MEC3705 – DYNAMICS

KINEMATICS OF PARTICLES

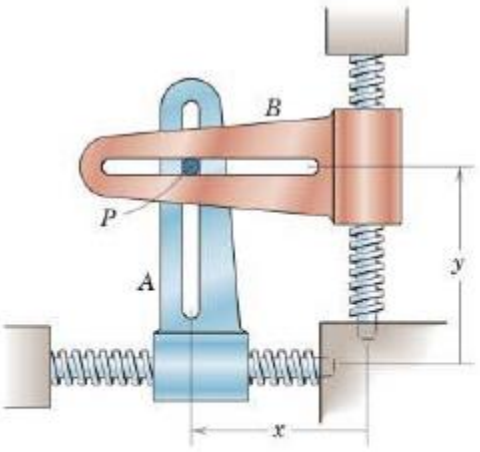
- **PLANE MOTION**

ASSIGNMENT 2 : Due: Thursday 29th July, 2021

INSTRUCTIONS: Please show your working clearly and use the SI units for all your calculations.

Question 1

2/66 The x- and y-motions of guides A and B with right-angle slots control the curvilinear motion of the connecting pin P, which slides in both slots. For a short interval, the motions are governed by $x = 20 + \frac{1}{4}t^2$ and $y = 15 - \frac{1}{6}t^3$, where x and y are in millimeters and t is in seconds. Calculate the magnitudes of the velocity $\mathbf{v}$ and acceleration $\mathbf{a}$ of the pin for $t = 2$ s. Sketch the direction of the path and indicate its curvature for this instant.



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Question 2

2/67 The position vector of a point which moves in the x-y plane is given by

$$\mathbf{r} = \left(\frac{2}{3}t^3 - \frac{3}{2}t^2\right)\mathbf{i} + \frac{t^4}{12}\mathbf{j}$$

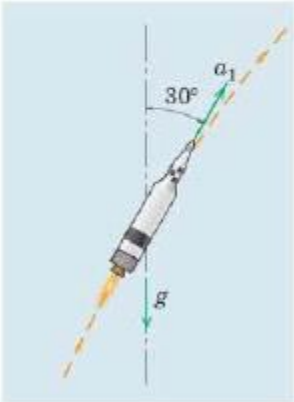
where $\mathbf{r}$ is in meters and t is in seconds. Determine the angle between the velocity $\mathbf{v}$ and the acceleration $\mathbf{a}$ when (a) $t = 2$ s and (b) $t = 3$ s.

Ans. (a) $\theta = 14.47°$, (b) $\theta = 0$

Question 3

2/119 A rocket traveling above the atmosphere at an altitude of 500 km would have a free-fall acceleration $g = 8.43$ m/s^2 in the absence of forces other than gravitational attraction. Because of thrust, however, the rocket has an additional acceleration component a_1 of 8.80 m/s^2 tangent to its trajectory, which makes an angle of 30° with the vertical at the instant considered. If the velocity v of the rocket is 30 000 km/h at this position, compute the radius of curvature ρ of the trajectory and the rate at which v is changing with time.

Ans. $\rho = 16\,480$ km, $\dot{v} = 1.499$ m/s^2



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