Work 1

Thaseus Karkabe-Olson

Problem 5.2

From example 5.2 we know that our equations of motion are

$$y(t) = C_1 Cos(\omega t) + C_2 Sin(\omega t) + \frac{E}{B}t + C_3$$
$$z(t) = C_2 Cos(\omega t) - C1 Sin(\omega t) + C_4$$

where

$$\omega = \frac{QB}{m}$$

Part b

We then know

$$\underline{\mathrm{x}}_0 = 0 \text{ and } \underline{\mathrm{v}}_0 = \frac{E}{2B}\hat{y}$$

We can put in our initial conditions to get

$$0 = C_1 Cos(\omega t) + C_2 Sin(\omega t) + \frac{E}{B}t + C_3$$
$$0 = C_2 Cos(\omega t) - C1 Sin(\omega t) + C_4$$
$$\frac{E}{2B} = -C_1 \omega Sin(\omega t) + C_2 \omega Cos(\omega t) + \frac{E}{B}$$
$$0 = -C_1 \omega Cos(\omega t) - C_2 \omega Sin(\omega t)$$

Back to my favourite program to find the constants

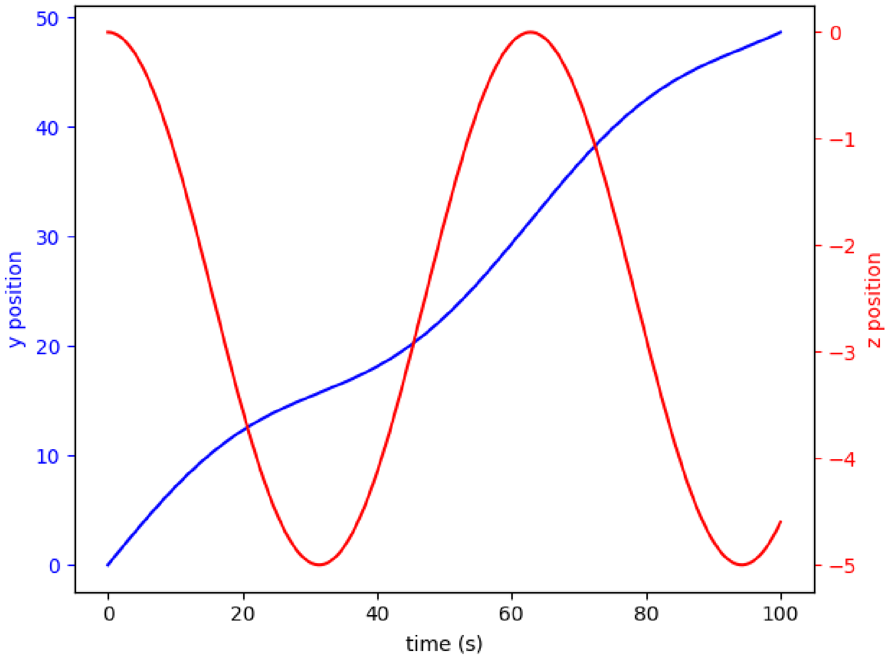
$$\text{Input: FullSimplify}\left[\text{RowReduce}\left[\begin{pmatrix} \cos(0) & \sin(0) & 1 & 0 & 0 \\ -\sin(0) & \cos(0) & 0 & 1 & 0 \\ -\omega\sin(0) & \omega\cos(0) & 0 & 0 & \frac{e}{2B} \\ -\omega\cos(0) & -\omega\sin(0) & 0 & 0 & 0 \end{pmatrix}\right]\right]$$

$$\text{Output: } \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & \frac{e}{2B\omega} \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & -\frac{e}{2B\omega} \end{pmatrix}$$

After simplifying, it turns out that our equations of motion are

$$y(t) = \frac{E(2t\omega + \sin(t\omega))}{2B\omega}$$
$$z(t) = \frac{E(\cos(t\omega) - 1)}{2B\omega}$$

Using some sample numbers and running these equations in python, we get the following behaviour



From this we can conclude that there is no motion in the x direction, that the particle follows an almost linear path in the y direction, and that it spins in a circle in the z direction

Part c

We then know

$$\underline{x}_0 = 0 \text{ and } \underline{v}_0 = \frac{E}{2B}\hat{y}$$

We can put in our initial conditions to get

$$0 = C_1 Cos(\omega t) + C_2 Sin(\omega t) + \frac{E}{B}t + C_3$$
$$0 = C_2 Cos(\omega t) - C1 Sin(\omega t) + C_4$$
$$\frac{E}{2B} = -C_1 \omega Sin(\omega t) + C_2 \omega Cos(\omega t) + \frac{E}{B}$$
$$0 = -C_1 \omega Cos(\omega t) - C_2 \omega Sin(\omega t)$$