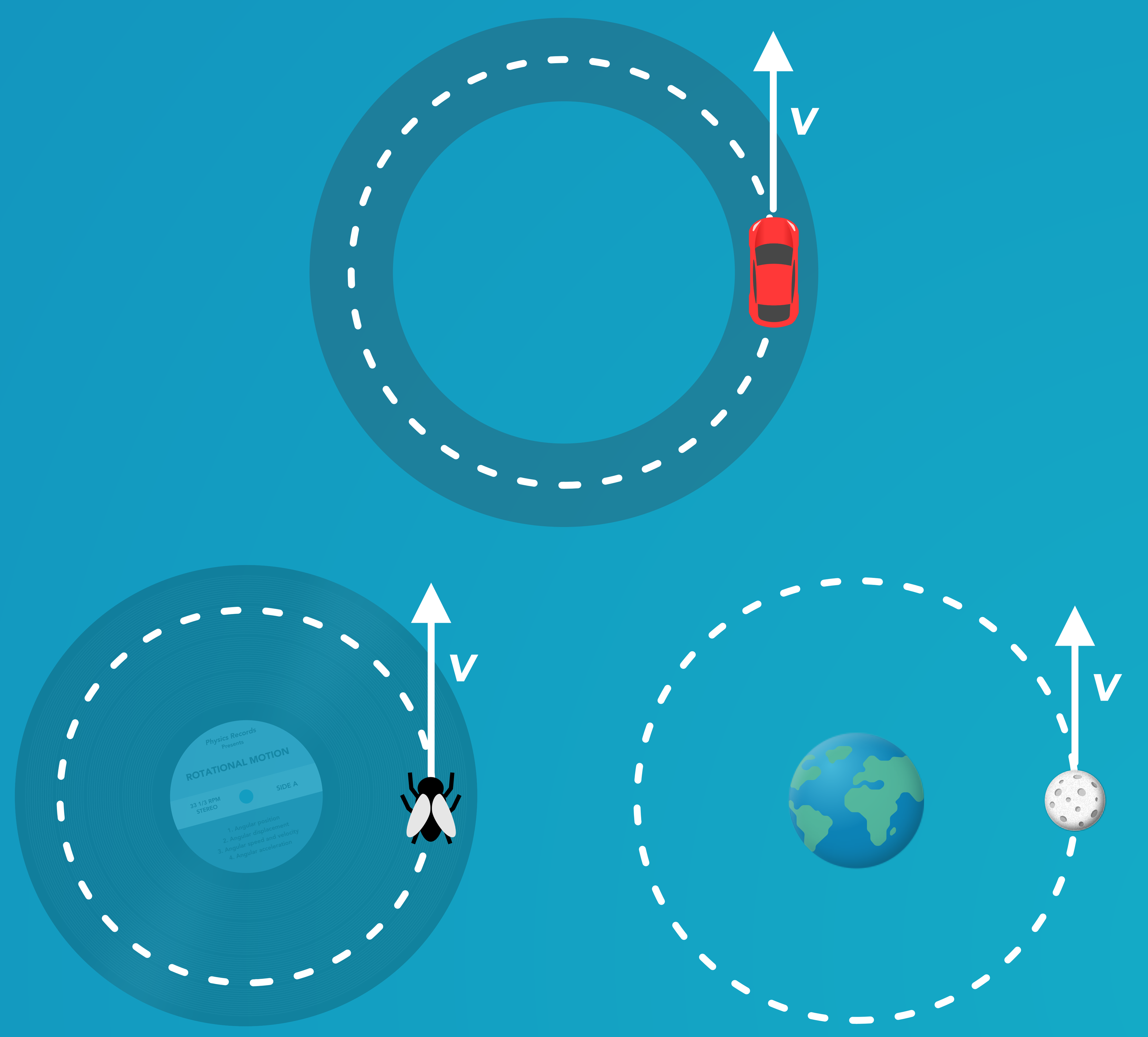
STUDY GUIDE

CONNECTING CIRCULAR AND ROTATIONAL MOTION

Connecting Circular and Rotational Motion (Tangential and Angular Descriptions)

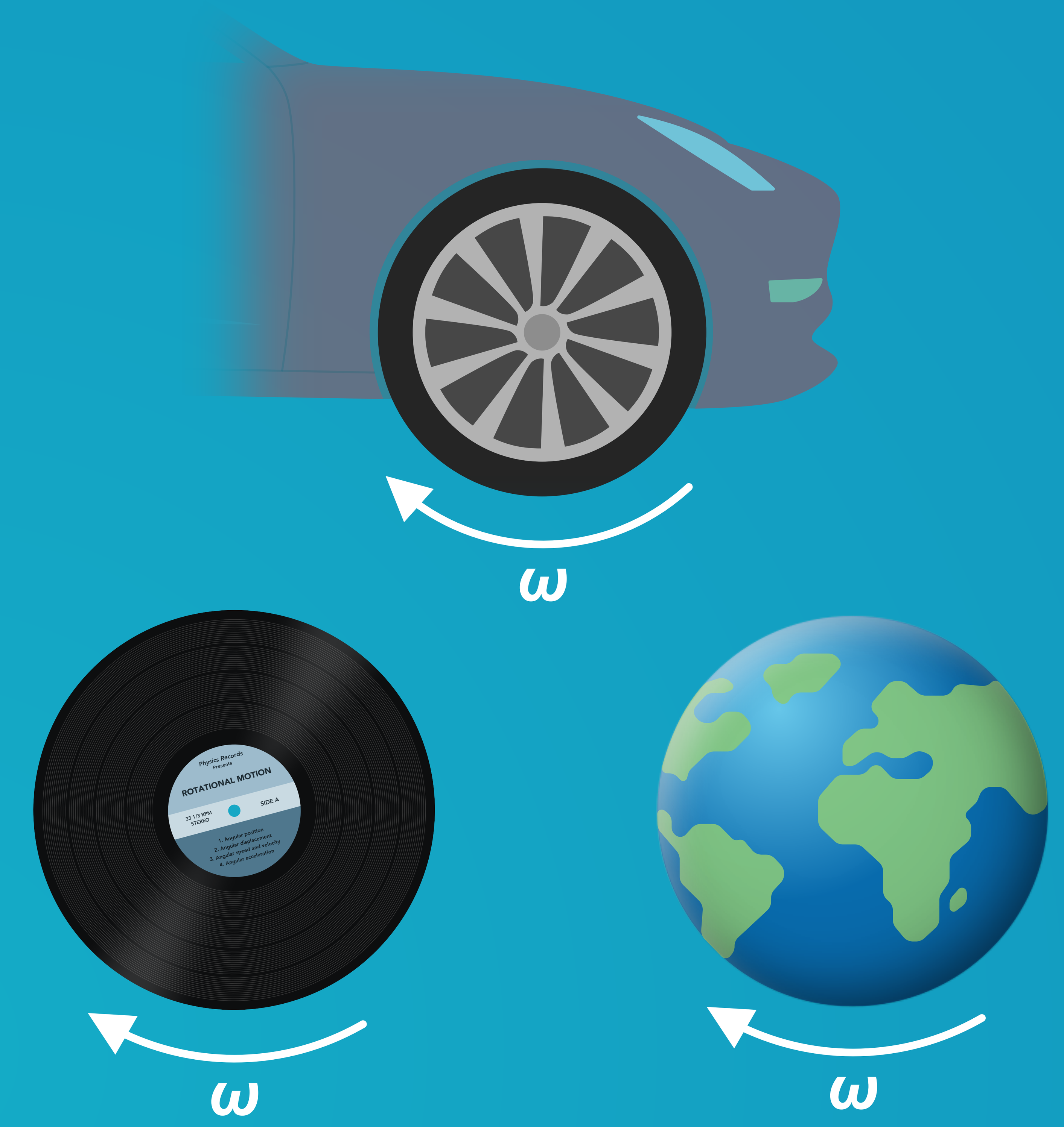
Circular Motion

- In circular motion, an object or a point travels along a circular path (around the circumference of a circle).
- Typically uses the **tangential description of motion**.
- A point on a rotating object is in circular motion.

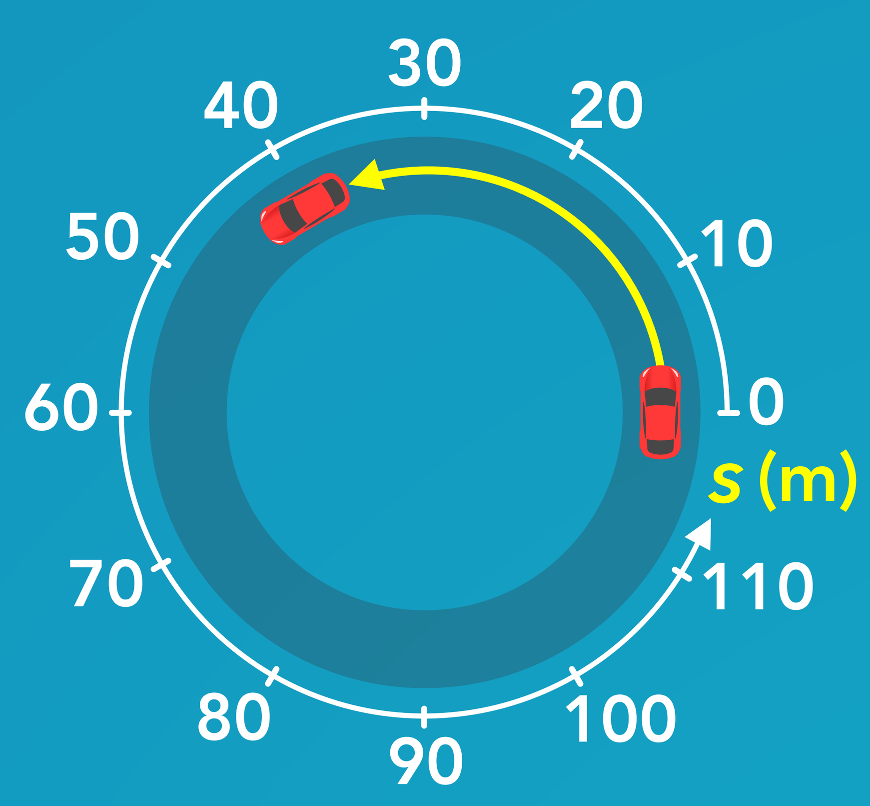


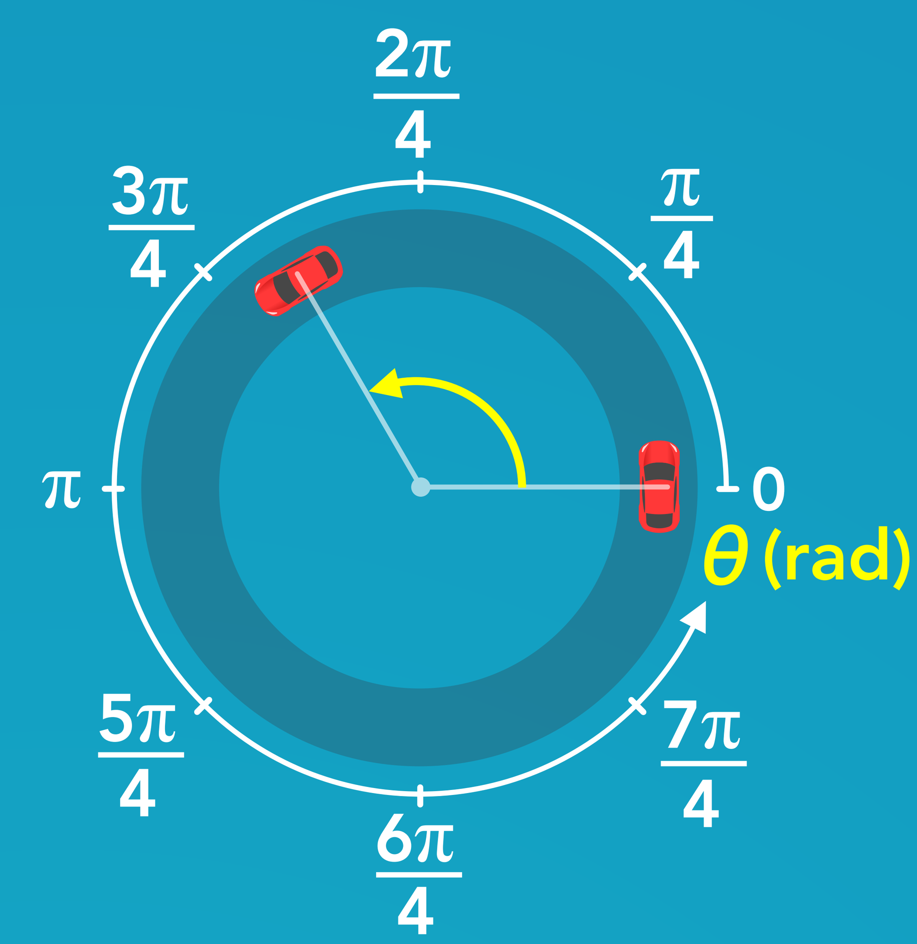
Rotational Motion

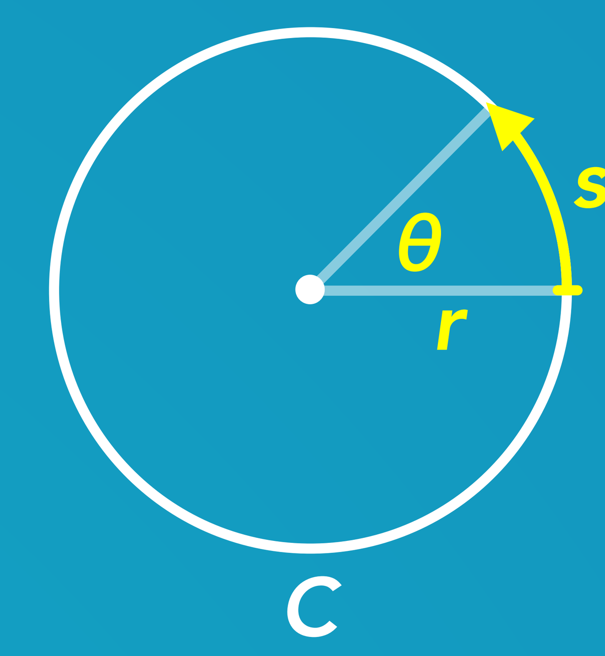
- In rotational motion, an object rotates about an axis and the orientation of the object changes over time.
- Typically uses the **angular description of motion**.
- All points on the object have the same angular motion.



- In some scenarios, it's useful to convert between the tangential description (circular motion) and the angular description (rotational motion). For example, a point on a rotating object follows a circular path and has a tangential velocity. An object in circular motion "sweeps out" an angle over time and its motion can be described using angular variables and equations. When an object is rolling without slipping, the object is rotating about its own center and it's also moving forward with a translational (linear) velocity that matches the tangential velocity of a point on the perimeter of the object.







Circumference

$C = 2\pi r$

Conversion
(Angular variable must use radians)

	Tangential description	Conversion ⟷	Angular description
Position:	s m	$s = r\theta$	θ rad
Displacement:	$\Delta s = s_f - s_i$ m	$\Delta s = r\,\Delta\theta$	$\Delta\theta = \theta_f - \theta_i$ rad
Velocity:	$v_t = \frac{\Delta s}{\Delta t}$ $\frac{m}{s}$	$v_t = r\,\omega$	$\omega = \frac{\Delta\theta}{\Delta t}$ $\frac{rad}{s}$
Acceleration:	$a_t = \frac{\Delta v_t}{\Delta t}$ $\frac{m}{s^2}$	$a_t = r\,\alpha$	$\alpha = \frac{\Delta\omega}{\Delta t}$ $\frac{rad}{s^2}$

Equivalent units:

1 circle
1 circumference
1 revolution
1 cycle
2π radians
360°