Exercise 3: Gravity and Coriolis accelerations

Name, First Name	
Matriculation number	
k-value	

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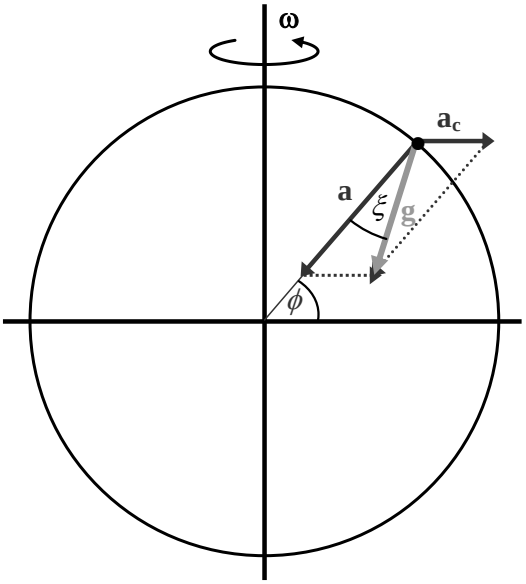
Task 1: Gravity, gravitation, and centrifugal accelerations

Assume the Earth as a rotating homogeneous sphere with a radius of $R_E = 6371\,\text{km}$ and a density of $\rho = 5515\,\text{kg/m}^3$. The angular velocity of the Earth is $\omega = 7.292115 \cdot 10^{-5}\,\text{s}^{-1}$. The Earth is further assumed as a rigid body, meaning that it does not flatten due to centrifugal forces.



i. Determine the gravitational potential, i.e., V, the centrifugal potential, i.e., V_c, and the gravity potential, i.e., W, as well as the magnitude (absolute value) of the gravitational attraction, i.e., $a = |\mathbf{a}|$, and that of the gravity attraction, i.e., $g = |\mathbf{g}|$, at a point with spherical coordinates $\lambda = 10°$, $\phi = (20 + 2k)°$, and $r = 6371\,\text{km}$. Furthermore, quantify the disturbance of the direction, i.e., ξ, which is caused by the centrifugal force. Finally, compute the disturbance of the attraction (absolute value) $\delta g = g - a$. Please note that the latter is not the same as the magnitude of the centrifugal attraction, i.e., $|\mathbf{a}_c|$.

ii. Plot the disturbances of the direction, i.e., ξ, and that of the attraction (absolute value), i.e., δg, within $0° \leq \phi \leq 90°$. Furthermore, make a picture of the centrifugal potential, i.e., V_c, in the same latitudinal domain.

Task 2: Eötvös correction

Gravity measurements are collected over Germany using airborne gravimetry. The region is surveyed at East-West and North-South directions. The velocity of the airplane is 400 km/h.

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Determine the Coriolis acceleration for both East-West and North-South directions. Furthermore, determine the Eötvös correction, which must be applied to the gravity measurements for both East-West and North-South directions. Quantify the accuracy required for the velocity in order to obtain the Eötvös correction with an accuracy of 1 mGal. Numerical values required for this task are provided below:

Gravitational constant	$G = 6.672 \cdot 10^{-11}\,m^3kg^{-1}s^{-2}$
Angular velocity of the Earth	$\omega = 7.292115 \cdot 10^{-5}\,s^{-1}$
Mean latitude of the surveyed area	$\phi = 42^\circ$

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