UNIVERSITÄT LEIPZIG

FAKULTÄT FÜR PHYSIK UND GEOWISSENSCHAFTEN

EXPERIMENTAL PHYSICS 1

EXERCISE 6
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Problem 1: Geostationary Satellite **$3 + 3$ Points**

A geostationary satellite is on a circular orbit around Earth above the equator. Later on, the satellite collides with some debris and loses 50 % of its speed. The debris does not deflect the satellite's direction of motion.

a. Before the collision: Calculate the height of the satellite above the ground and its speed.
b. After the collision: Will the satellite collide with the earth? Provide a calculation.

Hint: It may help to calculate the smallest possible orbit around the earth for the satellite.

Problem 2: Gravity, Flying to Mars **$2 + 2 + 1$ Points**

A space probe ($m_P = 600\,\mathrm{kg}$) is flying to the Mars (radius $r_M = 3390\,\mathrm{km}$, mass $M_M = 6.39 \cdot 10^{23}\,\mathrm{kg}$). At a height $h_1 = 122.5\,\mathrm{km}$ over the surface of the Mars the speed of the probe is $v_1 = 21\,000\,\mathrm{km/h}$. The parachute is supposed to open at a height of $h_2 = 11\,\mathrm{km}$ and a speed of $v_2 = 1650\,\mathrm{km/h}$.

a. How much work has been done to decelerate the probe to this point? (Gravity is not constant here).
b. Unfortunately, the parachute doesn't open. What is the speed of impact? (Neglect any friction, assume a constant gravity of $g = 3.69\,\mathrm{m/s^2}$.)
c. In another attempt the parachute actually does open. It decelerates the probe with a speed dependent Force $F_p = c_w \cdot v$, with $c_w = 450\,\mathrm{kg/s}$. What is the terminal speed? (Assume there is enough time to reach the terminal speed)

Problem 3: Rotating disk & amp; Coriolis force **$1 + 3$ Points**

We consider a rotating disk with a diameter of 4.0 m. The angular velocity of the disk is exactly such that the centrifugal acceleration at the edge of the disk corresponds to twice the acceleration due to gravity. Now a body of mass 1.5 kg moves with the constant speed 1 m/s on the disk in the direction of the center of the disk (axis of rotation).

a. Determine the direction in which the Coriolis force acts with respect to the direction of rotation of the disk.

b. Calculate the Coriolis force acting on the body.

Problem 4: Elastic head-on collision **$4 + 1 + 1$ Points**

In the center-of-mass reference frame a particle with mass m_1 and momentum p_1 makes an elastic head-on collision with a second particle of mass m_2 and momentum $p_2 = -p_1$. After the collision its momentum is p'_1.

a. Write the total kinetic energy in terms of m_1, m_2, and p_1 and the total final energy in terms of m_1, m_2, and p'_1.
b. Show that $p'_1 = \pm p_1$.
c. If $p'_1 = -p_1$, the particle is merely turned around by the collision and leaves with the speed it had initially. What is the situation for the $p'_1 = +p_1$ solution?