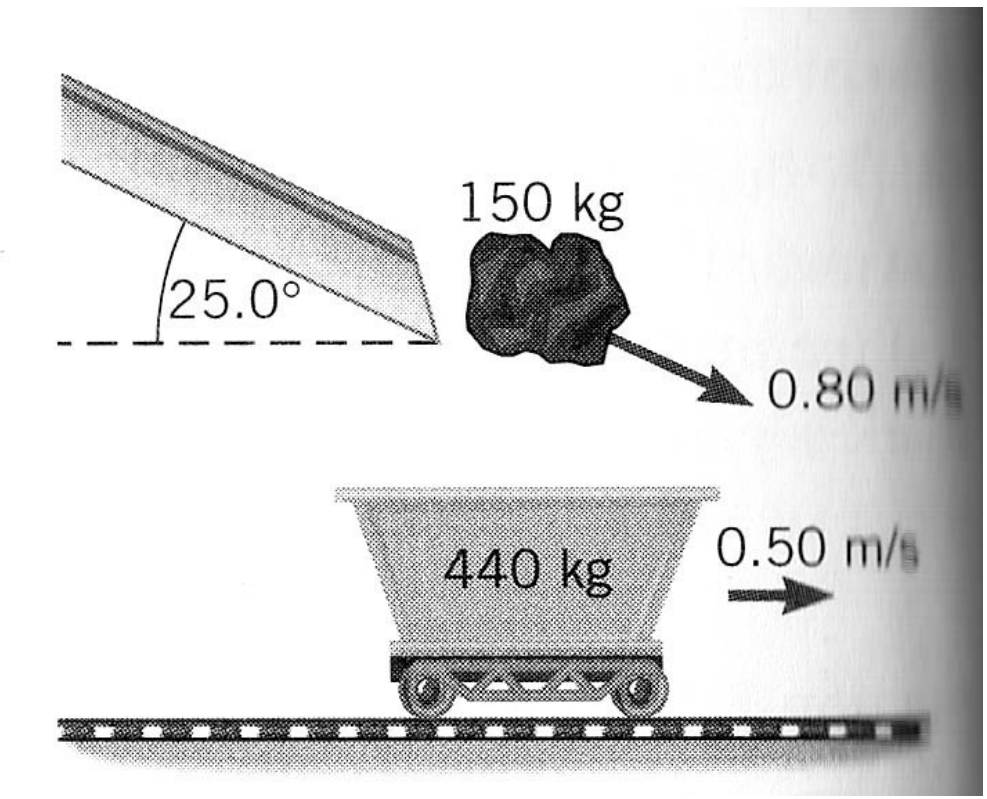
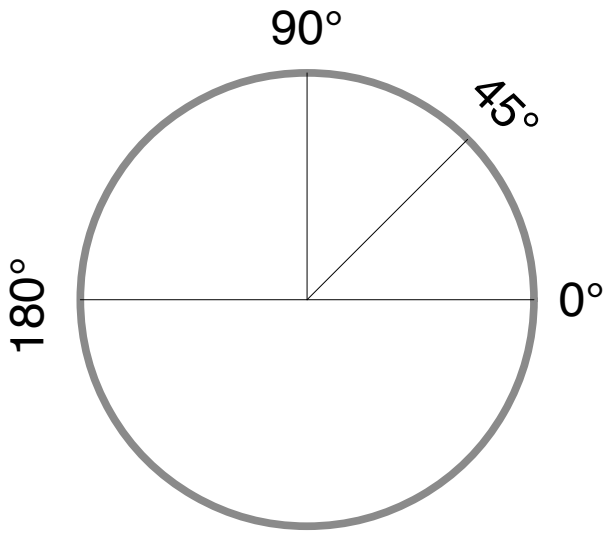
Mine car

A mine car whose mass is 440 kg, rolls at a speed of 0.50 m/s. A 150-kg chunk of coal has a speed of 0.80 m/s when it leaves the chute. Determine the velocity of the mine car after the coal has come to rest in the car.



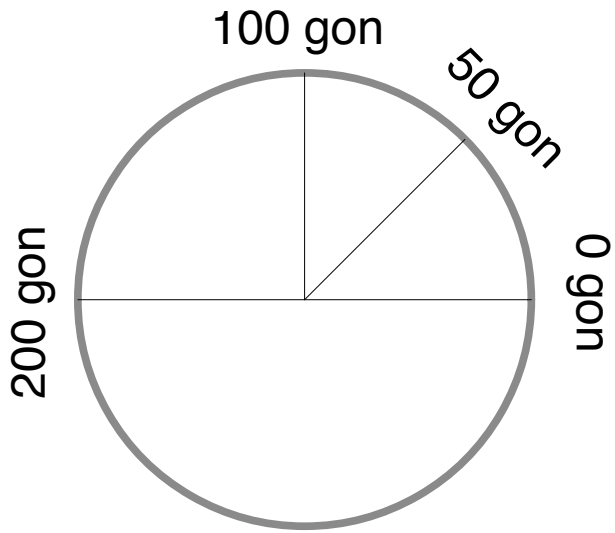
Measuring angles ...

degree



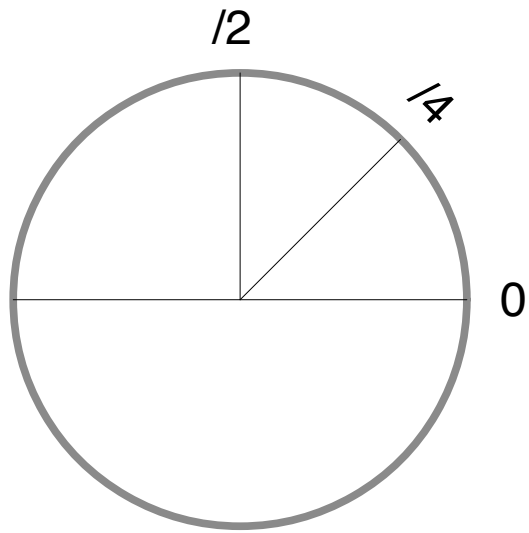
DEG or D

new degree or gon



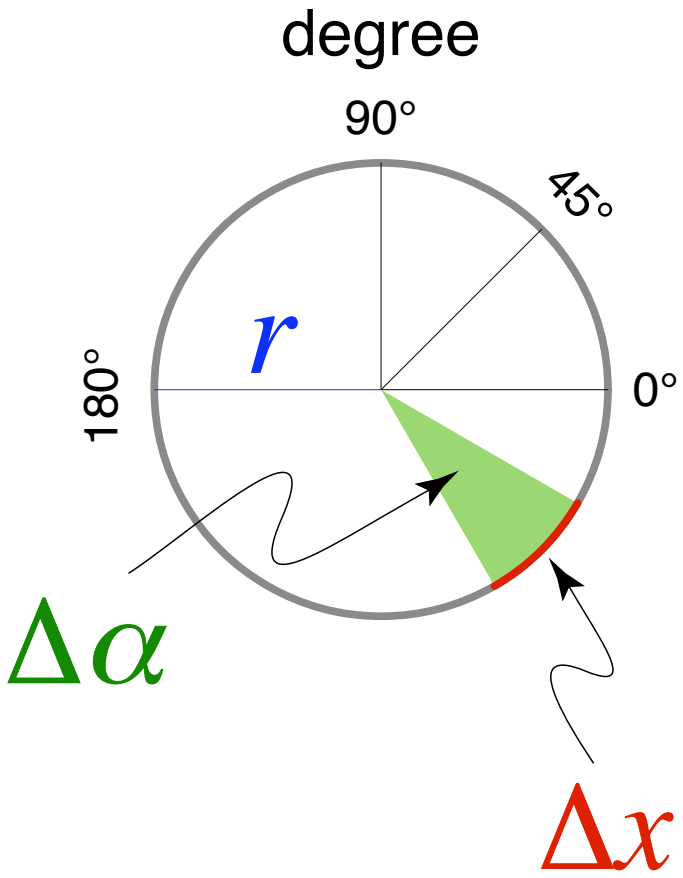
GRA or G

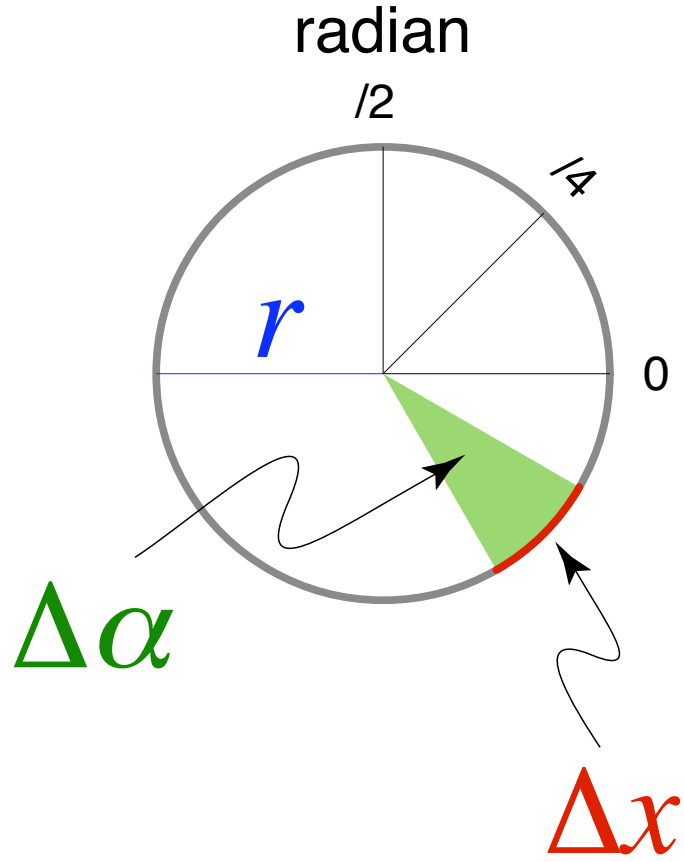
radian



RAD or R

... and calculating arc lengths





$$\Delta x = 2r\pi \cdot \frac{\Delta\alpha}{360°}$$

$$\Delta x = r \cdot \Delta\alpha$$

Quantities in kinematics

$$v = v_0 + a \cdot \Delta t$$

$$x = x_0 + v_0 \cdot \Delta t + \frac{1}{2} a \cdot \Delta t^2$$

$$\Delta x = \frac{1}{2} (v_0 + v) \cdot \Delta t$$

$$v^2 = v_0^2 + 2 \cdot a \cdot \Delta x$$

dislocation

velocity

acceleration

Quantities in rotational kinematics

$$\omega = \omega_0 + \alpha \cdot \Delta t$$

$$\theta = \theta_0 + \omega_0 \cdot \Delta t + \frac{1}{2} \alpha \cdot \Delta t^2$$

$$\Delta\theta = \frac{1}{2}(\omega_0 + \omega) \cdot \Delta t$$

$$\omega^2 = \omega_0^2 + 2 \cdot \alpha \cdot \Delta\theta$$

angular dislocation

angular velocity

angular acceleration

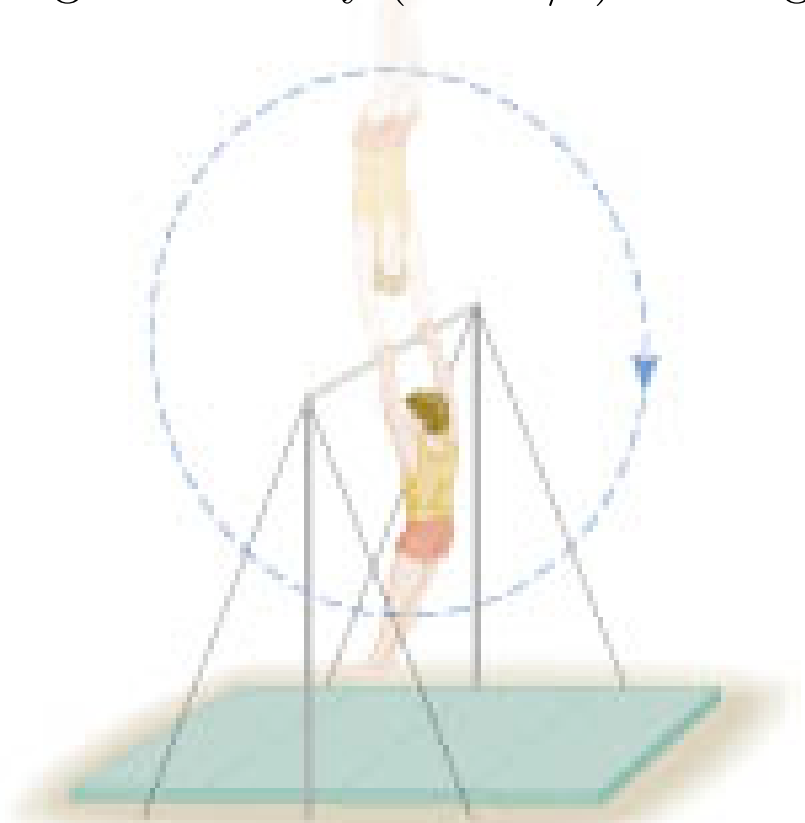
The Dictionary

t	t	t=t
x	θ	$x_T = r\theta$
$v = \frac{\Delta x}{\Delta t}$	$\omega = \frac{\Delta \theta}{\Delta t}$	$v_T = r\omega$
$a = \frac{\Delta v}{\Delta t}$	$\alpha = \frac{\Delta \omega}{\Delta t}$	$a_T = r\alpha$
$v = v_0 + a\,\Delta t$	$\omega = \omega_0 + \alpha\,\Delta t$	
$x = x_0 + v_0 + \frac{1}{2} a\,\Delta t^2$	$\theta = \theta_0 + \omega_0 + \frac{1}{2}\alpha\,\Delta t^2$	
$v^2 = v_0^2 + 2a\,\Delta x$	$\omega^2 = \omega_0^2 + 2\alpha\,\Delta\theta$	

$$\text{average angular velocity} = \frac{\text{angular displacement}}{\text{elapsed time}} \qquad \overline{\omega} = \frac{\Delta\theta}{\Delta t}$$

1 Gymnast on a High Bar

A gymnast on a high bar swings through two revolutions in a time of 1.90 sec. Find the average angular velocity (in rad/s) of the gymnast.



$$\text{average angular acceleration} = \frac{\text{change in angular velocity}}{\text{elapsed time}} \qquad \bar{\alpha} = \frac{\Delta\omega}{\Delta t}$$

2 A Jet Revving Its Engines

A jet awaiting clearance for takeoff is momentarily stopped on the runway. As seen from the front of one engine, the fan blades are rotating with an angular velocity of $-100\,\text{rad/s}$. (The negative sign indicates a clockwise rotation.) As the plane takes off, the angular velocity of the blades reaches $-300\,\text{rad/s}$ in a time of 14 s. Find the angular acceleration, assuming it to be constant.

3 A Helicopter Blade

A helicopter blade has an angular speed of $\omega = 6.50\,\text{rev/s}$ and an angular acceleration of $\alpha = 1.30\,\text{rev/s}^2$. For points 1 and 2 on the blade, find the magnitudes of the tangential speeds and the tangential acceleration.