Q. No. 2 Part (i) Numerical Problem

Given Data

Length (distance) of ripple tank = 80 cm

$= \frac{80}{100} = 0.8 m$

Frequency of vibrator = 5 Hz

Wavelength of waves = 40 mm

$= 40 \times 10^{-3} m$

Required

Time waves need to cross tank = t = ?

Solution

$v = f\lambda$

$v = 5 \times (40 \times 10^{-3})$

$v = 0.2 ms^{-1}$

$v = \frac{d}{t}$

$t = \frac{d}{v}$

$t = \frac{0.8}{0.2}$

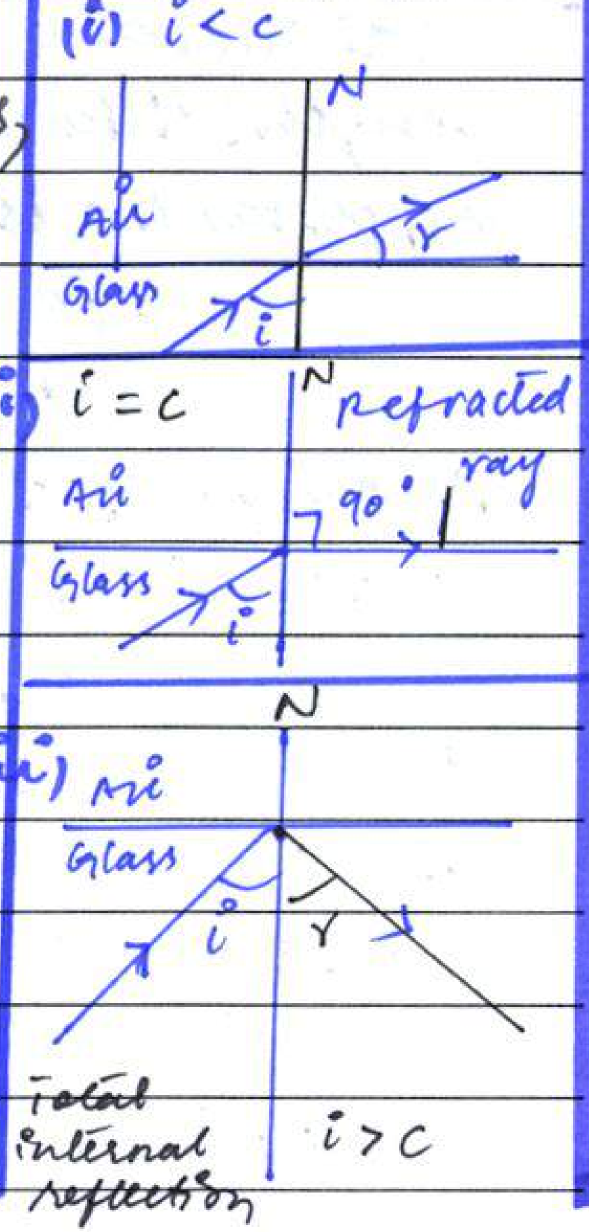
t = 4 seconds

Result:- waves need 4s to cross the tank of 80 cm. (4 second)

Q. No. 2 Part (ii) **Waves carriers of Energy:** Wave does not transfers matter.

Waves transfer only energy not matter. When we shake a string up and down we provide the muscular energy of our hand to the string. A series of disturbances in form of waves travel along the string. The vibratory motion due to muscular energy of our hand disturbs the particles of string and sets them in motion. So they ~~wave~~ travels along the string carrying the energy. The amount of energy transferred depends on amplitude of waves. If we shake the string faster we provide more energy per second to the particles which sets a higher frequency wave. Drop a stone in pond. Muscular energy of our hands converts into K.E & P.E of stone and sets a wave in water pond. Cork placed at some distance starts vibrating up & down by getting energy from waves. But waves transfer only energy not matter. Net displacement of cork is zero. Wave travels outwards transferring only energy.

Q. No. 2 Part (V) Total Internal Reflection When a ray of light enters from denser medium into rarer medium, if angle of incidence increases, angle of refraction also increases. The value of angle of incidence that causes that refracted ray in rarer medium to bend through 90° is called critical angle. When the angle of incidence becomes greater than angle of critical angle, the total is reflected back into the denser medium. No refraction occurs. This is known as total internal reflection.



Q. No. 2 Part (vi) Numerical Problem

Given Data

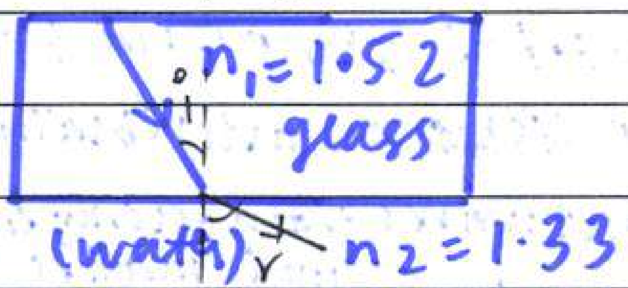
refractive index of glass $= n_g = 1.52$ (denser)

refractive index of water $= n_w = 1.33$ (rarer)

Angle of incidence in glass $= 40°$

Required

angle of refraction in water = ?



Solution

$$\frac{\sin i}{\sin r} = n$$

$$\sin i = n \times \sin r$$

$$\frac{\sin i}{n} = \sin r$$

$$\frac{\sin 40}{1.33} = \sin r$$

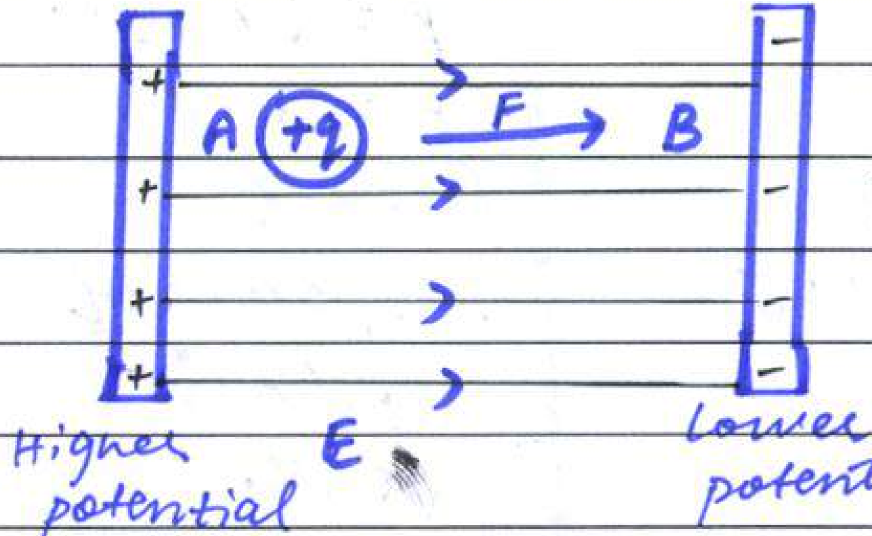
$$\sin^{-1} 0.483 = \hat{r}$$

$$\hat{r} = 28.90°$$

Result

The angle of refraction in water is $28.90°$.

Q. No. 2 Part (vii) **Potential Differrence**



Let the potential of charge +q be V_A at point B be V_B. The potential energies of the charge at these points are qV_A & qV_B respectively. The change in the potential energy of charge as it moves from A to B is $qV_A - qV_B$. This energy is utilized in doing some useful work. Energy supplied by charge = $q(V_A - V_B)$. If one coloumb is charge, so potential difference between two points is equal to the energy supplied by the charge. **Definition:** The energy supplied by the unit charge as it moves from one point to another in direction field is called potential differene.

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Q. No. 2 Part (ix) Factors Affecting Resistance of Conductor

(i) Length of Conductor

$R \propto L$ ——— (i)

The resistance R of conductor is directly related to length L of conductor. If length is doubled the resistance is also doubled.

(ii) Cross-Sectional Area of Conductor

$R \propto \frac{1}{A}$ ——— (ii)

Inverse relationship occurs, between Resistance of conductor and cross-sectional area. Thick wires have less resistance

(iii) Temperature of Conductor

$R \propto T$ Temperature increases, K.E increases, collisions increase.

Combining (i) & (ii)

$R \propto \frac{L}{A} \rightarrow R = \rho \frac{L}{A}$

ρ is specific resistance has unit ohm-metre.

Q. No. 2 Part (X) Numerical Problem

Given Data

time = 40 s

Electrical energy consumed by bulb during 40 s = 2400 J (W)

Required

Power of bulb = P = ?

Solution

$$P = \frac{W}{t}$$

$$P = \frac{\text{Electrical energy consumed}}{\text{time taken}}$$

$$P = \frac{2400\,J}{40\,s}$$

$P = 60\ Js^{-1}$

$P = 60\ W$

Result

The power of bulb is 60 W.

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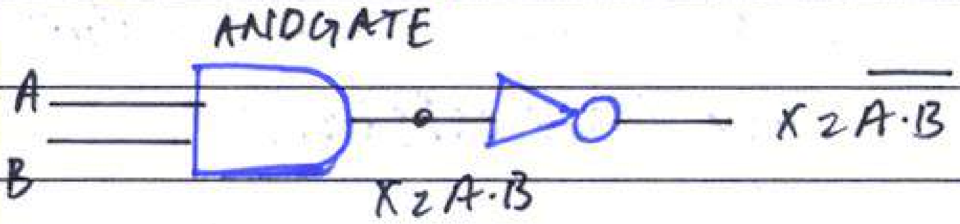
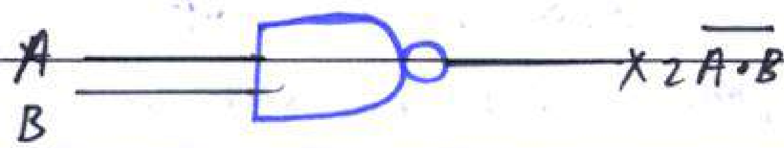
Q. No. 2 Part (XIII) NAND GATE :- Universal Logic Gate

Circuit diagram



Symbolic Representation



Truth Table

A	B	X = A·B	$X = \overline{A \cdot B}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

Definition:- NAND GATE is formed by coupled the NOT Gate at the output terminal of AND GATE.

Boolean Expression:- $X = \overline{A \cdot B}$

Description:- NAND GATE inverts the output of AND GATE. the output of NAND gate is 0 when when both of its input are at logic 1 that is inverted.

Q. No. 2 Part (XV) Numerical Problem

Given Data

Half life of Cobalt 60 = 5.25 years

Total duration = 26 years.

Required

Fraction of original sample after 26 years $\frac{N}{N_0} = ?$

Solution:-

No of half lives = $\frac{\text{Total duration}}{\text{Half life}}$

No of half lives $t = 4.95$ half lives

≈ 5 half lives

$$N = N_0 \times \frac{1}{2^t}$$

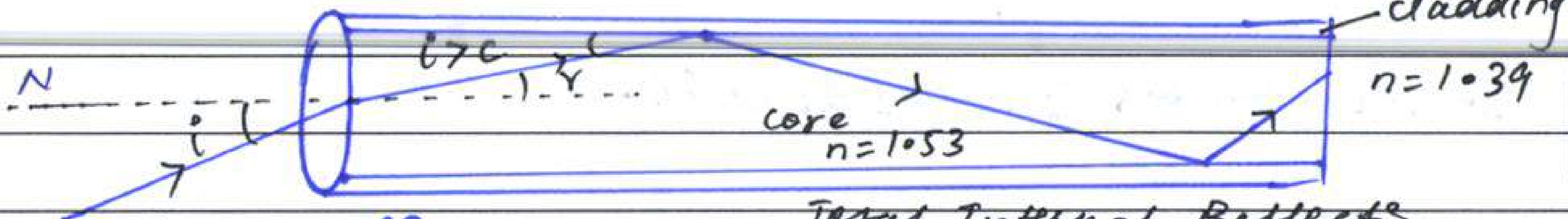
$$\frac{N}{N_0} = \frac{1}{2^t}$$

$$\frac{N}{N_0} = \frac{1}{2^5}$$

$$\frac{N}{N_0} = \frac{1}{32}$$

Result:- The fraction of original sample after 26 years is $\frac{1}{32}$.

Q. No. 2 Part (xiv) **Optical Fibre:- Communication Purpose**



Total Internal Reflection

Core & Cladding:-

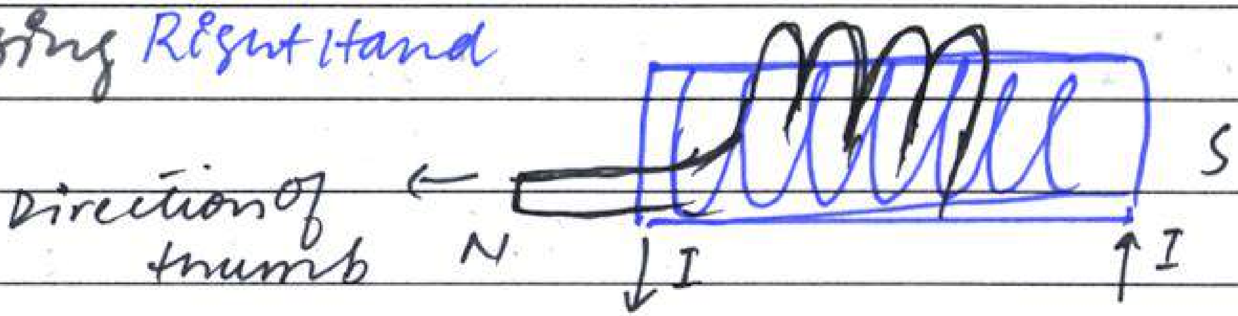
Cladding is made of glass or plastic with low refractive index. Core is made of glass or plastic with high refractive index. Cladding protects core. Light entering from one end of core strikes core-cladding boundary at an angle of incidence greater than critical angle, so it is totally reflected inside the core and travels many kilometers.

Advantages of Optical Fibre:- Signal security, low power losses, wide bandwidth, free from external interferences, and it is compact and light.

Q. No. 2 Part (xi) Polarity of current carrying solenoid

Right hand grip Rule:- "Grasp the coil with your right hand such curling fingers of your hand point in direction of conventional current, the direction of your thumb indicates the north pole of solenoid/ coil."

Current-carrying solenoid produces magnetic field similar to that of bar magnet. When you bring current-carrying solenoid near suspended bar magnet, it repels the north of bar magnet, it indicates that solenoid has a north and south which can be found using Right Hand Grip Rule.



Q. No. 2 Part (XII) Factors affecting magnitude of Induced emf.

1. The number of turns of coil.

2. The speed of frequency of vibrations of coil.

3. The strength of magnetic field.

4. The length of coil in magnetic field.

Simple Harmonic Motion

Motion of Simple Pendulum

(i) **Forces acting on it at point A & B.**

On space for diagram. pg13

(ii) **Force providing Restoring Force.**

component of weight mg sin θ is providing restoring force.

Equilibrium position O:- At Equilibrium position O, the weight of bob is balanced by upward reaction force of string. So net force is zero.

Position A:- When the bob is moved to extreme position A net force is not zero. The Tension in string is balanced by component of weight mgcosθ. Hence there is no motion along this direction.

Restoring force mgsinθ:- The component of weight mgsinθ is directed towards mean position and hence acts as a restoring force. Due to action of this restoring force the bob is moved/pulled towards mean position O.

Magnitude of Restoring forces:- Magnitude of restoring force decreases with the distance from mean position, and becomes zero at O.

(iii) **Velocity of bob at point A.**

Velocity of bob is zero at point A (extreme position).

Restoring force:- As bob moves towards A or B (extreme positions) the restoring force due to $mg \sin\theta$ increases. Due to action of restoring force the velocity of bob decreases as it moves towards A or B.

Velocity at point A:- The velocity at point becomes zero, bob briefly comes to rest at A and again moves towards mean position O due to restoring force.

To & Fro Motion:- As restoring force $mg \sin\theta$ acts towards mean position O, bob moves towards O, hence its restoring force decreases and velocity increases.

Velocity at Mean Position:- Velocity becomes maximum at mean position O and due to inertia does not stop at O rather continues its motion towards extreme position B. So velocity is maximum at mean position O and zero at extreme positions.

Direction of Acceleration:- As velocity decreases from going O to A, due to restoring force acting towards mean position, acceleration is also directed towards mean position O but acceleration is maximum at extreme positions.

Time Period of Pendulum:- $T = 2\pi \sqrt{\frac{l}{g}}$

Simple Harmonic Motion:- **Definition:-** "Simple Harmonic Motion occurs when net force is directly proportional to displacement from mean position and is directed towards mean position."

Hence, $F \propto -x$ $\quad a \propto -x$

Q. No. 3 Part (b) (Page 1/2) Fission Chain Reaction

Nuclear Fission

Definition:-

"When a heavy nucleus such as nucleus of Uranium-235 splits or fissions into two lighter nuclei by absorbing a slow-moving (low energy) neutron the process is called **Nuclear Fission**."

Reaction:-

$$^{1}_{0}n \longrightarrow {}^{235}_{92}U \longrightarrow {}^{236}_{92}U^{*} \longrightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n + E$$

neutron, Uranium nucleus, Intermediate nucleus, Fission Fragments, neutron, -nergy

Fission Fragments & Neutrons:-

Uranium-236 is intermediate state that lasts only for a fraction of second before splitting into two lighter nuclei called fission fragments. In each fission reaction, 2 or 3 neutrons are also produced with release of energy.

Fission Reaction vs Chemical Reaction:-

200 MeV of energy is released per fission event. While in chemical reaction like burning of 1 tonne of coal produces 3.6×10^{7} J of energy while a fission of 1 kg of uranium produces 6.7×10^{11} J of energy!!

Fission Chain Reaction:-

2 or 3 neutrons are released during a fission reaction when a uranium-235 nucleus splits up into two lighter nuclei by absorbing low-energy neutron

and releasing 200 MeV of energy.

Triggers Fission:- Neutrons:-

Neutrons released can trigger fission in other nuclei of uranium initiating a chain reaction.

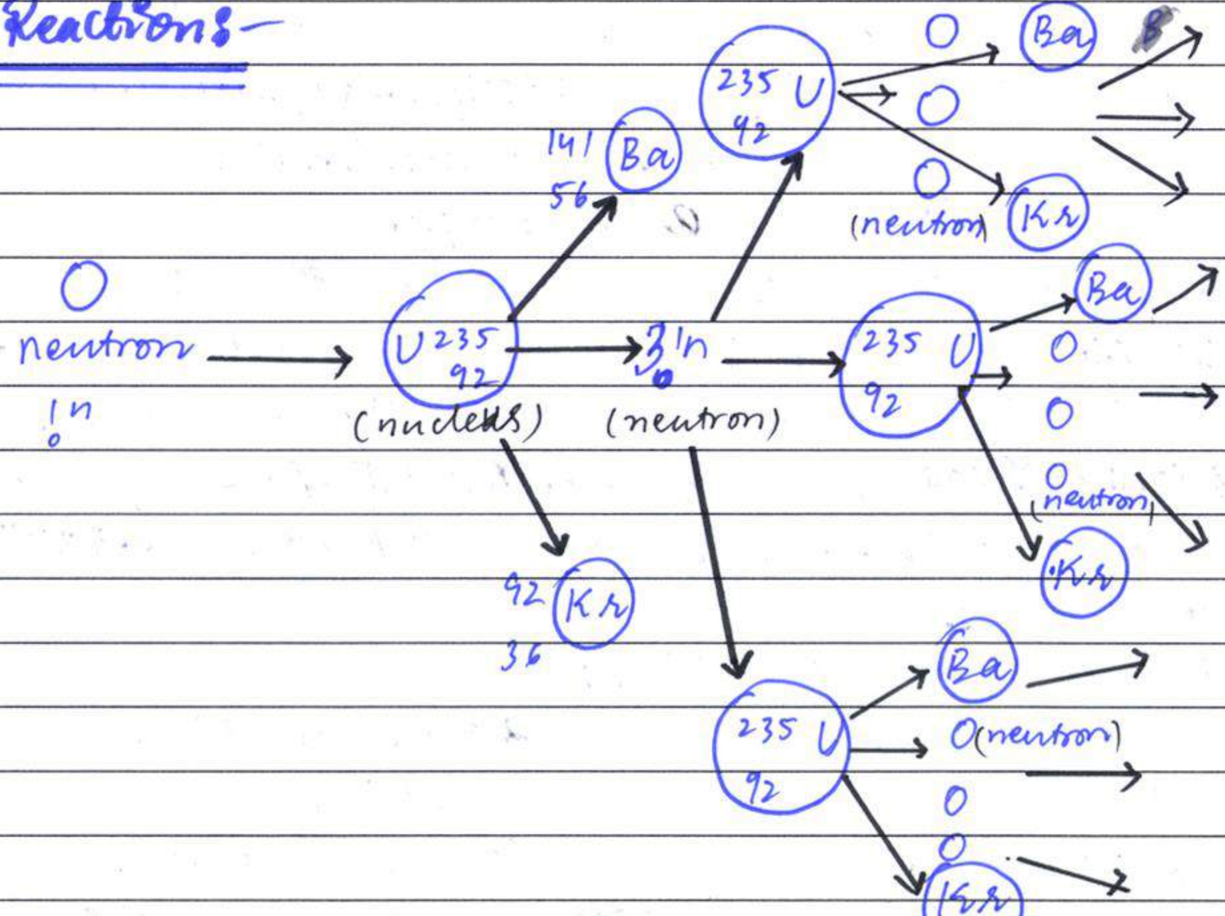
Chain Reaction:- This chain reaction proceeds very rapidly and completes in a short interval of time with a sudden explosion and release of energy (blast).

Uncontrollable Fission:-

Chain reaction is an uncontrollable fission, which occurs when it is not controlled in nuclear reactors.

Application:- Atomic Bomb uses Fission Chain Reaction (Uncontrollable Fission).

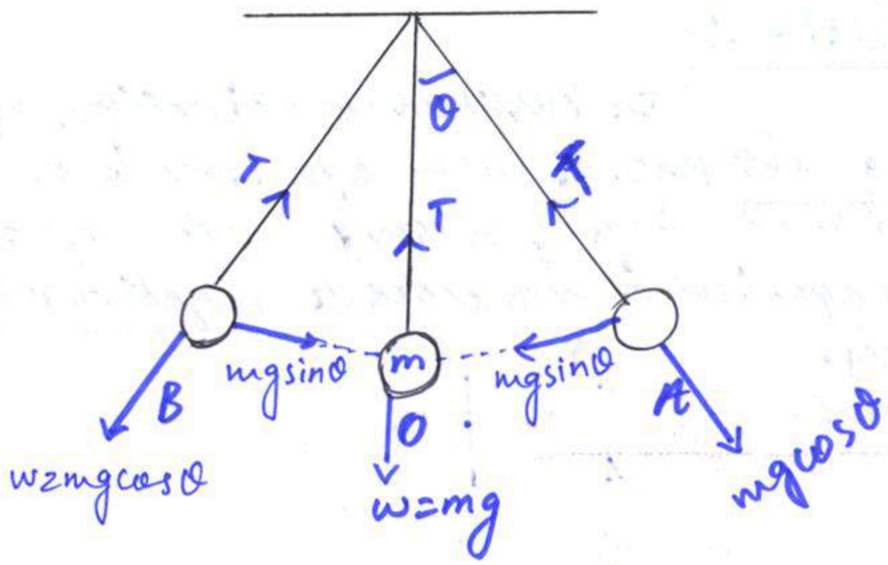
Reactions:-



(Section C)

Q. No. 3 Part (a)

(i) Forces acting on Pendulum on A & B.

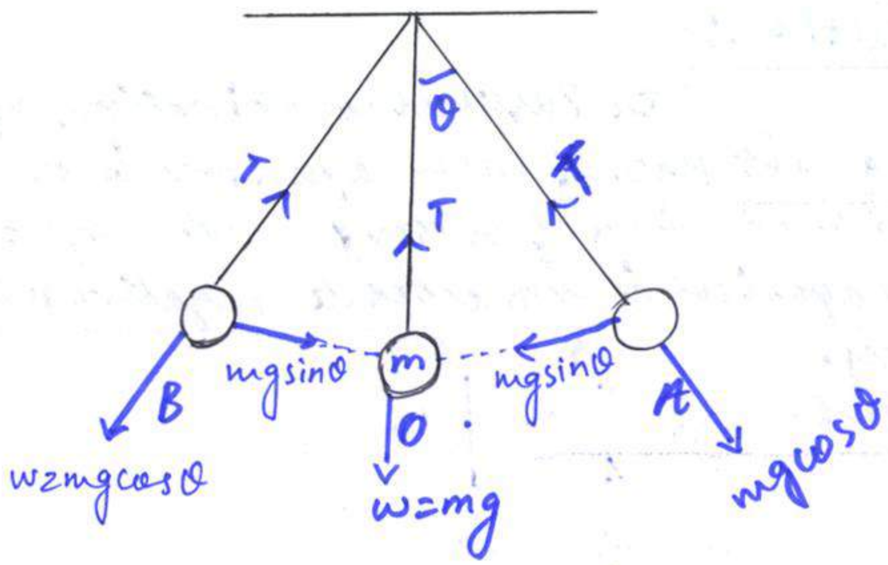


mgsinθ = restoring force acting towards mean position

(Section C)

Q. No. 3 Part (a)

(i) Forces acting on Pendulum at A & B.



mgsinθ = restoring force acting towards mean position

Q. No. 4 Part (a) (Page 1/2)

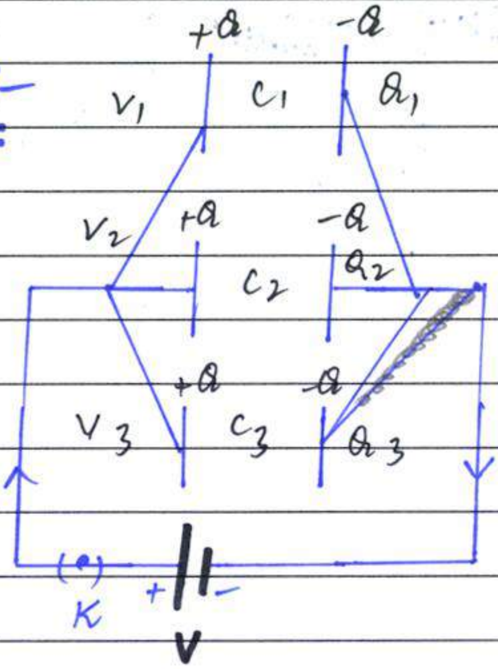
Equivalent Capacitance

Parallel Combination of Capacitors

Construction:-

In Parallel combination of capacitors, left plate of each capacitor is connected to positive terminal of battery and right plate of each capacitor is connected to negative terminal of battery.

Diagram:-



Characteristics:-

Potential Difference:-

As each capacitor is connected individually to the battery of V volts, the potential difference across each capacitor is same.

$V_1 = V_2 = V_3 = V$

Charge Storage:-

Charge stored on plates of each capacitor is different due to different values of capacitances.

$Q = Q_1 + Q_2 + Q_3$

Equivalent Capacitance:-

Total Charge of Battery:-

As the total charge Q supplied by the battery is divided among various capacitors.

Derivation:-

$$Q = Q_1 + Q_2 + Q_3$$

$$Q = CV$$

$$Q = C_1V + C_2V + C_3V$$

$$Q = V(C_1 + C_2 + C_3)$$

$$\frac{Q}{V} = C_1 + C_2 + C_3$$

We can replace the parallel combination of capacitors with one equivalent capacitor having capacitance C_{eq}.

$$C_{eq} = \frac{Q}{V}$$

$$C_{eq} = C_1 + C_2 + C_3 \quad \text{—— (i)}$$

'n' number of capacitors:- In case of 'n' number of capacitors, the equivalent capacitance is

$$C_{eq} = C_1 + C_2 + C_3 + \dots + C_n \quad \text{—— (ii)}$$

- Equivalent capacitance of parallel combination of capacitors is larger than any individual capacitances of capacitors.

Diagram on Space for diagram pg 18

Numerical Problem

Given Data

Voltage = 220V

Power of electric bulb = 100W

Time of use in hours of electric bulb = 5 hours

Required

(a) Resistance of filament = ?

(b) Energy in KWh consumed by bulb in one month = W = ?

Solution

(a) $P = \frac{QV}{t}$

$\therefore I = \frac{Q}{t}$

$P = IV$

$\therefore V = IR$

$I = \frac{V}{R}$

$P = \frac{V}{R} \times V$

$P = \frac{V^2}{R}$

$PR = V^2$

$$\boxed{R = \frac{V^2}{P}}$$

$$R = \frac{(220)^2}{100}$$

$$R = \frac{48400}{100}$$

$$R = 484\ \Omega$$

(b) Energy consumed = $\frac{\text{watt} \times \text{time of use in hours}}{1000}$

$$W = \frac{(100 \times 1) \times (5 \times 30)}{1000}$$

$$W = \frac{100 \times 150}{1000}$$

$$W = \frac{15000}{1000}$$

W = 15 kWh of energy

Result:-

(a) Resistance of filament is 484 Ω.

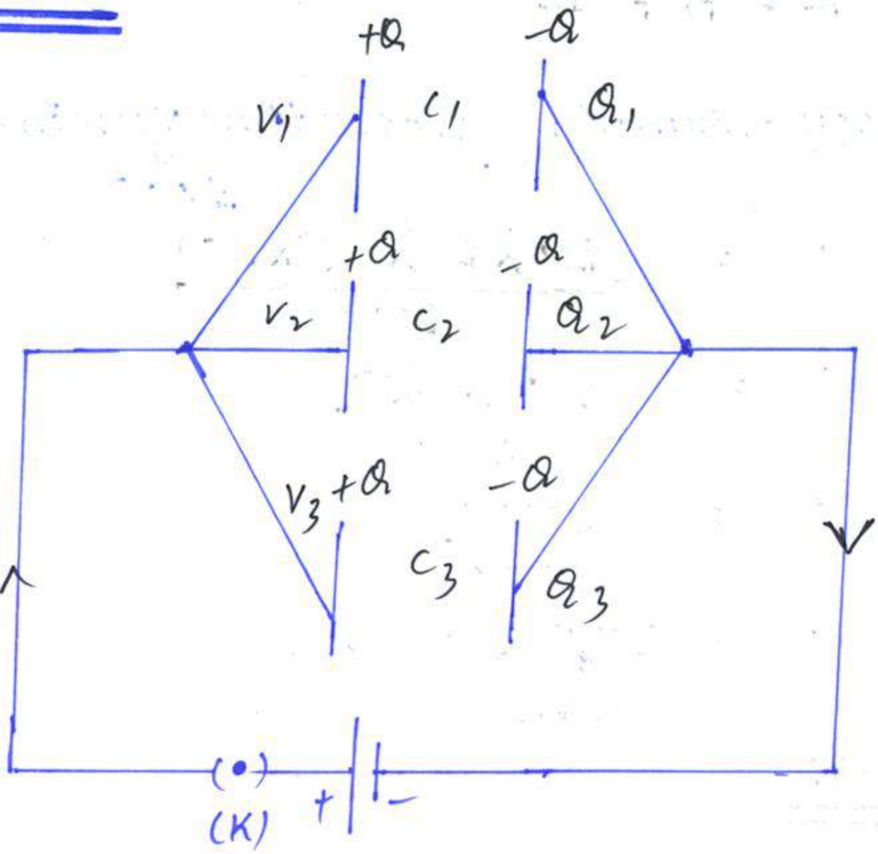
(b) Energy consumed by bulb in one month is 15 kWh of energy.

(Section C)

Q. No. 4 Part (a)

Equivalent Capacitance :-
Parallel Combination of Capacitors

Diagram:-



(Section C)

Q. No. 4 Part (a)

Equivalent Capacitance:-
Parallel Combination of Capacitors

Diagram:-