Problem	1.3	1.5	1.7(abc)	1.13	1.15	Total
Points						

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Math 174
Homework 1
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1 (Sagan 1.13). Here's an example of some things you can do with my pset class, and the associated packages it loads in.

Solution.

(a) Make an enumerated list! The default labeling scheme is paren-wrapped letters. But because I load in `enumitem`, you can also make things like

(1) A list with paren-wrapped numbers

i) A list with lower-case roman letters, with parens on the right-hand side

ii) See here for more.

(b) you can make text different colors!

■

You can change the text displayed at the start of solutions! Woohoo!

You can also change the QED symbol: △

Solution. . . . As well as doing a ton of cool math stuff. Let's see some examples:

$$\begin{aligned} f(x) &= \text{you can align things!} \\ &= \frac{1}{3x^2 + \sinh\left(\frac{1}{2x}\right)} \end{aligned}$$

and interrupt align environments briefly for an aside. . .

$$= g\Big(\exp\left(kx^{3/2}\right)\Big)$$

before resuming again! You can do casework

(1) Case 1: [. . .] ✓

(2) Case 2: [. . .] ✓

you can cancel things in equations:

$$\frac{1}{\cancel{\omega\kappa\eta^2}} \frac{\cancel{\kappa\eta^2}}{x^2}$$

note that `\cancel` and `\bcancel` go in different directions. There's always things like `\cancelto`

$$\begin{aligned} \int_{t_1}^{t_2} \left(\frac{\partial \mathcal{L}}{\partial \ddot{x}} \ddot{\eta}(t)\right) \, \mathrm{d}t &= \dot{\eta}(t) \cancelto{0}{\frac{\partial \mathcal{L}}{\partial \ddot{x}}\bigg|_{t_1}^{t_2}} - \int_{t_1}^{t_2} \dot{\eta}(t) \left(\frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{\partial \mathcal{L}}{\partial \ddot{x}}\right)\right) \, \mathrm{d}t \\ &= -\int_{t_1}^{t_2} \dot{\eta}(t) \left[\frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{\partial \mathcal{L}}{\partial \ddot{x}}\right)\right] \, \mathrm{d}t \\ &= -\left(\cancelto{0}{\eta(t)\frac{\partial \mathcal{L}}{\partial \ddot{x}}\bigg|_{t_1}^{t_2}} - \int_{t_1}^{t_2} \eta(t) \left[\frac{\mathrm{d}^2}{\mathrm{d}t^2}\left(\frac{\partial \mathcal{L}}{\partial \ddot{x}}\right)\right]\right) \, \mathrm{d}t \end{aligned}$$

$$= \boxed{\int_{t_1}^{t_2} \eta(t) \left[\frac{\mathrm{d}^2}{\mathrm{d}t^2} \left(\frac{\partial \mathcal{L}}{\partial \ddot{x}} \right) \right] \, \mathrm{d}t} \tag{1}$$

some other stuff I did in this equation:

- Use my auto-adjustable-sized-delimeters! There's a lot of these. The coolest one is `\MID`, which auto-sizes to match the surrounding delimeters. E.g.,

$$\mathcal{F} = \left\{ f(x) \in C[0,1] \,\middle|\, f\left(\frac{1}{2}\right) = e \right\}$$

- Use my partial / total derivative shortcuts. The syntax is like

```
\od[<order>]{<function>}{<variable of differentiation>}
```

for ordinary derivatives, e.g.

$$\frac{\mathrm{d}^6 f}{\mathrm{d}x^6} \qquad \frac{\partial^2 g}{\partial y^2}$$

- Use my mathcal shortcut macro:

$$\mathcal{ABCDEFGHIJLMNOPQRSTUVWXYZ}$$

there are also some for other math fonts, such as blackboard bold:

$$\mathbb{ABCDEFGHIJLMNOPQRSTUVWXYZ}$$

script font:

$$\mathscr{ABCDEFGHIJLMNOPQRSTUVWXYZ} \qquad \mathscr{abcdefghijlmnopqrstuvwxyz}$$

boldface:[1]

$$\mathbf{ABCDEFGHIJLMNOPQRSTUVWXYZ} \qquad \mathbf{abcdefghijlmnopqrstuvwxyz}$$

sans-serif font:

$$\mathsf{ABCDEFGHIJLMNOPQRSTUVWXYZ} \qquad \mathsf{abcdefghijlmnopqrstuvwxyz}$$

math roman:

$$\mathrm{ABCDEFGHIJLMNOPQRSTUVWXYZ} \qquad \mathrm{abcdefghijlmnopqrstuvwxyz}$$

as well as special macros for things that come up often, such as

  - $\mathbb{F}, \mathbb{C}, \mathbb{R}, \mathbb{Q}, \mathbb{Z}, \mathbb{N}$ for fields, complex numbers, reals, rationals, integers, and naturals
  - $\mathbb{P}$ for probability of an event, $\mathbb{E}$ for expected value of a random variable
  - $\mathbb{T}$ for tori, $\mathbb{D}$ for cubes, $\mathbb{S}$ for the standard n-sphere (this macro is a bit of an anomaly, because `\SS` was taken already)

And also you can automate referencing equations and things, such as Equation (1)

■

[1] Note, things like **a** also work for typesetting vectors quickly

2. There are more things you can do!

Solution.

> Hi look it's a leftbar environment!
>
> **Lemma 1.** *Oh wow a lemma! I love these!*

Or an $A \iff B$ proof:

($\Rightarrow$) : Suppose A. Then [...]

($\Leftarrow$) : Suppose B. Then [...]

Similarly with set equality proofs:

($\subseteq$) : WTS $A \subseteq B$.

($\supseteq$) : WTS $A \subseteq B$.

as well as induction:

Base Case: Notice $P(1)$. ✓

Inductive Hypothesis Let $k \in \mathbb{N}$, and suppose $P(k)$. ✓

Inductive Step: Then [...], hence $P(k+1)$. ✓

Easy denoting of surjective / injective functions!

- $f : A \hookrightarrow B$
- $f : A \twoheadrightarrow B$
- $f : A \hookrightarrow\!\!\!\!\twoheadrightarrow B$

Also, image, preimage, and so on.

$$f^{\rightarrow}(A) = g^{\leftarrow}(A)$$
$$\operatorname{im} f = \operatorname{pre} g$$

There's more stuff in the source. Some highlights are some integration things

$$\underline{\int} f(x)\ \mathrm{d}x = \overline{\int} f(x)\ \mathrm{d}x$$

some big operators

$$\bigoplus_{i=1}^{k} V^{(i)} \qquad \bigotimes_{i=1}^{k} V^{(i)} \qquad \#_{i=1}^{k} X_i$$

■