Physics Thinking

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Preface

Consider this as an option for developing (and publishing?) the book.

To learn more about Quarto books visit https://quarto.org/docs/books.

1 Introduction

This is a book created from markdown and executable code.

Table 1.1: SI units

Base Quantity	Base Unit	Symbol
length	meter	m
time	second	s
mass	kilogram	kg
electric current	ampere	A
Thermodynamic temperature	Kelvin	K
Amount of substance	mole	mol
Luminous Intensity	candela	cd

Table 1.2: Fundamental Units

length	time	mass	charge	temperature
m	s	kg	C	K

Table 1.3: Combinations

Concept	Units
Force	$kg\ m\ s^{-2} = N$
Energy	$kg\ m^2\ s^{-2} = N\ m = J$
Power	$kg\ m^2\ s^{-3} = J\ s^{-1} = W$
Current	$C\ s^{-1}$

Dimensional analysis: always checking and fudging (?).

Same units go to the same side of the equation!

Vectors vs scalars

Math is a tool, not the be all and end all – don't simply formula fit.

Sensible answers! Check!

1.1 Solving Problems with the 7D's and the little S

- Diagram: Big! (2/3 of a page) and as many as you need. Graphs
- Directions: Mark it (negative/positive)
- Definitions & Data: Put it on the page (all of them)
- Diagnosis: Type (how) conservation principles, force laws, angular momentum.
- Derivation: Equations (diagnosis in symbols) as many equations as variables add to diagram dimensions
- Determination - D'algebra - box the answer.
- Dimensions - Check and limiting cases – if makes sense then possibly right (if not prob wrong). LHS = RHS then :grinning:.
- Substitution: if necessary - do rough calc by hand an dunits include error!

2 Mechanics

2.1 Example Problem

Diagram

TODO

Directions

TODO

Definitions & Data

Variable	Description
m	Mass of object
H	Initial height
h	Final height
k	Spring constant
g	Acceleration due to gravity
x	Compression of spring
U_{gpe}	gravitational potential energy
U_E	elastic potential energy
E	energy

Diagnosis

Conservation of Energy (E is conserved).

$$U_{gpe} \rightarrow U_E$$

$$mgH = mgh + \frac{1}{2}kx^2$$

Derivation

$$F = -kx$$

$$\begin{aligned} U &= -\int F \,\mathrm{d}x \\ &= -\int_{x_i}^{x_f} kx \,\mathrm{d}x \\ &= \frac{1}{2}kx_f^2 \end{aligned}$$

Determination

$$mg\,(H-h) = \frac{1}{2}kx^2$$

$$\frac{2mg\,(H-h)}{k} = x^2$$

$$x = \sqrt{\frac{2mg(H-h)}{k}}$$

Dimensions

$$\begin{aligned} L &= \sqrt{\frac{MLT^{-2}\,(L)}{MT^{-2}}} \\ &= \sqrt{L^2} \end{aligned}$$

Limiting Cases

$$H \to h$$

$$H - h = 0 \implies x = 0$$

makes sense!

$$m \to 0 \implies x \to 0$$

makes sense!

$$k \to \infty \implies x \to 0$$

makes sense!

$$k \to 0 \implies x \to \infty$$

makes sense!

Substitution

Not needed.

3 Summary

A work in progress.

References