5 | Energy

IB Physics Content Guide

Big Ideas

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

Content Objectives

5.1 – Work and Power

📖 p. 69-73, 88-89

I can define and calculate the property of work			
I can identify situations where there is motion but no work being done			
I can calculate work when the force is at an angle to the direction of the motion			
I can use area under the curve to calculate the work of a variable force			
I can describe the difference between positive and negative work			
I can calculate power from work or velocity			

5.2 – Intro to Energy

📖 p. 75-80

I can use evidence (speed, stretch, height) to describe and calculate all types of energy present.			
I can derive a 'Joule' from the fundamental units kg, m, and s.			
I can describe and calculate kinetic energy			
I can describe and calculate gravitational potential energy			
I can use Hooke's Law to calculate the elastic force at a given displacement			
I can describe and calculate elastic potential energy			

5.3 – Conservation of Energy

📖 p. 81-84

I can explain the implications of the conservation of energy			
I can 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			

5.4 – Work-Energy Theorem

📖 p. 85-87

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			

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Shelving Guide

	Variable Symbol	Unit
Work	W	Joules [J]
Power	P	Watts [W]
Kinetic Energy	E_k	J
Elastic Potential Energy	E_p	J
Gravitational Potential Energy	ΔE_p	J
Spring Constant	k	$N\ m^{-1}$
Spring Stretch	Δx	m

Data Booklet Equations:

$$W = Fs\cos\theta$$

$$E_k = \frac{1}{2}mv^2$$

$$E_p = \frac{1}{2}k\Delta x^2$$

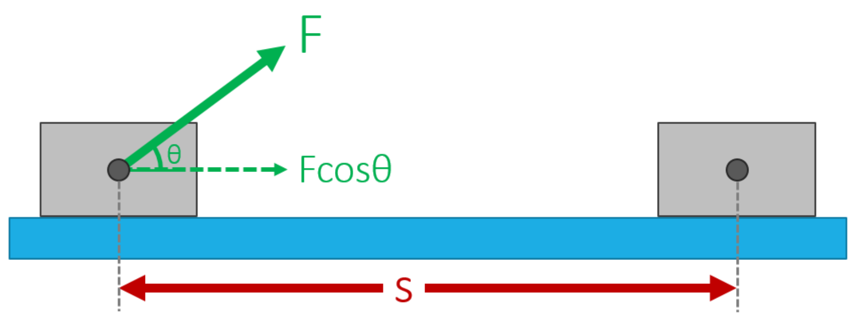
$$\Delta E_p = mg\Delta h$$

$$\text{power} = Fv$$

Calculating Work

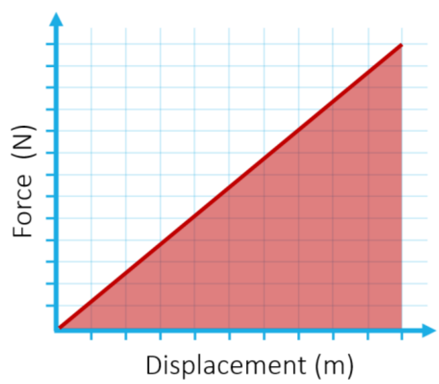
Constant force at an angle:

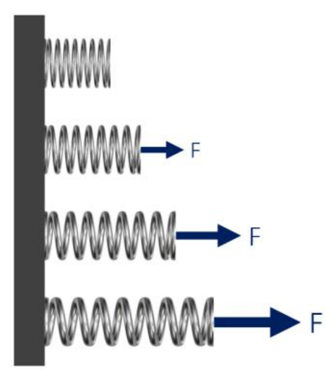
$$W = Fs\cos\theta$$



Varying Force:

Area under the curve





Examples of no work being done for an object in motion:

- Pushing something that doesn't move (no displacement, no work)
- Waiter carrying a tray horizontally (force is vertical, motion is horizontal)
- Orbiting object (velocity is tangent to path, force is toward the center)

Calculating Power

In terms of work and time:	*In terms of force and velocity:*
$$Power = \frac{Work}{Time}$$	$$Power = Force \times Velocity = Fv$$

Units

	Standard Unit	From Equation	Fundamental SI Units
Work	J	N m	kg m^2 s^{-2}
Power	W	J s^{-1}	kg m^2 s^{-3}

Types of Energy

Kinetic Energy	Elastic Potential Energy	Gravitational Potential Energy
$\frac{1}{2}mv^2$	$\frac{1}{2}k\Delta x^2$	$mg\Delta h$

Conservation of Energy

Total Energy Before = Total Energy After

Work-Energy Theorem

Work → Energy	Energy → Work
$Fs = \frac{1}{2}mv^2$	$\frac{1}{2}mv^2 = Fs$