Energy

IB Physics Content Guide

Big Ideas

- The total energy of a closed system must be constant
- Energy is neither created nor destroyed, it just changes form
- Work is done to change energy when a force is applied and the object moves in the same direction as the force

1 – Calculating Energy

I can describe and calculate kinetic energy and gravitational potential energy			
I can explain the conservation of energy and show that the total energy in a closed system is always the same			
I can interpret a scenario and set up an equality based on the energies present at different locations			
I can use the conservation of energy to solve for an unknown energy or variable in a problem			

2 – Elastic Energy and Work

I can describe and calculate elastic potential energy			
I can define and calculate the property of work			
I can calculate work when the force is at an angle to the direction of the motion			
I can equate work done on a system to the change in energy of an open system.			
I can use the work-energy theorem to solve for an unknown			

3 – Momentum, Units, and Power

I can describe the difference between elastic and non-elastic collisions			
I can calculate the amount of energy retained in a non-elastic collision			
I can derive a 'Joule' and from the fundamental units kg, m, and s.			
I can use area under the curve to calculate the work of a variable force			
I can identify situations where there is motion but no work being done			
I can calculate power from work or velocity			

Calculating Energy

KE	**Variable Symbol**	**Description**	**Unit**
$E_k = \frac{1}{2}mv^2$ $E_k = \frac{p^2}{2m}$	E_k	Kinetic Energy	[J]
	m	Mass	[kg]
	v	Velocity	[m/s] or [m s^{-1}]
	p	Momentum	[kg × m/s] or [kg m s^{-1}]

GPE	**Variable Symbol**	**Description**	**Unit**
$\Delta E_p = mg\Delta h$	ΔE_p	Gravitational Potential Energy	[J]
	m	Mass	[kg]
	g	Gravitational Field Strength	[N kg^{-1}] or [m s^{-2}]
	Δh	Change in Height	[m]

EPE	**Variable Symbol**	**Description**	**Unit**
$E_H = \frac{1}{2}k\Delta x^2$	E_H	Elastic Potential Energy	[J]
	k	Spring Constant	[N/m] or [N m^{-1}]
	Δx	Spring Stretch (change from rest)	[m]

Conservation of Energy

Before: KE + GPE + EPE = After: KE + GPE + EPE

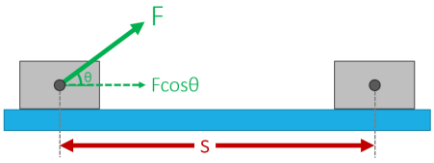
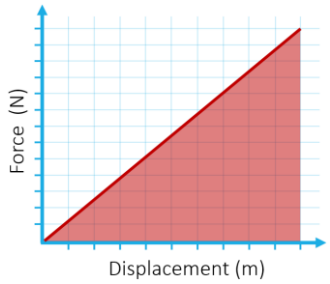
Types of Collisions

Elastic	Kinetic Energy is conserved (perfect hit and bounce) *Typically just found in particle collisions*
Inelastic	Kinetic Energy is not conserved Some energy is "lost" to heat

Work and Power

	Variable Symbol	Description	Unit
$W = Fs\cos\theta$	W	Work	[J] or [N m]
	F	Force	[N/m] or [N m^{-1}]
	s	Displacement	[m]
$P = \frac{\Delta W}{\Delta t} = Fv$	θ	Angle between force/motion	[°]
	P	Power	[W]
	t	Time	[s]
	v	Velocity	[m/s] or [m s^{-1}]

Calculating Work

Constant force at an angle	Varying Force	From Power
$W = Fs\cos\theta$	Area under the curve	$W = P \times t$
		

Examples of a force happening but no work being done:

- Pushing something that doesn't move (no displacement, no work)
- Waiter carrying a tray horizontally (force is vertical, motion is horizontal)
- Object moving in uniform circular motion (like the moon orbiting the earth)

Work-Energy Problem Solving

Initial Energy	+	Event	=	Final Energy
		$W = Fs\cos\theta$ or $W = P \times t$		