

**Problem 1** (30 marks)

Point masses that have energy  $E$  are scattered by the force field associated with the potential energy  $V(r) = B/r^2$  with  $B > 0$ . Find the differential scattering cross section.

**Problem 2** (20 marks)

A point mass  $m$  is at distance  $r$  from the center of a planet. The planet has mass  $M$  and the shape of a ball of radius  $R$ . The ball has uniform mass density  $\rho_0$  for  $R/2 < r < R$ , and the mass density is twice as big in the planet's inner core of radius  $R/2$ . What is the gravitational force that the planet exerts on the point mass?

**Problem 3** (50 marks)

Two equal point masses  $m$  can move without friction in the horizontal  $x, y$  plane. A spring (natural length  $a$ , spring constant  $k = m\omega_0^2$ ) connects the two masses. Another spring of the same kind connects one mass to point  $(x, y) = (-3a, 0)$ , and yet another spring of that kind connects the other mass to point  $(x, y) = (3a, 0)$ . Taking into account that the masses can move both in the  $x$  direction and in the  $y$  direction, find the characteristic frequencies of small-amplitude oscillations and describe the eigenmodes.