

A2 LEVEL

Environmental Technology

# The IPAT Equation

For first teaching from September 2014

For first award in Summer 2015



environmental  
technology

# FACT FILE

# environmental technology

## Sustainability and Future Development Fact File 2: The IPAT Equation



### Specification Content

#### Students should be able to:

- Debate the role of technology in meeting global requirements in the context of the relationship I=PAT



### Course Content

#### Introduction

Human survival relies on a number of resources and an environment that is ecologically healthy. Since the beginning of time people have used the earth's resources but since the industrial revolution, human activity, resource usage (consumption) and environmental impact have grown dramatically. We are now using many resources at a greater rate than they can be replaced or replenished. Scientists and researchers have tried to measure the effect of human activity on the environment by developing equations which calculate the interaction and impact of key factors, such as population growth, on the environment.

#### What is the IPAT Equation?

The IPAT Equation is an attempt to describe the impact of population, affluence and technology on the environment.

This equation does not look at each of the factors individually but is concerned with the interaction or 'multiplying' effect of the combined factors.

$$I = P \times A \times T$$

**I** → Total impact  
**P** → Population  
**A** → Affluence  
**T** → Technology



©iStock / Thinkstock.com

**(I)** is the total environmental impact in terms of resource depletion or waste accumulation.



©Thinkstock

**(P)** is population and refers to the size of the human population. That is, the number of people there are globally consuming resources and creating waste.



©Thinkstock

**(A)** is affluence and refers to the level of consumption by that population. In other words, the amount of goods and services we each use on-line.



©Thinkstock

**(T)** is technology and refers to the processes used to obtain resources and transform them into useful goods and associated waste.

### The role of technology

Technology has an important role to play in Earth's future survival. Technology is the way, or the methods that we use



to convert natural resources into real goods and services. It is important that developments in technology are resource efficient.

Resource efficiency refers not only to the operation of the technology or a product, for example, a mobile phone but also to what is described as the complete product life-cycle. This cycle includes the extraction of the raw materials required to make the phone to the actual design, manufacturing and end of life processes associated with the product.

**Sustainable design** requires exploring if a product is manufactured in the most energy efficient and resource efficient manner using minimal materials or components that can be recycled or re-used.



©Thinkstock

This is particularly important in manufacturing process technologies. Such technology should be developed so that they require less water, energy and raw materials and reduce waste discharges.

Consideration also needs to be given to raw material inputs and processes so that, for example, solvent-free inks and paints are used which do not damage the environment.

Many manufacturers have already invested heavily in improving the resource efficiency of their technology but even with the best available technology, an industrial way of life is inevitably resource-intensive.

### Waste

The environmental impact of waste is a consideration for many types of technology. This applies to the waste from manufacturing processes themselves, packaging, products that are surplus to requirements, such as excess food, and items that are worn out, broken-down, technologically obsolete (out of date) or otherwise no longer useful.



©Thinkstock

Consideration also needs to be given to what happens to the manufacturing equipment itself when it is no longer required.

Many companies are now making major efforts to minimise

waste and to recycle end-of-life materials and equipment. Indeed, some are designing their products to be easier to recycle and to be less harmful if they do end up in the environment. This is not always easy and recycling often incurs additional energy demand.

Industrially developed technological economies still need to improve the efficiency of the technology they employ. However it will become increasingly difficult to manufacture and supply goods using progressively smaller amounts of resources.

- Technology can only ever improve as far as the laws of physics allow.
- Renewable resources, including energy, are only renewable to a limited extent and are often expensive to harness.

Using the best available technology will help reduce human impact on the environment but technology on its own is not enough to make us sustainable or reduce environmental impact. The **IPAT equation** shows clearly:

- The need to reduce our individual **consumption**.
- The need to stabilise our **populations** at sustainable levels.



## Pupil Activity

### Activity 1:

Watch the TED Talk: **TED Debate: Can Technology Save Us from Ecological Overshoot?**

Have we overexploited the Earth's resources for so long that crisis is now not only inevitable, but just a few decades away? Or, is our ingenuity and technological know-how so great that we can overcome even Mother Nature's limits?

[www.ted.com/talks/paul\\_gilding\\_the\\_earth\\_is\\_full.html](http://www.ted.com/talks/paul_gilding_the_earth_is_full.html)

### Activity 2:

Consider the different components of the IPAT equation in relation to your school environment or your local community. Suggest ways that the overall impact (I) on the environment could be reduced.

### Activity 3:

Prepare a short debate on the role of technology in meeting global requirements in the context of the relationship  $I=PAT$

