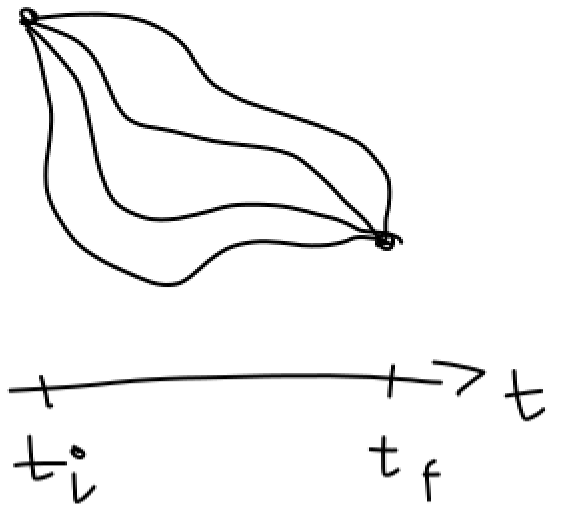
Lögmál Newtons -- aflfræði

Höfum hreyfilýsingu, hvernig $x(t)$, $v(t)$, og $a(t)$ tengjast.
Viljum skilja hvað veldur hreyfingu og hvernig hún þróast í tíma og rúmi.

Við munum nota aflfræði Newtons -- hreyfing undir áhrifum krafta
--> hreyfijöfnur

Um svipað leyti og Newton setti fram sín lögmál varð til önnur aðferð:
byggð á hnikareikningi:

$$S = \int_{t_i}^{t_f} L \, dt \, , \quad L = K - U \, , \quad \delta S = 0$$



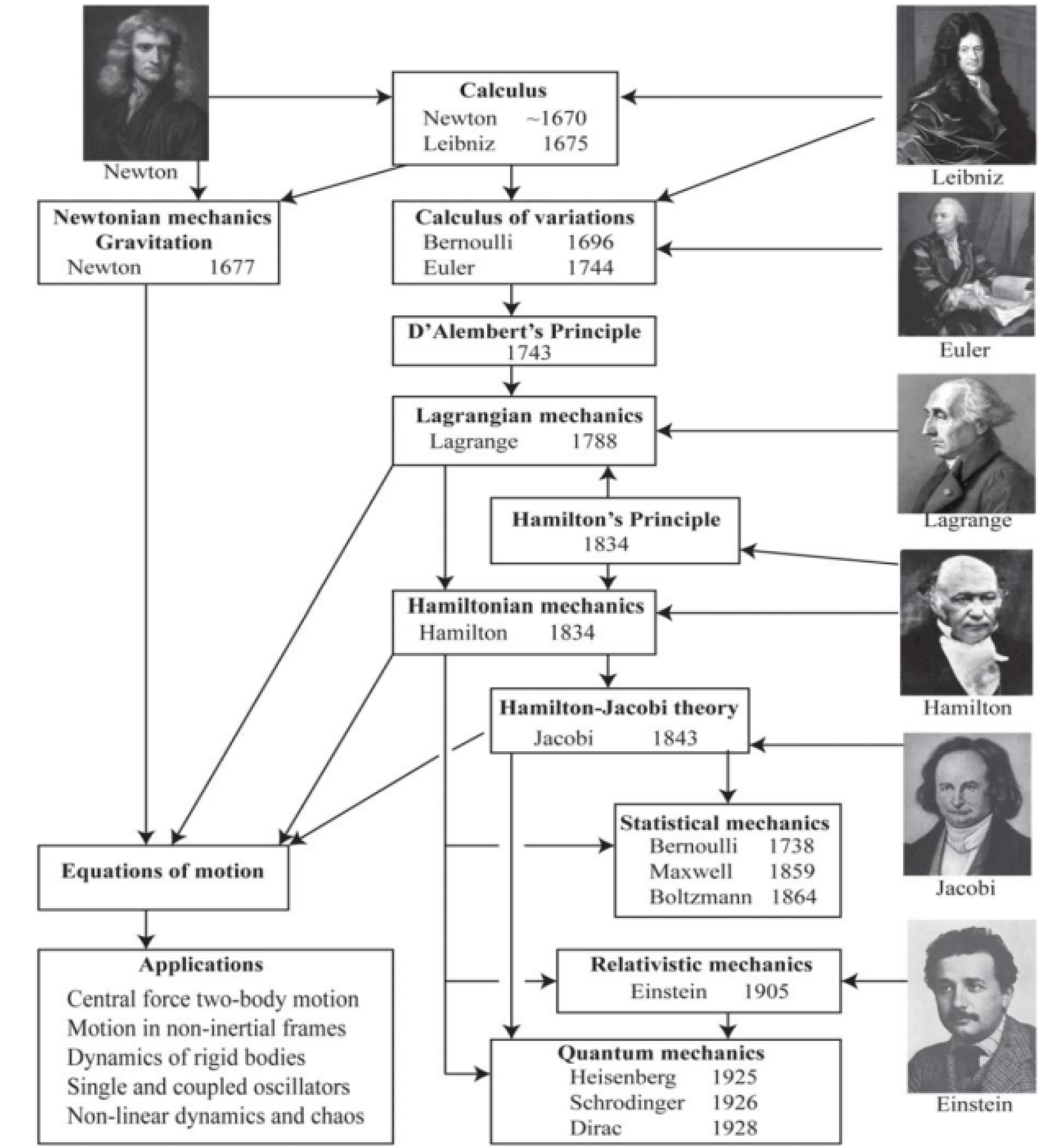


Figure 1.1: Chronological roadmap of the parallel development of the Newtonian and Variational-principles approaches to classical mechanics.

Þróun aflfræðinnar
úr bókinni:
Variational Principles
in Classical Mechnics

Douglas Cline

frjáls á vefnum:

http://classicalmechanics
.lib.rochester.edu

Kraftar

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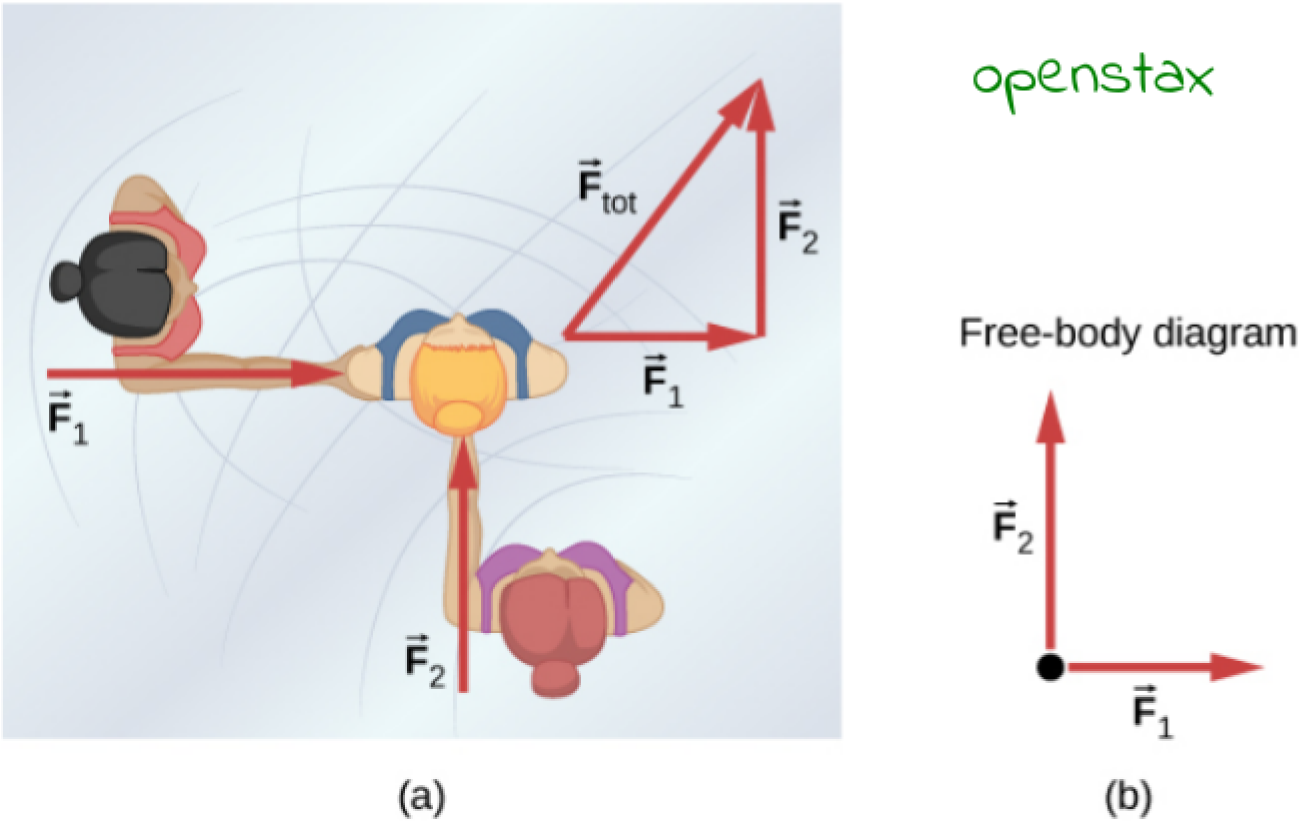

Figure 5.3 (a) An overhead view of two ice skaters pushing on a third skater. Forces are vectors and add like other vectors, so the total force on the third skater is in the direction shown. (b) A free-body diagram representing the forces acting on the third skater.

Figure 5.3(b) is our first example of a **free-body diagram**, which is a sketch showing all external forces acting on an object or system. The object or system is represented by a single isolated point (or free body), and only those forces acting *on* it that originate outside of the object or system—that is, **external forces**—are shown. (These forces are the only ones shown because only external forces acting on the free body affect its motion. We can ignore any internal forces within the body.) The forces are represented by vectors extending outward from the free body.

(a) Box at rest on a horizontal surface (b) Box on an inclined plane

Figure 5.4 In these free-body diagrams, $\vec{N}$ is the normal force, $\vec{w}$ is the weight of the object, and $\vec{f}$ is the friction.

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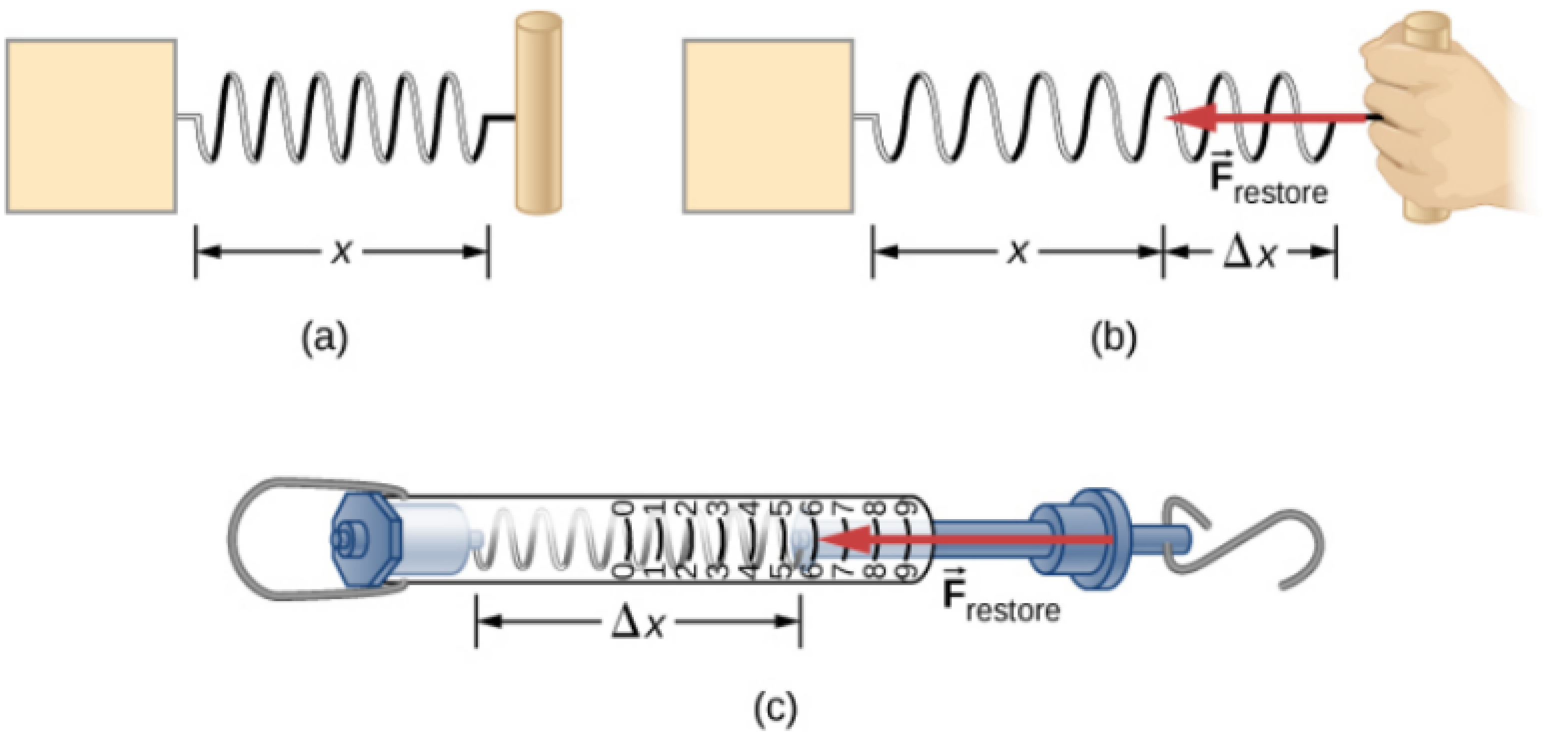

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<u>Mæling krafta</u>

regla Hooks fyrir gorm

$$F = -k\Delta X$$

kraftstuðull k

Fyrsta lögmál Newtons

Newton's First Law of Motion

A body at rest remains at rest or, if in motion, remains in motion at constant velocity unless acted on by a net external force.

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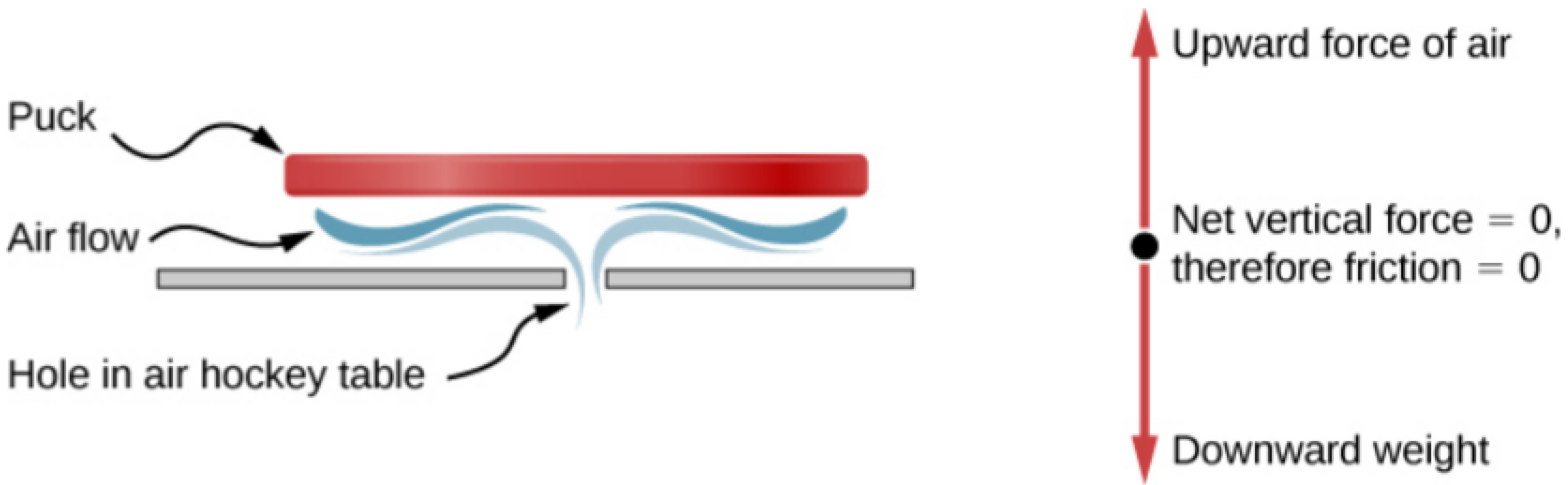
Tregðulögmálið



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Tregðukerfi

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Inertial Reference Frame

A reference frame moving at constant velocity relative to an inertial frame is also inertial. A reference frame accelerating relative to an inertial frame is not inertial.

Kerfi sem snýst miðað við tregðukerfi er ekki tregðukerfi ....

svo strangt tiltekið er yfirborð jarðar ekki tregðukerfi, áhrif þess sjást vel í veðurkerfum ...

Annað lögmál Newtons

Newton's Second Law of Motion

The acceleration of a system is directly proportional to and in the same direction as the net external force acting on the system and is inversely proportion to its mass. In equation form, Newton's second law is

$$\vec{\mathbf{a}} = \frac{\vec{\mathbf{F}}_{\text{net}}}{m},$$

where $\vec{\mathbf{a}}$ is the acceleration, $\vec{\mathbf{F}}_{\text{net}}$ is the net force, and m is the mass. This is often written in the more familiar form

$$\vec{\mathbf{F}}_{\text{net}} = \sum \vec{\mathbf{F}} = m\vec{\mathbf{a}}, \quad 5.3$$

but the first equation gives more insight into what Newton's second law means. When only the magnitude of force and acceleration are considered, this equation can be written in the simpler scalar form:

$$F_{\text{net}} = ma. \quad 5.4$$

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Ytri kraftar orsaka hröðun kerfis

(Hreyfijöfnur)

Við skoðum aðallega, $F = F(t)$

$$\rightarrow \quad m\bar{a} = \bar{F}(t)$$

$$\rightarrow \quad m\frac{d^2\bar{x}}{dt^2} = \bar{F}(t)$$

Einföld hreyfijafna, afleiðujafna sem leysa má með upphafs-skilyrðum og beinni heildun

oft er kraftur háður staðsetningu $F = F(x)$

$$\rightarrow \quad m\frac{d^2\bar{x}}{dt^2} = \bar{F}(\bar{x})$$

Annars stigs afleiðujöfnuhneppi sem venjulega verður ekki leyst með beinni heildun. Leysist sem afleiðujöfnuhneppi með greini eða tölulegum aðferðum eftir að upphafsgildi eru fest

þyngdarkraftur, gormkraftur ....

Skriðþungi

Skilgreinum skriðþunga

$$\vec{\mathbf{p}} = m\vec{\mathbf{v}}$$

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Fyrsta lögmálið er þá um varðveislu skriðþunga, og annað lögmálið lýsir hvernig ytri kraftur getur breytt skriðþunganum

$$\vec{\mathbf{F}}_{\text{net}} = \frac{d\vec{\mathbf{p}}}{dt}$$

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$$\vec{\mathbf{F}}_{\text{net}} = \frac{d\vec{\mathbf{p}}}{dt} = \frac{d\left(m\vec{\mathbf{v}}\right)}{dt}$$

$$\vec{\mathbf{F}}_{\text{net}} = m\frac{d\left(\vec{\mathbf{v}}\right)}{dt} = m\vec{\mathbf{a}}$$

þyngd

Eining krafts er "Newton"

$$1\,N = 1\,\frac{kg\,m}{s^2}, \quad (F = ma)$$

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Weight

The gravitational force on a mass is its weight. We can write this in vector form, where $\vec{\mathbf{w}}$ is weight and m is mass, as

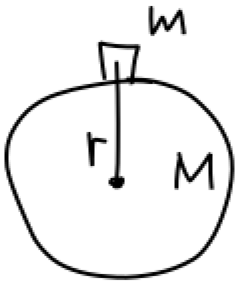
$$\vec{\mathbf{w}} = m\vec{\mathbf{g}}. \qquad 5.8$$

In scalar form, we can write

$$w = mg. \qquad 5.9$$

vegna þyngdarkrafts Newtons

$$|F| = G\,\frac{mM}{r^2}$$



$$\rightarrow \; mg = G\,\frac{mM}{r^2}$$

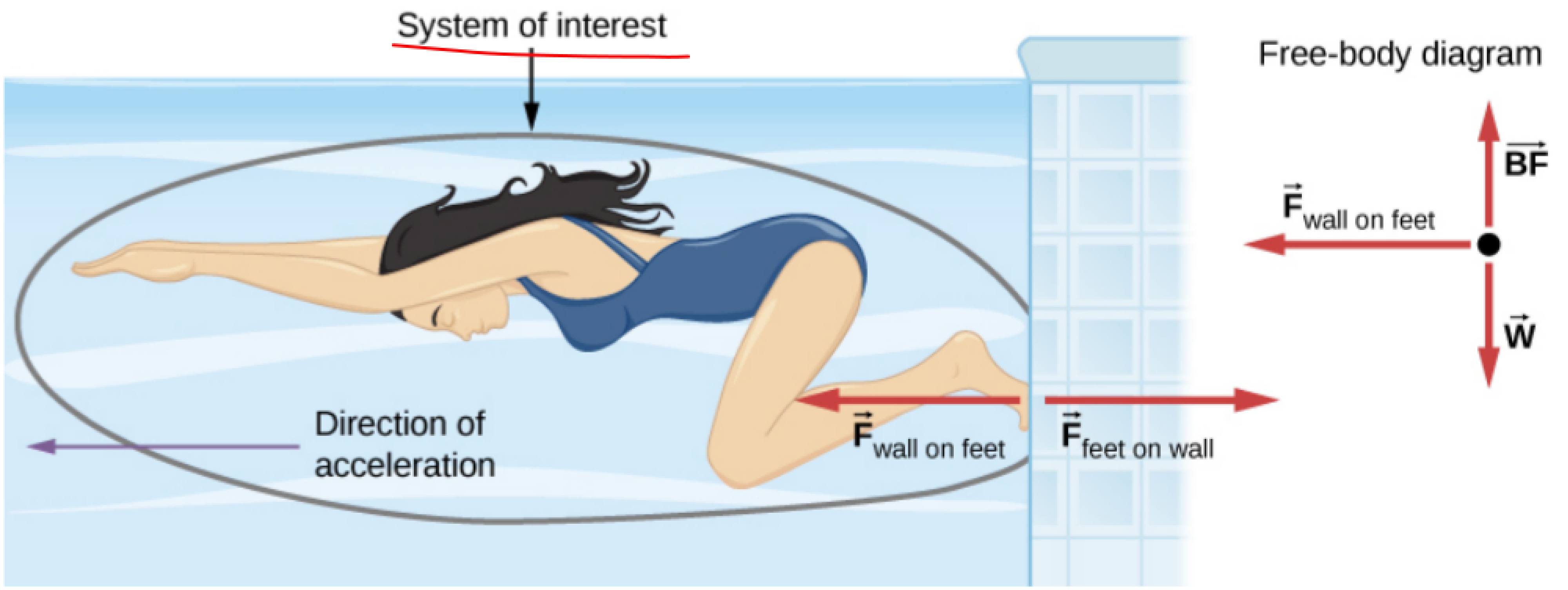
$$\rightarrow \; g = \frac{GM}{r^2}$$

Þriðja lögmál Newtons

Newton's Third Law of Motion

Whenever one body exerts a force on a second body, the first body experiences a force that is equal in magnitude and opposite in direction to the force that it exerts. Mathematically, if a body A exerts a force $\vec{\mathbf{F}}$ on body B, then B simultaneously exerts a force $-\vec{\mathbf{F}}$ on A, or in vector equation form,

$$\vec{\mathbf{F}}_{AB} = -\vec{\mathbf{F}}_{BA}. \quad (5.10)$$



Hér þarf að athuga vel hvaða "kerfi" við erum að skoða, og hverjir eru ytri kraftarnir á það

Skoðum betur með dæmum næst