

# Curriculum Links

## Activity 1C – Oil viscosity

The Department for Education is conducting a review of the primary and secondary National Curriculum. The links below relate to the statutory programmes of study for science in the National Curriculum, 2007 and specific sections of common science qualifications offered in UK schools.

### Key stage 3

#### 1.1 Scientific thinking

b. critically analysing and evaluating evidence from observations and experiments.

#### 1.2 Applications and implications of science

a. exploring how the creative application of scientific ideas can bring about technological developments and consequent changes in the way people think and behave.

#### 2.1 Practical and enquiry skills

Pupils should be able to:

- use a range of scientific methods and techniques to develop and test ideas and explanations
- assess risk and work safely in the laboratory, field and workplace
- plan and carry out practical and investigative activities, both individually and in groups.

#### 3.1 Energy, electricity and forces

a. energy can be transferred usefully, stored, or dissipated, but cannot be created or destroyed  
b. forces are interactions between objects and can affect their shape and motion

#### 3.2 Chemical and material behaviour

a. the particle model provides explanations for the different physical properties and behaviour of matter  
c. elements and compounds show characteristic chemical properties and patterns in their behaviour.

#### 3.4 The environment, Earth and universe

c. human activity and natural processes can lead to changes in the environment.

### Key stage 4

#### 1 How science works

##### 1.1 Data, evidence, theories and explanations Pupils should be taught:

a. how scientific data can be collected and analysed  
b. how interpretation of data, using creative thought, provides evidence to test ideas and develop theories  
c. how explanations of many phenomena can be developed using scientific theories, models and ideas

##### 1.2 Practical and enquiry skills Pupils should be taught to:

a. plan to test a scientific idea, answer a scientific question, or solve a scientific problem  
b. collect data from primary or secondary sources, including using ICT sources and tools  
c. work accurately and safely, individually and with others, when collecting first-hand data  
d. evaluate methods of collection of data and consider their validity and reliability as evidence.

##### 1.3 Communication skills Pupils should be taught to:

a. recall, analyse, interpret, apply and question scientific information or ideas  
b. use both qualitative and quantitative approaches  
c. present information, develop an argument and draw a conclusion, using scientific, technical and mathematical language, conventions and symbols and ICT tools.

##### 1.4 Applications and implications of science Pupils should be taught:

a. about the use of contemporary scientific and technological developments and their benefits, drawbacks and risks  
b. to consider how and why decisions about science and technology are made, including those that raise ethical issues, and about the social, economic and environmental effects of such decisions

##### 2.2 Chemical and material behaviour In their study of science, the following should be covered:

a. chemical change takes place by the rearrangement of atoms in substances

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- c. new materials are made from natural resources by chemical reactions
- d. the properties of a material determine its uses.

**2.3 Energy, electricity and radiations** In their study of science, the following should be covered:

- a. energy transfers can be measured and their efficiency calculated, which is important in considering the economic costs and environmental effects of energy use

**2.4 Environment, Earth and universe** In their study of science, the following should be covered:

- a. the effects of human activity on the environment can be assessed using living and non-living indicators
- b. the surface and the atmosphere of the Earth have changed since the Earth's origin and are changing at present

## SQA Intermediate Chemistry

Prescribed practical activity: Testing for unsaturation.

## AQA Chemistry GCSE and Science GCSE

### Unit C1.4 Crude oil and Fuels C1.4.3 Hydrocarbon fuels

e) Biofuels, including biodiesel and ethanol, are produced from plant material. There are economic, ethical and environmental issues surrounding their use.

### C1.6 Plant oils and their uses C1.6.1 Vegetable oils

Biodiesel fuel can be produced from vegetable oils.

a) Some fruits, seeds and nuts are rich in oils that can be extracted. The plant material is crushed and the oil removed by pressing or in some cases by distillation. Water and other impurities are removed.

#### Suggested ideas for practical work:

- using bromine water to test fats and oils for unsaturation, eg testing sunflower oil against butter (using colorimeter to measure level of unsaturation).

## AQA Science B GCSE

### 3.4.2.2 Fuels for cooking, heating and transport

 Candidates need to:

1. Name suitable fuels for cooking, heating our homes and for providing transport.
3. Explain some of the problems of burning fossil fuels (pollution, carbon dioxide production and global warming) and that resources of fossil fuels are finite.

### 3.4.2.3 Generation and distribution of electricity

 Candidates need to:

1. Define the terms renewable and non-renewable in the context of energy sources.
2. Know that fossil fuels (natural gas, oil and coal) release energy when they are burned, which can be used to generate electricity for our homes.
3. Explain how nuclear fuels and renewable energy sources (wind, solar, hydroelectric, wave, tidal, biomass and geothermal) may be used as alternatives to fossil fuels.

Within this context, candidates should be able to use scientific data and evidence to discuss, evaluate or suggest implications of the following:

- the environmental impact over time of energy production by comparing the advantages and disadvantages of using alternative energy sources
- the economic impact of using alternative energy sources

#### Suggestions for practical work

- Test oil fractions for viscosity, ease of ignition and sootiness of flame.

## AQA Environmental Science GCSE

### A2.4 What alternative energy technologies are available?

Scientists have developed alternative technologies to harness energy from sources other than fossil fuels. Environmental scientists use their knowledge to assess these alternatives for their efficiency and potential

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environmental impact.

Scientists have also developed methods of electricity generation from renewable resources that may be used instead of fossil fuels.

Candidates should know and understand that:

- renewable energy resources are usually sustainable:
- not depleted by use including wind power
- capable of rapid replacement including biofuels
- most renewable energy resources:
- use kinetic energy to turn generators, which produce electricity (exceptions include solar water heating, photovoltaics, geothermal and biofuels)
- usually need larger areas than thermal power stations to yield the same amount of energy
- may be unreliable or cannot provide a constant supply of energy
- may detract from the appearance of a land/seascape (A1)
- may affect wildlife populations or habitat (B1)

Agricultural scientists have developed plant crops, together with the use of animal and plant waste to produce renewable biofuels.

Candidates should know and understand that:

- biofuels, eg biogas, bioethanol, biodiesel, are also renewable and can:
  - be burned to produce heat but release carbon dioxide
  - be used as vehicle fuel
  - be 'carbon neutral' or 'green' as carbon dioxide taken out of the air by photosynthesis when energy crops grow is returned when the fuel is burnt so that no extra is added to the atmosphere (B2)
  - be a waste product eg from sewage plants, poultry farms (A1)
  - be environmentally damaging when land is cleared, and biodiversity (B1) and food-producing farmland are lost (A1)
  - *have a lower energy density than fossil fuel*

Environmental scientists use their knowledge of chemistry, physics and biology to consider both the advantages and disadvantages of various energy resources. They consider a number of factors before making conclusions and recommendations.

Candidates should be able to:

- describe: biofuels
- in terms of:
  - efficiency
    - predictability
    - intermittency
    - energy density*
  - potential environmental impact including:
    - emissions to air/water
    - mining/quarrying land take
    - disturbance to sediment patterns/water flow
    - hazardous waste
    - disruption of wildlife
    - noise/radio disturbance
    - loss of landscape value

Opportunities to investigate using scientific knowledge and skills:

- the amount of energy produced by different vegetable oils/alcohols
- the rise in temperature in a compost heap over time
- public attitudes towards different energy producing technologies

## OCR Chemistry and Science A 21st Century GCSE

### Module C2: Material choices C2.2 Why is crude oil important as a source of new materials such as plastics and fibres?

7. recall that crude oil consists mainly of hydrocarbons, which are chain molecules of varying lengths made from carbon and hydrogen atoms only

8. recall that only a small percentage of crude oil is used for chemical synthesis and that most is used as fuels

9. understand that the petrochemical industry refines crude oil by fractional distillation; hydrocarbons are separated into fractions of different boiling points, to produce fuels, lubricants and the raw materials for

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chemical synthesis

10. relate the size of the forces between hydrocarbon molecules to the size of the molecules

11. relate the strength of the forces between hydrocarbon molecules in crude oil to the amount of energy needed for them to break out of a liquid and form a gas, and to the temperature at which the liquid boils

## OCR Physics and Science A 21st Century GCSE

### Module P3: Sustainable energy P3.1 How much energy do we use?

1. understand that the demand for energy is continually increasing and that this raises issues about the availability of energy sources and the environmental effects of using these sources

2. recall the main primary energy sources that humans use: fossil fuels (oil, gas, coal), nuclear fuels, biofuels, wind, waves, and radiation from the Sun

## OCR Chemistry and Science B Gateway GCSE

### Module C1: Carbon Chemistry Item C1a: Making crude oil useful

#### Assessable learning outcomes Foundation Tier only: low demand

Recall that crude oil, coal and gas are fossil fuels.

Describe non-renewable fuels as ones which take a very long time to make and are used up faster than they are formed.

Recognise that fractional distillation separates crude oil into useful products called fractions.

Understand that fractional distillation works because of differences in boiling points.

Recognise that LPG, petrol, diesel, paraffin, heating oil, fuel oils and bitumen are fractions obtained from crude oil.

#### Assessable learning outcomes both tiers: standard demand

Explain why fossil fuels are finite resources and are non-renewable:

- finite resources are no longer being made or being made extremely slowly
- non-renewable resources are used up faster than they are formed.

Describe crude oil as a mixture of many hydrocarbons.

Interpret data fuels in order to choose the best fuel for a particular purpose (no recall expected).

Suggest the key factors that need to be considered when choosing a fuel for a particular purpose.

#### Assessable learning outcomes Higher Tier only: high demand

Discuss the problems associated with the finite nature of crude oil:

- all the readily extractable resources will be used up in the future
- finding replacements
- conflict between making petrochemicals and fuels.

Explain in terms of molecular size, intermolecular forces and boiling point why crude oil can be separated by fractional distillation.

Understand that during boiling the intermolecular forces between molecules break but covalent bonds within the molecule do not.

Evaluate the use (no recall expected) of different fuels.

#### Suggested practical and research activities

Demonstrate the fractional distillation of crude oil using synthetic crude oil mixture.

Research the different products that can be made from crude oil.

## Edexcel Biology GCSE

### Unit B3: Using Biology Topic 3 Biotechnology

3.19 Demonstrate an understanding of the advantages and disadvantages of replacing fossil fuels with biofuels, including the facts that biofuels are renewable and that their production uses carbon dioxide but that growing the crops to make them requires land and may affect the availability of land for growing food.

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## SQA Standard Grade Science

### Topic 3: Energy and its Uses Renewable Sources of Energy

1 Fossil fuels and nuclear fuels are non-renewable, but waves, wind, hydroelectricity and the sun are renewable sources of energy.

2 As the stocks of fossil fuels are depleted these alternative sources of energy will become more important.

Credit Level

3 Other renewable sources of energy include sugar alcohol and geothermal heat.

In sugar-growing countries, sugar can be fermented into alcohol which can be used as a fuel.

4 There are advantages and disadvantages in the use of each alternative or renewable energy source, to include: cost, the technology involved, visual pollution, and reliability of the energy source.

## Cambridge Physics iGCSE (with significant similarity to Coordinated and Combined Science iGCSE)

### 1. General physics 1.6 Energy, work and power 1.6 (b) Energy resources

- Distinguish between renewable and non-renewable sources of energy
- Give advantages and disadvantages of each method in terms of cost, reliability, scale and environmental impact

## Cambridge Chemistry iGCSE (with significant similarity to Physical science, Coordinated and Combined Science iGCSE)

### 6. Chemical energetic 6.2 Production of energy

- Describe the production of heat energy by burning fuels

### 7. Chemical reactions 7.1 Speed of reaction

- Describe the effect of concentration, particle size, catalysts (including enzymes) and temperature on the speeds of reactions

### 14.5 Alkenes

- Distinguish between saturated and unsaturated hydrocarbons
  - from molecular structures
  - by reaction with aqueous bromine

### 14.8 Macromolecules 14.8 (b) Natural macromolecules

- Describe fats as esters possessing the same linkage as *Terylene* but with different units

## Key stage 5

### AQA Biology B A-level

#### Unit 1 BIOL1 Biology and disease

3.1.3 Glycerol and fatty acids combine by condensation to produce triglycerides.

### OCR Chemistry A A-level

#### 2.1.2 Alkanes Hydrocarbons from crude oil

Candidates should be able to:

(c) state that alkanes and cycloalkanes are saturated hydrocarbons;

(e) explain, in terms of van der Waals' forces, the variations in the boiling points of alkanes with different carbon-chain length and branching;

#### Hydrocarbons as fuels

(i) explain that the petroleum industry processes straight-chain hydrocarbons into branched alkanes and cyclic hydrocarbons to promote efficient combustion;

(j) contrast the value of fossil fuels for providing energy and raw materials with:

**How Science Works 6a, 7b:**

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Desirability of renewable fuels by 'rich' countries may lead to problems of food supply for countries supplying the 'crops for fuel'. (i) the problem of an over-reliance on non-renewable fossil fuel reserves and the importance of developing renewable plant based fuels, ie alcohols and biodiesel (see also 2.4.2)

## 4.1.3 Carboxylic Acids and Esters. Esters, triglycerides, unsaturated and saturated fats

### How Science Works 7c:

Use of biodiesel as a fuel to increase contribution to energy requirements from renewable fuels.

(f) describe a triglyceride as a triester of glycerol (propane-1,2,3-triol) and fatty acids;

(g) compare the structures of saturated fats, unsaturated fats and fatty acids, including cis and trans isomers, from systematic names and shorthand formulae;

(i) describe and explain the increased use of esters of fatty acids as biodiesel.

## OCR Chemistry B Salters A-level

### Unit F331: *Chemistry for Life* Developing Fuels.

#### Organic functional groups

(o) explain and use the terms: *aliphatic, aromatic, saturated and unsaturated*;

#### Applications

(x) understand the benefits and risks associated with using fossil fuels and alternative fuels (biofuels, hydrogen, nuclear) and discuss the choices involved in making decisions about ensuring a sustainable energy supply.

## OCR Biology A-level

### 3.2 AS Unit F212: *Molecules, Biodiversity, Food and Health* Module 1 Biological Molecules

Candidates should be able to:

(p) compare, with the aid of diagrams, the structure of a triglyceride and a phospholipid;

(q) explain how the structures of triglyceride, phospholipid and cholesterol molecules relate to their functions in living organisms;

(r) describe how to carry out chemical tests to identify the presence of the following molecules: protein (biuret test), reducing and non-reducing sugars (Benedict's test), starch (iodine solution) and lipids (emulsion test);

## SQA Chemistry Higher

### Unit 2: *The World of Carbon* c) Reactions of carbon compounds

(i) **Addition** The characteristic reaction of an alkene is the addition reaction.

Alkenes can undergo the addition of hydrogen, hydrogen halides, halogens and water to form saturated products.

To meet market demand ethanol is made by means other than fermentation.

#### f) Natural products (i) Fats and oils

Natural fats and oils can be classified according to their origin as animal, vegetable or marine.

The lower melting points of oils compared to those of fats is related to the higher unsaturation of oil molecules.

The low melting points of oils is a result of the effect that the shapes of the molecules have on close packing, hence on the strength of van der Waals' forces of attraction.

Fats and oils are esters.

The hydrolysis of fats and oils produces fatty acids and glycerol in the ratio of three moles of fatty acid to one mole of glycerol.

Glycerol (propane-1,2,3-triol) is a trihydric alcohol.

Fatty acids are saturated or unsaturated straight-chain carboxylic acids containing even numbers of carbon atoms ranging from C4 to C24, primarily C16 and C18.

Fats and oils consist largely of mixtures of triglycerides in which the three fatty acid molecules which are combined with each molecule of glycerol may or may not be identical.

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## **SQA Biology: Advanced Higher Course**

### **Unit: Cell and Molecular Biology. Structure and function of cell components**

Lipids. Structure of glycerol, saturated and unsaturated fatty acids.

## **AQA Environmental Studies A-level**

### **A2 Unit 3 – ENV3 Energy Resources and Environmental Pollution 3.3.1 Energy**

Renewable energy resources

Examples should be used to illustrate the factors affecting the ease of use of renewable energy resources and therefore their likely use in the future

Energy density: biofuels have medium energy densities

Ease of storage: Energy can be stored as potential energy of water in reservoirs and chemical energy in biofuels

Future energy supplies New technologies

New technologies may increase the amount of energy available for use by

- increasing the amount of energy available from existing energy resources
- allowing new resources to be exploited

Atmospheric pollution

- incomplete combustion of fossil fuels and biofuels

## **AQA Science in Society A-level**

### **Unit 1 AS Exploring key scientific issues 3.1.3 Transport issues**

Technical ways of reducing the impact of transport on local air quality and on greenhouse gases.

The advantages and disadvantages of different fuels, to include: fossil fuels, bio-fuels, fuel cells and hydrogen.

Fuels are valuable because they are concentrated sources of energy. There is a finite amount of fossil fuel (coal, oil, natural gas) on Earth. Other energy sources (wind, wave, biomass such as wood) are renewable. They can be replaced in the same sort of time scale as they are used.

### **Unit 3 A2 Exploring key scientific issues 3.3.5 Energy futures The context**

The context for this topic is the challenge of reconciling the growing demand for energy resources worldwide, especially the demand for electricity, with the policy imperative to cut down the emission of carbon dioxide and other greenhouse gases. People want the benefits of a readily available supply of electricity but must balance this against the cost of each method of generation and its environmental impact.

Renewable sources of energy are naturally and continually replenished; they include wind, solar power, geothermal, hydropower, and various forms of biomass.