Principles of Physics

- Introduction
- Units and measurement
- Biomechanics in Linear Motion
  - Forces
  - Momentum
  - Work energy power
- Circular motion
  - Torques
  - Angular momentum
  - Work energy power
- Vectors

Introduction - schedule

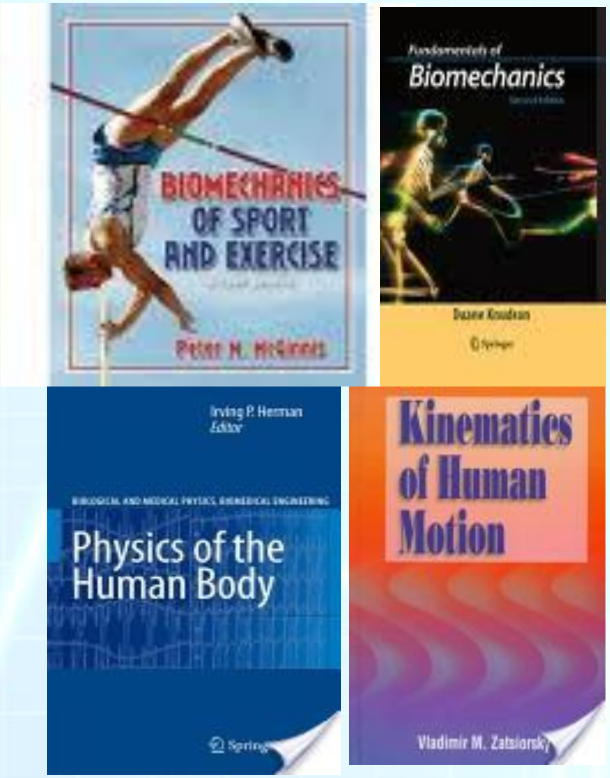
- 3 lectures a week
  - Monday 10:00 room 032
  - Monday 11:00 room 032
  - Monday 12:00 room 032
  - (also lab classes every Tuesday morning)
    - Will be on Tuesday mornings at 9:30-11:30 & 11:30-13:30
    - In TN-101
    - Start tomorrow, January 27th

Introduction - assessment

- End of semester exam in May
  - Worth 70% of final mark
- Weekly tests
  - Worth 30%
  - Use brightspace (make sure you're logged into system)
  - Based on previous weeks work
  - Get ~3 attempts over the course of the week
- Lab work assessed as part of common lab module

Introduction - textbooks

- Several available in library
- Course based on these
- Don't *need* to buy any of them
- Always worth checking google books for texts
- Should be consulting them regularly
- Also free good textbook at OpenStax (https://openstaxcollege.org/textbooks/collegephysics)



Introduction – why study physics?

- Helps explain sporting techniques
- Helps develop new sporting techniques
- Helps in development of new equipment
- Helps prevent injury
- Helps rehabilitation

Units and Measurement

- Physics explains events in nature through
  - measurement of different physical quantities
  - forming relationships between these different quantities
- To measure a quantity need a unit measure of the quantity
- These units need to be standard so that valid comparisons may be made

- Remarkably, in all science we just need seven units (and two associate units)
- And in mechanics it is possible to get by with just three fundamental quantities, deriving other units in terms of these three units
- The three quantities in question are
  - Mass in kilograms (kg)
  - Length in metres (m)
  - Time in seconds (s)
- There are careful calibration standards for these, e.g. the International ProtoType Kilogram kept in Paris


MÈTRE
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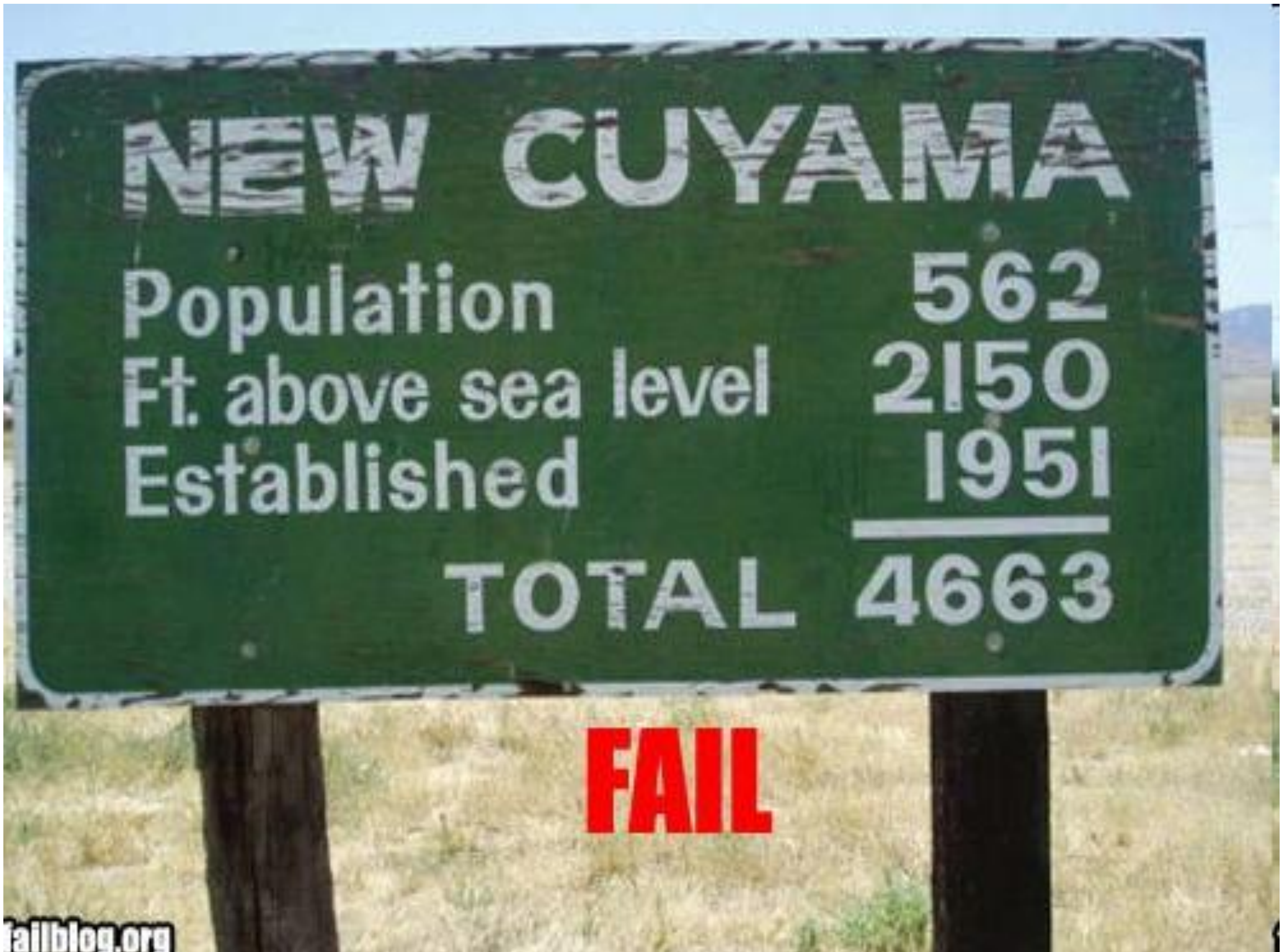
Derived Units

- With every measurement taken or calculation performed, units must be supplied.
- The dimensions of many other physical quantities may be expressed in terms of length mass and time
  - speed = [length] / [time]
  - density = [mass] / [volume]

    = [mass] / [length ^{3}]
- Some quantities do not have any dimensions

Velocity	**v**	**$m.s^{-1}$**
Acceleration	**a**	**$m.s^{-2}$**
Energy	**E**	**$kg.m^2.s^{-2}$**
Force	**F**	**$kg.m.s^{-2}$**
Work	**W**	**$kg.m^2.s^{-2}$**
Power	**P**	**$kg.m^2.s^{-3}$**
Pressure	**p**	**$kg.m^{-1}.s^{-2}$**
Density	**ρ**	**$kg.m^{-3}$**

Being Consistent with Units is Important



Dealing with Non-SI Units

- Not everyone uses SI units all the time (though they should)
- For example kilometres per hour
  - Kilometres are OK (we'll see this in a moment)
  - Hours are not SI
  - 1km / hr is 1000m in 3600 seconds
  - This is 1m in 3.6s
  - This is 1/3.6 m in 1 second
  - So 1km/hr is 0.278m/s
  - So 80 km/hr is 80x0.278 m/s = 22.22m/s

Dealing with Non-SI Units

- Similarly
  - 1 square yard is (1 yard) by (1 yard)

    = (0.9144m) x (0.9144m)

    = $0.836m^2$

  And $1m^2$ = 1/0.836 square yards = 1.196 square yards
  - One pound per cubic yard is

    = $0.4536 / (0.9144)^3$ kgm^{-3}

    = $0.593kgm^{-3}$
  - 1 degree fahrenheit is 1.8 times celsius plus 32

    i.e. $^oF = 1.8^oC + 32$

    or $^oC = 0.556 (^oF – 32)$

Dealing with Very Big and Very Small Measurements

- Metres, seconds, and kilograms are convenient sizes for people
- But in science, we deal with a much wider range of phenomena
- So we have a problem expressing our measurements clearly
  - Example, speed of light is 299792485m/s
- Two solutions
  - Use prefixes: changes size of unit
  - Use scientific notation: clever way of writing awkward numbers

Prefixes

Prefix	*Symbol*	*Power of 10*
– giga	G	10^9
– mega	M	10^6
– kilo	k	10^3
– base unit	-	10^0
– centi	c	10^{-2}
– milli	m	10^{-3}
– micro	μ	10^{-6}
– nano	n	10^{-9}

Scientific Notation

- An alternative to using prefixes
- Uses powers of ten to get across size of number
- For example speed of light is 300000000 m/s
- More convenient to write $3x10^8$m/s
- Big numbers
  - More decimal point to the left
  - Count number of jumps necessary to get simple number
  - Number of jumps becomes power of ten
  - Power of ten is positive
- Small numbers
  - More decimal point to the right
  - Count number of jumps necessary to get simple number
  - Number of jumps becomes power of ten
  - Power of ten is negative

Problems on Scientific Notation

1/ Express 0.00345m in scientific notation

- Move decimal point so that there is one significant figure to the left of the decimal point => 3.45 x 10something
- Decimal point moves to the right => negative power of 10
- Takes **3** steps to the right => power is –3
- Answer is 3.45×10^{-3}m

2/Express 0.078s in scientific notation

- **[7.8×10^{-2}s]**

3/Express 94300kg in scientific notation

- **[9.43×10^{4}kg]**

Unit Conversion

- **For all calculations in Physics it is necessary to convert all units to the same system. For this course all units must be converted to S.I.**
- **Length, Area and Volume**
- **Length:**
  - 1 cm = 1 x 10^{-2} m
  - 1 mm = 1 x 10^{-3} m
- **Area:**
  - 1 cm^2 = 1 x 10^{-4} m^2
  - 1 mm^2 = 1 x 10^{-6} m^2
- **Volume:**
  - 1 cm^3 = 1 x 10^{-6} m^3
  - 1 mm^3 = 1 x 10^{-9} m^2
- ***Note: 1 cm^3 = 1 ml = 1 cc***

Units of Volume

- ***The Cubic Metre (m^3)*** :

  This is the S.I. unit. It is the volume of a cube with an edge length of 1 m

- **<u>The Litre:</u>**

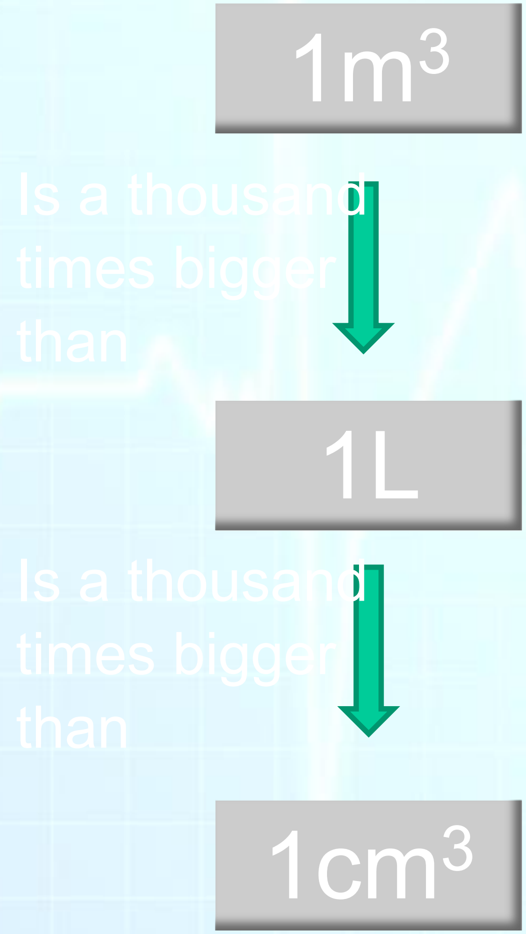
  A cube with an edge length of 1 dm contains a volume of 1 cubic decimeter (1 dm^3)

  The litre (1L) is a more common name for 1 dm^3

- **<u>The cubic centimeter (1 cm^3)</u>:**

  This is the volume of a cube with an edge length of 1 cm

  It is also called a milliliter (ml) and is 0.001 L



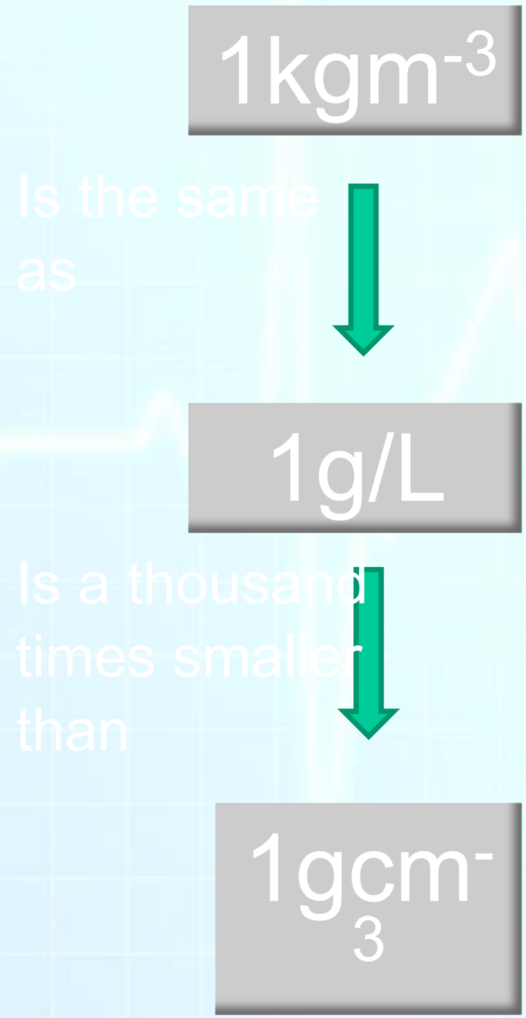
Density

Density is the ratio of the mass of a substance to its volume.

- SI unit = kg/m^3

  (using S.I. units of mass and volume)

- Other units:
  - g/cm^3
  - For gases we usually use units of g/L
- Most liquids and solids have densities that range from 0.9 g/cm^3 (ice) to 11.3 g/cm^3 (lead)
  - density of air = 1.2 g/L



Problems on Unit Conversion

1

Convert $2.87 \times 10^{-2} cm^2$ to m^2

- $1 cm^2 = 1 \times 10^{-4} m^2$
- take away 4 from the power of ten to change from cm^2 to m^2
- power goes from –2 to –6
- Answer is $2.87 \times 10^{-6}\ m^2$

2

Convert 9.2×10^{-12}m to mm

- [9.2×10^{-9} mm]

3

Convert $6.914 \times 10^{8} mm^3$ to m^3

- [$6.914 \times 10^{-1} m^3 = 0.6914 m^3$]

4

Convert $5.68 \times 10^{2} m^3$ to cc

- [5.68×10^{8}cc]