1 | **Coffee Cup**

We start off with an acceleration vector function:

$$\vec{a}(t) = \begin{bmatrix} -3\cos(t) \\ -2\sin(t) \\ 0 \end{bmatrix}$$

We can integrate this with respect to t to get velocity:

$$\begin{aligned} \vec{v}(t) &= \int \vec{a}(t)\,dt \\ &= \begin{bmatrix} -3\sin(t) + C_1 \\ 2\cos(t) + C_2 \\ C_3 \end{bmatrix} \end{aligned}$$

We know the values of $\vec{v}(0)$, so we know the values of C:

$$\vec{v}(t) = \begin{bmatrix} -3\sin(t) \\ 2\cos(t) + 0.1 \\ 1 \end{bmatrix}$$

We can integrate this again for a position function:

$$\begin{aligned} \vec{p}(t) &= \int \vec{v}(t)\,dt \\ &= \begin{bmatrix} 3\cos(t) + C_1 \\ 2\sin(t) + \frac{t}{10} + C_2 \\ t + C_3 \end{bmatrix} \end{aligned}$$

Again, we can plug in values for C:

$$\vec{p}(t) = \begin{bmatrix} 3\cos(t) \\ 2\sin(t) + \frac{t}{10} \\ t + 12 \end{bmatrix}$$

2 | **R2 -> R2**

We need to think of a way to find the maximum/minimum of h:

$$h(x,y) = (x^2 - 2y + 7)\hat{i} + (x^2 + y^2)\hat{j}$$

We can conceptualize the maximum/minimum of a function with a vector as its range as the point at which the magnitude of the vector is the greatest/smallest. Therefore, we only need to find the maximum/minimum of the following function:

$$h_m(x,y) = \sqrt{(x^2 - 2y + 7)^2 + (x^2 + y^2)^2}$$

This seems like a pain so I won't actually do it but good luck with it