St John Baptist De La Salle Catholic School, Addis Ababa

Grade 11 Physics Quiz

2^{nd} Quarter

December 20, 2023

Time Allowed: 30 minutes

Problems

1. (2 points) A point-like object is constrained to travel in a circle. The z-component of the angular acceleration of the object for the time interval $[0, 3]$ is given by the function

$$\alpha_z(t) = \begin{cases} 2\left(1 - \dfrac{t}{3}\right); 0 \leq t \leq t_1 \\ 0; t > t_1 \end{cases}$$

   where b is a positive constant with units rad/s^2

   (a) Determine an expression for the angular velocity of the object at $t = 3$.

   (b) Through what angle has the object rotated at time $t = 3$.

2. (3 points) A particle is moving in a circle of radius R. At $t = 0$, it is located on the x -axis. The angle the particle makes with the positive x -axis is given by $\theta(t) = 5t^3 - 3t$. Determine

   (a) the velocity vector, and

   (b) the acceleration vector.

   (c) Express your answer in polar coordinates. At what time is the centripetal acceleration zero?

BONUS

3. (1 point) A particle moves outward along a spiral starting from the origin at $t = 0$. Its trajectory is given by $r = b\theta$ where b is a positive constant with units $[m \cdot rad^{-1}] \cdot \theta$ increases in time according to $\theta = ct^2$, where $c > 0$ is a positive constant (with units $[rad \cdot s^{-2}]$)

   (a) Determine the acceleration as a function of time.

   (b) Determine the time at which the radial acceleration is zero.

   (c) What is the angle when the radial acceleration is zero?

   (d) Determine the time at which the radial and tangential accelerations have equal magnitude.