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| 1 | Science Skills | IB Physics Content Guide |

# Big Ideas

* Units are an arbitrary construct invented by humans to communicate quantitative measurements
* All units can be made up of the 7 Fundamental SI Units
* Metric prefixes and scientific notation can be used to make large or small values easier to communicate
* Units can cancel out when being divided by like units
* Unit analysis can be used to determine the validity of a formula or determine the unit of an unknown solution
* No measurement or calculation from measurement is exact. There is a certain range of uncertainty

# Content Objectives

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| 1.2 – Units |  |
| I can describe the difference between quantitative and qualitative observations |  |  |  |
| I can identify the 7 Fundamental SI units |  |  |  |
| I can define and give an example of a derived unit |  |  |  |
| I can represent fractional units with negative exponents |  |  |  |
| I can convert metric units between prefixes |  |  |  |

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| 1.3 – Dimensional Analysis |  |
| I can convert fraction units and exponential units using Dimensional Analysis |  |  |  |
| I can use dimensional analysis to verify a formula |  |  |  |
| I can use dimensional analysis to determine the units for a solution |  |  |  |
| I can represent large and small numbers using scientific notation |  |  |  |
| I can compare quantities by orders of magnitude |  |  |  |

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| 1.4 – Uncertainty |  |
| I can define and compare the terms precision and accuracy |  |  |  |
| I can define and compare random and systematic error |  |  |  |
| I can report a measurement to the appropriate level of precision (decimal places) |  |  |  |
| I can report a measurement with the proper uncertainty for the instrumentation used |  |  |  |
| I can determine the number of significant digits in a reported value |  |  |  |

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| 1.5 – Uncertainty in Calculations |  |
| I can calculate the uncertainty of an average taken from repeated measurements |  |  |  |
| I can define and calculate absolute, fractional, and percent uncertainty |  |  |  |
| I can determine the uncertainty when adding or subtracting two numbers |  |  |  |
| I can determine the uncertainty when multiplying or dividing two numbers |  |  |  |

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List the seven fundamental base units and their abbreviations:

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|  | Unit | Abbreviation |
| Length | Meter | m |
| Mass | Kilogram | kg |
| Time | Second | s |
| Electric Current | Ampere | A |
| Temperature | Kelvin | K |
| Amount of Substance | Mole | mol |
| Luminous Intensity | Candela | cd |

Metric Prefixes – List the unit prefixes in their appropriate decimal position



### Dimensional Analysis

Convert the following:

20 mi hr-1 🡪 m s-1

$$\frac{20 mi}{1 hr}×\frac{1609 m}{1 mi}×\frac{1 hr}{60 min}×\frac{1 min}{60 s}=8.9\frac{m}{s}=8.9 m s^{-1}$$

0.0007 km2 🡪 m2

$0.0007 km^{2}×\frac{1000 m}{1 km}×\frac{1000 m}{1 km}=700 m^{2}$ or $0.0007 km^{2}×\left(\frac{1000 m}{1 km}\right)^{2}=700 m^{2}$

Determine the units for Q:

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| Q = mc ΔT$$Q=\left(kg\right)\left(J kg^{-1} K^{-1}\right)\left(K\right)=\frac{\left(kg\right)\left(J\right)\left(K\right)}{kg K}=J$$ | m (mass) | kg |
| c (specific heat) | J kg-1 K-1 |
| ΔT (change in temp) | K |

### Error and Measurements

Define the following terms:

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| Precision | Accuracy |
| The degree of exactness in a measurement | The closeness of a measured value to the standard |

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| Random Error | Systematic Error |
| Imprecise measurements above or below “true” value – Human factor | Error/offset in the instrumentation used to make measurement |

Record the rules for recording measurements to the proper precision and uncertainty:

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|  | Measurement Precision | Measurement Uncertainty |
| Analog | Estimate 1 digit beyond smallest marking | ± (half the smallest division) |
| Digital | Go to the lease significant digit’s place | ± (smallest division) |

*\*the precision in the measurement and uncertainty MUST match*

### Significant Digits

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| 1. *All zeros between non-zero digits are significant*
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| 1. *Filler zeros to the left of an understood decimal place are not significant.*
 |
| 1. *Filler zeros to the right of a decimal place are not significant.*
 |
| 1. *All non-filler zeros to the right of a decimal place are significant.*
 |

IB grading will award full credit for answers within 1 significant digit of the actual so **round to 3 significant digits**

### Uncertainty

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| Absolute Uncertainty:$$2.0\pm 0.3 g$$ | *Data Booklet Equations:* |
| If: $y=a\pm b$Then: $∆y=∆a+∆b$ | Addition or subtraction: Add up the absolute uncertainties |
| Fractional Uncertainty:$$\pm \frac{0.3}{2.0}$$ |
| If: $y=\frac{ab}{c}$Then: $\frac{∆y}{y}=\frac{∆a}{a}+\frac{∆b}{b}+\frac{∆c}{c}$ | Multiplication or division: Add up the fractional or percent uncertainties |
| Percentage Uncertainty:$$\pm \left(\frac{0.3}{2.0}×100\%\right)$$ |