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Exercises and Complements for the Introduction to Physics I for Students of Biology, Pharmacy and Geoscience

Sheet 1 / 17.09.2020 Zoom - Q&A on the Exercises: **22.09.2020 / 23.09.2020**

Exercise 1.

Find the derivative dy/dx of the following functions:

(a) $y(x) = ax^3 + bx^2 + cx + d$

(b) $y(x) = b\ln(ax)$

(c) $y(x) = x\exp^{-ax}$

(d) $y(x) = ax\sqrt{1-bx^3}$

Find the derivative of the following functions with respect to time t:

(a) $E(t) = \frac{1}{2}mv^2(t)$

(b) $p(t) = mv(t)$

Calculate the integral $F(x) = \int f(x)dx$ of the following functions:

(a) $f(x) = 3x^3 + 2x^2$

(b) $f(x) = a\sin(bx)$

(c) $f(x) = \frac{4}{x}$

Given the vectors $\vec{a} = \begin{pmatrix} 1 \\ 3 \\ -4 \end{pmatrix}$ and $\vec{b} = \begin{pmatrix} 3 \\ 5 \\ -1 \end{pmatrix}$, calculate the following vectors:

(a) $\vec{s} = \vec{a} + \vec{b}$

(b) $\vec{s} = \vec{a} - \vec{b}$

(c) $\vec{c} = \vec{a} \times \vec{b}$

(d) $c = \vec{a} \cdot \vec{b}$

Solve (a) and (b) graphically in the xy-plane.

Exercise 2.

Determine the SI units of the two constants C_1 and C_2 (x[m], t[s], v[m/s], F[N], m_1[kg], m_2[kg]).

(a) $x = C_1 + C_2 t$

(b) $v^2 = 2C_1 x$

(c) $v = C_1 x \ln(C_2 t)$

(d) $F = C_1 \dfrac{m_1 m_2}{x^2}$

(e) $v = C_1 \exp(x/C_2)$

Exercise 3.

Light propagates in vacuum with a constant speed of $3 \cdot 10^8$ m/s.

(a) How long does light need to travel a distance equal to the diameter of the nucleus of a H-atom (10^{-15} m)?
(b) How long does light need to travel from the Sun to the Earth (calculate in s and min)? The distance between Sun and Earth is referred to as astronomical unit: 1 AU = $1.5{\cdot}10^8$ km.
(c) How long does light need to cross the solar system with a diameter of $1.2 \cdot 10^{10}$ km?

Exercise 4.

The ride of a car between one traffic light to the next one is observed and studied. The vehicle is uniformly accelerated from a standstill for a period of 6 s with 2.1 m/s^2. The car continues with this acquired velocity for 5 s. It stops at the next traffic light due to a deceleration (negative acceleration) of 4.2 m/s^2.

(a) What is the the maximum velocity which the car reaches (in km/h)?
(b) Which distance does the car cover during the acceleration?
(c) How far does the car drive with a constant velocity?
(d) Calculate the stopping distance.
(e) How long is the total distance between the two traffic lights?

Exercise 5.

Tell for each of the four $x(t)$-curves in the following figures, if:

(a) the velocity at the time t_2 is greater, less or equal than at the time t_1.
(b) the absolute value of the velocity at the time t_2 is greater, less or equal than the absolute value at the time t_1.