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| **Forces** | IB Physics Content Guide |

# Big Ideas

* Many forces acting on an object can be simplified down into one net force
* Acceleration is zero when net force is zero (could mean stopped or constant velocity)
* If you have the acceleration of an object, you can find the net force causing that acceleration and vice versa
* Force of friction is related to the normal reaction force
* For objects on a sloped surface, the weight must be broken down into its perpendicular and parallel component

# Content Objectives

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| 1 – Newton’s First Law and Free Body Diagrams |  |
| I can define a force (with proper units) in terms of the interaction between two objects |  |  |  |
| I can describe Newton’s first law |  |  |  |
| I can calculate the net force on an object |  |  |  |
| I can calculate an unknown force for an object in equilibrium |  |  |  |

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| 2 – Newton’s Second Law |  |
| I can describe Newton’s second law in terms of momentum |  |  |  |
| I can calculate force given mass and acceleration and calculate acceleration given force and mass |  |  |  |
| I can combine Newton’s second law with the kinematic equations to solve force/motion problems |  |  |  |
| I can explain the connection between constant velocity and balanced forces |  |  |  |

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| 3 – Weight, Normal Reaction, and Tension |  |
| I can calculate the weight of an object |  |  |  |
| I can describe the difference between mass and weight |  |  |  |
| I can use a diagram to identify the direction of tension and normal reaction forces |  |  |  |
| I can draw a free body diagram with weight, normal reaction force, friction, and any other forces |  |  |  |

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| 4 – Calculating Friction |  |
| I can calculate the force of friction when given the reaction force and coefficient of friction |  |  |  |
| I can quantitatively compare surfaces based on their coefficients of friction |  |  |  |
| I can calculate the acceleration of an object with friction based on the external force and mass |  |  |  |

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| 5 – Air Resistance |  |
| I can describe the factors that affect air resistance and how the resistance changes with velocity |  |  |  |
| I can define Terminal Velocity in terms of net force |  |  |  |
| I can graph the change in position and velocity for an object falling with air resistance  |  |  |  |

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| 6 – Forces on a Ramp |  |
| I can calculate parallel and perpendicular components of the force due to gravity on a ramp |  |  |  |
| I can calculate the force of friction required to keep an object in equilibrium |  |  |  |
| I can calculate the acceleration of an object with known mass on a ramp of known angle and friction |  |  |  |
| I can calculate parallel and perpendicular components of the force due to gravity on a ramp |  |  |  |

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| **Forces** | Shelving Guide |

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| Name of Force | Variable | Description/Important Properties | Equation |
|  | Fg |  |  |
|  | FT |  |  |
|  | R |  |  |
|  | Ff |  |  |
|  | Fair |  |  |

If an object has a net force of zero its motion is either:

|  |  |  |
| --- | --- | --- |
|  | or |  |

## Newton’s Laws

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| Newton’sFirst Law |  |
| Newton’sSecond Law |  |
| Newton’sThird Law |  |
| **Data Booklet** **Equations:** |  | Variable Symbol | Unit |
| Force |  |  |
| $$F=ma$$ | Mass |  |  |
| $$F\_{f}\leq μ\_{s}R$$ | Acceleration |  |  |
| $$F\_{f}=μ\_{d}R$$ | Normal Reaction Force |  |  |
|  | Coefficient of Kinetic Friction |  |  |
|  | Coefficient of Static Friction |  |  |

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| Terminal Velocity |  |
| A picture containing timeline  Description automatically generated | Chart  Description automatically generated with medium confidence |
| A picture containing graphical user interface  Description automatically generated |
| Sliding to a Stop | Constant Velocity |
| Icon  Description automatically generated | Icon  Description automatically generated |
| Fnet = | Fnet = | Fpull = |

|  |  |
| --- | --- |
| A picture containing text, clock  Description automatically generated | Forces on a Ramp |
|  | Equilibrium |  | Accelerating |
| R |  | R |  |
| Ff |  | Ff |  |
| F⊥ |  | Fnet |  | Fnet |  |
| F∥ |  | a |  | a |  |