EXPERIMENTELLE TEILCHENPHYSIK
Ludwig-Maximilians-Universität
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Physik E1, WS 2006/07

Übung Nr. 5

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Problem 1: **(7 points)**

A freight waggon (mass m, velocity v) bumps against three equal freight waggons, which are parked on a siding.

a) The parked waggons are not coupled, but have direct contact at the bumper. How many waggons move after the impact? Also calculate their velocity.

b) The parked waggons are coupled and a fast working shunter is able to also couple the impinging waggon in infinitely short time with the other waggons. At which velocity will the waggons move after the impact? Is the kinetic energy conserved in this process? (If not, also calculate the loss of energy!)

Problem 2: (Typical problem in a written exam[1]!) **(8 points)**

Two stars (like the sun) approach each other under the influence of their gravitational field from (nearly) infinite distance. In the beginning their velocity was zero. Which velocity do they have relatively to each other in the moment of collision?
At first, derive the general formula for the velocity and thereafter insert the given values! (Gravitational constant: $G_N = 6.67 \cdot 10^{-11}$ Nm^2/kg^2)

Radius of each star : $R = 7 \cdot 10^8$ m Mass of each star : $M = 2 \cdot 10^{30}$ kg

Problem 3: **(5 points)**

Perry Rhodan lands on an abandoned space station, which is located in space without gravitational force. The space station is a ring tunnel ("tyre") with an external diameter of $d = 80$ m. All controls are still working, especially those to create an artificial gravitational field $g = 10$ m/s^2 by rotating the space station. The axis of rotation is perpendicular to the plane of the ring and runs through the centre of the ring.

a) Calculate the angular velocity ω which Perry Rhodan has to choose for the rotation of the space station such that his dog Pluto (sitting in the lounge at furthest distance from the centre of the space station) feels the same weight as on earth. Where is the floor?

b) Which direction does the coriolis force point to for a person walking along the floor of the station in respectively against the direction of rotation?

A spoke connecting the centre to the ring tunnel contains a lift to transport crew members from the centre to the ring using centrifugal acceleration. The lift starts at a radius $R_0 = 4$ m from the centre of the ring.

c) Determine the direction and the value of the coriolis force, which acts upon Perry Rhodan if the lift elevates from the centre to the ring at constant angular velocity ω of the space station. Would he take notice this force?
(Note: Solve the differential equation using the ansatz $R(t) \propto \exp(t)$.)

[1] One should be able to solve this problem in approximately 15 minutes