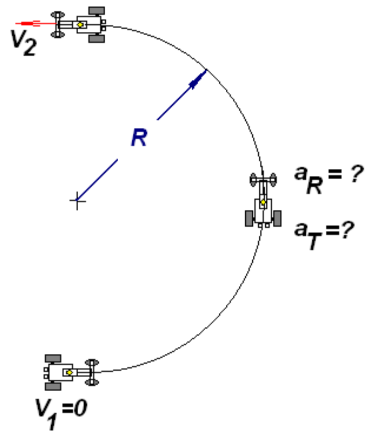
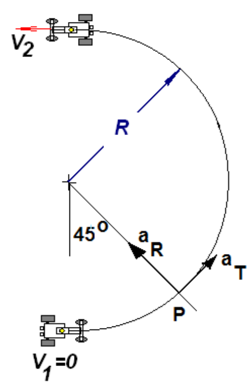
Physics I

Centripetal Acceleration

Problem 1.- A Formula 1 car accelerates uniformly from rest to a speed v_2=200 km/h by following a semicircle of radius R=350m. Calculate its centripetal and tangential accelerations in the middle of the curve.

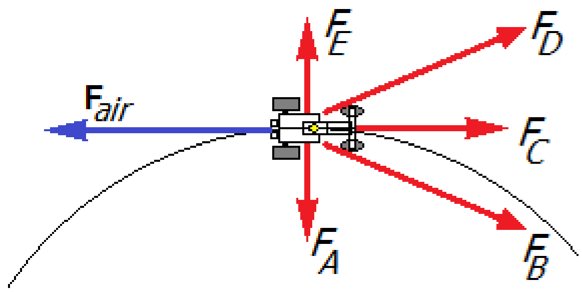


Problem 1b.- A Formula 1 car accelerates uniformly from rest to a speed of v_2=180 km/h by following a semicircle of radius R=280m. Calculate its centripetal and tangential accelerations when the car reaches point P, which is 45° from the initial point.



Problem 2.- A car travels with constant speed on a circular road on level ground. In the diagram below, $\mathbf{F_{air}}$ is the force of air resistance on the car. Which of the other forces shown best represents the horizontal force of the road on the car's tires? Give a short rationale of your answer.

(A) F_A **(B) F_B** **(C) F_C** **(D) F_D** **(E) F_E**

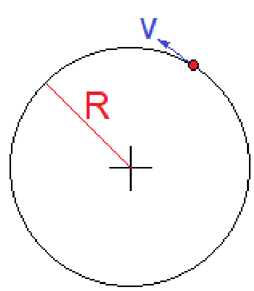


Problem 3.- Find the centripetal acceleration (radial acceleration) of a person standing on the Earth equator. Consider the radius of the Earth to be 6.4×10^6 m and the period of rotation to be 1 day [8.6×10^4 s].

Problem 3a.- Find the period that would make the centripetal acceleration (radial acceleration) of a person standing on the Earth equator equal to "g". Consider the radius of the Earth to be 6.4×10^6 m.

Notice that if the day had this period instead of 24 hours, we would feel weightless at the equator.

Problem 4.- The speed of a particle moving in a circle of radius R=8m is given by $v=5t^2+2t$. Where v is in m/s and t is in seconds. Find the **total** acceleration of the particle at t=1s



Problem 4a.- A particle is constrained to move in a circle with a 12-meter radius. At one instant, the particle's speed is 6 meters per second and is increasing at a rate of 4 meters per second squared. What is the magnitude of the total acceleration at that instant?

Problem 5.- Find the centripetal acceleration (radial acceleration) of a pilot pulling out of dive at 550m/s by following a circular trajectory of 8km radius.

Problem 5a.- Find the minimum radius of a circular trajectory of a pilot pulling out of dive at 450m/s if the centripetal acceleration should not exceed 3.5 “g”s.

Problem 6.- A clinical centrifuge reaches 7035 rpm in 28 seconds. Calculate the angular acceleration in rad/s^2 assuming it is constant. With this value calculate the *tangential acceleration* of a blood sample located at R=0.12m.

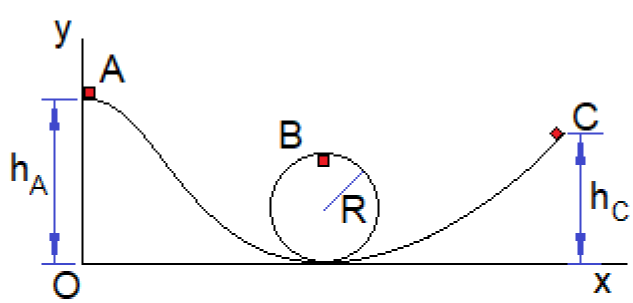
Problem 6a.- In the problem above, find the centripetal acceleration of the blood sample when the centrifuge reaches 7035 rpm.

Problem 7.- A modern centaur (a biker and his motorcycle) has a mass of 230 kg. He goes around a 35 m radius turn at 95 km/h. Find the centripetal force.

Problem 8.- The radius of a curve in the highway is 220m. What is the maximum possible speed of a vehicle rounding the curve if the centripetal acceleration should not exceed 3.5 m/s^2? Give your answer in miles per hour. [1 mile=1609m].

Problem 8a.- What should be the radius of a curve in a highway if the centripetal acceleration should not exceed 3.5 m/s^2 for a car driving at 65 miles/hour? [1 mile=1609m]

Problem 9.- An object slides without friction on the path shown below.



Its speed is given by the equation:

$$v = \sqrt{2g(h_A - y)} \qquad h_A = 3R$$

a) The magnitude of its acceleration is $a = \frac{g}{2}\sqrt{39}$ when its vertical position is 3/2R when going up inside the loop. Determine the tangential and radial acceleration vectors at that point.

b) Find the acceleration at the vertical position 3R/2, inside the loop, but going down.

c) Indicate at what position A, B or C the radial acceleration is maximum and minimum.

d) Indicate and justify at what position, B or C, the tangential acceleration is largest.

Problem 10.- Are the people inside a space station in orbit around the Earth in equilibrium?

Problem 11.- A 2.45kg ball is attached to a rotating pole by two identical massless strings, each of length 1.50m. The strings are tied to the pole separated by a distance d = 1.80m. The tension in the lower string is 10.0N. Calculate:

(a) The tension in the upper string.

(b) The net force on the ball.

(c) The speed of the ball.