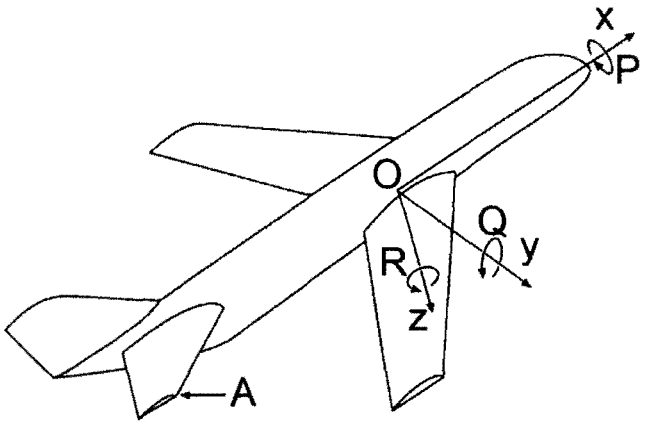
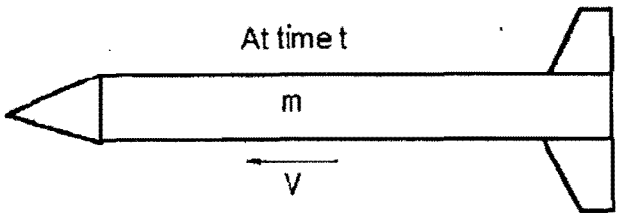
1. As shown in the following figure, a set of coordinate Oxyz is attached to the aircraft. Let the rolling rate P, pitching rate Q, and the yawing rate R be all constant. Also let the velocity and the acceleration of point O relative to the ground be $\mathbf{V}_O$ and $\mathbf{A}_O$, respectively, and the coordinate of a point A on the aircraft be (x_A, y_A, z_A), determine $\mathbf{V}_A$ and $\mathbf{A}_A$, the velocity and the acceleration of point A relative to the ground, respectively. (20%)



2. As shown in the following figure, assume that a rocket with mass m and velocity V is exhausting propellant continuously so that the mass rate $\dot{m} = -c$ where $c > 0$. The exhausted propellant is ejected with a constant speed V_e relative to the rocket. Assume that the rocket is flying in the space where the gravity force can be neglected. (c is constant.)

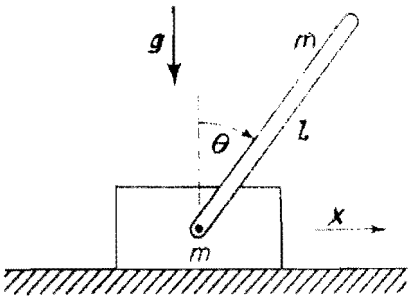
(a) Using the theory of momentum conservation, determine the acceleration of the rocket. (10%)

(b) If the initial mass and the final mass of the rocket are m_0 and m_f, respectively, determine the velocity increment of the rocket when all the fuel is exhausted. (10%)



(背面仍有題目,請繼續作答)

3. What are the principal moments of inertia at the center of mass of a thin circular disk of mass M and radius R? Find a point P in space such that any axis through this point is a principal axis. (20%)
4. A rod of mass m and length l is connected by a pivot at its lower end to a block of mass m which can slide on a frictionless plane. Using x and θ as generalized coordinates, obtain the differential equations of motion. (20%)



5. A particle of mass m can slide without friction along a fixed horizontal wire coinciding with the x axis. Another particle of mass m_0 moves with a constant speed v_0 along the line $y=h$ from $x=-\infty$ to $x=\infty$. If the particle m is initially at the origin and if an attractive force of magnitude K/r^2 exists between the two particles, where r is their separation, solve for the maximum speed of m. (20%)