …… **y:**……

e) **Why do we use thin tubes for the experiment?**

……

Write down two difficulties faced when we used water instead of alcohol?

……

……

f) **This experiment can be extended to find the saturated vapour pressure of water at room temperature (P_0) by trapping a thin water layer below the Hg thread .what are the partial pressure of trapped air at given instances?**

1) **When the open ends of inclined tube is upwards?**

……

2) **When the open end of inclined tube is downwards?**

……

g) **The experiment was done by varying the inclination to determine P_0**

1) **What are the variables you choose to draw the graph?**

x: …… **y:**……

2) **How to obtain p_0 using that?**

……

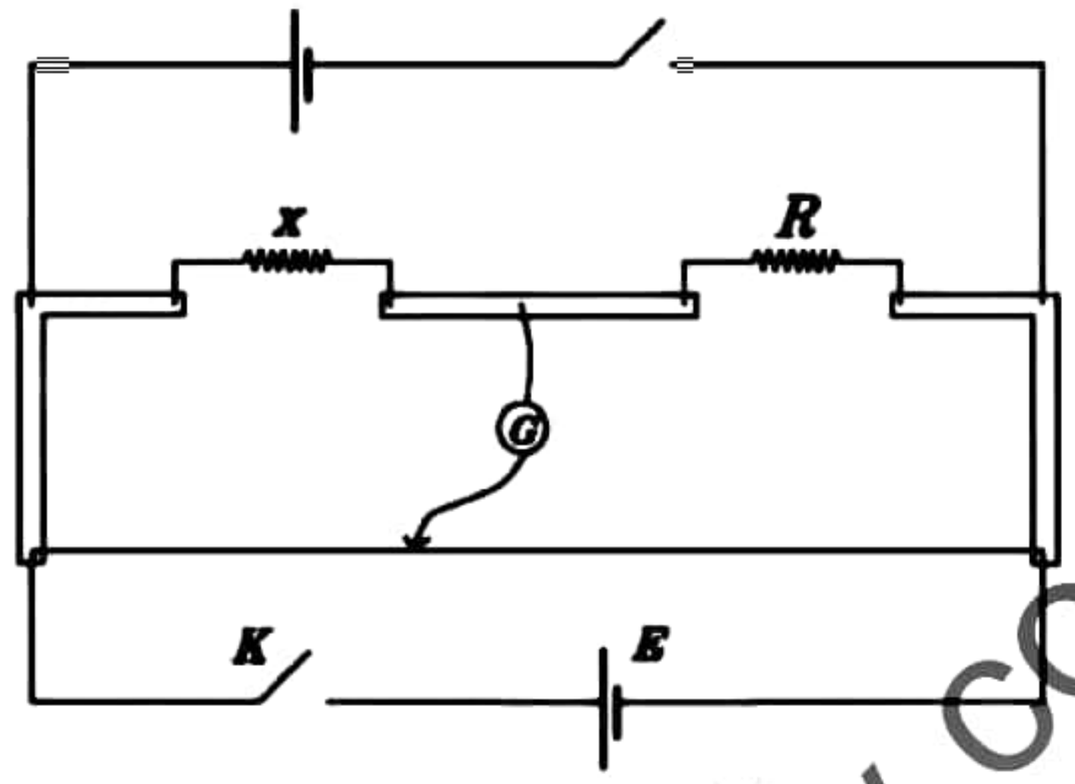
4

X -Unknown resistor

R - Resistor box

E - Cell

K -Key



a) Complete the given circuit

b) What are the reasons for being the galvanometer deflection only in one direction?

……

c) What is the value chosen for R to find x

……

Give reasons

……

d) Why do we prevent dragging the balance jockey along the wire when finding the balance point?

……

e) Why we interchange x and R and take 2 balance points?

……

f) Why is it essential to keep a resistor box with the galvanometer?

……

g) Why is the potentiometer more suitable to find small resistor than the meter bridge?

……

PART B

5. A farmer plans to prepare a system of water sprinklers (flowers) to supply water to a cultivating ground. Here water sprinklers are supplied by a water tank which 11m above the ground.

   The tank is having a uniform cross section. Its height is 1.25m. Water sprinklers are supplied using a pipe connected to the hole at the bottom of the vessel(tank). Each sprinkler is connected to a vertical pipe of 1m height and 2cm diameter. (Here water flows steadily)

a)

i. Calculate the velocity of sprinkling of water at the tip of vertical pipe initially. (Consider tank is completely filled with water)
   Write 2 hypothesis used in the calculation

ii. Calculate the medium volume flow rate from a one sprinkler in m^3s^{-1} up to the 4th decimal place, if the tank becomes completely empty at the end. ($\pi = 3$)

iii. Find the number of sprinklers needed to make the tank empty within 1/2h time if the volume of the tank is $79.2m^3$.

iv. When we consider the operation of the head of a sprinkler, it sprays a small water path vertically.
   Using a capsule in the sprinkler it is directed to the horizontal direction. Assume that it keeps the same cross section as in the small pore when going through the capsule.
   Capsule is rotatable and rotate due to the function of torque created by water column.

The capsule consists of 3 rectangular parts oriented in 3 perpendicular planes. (according to 2 & 3 figures) The water column travels in a circular pathway when the capsule rotates.

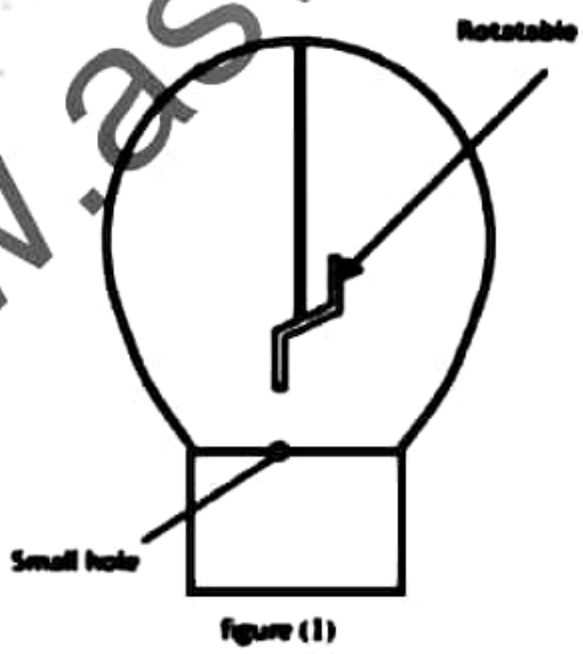
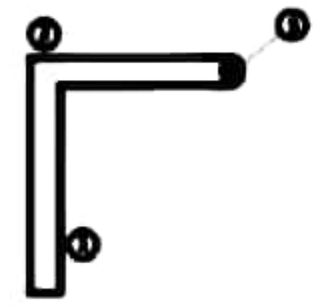
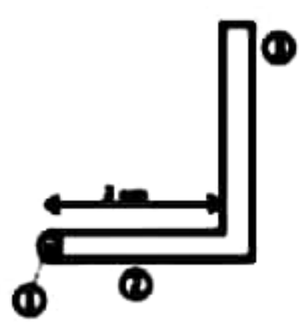


figure (1)



View from front

figure (2)



View from above

figure (3)

Water enters the capsule at lower end and passes 1,2,3, regions and moves out at the end of region 3.

(b)

i. Calculate the velocity flowing through the small hole.
(The cross section of small hole is half the value of that of the pipe) consider that the tank is completely filled with water.

ii. Calculate the frictional torque acting on the capsule if it rotates in constant angular velocity.
(ρ= 1000kgm^{-3})

iii. If the power of the flap of the sprinkler is p, calculate its rotating frequency. (π=3)

iv. Calculate the number of turns rotates by the flap in 5 minutes.

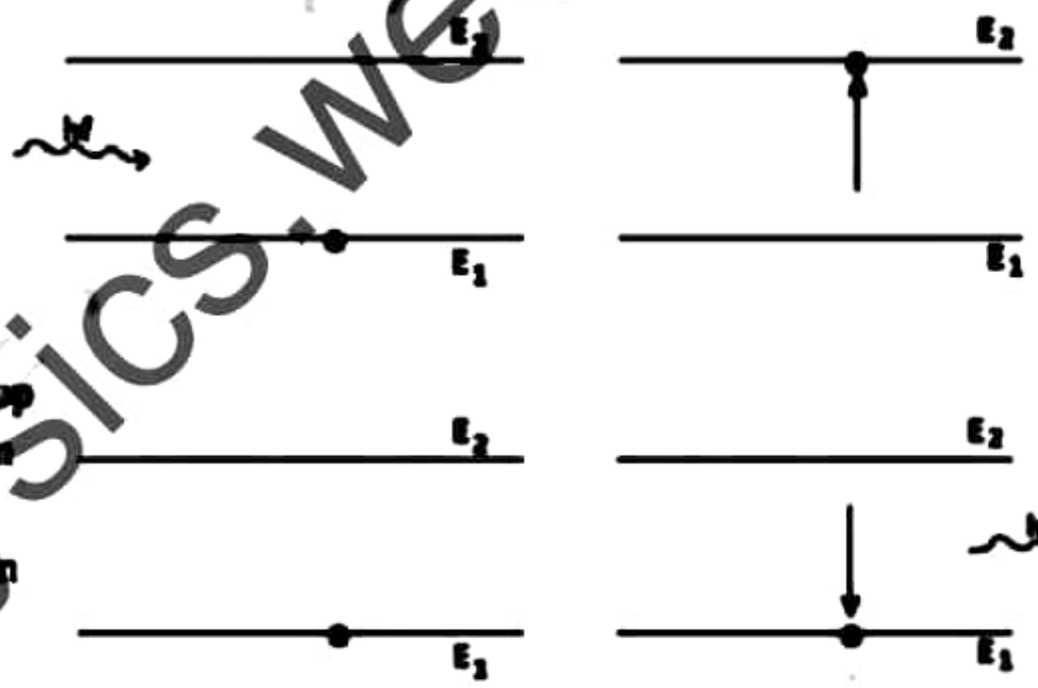
v. Find the radius of circular area through which water travels.

vi. Find the angle of inclination of to the vertical when water is on the ground.

6. One of the most exciting developments of the past three decades, which also quickly spawned a multimillion-dollar industry, is the Laser.
To understand the operation of "Laser" we summarize some information concerning transition between stationary states. Three kinds of transition, involving electromagnetic radiation are possible between two energy levels E_1 and E_2 in an atom.

1) Induced absorption

If an atom is initially in the lower state E_1, it can be raised to E_2 by absorbing a photon of energy E_2-E_1 =hf



2) The spontaneous emission

If the atom initially in the upper state E_2, it can drop to E_1, by emitting a photon of energy hf. The mean life of an atom is characteristic of energy state.
Some energy states have comparatively large mean life.

In spontaneous emission

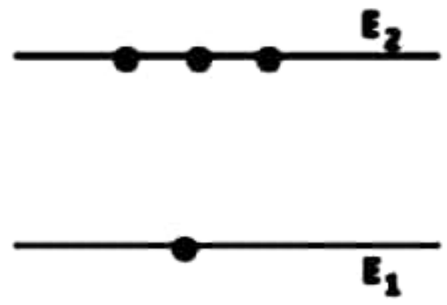
i. The emitted photon can move in any random direction.

ii. The photons emitted from various atoms in the assembly have no phase relationship between themselves.

The rate of spontaneous emission $\frac{dN}{dt}$ is proportional to the number of atoms in the excited state(N2).

But not on the presence of external radiation.

$\frac{dN}{dt} \propto N_2$



3) The stimulated emission

Under certain conditions it is possible to force excited atom to emit a photon by another matching photon.

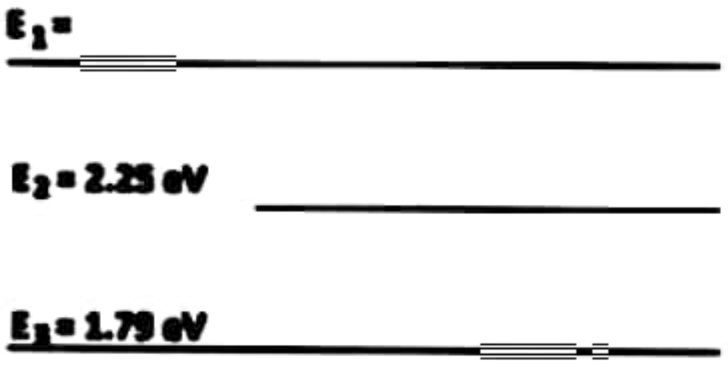
According to Einstein, an atom in an excited state may under the influence of the electromagnetic field of photon of frequency $f = \frac{E2-E1}{h}$ incident upon it, resonate in some fashion and jump to a lower energy level E, emitting an additional photon of some frequency f. Now there are two outgoing photons of the same frequency, same energy and same phase. Einstein also showed that the stimulated photon must move off in the direction as the incoming photon.

The transition rate of stimulated emission $\frac{dN}{dt}$ is proportional to N_2 and to the density of radiation incident on the atoms with energy equal to the energy difference between the two states.
The emitted photons can stimulate other atoms to emit photons in a chain of similar process. The result will be an amplification of the original light. This is the concept that underlies the operation of the "Laser".
In order that the stimulated emission result in laser light, we must have a buildup of photons in the system. To achieve this the, following three conditions must be satisfied.

1. The system must be in a state of population inversion.
2. The higher energy state should have longer mean life (should be in meta-stable state)
3. The emitted photons must be confirmed in the system long enough to enable them to stimulate further emission from excited atoms.

i. What do you mean be ''Laser Light''?
ii. Why the radiations given out by spontaneous emission is in – coherent.
iii. Explain why the intensity of radiated light from the stimulated emission is higher than the incident light.
iv. What do you mean by, Meta - stable state of an energy level?
v. In what ways does laser light differ from the light from the filament lamp.
vi. a) What do you mean by population inversion.
b) Is it possible to obtain a population inversion by increasing temperature.
vii. Why a system of two energy levels (E_1 and E_2) is not suitable to get a population inversion.
viii. In practice, population inversion is brought about by
a) a three-level scheme or
b) a four-level scheme

Figure shows a three energy levels of a scheme which produces Laser.



1) Name the three states.
(Copy the diagram to your answer script)
2) Find the frequency(f) and wavelength (λ) of the emitted laser beam.

ix. The method of producing population inversion is called pumping. What is the method of pumping in "Ruby Laser"?
x. a) Draw the symbol for laser that can be used for safety precautions.
b) Laser can harm skin or eyes due to the incident, Suggest one reason for this.

7. (a)

i. Write down the hook's law.
ii. Present the corresponding valid equation and describe the terms.
iii. Draw the strain-stress graph for a wire and mark special points on it.
iv. Show that the energy stored in the wire is given by $\frac{1}{2}$ $(Tension \times extension)$

(b) A steel wire of length 2m and diameter 1.6mm is stretched between 2 supporters at 30°C. Then the wire is cooled up to 0°C.

i. What is the tension at 0°C ? (If not exceeded the proportionality limit)

ii. Calculate mechanical energy stored at 0°C inside the wire.

iii. Describe the effect on the tension of the wire using a stress-strain graph if the wire exceeded the proportionality limit.

(calculations are not needed, assume that the wire has not reached the breaking point)

Young's modulus of steel = $2\times10^{11}Nm^{-1}$

Linear expansivity of steel = $1.1\times10^{-5}C^{-1}$

8. (a)

i. Write down the Newton's law of gravity.

ii. Compare a one difference between the gravitational force and the electric force

b) It is planned to launch a satellite of 60kg on to an orbit 600km away from earth surface.

i. If the radius of earth is R, gravitational acceleration on earth surface is g, distance from the centre to the orbit is r, write down an expression for the velocity(v) of satellite in the orbit

ii. Obtain an expression for the momentum of satellite after getting on to the orbit. (R= 6400km, $g=10ms^{-2}$)

iii. Then calculate the value of momentum

iv. If the satellite comes in a velocity $2000ms^{-1}$ from the earth centre to the orbit along the radial direction, calculate momentum at that position.

v. Calculate the value impulse needed to initiate the motion of the satellite.

vi. Calculate the total energy of the satellite.

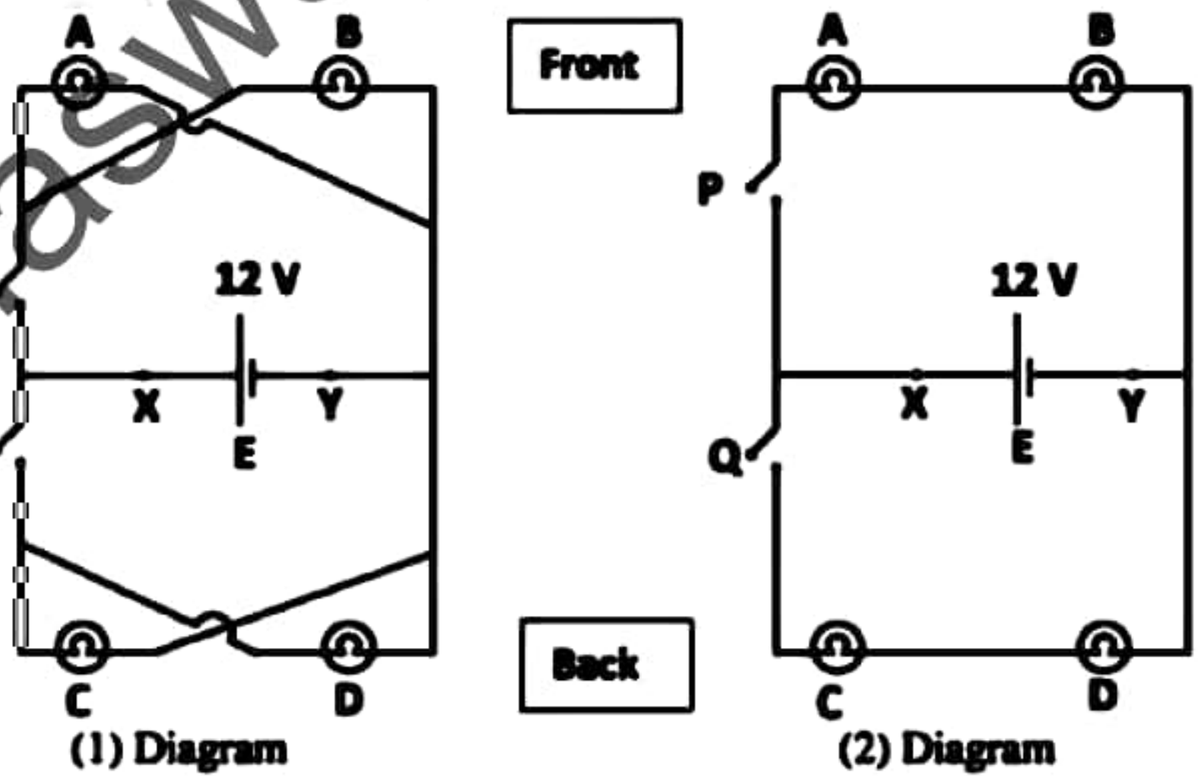
vii. Represent the variation of kinetic energy and potential energy in a same rough graph with the distance from earth surface to the satellite.

viii. Draw a free force diagram of the satellite with the forces acting on it. (orbit is circular)

ix. If the satellite experiences an equal and opposite force to the gravitational attraction force on the satellite due to blasting of the satellite engine, to which direction the satellite moves after the blast instantaneously?

9. (A)

A group of students have created a model of a motor vehicle. There two students separately introduced 2 circuits to lighten the 2 pairs of bulbs in front and back.



(1) Diagram (2) Diagram

A and B are 2 filament bulbs of maximum power 60W. C and D are 2 filament bulbs of maximum power 30W. P and Q are 2 tap keys. P controls the front bulbs. Q controls the breaks associated back side bulbs. E is a dry cell of internal resistance zero, 12V potential difference.

(a)

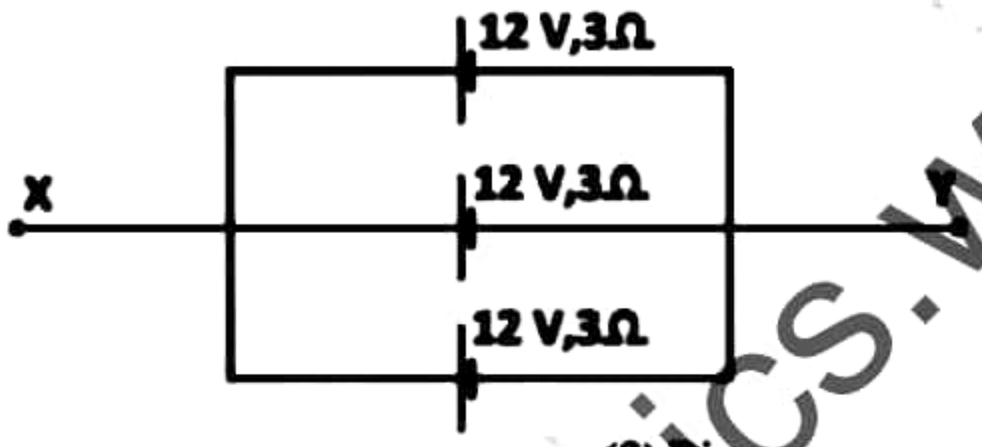
i. What is the best circuit to apply to a motor vehicle model among (1) and (2) circuits?
ii. Give the reason

(b) In the above selected circuit, A, B, C and D filament bulbs lightens in same maximum power under 12V supply. (P and Q are enclosed)

i. Calculate the internal resistance of A, B, C, D bulbs separately.
ii. What is the total current drown from a 12V battery when P and Q are enclosed?
iii. Calculate the current flowing through filament bulbs A, B, C and D.

(c) Q is closed only when breaks are applied. Do A and B bulbs lighten in the same brightness when Q is opened and P is closed and when both switches are closed? Explain using a suitable calculation.

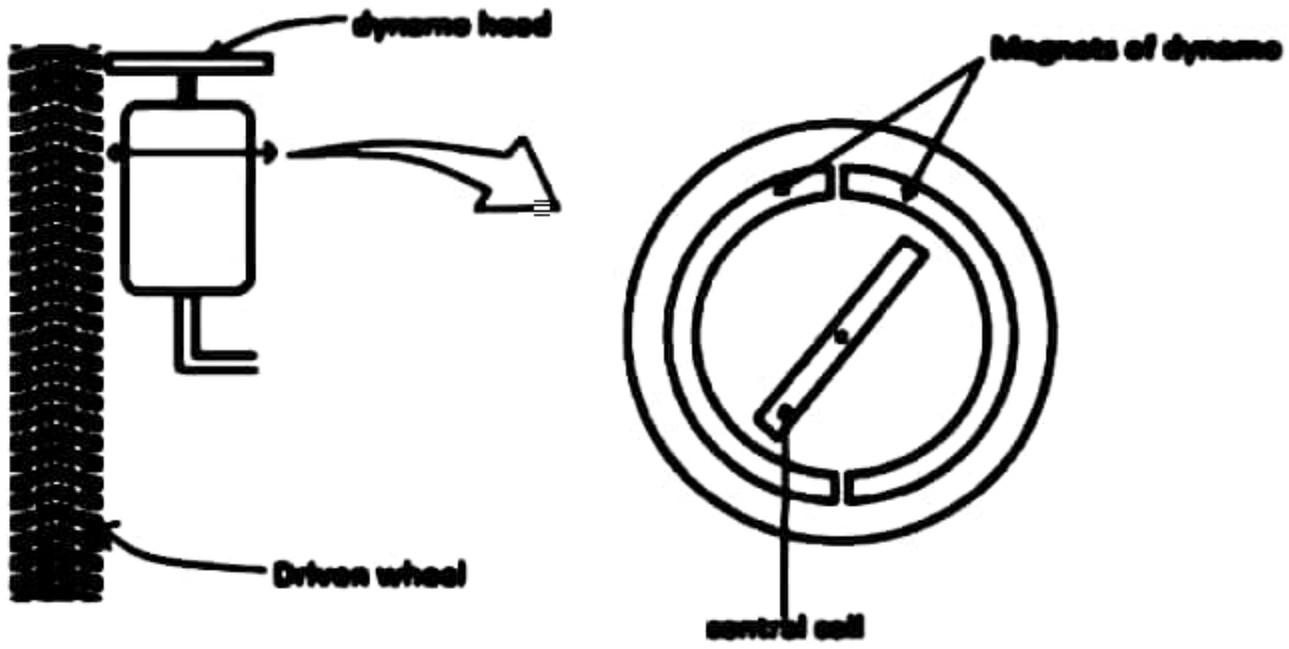
(d) Dry cells having zero internal resistance are practically unavailable. The student uses a system of 3 12V, 3Ω internal resistance cells instead of E cells as bellow



(3) Diagram

i. Calculate the equivalent internal resistance of cell system in diagram 3
ii. Calculate the total current flowing when it is applied to the total system you selected.
iii. If,
Internal resistance of cell = r
Equivalent resistance of circuit = R
Electrical efficiency of the system is given by = $\frac{R}{R+r} \times 100\%$
Then calculate the efficiency of the relevant system.

(e) The student decides to use an alternating current instead of a dry cell. The driven wheel of the model car is used to rotate the dynamo.



i. **What is the maximum pinch voltage (V_p) that has to be obtained by rotating alternative current dynamo to provide 12V root mean square voltage (V_{rms}) to the circuit? ($\sqrt{2} = 1.4$)**

ii. **Magnetic field intensity of dynamo is 1.68×10^{-3}T, number of turns of central coil is 1000, cross section of central coil is $0.05m^2$.**

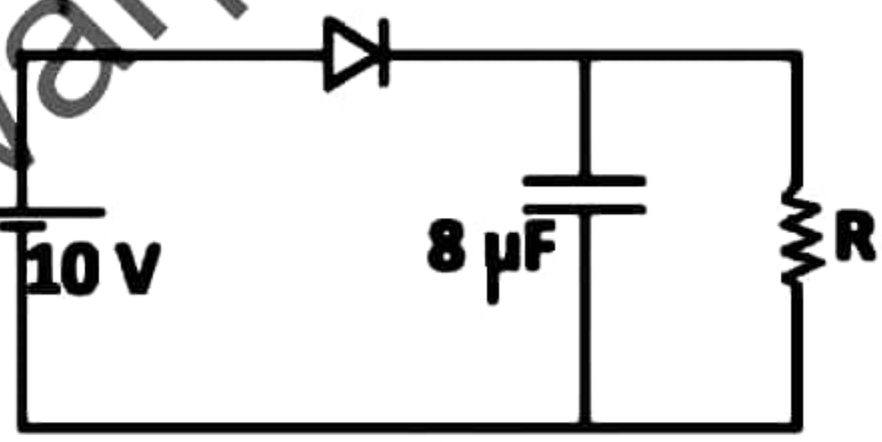
1. **Calculate the angular velocity that the dynamo has to be rotated (w) to obtain the calculated V_p.**
2. **Radius of driven wheel is 15cm. assume that the dynamo head is attached to the driven wheel circumference and axel of the dynamo rotate in the same speed as the wheel. Calculate the velocity that the vehicle should be driven to reach the above pinch voltage. (V_p)**

(B)

(a)

i. **Draw the I-V characteristics of a silicon diode of 0.7V forward biased voltage.**

ii. **Calculate the energy stored in the given capacitor if the diode in (a) is ideal.**



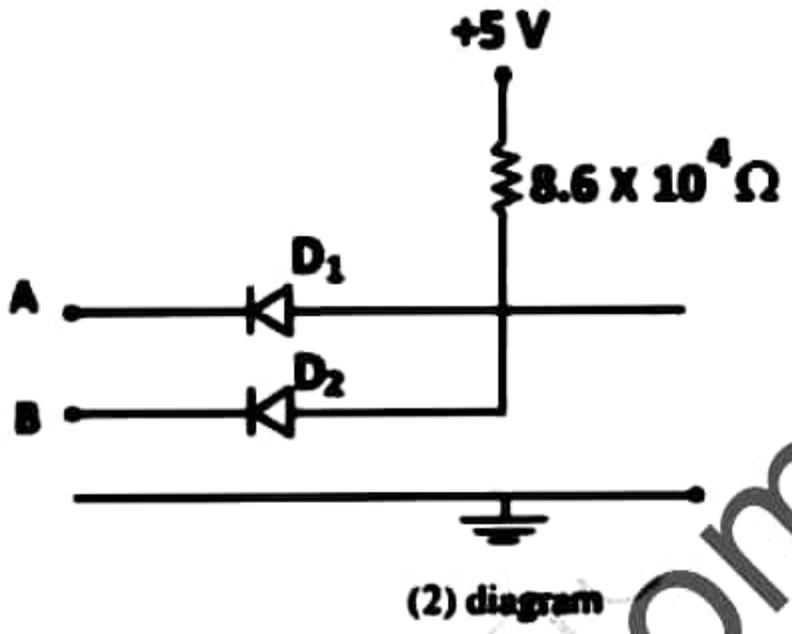
(I) diagram

(b) The following diodes are silicon. (forward biased voltage is 0.7V)

The input voltages of A and B may be 5V or 0V.

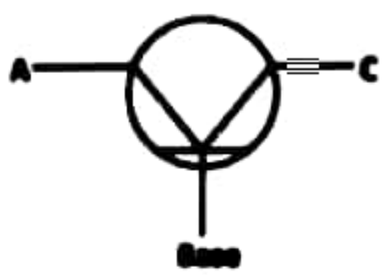
Copy the given table and provide relevant V_F values to the inputs.

A(V)	B(V)	V_R(V)
0	0	
5	0	
0	5	
5	5	

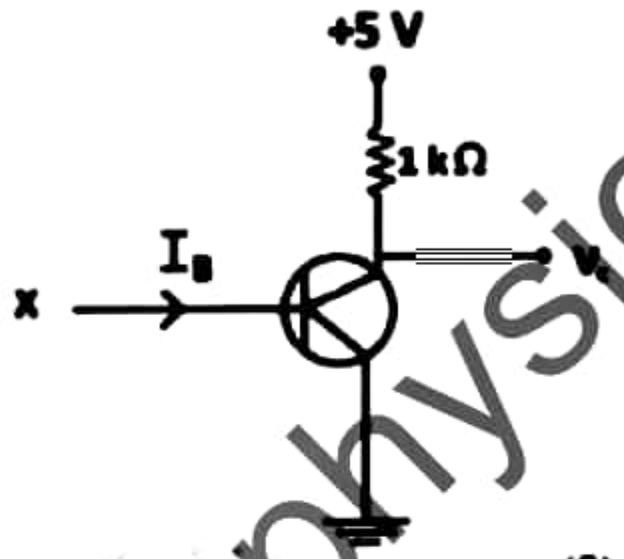


(2) diagram

(c) The C terminal is highly doped than A. So, name A and C terminals.

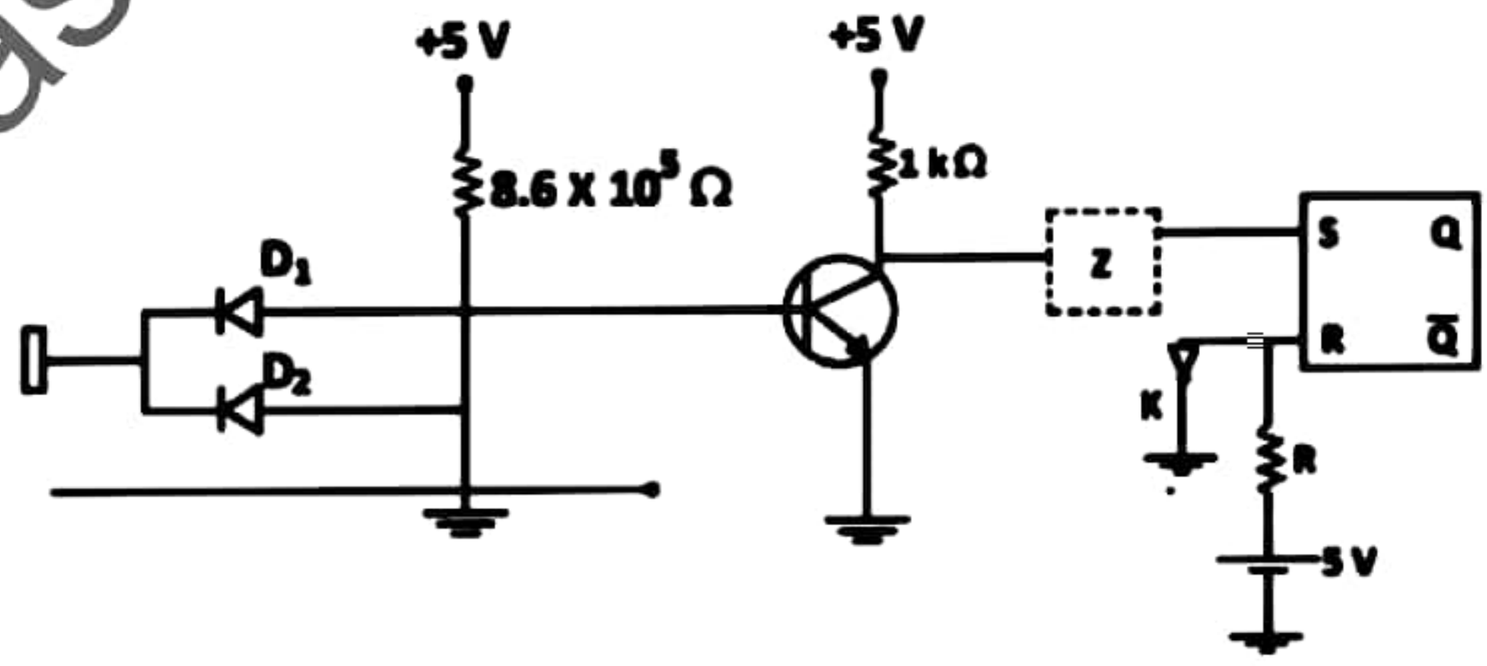


(d) Think that the F terminal of above (b) 2) diagram and X terminal of the following diagram are connected.



(3) diagram

i. A and b inputs are provided by 5V each. Then calculate I_B base current.
ii. If β= 100, what is the collector current.
iii. Then calculate V_c.



(e) The above system connected inside a hospital room. Here an alarm and a red bulb glows in an emergency situation of the patient. This gives a signal for the nurse.
The circuit of the system is as given above. When the patient turns the switch on, a 5V is generated.

i. What is the gate relevant to z box?
ii. Draw the SR flip flop of the above diagram using 2 NOR gates.
iii. Write the logic states of SR when the patient makes the switch on
(5V binary = 1, 0V binary = 0)
iv. Write the way in which bulb and the alarm turn off as soon as the nurse opens the door. (K is a door switch.)

10. (A)

Mercury bulb thermometer is mostly used to measure moderate temperature. Here a uniform capillary tube with a lower glass bulb is filled with mercury and the upperend is sealed.

i.
a) What is the thermometric property used here?
b) Briefly describe the method in which bulb get filled with mercury when forming the temperature.
c) Write both advantages and disadvantages 2 each of a mercury-glass thermometer when compared with a constant volume thermometer.

ii. When calibrating the thermometer, the height of the Hg column was 1mm when the bulb was immersed in lower fixed-point temperature, and 91mm when it was immersed in upper fixed-point temperature.
a) If the height of the mercury column was 34mm on exposure to air, what is the environmental temperature?
b) Mistakenly it was calibrated that the upper fixed point is 99°C and lower fixed point is 1°C. If this inaccurate thermometer shows 30°C what is the accurate value?
c) Find the stage where the accurate reading equals the reading of the inaccurate thermometer.

iii. The bulb volume of a mercury-glass thermometer is $30mm^3$ and $0.01mm^2$ cross section of capillary tube.
At 0°C bulb is completely filled with mercury. The real volume expansivity of Hg is $1.8X10^{-4}°C^{-1}$ and linear expansivity of glass is $8.5X10^{-6}°C^{-1}$
a) What is the gap between 0 °C and 100 °C fixed points?
b) Write down 2 characteristics that a glass tube must have to produce a Hg-glass thermometer of higher sensitivity.

iv. A student suggests to use water as the liquid in a glass-liquid thermometer.
a) Write 3 difficulties he could face when water is used instead of mercury.
b) If we neglect the expansion of glass, draw the variation of reading of water-glass thermometer (within 0-50 °C range) with the temperature.

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(B)

The intensity of solar radiation at the outer most end of the earth atmosphere is 12kWm^{-2}. The average distance from the sun to the earth is 1.5×10^{11}m. ($\pi = 3$)

i. **Calculate total power output of the solar radiation emission.**

ii.

a) **Sun emits energy by nuclear fusion of deuterium and forming ^4_2He nuclei as follows.**

$$^2_1H + ^2_1H \rightarrow ^4_2He + \Delta E$$

Calculate the energy released when one He nuclei is formed.

Mass of a He nuclei = 6.64×10^{-27}kg

Mass of a proton = 1.67×10^{-27}kg

Velocity of light in vacuum = 3×10^8ms^{-1}

(mass of proton and mass of neutron are approximately same)

b) **Calculate number of He nuclei produced per second from the sun.**

iii. **Sun was formed 4.6×10^7 years ago and its temperature was 5800K. it was visible in orange colour. But now the temperature was increased by 200K and it is now visible in yellow colour.**

a) **Describe the reason using wein displacement principle.**

b) **Find the wavelength of light in which the sun emits more intensely.**

iv.

a) **γC47 star which is dying appears in red colour. It emits radiation of wave length 1100 nm. The total power emission of radiation is $1.44X10^{23}$ W.**
Calculate the rate of emission of light photons by the star. (Plank's constant = $6.6X10^{-34}$ J s)

b) **If the radiation intensity at the outermost end of earth due to γC47 star is 0.025% times that of sun. What is the difference of percentage of the average distance from the earth to γC47 star and the average distance from the earth to the sun?**

v. **A normal skin emits a radiation corresponding to T°C, and skin with a cancer tubercle emits a radiation corresponding to a temperature which is ΔT°C more than the above value.**
If the skin emits radiation at a constant emissivity, write down an expression using ΔT and T about the fractional difference between the intensity of radiation emitted from a cancer tubercle and the intensity of radiation emitted from a normal skin. [If $1>>x$, $(1+x)^n = 1+nx$]