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http://exp-astro.de/mechanik

Übungen zur Experimentalphysik I (Mechanik)
Aufgabenblatt 2 von 6
Abgabe im OLAT: Montag, 16.11.2020, 18:00 Uhr

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

1) Gravity

Determine the gravity acceleration of the Earth g. Document your experiment with a video or with photos.
a) Perform a series of measurements. Calculate the mean value $\bar{g}$ and its standard deviation.
b) Which systematic uncertainties could occur during the measurement? Sketch an experimental setup and identify possible systematic uncertainties.
(A practical tool is https://phyphox.org, which is also available as a smartphone app.)

2) Off a cliff

a) Stuntwoman Carmen jumps off a 40 m high cliff with her motorcycle. How fast should she drive to hit her target on the ground 70 m away from the cliff?
b) Carmen only knows her velocity with an accuracy of 1 km/h. The cliff's height has been measured with an accuracy of 2 m. How long should the mat on the ground be to catch her savely?
(Hint: Use $g = 10\ \mathrm{m/s^2}$.)

3) On the road

Paragraph 3 of the German road traffic act states: "... You may only drive as fast as you can stop within the assessable distance. ..."
a) You are driving through a village. Suddenly, a traffic block appears. After a reaction time of 1 second you stand on the brakes. How many meters does it take for you to stop if you are driving with 7 km/h, 30 km/h or 50 km/h? (The mean deceleration is $10\ \mathrm{m/s^2}$.)
b) Suddenly, all drivers remember their driving lessons: "Distance to the car in front (in meter) is half the reading on the speedometer." How many cars per minute pass under a bridge when all cars drive at the same velocity and stick to the distance rule? (Consider the velocities 80 km/h and 130 km/h and compare the results.)

4) Velocities and tips for astronomical observations

a) Your are going on vacation to the city Macapá in Brasil. Macapá is located at the equator. Standing in Macapá, at which speed are you travelling because of the Earth's rotation? What is the speed back in Frankfurt? (Latitude 50°06'55" N)? (Radius of the Earth: 6380 km)

b) The international space station (ISS) orbits the Earth at a height of 400 km. Its orbital period is 92 minutes. What is the ISS's velocity in its orbit?

c) You want to observe the ISS at the night sky. Estimate the maximal time you can observe the ISS. (Neglect the Earth's rotation and consider the Earth to be a perfect sphere. Consider having perfect view in all directions.)

d) Assume that the Earth travels on a perfectly circular orbit arount the Sun. Calculate the Earth's mean orbital velocity. (Earth's mean distance to the Sun: 1 AU = 150 Million km, period: 1 year) What are the orbital velocities of Mercury (mean distance to the Sun: 0.387 AU, period: 88 days) and Neptune (mean distance to the Sun: 30 AU, period: 165 years)?

5) Round'n'Round it goes

a) How high are the orbital and angular velocites at the point of the hour, minute and second hand of a clock? The second and the minute hand are each 15 cm long, the hour hand is 12 cm long.

b) How large are the following radial accelerations: (i) laundry drum with a radius of 30 cm at 1200 revolutions per minute, (ii) at the Earth's equator and at Latitude 50° N, (iii) front gear tires of A380 (diameter 120 cm) at 300 km/h. Give the results as multiples of the mean gravitational acceleration $g = 10\ \mathrm{m/s^2}$.