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CYCLOTRON

Sol-1 given that magnetic flux density(B) = 3 Wb/m²
charge of duotron = 1.602×10^{-19} C
mass of deutron = 3.34×10^{-27} kg

As we frequency of cyclotron

$$f = \frac{1}{T} = \frac{qB}{2\pi m} = \frac{1.602 \times 10^{-19} \times 3}{3.34 \times 10^{-27} \times 3.4 \times 2}$$

$$f = 0.2911.60 \times 10^{8} \text{ sec}^{-1}$$

$$\boxed{f = 2.116 \times 10^{7} / \text{sec}}$$

Sol-2 flux density = 0.7 wb/m²
$q = 1.602 \times 10^{-19}$ C
mass (m) = 3.34×10^{-27} kg

$$f = \frac{qB}{2\pi m} = \frac{1.602 \times 10^{-19} \times 0.7}{3.34 \times 10^{27} \times 3.14 \times 2}$$

$$= 0.05346 \times 10^{8}$$

$$\boxed{f = 5.346 \times 10^{6} \text{ Hz}}$$

Sol-3 Given that radius of dee = 0.6 m
magnetic field B = 0.8 T
potential difference (ΔV) = 75 kV
f = ?

(a) $$f = \frac{qB}{2\pi m} = \frac{1.602 \times 10^{-19} \times 0.8}{2 \times 3.14 \times 1.67 \times 10^{-27}} = 0.1222 \times 10^{8}$$ H

Sol - 3 (b) Given that frequency = 12×10^6 cycle/sec.
radius of dees = 0.304 m

As we know maximum kinetic energy of particle in cyclotron will be

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

$$= \frac{1}{2} \times \frac{(1.602 \times 10^{-19} \times 0.8 \times 0.6)^2}{1.67 \times 10^{-27}}$$

$$\boxed{KE = 0.177035 \times 10^{-11} \text{ J}}$$

Sol - 4 frequency $(1/T) = 12 \times 10^6$ cycle/sec
radius of dee = 0.304 m
B = ?
E = ?
mass of deutron = 3.3×10^{-27} kg

As we know the formula of frequency

$$f = 12 \times 10^6 = \frac{qB}{2\pi m} = \frac{1.602 \times 10^{-19} \times B}{2 \times 3.14 \times 3.3 \times 10^{-27}}$$

$$B = \frac{12 \times 10^6 \times 2 \times 3.14 \times 3.3 \times 10^{-27}}{1.602 \times 10^{-19}}$$

$$\boxed{B = 1.5711 \text{ T}}$$

4 (b) As we have formula of Energy of particle in cyclotron

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

$$= \frac{1}{2} \times \frac{(1.602 \times 10^{-19} \times 1.5711 \times 0.3048)^2}{3.3 \times 10^{-27}}$$

$$\boxed{E = 0.08916 \times 10^{-11} \text{ J}}$$

Sol-5 (a) radius of dee = 0.32 m

magnetic field (B) = 6500 guass = 0.65 T

Velocity = ?

mass of proton = 1.67×10^{-27} kg

$$v = \frac{qrB}{m} = \frac{1.602 \times 10^{-19} \times 0.32 \times 0.65}{1.67 \times 10^{-27}}$$

$$\boxed{v = 0.1995 \times 10^{8} \text{ m/s}}$$

(b) Energy of proton = ?

as we have

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

$$= \frac{1}{2} \times \frac{(1.602 \times 10^{-19} \times 0.32 \times 0.65)^2}{1.67 \times 10^{-27}}$$

$$E = 0.03324 \times 10^{-11} \text{ J}$$

$$= 0.020 \times 10^{8} \text{ eV} = \underline{2 \text{ MeV}}$$

(c) frequency = $f = \frac{qB}{2\pi m}$

Here q of proton = 1.602×10^{-19}

B (magnetic field) = 0.65 T

$m = 1.67 \times 10^{-27}$ kg

$f = \frac{1.602 \times 10^{-19} \times 0.65}{2 \times 3.14 \times 1.67 \times 10^{-27}}$

$\boxed{f = 0.09928 \times 10^{8} = 9.928 \times 10^{6} \text{ Hz}}$

Sol → 6 Given that frequency = 10 M cycle/sec

radius of dee = 0.32m

flux density of magnetic field B = ?

velocity of deutron = ?

mass of deutron = 3.34×10^{-27} kg

B = ? charge of deutron = 1.602×10^{-19} C

(a) $f = \frac{qB}{2\pi m}$

$B = \frac{10^{7} \times 2 \times 3.14 \times 3.34 \times 10^{-27}}{1.602 \times 10^{-19}}$

$\boxed{B = 1.3093 \text{ T}}$

(b) Velocity = ?

$V = \frac{qrB}{m} = \frac{1.602 \times 10^{-19} \times 0.32 \times 1.3}{3.34 \times 10^{-27}}$

$\boxed{V = 0.1995 \times 10^{8} \text{ m/s}}$

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(21) As given in question that

magnetic field $B = 1.5\ Wb/m^2$

radius of dee/extraction = 0.5 m

mass and charge of deutron are 3.34×10^{-27} kg, 1.602×10^{-19} C

frequency of particle $f = \frac{qB}{2\pi m}$

$$f = \frac{1.602 \times 10^{-19} \times 1.5}{2 \times 3.14 \times 3.34 \times 10^{-27}}$$

$$= 0.1145 \times 10^{+8}\ Hz$$

$$\boxed{f = 1.145 \times 10^{7}\ Hz}$$

Energy of deutron = ?

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

$$= \frac{1}{2} \times \frac{(1.6 \times 10^{-19} \times 1.5 \times 0.5)^2}{3.34 \times 10^{-27}}$$

$$\boxed{E = 0.2155 \times 10^{-11}\ J}$$