1. Given the first order ordinary differential equation (ODE)

\[
\frac{dy(t)}{dt} = -\frac{\sin t}{y}, \quad t > 0.
\]

(i) Solve the above ODE with each of the following initial values: (a) \(y(0) = 2\); (b) \(y(0) = 1\); and (c) \(y(0) = 3\).

(ii) Sketch the solution with the initial condition \(y(0) = 2\).

2. The acceleration of a Maserati is proportional to the difference between 250 km/h and the velocity of this sports car. If this machine can accelerate from rest to 100 km/h in 10 seconds, how long will it take for the car to accelerate from rest to 200 km/h? What is the terminal velocity?

3. A rocket is to be launched in a vertical direction for a test flight. The total mass is 28,000 kg of which 20,000 kg is fuel. The engines emit exhaust gases at a constant rate of 500 meters per second and consume fuel at a constant rate of 800 kg per second. The designers of the rocket want an estimate of the maximum altitude of the rocket. They decide to ignore air resistance and to assume that the acceleration of gravity will be 9.81 m/s\(^2\) during the flight.

(i) Calculate the maximum altitude of the rocket as given by this simplified model.

(ii) Investigate whether the assumption that the acceleration of gravity is constant during the flight is valid in the light of your answer (Hint: Approximate the earth as a sphere with radius 6400 kilometers).