Einführung in die Physik I: Mechanik und Thermodynamik
Universität Basel
Herbstsemester 2022
Due to Friday 4.11.2022, 1 pm

Exercise Sheet 5

Remember to specify your name, the number of your group and the name of the assistants in your group on the sheet that you hand in.

Question 1 (4 points)

The comet Hale - Bopp has an orbital period of 2400 years.

(a) What is the mean distance from the Sun in AU? (1 AU = 1.5×10^8 km and it corresponds to the mean distance between the Earth and the Sun)
Hint: you can approximate the mean distance as half large axis of the elliptical path.

(b) At its closest approach, the comet is about 1 AU from the Sun. Knowing the mean distance evaluated in (a),what is the farthest distance?

(c) What is the ratio of the speed at the closest point to the speed at the farthest point?
Hint: you can approximate the areas with triangles if the time intervals are short enough.

Question 2 (3 points)

A point mass having m = 2 kg moves following a straight path (along x) and is subjected to a conservative force field of potential energy $E_p(x) = Ax^2$ ($A = 4$ J/m^2). The point mass crosses the origin of the axis with a velocity $v_0 = 4$ m/s, directed along the positive x direction. Evaluate the distance at which it will stop.

Question 3 (3 points)

A car of mass 1080 kg, when in neutral mode (not accelerating), slows down from 95 km/h to 65 km/h in 7 s on a flat horizontal road. What power is needed to avoid the deceleration of the car below 80 km/h?

Problem 1 (10 points)

Consider a satellite orbiting very close to the surface of the Earth.

(a) Evaluate the height above the Earth's surface at which the satellite is orbiting if its period T corresponds to the period that the Earth rotates on his axis (once in 24 hours).
Hint: for the satellite, consider only the contribution of the gravitational force due to the Earth and assume that the orbit is circular.

(b) Evaluate the speed of the satellite.

(c) Compare the velocity calculated in point (b) with that of a satellite orbiting 200 km above Earth's surface.

(d) Show that when a satellite orbits near the surface of a planet with period T, the density of the planet corresponds to $\rho = \mathrm{m}/\mathrm{V} = 3\pi/\mathrm{GT}^2$.

(e) Estimate the density of the Earth, considering that the satellite near the surface orbits with a period of 85 min (approximate the Earth as a uniform sphere).

Problem 2 (10 points)

A load having mass $\mathrm{m} = 1$ kg hangs on one side of a rubber band, having a cross-section $\mathrm{S} = 20\ \mathrm{mm}^2$ and original length $\mathrm{l} = 20$ cm (Figure 1).

(a) Evaluate the percent elongation of the rubber ($\mathrm{E} = 10^6\ \mathrm{N/m}^2$, Elastic limit $\mathrm{L} = 10^6\ \mathrm{N/m}^2$).

(b) Which elongation induces the elastic limit to be reached?

(c) Compare the elongation calculated in (b) with the case of a copper wire having the same dimensions.

(d) Which is the maximum value for the mass that the load can have before the rubber breaks?

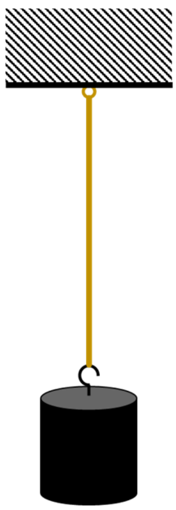

Figure 1