

MECH230 - Fall 2024

Recommended Problems - Set 02

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Kinetics of a particle in Cartesian Coordinates The balance of angular momentum of a particles (also known as Newton's second law or Euler's first law) is

$$\mathbf{F} = \dot{\mathbf{G}} \quad (1)$$

where \mathbf{F} is the sum of the external forces acting on the particle and $\mathbf{G} = m\mathbf{v}$ is the linear momentum of the particle.

The Four Steps to Solving a Kinetics Problem Follow these steps to solve a kinetics problem after reading the given carefully.

1. Choose an origin and draw the basis vectors. Draw the position vector \mathbf{r} from the origin to the particle, and differentiate it to obtain the velocity and acceleration vectors.
2. Draw the free body diagram of the and write the expressions of the all the forces on the side as applicable.
3. Write the vector equation of the balance of linear momentum.
4. Analyze your problem to answer the question. Your analysis will often involve projecting the equations of motion along certain directions.

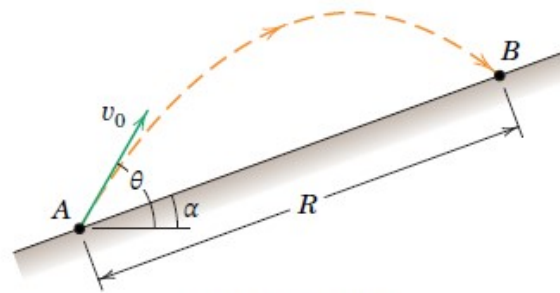
These problems are taken from J. L. Meriam, L. G. Kraige, and J. N. Bolton (MKB), Engineering Mechanics: Dynamics, Ninth Edition, Wiley, New York, 2018.

1. [MKB 2/75] Take \mathbf{E}_x to point along the incline and \mathbf{E}_y to point perpendicular to \mathbf{E}_x upwards. Follow the 4 steps. Take your origin to be at A . Projecting the balance of linear momentum along \mathbf{E}_x and \mathbf{E}_y should yield respectively

$$\ddot{x} = -g \sin(\alpha), \quad \ddot{y} = -g \cos(\alpha).$$

As a check on your answer for $\alpha = 0$, the maximum range occurs when $\theta = 45^\circ$.

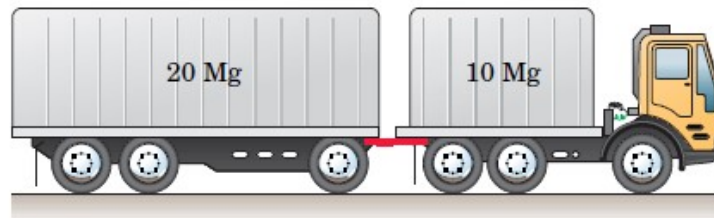
►2/75 A projectile is launched with speed v_0 from point A . Determine the launch angle θ which results in the maximum range R up the incline of angle α (where $0 \leq \alpha \leq 90^\circ$). Evaluate your results for $\alpha = 0, 30^\circ$, and 45° .



PROBLEM 2/75

2. [MKB 3/004] Take \mathbf{E}_x and \mathbf{E}_y to point horizontally to the right and vertically upwards respectively. Consider the system of the whole truck. Use the 4 steps to find the truck's acceleration. Then, consider either the front trailer or the back trailer. Use the 4 steps again to determine the tension in the horizontal drawbar.

3/4 The 10-Mg truck hauls the 20-Mg trailer. If the unit starts from rest on a level road with a tractive force of 20 kN between the driving wheels of the truck and the road, compute the tension T in the horizontal drawbar and the acceleration a of the rig.



PROBLEM 3/4