Karlsruhe Institute of Technology - International Department GmbH

Pre-Semester 2010 - Physics Course - Extra Tutorial

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Sheet 1
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1. Units

(a) Conversion between degree and radian – fill in the blanks:

°	360	90		180		30	
rad	2π		$\frac{\pi}{3}$		$\frac{\pi}{4}$		$\frac{3}{2}\pi$

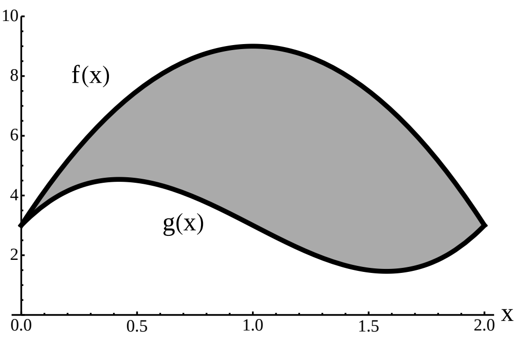
(b) Referring to Newton's second axiom, describe in words how 1 N [Newton] is related to the base units kg, m, and s.

2. Differentiation and Integration

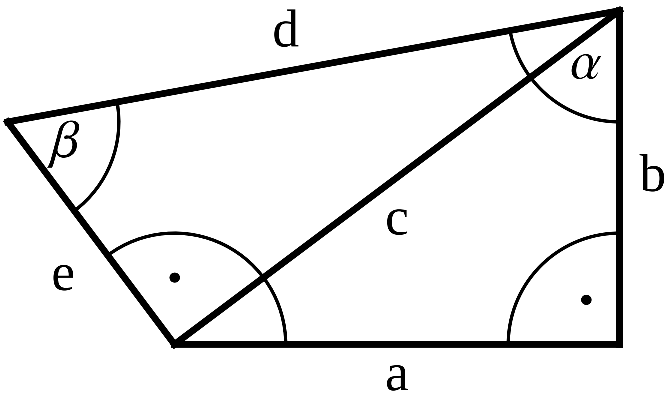
(a) Let $F(x)$ denote some antiderivative of $f(x)$: $F'(x) = f(x)$. Fill in the blanks:

$f(x)$	$\sin x$	$\cos x$	$\log x$	$9\ e^{3x}$	$7x^6 + 6x^2$
$f'(x)$					
$F(x)$					

(b) Compute the area of the region which is enclosed by the graphs of $f(x) = -6x^2 + 12x + 3$ and $g(x) = 4x^3 - 12x^2 + 8x + 3$ between $x = 0$ and $x = 2$ (see below).



3. Trigonometric Functions



Referring to the figure above fill in the blanks:

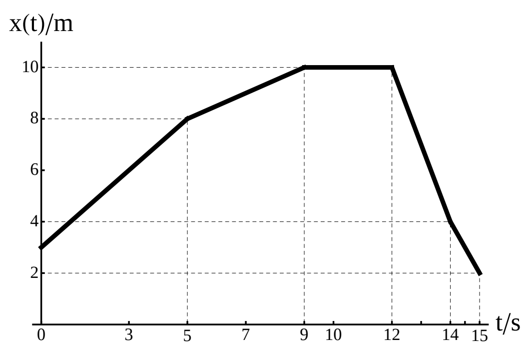
$\sin\alpha$	$\cos\alpha$	$\tan\alpha$	$\sin\beta$	$\cos\beta$	$\tan\beta$
a/c					

And again, fill in the blanks:

α	0	$\frac{\pi}{4}$	$\frac{\pi}{2}$	π
$\sin\alpha$				
$\cos\alpha$				
$\tan\alpha$			$-$	

4. Kinetics in 1 Dimension

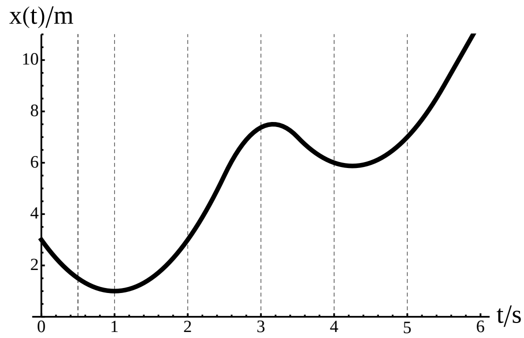
(a) We consider a particle which moves along a line. The following diagram shows its position $x(t)$ at time t.



Give the velocities at the respective times.

t/s	3	7	10	13	14.5
$v(t)/(\text{m/s})$					

(b) Consider now the motion depicted by the following diagram.



What is the sign (positive +, negative −, or zero 0) of velocity $v(t)$ and acceleration $a(t)$ at the respective times t? Fill in the blanks!

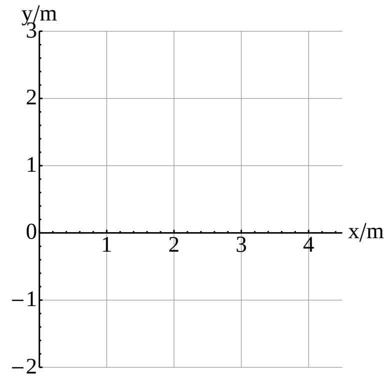
$t/$ s	0.5	1	2	3	4	5
sign $v(t)$						
sign $a(t)$						

5. Kinetics in 2 Dimensions

We consider the fate of an ant which, at time $t = 0s$, is located in the center of a room, which in cartesian coordinates corresponds to $(0\,\text{m}, 0\,\text{m})$. During the first second, $t \in (0\,\text{s}, 1\,\text{s}]$, the ant moves with velocity $\vec{v}_1$. In the following two, $t \in (1\,\text{s}, 3\,\text{s}]$ it moves with velocity $\vec{v}_2$, and in the time interval $t \in (3\,\text{s}, 5\,\text{s}]$ with $\vec{v}_3$. Then, taking a break, it rests for 2 s at the same point. Afterwards, starting with velocity 0 m/s, it moves with constant acceleration $\vec{a}$, stopping after 1 s. The aforementioned velocities and acceleration are

$$\vec{v}_1 = \begin{pmatrix} 1\,\text{m/s} \\ 0\,\text{m/s} \end{pmatrix}, \quad \vec{v}_2 = \begin{pmatrix} 0\,\text{m/s} \\ 1\,\text{m/s} \end{pmatrix}, \quad \vec{v}_3 = \begin{pmatrix} 1\,\text{m/s} \\ -1\,\text{m/s} \end{pmatrix}, \quad \vec{a} = \begin{pmatrix} 0\,\text{m/s}^2 \\ -2\,\text{m/s}^2 \end{pmatrix}.$$

(a) Sketch the path of the ant in the x-y-plane.



(b) Plot the coordinate $y(t)$ as well as the y-component of the velocity vector $\vec{v}(t)$ as a function of time.

(c) Once the ant reaches the point $(3\,\text{m}, -1\,\text{m})$ at time $t = 8\,\text{s}$, it starts moving counter-clockwise along a circle with constant velocity $|\vec{v}(t)| = v_0$ (the direction, of course, changes!). The circle's center is $(3\,\text{m}, 0\,\text{m})$, its radius is $r = 1\,\text{m}$. After 2 s the ant reaches the point $(3\,\text{m}, 1\,\text{m})$.

Sketch the new path. What is the ant's velocity v_0? Plot the components of the velocity vector $\vec{v}(t)$ for $t \in [8\,\text{s}, 10\,\text{s}]$.