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

Sheet 1 / 21.09.2020 **Solutions**

Exercise 1.

Derivatives dy/dx:

(a) $\frac{dy(x)}{dx} = 3ax^2 + 2bx + c$

(b) $\frac{dy(x)}{dx} = \frac{b}{x}$

(c) $\frac{dy(x)}{dx} = (1 - ax)\exp^{-ax}$

(d) $\frac{dy(x)}{dx} = \frac{2a - 5abx^3}{2\sqrt{1 - bx^3}}$

Derivatives with respect to time t:

(a) $\frac{dE(t)}{dt} = mv(t)\frac{dv}{dt}(t) = mv(t)a(t) = Fv(t) = P$

(b) $\frac{dp(t)}{dt} = ma(t) = F$

Integral $F(x) = \int f(x)dx$:

(a) $F(x) = \frac{3}{4}x^4 + \frac{2}{3}x^3 + C$

(b) $F(x) = -\frac{a}{b}\cos(bx) + C$

(c) $F(x) = 4\ln(x) + C$

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

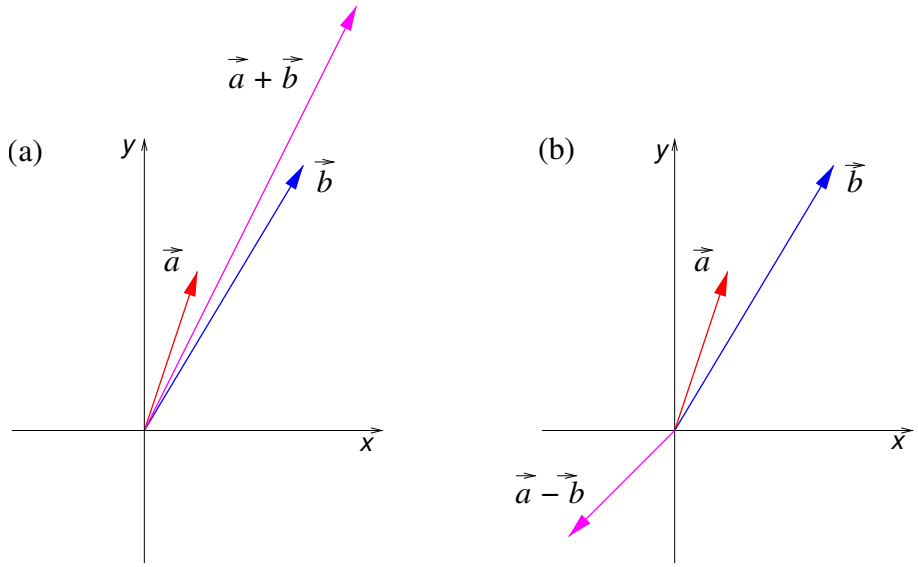
(a) $\vec{s} = \begin{pmatrix} a_1 + b_1 \\ a_2 + b_2 \\ a_3 + b_3 \end{pmatrix} = \begin{pmatrix} 4 \\ 8 \\ -5 \end{pmatrix}$

(b) $\vec{s} = \begin{pmatrix} a_1 - b_1 \\ a_2 - b_2 \\ a_3 - b_3 \end{pmatrix} = \begin{pmatrix} -2 \\ -2 \\ -3 \end{pmatrix}$

(c) $\vec{d} = \begin{pmatrix} a_2 b_3 - a_3 b_2 \\ a_3 b_1 - a_1 b_3 \\ a_1 b_2 - a_2 b_1 \end{pmatrix} = \begin{pmatrix} 17 \\ -11 \\ -4 \end{pmatrix}$

(d) $c = a_1 b_1 + a_2 b_2 + a_3 b_3 = 22$

Graphical solution (2-dimensional):



Exercise 2.

(a) C_1 in m and C_2 in m/s
(b) C_1 in m/s^2
(c) C_1 in 1/s and C_2 in 1/s
(d) C_1 in m^3/(kg$\cdot$ s^2)
(e) C_1 in m/s and C_2 in m

Exercise 3.

General: $t = \dfrac{s}{v}$

(a) $t = 3.3 \cdot 10^{-24}$ s
(b) $t = 500$ s $= 8$ min 20 s
(c) $t = 40000$ s $= 11$h 6 min 40s

Exercise 4.

(a) $v_{max} = a t_{acceleration} = 45.4$ km/h

(b) $s_{acceleration} = \dfrac{1}{2} a t^2_{acceleration} = 37.8$ m

(c) $s_{constant} = v_{max} t_{constant} = 63.0$ m $\qquad s_{braking} = \frac{1}{2} a_{braking} t_{braking}^2$ and $t_{braking} = \frac{v_{max}}{a_{braking}}$

(d) $s_{braking} = \frac{v_{max}^2}{2 a_{braking}} = 18.9$ m

(e) $s_{total} = s_{acceleration} + s_{constant} + s_{Brems} = 119.7$ m

Exercise 5.

	(a)	(b)
a)	$v(t_1) > v(t_2)$	$\lvert v(t_1)\rvert > \lvert v(t_2)\rvert$
b)	$v(t_1) = v(t_2)$	$\lvert v(t_1)\rvert = \lvert v(t_2)\rvert$
c)	$v(t_1) < v(t_2)$	$\lvert v(t_1)\rvert > \lvert v(t_2)\rvert$
d)	$v(t_1) > v(t_2)$	$\lvert v(t_1)\rvert = \lvert v(t_2)\rvert$