GNG 1105E – Engineering Mechanics

CHAPTER D2 – KINEMATICS OF PARTICLES

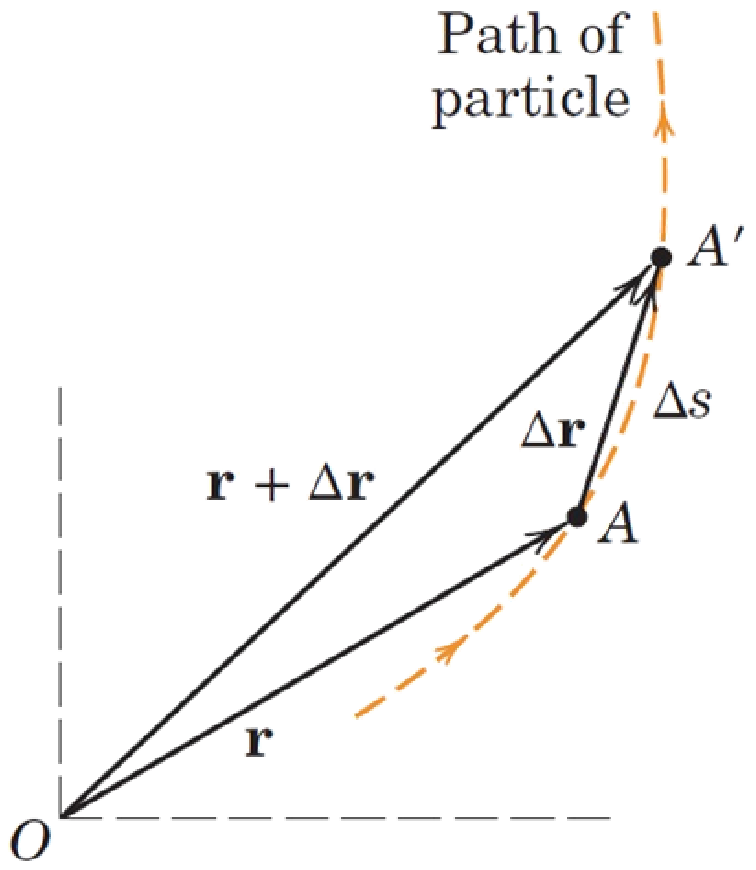
Assigned readings

2/3 Plane curvilinear motion

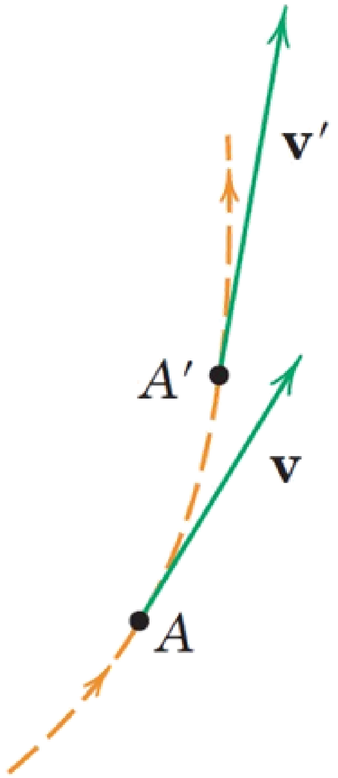
2/4 Rectangular coordinates

2/5 Normal and tangential coordinates

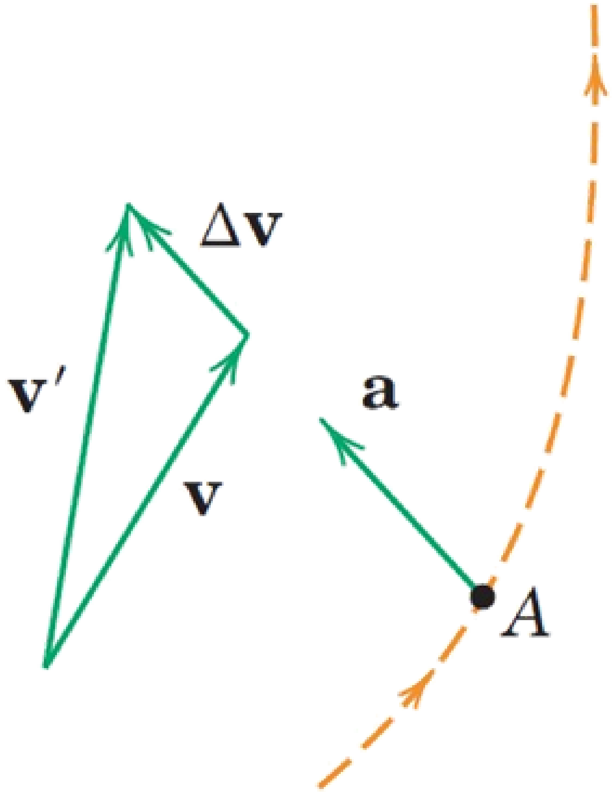
2/3 Plane curvilinear motion



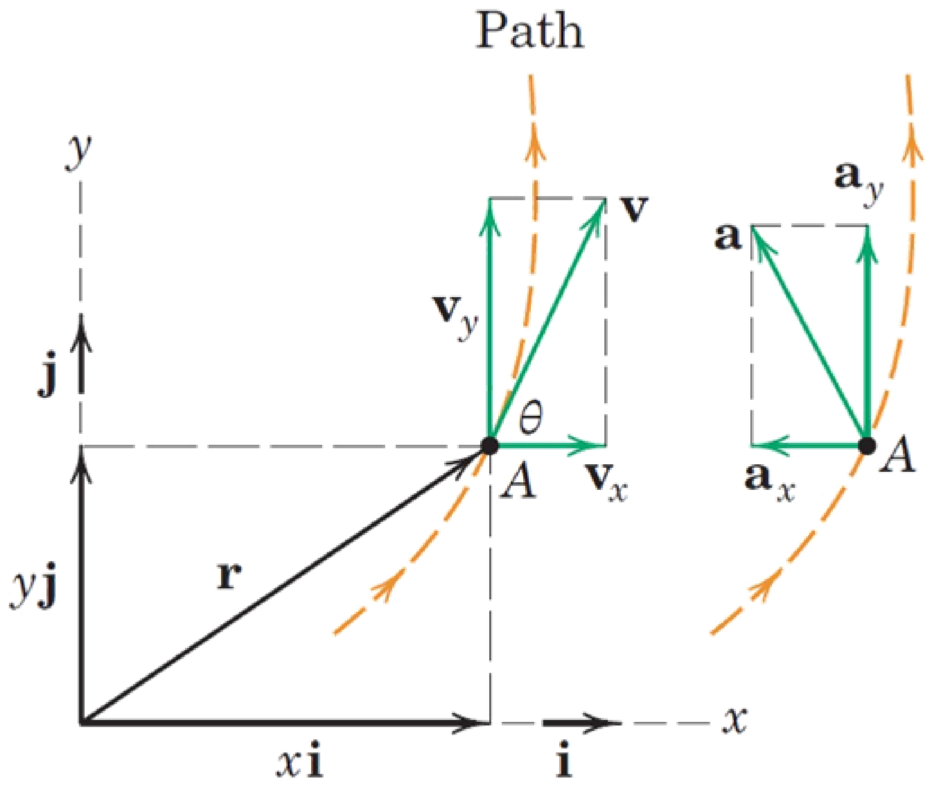
2/3 Plane curvilinear motion



2/3 Plane curvilinear motion



2/4 Rectangular coordinates



$$\mathbf{r} = x\mathbf{i} + y\mathbf{j}$$

$$\mathbf{v} = \dot{\mathbf{r}} = \dot{x}\mathbf{i} + \dot{y}\mathbf{j}$$

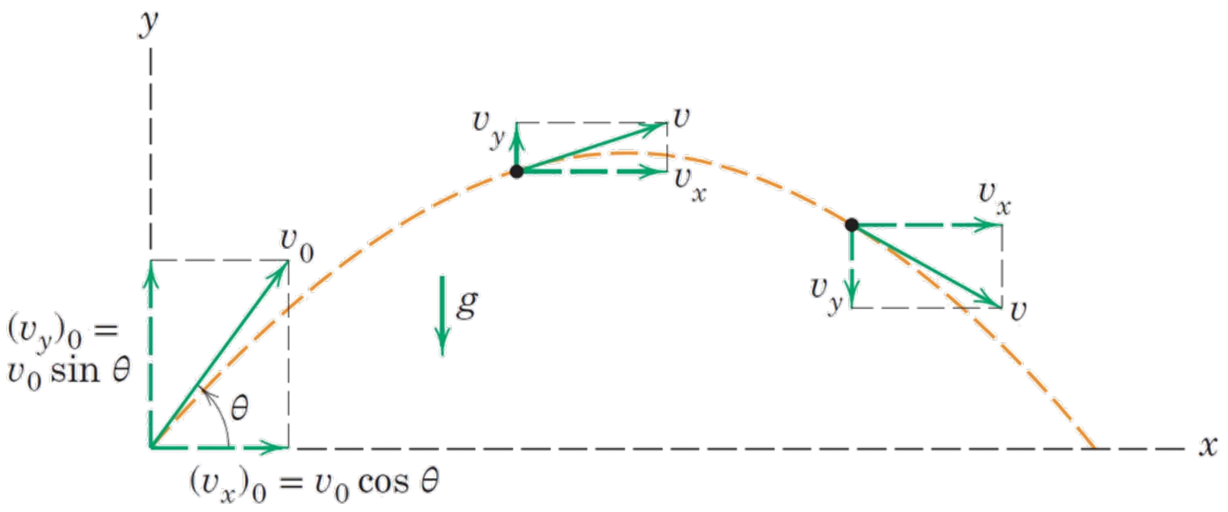
$$\mathbf{a} = \dot{\mathbf{v}} = \ddot{\mathbf{r}} = \ddot{x}\mathbf{i} + \ddot{y}\mathbf{j}$$

$$v^2 = {v_x}^2 + {v_y}^2 \quad v = \sqrt{{v_x}^2 + {v_y}^2} \quad \tan\theta = \frac{v_y}{v_x}$$

$$a^2 = {a_x}^2 + {a_y}^2 \quad a = \sqrt{{a_x}^2 + {a_y}^2}$$

2/4 Rectangular coordinates

Projectile motion



$$v_x = (v_x)_0 \qquad v_y = (v_y)_0 - gt$$

$$x = x_0 + (v_x)_0 t \qquad y = y_0 + (v_y)_0 t - \frac{1}{2} g t^2$$

$$v_y^{\,2} = (v_y)_0^{\,2} - 2g(y - y_0)$$

Sample problem 2/6

A team of engineering students designs a medium-size catapult which launches 8-lb steel spheres. The launch speed is v_0 = 80 ft/sec, the launch angle is θ = 35° above the horizontal, and the launch position is 6 ft above ground level. The students use an athletic field with an adjoining slope topped by an 8-ft fence as shown. Determine:

a. the time duration t_f of the flight

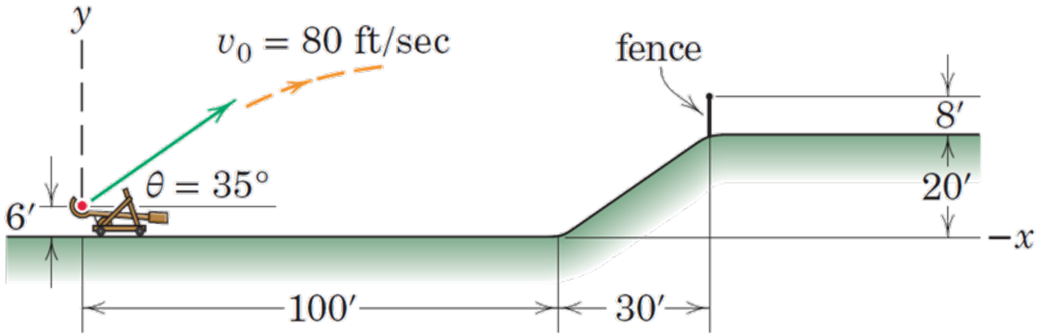
b. the *x*-*y* coordinates of the point of first impact

c. the maximum height *h* above the horizontal field attained by the ball

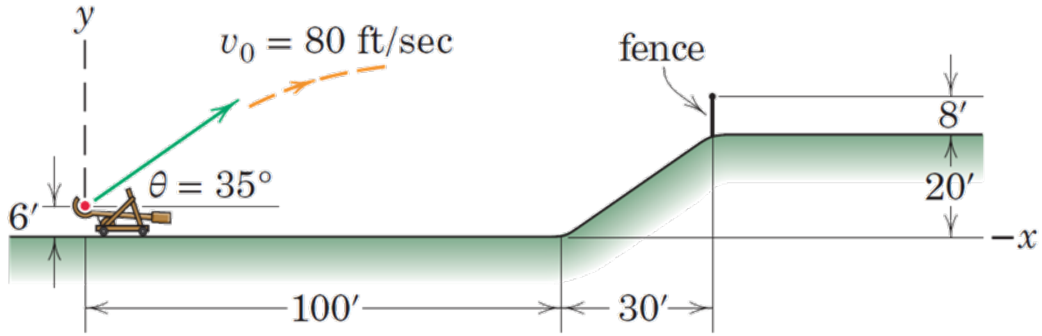
d. the velocity (expressed as a vector) with which the projectile strikes the ground (or the fence)

Repeat part (*b*) for a launch speed of v_0 = 75 ft/sec.

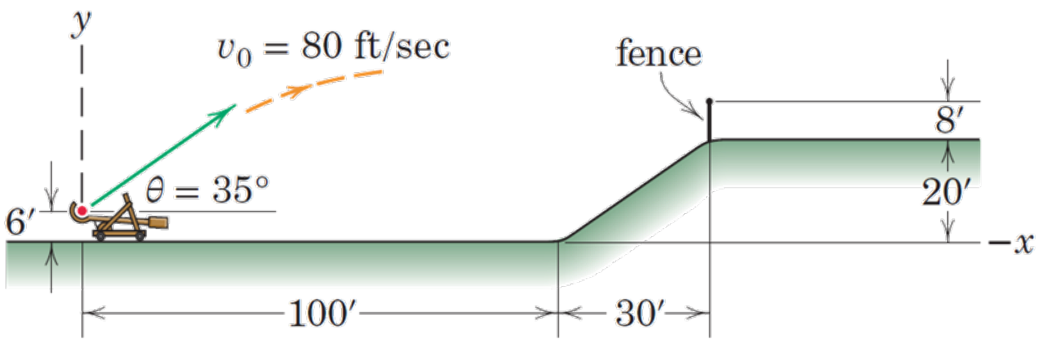
Sample problem 2/6



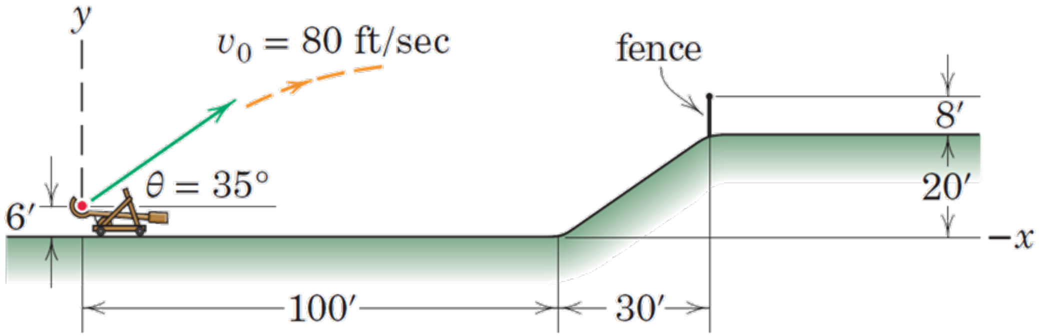
Sample problem 2/6



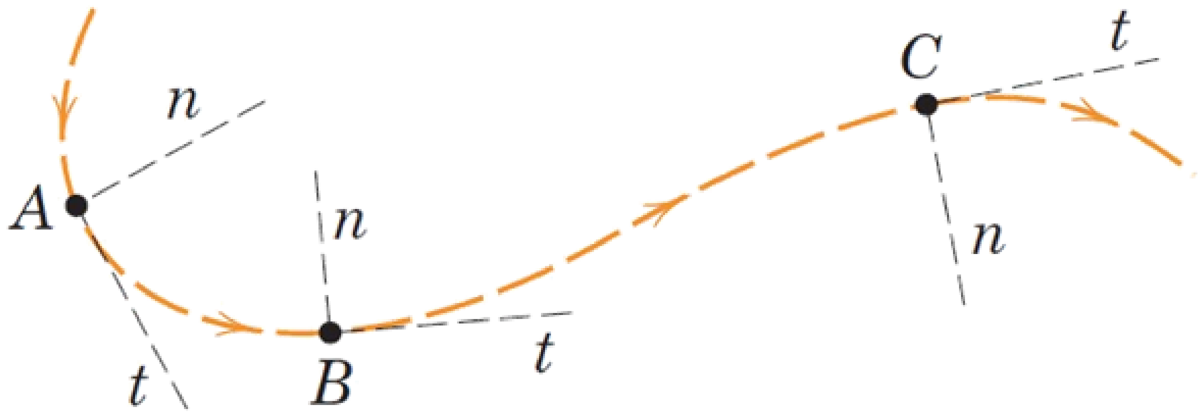
Sample problem 2/6



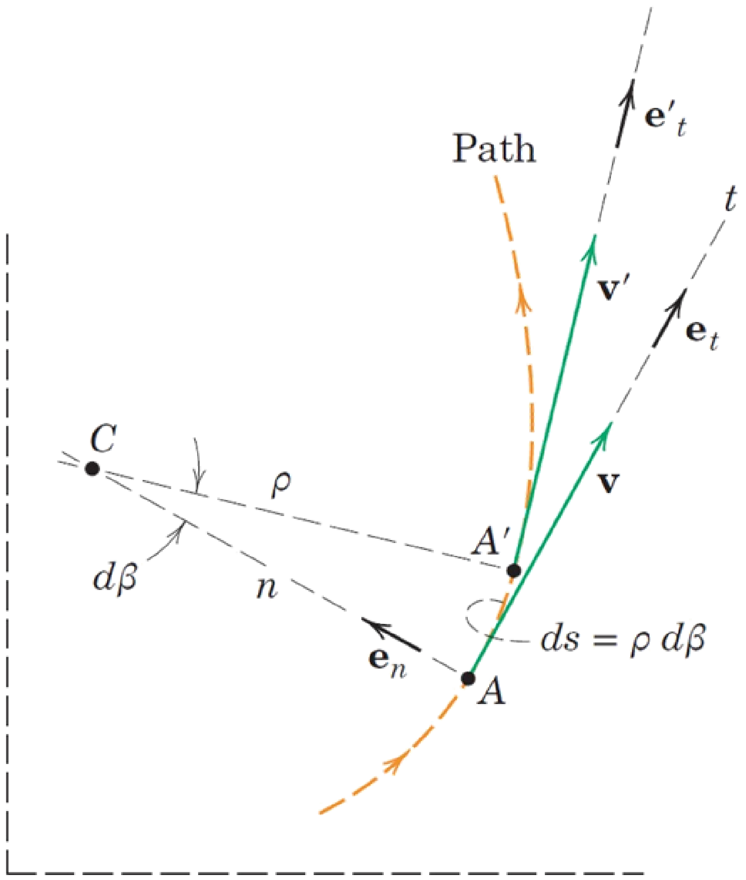
Sample problem 2/6

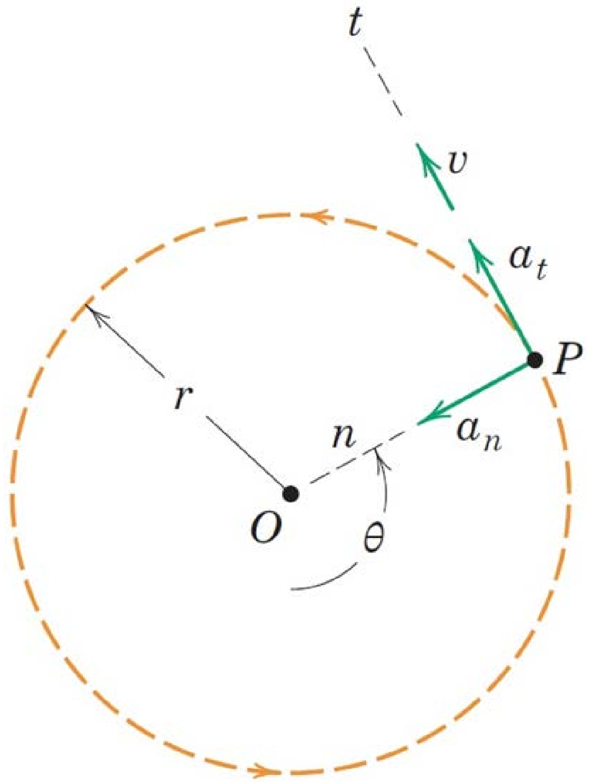


2/5 Normal and tangential coordinates



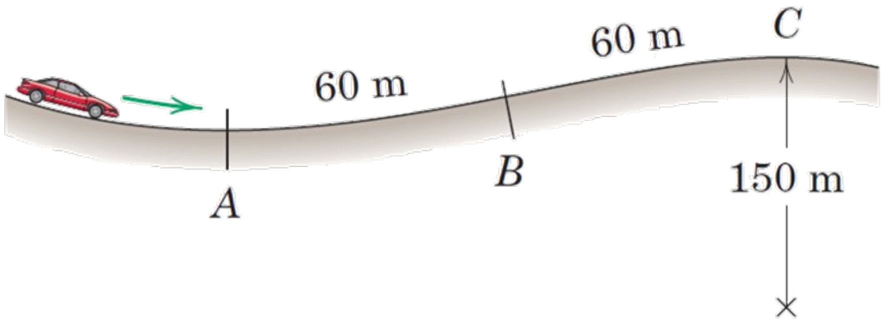
2/5 Normal and tangential coordinates



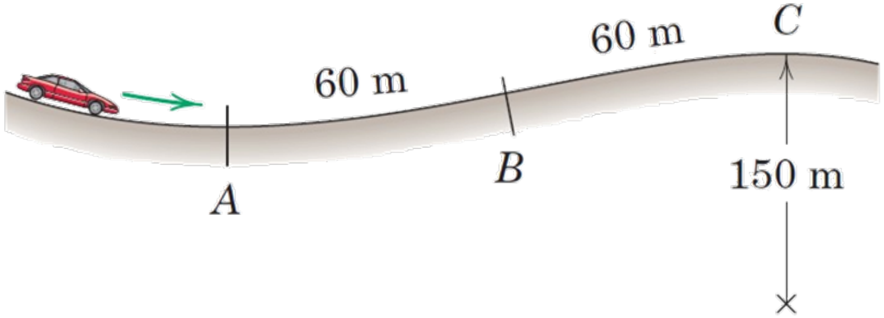


Sample problem 2/7

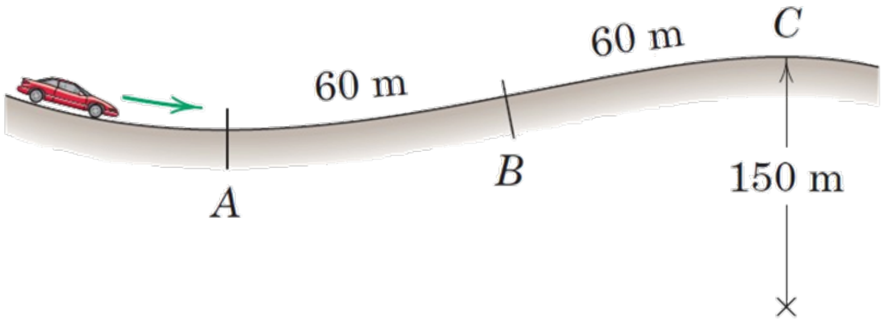
To anticipate the dip and hump in the road, the driver of a car applies her brakes to produce a uniform deceleration. Her speed is 100 km/h at the bottom *A* of the dip and 50 km/h at the top *C* of the hump, which is 120 m along the road from *A*. If the passengers experience a total acceleration of 3 m/s^2 at *A* and if the radius of curvature of the hump at *C* is 150 m, calculate (*a*) the radius of curvature ρ at *A*, (*b*) the acceleration at the inflection point *B*, and (*c*) the total acceleration at *C*.



Sample problem 2/7



Sample problem 2/7



Sample problem 2/7