Wrocław University of Science and Technology

Physics

JZL1001913C

summer semester

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Wednesday, 18:20 - 19:50

Friday, 18:20 - 19:50

virtual room (ZOOM)

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Outline

- **Introduction - Physics rules the world**
- **Motion phenomena - Kinematics**
- **Motion phenomena - Dynamics**
- **Rotational motion**
- **Harmonic motion**
- **Gravitational field**
- **Relativistic phenomena**
- **Basics of Thermodynamics**
- **Principles of Thermodynamics**
- **Fluids Statics**
- **Electrostatics**
- **Electric current**
- **Magnetic field**
- **Vibrations and electromagnetic waves**

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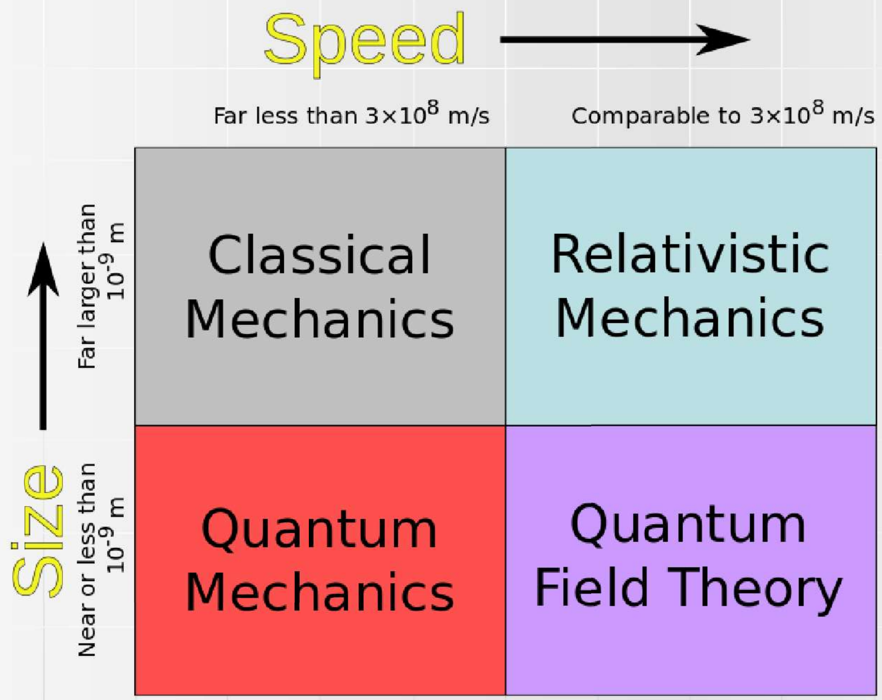
Units - rewiev

Quantity	Unit Name	Unit Symbol
Time	second	s
Length	metre	m
Mass	kilogram	kg
electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	Cd

- SI Units
- Prefixes
- Scientifical notation
- Significant Figures
- Decimal Places

Newtonian Mechanics

Newtonian mechanics does not apply to all situations. If the speeds of the interacting bodies are very large —an appreciable fraction of the speed of light—we must replace Newtonian mechanics with Einstein's special theory of relativity, which holds at any speed, including those near the speed of light. If the interacting bodies are on the scale of atomic structure (for example, they might be electrons in an atom), we must replace Newtonian mechanics with quantum mechanics.



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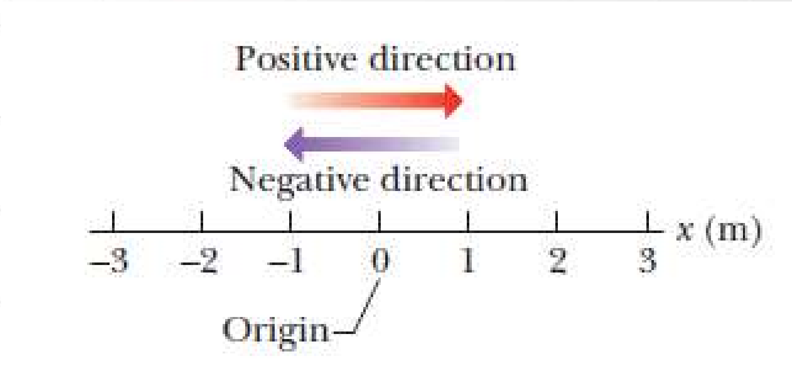
Kinematics - rewiev



Quantities:

- Position vs displacement
- Speed vs velocity
- Acceleration
- Free fal

$$\Delta x = x_2 - x_1$$

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}.$$

$$s_{avg} = \frac{\text{total distance}}{\Delta t}.$$

Equation	Missing Quantity
$v = v_0 + at$	$x - x_0$
$x - x_0 = v_0 t + \frac{1}{2}at^2$	v
$v^2 = v_0^2 + 2a(x - x_0)$	t
$x - x_0 = \frac{1}{2}(v_0 + v)t$	a
$x - x_0 = vt - \frac{1}{2}at^2$	v_0

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Dynamics - rewiev

Energy	1 Joule = 1 kg • m²/s²
Potential Energy (gravity)	PE_{grav} = mass • g • height PE_{grav} = m * • g • h
Elastic Energy (springs)	$PE_{spring} = 0.5 \bullet k \bullet x^2$ where k = spring constant x = amount of compression (relative to equilibrium position)
Kinetic Energy (movement)	$KE = 0.5 \bullet m \bullet v^2$ where **m** = mass of object **v** = speed of object

Quantities:

- Force
- Momentum
- Work
- Power
- Energy

Force	Unit
$F = ma$	1 Newton =1kg * m/s²
Momentum $p = m \bullet v$	Unit 1 kg * m/s²
Work $W_F = F \cdot \Delta x$	Unit 1 Joule = 1 kg • m²/s²
Power $P = \frac{dE}{dt} = \frac{dW}{dt}$	Unit 1 Watt = 1 J/s = =1kg * m²/s³

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Dynamics - rewiev

Newton's First Law: The Law of Inertia

Every body remains in its state of rest, or of uniform motion in a straight line, unless it is compelled to change that state by forces impressed thereon

$$\vec{F}_{net} = m\vec{a} \quad \text{(Newton's second law)}$$

Main point of Newton's third law:

ACTION = REACTION

Laws:

- Three dynamics laws
- Momentum Conservation Principle
- Energy Conservation Principle

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Rotational motion

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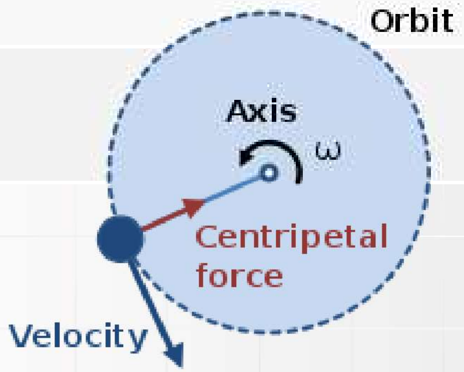
Force [1 Newton=1kg * m/s^2]

Centripetal force

$$F_c = ma_c = \frac{mv^2}{r}$$

$$a_c = \frac{v}{t}\hat{r} = \frac{r\omega}{t}\hat{r} = v\omega = \frac{v^2}{r}$$

Centripetal acceleration



Quantities:
- Angular displacement
- Period and frequency
  f = 1/s = 1Hz = 1s^{-1}
- Angular velocity
- Angular acceleration
- Centripetal and centrifugal force

Angular displacement $\Delta\theta = \theta_2 - \theta_1$	Unit rad
Angular velocity $\omega = 2\pi/T$	Unit rad/s
Angular acceleraton $\alpha = (\omega_{final} - \omega_{initial})/t$	Unit rad/s^2
Period -> T [s] Frequency -> 1/T	Unit 1 Herz = 1 1/s

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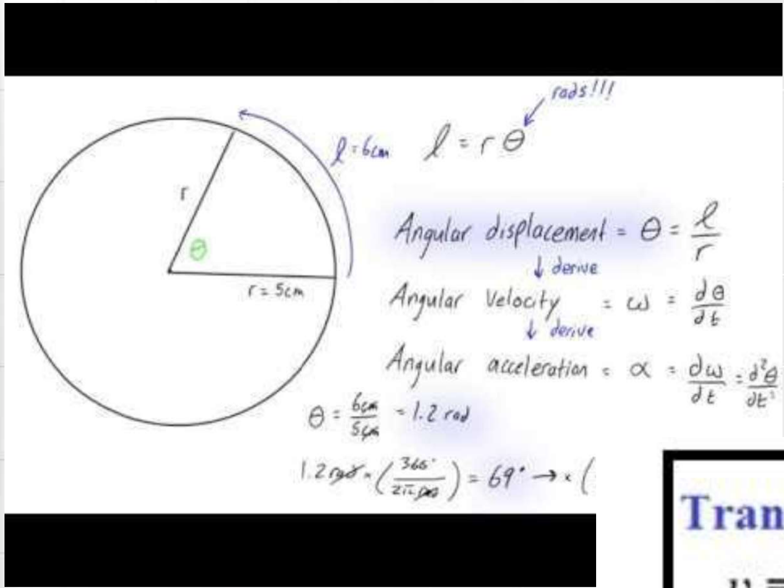
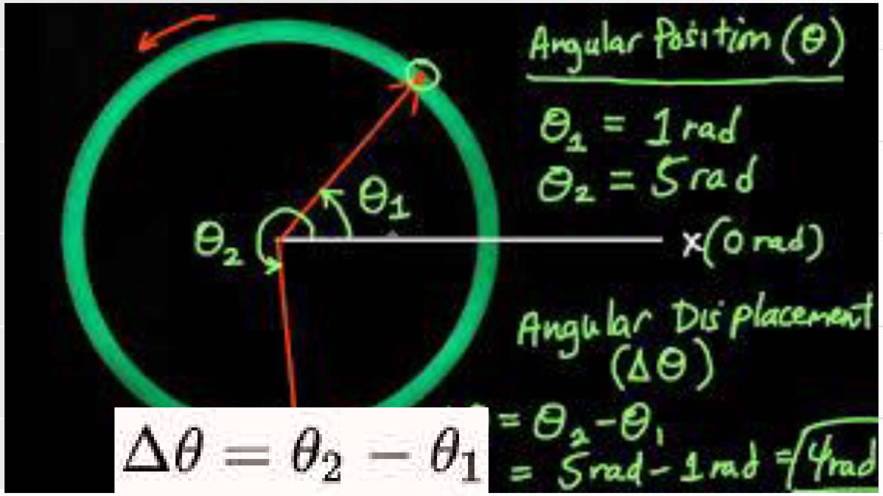
Rotational motion - kinematics





$$\Delta\theta = \theta_2 - \theta_1$$

$$\theta = \frac{s}{r}$$

Translational Motion		Rotational Motion
$v = v_0 + at$	$\longrightarrow$	$\omega = \omega_0 + \alpha t$
$x = x_0 + v_0 t + \frac{1}{2}at^2$	$\longrightarrow$	$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
$v^2 = v_0^2 + 2ax$	$\longrightarrow$	$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

$$1 \text{ revolution } = 360^\circ = 2\pi \text{ radians, and}$$
$$1 \text{ rad} = \frac{180^\circ}{\pi} \approx 57.27^\circ.$$

Where

- θ_0 = initial angular displacement of the rotating body
- ω_0 = initial angular velocity of the body.
- α = angular acceleration, which is constant is this section.

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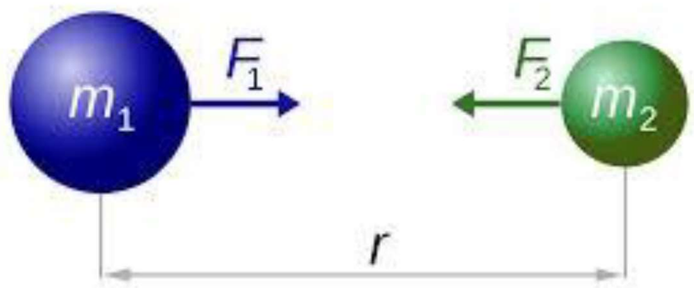
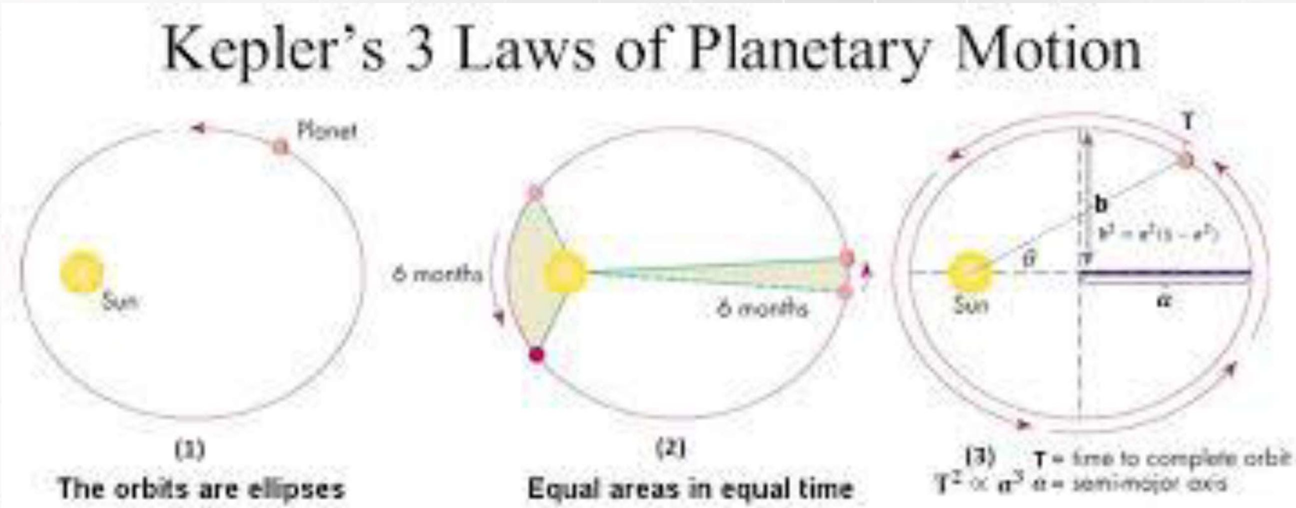
Gravitational field - review



$$F_1 = F_2 = G\frac{m_1 \times m_2}{r^2}$$

$$g = G\frac{M}{r^2}$$

$$G = 6.674 \times 10^{-11}\frac{\mathrm{N} \cdot \mathrm{m}^2}{\mathrm{kg}^2}$$



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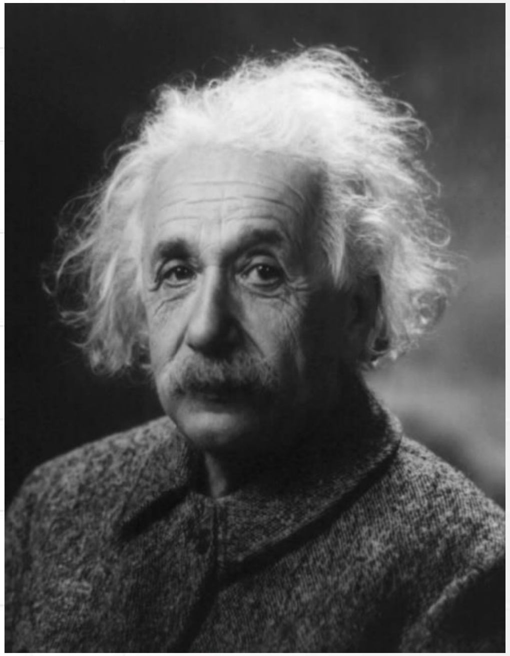
Motion phenomena – Relativistic phenomena



INERTIAL REFERENCE FRAME

An **inertial frame of reference** is a reference frame in which a body at rest remains at rest and a body in motion moves at a constant speed in a straight line unless acted on by an outside force.

FIRST POSTULATE OF SPECIAL RELATIVITY

The laws of physics are the same and can be stated in their simplest form in all inertial frames of reference.

SECOND POSTULATE OF SPECIAL RELATIVITY

The speed of light c is a constant, independent of the relative motion of the source.

Relativity is the study of how different observers measure the same event.

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Motion phenomena – Relativistic phenomena

$$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$

Term	Formula
Time dilation	$\Delta t = \Delta t_0 \gamma = \frac{\Delta t_0}{\sqrt{1-\frac{v^2}{c^2}}}$
Length Contraction	$L = \frac{L_0}{\gamma} = L_0\sqrt{1-\frac{v^2}{c^2}}$
Mass of a body at rest	$\Delta m_0 = \frac{\Delta E_0}{c^2}$
Relativistic momentum	$\mathrm{m}v\gamma = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}$
Total Energy	$\mathrm{m}c^2\gamma = \frac{\mathrm{m}c^2}{\sqrt{1-\frac{v^2}{c^2}}}$