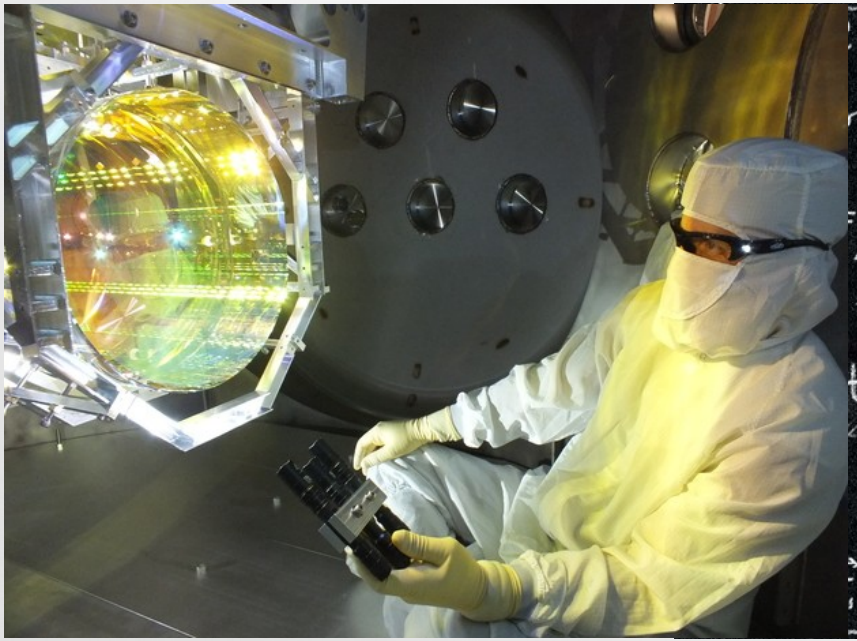
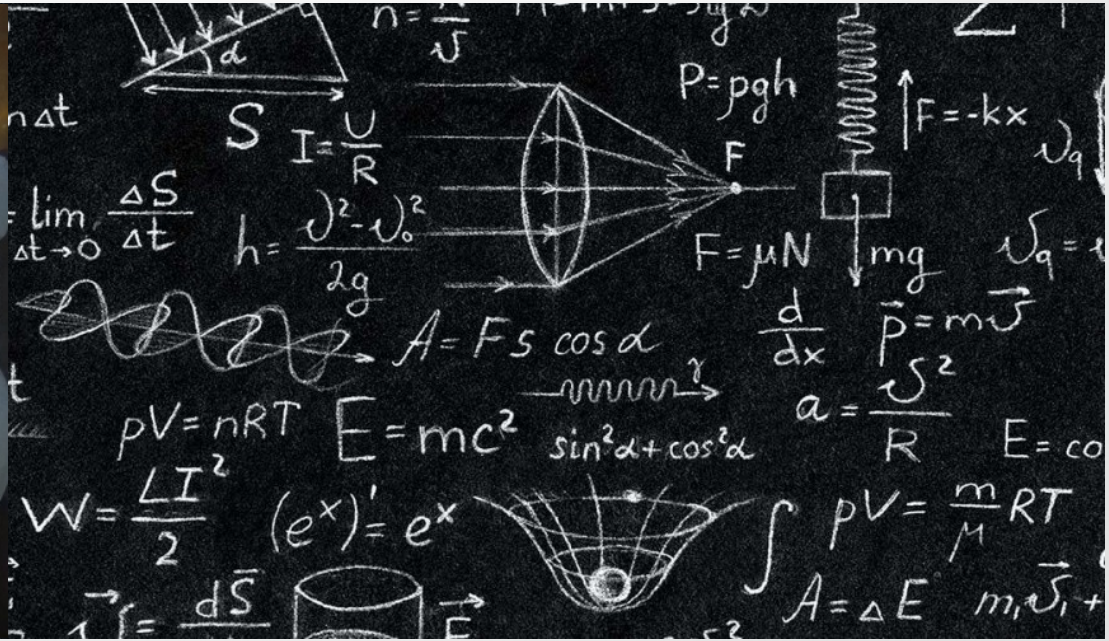
Physics 223 Lab 1

Serway and Vuille 11th ed.
Chapter 1.1 – 1.6
Precision and Units

What is physics?

- Physics is the study of matter and energy.
- Experimentation/observation and theory





Uncertainty in Measurement

- No measurement is absolutely (perfectly) precise.
- Measurements are expressed with uncertainty, either:

- Explicitly: 1.70 ± 0.05 cm
  - the uncertainty is 0.05 cm
  - this value is probably between 1.65 cm and 1.75 cm

- Implicitly: 1.70 cm
  - which means the uncertainty is 0.01 cm
  - this value is probably between 1.69 cm and 1.71 cm

Resolution and Uncertainty in Measured Values

- The number of digits given for a measured value depends on the resolution (smallest increment) of the measuring device.
- Analog devices

  Uncertainty = Resolution / 2

- Digital devices

  Uncertainty = Resolution

Write down the measured value with uncertainty for each.

Resolution and Uncertainty in Measured Values

- Resolution = 1°C
- Uncertainty = 0.5°C
- Measurement = 35.0 ± 0.5°C

- Resolution = 0.1°F
- Uncertainty = 0.1°F
- Measurement = 139.4 ± 0.1°F

Uncertainty in Calculated Values

- Usually physicists use directly measured values to do calculations.
- The uncertainty in the result can be calculated by propagation of error.
  - Quick approximation involves the number of significant figures
- The number of “sig figs” is the number of reliably known digits in the number.
  - 2 m 1 sig fig
  - 1.7 m 2 sig figs
  - 1.70 m 3 sig figs
  - 1.701 m 4 sig figs
  - 1.7005 m 5 sig figs
- Exact or counted values (4/3, π, 4) have infinite sig figs
  - Perimeter P of a square with side length x
  - Volume V of a sphere with radius r

$$P = 4x \qquad V = \frac{4}{3}\pi r^3$$

How many significant figures does each value have?

- All nonzero digits are significant.
- A zero is significant if it is:
  - between two significant digits OR
  - after all nonzero digits and after the decimal point.
- A zero is not significant if it is:
  - before all nonzero digits OR
  - at the end of a value but before the decimal point's position.
  - These are called placeholder zeroes and do not appear in scientific notation.
    - $1000 = 1 \times 10^3 \neq 1.00 \times 10^3$

1) 4.50
2) 130
3) 0.0004
4) 1.059
5) 310,050
6) 0.125
7) 10.04
8) 10,000
9) 10.000
10) 5.0

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1) 4.50 — 3 sig figs
2) 130 — 2 sig figs
3) 0.0004 — 1 sig fig
4) 1.059 — 4 sig figs
5) 310,050 — 5 sig figs
6) 0.125 — 3 sig figs
7) 10.04 — 4 sig figs
8) 10,000 — 1 sig fig
9) 10.000 — 5 sig figs
10) 5.0 — 2 sig figs

Significant figure rules for calculated values

- Addition and Subtraction:
  - The result is given to the same decimal place as the least precise of the last significant digits in each.

```
    14.05
+  315.2
+    0.145
----------
```

- All other operations
  - The result is given to the same number of sig figs as the least number of sig figs in any value.

(14.05)(315.2)(0.145) =

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    14.05
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   329.395   =  329.4
```

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(14.05)(315.2)(0.145) =

(4 SF)(4 SF)(3 SF) = 3 SF

642.1412 = 642

All values need units, unless unitless.

- We will use the International System of Units (SI)

TABLE 1–5 SI Base Quantities and Units

Quantity	Unit	Unit Abbreviation
Length	meter	m
Time	second	s
Mass	kilogram	kg
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Table 1.4 Some Prefixes for Powers of Ten Used with "Metric" (SI and cgs) Units

Power	Prefix	Abbreviation
10^{-18}	atto-	a
10^{-15}	femto-	f
10^{-12}	pico-	p
10^{-9}	nano-	n
10^{-6}	micro-	μ
10^{-3}	milli-	m
10^{-2}	centi-	c
10^{-1}	deci-	d
10^{1}	deka-	da
10^{3}	kilo-	k
10^{6}	mega-	M
10^{9}	giga-	G
10^{12}	tera-	T
10^{15}	peta-	P
10^{18}	exa-	E

Unit conversions

- If a measured or calculated value is not in the units we prefer (often SI), we can do a unit conversion.
- Some unit conversions are exact (2.54 cm = 1 inch, 5280 ft = 1 mi).
- Some are not (1 mi ≈ 1.609 km)
- Example: Convert 14.3 mi/h into m/s.

$$\frac{14.3\,\mathrm{mi}}{1\,\mathrm{h}}$$

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