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

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			

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			

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			

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			

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			

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			

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			

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			

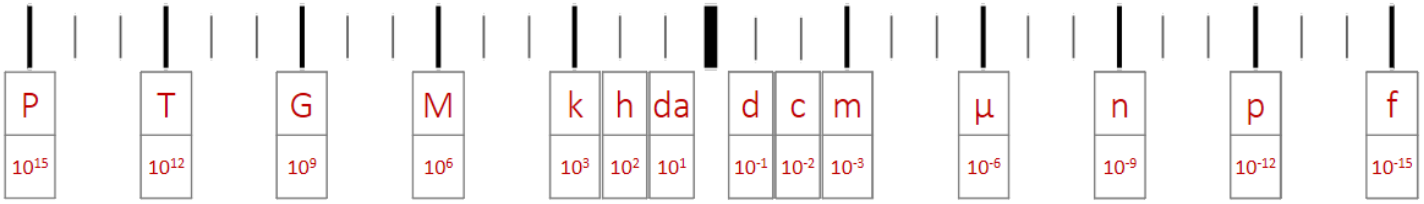
Motion

Shelving Guide

List the seven fundamental base units and their abbreviations:

	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}

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

0.0007 km^2 → m^2

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

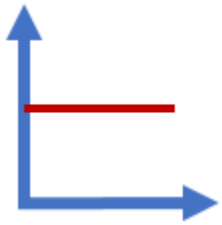
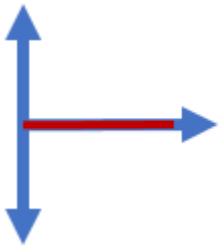
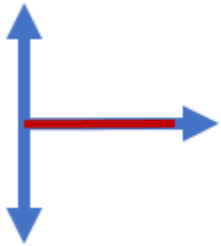
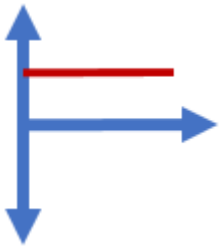
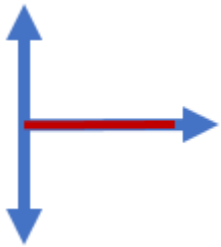
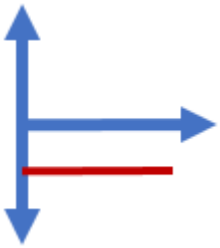
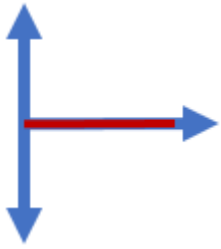
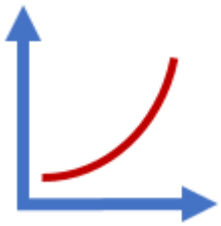
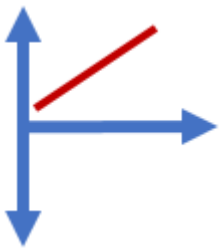
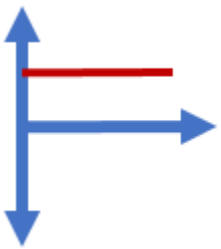
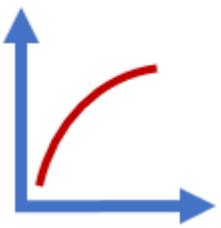
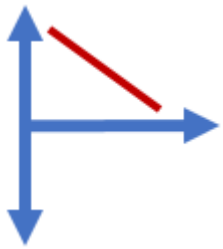
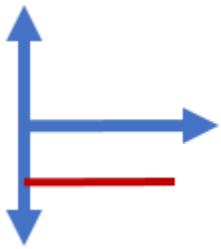
Determine the units for Q:

Q = mc ΔT

$$Q = (kg)(J\ kg^{-1}\ K^{-1})(K) = \frac{(kg)(J)(K)}{kg\ K} = J$$

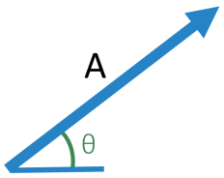
m (mass)	kg
c (specific heat)	J kg^{-1} K^{-1}
ΔT (change in temp)	K

	Scalar	Vector
How far (m)	Distance	Displacement
How fast (m s^{-1})	Speed	Velocity

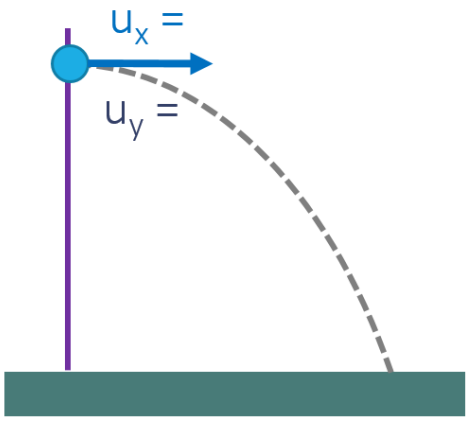
	Displacement vs Time	Velocity vs Time	Acceleration vs Time
Meaning of the Graph	Slope: Velocity	Slope: Acceleration Area under the Curve: Displacement	Area under the Curve: Velocity
Constant Displacement			
Constant Positive Velocity			
Constant Negative Velocity			
Constant Positive Acceleration (speeding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

	Variable Symbol	Unit
Displacement	s	m
Initial Velocity	u	m s^{-1}
Final Velocity	v	m s^{-1}
Acceleration	a	m s^{-2}
Time	t	s

Kinematic Equations	s	u	v	a	t
$v = u + at$		✓	✓	✓	✓
$s = ut + \frac{1}{2}at^2$	✓	✓		✓	✓
$v^2 = u^2 + 2as$	✓	✓	✓	✓	
$s = \frac{(v+u)t}{2}$	✓	✓	✓		✓

Horizontal Component	$A_H = A\cos\theta$	
Vertical Component	$A_V = A\sin\theta$	

	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