AREAS OF SUSTAINABILITY AND CIRCULAR ECONOMY IN THE UK CURRICULUM

This is a summary of how the lesson plans available on the website fit into the England GCSE curriculum, and some of the A-Level curriculum. The table below includes extracts from the individual specifications, highlighting key topics within the areas of circular economy, recycling and associated areas alongside the lesson plans which cover the relevant topics. The main exam boards are included, and the focus is on the subjects: combined science, geography and design and technology.

Associated Lesson Plan(s)	SCIENCE (GCSE)	
	GCSE - AQA Combined Science, Trilogy (Exams June 2018 onwards) https://filestore.aqa.org.uk/resources/science/specifications/AQA-8464-SP-2016.PDF	
Introduction to Biobased Economy Creating a Biobased economy	5.7.1.2 Fractional distillation and petrochemicals	The many hydrocarbons in crude oil may be separated into fractions, each of which contains molecules with a similar number of carbon atoms, by fractional distillation. The fractions can be processed to produce fuels and feedstock for the petrochemical industry. Many of the fuels on which we depend for our modern lifestyle, such as petrol, diesel oil, kerosene, heavy fuel oil and liquefied petroleum gases, are produced from crude oil. Many useful materials on which modern life depends are produced by the petrochemical industry, such as solvents, lubricants, polymers, detergents. The vast array of natural and synthetic carbon compounds occur due to the ability of carbon atoms to form families of similar compounds. Students should be able to explain how fractional distillation works in terms of evaporation and condensation. Knowledge of the names of other specific fractions or fuels is not required.
Introduction to ELFM ELFM case study	4.7.3.2 Waste management	Rapid growth in the human population and an increase in the standard of living mean that increasingly more resources are used and more waste is produced. Unless waste and chemical materials are properly handled, more pollution will be caused.
Introduction to ELFM	4.7.3.6 Maintaining biodiversity	• recycling resources rather than dumping waste in landfill.

Introduction to LCA LCA of materials Plastic v. Paper: Battle of the Bags	5.10.2 – Life cycle assessment and recycling	Life cycle assessments (LCAs) are carried out to assess the environmental impact of products in each of these stages: • extracting and processing raw materials • manufacturing and packaging • use and operation during its lifetime • disposal at the end of its useful life, including transport and distribution at each stage. Use of water, resources, energy sources and production of some wastes can be fairly easily quantified. Allocating numerical values to pollutant effects is less straightforward and requires value judgements, so LCA is not a purely objective process. Selective or abbreviated LCAs can be devised to evaluate a product but these can be misused to reach pre-determined conclusions, eg in support of claims for advertising purposes. Students should be able to carry out simple comparative LCAs for shopping bags made from plastic and paper.
What are the 6R's? Introduction to Paper Recycling Introduction to textile recycling	5.10.2.2 Ways of reducing the use of resources	The reduction in use, reuse and recycling of materials by end users reduces the use of limited resources, use of energy sources, waste and environmental impacts. Metals, glass, building materials, clay ceramics and most plastics are produced from limited raw materials. Much of the energy for the processes comes from limited resources. Obtaining raw materials from the Earth by quarrying and mining causes environmental impacts. Some products, such as glass bottles, can be reused. Glass bottles can be crushed and melted to make different glass products. Other products cannot be reused and so are recycled for a different use. Metals can be recycled by melting and recasting or reforming into different products. The amount of separation required for recycling depends on the material and the properties required of the final product. For example, some scrap steel can be added to iron from a blast furnace to reduce the amount of iron that needs to be extracted from iron ore. Students should be able to evaluate ways of reducing the use of limited resources, given appropriate information.
	GCSE - AQA Combined Science, Synergy (Exams June 2018 onwards) https://filestore.aqa.org.uk/resources/science/specifications/AQA-8465-SP-2016.PDF	
Introduction to Paper Recycling Introduction to Biobased Economy	4.4.1.5 Climate change: impacts and mitigation	Steps can be taken to mitigate the effects of climate change by reducing the overall rate at which greenhouse gases are added to the atmosphere. Examples of mitigation include: • using energy resources more efficiently • using renewable sources of energy in place of fossil fuels (see Resources of materials and energy (page 141)) • reducing waste by recycling • stopping the destruction of forests • regenerating forests • developing techniques to capture and store carbon dioxide from power stations.

ELFM case study	4.4.2.7 Positive human impacts on ecosystems	Describe positive human interactions within ecosystems and explain their impact on biodiversity. • recycling resources rather than dumping waste in landfill
Introduction to Biobased Economy Creating a Biobased economy	4.8.1.2 Hydrocarbons in crude oil	Many of the fuels on which our modern lifestyle depends such as petrol, diesel oil, kerosene, heavy fuel oil and liquefied petroleum gases, are produced from crude oil. Knowledge of the names of other specific fractions or fuels is not required. Alkenes are used to produce polymers and as starting materials for the production of many other chemicals. Small ethene molecules polymerise to produce long-chain molecules of poly(ethene) (see also Covalent bonding (page 101)).
Introduction to LCA LCA of materials Plastic v. Paper: Battle of the Bags	4.8.2.8 Life cycle assessment	Life cycle assessments (LCAs) are carried out to assess the environmental impact of the materials used and the energy resources needed for products in each of these stages: • extracting and processing raw materials • manufacturing and packaging • use and operation during its lifetime • disposal at the end of its useful life including transport and distribution at each stage. The use of water, energy resources and materials, as well as the production of some wastes, can be fairly easily quantified. Allocating numerical values to pollutant effects is less straightforward and requires value judgements, so LCA is not a purely objective process. Selective or abbreviated LCAs can be devised to evaluate a product but these can be misused to reach pre-determined conclusions, eg in support of claims for advertising purposes.
Introduction to Paper Recycling Introduction to textile recycling Introduction to Food Waste	4.8.2.9 Recycling	Describe a process where a material or product is recycled for a different use, and explain why this is viable Reuse and recycling of materials by end users cuts down the use of limited material resources. It can also cut the use of energy resources and the production of waste. Metals can be recycled by melting and recasting or reforming into different products. The amount of separation required for recycling depends on the metal and the properties required of the final product. For example, in steel making some scrap steel is added to the iron from a blast furnace to reduce the amount of iron that needs to be extracted from iron ore
	GCSE - OCR: Gateway Science Combined Science A https://www.ocr.org.uk/Images/234596-specification-accredited-gcse-gateway-science-suite-combined-science-a-j250.pdf	
Introduction to LCA LCA of materials	Topic C6 Global challenges	• C6.1d describe the basic principles in carrying out a life-cycle assessment of a material or product • C6.1e interpret data from a life-cycle assessment of a material or product • C6.1f describe a process where a material or product is recycled for a different use, and explain why this is viable • C6.1g evaluate factors that affect decisions on recycling

Plastic v. Paper: Battle of the Bags		
	GCSE - Twenty First Century Science: Combined Science B https://www.ocr.org.uk/Images/234597-specification-accredited-gcse-twenty-first-century-science-suite-combined-science-b-j260.pdf	
Introduction to Biobased Economy Creating a Biobased economy	Topic C3.4 Why is crude oil important as a source of new materials?	Crude oil is mixture of hydrocarbons. It is used as a source of fuels and as a feedstock for making chemicals (including polymers) for a very wide range of consumer products. Almost all of the consumer products we use involve the use of crude oil in their manufacture or transport. Crude oil is finite. If we continue to burn it at our present rate it will run out in the near future. Crude oil makes a significant positive difference to our lives, but our current use of crude oil is not sustainable. Decision about the use of crude oil must balance short-term benefits with the need to conserve this resource for future generations (IaS4).
Introduction to LCA LCA of materials Plastic v. Paper: Battle of the Bags Introduction to textile recycling Introduction to Paper Recycling Dissolving old T-shirts	Topic C4.4 What happens to products at the end of their useful life?	Life cycle assessments (LCAs) are used to consider the overall impact of our making, using and disposing of a product. LCAs involve considering the use of resources and the impact on the environment of all stages of making materials for a product from raw materials, making the finished product, the use of the product, transport and the method used for its disposal at the end of its useful life. It is difficult to make secure judgments when writing LCAs because there is not always enough data and people do not always follow recommended disposal advice (IaS4). Some products can be recycled at the end of their useful life. In recycling, the products are broken down into the materials used to make them; these materials are then used to make something else. Reusing products uses less energy than recycling them. Reusing and recycling both affects the LCA. Recycling conserves resources such as crude oil and metal ores, but will not be sufficient to meet future demand for these resources unless habits change. The viability of a recycling process depends on a number of factors: the finite nature of some deposits of raw materials (such as metal ores and crude oil), availability of the material to be recycled, economic and practical considerations of collection and sorting, removal of impurities, energy use in transport and processing, scale of demand for new product, environmental impact of the process. Products made from recycled materials do not always have a lower environmental impact than those made from new resources (IaS4)
	GCSE Combined Science – Pearson Edexcel https://qualifications.pearson.com/content/dam/pdf/GCSE/Science/2016/Specification/GCSE_CombinedScience_Spec.pdf	
Introduction to LCA LCA of materials Plastic v. Paper: Battle of the Bags	Topic 4 – Extracting metals and equilibria	4.10 Evaluate the advantages of recycling metals, including economic implications and how recycling can preserve both the environment and the supply of valuable raw materials 4.11 Describe that a life-cycle assessment for a product involves consideration of the effect on the environment of obtaining the raw materials, manufacturing the product, using the product and disposing of the product when it is no longer useful 4.12 Evaluate data from a life cycle assessment of a product

Introduction to Biobased Economy Creating a Biobased economy	Topic 8 – Fuels and Earth science	8.2 Describe crude oil as: a. a complex mixture of hydrocarbons b. containing molecules in which carbon atoms are in chains or rings (names, formulae and structures of specific ring molecules not required) c. an important source of useful substances (fuels and feedstock for the petrochemical industry) d. a finite resource
	GCSE WJEC Science double award https://www.wjec.co.uk/media/lknfmp5c/wjec-gcse-science-double-award-spec-from-2016.pdf	
Introduction to Paper Recycling Introduction to textile recycling Introduction to Food Waste The e-waste problem	5.3 Metals and their extraction	(l) factors affecting economic viability and sustainability of extraction processes e.g. siting of plants, fuel and energy costs, greenhouse emissions and recycling
Introduction to Biobased Economy Creating a Biobased economy	5.5 Crude oil, fuels and carbon compounds	(q) the environmental issues relating to the disposal of plastics, in terms of their non-biodegradability, increasing pressure on landfill for waste disposal, and how recycling addresses these issues as well as the need to carefully manage the use of finite natural resources such as crude oil
	Geography (GCSE)	
	GCSE - AQA -Geography https://filestore.aqa.org.uk/resources/geography/specifications/AQA-8035-SP-2016.PDF	
Introduction to ELFM ELFM case study The e-waste problem Introduction to Paper Recycling	3.2.1 Section A: Urban issues and challenges	Urban sustainability requires management of resources and transport. Features of sustainable urban living: • water and energy conservation • waste recycling • creating green space. Urban growth creates opportunities and challenges for cities in LICs and NEEs. **Challenges** • managing environmental issues – waste disposal, air and water pollution, traffic congestion.

Introduction to textile recycling Introduction to Food Waste		
	GCSE - WJEC Geography https://www.wjec.co.uk/qualifications/geography-gcse/#tab_overview	
The e-waste problem The e-waste gold mine	**Theme 8:** Environmental Challenges	8.1.1 What are the impacts of increasing consumer choice on the global environment? How consumerism has impacts on the environment through the disposal of waste, including the impact of e-waste on people and the environment.
	GCSE – OCR Geography A (Geographical themes) https://www.ocr.org.uk/Images/207306-specification-accredited-gcse-geography-a-j383.pdf	
Introduction to ELFM ELFM case study	1.2.6. Cities have distinct challenges and ways of life, influenced by its people, culture and geography	• Case study of one major city in the UK including the influences of: contemporary challenges that affect urban change, including housing availability, transport provision and waste management
	GCSE – OCR Geography B (Geography for enquiring minds) https://www.ocr.org.uk/Images/207307-specification-accredited-gcse-geography-b-j384.pdf	
Introduction to ELFM ELFM case study	5.2. What are the challenges and opportunities for cities today?	b. How can cities become more sustainable? For each city investigate one initiative to make it more sustainable, such as use of brownfield sites, waste recycling and transport improvements.
Introduction to Food Waste	8.2. Can we feed nine billion people by 2050?	Explore the environmental, economic and social sustainability of attempts to achieve food security, in relation to: • ethical consumerism, such as fairly traded goods and food waste
	GCSE – Edexcel Geography B https://qualifications.pearson.com/content/dam/pdf/GCSE/Geography-B/2016/specification-and-sample-assessments/Specification_GCSE_L1-L2_Geography_B.pdf	
Introduction to ELFM ELFM case study	3.7 Quality of life in the chosen megacity can be improved by different strategies for achieving sustainability	a. Advantages and disadvantages of city-wide government (topdown) strategies for making the megacity more sustainable (managing water supply, waste disposal, transport and air quality).

The e-waste problem Introduction to Paper Recycling Introduction to textile recycling Introduction to Food Waste	5.6 Ways of life in the city can be improved by different strategies (1)	b. Strategies aimed at making urban living more sustainable and improving quality of life in the city (recycling, employment, green spaces, transport, affordable and energy-efficient housing). (5)
	Design and Technology (GCSE & A-Level)	
	GCSE - AQA Design and Technology https://filestore.aqa.org.uk/resources/design-and-technology/specifications/AQA-8552-SP-2017.PDF	
The e-waste problem Introduction to Paper Recycling Introduction to textile recycling Introduction to Food Waste	3.1.1 New and emerging technologies	Sustainability: The impact of resource consumption on the planet: • finite • non-finite • disposal of waste.
	3.2.1 Selection of materials or components	Functionality: application of use, ease of working. Aesthetics: surface finish, texture and colour. Environmental factors: recyclable or reused materials. Availability: ease of sourcing and purchase. Cost: bulk buying. Social factors: social responsibility. Cultural factors: sensitive to cultural influences. Ethical factors: purchased from ethical sources such as FSC
What are the 6R's?	3.2.3 Ecological and social footprint	Deforestation, mining, drilling and farming. Mileage of product from raw material source, manufacture, distribution, user location and final disposal. That carbon is produced during the manufacture of products. Reduce, refuse, re-use, repair, recycle and rethink.
Introduction to LCA LCA of materials Plastic v. Paper: Battle of the Bags	3.2.4 Sources and origins	Primary sources of materials and the main processes involved in converting into workable forms for at least one material area. • Paper and board (how cellulose fibres are derived from wood and grasses and converted into paper). • Timber based materials (seasoning, conversion and creation of manufactured timbers). • Metal based materials (extraction and refining).

		• Polymers (refining crude oil, fractional distillation and cracking). • Textile based materials (obtaining raw material from animal, chemical and vegetable sources, processing and spinning). Potential links to moths and science: Life cycle assessment and recycling ie the basic principles in carrying out a life cycle assessment of a material.
	GCSE OCR – Design and Technology https://www.ocr.org.uk/Images/304658-specification-accredited-gcse-design-and-technology-j310.pdf	
Introduction to the Circular Economy	3.1 What are the impacts of new and emerging technologies when developing design solutions?	a. Exploration of the impacts within different contexts on: i. industry and enterprise, such as the circular economy ii. people, in relation to lifestyle, culture and society iii. the environment iv. sustainability
What are the 6R's? Introduction to LCA LCA of materials	5.3 Why is it important to understand the sources or origins of materials and/or system components?	c. Consideration of the ecological, social and ethical issues associated with processing specific materials and/or system components to convert them into workable forms, such as: • mining, harvesting, manufacturing, transporting. d. The lifecycle of specific materials and/or system components when used in products e. Consideration of recycling, reuse and disposal of specific materials and/or system components, such as: • recycling and sustainability schemes • eco-materials • upcycling
Introduction to the Circular Economy	5e. Glossary of terms from the specification content	A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life. It aims to keep products, components and materials at their highest utility and value at all times
	GCSE Edexcel – Design and Technology https://qualifications.pearson.com/content/dam/pdf/GCSE/design-and-technology/2017/specification-and-sample-assessments/Specification-GCSE-L1-L2-in-Design-and-Technology.pdf	
What are the 6R's? Introduction to LCA LCA of materials	1.14 Investigate environmental, social and economic challenges when identifying opportunities and constraints that influence the processes of designing and making	1.14.3 The main factors relating to 'Green Designs'. 1.14.4 The main factors relating to recycling and reusing materials or products. 1.14.8 Environmental impact – life cycle analysis (LCA)

Introduction to Paper Recycling	3.3 The way in which the selection of papers and boards is influenced	3.3.2 Environmental factors: a sustainability b pollution c genetic engineering. 3.3.4 Cost factors: a quality of material b decorative techniques c manufacturing processes necessary d commodity price e cost of recycling in comparison to cost of production from raw materials.
Introduction to textile recycling	6.3 The way in which the selection of natural, synthetic, blended and mixed-fibre textiles is influenced by	6.3.2 Environmental factors: a sustainability b pollution c upcycling.
	A-Level - AQA Design and Technology Fashion and Textiles https://filestore.aqa.org.uk/resources/design-and-technology/specifications/AQA-7562-SP-2017.PDF	
What are the 6R's?	3.1.11 Design for manufacturing, maintenance, repair and disposal	The need to modify designs to make them more efficient to manufacture, including: • reducing the number of manufacturing processes • how the choice of materials affects the use, care and disposal of products: advisory labelling to encourage responsible use and care of textile products • application of the six Rs of sustainability: reduce the quantity of materials, of toxic materials, of damaging materials and associated energy use, reuse components and parts, rethink by using eco-friendly alternative materials, recycle materials and/or components into new products • maintenance: temporary and integral fixings, use of standardised parts, allowing for service and repair/ replacement of parts, ability to upgrade with software downloads, selection of fabrics and components that can be cared for without the need for special treatments, advisory labelling to encourage responsible washing and drying of textile products.
What are the 6R's? Introduction to LCA LCA of materials	3.2.3 How technology and cultural changes can impact on the work of designers	Product life cycle. The stages of the product life cycle, including: • design introduction • evolution • growth • maturity • decline • replacement. Students should be able illustrate their understanding with examples of how, with reference to specific products, designers have refined and redeveloped products. Social, moral and ethical issues • designing products to consider the six Rs of sustainability • the concept of upcycling.
Introduction to the Circular Economy Introduction to textile recycling	3.2.8 Responsible design	Environmental Issues The importance of environmental issues in design and manufacture, including: • the responsibilities of designers and manufacturers in ensuring products are made from sustainable materials and components • the environmental impact of sourcing textile materials, their use and care on the environment • the environmental impact of packaging textile products, eg use of excessive packaging and plastic.

Dissolving old T-shirts		Conservation of energy and resources The concept of a circular economy, including: • how products are designed to conserve energy, materials and components • the design of fashion, clothing and textiles for minimum impact on the environment including raw material extraction, consumption, ease of repair, maintenance and end of life • sustainable manufacturing including the use of alternative energy and methods to minimise waste • the impact of waste, surplus and byproducts created in the process of manufacture including reuse of material off-cuts, chemicals, heat and water • cost implications of dealing with waste • the impact of global manufacturing on product miles.
	A-Level AQA Design and Technology: Product Design https://www.aqa.org.uk/subjects/design-and-technology/as-and-a-level/design-and-technology-product-design-7552	
Introduction to the Circular Economy What are the 6R's? Introduction to Textile Recycling Dissolving old T-shirts	3.1.11 Design for manufacturing, maintenance, repair and disposal	• reducing the number of manufacturing processes • how the choice of materials affects the use, care and disposal of products: • labelling of materials to aid separation for recycling • making products easy to disassemble or separate Application of the six Rs of sustainability: • reduce the quantity of materials, of toxic materials, of damaging materials and associated energy use • reuse components and parts • rethink by using eco-friendly alternative materials • recycle materials and/or components into new products
What are the 6R's?	3.2.3 How technology and cultural changes can impact on the work of designers	• products are made using sustainable materials and ethical production methods • designing products to consider the six Rs of sustainability.
	3.2.8 Responsible design	Environmental issues Students should be aware of, and able to discuss, the importance environmental issues in design and manufacture, including: • the responsibilities of designers and manufacturers in ensuring products are made from sustainable materials and components • the environmental impact of packaging of products, eg the use of excessive packaging and plastics.
The e-waste problem The e-waste gold mine	3.2.10 National and international standards in product design	• polymer codes for identification and recycling • packaging directives • WEEE directives

	Environmental Sciences (A-Level)	
	A-Level AQA Environmental Science https://filestore.aqa.org.uk/resources/science/specifications/AQA-7447-SP-2017.PDF	
Introduction to LCA LCA of materials	3.2.3.7 Strategies to secure future mineral supplies	• Cradle to Cradle design. The advantages of recycling. • Conservation of mineral resources. • Reduced energy use (of mineral extraction). • Reduced mineral extraction/processing impacts. • Reduced waste disposal impacts. Difficulties with recycling schemes: • Identification of materials. • Separation of mixed materials. • Reduction in quality. • Increased transport costs/impacts. • Collection difficulties. • Lack of consumer cooperation.
Introduction to ELFM ELFM case study Introduction to Food Waste The e-waste problem Introduction to Paper Recycling Introduction to textile recycling	3.4.3.2.12 Solid wastes	Domestic wastes The advantages and disadvantages of the treatment options should be evaluated: • landfill • incineration • recycling • composting. Specialist solid wastes. Solid wastes with particular risks should be separated and treated individually.
Introduction to Biobased Economy Creating a Biobased economy Introduction to the Circular Economy	3.2.4 Biogeochemical cycles	Many elements have low availability to living organisms. Biogeochemical cycles involve inter-linked processes that allow materials to be recycled and repeatedly re-used.

Introduction to Biobased Economy	3.6.3.1 Linear human systems lead to resource depletion and waste generation	The use of fossil fuels The reliance on non-renewable energy resources cannot be sustainable. Inefficient use and use when renewable resources are available accelerates depletion rates.
Introduction to the Circular Economy	3.6.4 The circular economy	3.6.4.1 The application of the principles of the circular economy to the development of sustainable lifestyles