Teacher Notes

Six for Six features 6 sets of complementary resources and/or activity suggestions aligned to curriculum requirements for KS2, 3 and 4 STEM subjects using real-world examples of Siemens technology, engineering or manufacturing principles as basis for learning.

Teachers are invited to select one or more suites of Six for Six materials to be used at their own discretion over the course of a half-term or term.

Each set of six includes:

- Comprehensive teacher notes
  - Introducing and providing an overview of key learning objectives for the six resources and/or activity suggestions
  - Curriculum matrix including learning outcomes
  - Recommendations for when and how to use the resources
  - Links to additional learning opportunities and events associated with the STEM learning framework and calendar
- Six, curated lesson plans, films, interactive learning tools, workshop or challenge event activity suggestions each linked to the other to repeat and reinforce learning opportunities

Download here

Module 1: Understanding the body and how it works – using and interpreting images to understand systems such as digestion and skeletal in the human body.

Module 2: Living in a world made by STEM – looking at the changes made to the world around us by developments in science and technology.

Module 3: Energy for thrills – seeing how the concept of energy transfer can help us make sense of everything from rollercoasters to double deck buses.

Module 4: Power to the people – the quality of our lives depends upon a reliable and cheap supply of energy. This needs to be achieved without damaging the environment however.

Module 5: Getting around – transport systems are crucial to modern life but need careful planning and operation to be fit for purpose. Thought needs to be given to the technology used, organisation and energy sources.

Module 6: Building the things we need – manufacturing skills are crucial to providing the products we need but they also provide jobs and develop skills. Manufacturing uses scientific ideas, logical thinking and an understanding of the wider world.

Module 3: Energy for thrills

Introduction

Energy is a fundamental concept in science and one which is easier to draw attention to the effects of rather than to grasp as an overarching idea. Students sometimes struggle to make use of it effectively.

Furthermore the model that is used to explain and apply energy in the secondary curriculum has changed. Rather than using the transformation model (referring to different types of energy) the preferred approach is now to make use of the 'stores and transfers' model, in which the focus is upon where energy is being stored and how it is being transferred from one store to another.

It is important that students encounter this model and have the opportunity to apply their use of it in a range of contexts. The suite of materials provides a number of opportunities that can be used as and when appropriate.

Educational context/curriculum links

This suite of materials is designed to support the teaching of science over a period of time. The resources are gathered together here for sake of convenience but there is no expectation or suggestion that they be used consecutively. Rather the idea is that as and when the topics arise in schemes of learning that the resources are accessed and deployed.

Subject references:

Science

Energy changes in a system, and in the ways energy is stored before and after such changes

- calculate the amounts of energy associated with a moving body and an object raised above ground level
- describe all the changes involved in the way energy is stored when a system changes, for common situations
- describe, with examples, the relationship between the power ratings for domestic electrical appliances and the changes in stored energy when they are in use.

Conservation, dissipation and national and global energy sources

- describe with examples where there are energy transfers in a system, that there is no net change to the total energy of a closed system
- describe, with examples, how in all system changes, energy is dissipated, so that it is stored in less useful ways
- explain ways of reducing unwanted energy transfer
- calculate energy efficiency for any energy transfer, and describe ways to increase efficiency
- describe the main energy sources available for use on Earth, compare the ways in which they are used and distinguish between renewable and non-renewable sources
- explain patterns and trends in the use of energy resources.

Overview of assets

Type of resource	Title of resource
Lesson plan and activity suggestions	Formula for thrills
Interactive learning tool	Formula for thrills
Digital Badge reward	Rollercoaster challeng
Lesson plan and activity suggestions	Monte Rosa mountain hut
Lesson plan and activity suggestions	Here comes the Sun
Lesson plan and activity suggestions	Blowing in the Wind
Links to careers and employment opportunities	Early Careers

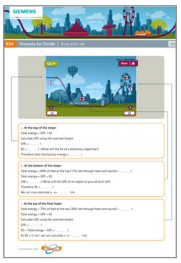
Rationale

The key idea with the activities is to get students to engage with ideas about energy and to apply them to a range of different contexts. This is an essential and overarching concept in science and one that students are unlikely to fully grasp at the first point of contact. It is therefore important to revisit it in a variety of settings.

These activities can be used in any order and at different points in a long term plan but in each case the fundamental questions about where it is being stored and how it is being transferred can be explored.

1. Lesson plan: Formula for thrills

KS3 Formula for Thrills teacher notes and activity sheets



The Formula for thrills suite of materials is based on the context of a rollercoaster. The idea is that students can make sense of the challenge of designing a rollercoaster ride by understanding and applying ideas about gravitational potential energy, kinetic energy and efficiency.

The teaching resources are based around the use of an online digital resource. This is designed to run on a wide range of platforms and is also accessible from any location, so students can use it at home as well as at school. This resource is based on the challenge of designing a rollercoaster ride. In this ride the train starts off at the start of the track and rolls down the track, gaining speed. The height of the start and end of the track can be selected and the aim is to select these so that the train completes the journey without stalling but doesn't have excessive speed at the end. Students use trial and error to come up with a successful combination of values. There is more than one successful combination as well as many unsuccessful ones.

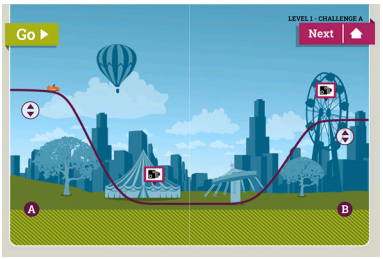
The second stage involves the inclusion of a further variable – that of the length of the track. Built into the algorithm behind the design of the simulation is the idea that the ride is not a closed system; energy is being transferred out of it. The difference in height between the start and end points has to be balanced with the length of the track. If the latter is increased then the former has to be greater as well in order for the journey to be completed as required.

The third stage involves using equations for GPE and KE as well as allowing for percentage efficiency. The idea here is that students use these ideas and apply them to predict a set of values that will work; they can then use the resource to produce a set of values which can then be tested.

The context is then used in the extension activities to explore a different set of ideas with an emphasis upon maths and business skills. These resources can either be used in the classroom or for more independent work. They include activities such as designing structures such as track support and ticket booths, business planning and managing rides.

2. Interactive learning tool: Formula for Thrills

Formula for thrills



This is the resource associated with the teaching materials. It is supported by activity sheets which guide students through the stages and suggest an approach to the work involving equations and calculations.

The first level involves students in manipulating the start and end heights by trial and error to get the train running well, the second introduces the length of the track as another variable and the third requires the user to insert calculated values.

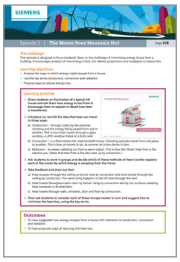
3. Digital Badge reward: Rollercoaster challenge

Digital badges

This digital badge is based on the use of the Formula for thrills materials and provides students with challenges to respond to in order to gain the badge. It is suitable either for school based work or for completing at home. Although originally designed to be completed at the completion of a construction project it links well to the online resources and encourages students to articulate how their ideas and understanding of a context have changed.

4. Lesson plan: Monte Rosa Mountain Hut

KS3 Energy badge Monte Rosa Scheme of work



This set of activities is centred around the design of a large mountain hut. The context is introduced with clear reference to the need for effective insulation. This is related to ideas about conduction, convection and radiation; students are encouraged to link a theoretical understanding of these to the challenge of designing an energy efficient structure in a challenging location.

The idea of setting up a model is then used to explore the value of such an approach. On the one hand it is useful to explore an approach on a smaller scale before committing to a full sized structure but on the other hand the results will only be valid if the key features are accurately represented. The use of various materials is suggested and the possibility of using software to produce a design put forward.

The model can then be used to test the effectiveness of different types of insulation. Gathering data can then be used to evaluate these materials and relate their effectiveness to key ideas about energy transfer and properties of materials.

5. Lesson plan: Here comes the Sun

KS3 Science, Maths, Technology

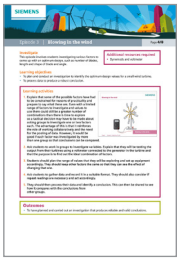
This set of activities starts off with the context of electricity supplies in a city in Nigeria. The challenge is presented as to whether the unreliable supply network would be better backed up by either a petrol generator or by solar cells. The pros and cons of each of these are explored. This is developed by the use of supporting resources which explore a more detailed analysis and comparison. Students are asked to consider a number of different factors and to come up with an overall solution.

This is then extended into thinking about energy storage and also the idea of power ratings. Students are then asked to consider a range of applications and to suggest whether one method of power generation might be better for some uses and the other for different ones.

Finally students need to draw together their ideas and make a case for one method or the other. Their presentation needs to include a clear judgment and supporting evidence.

6. Lesson plan: Blowing in the Wind

KS3 Energy badge Blowing in the wind Scheme of work



This set of activities uses the context of wind power. It involves the construction and testing of a simple wind turbine and the analysis of a number of design factors such as the number of blades and the material being used. The wind turbines should be set up to power small electric motors (therefore working as generators) and the voltage output measured to indicate the effectiveness of the design.

Best teaching practice

There are various ways in which the resources can be used effectively but there are some key components that should be maintained.

The first of these is that although each of these contexts is (intentionally) different, they all offer opportunities to develop and apply concepts of energy being stored and transferred. It is useful to make a point of asking generic as well as specific questions such as:

- Where is energy being stored?
- Which stores is energy being transferred between?
- How is the energy being transferred?

This will encourage students to see beyond the details of the specific and to use this model as an overarching way of explaining a range of phenomena.

Secondly it emphasises the application of the ideas to novel contexts. Students need to see that we go beyond the same examples and can use the ideas in a range of settings.

Thirdly some of these instances involve a greater use of mathematical skills. This is not accidental; many topics in science require the use of these skills. In the case of formula for thrills students need to use maths skills to predict the behaviour of the train at the third level – they can then test it to see if they had got it right.

Links to careers and employment opportunities

Although it will be some years before pupils make crucial decisions about subjects they study at school, research shows that they often form attitudes towards STEM subjects at an early stage. It is useful if early interest can be nurtured and if pupils can be supported to see themselves as potentially being active in this area.

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Further reference

Background information on stores and transfers model of energy is available from a number of places but two widely used ones are: 'Helpful Language for Energy Talk' at: Helpful language energy talk and the IoP's 'Supporting Physics Teaching' materials on energy at: Helpful language energy talk

There are many online references to the physics of roller coasters including the World Science Festival one at Rollercoaster science thrills chills physics

For a more practical exploration of the use of solar cells Practical Action have on their site a suite of resources on solar electricity aimed at KS3: The solar challenge

For additional modules, visit www.siemens.co.uk/education

Suite No.		1	2	3	4	5	6
Phase		Primary	Primary	Secondary	Secondary	Secondary	Secondary
Focus		STEM	STEM	Science	Design Technology	STEM	STEM
Module:		1	2	3	4	5	6
Title		Understanding the body and how it works	Living in a world made by STEM	Energy for thrills	Power to the people	Getting around	Building the things we need
Asset #1	Lesson plan and activity suggestions	The human body - skeletal muscular system	Clean silent trains	Formula for thrills	E-zero Island	Inspired bus company	Keeping it lean and mean
Asset #2	Lesson plan and activity suggestions	The human body – digestive system	Bus activity sheet	Monte Rosa Mountain Hut	Interactive learning tool. Energy Island	Green power challenge	Totally in control
Asset #3	Interactive learning tool	Inside the Human Body	Life without STEM	Formula for thrills	Siemens Farm	Self driving challenge	Lean machines
Asset #4	Digital Badge reward	Curiosity	Technology	Rollercoaster challenge	Energy Challenger	On the move Challenger	Mechatronics Challenger
Asset #5	Lesson plan and activity suggestions	The human body – circulatory system	Words along wires	Here comes the Sun	Blowing in the Wind	Ringing true	A case to resolve
Asset #6	Lesson plan and activity suggestions	More than skin deep	Let there be light	Blowing in the Wind	Underwater Energy	A case to resolve	Sustainability