The **key areas** are from the *Unit Specifications*. **Suggested learning activities** are not mandatory. This offers examples of suggested activities from which you could select a range. It is not expected that all will be covered. The contexts for key areas are open to personalisation and choice, so centres are likely to devise their own learning activities. **Exemplification of key areas** is not mandatory. It provides an outline of the level of demand and detail of the key areas.

Risk assessment should always be carried out by teachers/lecturers prior to doing any of the experiments and demonstrations listed in the table.

Fragile Earth

In this Unit there are opportunities for personalisation and choice. Learners will focus on two choices from the following four:

- energy
- metals
- water
- food

They will investigate these resources through activities related to their source, origin, production and/or extraction. Uses and benefits will be explored. Conflicts and also possible local, national, or global solutions will be identified. Learners will gain knowledge of how science is involved in environmental issues.

Fragile Earth — Energy

Key areas	Suggested contexts	Suggested learning activities and exemplified key areas
For one renewable and one non-renewable source, investigate and compare: ♦ source/origin, production and/or extraction ♦ use (as appropriate) ♦ conflicts, benefits and issues	You live in a small town on the coast. The nearest big city is about 75 miles away. Most people in your town work in agriculture and fishing, but the population is growing and communication with the outside world via internet and telephone is essential. At the moment, electricity is supplied via individual generators in people's homes, which need diesel transported to the town by road. The generators are unreliable and break down often. The town also regularly runs out of fuel as the roads are unusable during the rainy season. Some of the wealthier homes have	Activities are themed around a context and are designed to allow learners to answer the questions posed through practical experiments and web-based research. The Energy Quest Room is a comprehensive Californian website which covers all the necessary content. Additional web resources are given for each relevant activity. **Introduction** Suggested content: Energy is needed for transport, heating, cooking, lighting, ICT, sport, leisure and healthcare. Electricity, gas and oil are the main domestic energy sources, but are produced from a mixture of renewable and non-renewable sources. c.f. Energy Quest Room

Possible solutions could be local, national or global	solar panels which provide a backup when the generator breaks down. The town council have decided to provide a central source of energy to provide power to the growing population. You are a member of the town council — what would be your choice of energy for this town? Use the information available and the results from your experiments to help you reach a decision. *Thinking through the problem* The council need to consult the locals as some money will be required to fund the new system. At the first public meeting, a fight breaks out among the residents. Here are some of the things they say: What's wrong with the generators? Mine works fine!	**Suggested activities** Keep a logbook of a whole day or whole week's activities, noting down the type of energy source used: electrical, gas, wind, etc for each activity. Do a class survey of the main energy source for heating, lighting and cooking in each home. Draw a bar graph of results. An additional useful web resource is provided by Parsel University in Denmark: 'How to heat my house?' Introduce the questions asked by the council members about each type of energy source. Each question can be reviewed after the chosen experiments and activities have been completed. **Suggested content** Electricity, gas and oil are the main domestic energy sources, but are produced from a mixture of renewable and non-renewable sources. Finite energy sources are limited and will run out one day. Coal, oil, gas and nuclear fuel are all examples of the main finite (non-renewable) fuel sources. Renewable energy sources are those which will not run out, ie can be replaced or regrown. The production of ethanol from sugar cane is a renewable fuel source. cf: Energy Quest Room **Suggested activities** Experiment — How much energy can we get from fossil fuels like diesel? Measure the heat produced when diesel (or a synthetic substitute) is burned and compare it with the heat produced from burning ethanol. Simple temperature changes in a given mass of water can be used. Experiment — Would ethanol be easier to get than diesel? Ferment sugar (or locally grown fruit or potatoes) to produce ethanol. **Suggested content** Renewable energy sources are those which will not run out, ie can be replaced or regrown. Wind power, solar power, hydroelectric, biofuels, geothermal energy, tidal and wave power are all examples of renewable energy sources.

	I've spent a fortune on my solar panel! Why should I have to pay for a new system? Everyone should buy their own! If we build a power plant, it will cause pollution and our fish and plants will die.	Experiment — How efficient are solar panels? Use solar cells to power a light bulb, LED, toy car and fan. Compare the effectiveness of the solar cell with a conventional alkaline battery. Solar buggy kits are available from the Natural History Museum. EPSRC and the University of Edinburgh have some useful online resources available as part of their Renewable Energy Roadshow. Experiment — Build your own solar cell Build a homemade solar cell. The Solar Spark provides a recipe and some extra information on this. Try different dyes from fruit or food colouring to see which make the best cell. **Suggested content** Fossil fuels like coal, oil and gas produce acidic gases when they are burned. These acidic gases can lead to the loss of plant and aquatic life. **Suggested activities** Experiment — Burn sulphur and carbon in oxygen to show that acid rain is produced. Show a video or animation on the formation of acid rain from sulphur and nitrogen oxides. The United States EPA website and the *Times Educational Supplement* online database are good resources for these animations. Prepare a poster, PowerPoint or report. What are the main advantages of renewable fuels over coal- or gas-powered stations? What are the disadvantages? What would learners choose as a possible solution? Visit a power station if one is available locally. **Suggested content** There are losses incurred whenever electricity is transmitted, and good infrastructure is necessary to do it efficiently. High voltage, low current transmission is necessary to avoid high losses.

	We should use our new energy plant to sell power to the next town down the coast. Maybe they will sell us some of their hilly land to put up a windfarm? What proposal will you make to council?	**Suggested activities** Experiment — Set up a model transmission line for electricity. Compare the losses using a DC and AC current and changing the voltage. NB learners do not need to understand the concept of a transformer for this, just that infrastructure for high voltage transmission is necessary for efficient transmission. Experiments 352 and 423 on the Practical Physics website may be used to illustrate/investigate these losses. **Suggested content** vi) Wind power, solar power, hydroelectric, biofuels, geothermal energy, tidal and wave power are all examples of renewable energy sources. **Suggested activities** Experiment — Build a wind turbine or use the school wind turbine to measure the power available and plot a table to show which types of devices could be powered by different numbers or sizes of individual wind turbines. cf: EPSRC/University of Edinburgh Renewable Energy Roadshow Make a visit to a local windfarm to find out what the advantages are in running a large scale operation. **Consolidation activity** Learners can choose one renewable and one non-renewable source of energy from the ones they have investigated, and produce a media item summarising what they have learned about these sources (eg PowerPoint, poster, video, animation, poem, newspaper article etc). Comparisons between the two might include sustainability, cost, practicality etc.

Fragile Earth — Metals		
Key areas	**Suggested contexts**	**Suggested learning activities and exemplified key areas**
For two different metals, one commercially used on a large scale and one commercially used on a small scale, investigate and compare: ♦ source/origin, production and/or extraction ♦ use (as appropriate) ♦ conflicts, benefits and issues Possible solutions: one from a local, national or global context.	**Mobile metals of the future** **Who** has got the metal that **you** need: Centre chooses an application that they can research (the mobile phone, computer, solar cell, electric cars etc.) Scenario It is the 22nd century. We are running out of metals for communications and renewable energies. In an independent or post-recession Scotland (fictional future scenario of your choice) we need more metals for solar panels, optical cables and computer hard drives (these are rare earth metals 'Rare earth' is an alternative name for the lanthanides — elements 57 to 71 — plus yttrium and scandium). The elements are integral to modern life, and are used in everything from disc drives, hybrid cars and sunglasses to lasers and aircraft used by the military (more information in the *New Scientist* article reference in resources column for the teacher to use in setting up the context) Can you dig the metals up in your backyard to make a mobile phone, computer hard drive, and solar panels?	Investigate: conductivity (thermal and electrical), density, strength, malleability and ductility of at least two metals. Also metals are sonorous. Compare the properties of metals with non-metals. Compare physical and chemical properties of different metals. **Resources** Interactive world map to investigate metal abundance, availability and cost. Education Scotland Some internet resources: ♦ Science videos on RSC website will provide an illustrative background to metal properties and uses. ♦ From the TES website you can download various teacher and learner resources that will revise the properties and use of metals already covered in the level 4 outcomes covered in S1 to S3 ♦ Metal uses in pigments and in colour. This practical application of why metals are so useful can be used in the introduction to this topic. ♦ You can use the Practical Chemistry website and show 'Flame colours — a demonstration'. This is an experiment with flame tests and explains why we see colours in metal pigments and fireworks. There were some articles in *New Scientist* magazine about the low abundance and difficulty of extraction of metals used in touch screens for phones and computers. These can be accessed from the *New Scientist* website and could be used by the teacher to set the scene to research metal uses and abundance for this context.

	Ethical resources Unethical use of children in mining valuable and rare metals used in touch-screen computers. How can you be sure the metals in your mobile phone computer are ethically sourced? **Precious metals** Thieves steal and resell metals as they become more valuable. Look at where metals are stolen from and the prices they can be sold for investigate how they can be protected. **Metals of the future** New alloys can be made with different properties. For new technologies we need new materials. What metals would we use to make a flying car or a space elevator? **Metal catalysts** are used in many ways to make new materials or to save energy investigate some of these, where they are found and how they are used.	As a scene setter for this context, *The Guardian* newspaper had articles about unethically sourced metals used to make mobile phones and laptops. The metals were mined using child slave labour in war-torn Congo. Can be used by the teacher to set the scene for researching metal abundance and some of the human costs in using these metals. **Lesson plans and class activities** about recycling mobile phones from Oxfam, for ages 12–16 can be accessed on the Oxfam website. These tie in with recycling valuable resources and using them to help others. To give some background to this context, there are some news articles that can be found on the Guardian website about thieves stealing metals. You could investigate why these metals are being stolen using the following questions:

	Gold on our doorstep Gold is to be mined at Cononish near Tyndrum. Work on constructing the mine first began in the 1980s but low gold prices forced closure before the mine became fully operational. The mine is now viable because the price of gold has gone up. Research into the pros and cons of having this resource on our doorstep. Does it bring wealth and new jobs or irreparable environmental damage to this beautiful area?	♦ What are they used for and why? ♦ Why are they so valuable (the recession is making metal costs rapidly increase) ♦ How reactive are they? ♦ Are these metals always recycled? ♦ What is the cost of this? ♦ How abundant are they? To give some background to this context there was an article in *New Scientist* magazine about making new alloys that are strong enough to make improved jet engines. You could investigate uses of alloys and the new properties that they give metals. Possibly design a new alloy with the class. Experiment — from the Practical Chemistry website, 'Making an alloy (solder)'. You could also use soldering to make a useful object or sculpture. 'Sustainability is Precious' is a series of **activities and experiments** from Johnson Matthey that explain how precious metals play a vital role in removing harmful pollutants from the air we breathe. This gives us some insights into why these metals are precious. This can be downloaded from the TES website. To give some background to this context, some news articles about the gold mine at Cononish near Tyndrum can be found on the Glasgow Herald and BBC websites. Some suggested activities that fit in with the context. ♦ Visit to a mine or mining museum (if available locally). ♦ Try gold panning **practical activity** (could demo this with copper powder and sand in sink). ♦ Design and make a medal for the Commonwealth Games — choose between a pure metal or alloy (research cost, availability and abundance).

	Recycling metals Having gathered information during the Unit on how rare expensive and difficult to extract metals are, investigate recycling metals using some of these activities.	Some other experiments and activities to illustrate metal extraction that could be used in conjunction with the context you choose. The following two activities are from the TES website: ♦ A PowerPoint presentation that: Asks a pupil to link the special properties of titanium to specific uses (golf clubs, aircraft, piercing, and hip replacements). Links to websites with video clips showing uses and also a titanium quiz. Looks at extraction from its ore, via use of displacement reactions. ♦ A series of questions about the extraction of metals, and their properties, uses and alloys. Suitable websites are given to help students find the information, with links to a couple of short films for them to watch along the way. Also some different ways of extracting metals from their ores. ♦ Extract copper from copper chloride using electrolysis. ♦ Extraction of iron form iron(III) oxide using a match head. ♦ Extraction of copper from fake malachite ore (use a mixture of cement and copper carbonate to make fake malachite and then design an experiment to extract the copper from this). ♦ Extraction of copper from copper oxide by burning with Bunsen on a piece of burnt wood (this provides the carbon for the reduction reaction). You need to use two safety mats and cool the reduced copper oxide with water. ♦ A magnet to compare iron content in different breakfast cereals. (Link to mineral nutrients in food.) ♦ Research why the more valuable metals are more expensive to extract. ♦ Visit a local waste management site. ♦ Research local and national policy on metal recycling. ♦ School or class project on recycling metals. ♦ Make a new and useful item out of cans, bottle tops or foil wrappings. ♦ Build a sculpture with soldering skills learned in properties of metals.

Fragile Earth – Water		
Key areas	**Suggested contexts**	**Suggested learning activities and exemplified key areas**
For **two** different water supplies, one local and one global, investigate and compare: ♦ source/origin, extraction ♦ use (as appropriate) ♦ conflicts, benefits and issues	There is a problem with your local water supply. The main water pipe that supplies the town has been damaged, or terrorists poison the water, accidental pollution. Choose the scenario which would best motivate. The water has been cut off.	Activities are themed around a context and are designed to allow pupils to answer the questions posed through practical experiments and web-based research. General websites which give an overview: The Creative Chemistry website and Science Buddies website (Earth and Environmental Science) give ideas for various practical projects. There are several websites: Scottish Water Education website, Wateraid Learnzone; Practical Action, water and sanitation; Engineering without Borders, Water Filter Challenge. Scottish Water, Education area of website. The SEPA website has useful background information for teachers. Additional internet resources are given for each relevant activity or content. **Introduction** Suggested content: Local reservoirs and location of water supplies and reservoirs. Information on this can be found on the Scottish Government website, environment and water area. How does water arrive in our homes? Drinking water comes through main water pipes from reservoirs. Visit a local reservoir and or water treatment works Investigate how much water there is on the surface of the Earth and what % of the human body/plants etc. is water. How Stuff Works website, under how much water is there on Earth is a useful resource for this.

	How does water get to the reservoir?	How does water get to the reservoirs? A water cycle PowerPoint and diagram can be found on the Jefferson Lab website. Another water cycle diagram can be found on the Enchanted Learning website. Another way of presenting the water cycle is the Water Cycle Wheel on the Illinois Environmental Protection Agency website, in the Kids and Education area of the site. Why does water need to be purified? What water-borne diseases can occur even in industrialised countries? The Water Aid website is a useful resource for this. What is in tap water, pond water? Look at tap water under microscope, evaporate it. Similarly, evaporate pond water. Investigate water-related diseases. Investigate why chlorine makes water safe to swim in and/or drink. Chlorination. This can be found on a commercial company's website, Prowater Ltd. Water can be used as a means of mass medication. Fluoridation. Information about this can be found on NHS South Central website. Investigate how commercially available water purification systems work, eg boiling, filtration, activated charcoal absorption, chemical disinfection, ultraviolet purification, solar water disinfection, solar distillation, homemade water filters. Information and projects on these suggestions can be found on the Water Filter Challenge website, a portable water purification system can be found on the Wikipedia website. Design your own method for collecting water from the atmosphere. Investigate how hot countries with little rainfall obtain freshwater. The Darjeeling Children's Trust website has information about water harvesting techniques.

	Why is water so important? What are the consequences for your community? Think of the different people in your family, street, the school, shops, offices, factories, leisure facilities. Choose one group you want to help. How would each of them be affected? What activities would be affected? List the problem each would have. What are some solutions?	The Eco School website has a water butt to purchase. Information about a Water Purification Station is available on the web. Design a water filter to clean muddy water and discuss how safe the water would be for drinking. World water filter challenge can be found on the Engineers Without Borders website. Domestic usage of water: the US Environmental Protection Agency (Water Sense Kids). Investigate how water is needed for cleaning, drinking, cooking, farming, industry and leisure activities: eg use manufacturer's data to find out how much water a washing machine or dishwasher uses. At home, the learners can investigate how much water is used when brushing teeth by putting the plug in the sink while brushing their teeth and then comparing the amount of water used if they turn the tap on only when needed. How much water was in the sink this time? Cleaning: information about using waste water and cooking in the Third World can be found on the Saakshar School Appeal website. Visit to a local swimming pool. This is an opportunity to cover chlorination so can be tied in with above or used separately. Information about water and agriculture can be found on the Water and Agriculture website. Hydroponics and irrigation systems, hydroponics. Scope Curriculum website has information on growing plants by hydroponics and a hydroponics diagram. Grow seeds with varying amounts of water. Investigate the efficiency of soft and hard water for cleaning eg lathering of detergent.

		There is an experiment about hard/soft water on the chemistry part of About.com website. Make a cup of tea with hard and soft water and compare what is left in the cup. Investigate an industry that uses a lot of water, eg dyeing, paper making. Information about dyeing can be found on Wikipedia and on the Creative Chemistry website. Make paper by recycling, instructions on the What Katie did website, 'I made paper with 5 year olds', Filth Wizardry website. Collect drinking water from salt water by evaporation. Discuss the practicalities of desalination to obtain fresh water, eg whisky, paper, soft drinks etc. The principals of desalination A simple diagram of desalination and information about desalination can be found on the Water Online website in the article 'Yale To Build Novel Forward Osmosis Desalination Pilot Plant'. The principles of distillation. Resources for this are readily available in Standard Grade resources. Global issues are dealt with on Water Aid, Learn Zone area of the website and water and sanitation area of the Practical Action website.

Fragile Earth — food		
Key areas	**Suggested contexts**	**Suggested learning activities and exemplified key areas**
For two foods, investigate and compare: ♦ source/origin, production and/or extraction ♦ use (as appropriate) ♦ conflicts, benefits and issues Possible solutions: one from a local, national or global context	It is estimated that almost one billion people worldwide go hungry every day and at least half of all deaths of children under five are malnutrition-related. The problem of food shortages affects mainly the developing world and is predicted to get worse due to a combination of factors including climate change, ecological degradation, population growth, rising energy prices, increasing demand for meat and dairy products and competition with other land uses such as the production of biofuels and urban expansion. This contrasts with the developed nations where food surpluses lead to overeating and give rise to an alternative set of health problems such as obesity, diabetes and heart disease. In future, spiraling transport energy costs will make it prohibitively expensive to ship large amounts of food around the world. This will	**Growing plants from seeds** Collect and examine seeds from a variety of plants, eg cress, mung bean, broad beans, etc. Measure water content of stored and fresh seeds (eg peas). Test seeds for starch. Grow a collection of plants from a variety of seeds (eg watercress, tomatoes, courgettes, etc). Demonstrate the conditions needed for the germination of seeds. Demonstrate plant life cycle using 'fast plants'. Test plants grown under different conditions to demonstrate the factors needed for photosynthesis. Measure changes in mass of germinating seeds and photosynthesizing seedlings. Investigate sowing seeds. **Plant production** Make and use rooting and potting composts. Demonstrate the water-holding capacity of different composts. Investigate drainage of composts with different compositions. Demonstrate the importance of plant nutrients. Investigate watering of plants. Design and make a watering system for house plants which could run for a week or more. Monitor environmental conditions such as minimum and maximum temperatures, relative humidity and wind speed. Examine leaflets etc on greenhouse design, heating systems and ventilation devices. Demonstrate the use of a thermostat. Investigate the effects of sunlight, shade, artificial lighting on plant growth. Prick out seedlings sown earlier. Dead head bedding plants in the vicinity. Pot-on plants. Compare different methods of controlling pests and diseases. Examine leaflets on cloches and tunnels.

	reduce the ability of rich countries to provide food aid for those countries that need it. The increase in fuel prices and concerns about carbon emissions will also make it less attractive to source out-of-season foods from distant parts of the world. As a result, it will be necessary to develop more sustainable ways of producing and consuming food locally. This will have a significant impact on food production that will see a focus on organically farmed local produce and a reduction in livestock with consequential changes in diet.	Examine horticultural fleece. Analyse and interpret data on characteristics of selected species. Give examples of genetically engineered plants of economic importance to humanity. **Livestock production** Analyse and interpret data on characteristics of selected species. Give two examples of improved characteristics resulting from selective breeding. Discuss economic importance of selective breeding. Examples of uses made of various cuts. Religious/cultural influence on food processing. **Impact of technology on food production** Microbial tests for consumption safety (Resazurin test). Investigate various processing treatments for milk. Make yoghurt. Investigate different types of rennet. Make dough. Investigate factors necessary for fermentation to take place. Investigate artificial colouring and flavours. Investigate upgrading of waste materials from yeast or whey industry. **Use of foods** Consider several common foods and compare their contents. Compare animal and plant food sources for content. Compare the main types of farming in different regions of the UK or the world. Investigate why some farmers raise livestock while others prefer to grow crops. **Conflicts and issues** Identify on a world map regions where food shortages and food surpluses exist and investigate the reasons for this. Consider the ethical issues involved in genetic modification.

Human Health

What is health? – social/mental/physical
This Unit covers the individual's immediate health, expanding to taking responsibility for the family's health. It then looks at health within the community, and finally global issues affecting health. In this Unit there is opportunity for learner personalisation and choice. Teachers/lecturers may choose the appropriate health parameters for their learners and not all are expected to be covered.

Typical resources:
Resources such as BBC, NHS website, Discovery or Channel 4 will cover just about every health issue from preventative health to childhood infections, cancer to healthy weight levels.
Many free apps or useful interactive anatomy sites are available.
The World Health Organisation site has lots of information on diseases worldwide.
Many of the above sites will provide interactive games so that learners can choose games and quizzes related to organs.
Sites relating to quitting smoking will provide information on smoking and pollution and their effects on lungs.
Many sites provide information specific to disease, eg diabetes, heart disease.
Science videos: obesity, lungs and smoking, health and disease, nutrition, deficiency, substance misuse.

Key areas	Suggested contexts	Suggested learning activities and exemplified key areas
Threats to health — establishing what is meant by health. Social, physical and mental components.	Learners can complete a personalised health report. Content of report could include: ♦ describing in detail the main features of a healthy lifestyle ♦ recognising and discussing the various healthy parameters for a teenage body, and how this is related to circulation and breathing ♦ describing how various parameters relating to health are measured, including circulation and breathing ♦ discussing aspects of health relating to lifestyle	Suggested areas may include: ♦ Explore the health triangle. ♦ Normal pulse rates, how to measure and what can affect them. Extremes of pulse rate. ♦ Relationship between recovery time and health. ♦ Measurement of blood pressure, and causes and consequences of extremes. ♦ Describe advantages and disadvantages of high- and low-tech measuring devices. ♦ Body temperature, measurement and diagnosis of small changes, within key age groups. Learners could attend a first aid course/ invite medical practitioners for talk etc and undergo/carry out a health assessment of peers/staff/fictitious person at the beginning of the course.

		Outside speakers eg health visitors, school nurse, St. Johns ambulance, Police. Meditation and relaxation techniques. Survey and (if appropriate) measure health of staff and learners, eg: ♦ blood pressure ♦ pulse ♦ tidal volume ♦ vital capacity ♦ temperature ♦ body fat ♦ vaccination ♦ peak flow Equipment in for measuring height, weight (optional), skin fold callipers. Pulse can be measured using a pulsometer or heartrate monitor, stethoscope/finger and stopwatch. Blood pressure can be measured using a digital sphygmomanometer or a stethoscope and mercury manometer. Peak flow. Learners can watch videos, research or use information from informed speakers to identify causes and treatments for various health issues. Examine lungs from a sheep to compare clean lungs with photographs of smoke-damaged lungs.

Key areas	Suggested context	Suggested learning activities and exemplified key areas
Threats to health	Possible use of scenario of two different family situations to analyse and discuss aspects of healthy living and supportive environments. Examples could include a two-plus-two working family with an elderly dependant, compared with a single, unemployed mother. Mixing-up of stereotypes, should then be encouraged, to include some of the following: ♦ poverty ♦ hygiene ♦ drug and alcohol abuse ♦ smoking ♦ sexual health ♦ diet and obesity ♦ exercise ♦ stress and mental health ♦ mobility impairment Learners may produce their own versions of specific scenarios predicting possible issues and necessary interventions	Suggested areas may include: ♦ Energy balance study. ♦ Knowledge of various vitamins and minerals and effects of deficiencies/ disorders. ♦ Examine labels on foods comparing nutritional values for learner food diary. ♦ Burning foodstuff and graph work on results. ♦ Agar plates showing microbiological growth pre-/post-hand washing. ♦ Hand-washing techniques and UV light. ♦ Research meditation and relaxation techniques. ♦ Doctors visit to the school. ♦ Supermarket visit. ♦ Links to Government campaign on 'five-a-day'. ♦ Outside speakers from police, youth support services. ♦ Research poor diets and produce presentation poster examples of poor diets. Could include famine, anorexia, bulimia, and kwashiorkor, obesity, rickets. ♦ PowerPoint presentation on personality whose diet is specialised for their job. For example: sports person, explorer, athlete. ♦ Collect and discuss newspaper/magazine cuttings relating to health and relate to the three aspects of health.

Key areas	Suggested contexts	Suggested learning activities and exemplified key areas
Health claims Media report analysis.	Learners can choose a topical media health report to investigate and evaluate.	Suggested areas may include: ♦ Survey of class and what vaccinations they have had. ♦ Jenner's experiment. ♦ Effects on the body of poor hygiene. ♦ Possible internet/research project on worldwide diseases and controversial vaccination programmes. ♦ Investigate information on conditions such as asthma, cancer, depression. ♦ Investigate information on the effect of foods, eg energy drinks, fizzy drinks, effects of caffeine.

Applications of Science

This Unit lets learners explore science's contribution to communication technologies, new materials and how science helps the understanding of risk and how it can be reduced in modern life.
Teachers/lecturers may cover all key areas of the Unit using one context, a mixture of key areas in one context or as separate topics.

Key areas	Suggested context	Suggested learning activities and exemplified key areas
Telecommunications Principles and applications of telecommunications: electromagnetic waves (radio, microwaves and light waves) and sound waves Applications — from at least two of: ♦ satellite technology ♦ fibre optics ♦ electromagnetic wave technology ♦ storage technologies ♦ opto-electronics ♦ screens ♦ speakers /ear phones etc. ♦ amplifiers ♦ microphones ♦ radio Others	The contexts given below can be used to cover all or some of the key areas in this Unit. **Adventure race** Adventure race involves a team of young people who have to kayak, cycle, run, abseil and canoe around a 10 mile course. Materials suitable for these activities are explored. In particular, telecommunication and satellite technology can be explored when one of the participants gets lost or hurt and rescue or medical assistance is required. However, they find it difficult to maintain a signal possibly due to the terrain or weather. One of the team remembers passing a forester's hut which contains a radio set. Could the radio be used to call for help? The way in which the news media report the incident and how this is communicated to an audience via television, radio and the internet could be explored. On being safely rescued one of team is taken to hospital where their leg is X-rayed. The X-ray is automatically digitised and displayed on one of the hospital monitors for analysis. Risk and safety issues can also be considered in relation to young people taking part in an adventure race.	Investigate the distance over which a mobile phone signal can be received using cell maps available from network operators Investigate the effect of wavelength on the ability of a wave to bend round obstacles. Research the different frequencies used to operate mobile phones, TV signals and radio signals. Investigate the frequency of a transmitted mobile phone signal. Use internet sites which track, in real time, orbiting satellites. The same sites could be used to compare the height and speeds of satellites. Geostationary satellites could be investigated. Bluetooth communication between phones could also be investigated. Investigate the focusing of waves by curved (concave) reflectors. Investigate the gain of an amplifier by comparing an amplifier input voltage with its output voltage. Investigate the focusing of waves using a ray box and concave lenses to illustrate focusing of signals using curved reflectors. Measure the thickness of optical fibres using a digital vernier gauge. Investigate the advantages of fibre optics over copper cables. Various videos online of how optical fibres are made. Build a simple circuit containing an LED. Use a signal generator to investigate the digital properties of an LED. This can demonstrated that an electrical signal can be converted to a light signal. Investigate total internal reflection of light rays using ray boxes and

	Car science On a car journey a breakdown/accident occurs. Investigate the science in cars eg, music systems, voice recognition, satellite navigation storage systems. Smart materials around bumpers and Telecommunication technology should be investigated. Transport risk and safety issues could be addressed. Hospital visit could lead to the science around fibre optics, X-rays and other materials used in health.	semi-circular transparent blocks. Investigate the medical applications of X-rays. Use a radio receiver (eg a mobile phone) to illustrate the conversion of radio signals to electrical signals and into sound waves. Videos/cds are available which cover the following: Electromagnetic radiation — where does this radiation come from and how do the frequencies and wavelengths vary? Microwaves are not only used to heat food but also to communicate over large distances. How has GPS enhanced our lives — from military systems to social applications like tagging locations in Facebook, or locating hillwalkers. The properties of high frequency electromagnetic radiation, allowing physicians to look inside the human body and even combat cancer. There are BBC class clips on mobile phone coverage/GPS opinions including parents tracking children. Other communication videos on include: How do mobile phones work? Submarine communication. Echolocation: dolphins, The satellite story, Satellites, How does GPS work? Option to expand communications topic to include materials: ♦ The science behind materials used for sports clothing, eg waterproofs, wicking material (material that dries quickly). ♦ The materials used in the making of sporting equipment, eg bikes, canoes and kayaks. ♦ Exploration of the aerodynamics with regards to cycling and water sports ♦ Look at design of footwear for different sports. ♦ These points may expand the breath of the context from a physics topic into a more general science subject.

Materials Source, production, use and issues. At least two from: ♦ plastics ♦ fibres ♦ 'smart' materials ♦ alloys ♦ cosmetics ♦ composite materials ♦ biological ♦ recycled	Either approach as stand-alone topic on materials or incorporate into contexts given above. **Smart materials — sensory room** You are an interior designer and you have been commissioned to create a multi-sensory room, eg for a child with autism/ASD or for a state-of-the-art bedroom. As well as smart materials and telecommunications, other areas which could be investigated are given in the column on the left.	Suggested activities for sensory room can be found on BBC Bitesize website, eg designing with electronics and materials. **Colours** Pupils could investigate colour changes using: Toy ducks with thermochromic pigments'Baby bath thermometers Thermochromic wire/film (secret message) Mugs with thermochromic UV beads/thread – investigate sun cream. Clothes that change colour. Suitable videos (Dragon's Den/The Apprentice) They could also predict future uses and possible environmental issues *Note — The 'colour change' ducks contain thermochromic pigments which change colour in response to heat and that these can be added to fabric.* *Show learners UV beads which change colour when exposed to UV radiation. Explain how photochromic pigments can be added to fabric and that they can change colour when exposed to UV radiation. Show pictures of smart bikini which can be used to measure UV exposure and help protect skin.* *A smart material changes its properties due to external stimulus.* *Give examples of smart materials which change colour due to outside stimuli.* *Know that a thermochromic materials change colour because of changes in heat.* *Be able to give use(s) of smart colour materials.* **Fluids** Be able to give example(s) of use(s) of smart fluids. Be able to come up with solutions to problems using smart fluids. Smart putty (hammer or throw at wall). D3O Video on YouTube (smacking spade on head with D3O hat). Custard bouncy balls (borax, custard powder and PVA glue). Without custard powder — noisy putty. Cornflour/water mix (quick sand).

		This experiment shows that fluids have the ability to flow and are not necessarily liquids. They should know that materials exist which can behave as both liquids and solids. Brainiac on YouTube — swimming pool filled with custard. Brainiac — quick sand. Ferrofluid and magnet (used in speakers) (suitable videos on internet). Polymorph (thermoplastic). Predict uses in future and possible environmental issues. Learners should understand the basic operating principle of a shape memory alloy/plastic (that it 'remembers' to return to a particular shape when heated). They should also know some applications of this property. Short length of memory wire (nickel-titanium), memory alloy springs. Possible kits — muscle wire kit (simulate muscle contraction). Memory foam (mattresses and pillows) (bed shops have free samples). Memory foam was developed by NASA for use in space. Car bumpers made from memory foam'can be reshaped after an accident. Quantum Tunnelling Composite — material that conducts electricity when pressure is applied (used in ski/sport jackets to function mobile phones and iPods from the sleeve) Video on gadget show website. Transparent conducting oxide glass: predict uses in future and possible environmental issues. Learners could investigate how this could be used in the future for displaying TV screens on fabric and walls. Memory flex glasses. *Note — This demonstration will introduce learners to glass used in the manufacture of solar cells. They have a conducting oxide layer on one side only. This can be simply demonstrated using a multimeter set to measure resistance and placing the leads on conducting and non-conducting surfaces and comparing the*

	Cosmetic wonder product A wonder product has appeared on the market. Examples of the product could be: ♦ tanning product ♦ skin cream ♦ a semi-permanent tattoo ♦ acne treatment The drug, or cosmetic company, has scientific evidence to show how effective the product is. It becomes a market leader and the company makes a lot of money from it. The product is derived from a biological source. Claims on the dangers of this product start to appear. Risk issues can be explored as well as source, production, use and issues.	*results. One side has a low resistance and conducts whereas the other side has a high resistance and does not conduct.* Learners could also investigate fibre optics if not done already in telecommunications — transmit light. **Science of skincare** (a) Tanning products Structure of the skin. Investigate the ingredients in the tanning and bronzers. Investigate how tan-enhancers work Explain why some tanning products smell. How do tanning products stain the skin? How do tanning pills work? Discuss the dangers of tanning pills. Tanning products vs. sun beds. Describe the effect of UV radiation on UV beads experiment and relate this to the increase in melanin in the skin What is melanin? What does it do? Examine guidelines around safe exposure to sunlight. How do you assess how a good tanning product is? Examination of skin melanomas caused by UV radiation. Ingredients of sun block cream. What are the active ingredients in sun cream? (b) Skin cream Structure of the skin. Make home-made creams (emulsions). Examine the ingredients of exfoliant products. Compare ingredients of cheap and expensive creams. Discuss the scientific claims made by cosmetic companies. (c) Body art Structure of skin. Use chromatography investigate contents of tattoo ink and non-permanent ink. How are tattoos applied? How are non-permanent tattoos applied and removed? Issues around body art (age of consent, risk of infection, permanency, peer grouping).

		Risks of home-tattooing. How are tattoos removed? Examination of infected tattoos and attempts to remove tattoos (d) Acne treatment Structure of skin. What is acne? Chemical treatment of acne. Radiation treatment of acne. Analysis of the scientific claims made by drug companies.
Risk and safety Identifying, measuring (risk assessment) and minimising risk for at least one of the following ♦ home safety (including safety devices) ♦ electrical safety — earth wire, fuses, circuit breakers, trip switches ♦ work safety ♦ transport safety (eg airbags, seat belts, response times) ♦ radiation safety	Either approach as stand-alone topic on risk and safety relating to real-life examples which are linked in to the areas covered in the Course or incorporated into contexts given. You could also approach Risk and Safety as a context or give a 'Bringing it all together' task at the end. For example, 'you are a group of car designers and have to give a health and safety report and risk assessment to your company director'. Home safety may be more appropriate for National 3. **Electrical safety** Earth wire, fuses, circuit breakers, residual current monitor (in lawnmowers and guitars). Make circuits to simulate alarms. Learners could explore electronic systems and their applications in real life situations.	**Electrical safety** How Stuff Works could also be used for electrical safety devices. video's on electrical safety. BBC Class Clips The dangers of approaching a powerful source of electricity are demonstrated on BBC learning zone clips. It includes images of dangerous sources of electricity which children might see in their local environment. To demonstrate the dangers of electricity, a dummy is moved towards an electricity cable and is struck by electrical sparks. The importance of following the instructions on the warning signs is explained. There is also an introduction to the concept of electric shock and the functions of fuses and RCDs. A fuse is designed to allow several amperes of current before it melts or blows. In this way it protects household wiring. A residual current device, or RCD, protects against electrocution by detecting any difference in current between connecting wires. **Work safety** You can download leaflets/posters and videos eg what you need to know from the Health and Safety Executive government website. The government website also has 'case studies' of current British companies or you can search for an industry type. Pupils could choose area to investigate. There are numerous work experience resources which provide

	Work safety Understand that everyone at work has a duty of care to follow the Safety at Work Act. Learners could look at various jobs and investigate the safety procedures, protective clothing. Link to the World Of Work and Work Experience using health and safety at work act. You could also investigate real 'case studies' online. **Chemical safety** Could be included in home safety eg cleaning chemicals Identify chemical hazard symbols. Identify risks in chemical safety and how they are minimised. Learners do not need to do full COSHH assessments. They should understand the terms hazard, risk, hazcard, risk assessments and be able to identify hazard symbols. Pupils do not need to do full COSHH assessments. Pupils should understand the terms hazard, risk, hazcard, risk assessments and be able to identify hazard symbols. **Transport safety** Identify risks in transport safety and how they are minimised.	information for teachers, training providers, youth workers and employers. There are sites with activities for training, work experience preparation or classroom lessons. Eg wise up to work **Chemical safety** Hazcard dominoes/safety symbol games on TES and numerous websites let you design your own hazcards. BBC Bitesize and EChalk have information and activities on hazard symbols. Learners could investigate dangers of chemicals that they will come across in school science labs and in the home, and write simple risk assessments for those chemicals. **Transport safety** Experiment — Crash trolleys with dummies. Use with/without elastic bands for seatbelts. Experiment — Egg and sheet experiment can be found on the Practical Physics website. Video on safety. Debate on speed limits. Video on BBC Class Clips – Cars that automatically obey the speed limits. Breaking distances under different road and tyre conditions. Investigate design features which reduce the impact of forces on drivers, eg airbags. Investigate other real-life examples, eg gannets — diving sea birds in Scotland with 'airbags' in their heads. There are video clips and information on these birds on the BBC website. Experiments for response times, drunk glasses using prisms. Drug and drink driving.

	Radiation safety Learners could investigate identifying risks in radiation safety and how they are minimised.	Various websites have response time tests which you can try whilst using a mobile phone etc to see how response time is affected. Debate about using mobile phones whilst driving. Echalk website has useful animations. Requires subscription for full version but previews available for free — eg stopping distance, reaction test, safe driving. BBC class clips have video clips about safety and bike riding. Top Gear has clips of Stephen Fry when he decided to give up his motorbike. **Radiation safety** X-rays in hospitals/dentists. Why use a lead vest? Why do dentists/doctors use radiation badges? Information about radiation from mobile phone masts/cell phone radiation can be found on various websites like How Stuff Works. Various videos including reducing radiation risk, MRI, radioactive half-life etc. BBC Class clips could also be used.