www.PapaCambridge.com

UNIT 5 Energy and Energy Sources

Recommended Prior Knowledge
Most pupils will have some concept of energy in a general industrial or domestic sense but they are less likely to be as precise in their understanding as the subject demands at this level. An elementary experience of the distinctions between the different forms of energy would be useful even at the start of this unit.

Context
Since energy is one of the fundamental ideas which underpin the whole of this subject, this is another fundamental unit. In the first section, however, one can afford to swim with the tide and leave the idea of energy less than properly defined. It does lead into the full and fundamental definition, however, and at that point more care will be needed as the concepts and definitions are used throughout the rest of the course.

Outline
At first, the fairly gentle topic of energy transformation and energy sources is dealt with. There are few difficult or abstract ideas here and it lends itself to a less mathematical treatment than many other areas. It is desirable, however, to keep the subject as precise as possible and to make sure that pupils do not start using terms like power, energy and force interchangeably. It is essential that when energy is properly defined in the second half of this unit, it is done carefully and that its structural importance as a concept is thoroughly emphasised. The terms kinetic and potential energy can be used quantitatively and the definition of work is included. Efficiency and power can be fully defined here, even if they have featured in previous units. The formula, $E = mc^2$, will excite some pupils who will believe that they are now real physicists – encourage them. Finally the environmental consequences of power generation will return them to more straightforward and familiar areas.

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
8(a)	List the different forms of energy with examples in which each form occurs.	It is probably best to name and describe the different forms of energy as they occur in the course rather than to list them in an somewhat abstract and artificial way all at once. At some point, however, it makes sense to list the energy forms which have been encountered and to ensure that pupils can identify which form of energy is most important in a given change. Energy cannot be properly defined until work done has been defined (later in this unit), but most pupils will have some idea of what energy means here.	Types of energy: http://www.gcse.com/energy/types.htm or: http://powermin.nic.in/kids/types_of_energy.htm	
8(b)	State the principle of the conservation of energy and apply this principle to the conversion of energy from one form to another.	Consider some particular examples of energy change. What energy changes occur in a hydroelectric power station? What energy changes occur when electrical energy is used domestically in the cooker? An electric drill? A mobile telephone charger? What energy changes occur in a motor vehicle? When it is going up hill? As it accelerates? What energy changes occur in a nuclear power station?	Conservation of energy: http://www.irish-energy.ie/content/content.asp?section_id=1135&language_id=1 Energy transformations: http://www.physicsclassroom.com/mmedia/energy/pe.html or:	

www.PapaCambridge.com

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
			http://www.nottinghamschools.co.uk/eduweb/schools/schools-template.aspx?id=874	
8(d)	List renewable and non-renewable energy sources.	This can be quite an arid topic if taught conventionally, but it does lend itself to project work.	Non-renewable energy sources: http://www.sustainableenergy.qld.edu.au/sources/nonrenewable.html Renewable energy sources: http://www.sustainableenergy.qld.edu.au/sources/renewable.html or: http://www.factmonster.com/ipka/A0907040.html	Emphasise that the Sun is the ultimate source of most energy consumed on Earth but that this is not true of geothermal energy, nuclear energy and tidal energy.
8(e)	Describe the processes by which energy is converted from one form to another, including reference to • chemical/fuel energy (a regrouping of atoms) • hydroelectric generation (emphasising the mechanical energies involved) • solar energy (nuclei of atoms in the Sun) • nuclear energy • geothermal energy • wind energy.	Pupils might research the whole topic individually or a small group of pupils might research one type of renewable energy and then explain their findings to the whole class. It is important that pupils remember that this is a physics project and they should make clear the origins of the energy source as well as any environmental benefits, e.g. hydrogen is not a source of renewable energy since it has to be generated by some means. What is the pupil proposing as the source of the energy to generate it? Pupils should understand that renewable energy does **not** mean that it can be "used again", rather that it is being renewed as it is used so that it will "not run out".		
8(j)	Calculate work done from the formula *work = force x distance moved in the line of*	Emphasise the difference between doing work and getting tired.	Work done: http://www.glenbrook.k12.il.us/gbssci/phys/Class/energy/u5l	The formula *mgh* comes from *force x distance.*

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
	action of the force.	A human gets tired supporting a weight at a constant height even though no work is being done. Likewise no work is done against gravity when a suitcase is moved horizontally. Give many examples including: lifting a load vertically upwards, rolling a barrel up a plank at an angle, removing an electron from an atom, excited nuclei rearranging themselves after radioactive decay (gamma-radiation).	1aa.html Mechanical energy: http://www.bbc.co.uk/schools/gcsebitesize/physics/energy/potentialandkineticrev1.shtml	Doing work is the [illegible] as transferring energy, and energy is the ability to do work. The two quantities are inextricably intertwined. This is true quantitatively and so they have the same unit.
8(c)	State that *kinetic energy* $E_k = ½mv^2$ and that *potential energy* $E_p = mgh$ and use these equations in calculations.	The formula $½mv^2$ can be deduced from $F = ma$ and $a = (v^2-u^2)/2$. It is usually better just to state it at this stage.	Kinetic energy: http://hyperphysics.phy-astr.gsu.edu/hbase/ke.html Potential energy: http://www.glenbrook.k12.il.us/gbssci/phys/Class/energy/u5l1b.html	
8(k)	Calculate the efficiency of an energy conversion using the formula *efficiency = energy converted to the required form/total energy input.*			
8(h)	Describe the process of electricity generation and draw a block diagram of the process from fuel input to electricity output.	Emphasise that every energy conversion generates some heat which is usually lost to the surroundings. Try to discourage pupils from writing, "…lost as heat, light and sound". Few systems waste energy as light and those which do lose energy as sound, lose very little when compared to the quantity lost as heat.		
8(l)	Discuss the efficiency of energy conversions in common use, particularly	Figures on energy input and output are usually available from a local power station and this may even be a convenient place in the course to arrange a visit.	Power station efficiency: http://www.aie.org.au/melb/material/resource/pwr-eff.htm	

www.PapaCambridge.com

www.PapaCambridge.com

	Learning Outcomes	Suggested Teaching Activities	Online Resources	Other resources
	those giving electrical output.	A discussion of power station efficiency might include more efficient systems including combined power and heat (C.P.H.)	or: http://www.memagazine.org/backissues/apr02/features/sixtypc/sixtypc.html	
8(m)	Discuss the usefulness of energy output from a number of energy conversions.			
8(n)	Calculate the power from the formula *power = work done/time taken.*	This definition gives a specific meaning to power which is distinct from energy. Power is always: the rate of change of something measured in joules. Give examples: the rate of doing work, the rate of losing heat, the rate of generating energy, etc.	Work and power: http://www.physicsclassroom.com/Class/energy/U5L1a.html	
8(f)	Explain nuclear fusion and fission in terms of energy releasing processes.	These two opposite processes both release energy but emphasise that fusion only releases energy for small nuclei and fission for large ones. Quote the accurate masses of the proton, neutron and helium nucleus and show that $m_{He} < 2m_p + 2m_n$.	Energy in fission and fusion: http://www.energyquest.ca.gov/story/chapter13.html	
8(g)	Do calculations using the mass-energy equation: $E = mc^2$.	Consider a few **specific** examples of fission such as: $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3\,^{1}_{0}n$		
8(i)	Discuss the environmental issues associated with power generation.	Start a class discussion. Groups put forward the merits of building a particular sort of power station for their country/community. Pupils concentrate on the negative aspects of power generation: global-warming, pollution, radioactive discharges, and health effects. They should be reminded of the importance of an adequate power supply.	Environmental issues: http://www.gcse.com/energy/climate_change.htm	