Force Fields

IB Physics Content Guide

Big Ideas

- Opposite charges/poles attract while like charges/poles repel
- The force between charged particles demonstrates the same relationship as the force between bodies with mass
- A force field describes the force at a location per unit mass, charge, or current
- A current flowing through a conductor produces a magnetic field
- The relative directions of current, magnetic field, and electromagnetic force can be found using the right-hand rules

1 – Static Electricity

I can describe the conservation of charge and the types of charging			
I can describe the process for how Millikan experimentally determined the charge of an electron			
I can calculate the charge on an object based on the number of electrons and protons			

2 – Electrostatic and Gravitational Force

I can use Coulomb's Law to relate electrostatic force to particle charge and separation distance			
I can use the Law of Gravitation to relate gravitation force to object mass and separation distance			
I can determine the units of Coulomb's Constant and the Gravitation Constant using unit analysis			
I can describe how the sign of the calculated electrostatic force indicates attraction or repulsion			
I can describe the impact of separation distance on electric and gravitational force			
I can discuss the impact of permittivity on Coulomb's Constant			

3 – Mapping Force Fields

I can draw gravitational fields using vectors			
I can describe the role of a test charge or test mass in representing force fields			
I can describe gravitational fields as warping spacetime			
I can draw electric fields for point charges and charged plates using vectors			
I can draw magnetic fields around north and south poles			

4 – Calculating Field Strength

I can use the law of gravitation and circular motion to describe the motion of an orbiting body			
I can calculate field strength with proper units around a single object			
I can calculate the net field strength based on two or more objects			
I can determine the location where the net field strength is zero			

5 – Magnetism and the Right Hand Rule

I can describe how permanent magnets are created by aligned magnetic domains			
I can indicate a vector that is pointing into or out of the page			
I can use the right-hand rule to draw the magnetic field around a current carrying wire			
I can use the right-hand rule to predict the forces on a current carrying wire in a magnetic field			
I can predict the trajectory of a charged particle moving through a magnetic field at different speeds			

6 – Electromagnetic Force

I can calculate electromagnetic force on a current carrying wire in a magnetic field			
I can describe and calculate the force between two parallel current carrying wires			
I can calculate the force on a charged particle in a magnetic field			

Charging and Electric Charge

Friction	Conduction	Induction

Millikan's Oil Drop Experiment	
Charge magnitude of 1 electron or proton	

Electrostatic Force

	Variable Symbol	Description	Unit
$F = k\frac{q_1 q_2}{r^2}$ $k = \frac{1}{4\pi\varepsilon_0}$	F		
	q_1		
	q_2		
	r		
	k		
	ε_0		

Gravitational Force

	Variable Symbol	Description	Unit
$F = G\frac{Mm}{r^2}$	F		
	M		
	m		
	r		
	G		

Force Fields

<table>
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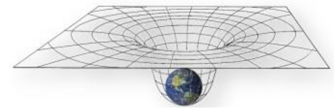
<tr><td colspan="2"></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>Symbol</td><td></td><td rowspan="2">Data Booklet Equation:
$E = \frac{F}{q}$ $E = \frac{V}{d}$</td><td>Symbol</td><td></td><td rowspan="2">Data Booklet Equation:
$g = \frac{F}{m}$ $g = G\frac{M}{r^2}$</td></tr>
<tr><td>Units</td><td></td><td>Units</td><td></td></tr>
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Magnetic Fields

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Right Hand Rule

<table>
<tr><th colspan="3">Right Hand Rule #1</th><th colspan="2">Right Hand Rule #2</th></tr>
<tr><td colspan="3">Magnetic field around a current carrying wire</td><td colspan="2">Electromagnetic force direction on a wire or moving particle</td></tr>
<tr><td>Thumb</td><td colspan="2"></td><td>Thumb</td><td></td></tr>
<tr><td>Fingers</td><td colspan="2"></td><td>Fingers</td><td></td></tr>
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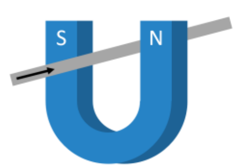
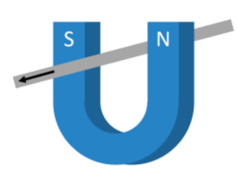
</td><td>Palm</td><td></td></tr>
<tr><td rowspan="2">
</td><td rowspan="2">
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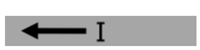
<tr><td>
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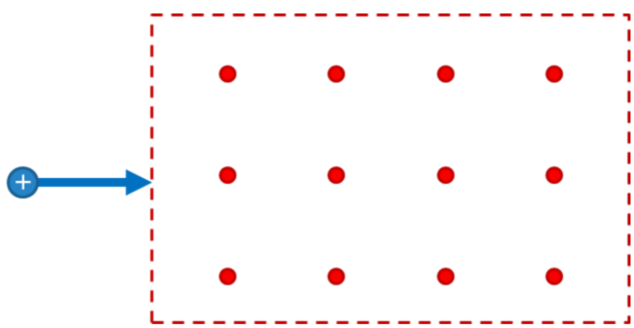
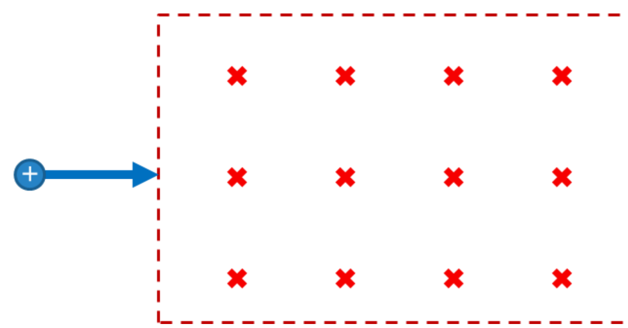
Electromagnetic Force

	Variable Symbol	Description	Unit
$F = BIL\sin\theta$ $F = qvB\sin\theta$ $\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi r}$	F		
	B		
	I		
	L		
	θ		
	q		
	v		
	r		
	μ_0		

Charged Particles Moving through a Magnetic Field

	Magnetic Field | Out of Screen	Magnetic Field | Into Screen
Positive Particle		
Negative Particle