Typesetting a math(s) textbook with ConTEXt

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Produced with free software: ConTEXt, Emacs, and xpdf.

Take-home message

Configurable, well-integrated design of ConTEXt makes it possible and enjoyable to typeset a technical textbook and deliver publication-quality, camera-ready copy.

What worries me with other systems

Make sure it comes last of your loaded packages, to give it a fighting chance of not being over-written, since its job is to redefine many LaTeX commands.

—*Hypertext marks in LaTeX: A manual for hyperref* (Sept 2006)

Simplify by subdividing: projects/products/compenents

Makefile
env.tex *setups global to whole project*
project.bib
project.tex
book/
  book.tex *product file*
  env_book.tex *setups local to the book*
  titlepage.tex
  dimensions.tex *chapter 1*
  . . .
  fig.mp
inputs/
  defs.mp
  defs.tex
util/
  chapterpdf.py *parses .tuo file to extract chapters*

Simplify by subdividing: projects/products/compenents

The project file project.tex:

```
\startproject project
\environment env
\product book/book
\stopproject
```

Simplify by subdividing: projects/products/compenents

The beginning of book.tex, the product file:

```
\startproduct book
\project project
\environment env_book

\component titlepage
\completecontent
\component dimensions     % chapter 1
\component extreme-cases  % chapter 2
% ...
\stopproduct
```

Simplify by subdividing: projects/products/compenents

Beginning of Chapter 1 (`dimensions.tex`):

```
\startcomponent dimensions
\product book
\project project

\startnotmode[*product]
  \environment env_book
\stopnotmode

% ... lots of math and words ...

\endchapter
```

Simplify by subdividing: projects/products/compenents

Here is the definition of endchapter:

```
\def\endchapter{%
\startnotmode[*product]
  \subject{References}
  \placepublications[criterium=chapter]
\stopnotmode
\stopcomponent}
```

Use modes for flexibility

Last example used modes to make components almost self-contained.

Other uses include color, black/white, or screen formats:

```
% for cheaper (black/white) printing
\startnotmode[color]
  \definecolor[headingcolor][black]
\stopnotmode

% for expensive printing
\startmode[color]
  \definecolor[headingcolor][red]
\stopmode

% for online viewing: use internal and external PDF hyperlinks
\startnotmode[print]
  \setupinteraction[state=start]
\stopnotmode
```

Make publication-ready papersizes and layouts

This derivation has many spots to make algebra mistakes: for example, forgetting to take the square root when solving for t_0, or dividing rather than multiplying by g when finding the speed. Probably I would not make those mistakes on a simple problem, but I want to develop methods for when the problems become complex and the pitfalls numerous.

Here's the same problem rewritten so that dimensions help you analyze it:

> A ball falls from a height h. Find its speed when it hits the ground, given a gravitational acceleration of g and neglecting air resistance.

In this version, the dimensions of h and g are part of the quantities. The reunion helps you guess the final speed without solving differential equations. There is one caveat: It helps if you know the dimensions of the quantities. In some fields, such as electromagnetism, the systems of units are miserable. For example, what are the dimensions of magnetic field? Electric field? But learning such dimensions helps solve many electromagnetic problems. Fortunately, most problems including the free-fall problem involve quantities with simple dimensions.

Problem: Energy and power. In terms of length L, mass M, and time T, find the dimensions of energy and of power.

In the free-fall problem, the dimensions of height h are length or L for short. The dimensions of g are length per time squared or LT^{-2}, where T stands for the dimension of time, and the dimensions of speed are LT^{-1}. The speed is a function of g and h, so look for a combination of g and h with the correct dimensions.

Problem: A candidate. Show that $\sqrt{gh}$ is one combination of g and h with the dimensions of speed.

Here are the dimensions of $\sqrt{gh}$:

$$\sqrt{\mathrm{LT}^{-2} \times \mathrm{L}} = \sqrt{\mathrm{L}^2\mathrm{T}^{-2}} = \mathrm{LT}^{-1},$$

which are, as hoped, the dimensions of speed. Is $\sqrt{gh}$ the only option?

Make publication-ready papersizes and layouts

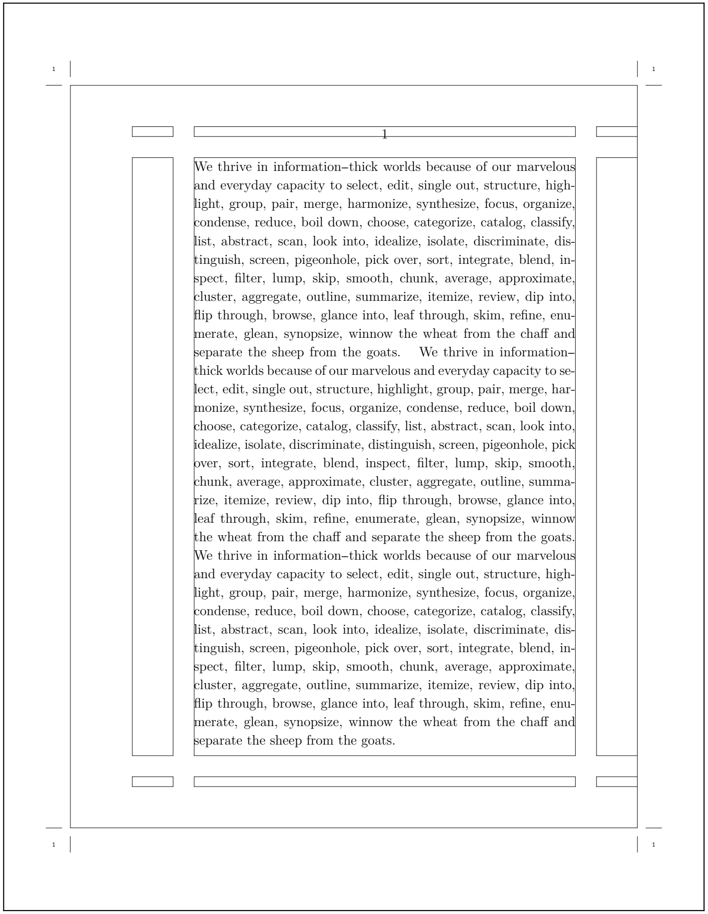
From book/env_book.tex:

```
\definepapersize[bookpage][width=6.875in,height=9in]
\setuppapersize[bookpage][letter]

\setuplayout[marking=on,location=middle,
backspace=1.5in,leftmargindistance=0.25in,leftmargin=0.5in,
width=4.625in,rightmargindistance=0.25in,rightmargin=0.5in,
topspace=0.5in, header=0.125in, headerdistance=0.25in,
height=middle,
footerdistance=0.25in, footer=0.125in,
bottomdistance=0.5in,bottom=24pt]

% needs to go after the \setuplayout ?
\baselineskip=3.136ex  % should use \setupinterspace instead!
```

Make publication-ready papersizes and layouts



1

We thrive in information–thick worlds because of our marvelous and everyday capacity to select, edit, single out, structure, highlight, group, pair, merge, harmonize, synthesize, focus, organize, condense, reduce, boil down, choose, categorize, catalog, classify, list, abstract, scan, look into, idealize, isolate, discriminate, distinguish, screen, pigeonhole, pick over, sort, integrate, blend, inspect, filter, lump, skip, smooth, chunk, average, approximate, cluster, aggregate, outline, summarize, itemize, review, dip into, flip through, browse, glance into, leaf through, skim, refine, enumerate, glean, synopsize, winnow the wheat from the chaff and separate the sheep from the goats. We thrive in information–thick worlds because of our marvelous and everyday capacity to select, edit, single out, structure, highlight, group, pair, merge, harmonize, synthesize, focus, organize, condense, reduce, boil down, choose, categorize, catalog, classify, list, abstract, scan, look into, idealize, isolate, discriminate, distinguish, screen, pigeonhole, pick over, sort, integrate, blend, inspect, filter, lump, skip, smooth, chunk, average, approximate, cluster, aggregate, outline, summarize, itemize, review, dip into, flip through, browse, glance into, leaf through, skim, refine, enumerate, glean, synopsize, winnow the wheat from the chaff and separate the sheep from the goats. We thrive in information–thick worlds because of our marvelous and everyday capacity to select, edit, single out, structure, highlight, group, pair, merge, harmonize, synthesize, focus, organize, condense, reduce, boil down, choose, categorize, catalog, classify, list, abstract, scan, look into, idealize, isolate, discriminate, distinguish, screen, pigeonhole, pick over, sort, integrate, blend, inspect, filter, lump, skip, smooth, chunk, average, approximate, cluster, aggregate, outline, summarize, itemize, review, dip into, flip through, browse, glance into, leaf through, skim, refine, enumerate, glean, synopsize, winnow the wheat from the chaff and separate the sheep from the goats.

Should use joined figures and text

if we knew the 50-odd measurements. This situation is just the sort for which order-of-magnitude physics is designed; the problem is messy and underspecified. So we **lie skillfully**: We pretend that the storage space is a simple shape with a volume that we can find. In this case, we pretend that it is a rectangular prism (‘`armored-car-interior-figure`’).

To estimate the volume of the prism, we divide and conquer. We divide estimating the volume into estimating the three dimensions of the prism. The compound structure of the formula

$$V \sim \text{length} \times \text{width} \times \text{height} \tag{1.2}$$

suggests that we divide and conquer. Probably an average-sized person can lie down inside with room to spare, so each dimension is roughly 2 m, and the interior volume is

$$V \sim 2\,\text{m} \times 2\,\text{m} \times 2\,\text{m} \sim 10\,\text{m}^3 = 10^7\,\text{cm}^3. \tag{1.3}$$

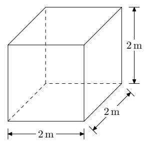


Figure 1.1. *Interior of a Brinks armored car. The actual shape is irregular, but to order of magnitude, the interior is a cube. A person can probably lie down or stand up with room to spare, so we estimate the volume as* $V \sim 2\,\text{m} \times 2\,\text{m} \times 2\,\text{m} \sim 10\,\text{m}^3$.

In this text, $2 \times 2 \times 2$ is almost always 10. We are already working with crude approximations, which we signal by using $\sim$ in $N \sim V/v$, so we do not waste effort in keeping track of a factor of 1.25 (from using 10 instead of 8). We converted the m^3 to cm^3 in anticipation of the dollar-bill-volume calculation: We want to use units that match the volume of a dollar bill, which is certainly much smaller than $1\,\text{m}^3$.

Now we estimate the volume of a dollar bill (the volumes of US denominations are roughly the same). You can lay a ruler next to a dollar bill, or you can just guess that a bill measures 2 or 3 inches by 6 inches, or $6\,\text{cm} \times 15\,\text{cm}$. To develop your feel for sizes, guess first; then, if you feel uneasy, check your answer with a ruler. As your feel for sizes develops, you will need to bring out the ruler less frequently. How thick is the dollar bill? Now we apply another order-of-magnitude technique: **guerrilla warfare**. We take any piece of information that we can get.[1] What’s a dollar bill? We lie skillfully and say that a dollar bill is just ordinary paper. How thick is paper? Next to the computer used to compose this textbook is an inkjet printer; next to the printer is a ream of printer paper. The ream (500 sheets) is roughly 5 cm thick, so a sheet of quality paper has thickness 10^{-2} cm. Now we have the pieces to compute the volume of the bill:

$$v \sim 6\,\text{cm} \times 15\,\text{cm} \times 10^{-2}\,\text{cm} \sim 1\,\text{cm}^3. \tag{1.4}$$

The original point of computing the volume of the armored car and the volume of the bill was to find how many bills fit into the car: $N \sim V/v \sim 10^7\,\text{cm}^3/1\,\text{cm}^3 = 10^7$. If the money is in \$20 bills, then the car would contain \$200 million.

The bills could also be \$1 or \$1000 bills, or any of the intermediate sizes. We chose the intermediate size \$20, because it lies nearly

1. *‘I seen my opportunities and I took ’em.’—George Washington Plunkitt, of Tammany Hall, quoted by Riordan [*`Riordan`*, page 3].*

My old layout in plain TeX:
It overloads short-term memory!

Join figures and text: The paragraph is the caption

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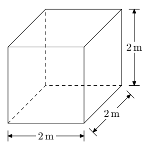

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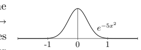
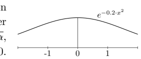
2.1.1 Extreme values of α

You can make the correct choice by by looking at the integrand $e^{-\alpha x^2}$ in the two extremes $\alpha \to \infty$ and $\alpha \to 0$. As α becomes large, the exponent $-\alpha x^2$ becomes large and negative even when x is only slightly greater than zero. The exponential of a large negative number is nearly zero, so the bell curve narrows, and its area shrinks. As $\alpha \to \infty$, the area and therefore the integral should shrink to zero. The first option, $\sqrt{\alpha\pi}$, instead goes to infinity. It must be wrong. The second option, $\sqrt{\pi/\alpha}$, goes to infinity and could be correct.



The complementary test is $\alpha \to 0$. The function flattens to the horizontal line $y = 1$; its integral over an infinite range is infinity. The first choice, $\sqrt{\pi\alpha}$, fails this test because instead it goes to zero as $\alpha \to 0$. The second option, $\sqrt{\pi/\alpha}$, goes to infinity and passes the test. So the second option passes both tests, and the first option fails both tests. This increases my confidence in $\sqrt{\pi/\alpha}$ while decreasing it, nearly to zero, in $\sqrt{\pi\alpha}$.



If those were the only choices, *and I knew that one choice was correct*, I would choose $\sqrt{\pi/\alpha}$. However, if the joker who wrote the problem also offered $\sqrt{2/\alpha}$ among the choices, then I need a test to distinguish between $\sqrt{2/\alpha}$ and $\sqrt{\pi/\alpha}$. For this test, use a third extreme case: $\alpha \to 1$. How can 1 be an extreme case? Infinity and zero are extreme, but 1 lies between those two so it cannot be an extreme.

2.1.2 The special case $\alpha = 1$

Speaking literally, 1 is a special case rather than an extreme case. So extend the meaning of extreme with poetic license and include special cases. The tool, named in full, would be the 'method of extreme and special cases'. Or, since extreme cases are also special, it could be the 'method of special cases'. The first option, although correct, is unwieldy. The second option, although also sharing the merit of correctness, is cryptic. It does not help you think of special cases, whereas 'extreme cases' does help you: It tells you to look at the extremes. So I prefer to keep

Overloads STM

Lowers cognitive load

Join figures and text: The paragraph is the caption

```
\definefloat[displayfig][figure]
\setupfloat[displayfig][rightmargindistance=-0.5in,
   default={force,none}]
\def\dfig#1{\placedisplayfig{}{\externalfigure[#1]}}
\def\rfig#1{\placedisplayfig[right,none]{}{\externalfigure[#1]}}
```

Use rfig when paragraph should wrap around the figure, and dfig for when figure is 'displayed'. Examples:

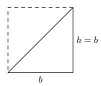
```
\rfig{fig.206}   % Directly use MetaPost EPS from fig.mp

You may wonder about the factor of one-third in the volumes of
this truncated pyramid. ...

The following figure is a redrawn tetrahedron:
\dfig{fig.207}
```

Join figures and text: The paragraph is the caption

1 Tetrahedrons



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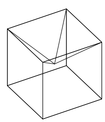
The following figure shows the result of combining six tetrahedrons:



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Improve navigation using local tables of contents

2 Extreme cases

The next item for your toolbox is the method of **extreme cases**. You can use it to check results and even to guess them, as the following examples illustrate.

2.1 Gaussian integral revisited

An integral from **Section 1.3**, on using dimensions to guess integrals, illustrates extreme cases as well as dimensions. Which of these results is correct:

$$\int_{-\infty}^{\infty} e^{-\alpha x^2}\,dx = \begin{cases} \sqrt{\alpha\pi} \\ \text{or} \\ \sqrt{\dfrac{\pi}{\alpha}} \end{cases} \quad ?$$

Dimensional analysis answered this question, as could variable substitution, but forget that knowledge for the moment so that you can practice a new technique: Learn a new technique in a familiar context, then use it in a less-familiar context.


```
\placecontent[criterium=chapter,level=section]
```

Improve navigation using local tables of contents

```
\def\localcontents{\startframedtext[corner=round]
\relax  % probably not needed but I'm paranoid and lazy
\placecontent[criterium=chapter, level=section]
\stopframedtext\medskip
\noindent\ignorespaces   % A for effort, but doesn't work
}

\setuphead[chapter][after={\vskip1.5in\localcontents}]
```

Summary: Benefits of using ConTEXt

With ConTEXt's clean design, you can do complicated technical typesetting and layout yourself to make a publication-quality document and deliver camera-ready copy.

Unexpected benefit: Easier to convince the publishers to release the book under the GNU GPL free-software license (licence).