Problem 29.24

a.) The cyclotron "speed" is actually its *angular frequency*, or the number of radians swept out per unit time. It is such that

$$\omega = \frac{v}{r}$$

We can use the magnetic force relationship to determine this "v/r" quantity by writing:

$$qvB\sin 90° = m\frac{v^2}{r}$$

$$\Rightarrow \quad \frac{v}{r} = \frac{qB}{m}$$

$$= \frac{\left(1.6\text{x}10^{-19} \text{ C}\right)\left(.45 \text{ T}\right)}{\left(1.67\text{x}10^{-27} \text{ kg}\right)}$$

$$= 4.31\text{x}10^{7} \text{ radians/second}$$

b.) Knowing the "speed" relationship and the arc radius (hence the number of meters per radian), we can write:

$$v = r\omega$$

$$= \left(1.2 \text{ m/radian}\right)\left(4.31\text{x}10^{7} \text{ radians/sec}\right)$$

$$= 5.17\text{x}10^{7} \text{ m/s}$$