

EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE 2004/05 (OCT-DEC. 2006)

SECOND SEMESTER

PH 204 - MECHANICS II

Time: 01 hour.

Answer ALL Questions.

01. State and explain the principle of conservation of linear momentum.

A rocket of total mass $M + m_0$ contains fuel of mass εM ($\varepsilon < 1$). The payload is of mass m_0 and $(1 - \varepsilon)M$ is the mass of the rocket casing. Suppose it is technically possible to discard the casing continuously at a constant rate whilst the fuel is burning so that no casing remains when the fuel is burnt. If the fuel is burnt at constant rate k , show that the casing must be discarded at the rate $\left(\frac{1 - \varepsilon}{\varepsilon}\right)k$.

Verify that, if $\varepsilon = \frac{5}{6}$ and $m_0 = \frac{M}{100}$, the rocket's final velocity will be approximately $3.8c$, where c is the exhaust velocity.

All external forces on the rocket may be neglected.

02. A particle of mass m in a central force field $F(r)$ moves with a constant angular momentum L about the force center. Show that the general equation of the particle's orbit is given by

$$\frac{d^2u}{d\theta^2} + u = -\frac{m}{L^2u^2} F\left(\frac{1}{u}\right)$$

where r and θ are the plane polar coordinates of the particle and $u = \frac{1}{r}$.

An object of unit mass orbits in a central potential $V(r)$. Its orbit is $r = ae^{-b\theta}$, where θ is the azimuthal angle measured in the orbital plane and a, b are the constants. Find the central potential $V(r)$.