# I. Stokes' theorem example

```
#showybox(
  title: "Stokes' theorem",
  frame: (
    border-color: blue,
    title-color: blue.lighten(30%),
    body-color: blue.lighten(95%),
    footer-color: blue.lighten(80%)
  ),
  footer: "Information extracted from a well-known public encyclopedia"
)[
  Let $Sigma$ be a smooth oriented surface in $RR^3$ with boundary $diff Sigma equiv Gamma$. If a vector field $bold(F)(x,y,z)=(F_x(x,y,z), F_y(x,y,z), F_z(x,y,z))$ is defined and has continuous first order partial derivatives in a region containing $Sigma$, then

  $ integral.double_Sigma (bold(nabla) times bold(F)) dot bold(Sigma) = integral.cont_(diff Sigma) bold(F) dot dif bold(Gamma) $
]
```

Stokes' theorem

Let $\Sigma$ be a smooth oriented surface in $\mathbb{R}^3$ with boundary $\partial\Sigma \equiv \Gamma$. If a vector field $\boldsymbol{F}(x, y, z) = \left(F_{x(x,y,z)}, F_{y(x,y,z)}, F_{z(x,y,z)}\right)$ is defined and has continuous first order partial derivatives in a region containing $\Sigma$, then

$$\iint_{\Sigma} (\boldsymbol{\nabla} \times \boldsymbol{F}) \cdot \boldsymbol{\Sigma} = \oint_{\partial\Sigma} \boldsymbol{F} \cdot \mathrm{d}\boldsymbol{\Gamma}$$

Information extracted from a well-known public encyclopedia

# II. Gauss's Law example

```
#showybox(
  frame: (
    border-color: red.darken(30%),
    title-color: red.darken(30%),
    radius: 0pt,
    thickness: 2pt,
    body-inset: 2em,
    dash: "densely-dash-dotted"
  ),
  title: "Gauss's Law"
)[
  The net electric flux through any hypothetical closed surface is equal to $1/epsilon_0$ times the net electric charge enclosed within that
```

```
  closed surface. The closed surface is also referred to as Gaussian
  surface. In its integral form:

  $ Phi_E = integral.surf_S bold(E) dot dif bold(A) = Q/epsilon_0 $
]
```

Gauss's Law

The net electric flux through any hypothetical closed surface is equal to $\frac{1}{\varepsilon_0}$ times the net electric charge enclosed within that closed surface. The closed surface is also referred to as Gaussian surface. In its integral form:

$$\Phi_E = \oiint_S \boldsymbol{E} \cdot \mathrm{d}\boldsymbol{A} = \frac{Q}{\varepsilon_0}$$

## III. Carnot's cycle efficency example

```
#showybox(
  title-style: (
    weight: 900,
    color: red.darken(40%),
    sep-thickness: 0pt,
    align: center
  ),
  frame: (
    title-color: red.lighten(80%),
    border-color: red.darken(40%),
    thickness: (left: 1pt),
    radius: 0pt
  ),
  title: "Carnot cycle's efficency"
)[
  Inside a Carnot cycle, the efficiency $eta$ is defined to be:

  $ eta = W/Q_H = frac(Q_H + Q_C, Q_H) = 1 - T_C/T_H $
]
```

**Carnot cycle's efficency**

Inside a Carnot cycle, the efficiency $\eta$ is defined to be:

$$\eta = \frac{W}{Q_H} = \frac{Q_H + Q_C}{Q_H} = 1 - \frac{T_C}{T_H}$$

## IV. Clairaut's theorem example

```
#showybox(
  title-style: (
    boxed-style: (
      anchor: (
        x: center,
        y: horizon
      ),
      radius: (top-left: 10pt, bottom-right: 10pt, rest: 0pt),
    )
  ),
  frame: (
    title-color: green.darken(40%),
    body-color: green.lighten(80%),
    footer-color: green.lighten(60%),
    border-color: green.darken(60%),
    radius: (top-left: 10pt, bottom-right: 10pt, rest: 0pt)
  ),
  title: "Clairaut's theorem",
  footer: text(size: 10pt, weight: 600, emph("This will be useful every time you want to interchange partial derivatives in the future."))
)[
  Let $f: A arrow RR$ with $A subset RR^n$ an open set such that its cross derivatives of any order exist and are continuous in $A$. Then for any point $(a_1, a_2, ..., a_n) in A$ it is true that

  $ frac(diff^n f, diff x_i ... diff x_j)(a_1, a_2, ..., a_n) = frac(diff^n f, diff x_j ... diff x_i)(a_1, a_2, ..., a_n) $
]
```

Clairaut's theorem

Let $f : A \to \mathbb{R}$ with $A \subset \mathbb{R}^n$ an open set such that its cross derivatives of any order exist and are continuous in $A$. Then for any point $(a_1, a_2, ..., a_n) \in A$ it is true that

$$\frac{\partial^n f}{\partial x_i ... \partial x_j}(a_1, a_2, ..., a_n) = \frac{\partial^n f}{\partial x_j ... \partial x_i}(a_1, a_2, ..., a_n)$$

*This will be useful every time you want to interchange partial derivatives in the future.*

## V. Divergence theorem example

```
#showybox(
  footer-style: (
    sep-thickness: 0pt,
```

```
    align: right,
    color: black
  ),
  title: "Divergence theorem",
  footer: [
    In the case of $n=3$, $V$ represents a volumne in three-dimensional space, and $diff V = S$ its surface
  ]
)[
  Suppose $V$ is a subset of $RR^n$ which is compact and has a piecewise smooth boundary $S$ (also indicated with $diff V = S$). If $bold(F)$ is a continuously differentiable vector field defined on a neighborhood of $V$, then:

  $ integral.triple_V (bold(nabla) dot bold(F)) dif V = integral.surf_S (bold(F) dot bold(hat(n))) dif S $
]
```

Divergence theorem

Suppose $V$ is a subset of $\mathbb{R}^n$ which is compact and has a piecewise smooth boundary $S$ (also indicated with $\partial V = S$). If $\boldsymbol{F}$ is a continuously differentiable vector field defined on a neighborhood of $V$, then:

$$\iiint_V (\boldsymbol{\nabla} \cdot \boldsymbol{F})\, \mathrm{d}V = \oiint_S (\boldsymbol{F} \cdot \hat{\boldsymbol{n}})\, \mathrm{d}S$$

In the case of $n = 3$, $V$ represents a volumne in three-dimensional space, and $\partial V = S$ its surface

## VI. Coulomb's law example

```
#showybox(
  shadow: (
    color: yellow.lighten(55%),
    offset: 3pt
  ),
  frame: (
    title-color: red.darken(30%),
    border-color: red.darken(30%),
    body-color: red.lighten(80%)
  ),
  title: "Coulomb's law"
)[
  Coulomb's law in vector form states that the electrostatic force $bold(F)$ experienced by a charge $q_1$ at position $bold(r)$ in the vecinity of another charge $q_2$ at position $bold(r')$, in a vacuum is equal to
```

```
  $ bold(F) = frac(q_1 q_2, 4 pi epsilon_0) frac(bold(r) - bold(r'), bar.v bold(r) - bold(r') bar.v^3) $
]
```

Coulomb's law

Coulomb’s law in vector form states that the electrostatic force $\boldsymbol{F}$ experienced by a charge $q_1$ at position $\boldsymbol{r}$ in the vecinity of another charge $q_2$ at position $\boldsymbol{r}'$, in a vacuum is equal to

$$\boldsymbol{F} = \frac{q_1 q_2}{4\pi\varepsilon_0} \frac{\boldsymbol{r} - \boldsymbol{r}'}{|\ \boldsymbol{r} - \boldsymbol{r}'|^3}$$

## VII. Newton’s second law example

```
#block(
  height: 4.5cm,
  inset: 1em,
  fill: luma(250),
  stroke: luma(200),
  breakable: false,
  columns(2)[
    #showybox(
      title-style: (
        boxed-style: (
          anchor: (x: center, y: horizon)
        )
      ),
      breakable: true,
      width: 90%,
      align: center,
      title: "Newton's second law"
    )[
      If a body of mass $m$ experiments an acceleration $bold(a)$ due to a net force $sum bold(F)$, this acceleration is related to the mass and force by the following equation:

      $ bold(a) = frac(sum bold(F), m) $
    ]
  ]
)
```

Newton's second law

If a body of mass $m$ experiments an acceleration $\boldsymbol{a}$ due to a net force $\sum \boldsymbol{F}$, this acceleration is related to the mass and force by the following equation:

$$\boldsymbol{a} = \frac{\sum \boldsymbol{F}}{m}$$

## VIII. Encapsulation example

```
#showybox(
  title: "Parent container",
  lorem(10),
  columns(2)[
    #showybox(
      title-style: (boxed-style: (:)),
      title: "Child 1",
      lorem(10)
    )
    #colbreak()
    #showybox(
      title-style: (boxed-style: (:)),
      title: "Child 2",
      lorem(10)
    )
  ]
)
```

Parent container

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do.

Child 1

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do.

Child 2

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do.