Today: Syllabus & sections 1.1-1.6 L1

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Monday: Sections 1.7, 1.8

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HW#1: Due August 28th {Next Friday}

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Problems:

1.5, 1.6, 1.9	§1.4
1.11, 1.13	§1.5
1.24, 1.25, 1.32	§1.8
1.34d, 1.35, 1.36 a & b, 1.39	§1.9
1.41, 1.42, 1.43a, 1.45, 1.46	§1.10

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Problems:

1.5, 1.6, 1.9	§1.4
1.11, 1.13	§1.5
1.24, 1.25, 1.32	§1.8
1.34a, 1.35, 1.36a & b, 1.39	§1.9
1.41, 1.42, 1.43a, 1.45, 1.46	§1.10

* Syllabus

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Who are we?

Who are we?

1 Exploratory [Math, Science, Engineering, Tech]

Who are we?$_x$

1 Exploratory [Math, Science, Engineering, Tech]
3 Engineering

Who are we?

1 Exploratory [Math, Science, Engineering, Tech]
3 Engineering
11 Engineering – Auto systems

Who are we?

1 Exploratory [Math, Science, Engineering, Tech]
3 Engineering
11 Engineering – Auto systems
10 Engineering – Mechanical systems

Who are we?

1 Exploratory [Math, Science, Engineering, Tech]
3 Engineering
11 Engineering – Auto systems
10 Engineering – Mechanical systems
12 Engineering – Robotics

Who are we?

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10 Engineering – Mechanical systems
12 Engineering – Robotics
4 Engineering – Electrical systems

Who are we?

1 Exploratory [Math, Science, Engineering, Tech]
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11 Engineering – Auto systems
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4 Engineering – Electrical systems
2 Engineering – Manufacturing

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Who are we?

1 Exploratory [Math, Science, Engineering, Tech]
3 Engineering
11 Engineering – Auto systems
10 Engineering – Mechanical systems
12 Engineering – Robotics
4 Engineering – Electrical systems
2 Engineering – Manufacturing
4 Engineering – Software

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Who are we?

1 Exploratory [Math, Science, Engineering, Tech]
3 Engineering
11 Engineering – Auto systems
10 Engineering – Mechanical systems
12 Engineering – Robotics
4 Engineering – Electrical systems
2 Engineering – Manufacturing
4 Engineering – Software
1 Biological systems

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Who are we?

1 Exploratory [Math, Science, Engineering, Tech]
3 Engineering
11 Engineering – Auto systems
10 Engineering – Mechanical systems
12 Engineering – Robotics
4 Engineering – Electrical systems
2 Engineering – Manufacturing
4 Engineering – Software

} 46

1 Biological systems

Academic level

1 Freshman

Academic level

1 Freshman
32 Sophomore

Academic level

1	Freshman
32	Sophomore
12	Junior

Academic level

1 Freshman

3 2 Sophomore

1 2 Junior

3 Senior

Locally sourced

Hand-crafted

Lectures

§1.1 The nature of physics

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"Physics is an experimental science"

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"A theory is an explanation of natural phenomena based on observation"

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"Physics is an <u>experimental</u> science"

"A theory is an explanation of natural phenomena based on observation"

Theories tend to have a range of validity

§1.2 Solving physics problems

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"you don't know physics unless you can <u>do</u> physics"

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Idealized models

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It is often useful to simplify a physical problem.

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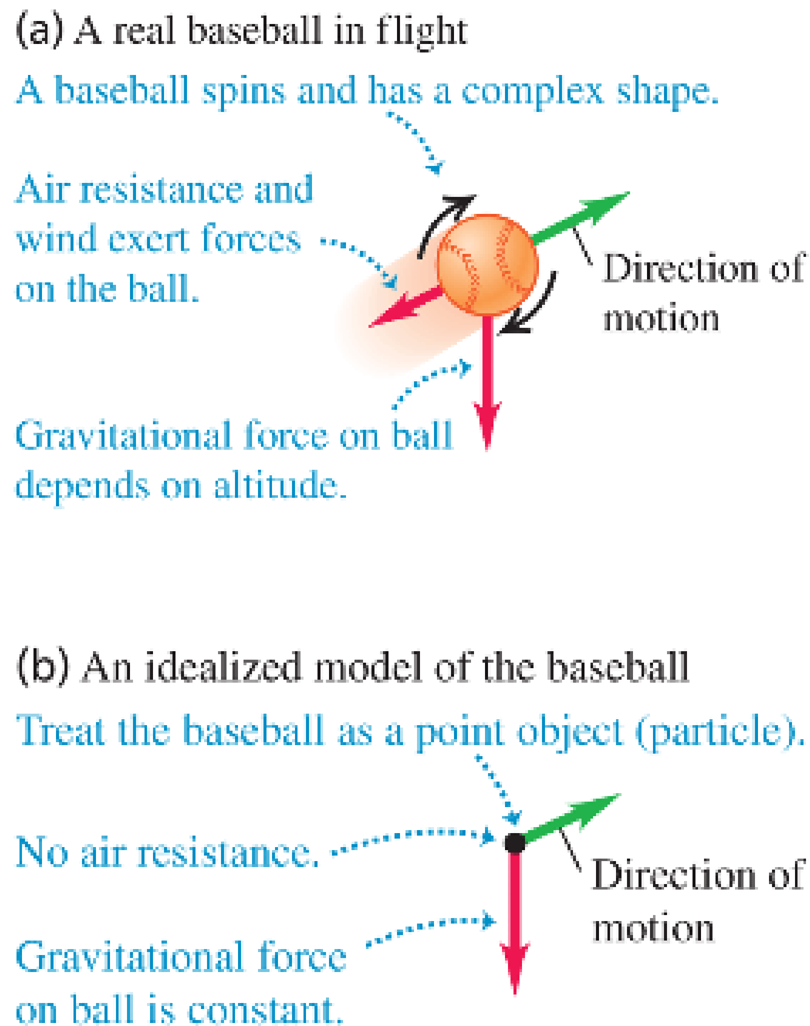
Extract the most important parts.

Idealized models

It is often useful to simplify a physical problem. Extract the most important parts.

Example



§1.3 Standards and units

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<u>Physical quantity</u>: Number that describes a physical phenomenon

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Operational definition: Physical quantities defined by how they are measured [e.g. length by ruler & time by clock]

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<u>Physical quantity</u>: Number that describes a physical phenomenon

<u>Operational definition</u>: Physical quantities defined by how they are measured [e.g. length by ruler & time by clock]

<u>Units</u>: Need units of measurement that we can all agree on.

We will use SI & British units

SI

<u>time</u>: second (s)

SI

time: second (s)

length: meter (m)

SI

time : second (s)

length : meter (m)

Mass : Kilogram (kg)

	SI		British
time:	second (s)	⟷	Same
length:	meter (m)		
Mass:	Kilogram (kg)		

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	SI	British
time:	second (s) ⟷	Same
length:	meter (m)	foot (ft)
Mass:	Kilogram (kg)	

	SI	British
time:	second (s) ⟷	Same
length:	meter (m)	foot (ft)
Mass:	Kilogram (kg)	slug

	SI	British
time	second (s) ⟷	Same
length	meter (m)	foot (ft)
Mass	Kilogram (Kg)	slug

Unit Prefixe examples

nano (n) : 10^{-9}
micro (μ) : 10^{-6}
milli (m) : 10^{-3}
Centi (c) : 10^{-2}

Kilo (K) : 10^{3}
Mega (M) : 10^{6}
giga (G) : 10^{9}
tera (T) : 10^{12}

§1.4 Using and converting units

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* Equations <u>MUST</u> be dimensionally consistent. "can't add apples to automobiles"

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Example: If $d \equiv$ distance & $v \equiv$ speed & $t \equiv$ time

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Example: If $d \equiv$ distance & $v \equiv$ speed & $t \equiv$ time

Then $d = vt$

is dimensionally consistent

§1.4 Using and converting units

* Equations <u>must</u> be dimensionally consistent. "can't add apples to automobiles"

Example: If $d \equiv$ distance & $v \equiv$ speed & $t \equiv$ time

Then $d = vt$

is dimensionally consistent

since $\text{distance} = \left[\frac{\text{distance}}{\text{time}}\right] \text{time}$

$$d = v \quad t$$

Conversion

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It is as simple as always multiplying by one

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<u>Example</u>: Convert n hr to seconds

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so $$N\,\text{hr}\left[\frac{60\,\text{min}}{\text{hr}}\right]\left[\frac{60\,\text{s}}{\text{min}}\right]$$

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So

$$N\,\cancel{\text{hr}}\left[\frac{60\,\text{min}}{\cancel{\text{hr}}}\right]\left[\frac{60\,\text{s}}{\text{min}}\right]$$

Conversion

It is as simple as always multiplying by one

Example: Convert N hr to seconds

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$$1 \text{ min} = 60 \text{ s} \Rightarrow 1 = \frac{60 \text{ s}}{\text{min}}$$

So $$N \cancel{\text{hr}} \left[\frac{60 \cancel{\text{min}}}{\cancel{\text{hr}}}\right]\left[\frac{60 \text{ s}}{\cancel{\text{min}}}\right]$$

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So

$$N\,\text{hr}\left[\frac{60\,\text{min}}{\text{hr}}\right]\left[\frac{60\,\text{s}}{\text{min}}\right] = N*3600\,\text{s}$$

Conversion

It is as simple as always multiplying by one

Example: Convert N hr to seconds

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$$1\text{ min} = 60\text{ s} \Rightarrow 1 = \frac{60\text{ s}}{\text{min}}$$

So

$$N\,\text{hr}\left[\frac{60\,\text{min}}{\text{hr}}\right]\left[\frac{60\,\text{s}}{\text{min}}\right] = \underline{N * 3600\,\text{s}}$$

Multiplying by one is fairly safe ☺

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§1.5 Uncertainty & significant figures

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Measurements ALWAYS have uncertainties.

Example: measure thickness of book cover with ruler that measures to nearest mm.

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§1.5 Uncertainty & significant figures

Measurements **ALWAYS** have uncertainties.

Example: measure thickness of book cover with ruler that measures to nearest mm. Result would be 3 mm. It would be wrong to state 3.00 mm or 3.0 mm.

If caliper used that can measure to nearest 0.01 mm you could get 2.91 mm But it would be wrong to say 2.910 mm.

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* Accuracy ≡ How close measurement is likely to be to the true value

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* Use $\pm$ to indicate accuracy

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Example: diameter d measured to be $d = 56.47$ with device with uncertainty of 0.02 mm

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* Use ± to indicate accuracy

<u>Example</u>: diameter d measured to be $d = 56.47$ with device with uncertainty of 0.02mm we could write

$$d = 56.47 \pm 0.02\,\text{mm}$$

Significant Figures

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Examples:

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137 km → 3 sig fig

Significant figures

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Examples: 2.91 mm → 3 sig fig

137 km → 3 sig fig **But**

0.25 km → 2 sig fig [zero to left of decimal does not count]

ASU

Multiplication & Division

Multiplication & Division

Factor with fewest sig fig determines sig fig of result.

Example:

$3.14159 * 2.34 * 0.58 = 4.3$

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6 sig fig

Multiplication & Division

Factor with fewest sig fig determines sig fig of result.

Example:

$3.14159 * 2.34 * 0.58 = 4.3$

3.14159: 6 sig fig

2.34: 3 sig fig

Multiplication & Division

Factor with fewest sig fig determines sig fig of result.

Example:

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6 sig fig, 3 sig fig, 2 sig fig

Multiplication & Division

Factor with fewest sig fig determines sig fig of result.

Example:

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6 sig fig — 3 sig fig — 2 sig fig

Fewest sig fig at 2

Multiplication & Division

Factor with fewest sig fig determines sig fig of result.

Example:

$3.14159 * 2.34 * 0.58 = 4.3$

6 sig fig, 3 sig fig, 2 sig fig

Fewest sig fig at 2

forces result to have 2 sig fig

Addition or subtraction

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Numbers of sig fig determined by term with largest uncertainty

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Example:

$27.153 + 138.2 - 11.74 = 153.6$

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$$27.153 + 138.2 - 11.74 = 153.6$$

27.153: 0.001 precision

138.2: 0.1 precision

Addition or subtraction

Numbers of sig fig determined by term with largest uncertainty

Example:

$$27{,}153 + 138.2 - 11.74 = 153.6$$

27,153: 0.001 precision

138.2: 0.1 precision

11.74: 0.01 precision

Addition or subtraction

Numbers of sig fig determined by term with largest uncertainty

Example:

$27,153 + 138.2 - 11.74 = 153.6$

0.001 precision

0.1 precision

0.01 precision

Least precise with one decimal place

Addition or subtraction

Numbers of sig fig determined by term with largest uncertainty

Example:

27,153 + 138.2 − 11.74 = 153.6

0.001 precision

0.1 precision

0.01 precision

Least precise with one decimal place

Forces result to have one decimal place

§1.6 Estimates & orders of magnitude

Rough "back-of-the-envelope" calculations can be very useful