T172 Notes

Theme 1 - You and the Environment

Domestic energy consumption accounts for about 30% of all delivered energy. But if you include the personal transport element, households account for about half of the energy used in the UK. Are a significant source of CO_2 emissions as well as air pollution and other environmental effects.

Carbon dioxide emissions are frequently used to measure environmental impacts. Climate change is closely linked with CO_2, which creates greenhouse gas, which comes directly, and indirectly from fossil fuels.

CFC's are associated with depletion of the ozone layer, skin cancer due to ultraviolet radiation, loss of habitat for wildlife due to acid rain, smog.

Theme trying to quantify the environmental impacts of an activity or a whole economy. EcoCal directly ties this in but doesn't give a picture of a whole economy. Results depend on what indicators are chosen and how they are defined and measured.

Sustainable development implies providing a decent quality of life for the world's present population without damaging the environment or depleting resources such that the earth cannot provide for the needs of future generations.

Sulphur dioxide results in acid rain. Sulphur Dioxide = $S + O_2 = SO_2$

Type of ***models*** are **physical** (such as a scale model of a car used in wind tunnel testing); **ionic** (such as a map or an engineering drawing); **analogue** (such as thinking of heat flowing from hotter to cooler objects as like water flowing from one level to a lower level) and **mathematical** (such as the equation for calculating the rate of heat loss thought a house wall). A conceptual model of which the EcoCal would be an example of.

Emissions from cars are: CO, NO_x, SO_2, VOC's PM's and lead.

The lower the U-value, the lower the rate of heat loss will escape through it.

Wood is a renewable resource where as minerals and metals used for building materials are non-renewable.

Theme 2 - Travelling Light

The total volume of travel that takes place can be broken down according to key characteristics. For personal travel (rather than freight), these factors are:

the number of trips;
the average length;
the method (or mode) of transport used; and
the size and occupancy of vehicles used.

Main point is that are transport intensive lifestyles we are travelling further yet not more often. We also are devoting more time to travelling.

Although walking still represents a large proportion of journeys (29%), journey destinations are shifting to beyond walking distance.

Goodwin showed that even a massive road building could not be sustained by government funding not would it solve the congestion problem.

Life cycle analysis is a technique, which is used to look at the environmental impacts pertaining to either a product or a whole area such as transport. It is a 'systems approach' in that it traces the environmental impacts at all stages of a 'life cycle' of a product.

The aim of the LCA is to identify where the greatest environmental impacts occur in order to help decide the best approach to reduce them. LCA's are very helpful in identifying environmental 'hot spots' and clarifying the decisions that need to be made. Page 29 has a good graphic for seeing the life cycle of a car.

Air pollution causes over 24 000 deaths a year, which is six times the amount of people killed each year in traffic accidents. Noise pollution also contributes to health concerns. It raises blood pressure, while is also thought to aggravate mental illness. Also because of the rise in automobile usage people have now more sedentary lives. Car dependency is generally associated with less exercise and poorer health. Direct land take is also a big issue, but also the indirect land-take effects. Urban housing and retail developments have made people very car dependent while also inhibiting public transport to these areas. High speed commuting railways are now thought to be enviromentally damaging

When considering transports environmental impacts, life-cycle approach leads to an emphasis on energy consumed while vehicles are in use, rather than the energy involved in the vehicle's manufacture or disposal.

Energy Files – Part 1

Forms of energy: thermal (heat), chemical (fuels or batteries), kinetic energy (moving substances), electrical, gravitational, potential. Definition of *energy* is the *capacity, or ability, to do work.*

Work is done when a force moves through a distance. work = force x distance

Force is expressed in Newtons (N), distance is expressed in metres (m), and units of work will be joules (J).

A newton is defined as *that force which will cause a mass of 1 kilogram(kg) to accelerate at the rate of 1 metre per second per second* ($m\ s^{-2}$).

Power is defined as the *rate of working or the rate of conversion of one from of energy to another*.

Often energy is referred to as *power used for a given period of time*.

See pages 14 & 17 of Theme 1 for conversion rates.

Renewable energy sources are naturally occurring or replenished (e.g. sunlight, winds, waves, tides).

Fossil fuels are coal, oil, gas. Not replenished easily and not in our lifetime. Often referred to as non-renewable resources.

First Law of Thermodynamics, the *total quantity* of energy is always conserved. The Second Law of Thermodynamics is there is necessarily a *limit to the efficiency* of any heat engine.

We don't consume energy, we just convert it from one form into other forms.

When discussing energy matters it is important to be clear about the difference between the *quantities* of energy involved, and the *rate* at which energy is converted from one form to another or transmitted from one place to another. The **rate** per second at which energy is converted (or transmitted) is called the **power** of the conversion (or transmission).

Carbon burns to carbon dioxide, sulphur burns to sulphur dioxide. Hydrocarbons burn to a mixture of carbon dioxide and water. Octane burns to carbon dioxide and water. Also all high temperature combustion combines some nitrogen and react with the oxygen to form nitric oxides - or acid rain. For chemical equations look at page 23 of Energy File - Part 1a.

Primary energy is coal, petroleum, gas and nuclear heat. Delivered energy is by fuel, sector and end use. See graph on page 25, of Energy File - Part 1a for more detail.

In practice, speeds for cars are measured in miles per hour (mph) or kilometres per hour (kph). The more scientific unit is metres per second ($m\ s^{-1}$).
50 miles per hour = 80 kilometres per hour = 22.2 metres per second.

A mass of one kilogram travelling at a speed of $1\ m\ s^{-1}$ hs a kinetic energy :
$E_k = 0.5 \times 1 \times (1 \times 1) = 0.5$ joules

Therefore, a car with a mass of 800 kg and a velocity of $30\ m\ s^{-1}$ (approximately 110 kph or 70 mph) would have a kinetic energy of:
$E_k = 0.5 \times 800 \times (30 \times 30) = 360\ 000$ joules or 0.36 MJ

The total drag force, F, depends upon the velocity, v; the density of the air, normally indicated by the Greek letter ρ, 'rho'; the frontal surface area, A; and a drag coefficient, C_d.

Chemical Forms

Carbon Dioxide	=	$C + O_2 = CO_2$		
Sulphur Dioxide	=	$S + O_2 = SO_2$		
Carbon monoxide	=	$C + O = CO$		
Nitrogen Oxides	=	$N + O_x = NO_x$		
Nitrous Oxide	=	$N_2 + O = N_2O$		
Methane	=	CH_4		
Natural Gas	=	$CH_4 + 2\ O_2$	=	$CO_2 + 2\ H_2O$
Oil & Petrol	=	$2\ C_8H_{18} + 25\ O_2$	=	$16\ CO_2 + 18\ H_2O$

Summary of the properties of atomic particles

	Number of atom	*Mass units*	*Charge*
Protons	Fixed	1	Positive
Neutrons	Varied	1	None
Electrons	Same as protons	Negligible	Negative

Formulas

Power is the rate at which energy is expended and is calculated from:

$$\text{Power} = \frac{\text{energy used}}{\text{time}}$$

$$\frac{\text{Useful heat output}}{\text{Total fuel energy used}} \times 100\% = \%\ \text{efficiency}$$

Ml = Megalitre = 1×10^6 (i.e. one million litres)

Kinetic energy = ½ x mass x $(\text{velocity})^2$

$$\frac{\text{Useful heat output}}{\text{Efficiency }\%} \times 100 = 100\%\ \text{efficiency of useful energy}$$

Potential energy= force x distance = weight x height = m x g x h

Formula explained on page 15 Energy File Part 1.

Heat loss rate = U-value x area x temperature difference.

The U-value is given as 1.5 W per m^2 per degree °C and the area is 50 m^2

The temperature difference is 20 °C – 6 °C = 14 °C

Heat loss rate = 1.5 x 50 x 14

= 1050 watts

Degree days = average internal temperature - average external temperature

Watts = volts x amps

Maximum theoretical efficiency = $1 - T_{out} / T_{in}$

Absolute Zero = 0 K = -273°C

Temperature in kelvin (K) = Temperature in degrees centigrade (°C) + 273

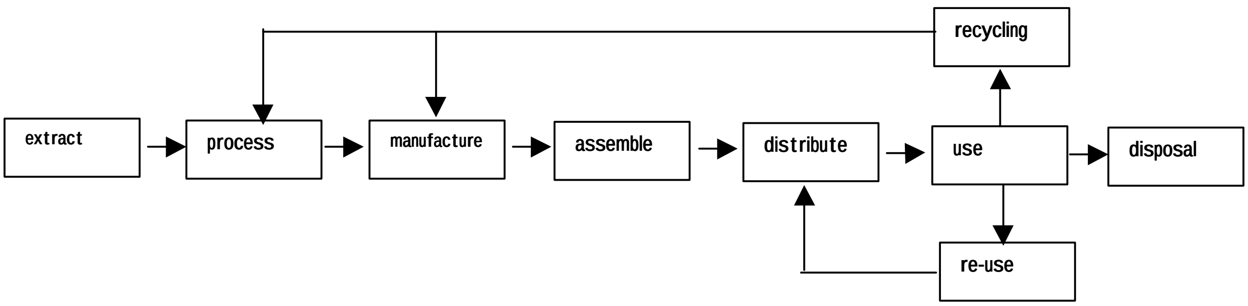
Kilograms CO_2 emitted per kWh of heat energy produced	
	Kg CO_2
Coal	0.32
Oil	0.25
Gas	0.18

Kilograms CO_2 emitted per kWh of electricity generated	
	Kg CO_2
New coal stations	0.95
Gas combined cycle stations	0.45

To convert ppb to ppm divide the ppb result by 1 000.

The kinetic energy E_k of an object in motion is proportional to its mass *m* and the square of its velocity, *v*. **-OR-** $E_k = 0.5\, mv^2$

Resources File – Part 1



To work out the **relative molecular mass** of a molecule all you need to do is **add up** the relative atomic masses of the atoms in the chemical formula of the molecule. For example, a molecule of carbon dioxide consists of one carbon atom (with an atomic mass of 12 and two oxygen atoms (with an atomic masses of 16 each) so the relative molecular mass of carbon dioxide is 12 + 16 +16 = 44.

The third atomic particle is the *electron*, which is very small and contributes nothing to the mass but is significant in the chemical reactivity of the element. Electrons carry a negative electromagnetic charge that is opposite to the positive charge of protons. An atom is an uncharged particle so the number of electrons in an atom must be a fixed number equal to the number of protons.

Health File – Part 1

Concentration /   g m^{-3} means concentration in micrograms per thousandths.

Vocabulary List

Word	Definition
Atoms	the smallest component of an element having the chemical properties of the element
Balancing reactions	
Carbon Sink	
Electrons	An elementary particle with negative charge
Gas	A fluid in the gaseous state having neither independent shape nor volume and being able to expand indefinitely
Liquid	A substance in the fluid state of matter having no fixed shape but a fixed volume
Moles	The molecular weight of a substance expressed in grams; the basic unit of amount of substance adopted under the System International d'Unites
Solid	The state in which a substance has no tendency to flow under moderate stress; resists forces (such as compression) that tend to deform it; and retains an definite size and shape

T172 Equivalents

1 watt	=	1 joule per second
1 kilowatt	=	1000 joules per second
1 Terawatt hour	=	10^{12} watt hours

1 kilowatt hour (kWh) = 10^3 watt hours
1 kWh = 3.6 MJ = 3600 kJ
1 GJ = 10^3 MJ
1 joule = 10^7 ergs
1 calorie = 4.2 joules = 1 kilo calorie
1 BTU = 1055 J
1 Therm of Gas = 100 000 BTU = 105.5 MJ
1 Quad (10^{15}) BTU = 1055 PJ
1 cubic metre (m^3) of natural gas = 38 MJ (heat energy content of)
1 calorie, the energy to raise 1 gram of water by 1° = 4.18 J
1 Calorie = 1 kcal = 1000 calories = 4.18 kJ
mph = miles per hour
kph = kilometres per hour
metres per second = $m\ s^{-1}$
1000 kilograms = 1 tonne (or also known as a metric tonne)
1 ton (short) = 907.1847 kilograms
miligrams per litre (mg/L) is the same as ppm
micrograms per litre (g/L) is the same as ppb
0.01   mg/L or ppm equals 1.0   g.L or ppb
1000   g/L or ppb equals 1.0 mg/L or ppm

Commonly used prefixes and powers of ten in SI (Système Internationale)

Prefix	Prefix Name	Meaning	Power of Ten	Abbreviation
Y	yotta-	septillion		10^{24}
Z	zeta-	sextillion		10^{21}
E	exa-	quintillion		10^{18}
P	peta-	million billion	1 000 000 000 000 000	10^{15}
T	tera-	hundred thousand million (thousand billion - or trillion)	1 000 000 000 000	10^{12}
G	giga-	thousand million (billion)	1 000 000 000	10^9
?	?	hundred million	100 000 000	10^8
M	mega-	million	1 000 000	10^6
k	kilo-	thousand	1000	10^3
h	hecto-	hundred	100	10^2
d	deka-	tens	10	10^1
		units	1	10^0
d	deci-	tenth	0.1	10^{-1}
c	centi-	hundredth	0.01	10^{-2}
m	milli-	thousandth	0.001	10^{-3}
	micro-	millionth	0.000 001	10^{-6}
n	nano-	thousand millionth	0.000 000 001	10^{-9}
p	pico-	hundred thousand millionth	0.000 000 000 001	10^{-12}
f	femto-	million billionth	0.000 000 000 000 001	10^{-15}
a	atto-	quintillionth	0.000 000 000 000 000 001	10^{-18}
z	zepto-	sextillionth		10^{-21}
y	yocto-	septillionth		10^{-24}

Energy Conversions	
kWh	**Joules**
1 kWh	3.6 MJ
1MWh	3.6 GJ
1 GWh	3.6TJ
1 TWh	3.6 PJ
1 PWh	3.6 EJ