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B.Sc. Part - II (Hons)

Modern Physics

of lines of force.

B.Sc- III Part II

May 2020

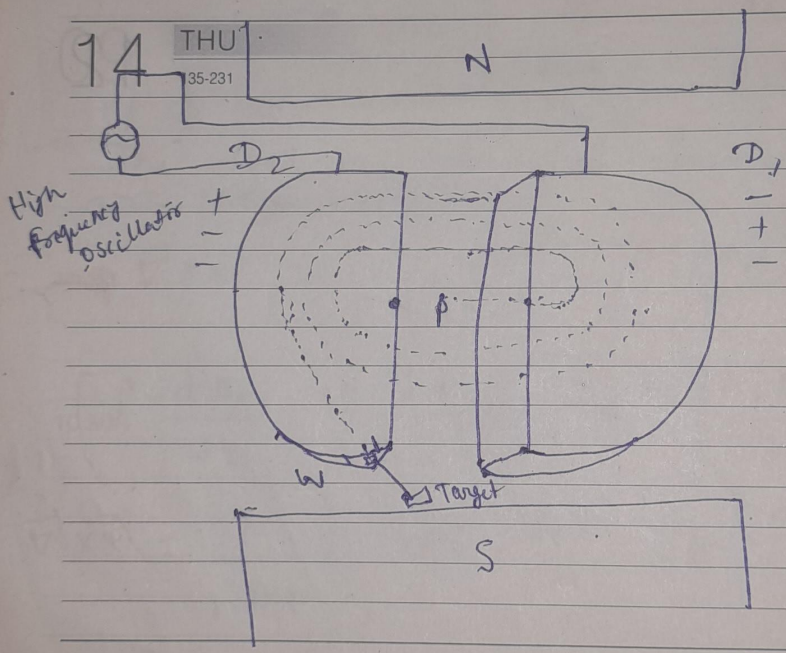
13 WED
134-232

Cyclotron :- It is a device which is used to accelerate positively charged particle.

Principle :- It is based on the fact that a charged particle can be accelerate to a sufficient high energy by oscillating Electric field and Uniform magnetic field.

Construction :- It consist of a magnet represented by N & S where N is north pole and S is south pole as shown in fig

14 THU
35-231



between the two poles, two hollow metallic dees are placed which are connected to high frequency oscillator between these dees, a positively charged particle is placed and there is a window W, through which the charged particle comes out.

working :- At any instant, let us consider D_1 to be negative and D_2 to be positive due to this positively charged particle will be attracted towards D_1.

Now charged particle enter inside D_1 and inside D_1, there is no electric field, only Perpendicular Magnetic field exist. As the charged particle is entering in uniform Mag. F its motion becomes circular. As it covers a semicircle, Dees changes their polarity i.e. D_2 becomes -ve. where as D_1 become +ve.

In this way charged particle enter inside D_2 & cover a semicircle. In that way process is continue till it reaches to its Max speed & come outside from window to hit the target.

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May 2020

18 MON 139-227

Radius of circular Path

→ force experience by charged partid in uniform M.F

$$F = qBV \sin\theta$$

$$F = qBV \sin 90^\circ \qquad \theta = 90^\circ$$

$$F = qBV \quad — (1)$$

the necessary centripetal force is given by

$$F = \frac{mv^2}{r} \quad — (2)$$

Compare (1) & (2)

19 TUE 140-226

$$qBV = \frac{mv^2}{r}$$

$$r = \frac{mv}{qB} \quad — (3)$$

from here

$$r \propto v$$

It is the radius of semi circle covered by the charge particle.

Time taken to cover a semi circle

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

WED 20
141-225

$$t = \frac{\pi r}{v}$$

Put $q_n - 3$

$$t = \frac{\pi}{v} \times \frac{mv}{qB}$$

$$\boxed{t = \frac{\pi m}{qB}}$$

Time is constant as $r \propto v$

Total time to complete one circle

$$T = 2t$$

THU 21
142-224

$$\boxed{T = \frac{2\pi m}{qB}}$$

Cyclotron frequency $\nu = \frac{1}{T}$

$$\nu = \frac{qB}{2\pi m}$$

Angular fre. $\omega = 2\pi\nu$ (eq 2)

$$= 2\pi \frac{qB}{2\pi m}$$

$$= \frac{qB}{m}$$

June 2020

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

of lines of force.
Scalar

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May 2020

22 FRI Uses → ① To study Nuclear reaction
(2) To insert an ion in a solid
(3) Used to start radioactive decay.

Kinetic Energy $KE = \frac{1}{2} m v^2$

From eq (3) $r = \frac{mv}{qB}$

$$\frac{rqB}{m} = v$$

$$K.E = \frac{1}{2} m \left(\frac{rqB}{m}\right)^2$$

23 SAT 144-222

$$= \frac{1}{2} \frac{r^2 q^2 B^2}{m}$$

$$\boxed{K.E = \frac{1}{2} \frac{r^2 q^2 B^2}{m}}$$

$$KE = \frac{1}{2} m v_0^2$$

$$r_0 = \frac{m v_0}{qB}$$

24 SUN

$$\frac{r_0 qB}{m} = v_0$$

$$KE = \frac{1}{2} m \left(\frac{r_0 qB}{m}\right)^2$$

$$= \frac{1}{2} \frac{r_0^2 q^2 B^2}{m}$$

May 2020

Su	Mo	Tu	We	Th	Fr	Sa
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

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Max K.E $= \frac{1}{2} \frac{r_0^2 q^2 B^2}{m}$

Resonance condition :- The time taken by the charge particle to cover a semicircle is equal to the time to change the polarities of dees than resonance is said to be occur & cyclotron work.

limitation of cyclotron

1. It can not be used to accelerate neutral particles like Neutron.

2. Its can not be accelerated using cyclotron because there acceleration is high & it goes out of step very early.

TUE 26

3. Positively charged particle also can not be accelerated using cyclotron beyond certain limit because as velocity increases mass is also increased by relation.

$m_0 = 50$

$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$

So time period of semicircle is also increased & synchronization is cut out & cyclotron stop working

$v^2 = 0.84$

June 2020

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$\frac{50}{0.4} = \frac{50 \times 10}{4} = 125$