Q. No. 2 Part (i) **Data:**

distance $d = 80cm = 0.8m$

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

vibrator's frequency $f = 5Hz$

Time taken $t = ?$ (To find)

Solution:

As per wave equation;

$$v = f\lambda$$

hence, $v = 5 \times 40 \times 10^{-3} = 0.2\, ms^{-1}$

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

So, $t = \frac{0.8}{0.2} = 4secs \Rightarrow \boxed{t = 4secs}$.

Conclusion: time taken by waves will be 4secs.

Q. No. 2 Part (ii) **Waves: Transfer only energy**

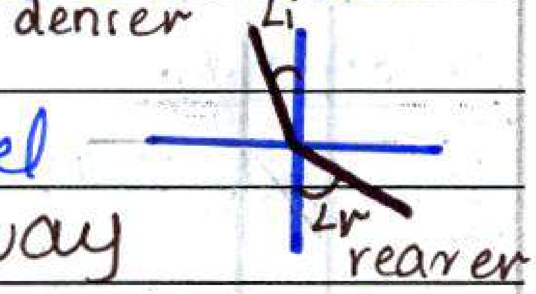
Waves; A disturbance in the medium which causes indivisual particles of medium to vibrates about their mean position in equal intervals of time is called a wave. waves transfer only energy, not matter.

Explanation;

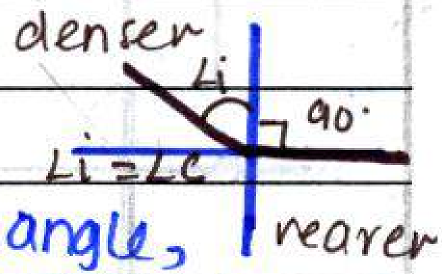
1. Take a stone and drop it in a pond of water.
2. It will cause disturbance, generating waves.
3. ~~D~~ Place a cork near the disturbance.
4. As the waves will move through it, it will vibrate, ~~bu~~ about it's mean position due to energy it gets from waves but it's net displacement will remain zero because waves donot transfer matter, they only transfer energy.

Q. No. 2 Part (V) **Total Internal Reflection**

Def: When a ray travelling from a denser to rarer medium is incident at an angle greater than the critical angle, it reflects within the denser medium. This is called total internal reflection.



Explanation: When light rays travel from denser to rearer, they bend away from the normal. As incident ∠ rises, angle of refraction increases.

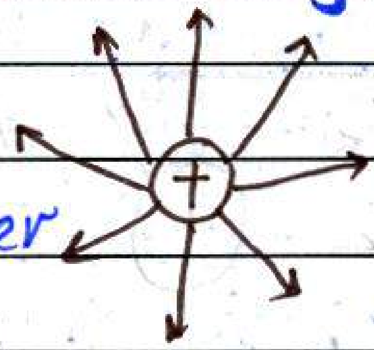


Critical Angle: For a particular incident angle, light rays bend through 90°. This critical angle.

Total Internal Reflection: When incident angle exceeds critical angle, light rays entirely reflect.

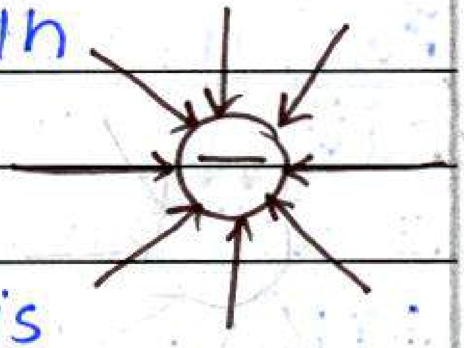
Q. No. 2 Part (vii) **Electric Feild and it's Intensity**

Electric Feild



Def; The region around a charge within which it exerts a force on another charge is called it's electric feild.

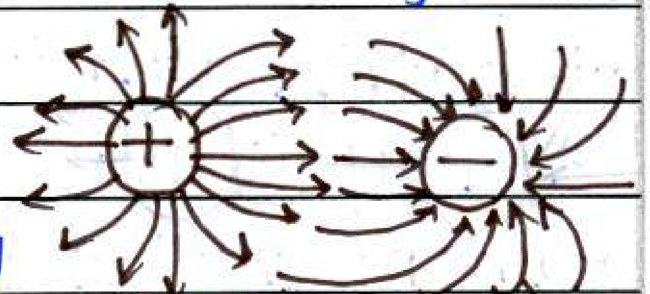
Electric Feild Nature; It possesses both magnitude and direction.



Electric Feild Intensity;

Def; Electric feild Intensity at a point is equal to force exerted on a unit positive charge placed at that point. That is;

$E = F/q$ "OR" $F = qE$



(Electric Feild)

Intensity is shown by lines called electric feild lines which move from +ve to -ve charge.

Q. No. 2 Part (X) **Data;**

Time t = 40 secs

Energy W = 2400 J

To find;

Power P = ?

Solution;

As know,

$$\text{Power} = \frac{\text{Work done}}{\text{time taken}}$$

hence,

$$P = \frac{W}{t} = \frac{2400}{40} = 60\ W$$

Conclusion; hence power of light bulb is 60 W.

Q. No. 2 Part (xii) **Magnitude of Induced EMF Dependent Factor;**

EMF induced in a current carrying coil depends upon several factors including;

(I)- Strength of Magnetic feild applied. the greater the magnetic feild, greater will be the force acting on the conductor. consequently, greater emf induced.

(II)- Number of turns of the coil.

(III)- Speed of relative motion between coil and the magnet.

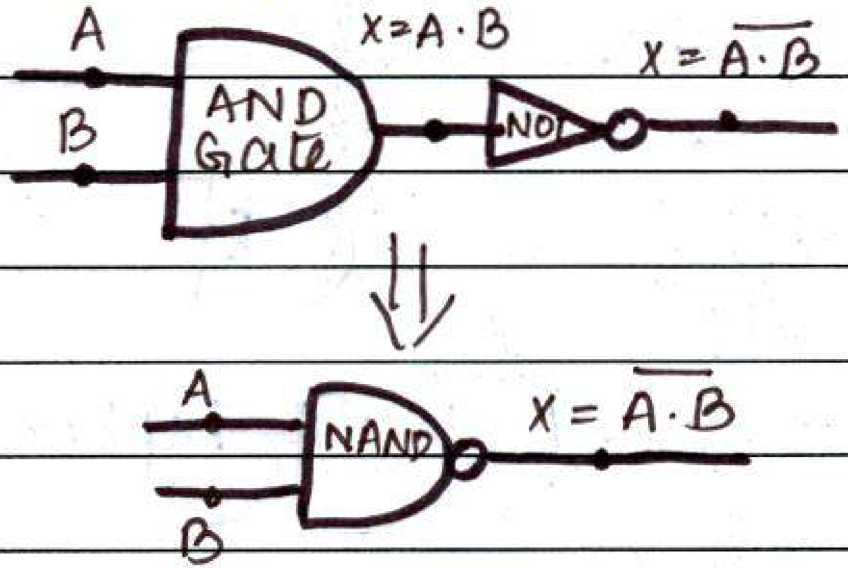
Hence, the greater the rate of change of magnetic of magnetic flux, greater induced emf.

Q. No. 2 Part (xiii) **NAND Gate**

"The gate formed by coupling NOT gate to the output terminal of AND Gate is called NAND Gate."

Boolean Expression and symbols:

AND gates gives an output of $X = A \cdot B$. NOT gate, also called invertor, inverts the output. so it becomes, $X = \overline{A \cdot B}$. (X equals A ANB NOT).



TRUTH TABLE:-

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

Q. No. 2 Part (xiv) **Use of Optical Fibres in Communication**

Reasons;

Optical fibres is used for communication because;

(1)- In optical fibres, information travels in the form of light which has a fast speed of $3 \times 10^8 \, ms^{-1}$ (air). So, communication is quick.

(2)- Rate of signal loss ~~or~~ is low.

(3). Information can be sent at higher data rates. Relative to radiowaves or wires, in optical fibres, if information is sent at higher data rates, rate of signal loss is low. so, quality of signal is mantained.

Q. No. 2 Part (XV) **Half-Life**

Data;

Half life of cobalt-60 = 5.25 years. ($T_{1/2}$)

Time period = 26 years.

To find;

Sample left = ?

Sol; let original sample be N_o.

after $1T_{1/2} = \frac{1}{2}N_o$ (5.25yrs)

after $2T_{1/2}$ (10.5yrs) $= \frac{1}{4}N_o$

after $3T_{1/2}$ (15.75yrs) $= \frac{1}{4} \times \frac{1}{2} = \frac{1}{8}N_o$

after $4T_{1/2}$ (21yrs) $= 1/8 \times 1/2 = 1/16\,N_o$

$= 0.0625\,N_o$

sample will be $0.0625N_o$ after 21years and after another halflife, it'll be nearly 0.03125 of N_o.

after $5T_{1/2}$ (26.25yrs) $= 1/16 \times 1/2 = 1/32\,N_o = 0.03125\,N_o$

Q. No. 2 Part (iii) **Sound by a Simple Pendulum**

Human ear can not hear sound produced by a simple pendulum because simple pendulums produce sounds of very small frequencies which are way too small for human ear to listen to.

Audible Frequency Range:

"The range of frequencies within which a human ear can hear is called the audible frequency range."

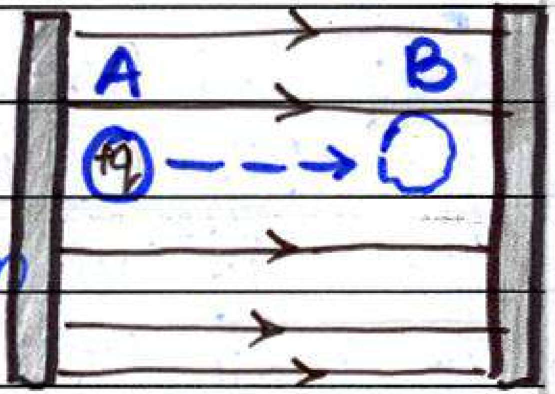
For humans this range is **20 Hz - 20,000 Hz**

In contrast, simple pendulums frequency is very low. It is way below 20 Hz in most cases. Hence, inaudible to human ear.

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

Def; The energy ~~tranfferred~~ supplied by a charge as it moves from one point to another in the direction of the feild is equal to the potential difference between the two points.

Proof; Consider two points A and B where A is at higher potential and B is at lower potential. If a charge q is released in the feild it moves from A to B. The potential energies at A and B are given by $V_a = qV_a$ and $V_b = qV_b$ respectively. Difference in energies is $= q(V_a - V_b)$. This energy is utilized in doing useful work. If q is 1 Coulomb, then difference in potential is equal to energy supplied



Q. No. 2 Part (iv) **Speed of Sound**

Speed of sound depends on various factors like temperature, pressure humidity etc.

for dry gas, at 1 atm pressure;

$$v = 331\ ms^{-1}$$

Per degree rise in temperature, velocity increases by $0.6 ms^{-1}$.

hence velocity at any temperature is calculated by;

$$V = 331 + 0.6T$$

At −20°C (air);

$$v = 331 + 0.6(-20)$$

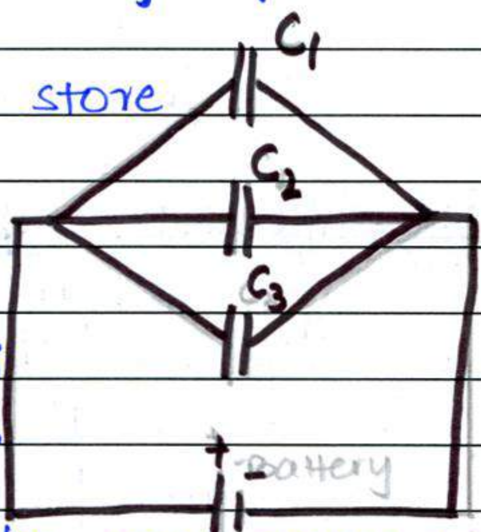
$$\boxed{v = 319\ ms^{-1}}$$

CAPACITOR

Parallel Combination of Capacitors

Capacitor;

Def; A device used to store charge is called a capacitor.



Parallel combination;

consider three capacitors, C_1, C_2 and C_3 ~~is~~ which are connected parallel to each other to a battery supplying V voltas.

VOLTAGE:- One plate to each capacitor is connected to positive terminal of the battery while the other plate of each capacitor is connected to negative ~~plate~~ terminal of ~~each~~ the battery. Hence voltage through the circuit is the same. i.e;

$$V = V_1 = V_2 = V_3 .$$

CHARGE:- The charge across each capacitor varies as it depends upon the capacitance of each capacitor. Hence-forth, total charge Q supplied by the battery is distributed among the capacitors. So,

$$Q = Q_1 + Q_2 + Q_3$$

as,

$$Q = CV$$

hence,

$$Q = C_1V + C_2V + C_3V$$

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

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

Equivalent capacitance:

All the capacitors in the circuit can be replaced by a single capacitor with equivalent capacitance equal to the sum of indivisual capacitances. That is;

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

or

$$\boxed{C_{eq} = C_1 + C_2 + C_3 \cdots C_n}$$

where "n" is the number of capacitors.

As indivisual capacitances will increase, equivalent capacitances will also increase.

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

Data;

Voltage $V = 220V$
Power $P = 100W$
Time period t used = 5 hours daily
Total time period = 1 month (30 days).

To find;

(i) energy used in kWHr = ?
(ii) resistance in bulb's filament $R = ?$

Solution;

(ii)- $P = IV$

by ohm's law, $V = IR$

hence,

$$P = I^2R \quad \text{or} \quad P = \frac{V^2}{R}$$

So,

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

$$R = \frac{(220)^2}{(100)} = \frac{48400}{100}$$

So, $\boxed{R = 484\,\Omega}$

Now,

(i)- energy consumed (kW-Hr) $= \dfrac{\text{watts} \times \text{hours used}}{1000}$

henceforth,

energy consumed in 1 day (5hr/daily) $= \dfrac{100 \times 5}{1000}$

$= 0.5$ KWHr

Since the bulb is used for 30 days

hence,

$\boxed{\text{energy used} = 30(0.5) = 15\text{KWHr.}}$

Conclusion:

→ Resistance in the filament is 484 Ω.

→ energy consumed by bulb in a month is 15 kWHr.

•———•

(Section C)

Q. No. Part ( )

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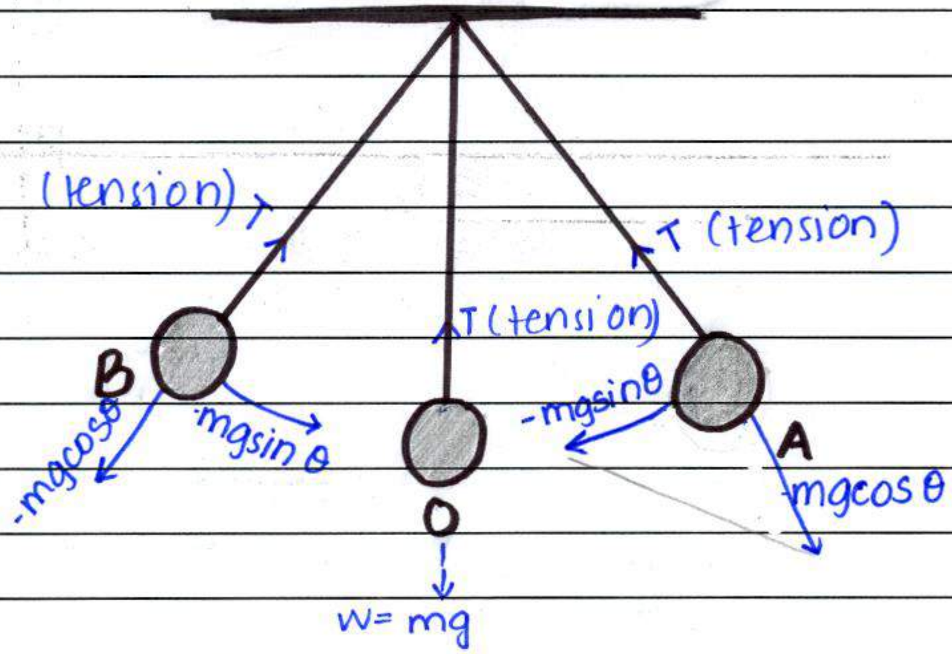
Q. No. Part ( )

"Motion of a Simple Pendulum"

(i)-



Initially, mass m is at rest at mean position O. Net force acting on it is 0 as weight mg in a downward direction cancels tension T in an upward direction in the string.

At A and B, components of the weight mgsinθ and mgcosθ act as shown.

(ii)- **A**:- When the mass is at A, component of the weight mgsinθ acts as the restoring force. No force acts on the mass along the length of the string because tension T cancels component of weight mgcosθ.

Since, mgsin θ pulls mass back towards means position, hence it is the restoring force.

B:- Similarly, at B, mgsinθ acts as the restoring force. component of the weight mgcosθ and Tension T in the string cancel eachother.

(iii)- Velocity of bob at extreme position A.

One of the features of simple Harmonic Motion as exhibitted by the pendulum is that acceleration is always directly proportional to displacement from mean position and is directed to mean position. ~~Hence it is maximum at~~ With respect to that, velocity is maximum at mean position and minimum at extreme points.

explanation;

As the mass m moves from O to A, restoring force comes into action and pulls the mass towards it's mean position. Hence, velocity decreases over time and eventually becomes zero (0) at A.

Similarly velocity will be zero at B but at O it will be maximum.

This is because as mass moves from A to O, restoring force reduces in strength and eventually becomes zero at O but due to inertia, mass gains maximum speeds at O and continues motion.

Fission: Chain Reaction

Fission Reaction;

Def;

The process in which a heavy nucleus splits into two smaller nuclei with the ~~emiss~~ release of energy is called fission reaction.

Process;

A heavy uranium atom (U-235) is bombarded with a slow-moving neutron (slow-energy). Consequently, U-235 splits into two nearly equal nuclei. Generally,

$${}_{0}^{1}n + {}_{92}^{235}U \longrightarrow {}_{92}^{236}U^{*} \longrightarrow Y + X + \text{energy} + 3\,{}_{0}^{1}n$$

(Kindly refer to diagram ahead)

${}_{92}^{236}U^{*}$ is an intermediate state that lasts for a few fraction of a second before splitting.

Fission of Uranium proceeds as;

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

Production of Energy;

~~It~~ The two daughter nuclei formed are collectively less in mass than uranium (U-235). As per Einstein's mass-energy equation, $E = mc^2$, this loss of mass is converted to energy. Per fission event, on average, 2.47 neutrons and 200 MeV of energy is released where,

$$1\,eV = 1.6 \times 10^{-19}\,J$$

(eV is the unit of energy used in nuclear and atomic physics.)

Chain Reaction and it's Hazards:

Per fission event, 3 neutrons are emitted. These neutrons can in turn trigger other uranium-235 atoms to undergo fission. So, there is a possibility for a chain reaction to occur. (Kindly refer to diagram ahead)

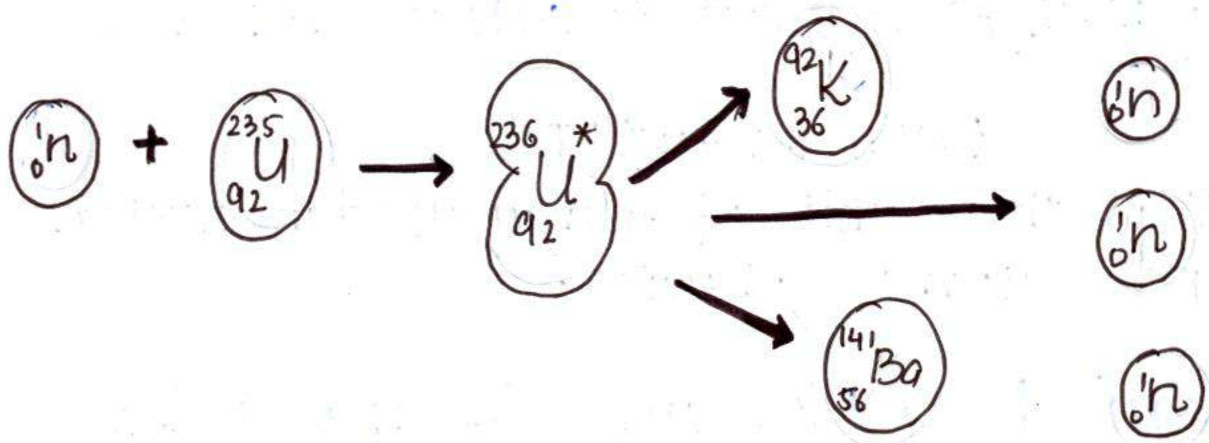
Calculation shows that if chain reaction proceeds uncontrolled, it will result in production of an excessive amount of energy. This can lead to explosions.

Use of Nuclear Reactors;

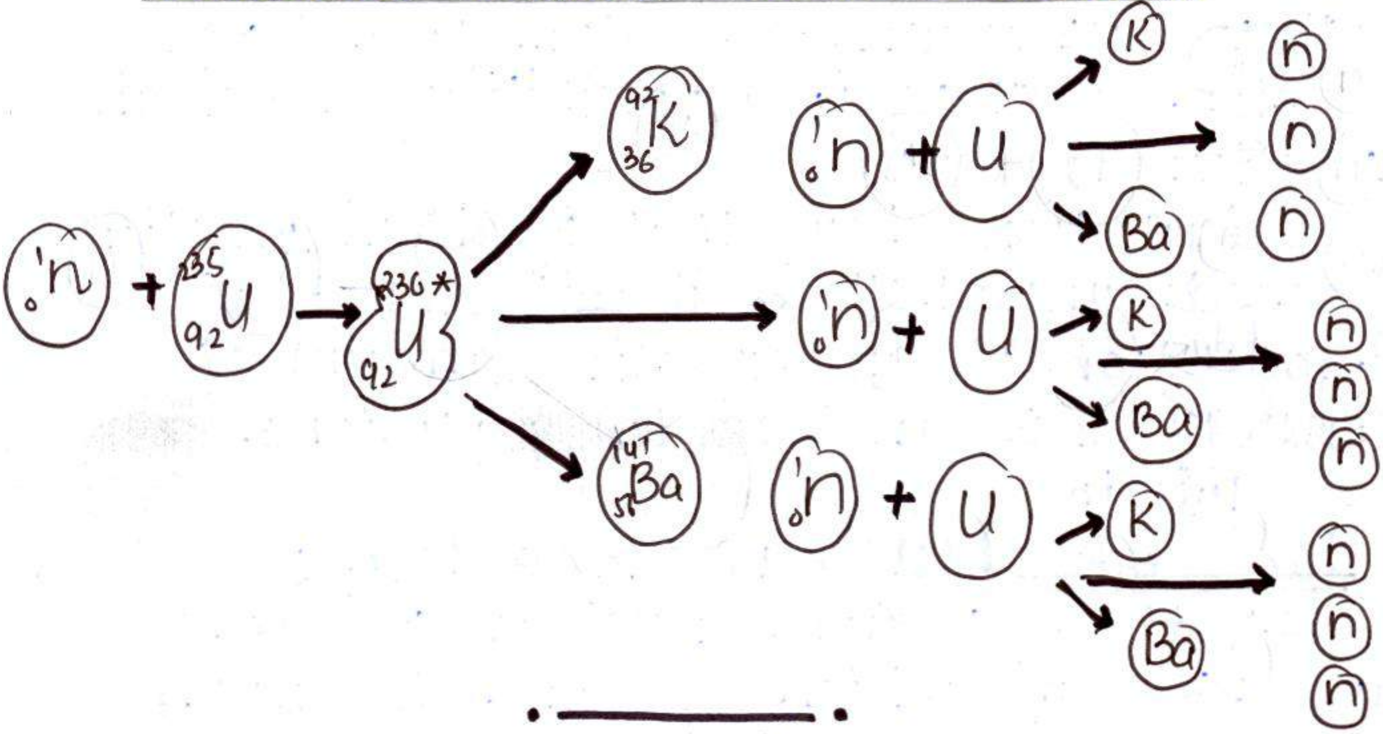
For this reason, nuclear reactors are used in which a control fission reaction proceeds. Nuclear Reactors absorb extra neutrons to slow down the fission process and prevent explosions.

Q. No. 3 Part (b)

A Nuclear Fission Event:-

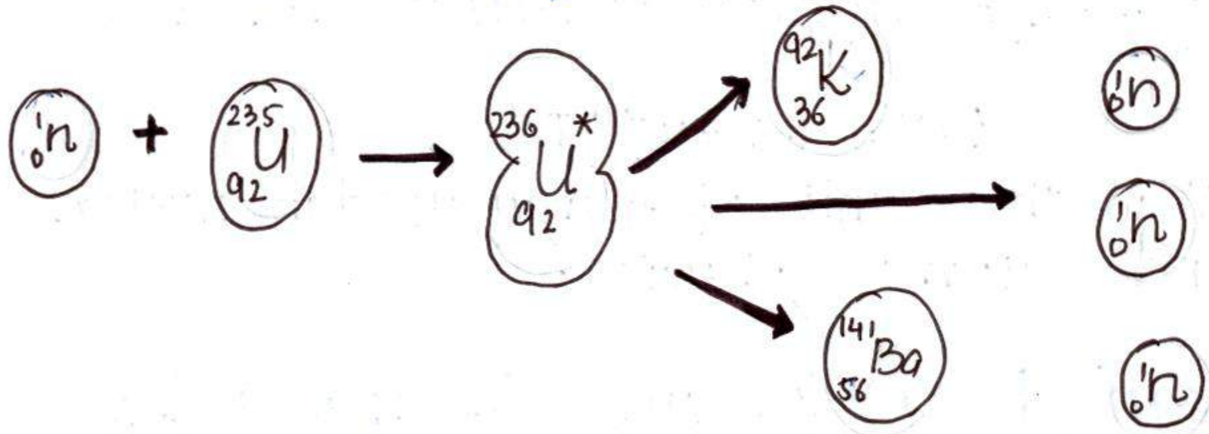


Nuclear Fission Chain Reaction:-



Q. No. 3 Part (b)

A Nuclear Fission Event:-



Nuclear Fission Chain Reaction:-