BME-Second Year, First SemesterExamination, 2024

Engineering Dynamics

Full Marks: 100 **Time**: 3.0 Hours

Answer any Five (5) Questions. All carry equal Marks.

[Assume any missing data with proper justifications

Take acceleration due to gravity, $g = 9.81 \text{m/s}^2$]

1. The position vector of a particle moving in the *x-y* plane is given by $\bar{r} = 20t^2\boldsymbol{i} + \frac{20}{3}t^3\boldsymbol{j}$ where $\bar{r}$ is in mm and t is in seconds. Calculate the radius of curvature ρ of the path at t=2s.

2. A jet plane flying at a constant velocity v at an altitude of h=8 km is tracked by a radar located at O (refer Fig Q2) directly below the line of flight. If the angle θ is decreasing at the rate of **0.025 rad/s** when $\theta = 60^0$, determine $\ddot{r}$ at this instant and magnitude of the velocity of the plane.

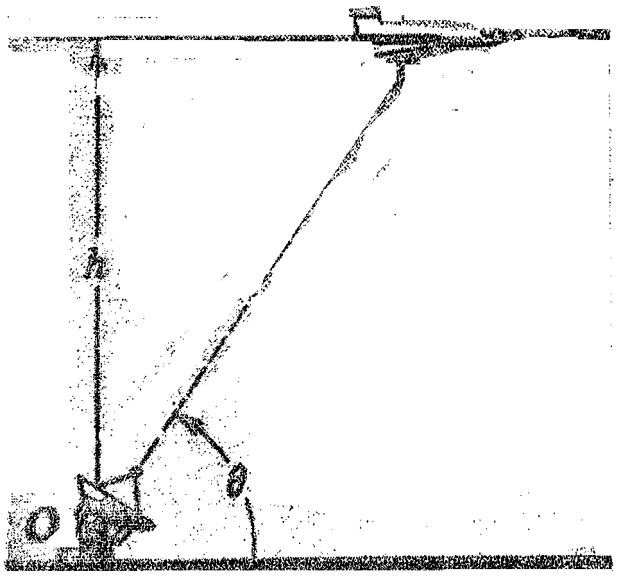
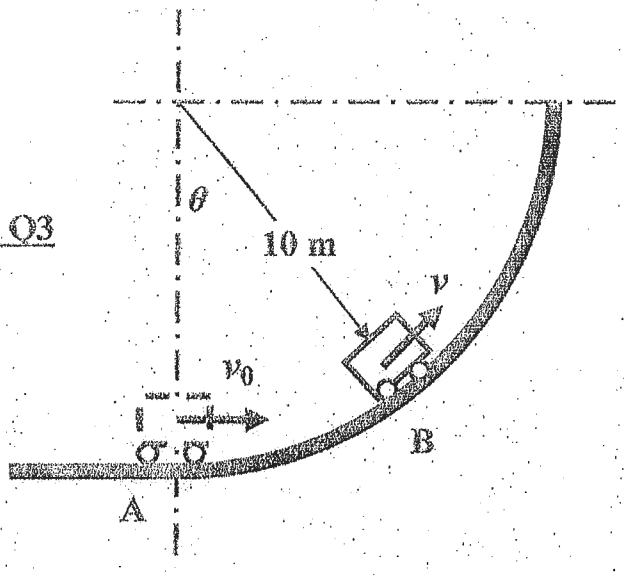


Fig Q2

3. Refer Fig Q3. The small vehicle has a mass of 30 kg and is given an initial velocity $v_0 = 8\,m/s$ at the bottom of the circular track. Calculate the velocity v of the vehicle and normal reaction R on its wheels as it passes the position at which $\theta = 30^0$. Neglect friction. *DO NOT USE ENERGY METHOD*

Fig Q3



4. Refer **Fig Q4**. The small sphere of mass m is fastened to the end of the rigid rod of negligible mass freely pivoted at **O**. A horizontal force P, constant in magnitude and direction is applied to the rod initially at rest in the vertical position $\theta = 0$. Calculate the velocity of the sphere when $\theta = 30^0$ if $P = 20$ N, m=2 kg, $b = 0.6$ m and l=0.8 m. *USE ENERGY METHOD.*

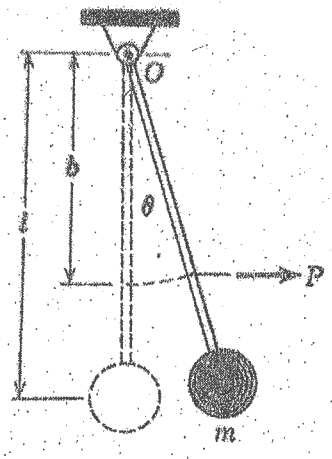


Fig Q4

5. Refer **Fig Q5**. The wheel rolls without slipping and its position is controlled by the motion of the slider **B**. If **B** has a constant velocity of **250 mm/s** to the left, determine the angular velocity of **AB** and velocity of centre **O** of the wheel when $\theta = 0$.

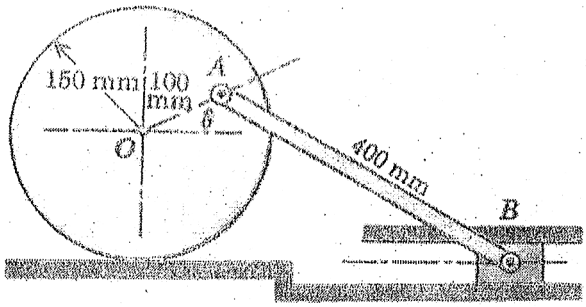


Fig Q5

6. Refer Fig Q6. The coefficient of friction at both ends of the uniform bar is **0.4**. Determine the maximum horizontal acceleration a which the truck may have without causing the bar to slip.

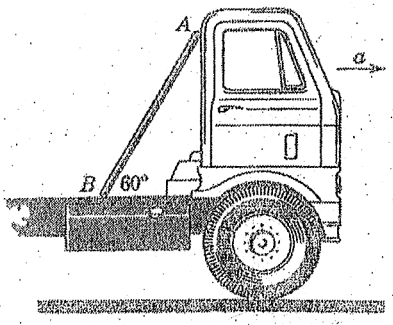


Fig Q6

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