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| **Motion** | IB Physics Content Guide |

# Big Ideas

* Motion is described relative to a chosen coordinate system.
* Displacement-time, velocity-time, and accel-time graphs are connected in the representation of physical motion.
* When an object is at constant velocity, displacement-time is linear.
* When an object is at constant acceleration, displacement-time is quadratic (curved), and velocity-time is linear.
* Kinematic equations can take three of the *suvat* variables to solve for the remaining two
* Vector quantities can be combined to find resultant vectors or divided into their component parts
* X and Y motion are independent of each other for a two-dimensional projectile

# Content Objectives

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| 1 – 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 | |  |  |  |
| 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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| 2 – Displacement Graphs |  | | | |
| I can describe the difference between distance and displacement | |  |  |  |
| I can calculate distance and displacement for 1D motion | |  |  |  |
| I can plot constant velocity on a displacement vs time graph | |  |  |  |
| I can plot changing velocity on a displacement vs time graph | |  |  |  |
| I can use a d vs t graph to identify if an object is moving in the positive/negative/speeding/slowing | |  |  |  |

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| 3 – Velocity Graphs |  | | | |
| I can describe the difference between speed and velocity | |  |  |  |
| I can compare the difference between a vector and scalar quantity | |  |  |  |
| I can plot constant velocity on a velocity vs time graph | |  |  |  |
| I can plot changing velocity on a velocity vs time graph | |  |  |  |
| I can use a v vs t graph to identify if an object is moving in the positive/negative/speeding/slowing | |  |  |  |
| I can define acceleration in terms of velocity | |  |  |  |

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| 4 – Calculating from Graphs |  | | | |
| I can use an equation to calculate average speed/velocity | |  |  |  |
| I can calculate instantaneous velocity using the slope of a displacement vs time graph | |  |  |  |
| I can calculate instantaneous acceleration using the slope of a displacement vs time graph | |  |  |  |
| I can calculate overall displacement using the area of a velocity vs time graph | |  |  |  |

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| 5 – The Kinematic Equations |  | | | |
| I can identify the 5 primary variables of accelerating motion (suvat) | |  |  |  |
| I can identify the proper kinematic equation to use for a problem that is presented | |  |  |  |
| I can rearrange to solve for the unknown variable | |  |  |  |
| I can calculate for an unknown using the kinematic equations | |  |  |  |

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| 6 – Free Fall |  | | | |
| I can identify the constant acceleration due to gravity neglecting air resistance | |  |  |  |
| I can interpret a free fall problem to identify hidden values and understand | |  |  |  |
| I can use the kinematic equations to solve free fall problems | |  |  |  |
| I can experimentally determine the acceleration due to gravity | |  |  |  |

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| 7 – Horizontal Projectiles |
| I can add and subtract vectors to find a resultant | |  |  |  |
| I can calculate an angle from two components of a right triangle | |  |  |  |
| I can calculate the x and y components of a vector given the magnitude and angle | |  |  |  |
| I can identify hidden values for a horizontal projectile problem | |  |  |  |
| I can use information about a horizontal projectile’s motion to calculate the initial velocity | |  |  |  |
| I can use the x and y velocity components to calculate a projectile’s impact velocity and angle | |  |  |  |

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| 8 – Projectile Motion |  | | | |
| I can identify hidden values for a projectile launched at an angle | |  |  |  |
| I can calculate the x and y components for an initial velocity at an angle | |  |  |  |
| I can calculate max height for a projectile launched at angle | |  |  |  |
| I can calculate distance traveled for a projectile launched at angle | |  |  |  |
| I can calculate total air time for a projectile launched at angle | |  |  |  |

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| **Motion** | Shelving Guide |

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

A picture containing calendar

Description automatically generated

### Dimensional Analysis

Convert the following:

20 mi hr-1 🡪 m s-1

0.0007 km2 🡪 m2

or

Determine the units for Q:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Q = mc ΔT | | | m (mass) | kg | |
| c (specific heat) | J kg-1 K-1 | |
| ΔT (change in temp) | K | |
|  | Scalar | Vector | | |
| How far (m) | Distance | Displacement | | |
| How fast (m s-1) | Speed | Velocity | | |

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| --- | --- | --- | --- |
|  | **Displacement vs Time** | **Velocity vs Time** | **Acceleration vs Time** |
| Meaning of the Graph | Slope:  Velocity | Slope:  Acceleration  Area under the Curve:  Displacement | Area under the Curve:  Velocity |
| **Constant Displacement** |  |  |  |
| **Constant Positive Velocity** |  |  |  |
| **Constant Negative Velocity** |  |  |  |
| **Constant Positive Acceleration**  (speeding up) |  |  |  |
| **Constant Negative Acceleration**  (slowing down) |  |  |  |

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|  | Variable Symbol | Unit |  | Kinematic Equations | s | u | v | a | t |
| Displacement | s | m |  |  |  | **✔️** | **✔️** | **✔️** | **✔️** |
| Initial Velocity | u | m s-1 |  |  | **✔️** | **✔️** |  | **✔️** | **✔️** |
| Final Velocity | v | m s-1 |  |  | **✔️** | **✔️** | **✔️** | **✔️** |  |
| Acceleration | a | m s-2 |  |  | **✔️** | **✔️** | **✔️** |  | **✔️** |
| Time | t | s |  |  |  |  |  |  |  |

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| Horizontal Component |  |  |
| Vertical Component |  |

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| --- | --- | --- |
|  | Vertical |  |
| s |  |
| u | 0 m s-1 |
| v |  |
| a | -9.81 m s-2 |
| t |  |

|  |  |  |
| --- | --- | --- |
|  | Vertical |  |
| s |  |
| u | u sinθ |
| v | 0 m s-1 |
| a | -9.81 m s-2 |
| t |  |