APME

PLATFORM

Kansainvälinen opetuspaketti muoveista yläasteille ja lukioille

Platform on muoviaiheinen opetusmateriaalipaketti, joka tarjoaa tietoa muovien kemiasta ja ympäristökysymyksistä englanninkielellä. Opetusmateriaali sopii paitsi kemian opetukseen, myös muiden oppiaineiden tunneille, joilla käsitellään esimerkiksi jäteongelmaa tai elinkaariajattelua.

Platform-kansioon kuuluu:

- **kuusi englanninkielistä aihekorttia tehtävineen**
- **suomenkielinen työohjekortti**
- **englanninkielinen opettajan ohjeisto**
- **englanti – suomi – ruotsi -sanasto**

Platform-materiaali on tarkoitettu ensisijaisesti **peruskoulun kahdeksannelle ja yhdeksännelle luokalle sekä lukion ensimmäiselle vuosikurssille.** Oppilaiden valmiuksien ja innostuksen mukaan opetusmateriaalia voi käyttää myös muiden luokka-asteiden ja koulujen opetuksessa.

Opetuspaketin aihekorteissa on runsaasti erilaisia tehtäviä ja laajempia tutkimuksia. Tutkimusehdotukset tarjoavat oppilaille haasteita ja mahdollisuuden kehittää ongelmanratkaisutaitoaan tutkimusasetelman luomisessa ja toteuttamisessa.

Ehdotuksia Platformin käyttöön:

- Opetuspaketti muodostaa muoveja monipuolisesti tarkastelevan kokonaisuuden ja sopii erityisen hyvin kemian- ja englanninopetuksen yhdistävälle erikoiskurssille
- Paketin aihekortteja ja tehtäviä voi käyttää myös toisistaan irrallaan täydentämään muuta opetusta
- Opettaja voi rakentaa paketista oman kokonaisuutensa leikkaamalla korteista mielenkiintoisimpia tekstejä ja tehtäviä ja yhdistämällä ne monistamalla uusiksi korteiksi
- Platform-materiaali tarjoaa opettajalle ja oppilaille tilaisuuden kokeilla englanninkieltä opetuksessa ja ryhmätöissä; opetuspaketti soveltuu kuitenkin hyvin myös äidinkielellä tapahtuvan opetuksen oheismateriaaliksi

Korttien sisältö:

Kortti 1 *Introducing Plastics* toimii johdatuksena muoveihin. Kortissa kerrotaan muovien rakenteesta ja käytöstä nyky-yhteiskunnassa. Korttiin kuuluu myös katsaus muovien historiaan.

Kortit 2 *The Raw Materials* ja **3** *Polymers and Processing* keskittyvät muovimolekyylien rakenteeseen ja muovituotteiden prosessointiin. Kolmoskortin viimeisestä tehtävästä alkavat avoimen tutkimusongelman sisältävät ryhmätyöehdotukset.

Kortin 4 *The Properties of Plastics*in aiheena ovat muovien ominaisuudet. Kortti koostuu pääasiassa laajahkoista tehtävistä ja tutkimusehdotuksista.

Kortit 5 ja **6** *The Environmental Impact* ja *Dealing with waste* tarkastelevat muovien ympäristövaikutuksia ja jätekysymystä. Kortit sopivat hyvin kaikille ympäristöasioita käsitteleville tunneille. Tehtävissä pohditaan muun muassa kierrätystä ja muovimateriaalin sisältämän energian hyötykäyttöä.

Kortti 7 *Teemme ja tutkimme muovia* sisältää muovityyppien tunnistuskokeita ja muovin valmistusohjeita.

Englanninkielinen opettajan ohjeisto tarjoaa ehdotuksia tehtävien vastauksiksi.

Sanasto on laadittu kahdeksasluokkalaisten kielitaidon mukaan. Jos samat sanat esiintyvät kahteen kertaan, on ne jälkimmäisellä kerralla kirjoitettu kursiivilla. Kaikilla kielillä lähes identtisiä kemiallisia termejä ei ole käännetty.

Lisämateriaalia muovien opiskeluun tarjoavat muun muassa:

- Muoviyhdistys ry, p. 09-135 1200
- Chemas Oy, esim. Tutustumme muoveihin -opetusvihko (25 mk) sekä Öljyn tie – Lähteiltä tuotteiksi -kirja (25 mk) ja työ- ja tehtävävihko (20 mk), fax 09-630 225
- Inforviestintä Oy, esim. Näin on muovit ja Totta vai taikauskoa -videot sekä videoita öljyn etsinnästä ja jalostuksesta, p. 09-1315 1500

Platform-paketin on kehittänyt Euroopan muovinvalmistajien järjestö APME yhdessä Suomen Muoviteollisuusliiton sekä opetuksen ja teollisuuden asiantuntijoiden kanssa. Suomen lisäksi Platform-materiaali on käytössä kymmenessä muussa Euroopan maassa.

Tekijä: Dr W. A. Scott, University of Bath, Englanti
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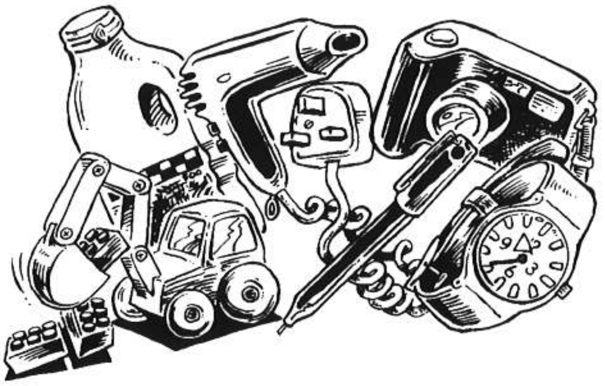
Toinen, korjattu painos.

1 *Introducing* **Plastics**

Plastics are all around us today and help to make our personal lives cleaner, easier, safer, more convenient, and more enjoyable.



The use of plastics is increasing all the time. Plastics can now replace many other materials such as metal, wood, paper, ceramics and glass. There are also new roles which only plastics can fulfil.

Activity One

1/ Think of at least three objects which, a few years ago, would have been made of these other materials and which are now commonly made of plastics.

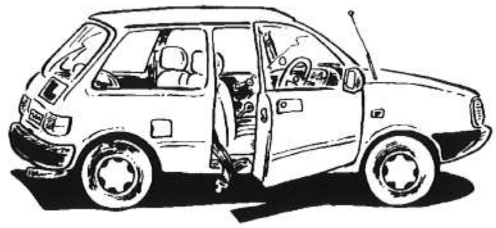
2/ For each object you listed, see if there are any obvious advantages of the plastic over the other material. Give reasons why plastics are now used.

The motor car is a good example of a product in which plastics are now extensively used. Since 1983 the proportion of the car made from steel has fallen from 75% to approximately 60%. A small family car can contain 5000 parts – of which around 1700 will now be made of plastics. This has resulted in an estimated reduction in mass of 40% .

Activity Two

1/ This picture shows a typical modern car. Which parts are made of plastics materials? What advantages do you think plastics have over metal? Think of

safety economy style colour cost

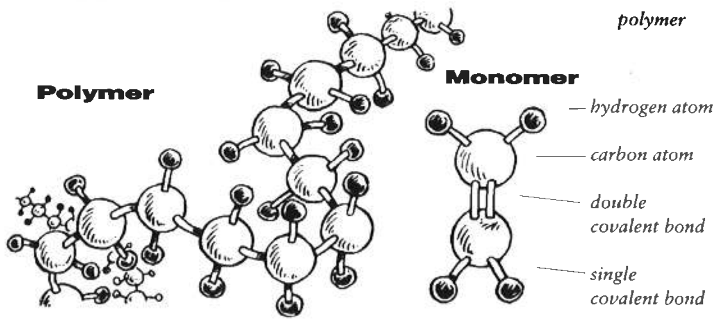


2/ It is estimated that a 1000 kg car, containing 100 kg of plastics, uses 4% less fuel than if only metals were used. If a car uses 2000 litres of fuel each year, costing £ 0,50 p per litre, how much money is saved through the use of plastics?

But what are plastics? Why are they so useful and so widespread? Why do they behave as they do? What is their chemical structure?

Many materials we use every day are made of polymers. These are large, long molecules constructed of smaller, shorter molecules called monomers. Polymers can be natural or synthetic. Natural polymers are common in animals and plants. Much living tissue is based on polymers – for example, proteins in animals and carbohydrates in plants. A lot of our food is based on polymers – for example, fibre, grain and meat. Plants and animals also produce non-living materials based on polymers. These are usually produced as fibres and then have to be processed to produce materials such as threads and fabrics.

This diagram shows the structure of a monomer and a polymer



Synthetic polymers are made mainly from petroleum. This is processed in an oil refinery to produce simple chemicals which form the monomers. The monomers are then turned into polymers. Some polymers are turned into a solid plastics material, and others into a fibre. Some can be turned into either, depending on how they are processed.

Activity Three

Look at these pictures of objects made from synthetic polymers. Try to decide whether the polymer is a solid plastic material or a fibre.

Whether a plastic is a solid material or whether it is a thread-like fibre depends only on how it has been produced. From now on, the word plastics will be used to describe all such materials.

The history of plastics

Plastics products were first made in 1862 from plant materials. Cellulose fibres in the form of cotton wool were treated with nitric acid to form cellulose nitrate ('Celluloid'), which was used to make objects such as ornaments, knife handles, boxes, cuffs and collars.

In 1909 a new source of raw materials was found – coal tar. This provided the 'Bakelite' plastics, used for electrical insulation and the cases for cameras and early radios.

In the early years of this century, chemists began to understand the reactions which they were observing, thus accelerating the search for new types of material. In the 1930's the manufacture of plastics from chemicals produced from petroleum began, and polystyrene, acrylic polymers, and polyvinyl chloride were produced, although their use grew only slowly.

Nylon was discovered in 1928, and entered production in the late 1930's. It was produced as long filaments which could be spun and woven or knitted.

The production and manufacture of other plastics materials – polyethene (or polyethylene), polyurethane, PTFE, polyesters, silicones, epoxy resins – grew during the 1940's. Polypropene (or polypropylene) and polycarbonates were added in the 1950's.

There are now over thirty different kinds of plastics materials produced to make everyday objects. This project will look at many of them.

Activity Four

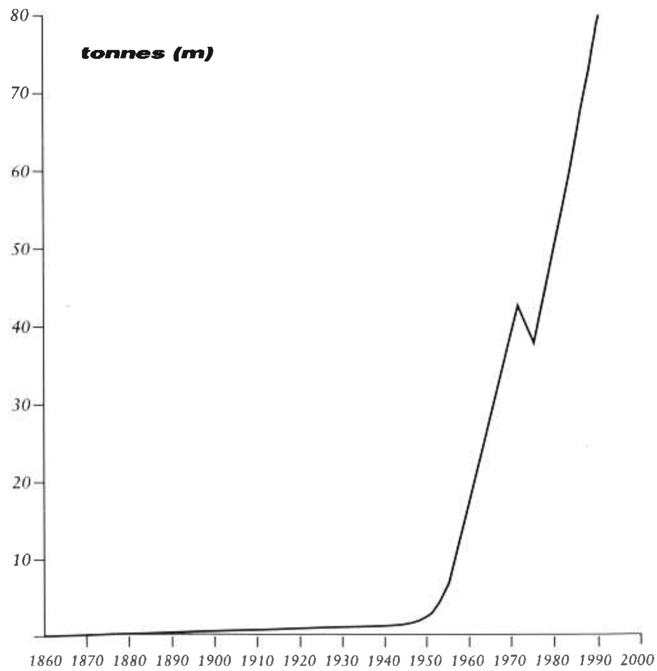
1/ Describe the shape of this graph.

2/ Why do you think the graph changes shape so much during the 1950's?

3/ What happened in the early 1970's to make the graph change direction so sharply?

4/ Extend the graph to the year 2000. What does this suggest the level of production will be?

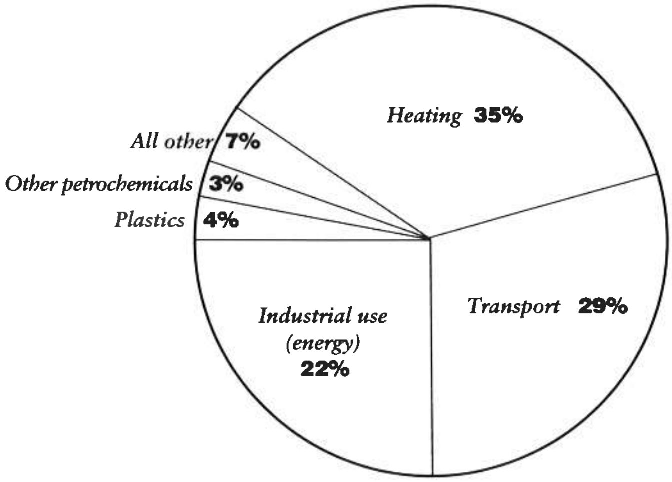
5/ What happened in 1992 and 1993 to reduce these estimates?



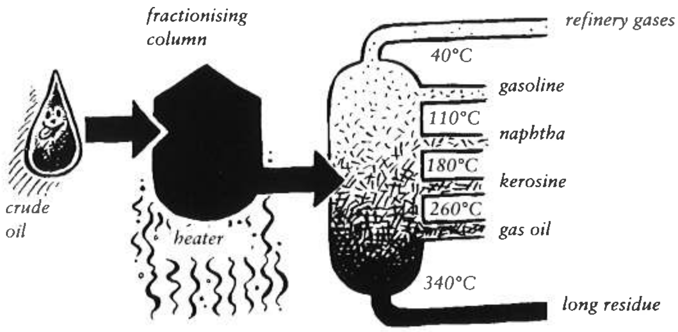
The growth in the production of plastics across the world.

2 *The* **Raw Materials**

The raw material for plastics is crude oil, a complex mixture of thousands of compounds. To become useful, it must be processed. Around 4% of the world's production is turned into plastics.



Because the compounds in crude oil have different masses, and therefore boil at different temperatures, it is possible to separate them by a process known as fractional distillation. The mixture is separated into fractions, not into individual compounds. Fractions contain a mixture of compounds whose boiling temperatures are similar.



This diagram shows the fractional distillation process. It is mainly the naphtha and gas oil fractions which are used for further processing to make chemicals such as plastics.

Activity One

Most compounds in crude oil are hydrocarbon molecules – they contain carbon and hydrogen atoms only. These diagrams show a few of the compounds which can be refined from crude oil. Diagram (a) shows ethene.

1/ Draw the formula of each of these compounds in the following form

$CH_2=CH_2$ *This is the structural formula of ethene* **(a)**

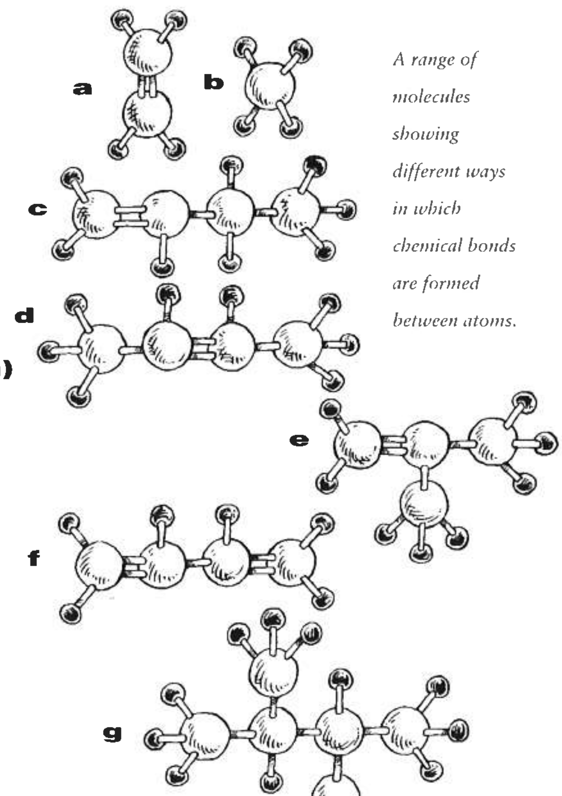
2/ And then write the formula in this form

C_2H_4 *This is the molecular formula of ethene*

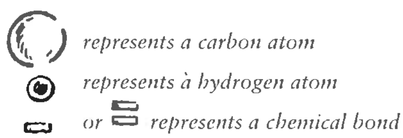
The mass of a molecule depends on the number of carbon and hydrogen atoms in it. A carbon atom has a mass of 12 units; a hydrogen atom has a mass of 1 unit. In the example shown below, the mass of an ethane molecule, C_2H_6, is [2x12] + [6x1] = 30 units

3/ Work out the mass of the molecules shown here (a-g).

4/ If the boiling point of the compound increases as its mass rises, arrange the compounds in order of increasing boiling point.



A range of molecules showing different ways in which chemical bonds are formed between atoms.



These fractions are still complex mixtures of compounds and no chemical changes have yet taken place. They need to be chemically altered to make them into more useful products with different melting and boiling points and different chemical properties. There are two types of process:

Cracking

Cracking breaks large molecules into smaller ones which are more useful – and therefore of greater value. For example, very high boiling point fractions are cracked to produce gasoline and gas oil fractions. Today, most cracking uses catalysts, but some heat treatment still occurs.

Reforming

Reforming changes the internal structure of molecules to produce different compounds with a greater usefulness – and therefore higher value. By altering conditions – such as temperature, pressure and the catalyst – the cracking and reforming techniques can now be controlled to produce exactly the blend of compounds which will be most useful at a particular time.

Naphtha is cracked by mixing it with steam and heating it to 800°C. It is cooled rapidly to 400°C, causing chemical changes. The mixture of C_6 to C_{10} compounds is converted to a small number of C_2, C_3 and C_4 compounds which contain carbon-carbon double bonds, C=C.

The simple compounds are often known as 'basic chemicals' – many of these are shown on this Card in Activity 1.

All the basic chemicals are small molecules containing between two and seven carbon atoms. It is these molecules which are the 'monomers' from which the 'polymers' are then made.

The small monomer molecules are reacted together to form a polymer. This is a different compound with very different properties.

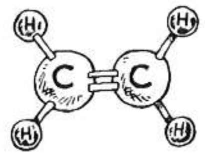
The main differences between polymers and monomers

Monomers	**Polymers**
reactive compounds	*unreactive compounds*
small number of carbon atoms in a molecule	*very large number of carbon atoms in a chain*
usually a gas or a liquid	*always a solid*
cheap compounds to produce	*more valuable to sell*
of little use as they are	*very useful once they have been processed*

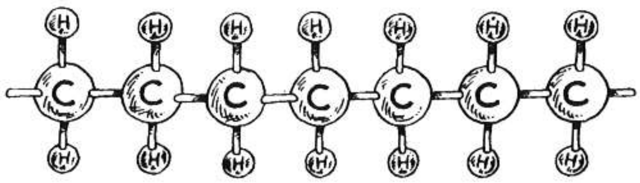
Activity Two

1/ One of the simplest synthetic polymers is polyethene. This is made from ethene.

The structure of ethene is:



Part of the structure of polyethene is



List the structural differences between the two molecules.

2/ The monomers react by the end of one molecule bonding to the end of another. In this way chains are formed. This is rather like bar magnets being joined north pole to south pole to north pole etc. Draw your own picture of how this chain formation takes place.

Increasingly, research is being carried out on plant materials as a source of plastics. The plants being looked at are mainly the oil seeds such as rape and linseed. Both biotechnology and genetic engineering are being used to change the plants into forms which will increase the yields of useful industrial chemicals.

3 **Polymers** *and* **Processing**

Eight of the most important polymers are produced from only three basic chemicals which come from naphtha.

Ethene C_2H_4	
polymerization to form high density polyethene (HDPE), low density polyethene (LDPE) or linear low density polyethene (LLDPE)	
reaction with chlorine to form chloroethene	*polymerization to form polyvinyl chloride (PVC)*
reaction with benzene to form styrene	*polymerization to form polystyrene (PS)*
reaction with oxygen to form ethene oxide	*further reaction and polymerization to form polyethene terephthalate (PET)*
Propene C_3H_6	
polymerization to form polypropene (PP)	
reaction with oxygen to form propene oxide	*further reaction and polymerization to form polyurethanes (PU)*
Butadiene C_4H_6	
polymerization to form polybutadiene which is a synthetic rubber	

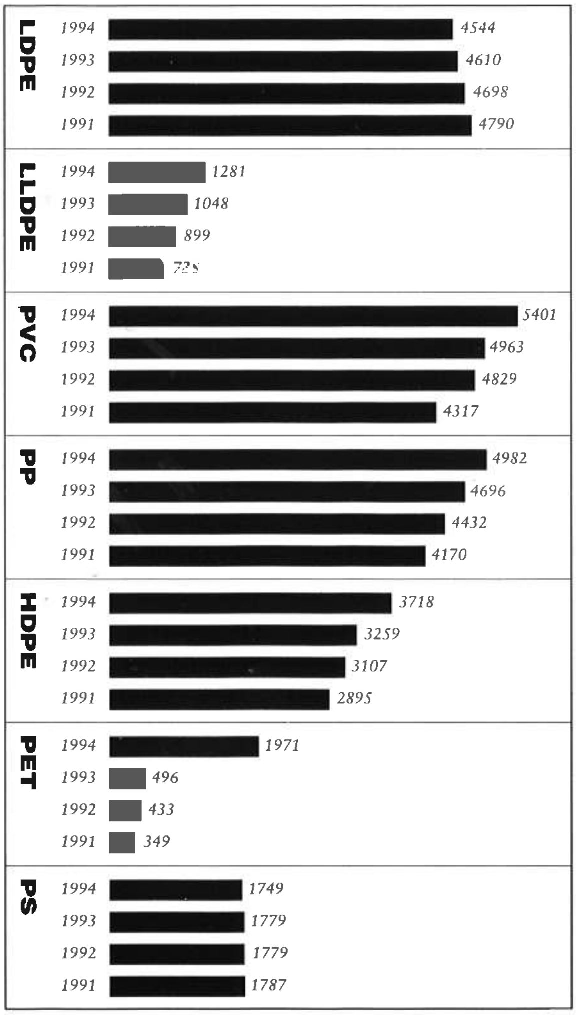
Activity One

The table to the right shows the total sales of the major plastics by Western European manufacturers from 1991 to 1994 (figures show thousands of tonnes sold).

1/ Describe how sales have changed for each of the plastics.

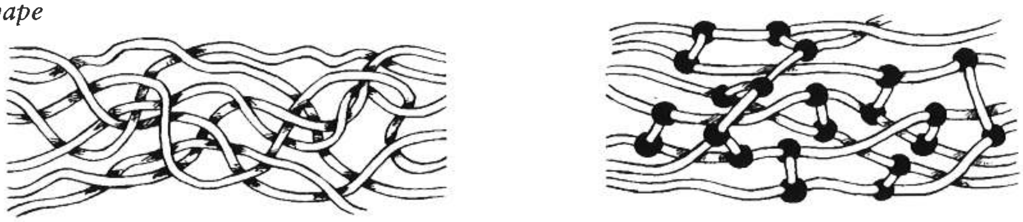
2/ Summarize in one sentence how sales of plastics generally have changed over the period.

3/ Suggest reasons for the changes you have reported.



Although there are many different examples of plastics, they fall into two distinct catagories:

Those which soften on heating and then harden again on cooling	**Those which never soften once they have been moulded**
These are called thermoplastic polymers *because they keep their plastic properties* *These polymer molecules consist of long chains which have only weak bonds between the chains* *The bonds between the chains are so weak that they can be broken when the plastic is heated* *The chains can then move around to form a different shape* *The weak bonds reform when it is cooled and the thermoplastic material keeps its new shape*	*These are called* thermosetting polymers *because once set into a shape, that shape cannot be altered.* *These polymer molecules consist of long chains which have many strong bonds between the chains.* *The bonds between the chains are so strong that they cannot be broken when the plastic is heated* *This means that the thermosetting material always keeps its shape*



The bonding process. When thermoplastic polymers are heated they become flexible. There are no cross-links and the molecules can slide over each other. Thermosetting polymers do not soften when heated because molecules are cross-linked

It is clear from this that the chemical bonding in a polymer and the shape of the polymer will affect its properties.

Activity Two

Imagine that you are a small part of a thermoplastic polymer. You are part of a lump of plastic material which is waiting to be processed into a cup.

You have strong chemical bonds *along* the polymer chain to parts of the molecule next to you; you also have some weak chemical bonds *across* to parts of the polymer which are positioned near to you. The weak bonds keep the plastic material solid and rigid.

As part of the manufacturing process, the plastic material is warmed to make it soft and pliable; then squeezed in a press into a new shape; then allowed to cool and solidify into the new shape.

Describe what happens to your part of the polymer as this processing takes place.

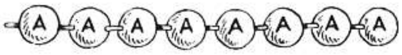
Use words, a diagram, or a cartoon to do this.

Most plastics made from the basic chemicals which come from naphtha are thermoplastic	*Common examples of thermosetting plastics are polymers based on formaldehyde (Bakelite was the earliest example)*
Examples are polyethene (HDPE, LDPE and LLDPE), polypropene (PP), polystyrene (PS), polyethene terephthalate (PET), and polyvinyl chloride (PVC)	*Examples are melamine/formaldehyde (MF), urea/ formaldehyde (UF) and phenol/ formaldehyde (PF)*
	Epoxy glues are also thermosetting plastics

There are two ways of producing polymer chains:

Addition reactions

The polymer is made from one monomer eg A-A produces

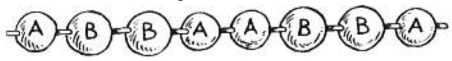


In addition reactions chains are formed from one small molecule. The monomer always contains a carbon-carbon double bond

Most thermoplastic plastics made from naphtha are addition polymers. eg polyethene, polypropene, polystyrene

Condensation reactions

The polymer is made from two monomers eg A-A and B-B produce



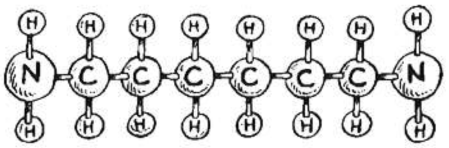
In condensation reactions chains are formed from two small molecules. During the reaction a small molecule such as water is formed and removed (condensed out)

All thermosetting polymers are condensation polymers, for example, formaldehyde-based plastics and epoxides

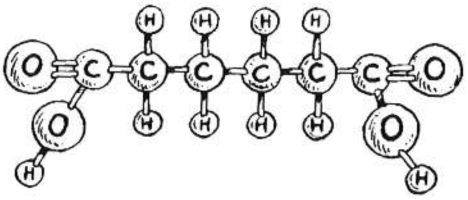
Some thermoplastic polymers are condensation polymers. Examples are Nylon and polyethene terephthalate (PET)

Nylon belongs to a class of polymers called polyamides. Nylons are produced by condensation polymerization. Two monomers which can produce Nylon are:

A



B



Activity Three

1/ Write down the molecular formula of each of the compounds shown on the left, in this form:

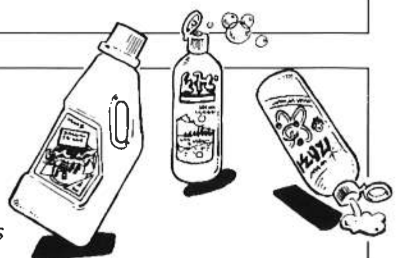
$C_xH_yN_z$ and $C_xH_yO_z$

The first step in the polymerization is the two monomers reacting together to form a dimer. In this reaction a molecule of water H_2O is produced from the H of one of the NH_2 groups and the OH of one of the COOH groups.

2/ Draw a diagram of this dimer.

3/ Write down the formula of each of these compounds in this form:

$C_xH_yO_zN_w$



This table shows the main plastics and gives examples of some of their uses.

Plastic	**Uses**		
Polyethene (HDPE)	*Dustbins*	*Bottles*	*Pipes*
Polyethene (LDPE and LLDPE)	*Bags and sacks*	*Bin liners*	*Squeezable detergent bottles*
Polypropene	*Margarine tubs*	*Garden furniture, crates*	*Wrappings for biscuits and crisps*
Polystyrene	*Food containers*	*Egg packs*	*Video and audio cassettes*
PVC	*Food trays, bottles*	*Credit cards*	*Window frames and pipes*
PET	*Fizzy drinks bottles*	*Oven-proof trays*	*Freezer tubs*
Polyurethane	*Upholstery*	*Sports shoe soles*	*Roller skate wheels*
Acrylics (eg Perspex)	*Sink and bath tap tops*	*Protective glasses*	*Car light covers*








Activity Four

1/ Find out more about the uses of plastics. Suggest two properties which PET has which the other plastics do not have.

2/ What special properties do you think that polypropene has, if it is used as a wrapping for food such as biscuits and crisps?

3/ Look at the uses of the two forms of polyethene. From your knowledge of the different things which the two plastics are made into, list the main differences in their properties.

4/ Think about these objects which are all made from polyethene.

toys *pipes* *film wrap*
coatings for cardboard containers
petrol tanks in cars
electrical cable coatings

Which is likely to be made from the high density form, and which from the low density form? Why?

5/ Consider PVC window frames. Suggest reasons why PVC compares favourably with other materials used for window frames. Try and find out why PVC is used rather than other materials.

6/ Design an investigation to test the effectiveness of the plastic used to wrap biscuits. Begin with a clear statement of what you wish to test. Now design a simple method of investigation.

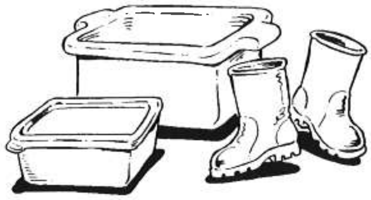
The family of materials which form plastics has a wide variety of different properties. Some resist high pressure and extremes of temperature, some resist air and moisture. There are different forms of the same basic plastics type which can be stiff or flexible and so suitable for particular applications.

Plastics' properties can also be tailored by the use of additives (see Card 4).

Polymers are converted into plastics products in seven main ways. These are listed here. A brief description of the different methods is given and a list of typical products.

1 Injection moulding

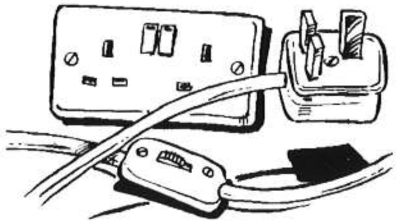
The warm, soft polymer is forced under pressure into a cold, closed mould



Tins, containers, lids, footwear, crates, gear wheels

2 Compression moulding

The polymer is placed in a mould; pressure is applied to make the plastic take up the shape of the mould



Complex shaped objects such as electrical plugs and sockets

3 Blow moulding

The warm, soft polymer is blown into the shape of a mould by compressed air or steam

Bottles, containers

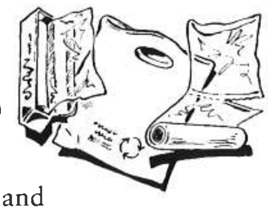
4 Rotational moulding

Plastics powder or paste is heated inside a closed mould which is rotated until the walls of the mould are covered with an even layer of polymer

Large, hollow items such as litter bins, fuel tanks, drums

5 Blown film extrusion

Soft polymer is forced into a tube-shape. This is blown up with air and either heat sealed or slit



Bags, film

6 Extrusion and extrusion coating

The materials are compressed, heated and extruded through a die of the desired shape. Materials can also be coated with soft polymer and then passed between rollers to give an even coating

Coatings on food and drink containers

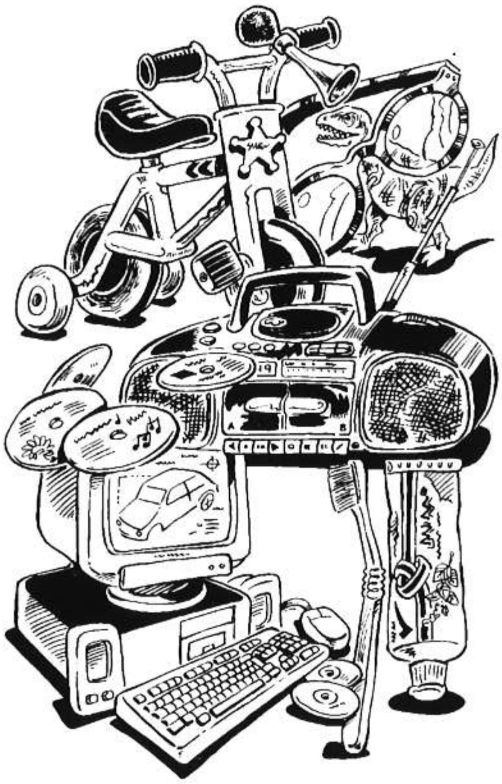
7 Calendering

Heated polymer is fed between two rollers which squeeze it into a thin sheet

Flooring, tiles, panelling, sheeting

4 *The* **Properties** *of* **Plastics**

Today – and for the future – plastics are the real thing. Whether you're using your first toy, riding in your modern baby buggy, using a CD player, working with computer disks, eating a 1990s' diet, riding in a modern car or jet plane, having new knee joints or synthetic heart valves fitted, or just living normal everyday lives, plastics are at the heart of everything you do.



Industries, especially the hi-tech ones such as aerospace, medicine, computing and communications, rely on new plastics materials for progress in engineering and design. Plastics are now superior to any other materials in these fields. New developments would not be possible without them.

Why are plastics so widely used in all our lives? It is because they are:

1 **safe and hygienic**

2 **tough and durable**

3 **lightweight, cost-effective and convenient**

4 **good insulators**

5 **flexible and adaptable**

6 **capable of re-use?**

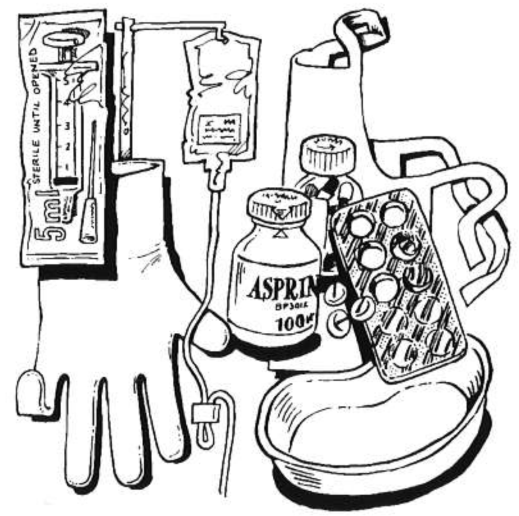
Safe and hygienic

Activity One

1/ Plastics do not usually conduct electricity. Think of as many different ways in which this property is used in the home or at work.

2/ A lot of the plastics used to package foods are transparent. How might this increase food safety?

3/ Plastics are widely used in hospitals. Look at this picture. What are the particular advantages of using plastics in this way? Think of the advantages that cheapness of production brings.



4/ Plastics are likely to be safer than glass because they do not break, and safer than steel because they don't rust and are less likely to have jagged edges. Can you think of objects made from plastics which might pose a hazard to people or animals if not disposed of sensibly? What action could you take to help avoid this? Think of litter and other issues.

5/ What kinds of safeguards are needed here?

6/ Some plastics are waterproof and resistant to attack by chemicals. Think of ways in which these properties are useful to us.

Tough and durable

Activity Two

1/ Around 30-50% of food produced in developing countries is wasted before it reaches the consumer, whereas in the EU this figure is only 2-3%. Modern plastics packaging plays a part in this. What other factors might be responsible for this wide difference?

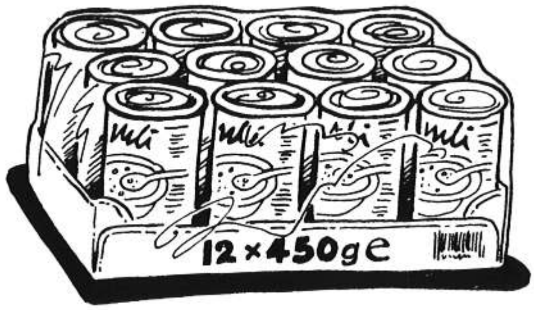
2/ Look around at home in the kitchen or bathroom – or in a supermarket. Find as many different ways as you can in which plastics add to the safe use of other things.

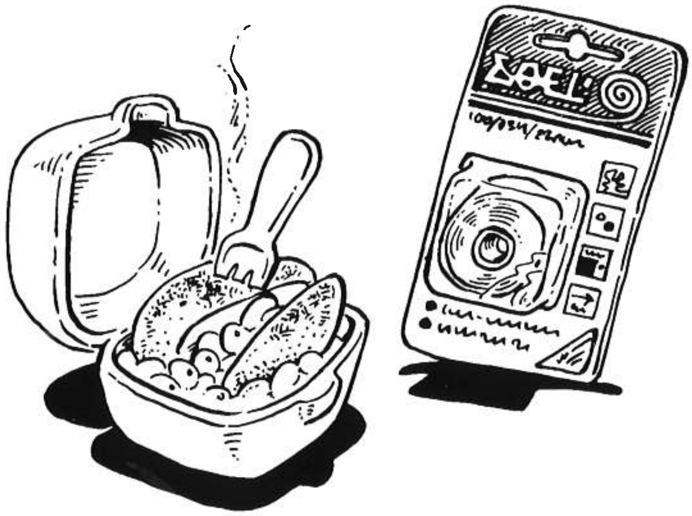
3/ Around 50% of the food sold in supermarkets today is packaged in plastics. Look at these pictures and think of the food you buy yourselves. Make a list of different types of packaging for food. Think in particular of examples of how shape is used as a means of protection.

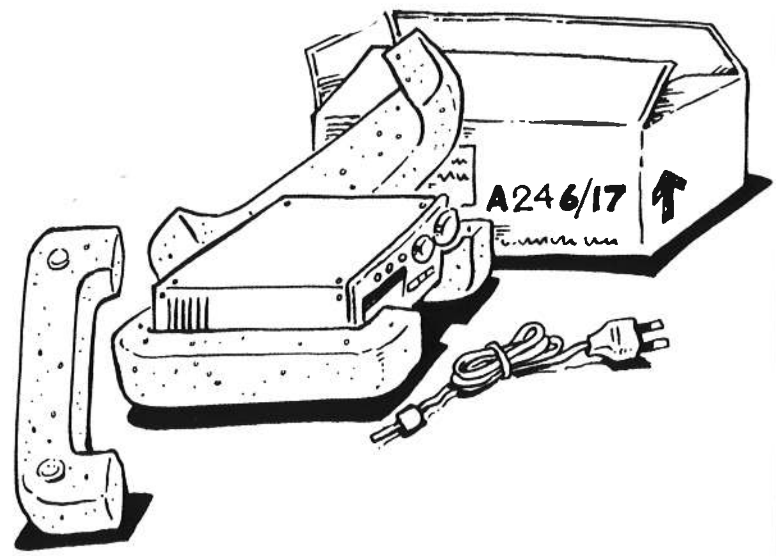
4/ Expanded polystyrene is an alternative to corrugated cardboard as a protective packaging material. Design an investigation to compare the effectiveness of the protection offered by the two materials against penetration by a sharp object such as a screwdriver. You will need to think of the quantity of each material used to provide a fair comparison. Discuss your ideas before you begin the investigation.

5/ Bubble-wrap is widely used to protect delicate objects such as crockery. Just how effective is it? How much protection can it give to an egg?

Design an investigation which compares the amount of protection given to the shell of a hard-boiled egg as the amount of bubble-wrap used changes. Begin by thinking of ways in which you can carry out the investigation.







Lightweight, cost-effective and convenient

Activity Three

1/ Suggest why using bottles made from plastics on jet aircraft can save up to £6000 per year on the cost of running an aircraft.

2/ What else might you need to know about the plastic bottles before you could say whether the real saving was £6000? Explain how it might be more or less than this figure.

3/ When faced with a choice of using plastic or paper bags which do you choose? Why? What does it depend on? Make a list of the advantages of both paper and plastic bags in terms of holding fruit and vegetables.

4/ Compare the masses of plastic and paper bags which are used to carry fruit and vegetables. First of all decide how you will ensure that your test is a fair one.

5/ Looking at your results discuss what the impact would be on the mass of packaging used if we had to use paper bags all the time.

6/ Compare a soft drink carried in a plastic, glass, metal, and card container. Measure the masses of the total package and the masses of the liquids they contain. Make a chart showing the percentage of the total mass which is taken up by the packaging material.

7/ Compare a one litre drink packed in glass and one packed in plastics. Make a list of the differences in the use of energy as it moves:

from the factory to warehouse to storage in the shop
from storage in the shop to the shelves
from shelves to checkout to home and storage

8/ Now do the same but compare metal and card drinks packaging with plastics. Are these likely to be similar to glass or plastics? Why?

9/ Compare the four materials again. Think of other advantages and disadvantages of each one.

10/ Now summarise the advantages and disadvantages of using plastics as containers. Think of energy savings, the amount of raw materials needed, other environmental issues such as pollution and waste, and the impact on our lives.

Good insulators

Activity Four

1/ Plastics are widely used in cups, mugs and beakers, at home and in vending machines. You know that various plastics materials conduct heat to different extents.

Design an investigation to see how the material used affects the rate at which heat is lost from a cup containing hot water. Try to use expanded polystyrene, a thin-walled plastic cup and a paper cup. You will need the cups, a thermometer and a clock or watch that records seconds. Discuss ways in which you will make this a fair comparison.

2/ Plastics are normally poor conductors of electricity. Look around your home and make a list of ways in which plastics are used in objects with an electrical power supply. Ask an adult if this is a new or an old use of plastics. See if you can identify the material which plastics have replaced.

Flexible and adaptable

The properties of everyday plastics are very different from those of the basic polymers. A wide range of additives is used to give plastics the required properties. They are 'designer' materials – we are able to create exactly what we want from the raw materials.

The additives used include:

Pigments incorporated into plastics to add colour.

Impact modifiers to ensure that plastics don't crack or break when they are knocked or bumped.

Plasticizers making plastics flexible.

Anti-static agents to reduce the amount of dust and dirt which adheres to the plastic due to static electricity.

UV absorbers protecting against decomposition by ultra-violet light.

Stabilizers prolonging the life of plastics by reducing unwanted chemical reactions.

Flame retardants reducing the flammability.

Mineral fillers increasing rigidity and improving the properties of electrical insulation. Inert materials such as talc, chalk and clay are used.

Blowing agents which break down above 220°C to release gases such as nitrogen or carbon dioxide. When this happens inside a plastic in a mould, a foam is produced.

Anti-oxidants used widely in plastics to prevent reaction with oxygen.

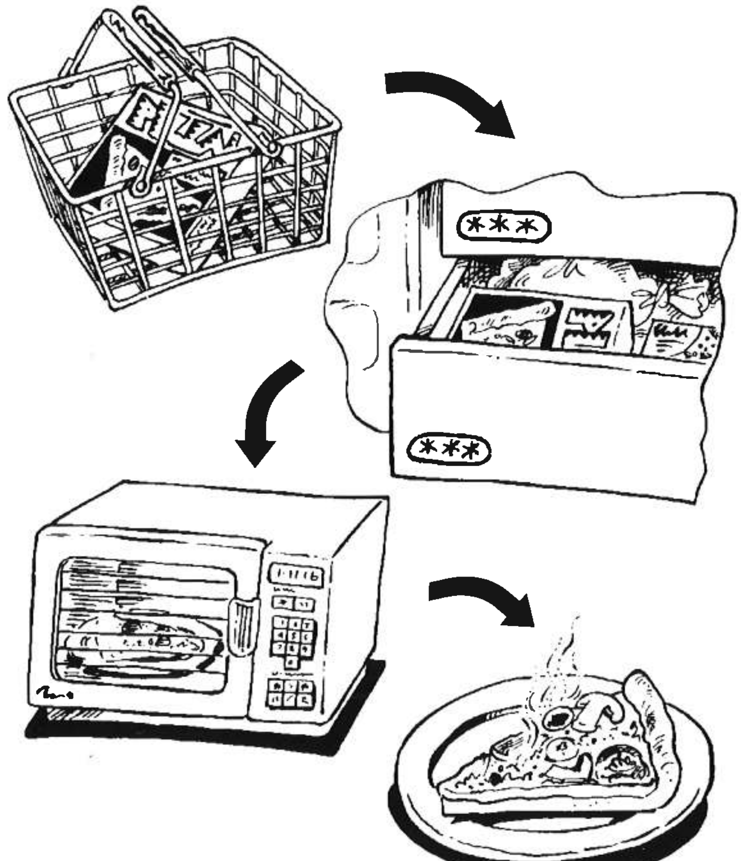
Capable of re-use

Plastics use valuable resources efficiently in both manufacture and processing. Products are light and strong and are made from minimal amounts of the raw material. They also require less energy in production than other materials – for example, metals.

But plastics also have another advantage – many can be re-used easily.

Activity Five

Look at what happens to plastics which come into the home. How many are used again – and what for? How many are disposed of – and how? Which are re-used and which are thrown away? Why is this?

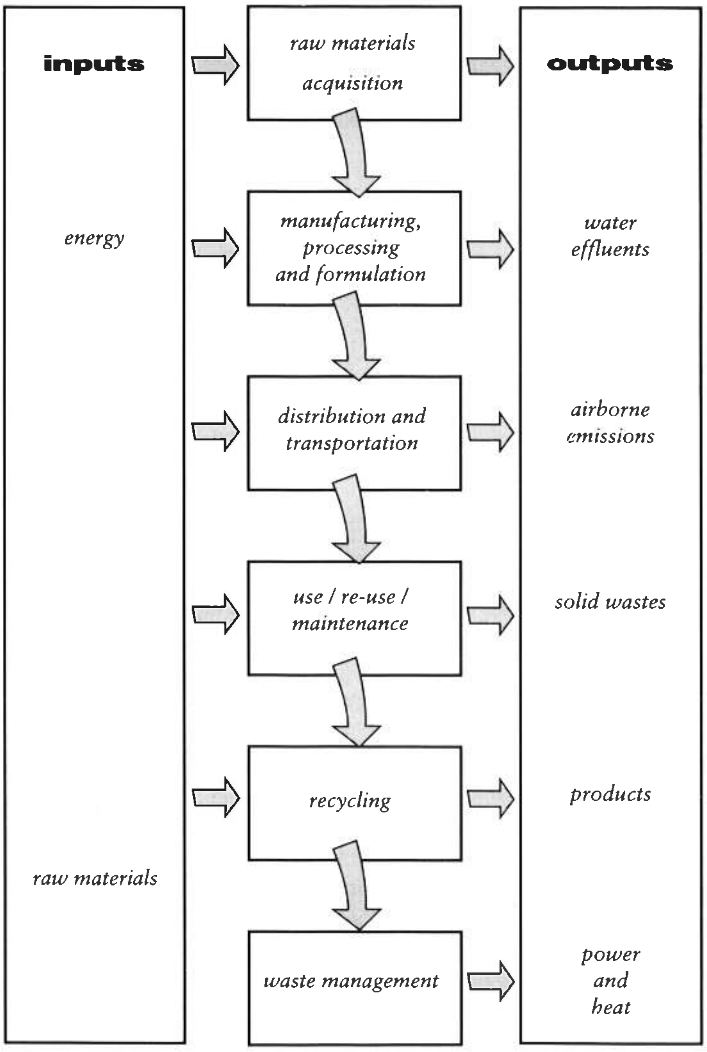


The versatility of plastics. The plastic wrapping is used to store and safeguard this frozen meal. The plastic wrapping is removed and the meal can be quickly reheated in a microwave oven using the plastic container and can then be eaten on the plastic plate.

5 *The* **Environmental Impact**

Everything we use, whether made of wood, glass, plastics, paper or metal, has an impact on the environment. This relates to finding raw materials, making and using products and throwing them away. Environmental impacts include contribution to global warming, depletion of finite natural resources and waste. Without taking all of these factors into account, through proper studies, it is impossible to make sound environmental decisions.

Such studies involve a 'cradle-to-grave' analysis or 'life-cycle' analysis. This involves looking at each part of the life of a product, as shown here.



The rest of this card looks at various stages in the life cycle of plastics using this kind of life-cycle analysis.

Activity One

1/
Describe three examples of efforts people are making now to live more sustainable lives than, say, 40 years ago, e.g. using less energy than before, or using resources more efficiently. What benefits do these efforts bring?

2/ Use these ideas to develop guidelines for environmentally sound practice. Think of the use of resources and energy, and economic issues.

3/ Draw your own flow diagram which shows the life cycle of a plastics item. Use the following key words

raw materials • energy • manufacture
product distribution • consumer use • re-use
disposal • combustion with energy recovery
recycle • chemical treatment • landfill

Begin by making a rough sketch and then compare notes with others in your group. Then see if there are any points you want to add to your sketch.

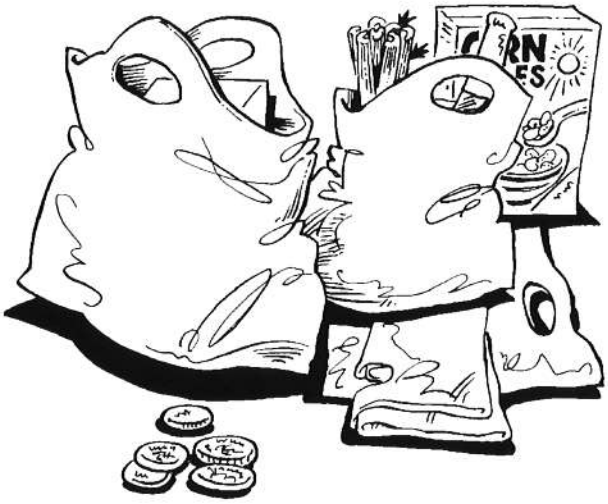
Now make your final diagram; you might find it helpful to add artwork of some kind. Make sure it is labelled clearly.

Use of raw materials

All products are made from raw materials. Most plastics are produced from crude oil, which is a limited and valuable resource. However, very little of the total oil production is used for this purpose - only 4%. Although the production and use of plastics have grown steadily, the amount of oil used has grown less quickly because industry continues to try to find more efficient and effective ways of producing goods.

Savings during use

The extent to which used plastics are either recycled or thrown away after use varies greatly across Europe. It varies from country to country and within countries too. But an important question should be asked before anything is either recycled or thrown away – can it be used again?



A large chain of supermarkets encouraged customers recently to bring the company's plastic bags back to their stores and use them again. The incentive was a small refund for every bag re-used. As a result, they reduced their usage of new bags by 60 million in one year and saved 1000 tonnes of plastics.

It is also important to reduce the amount of raw material used in the first place and the plastics industry continues to research ways of achieving this.

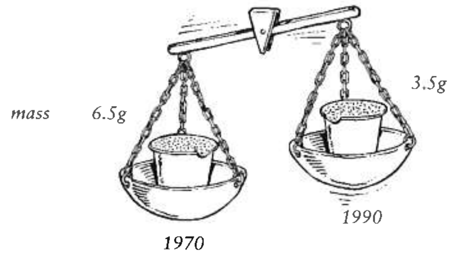
Activity Two

1/ Think of ways in which you re-use plastics products at home.

2/ Compare notes with your group and then make one list.

Activity Three

1/ Look at this diagram which shows the change in the mass of a pot used to package 125g of yoghurt since 1970. Calculate the percentage fall in mass during that period.

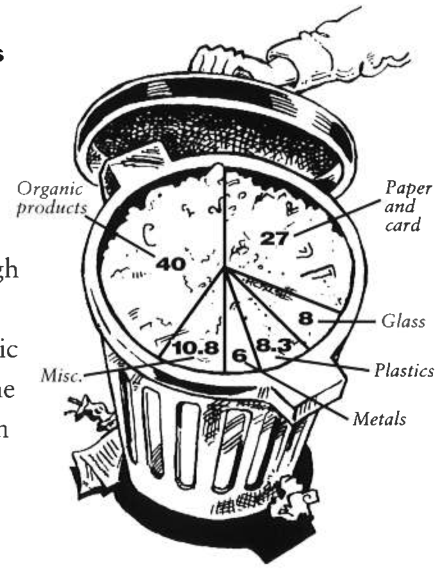


2/ This mass reduction process is called 'light-weighting'. How do you think it is done?

3/ Explain why refill pouches, large packs and packs of concentrate all help to reduce the amount of packaging required.

Waste issues

If the use of plastics is increasing, does this mean that the amount of plastics waste is also getting larger? Although packaging takes up around 60% of domestic waste across Europe, the proportion of plastics in domestic waste in Europe is only 8% by weight.



Activity Four

1/ In 1994 the total domestic waste in the European Union was 138 million tonnes. How many tonnes of plastics were found in this?

2/ Total plastics waste across a range of sectors (including automotive, distributive, domestic and construction waste) was 17.5 million tonnes. 6.3% of the plastics waste was recycled to form new plastics. 13.4% was burnt in order to extract heat energy. Work out how much plastics material was recycled.

3/ Suggest reasons why it is easier to recycle plastics from the waste of industries using plastics than from domestic waste.

6 **Dealing** *with* **waste**

Despite reduction and re-use, there will always be waste to deal with. There are three main options to manage waste:

Recycling	**Combustion**	**Disposal**
to recover the materials to make new products	*to recover the energy for heat and power*	*in landfill sites*

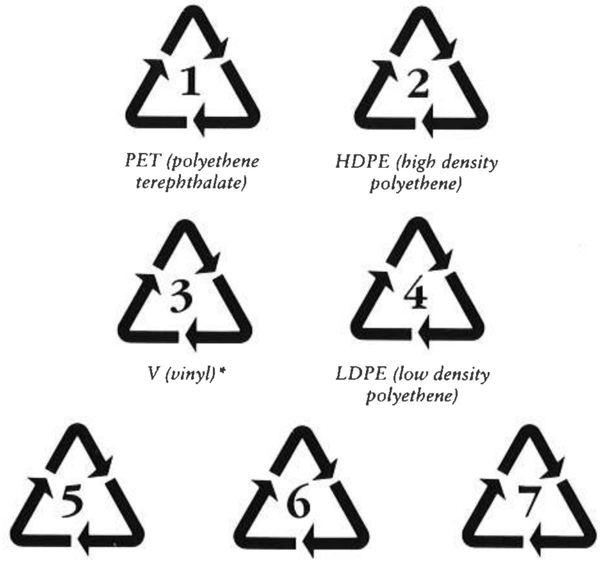
Recycling

This process will always need to be encouraged where it makes economic and environmental sense. The five stages in the recycling of plastics are:

1 Disposal by the user.
2 Collection by a local authority or company.
3 Sorting into different types of plastics.
4 Cleaning to remove labels, dirt and contents.
5 Re-processing to make new products.

Throughout the European Union there are now increasing opportunities to recycle plastics materials. These are arising in areas such as agriculture, the automotive industry, packaging and construction.

The common plastics have been given a code number which you will find on many of today's products. This coding system can now be used to help identify plastics when separated by hand.



PET (polyethene terephthalate) — *HDPE (high density polyethene)* — *V (vinyl)** — *LDPE (low density polyethene)* — *PP (polypropene)* — *PS (polystyrene)* — *Other (including multi-layer)*

*PVC

Activity One

It is important to try to separate different plastics early in the recycling process.

1/ Suggest reasons why thermosetting plastics need to be separated from thermoplastic materials.

2/ Why is waste separated into different plastics always likely to be more valuable and more useful than waste which remains mixed?

3/ Why are dark plastics separated from clear plastics – even though they are made from the same material?

4/ Have a look at home at the plastics materials in the kitchen or bathroom. Look for the code number stamped on the bottom or inside of a container. Make a table showing which plastics are used for which purposes.

5/ Make a careful note of where two different plastics are used in the same item eg for a lid and a container.

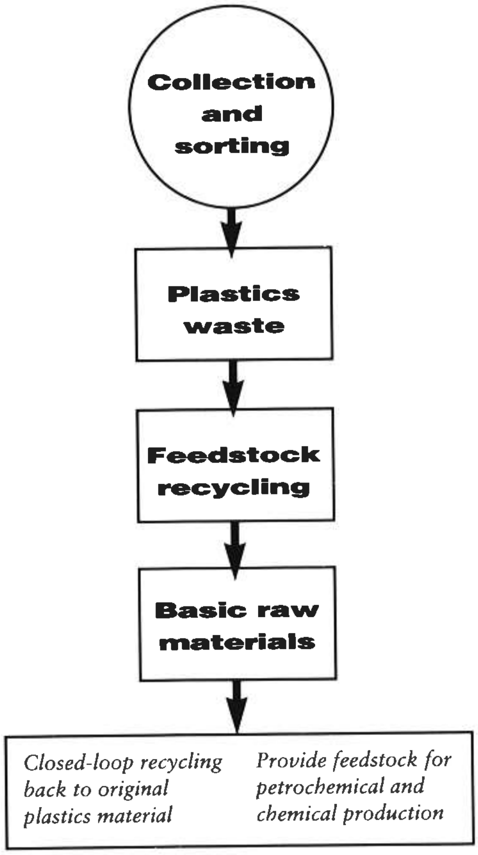
Apart from hand-sorting, three other methods for separation are used:

- *analysis of the elements in the plastic.* PVC is easy to spot because of the chlorine atom in the molecule.
- *separation by density.* The plastics are cut into flakes and mixed with a liquid so that some float and some sink.
- *electrostatic separation.* This can be used with plastics which take different electrical charges – for example, PET and PVC.

Feedstock recycling

The potential of new recycling technologies is currently being investigated by the plastics industry.

Feedstock recycling for example 'unzips' the molecules of the polymer chains to produce a range of chemical raw materials which can be used in new products. This technique is at the development phase but may offer the opportunity to increase recycling in the future.



Activity Two

1/ The density of polypropene is 0.91 g/cm³. The density of polystyrene is 1.05 g/cm³. What density would a liquid need to be to make sure that the polypropene floated and the polystyrene sank?

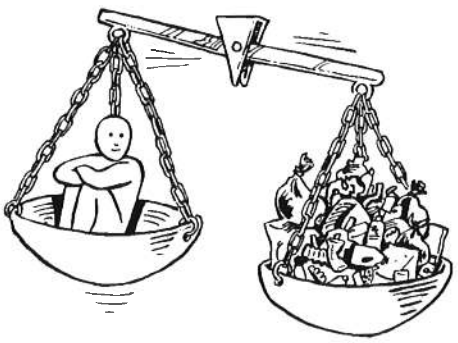
2/ PET has a density of 1.35 g/cm³. What density would a liquid need if it was to separate PET from polystyrene?

3/ Ease of separation of plastics materials is now being taken into account at the design stage. What recommendations about design rules would you make? Think about densities, colour, inks, and labels.

4/ Recycling makes a lot of sense, but only if the demand for recycled materials matches the supply. If demand is much less than the supply, what will happen to

- **the price paid for the recycled material**
- **the amount of recycled material in storage**
- **the costs of the process**
- **the profitability of the process?**

5/ If there is a large difference between supply and demand, the amount of waste being collected will have to be reduced. What effect might this have on public opinion and on the wisdom of recycling?



There are four main methods of feedstock recycling:

Pyrolysis
Plastics waste is heated in a vacuum producing a mixture of gaseous and liquid hydrocarbons not unlike petroleum.

Hydrogenation
Plastics waste is heated with hydrogen. This 'cracks' the polymers into a liquid hydrocarbon.

Gassification
Plastics waste is heated in air producing a mixture of carbon monoxide and hydrogen gases. This is used to produce new raw materials such as methanol.

Chemolysis
Individual plastics are chemically treated and turned into the raw materials for making the same plastics.

Activity Three

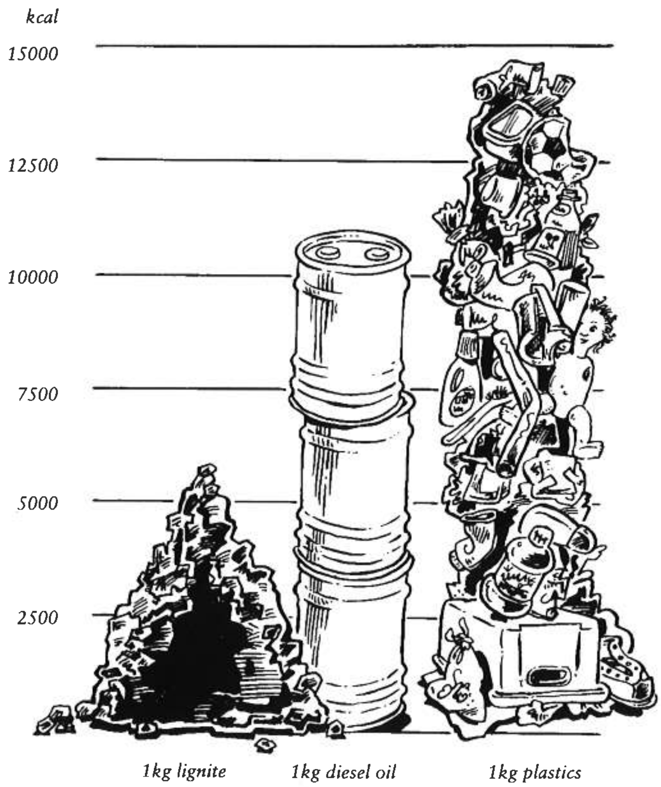
1/ Summarize these processes in a flow diagram. Make sure that you distinguish between the different stages, and between the usefulness of the four end-products.

2/ What other factors do we need to take into account before we can know whether processes such as these are actually of any benefit? Think of the costs involved.

Energy from waste

Reduction, re-use and recycling are not the only waste management options. Waste can also be burnt and the heat energy produced used as heating or in power generation.

This diagram shows the heat energy content equivalent of 1kg of lignite, diesel oil and plastics.



The energy content of waste plastics can be equivalent to coal or oil.

And it is the plastics in waste, along with other combustible items, which makes the waste such a good fuel. The 8% plastics content produces 30% of the heat energy released.

Already across Europe over 27 million tonnes of waste is burnt each year to produce useful heat energy.

Activity Four

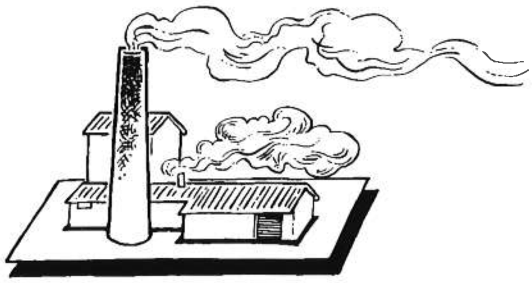
1/ Look at the following information and produce a poster which summarizes it.

2.6 tonnes of domestic waste has the energy value of 1 tonne of coal. A 10% increase in the amount of waste combusted would save over 2 million tonnes of coal.

Sweden already recovers energy from 47% of its plastics in domestic waste, providing 15% of its total district heating needs. In Denmark, 80% of plastics in domestic waste is recovered for energy. In Switzerland the figure is 53%.

If European waste was incinerated and the heat energy recovered, it could provide 5% of our domestic electricity needs and halve coal imports.

2/ One criticism often levelled at waste incineration is that it is a major contributor to the production of acid rain. This is because small amounts of chlorine (from food, paper and some packaging) can be released as hydrogen chloride gas.



In fact, waste incineration contributes only 0.5% to acidity in the atmosphere. Identify the other causes of acid rain and write a brief report on what you find out.

3/ This table shows what happens to plastics waste across Europe

Amounts ('000 tonnes)	**1992**	**1993**	**1994**
Total plastics waste	15 230		17 505
Amount recycled	1 036	915	
Amount from which energy is recovered	2 422	2 425	2 348
Total plastics waste recovered		3 340	3 456
Total percentage plastics waste recovered	22.7	20.6	19.7

Complete the table by calculating the data missing from the empty boxes.

There is an obvious need in recycling to balance supply and demand. There is no point in collecting material for recycling if the recycled material cannot be produced and marketed in an economic and environmentally acceptable way. There is also a need to balance with other means of treating waste.

What should we do?

- *Recycle plastics as materials?*
- *Recycle them as feedstock chemicals?*
- *Burn them as part of the waste stream and so recycle the energy they contain?*

The answer is probably to do all three, but to be sensitive about how much of each is done at any one time. We need to make a life-cycle analysis to show us the impact our choices will have.

Degradability

Degradable plastics have been produced which are broken down either by light or bacteria, but they are not widely used. Such plastics are not a solution to waste management. However, they do have certain applications in medicine (e.g. sutures and other bio-products) and agriculture (e.g. film for improving the growth of crops).

Landfill

In parts of Europe where waste cannot be burnt to release energy, it is still disposed of in landfill sites. Landfill is, however, a waste of resources.

In the past, landfill sites have often been located in disused quarries or clay pits. Filling these large holes in the ground with solid waste has been a good way of removing landscape eye-sores and restoring land.

Landfill sites contain organic material – usually more than 50% of the total mass of waste. Because of this they behave like gigantic compost heaps with the material such as paper, food and natural fibres slowly breaking down through bacterial activity. Modern sites can contain many millions of tonnes of material, with thousands of tonnes being added each day.

Landfill sites create two by-products – a liquid and a gas. The liquid is rather like concentrated sewage and must be contained within the site in case it seeps into the water supply. To prevent this, the site is usually lined with clay or plastics. The gas is a mixture of carbon dioxide and methane and is dangerously explosive if not properly controlled. There are many sites where this gas is now collected and used for the generation of electricity or heat.

Activity Five

1/ Draw up a table of advantages and disadvantages of

i recycling of waste
ii energy recovery from waste through burning

Think of transport costs, emissions, effect on other resources, land use.

Legislation now strictly controls the design and operation of landfill areas.

This card has shown something of the three main options for dealing with plastics.

- Recycling
- Combustion
- Disposal

All of these are used to varying degrees across Europe today. There are changes from time to time in which process predominates.
For example, changing oil prices on the world market can affect the value of recovered plastics materials and hence the cost of recycling.

7 *Teemme ja tutkimme* **muovia**

Tutkimusongelma:

Tavallisimpien kestomuovien tunnistaminen

Tutkimuksen tarkoituksena on selvittää eri keinoin, mistä muovityypistä näytteet on valmistettu. Tavallisimmin käytetyt muovit voidaan tunnistaa yksinkertaisin menetelmin. Tunnistustehtävä kannattaa aloittaa materiaalin tutkimisella aistinvaraisesti. Sen jälkeen muovi luokitellaan tiheyden mukaan kellutuskokeella. Halutessa voidaan tehdä myös polttokoe.

Muovimateriaalin tunnistamista vaikeuttavat polymeeriseokset, täyteaineet ja monissa pakkauksissa olevat monikerroskalvot, joissa voi olla yhdessä useita eri muovityyppejä. Tunnistamista helpottaa huomattavasti, jos muovin käyttökohde tiedetään. Kaikkein yksinkertaisinta muovin tunnistaminen on silloin, kun tuotteessa on raaka-aineesta kertova merkintä. Euroopassa yleistyneet muovimerkinnät löytyvät Platform-kortista numero kuusi.

Tutkimustehtävän valmistelu:

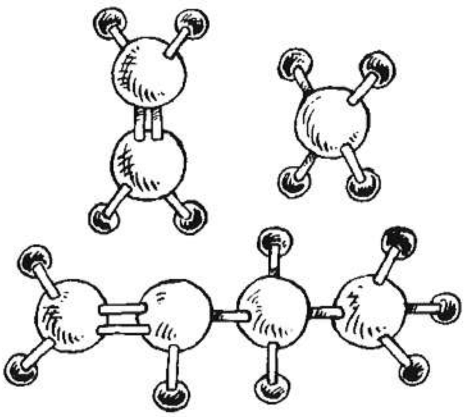
Jokainen tuo kotoaan erilaisia, mielestään erityyppisiä muovin palasia tai muoviesineitä näytteiksi. Luokassa muovinäytteet kootaan yhteen. Jokainen ryhmä ottaa vähintään kolme mielestään erityyppistä muovinäytettä.

Tutkimustehtävän eteneminen:

1) Muovin tunnistaminen on helpointa aloittaa aistinvaraisesti ja edetä sitten tarvittaessa kellutuskokeeseen ja polttokokeeseen. Tutustu alla oleviin ohjeisiin ja valitse yhdessä opettajasi kanssa mitkä tunnistuskokeet teet.

2) Suunnittele taulukko valitsemasi kokeen tuloksia varten. Merkitse taulukkoon myös muovinäytteesi käyttökohde, jos se on tiedossa. Suorita koe ja kirjaa tuloksesi.

3) Vertaile saamiasi tuloksia tunnistustaulukkoon ja varmista näytteittesi muovityypit. Mieti, miten tutkimiesi muovityyppien ominaisuudet liittyvät niiden käyttötarkoituksiin. Eri muovityyppien käytöstä löytyy englanninkielinen taulukko myös Platform-kortissa numero kolme.



A. Muovien tunnistaminen aistinvaraisesti

- Tutki muovinäytteiden ulkonäköä. Huomioi väri, haju, läpinäkyvyys ja pehmeys.
- Tutki muovinäytteiden kovuutta pintaa raaputtamalla. Yritä varovasti leikata näytteestä veitsellä lastuja.
- Pudota muovikappaleita pöydälle tai lattialle ja kuuntele putoamisen ääntä.
- Tutki muovinäytteiden taipuisuutta, sitkeyttä ja haurautta. Taivuta kunnes näyte murtuu ja tutki murtopintaa.
- Tutki kalvomaisten näytteiden vetolujuutta ja venymistä eri suunnissa.
- Tutki muovien kestävyyttä kuumassa ja kylmässä.
- Piirrä kuulakärkikynällä näytteen pintaan ja kokeile pyyhkiä jälki pois sormella.

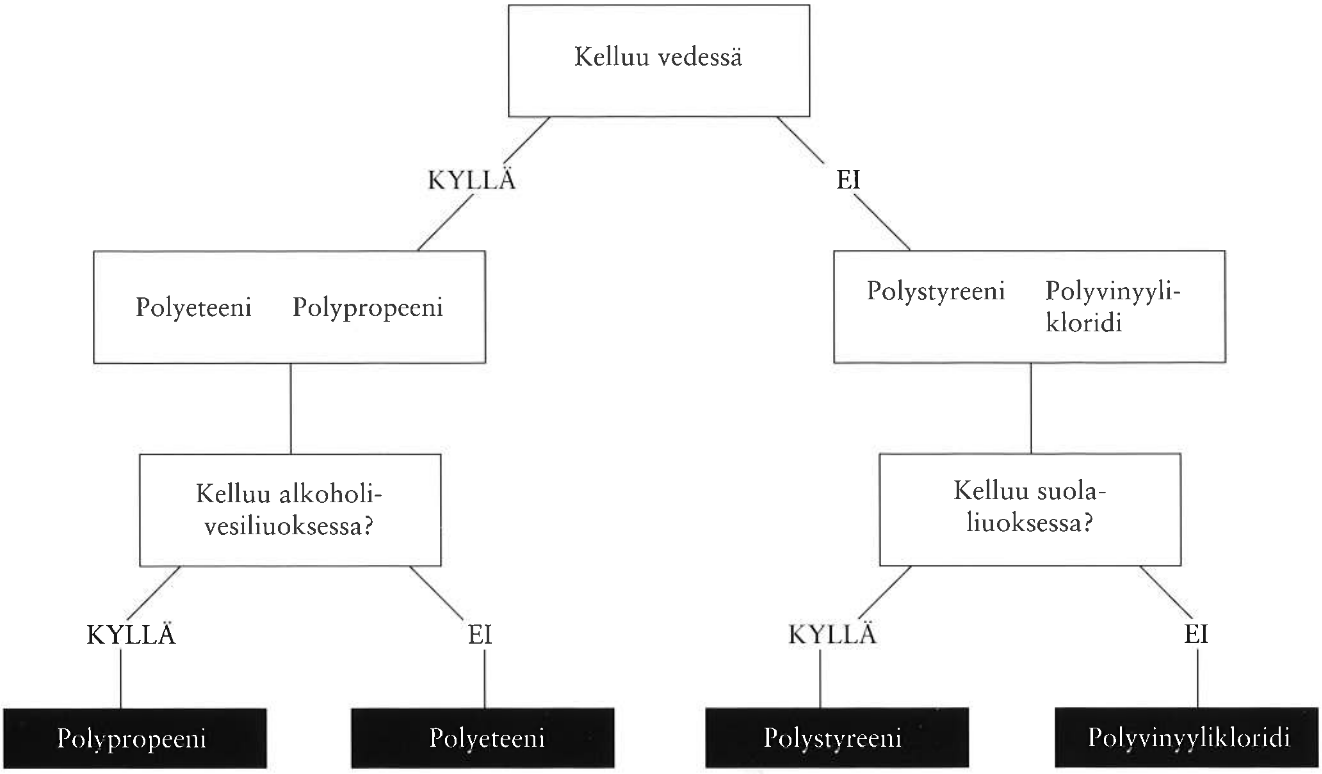
B. Kellutuskoe

Yleisimmät kestomuovit voi helposti tunnistaa niiden tiheyden perusteella. Tiheys määritetään upottamalla muovikappaleita nesteisiin, joiden tiheys tunnetaan. Jos muovi uppoaa, sen tiheys on suurempi kuin nesteen. Muovien tunnistustaulukosta löydät eri muovien tiheydet ja käyttäytymisen vedessä, alkoholi-vesiliuoksessa sekä suolaliuoksessa.

Ohje:

Kokeile näytteiden kelluvuutta ensin pelkässä vedessä. Siirrä vedessä kelluvat muovit toiseen keitinlasiin ja kaada päälle alkoholia. Lisää vähitellen vettä liuosta sekoittaen.

Kaada veteen uponneiden muovien joukkoon varovasti valmista väkevää suolaliuosta. Sekoita hyvin.



C. Polttokoe

Polttokokeella todetaan muovin syttyvyys, palavuus, liekin väri, muovin sulavuus ja tippuvuus sekä savun muodostus ja savukaasujen haju.

Koetta tehtäessä on muistettava turvallisuus: koe on tehtävä **vetokaapissa suojalaseja käyttäen.** Palava näyte on ehdottomasti sammutettava ennen savukaasujen hajun toteamista. Muovin palaessa saattaa syntyä haitallisia kaasumaisia palamistuotteita, mutta niiden määrät ovat niin pienet, ettei terveysriskiä ole.

Ohje:

- Laita suojalasit. Vie pieniä muovin kappaleita upokaspihdeillä kaasupolttimen tai kynttilän liekin kärkeen yksi kerrallaan.
- Vie kappale pois liekistä heti, jos se syttyy. Ole varovainen, sula muovi voi tippua.
- Tarkkaile liekistä pois ottamaasi muovia. Jatkaako se palamista?
- Mikä on liekin väri? Sulaako, turpoaako, rätiseekö muovi?
- Sammuta muovinkappale varovasti. Leyhytä palamiskaasuja kohti nenääsi. Älä työnnä koepalaa suoraan nenäsi alle! Koita tunnistaa haju.

Tehtäviä laboratoriotyöskentelyyn

1. Polyamidin (nailonin) valmistus

Liuos A: 50 ml vettä
1,2 g 1,6 diaminoheksaania
2,2 g natriumkarbonaattia Na_2CO_3

Liuos B: 3,6 ml sebasiinihapon dikloridia
100 ml bensiiniä

Ohje:

- Valmista liuokset A ja B eri keitinlaseissa
- Valuta varovasti liuosta A liuoksen B päälle
- Nosta liuoksen rajapintaan kertynyttä reaktiotuotetta, polyamidia, varovasti lasisauvalla. Voit kiertää polyamidilankaa lasisauvan ympärille.

2. Superpallon valmistus

Valmistetaan superpallo silikonikumista. Silikonikumi on rakenteeltaan ja joiltakin ominaisuuksiltaan muovien kaltaista, vaikka se ei ole muovi. Silikoni on polymeeri, joka syntyy samalla tavalla kuin monet muovit.

Ohje:

Keitinlasiin kaadetaan puoli koeputkellista natriumsilikaattia (vesilasia, Na_2SiO_3). Koeputkeen kaadetaan noin 3 cm verran etanolia (C_2H_5OH). Etanoli kaadetaan keitinlasiin ja sekoitetaan nopeasti lasisauvalla natriumsilikaatin kanssa. Muovaile reaktiotuote kädessäsi palloksi ja huuhtele juoksevassa kylmässä vedessä.

Lähteet:
Tutustumme muoveihin -opetusvihko ja Öljyn tie – Lähteiltä tuotteiksi -opetuspaketin työ- ja tehtäväohjeet.

Muistiinpanoja:

Muovi	Käyttökohteita	Tuntuma, ulkonäkö	Tiheys	Polttokoe
PE-LD (LDPE) Pientiheyksinen polyeteeni	Tavalliset muovikassit ja -pussit, pakasterasiat, maitopurkin pinta, jätesäkit, monet lelut	Taipuisaa ja pehmeää, vahamaista. Kuulakärkikynän jälki pyyhkiytyy helposti. Ohut kalvo kirkas, paksumpana sameaa	Kelluu vedessä 0,91–0,94 g/cm^3	Palaa, sulaa ja tippuu palaen. Savu haisee kynttilälle. Ei juuri nokea
PE-HD (HDPE) Korkeatiheyksinen polyeteeni	Rapisevat muovikassit ja -pussit, pullot, mehukanisterit, ämpärit, pesuvadit	Melko kovaa ja jäykkää, sameaa. Kuulakärkikynän jälki pyyhkiytyy helposti	Kelluu vedessä 0,94–0,98 g/cm^3	Kuten PE-LD
PP Polypropeeni	Muovinarut ja -köydet, lahjapakettien sidenauhat, limsapullojen korkit, keksipakettien päällyskalvot, auton puskurit	Melko kovaa ja jäykkää. Ohut kalvo kirkas. Kuulakärkikynän jälki pyyhkiytyy helposti	Kelluu vedessä ja alkoholi-vesiliuoksessa (1:1) 0,905 g/cm^3	Pääosin sama kuin PE-LD ja PE-HD, savu haisee hieman petrolille
PVC (kova) Polyvinyylikloridi (Kova PVC)	Läpinäkyvät shampoopullot, vanhat äänilevyt (ei CD), kovat harjakset, viemäriputket	Jäykkää ja kovaa. Vaalenee taivutuskohdassa	Uppoaa vedessä yli 1,3 g/cm^3	Palaa vain liekissä, sammuu itse, savu happomaisen pistävä, nokeaa
PVC-P (pehmitetty) Polyvinyylikloridi (Pehmeä PVC)	Tekonahka, sadetakit, lattiapäällysteet, letkut, kansion kannet, sähköjohtojen eristeet	Olemus vaihtelee pehmittimistä ja täyteaineista riippuen, kuulakärkikynän jälki pysyy	Uppoaa vedessä yli 1,3 g/cm^3	Yleensä itsesammuva, savu happomainen, pehmitin antaa lisäaromin
PS, PS-E (EPS) Polystyreeni, soluuntuva polystyreeni	Kertakäyttöiset, kirkkaat astiat, korurasioiden kannet. Soluuntuneena eristeet (Styrox), hampurilaispakkaukset	Kovaa, kirkasta ja haurasta. Lohkeaa räsähtäen ja kolahtaa pudotessa	Uppoaa vedessä, mutta kelluu suolaliuoksessa. Soluuntuva kelluu myös vedessä 1,05 g/cm^3	Syttyy hyvin, musta savu ja nokihiutaleita, tunnusomainen haju
PS-HI (HIPS) Iskunkestävä polystyreeni	Jugurttipurkit, valkoiset kertakäyttömukit, veitset ja haarukat	Kovahkoa, taipuisaa, vaalenee taivutuskohdasta	Uppoaa vedessä, mutta kelluu suolaliuoksessa 1,04–1,06 g/cm^3	Sama kuin PS mutta sulaa huonommin
PET Polyeteenitereftalaatti	Palautusmuovipullot, keksien kotelot, piirtoheitinkalvot, tekstiilit	Jäykkää, kovaa. Kirkasta, jollei värjätty	Uppoaa vedessä 1,37 g/cm^3	Palaa, mustaa savua, makea, liköörimäinen tuoksu
PA Polyamidi (nailon)	Tekstiilit, siima, hammasharjan harjakset	Jäykkää, kovaa, sitkeää. Kirkas kalvo, muuten sameaa	Uppoaa vedessä 1,02–1,21 g/cm^3	Palaa ritisten ja tippuen, haisee palaneille hiuksille
ABS Akryylinitriili/butadieeni/styreeni	Huonekalut, talouskoneiden kuoret, legonappulat	Jäykkää, sitkeää, läpinäkymätöntä	Uppoaa vedessä 1,06–1,12 g/cm^3	Kuten PS, tarkkanenäiselle kanelimainen haju

Teachers' Notes

Card 1

1.1 **Now**	1.1 **Before**	1.2 **Reasons for using plastics**
pencils	wood	*cheaper to manufacture; do not need sharpening and do not change length during use*
rulers	wood	*cheap; easier to read; easy to clean*
car bumpers	chrome-plated steel	*plastics do not rust and can be made so that they absorb impacts without changing shape*
hi-fi cabinets	aluminium	*more attractive design features; easier to mould into interesting shapes*
lenses on car lights	glass	*easier to make; safer when broken and lying on the road*
lemonade bottles	glass	*lighter and safer to carry; cheaper to transport*
jumpers and sweaters made from acrylics	wool	*cheaper to manufacture; easier to wash*
rayon and polyester clothing	silk	*low cost and easy care*
cutlery handles	pottery/horn	*materials more available; dishwasher-proof*

2.1

Feature	**Advantage**
Safety	*Plastics can absorb impact protecting occupants; plastics are less likely to produce jagged edges when bent or broken*
Economy	*Plastics have low densities and reduce the mass of the car; this reduces fuel consumption*
Style	*Plastics can be manufactured in any shape, producing cars with low wind resistance and good fuel economy*
Colour	*Plastics can be coloured throughout rather than be painted on; this reduces unsightly scarring from stone chips and scratches*
Cost	*Plastics are easier to work with than metals reducing manufacturing times and costs; plastics can be cheaper than metals reducing raw material costs*

2.2

Cost of fuel without use of plastics =

2000 x £0.50p = £1000

4% saving = 4 x 1000 / 100 = £40

4.1 The first plastics were developed in the 1860's, but use grew only slightly up to the mid-1940's when 2 million tonnes per year were produced. By the late 1960's this figure had doubled; production then continued to grow at the rate of around 3 million tonnes per year until the early 1970's when production fell from 42 to 38 million tonnes. The same rapid growth resumed in the mid-1970's and continues now.

4.2 Economic growth during the 1950's in the post-war period stimulated the demand for new plastics.

4.3 The price of oil was doubled which forced prices up and cut the demand for manufactured goods.

4.4 2000 110 million tonnes

4.5 There was a world-wide recession which reduced the demand for all manufactured goods.

Card 2

	1.1	1.2	1.3
A	$CH_2 = CH_2$	C_2H_4	28
B	CH_4	CH_4	16
C	$CH_2 = CH - CH_2 - CH_3$	C_4H_8	56
D	$CH_3 - CH = CH - CH_3$	C_4H_8	56

E	$CH_2 = C - CH_3$
	         |
	       CH_3
		C_4H_8	56

F	$CH_2 = CH - CH = CH_2$	C_4H_6	54

G	CH_3
	      |
	$CH_3 - CH - CH - CH_3$
	            |
	           CH_3
		C_6H_{14}	86

1.4 The order of increasing boiling point (lowest to highest) is likely to be: BAFCDEG.

The mass of the molecule is one factor which influences boiling point. The shape of the molecule is also important.

2.1 Ethene is a small molecule which contains a carbon-carbon double bond. It is a flat 'planar' molecule which is very reactive because of the double bond.

Polyethene is a long molecule with only carbon-carbon single bonds. It is not planar and is very unreactive because there are no double bonds.

2.2 $CH_2 = CH_2 \quad CH_2 = CH_2 \quad CH_2 = CH_2 \longrightarrow$

$CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 -$

Card 3

3.1 $C_6H_{10}O_4$ $C_6H_{16}N_2$

3.2 NH_2-CH_2-CH_2-CH_2-CH_2-CH_2 -CH_2- NH - CO - CH_2 - CH_2 - CH_2 - CH_2 - COOH

3.3 $C_{12}H_{24}O_3N_2$

4.1 PET can withstand extremes of temperature and so can be used [a] in the oven and [b] in the freezer without damage being done to the plastic.

4.2 It prevents air and moisture passing through it.

4.3 LD polyethene is more flexible than HD polyethene and therefore more useful in goods which have to be bent, squeezed or twisted.

4.4

LD uses	HD uses
• film wrap	• toys
• coatings for containers and electrical cables	• petrol tanks in cars
	• pipes

HD polyethene is used for products which need to be reasonably rigid; the LD form for goods which need to be flexible.

4.5

PVC	**Wood**	**Aluminium**
Weathers well and does not rot	Weathers over time and rots	Can weather over time
Does not require painting, meaning lower maintenance costs. No painting means less impact on the environment*	Requires regular painting throughout life	Often painted to avoid damage through weathering and achieve customer colour preference
Recyclable at the end of life	Cannot usually be recycled/ reused	Recyclable at the end of life
Is flame retardant	Burns	Does not burn
Does not easily chip, dent or crack	Can be chipped, dented and cracked	Does not easily chip and dent

* producing and using paint has its own effect on the environment on top of the production of the window frames themselves

PVC is particulary successful at being precisely tailored, with added ingredients, to give long term weather resistance, toughness, colour retention and durability to window frames. PVC has inherent flame retardant properties because of its chlorine content which reduces the threat of fire.

4.6 One possible investigation is to use cling wrap and other wrappings such as plastic bags, paper bags, cellulose, and so on, to see how effective it is at keeping biscuits dry.

The biscuits would need to be weighed beforehand, and then weighed at regular intervals to see what increase in mass there has been. Unwrapped biscuits can be used as a control.

Card 4

1.1 Plastics are used for the casings of electrical goods such as irons, toasters, hair-driers, radios, hi-fis. They are also used for electrical fittings such as plugs, sockets, switches, extension leads and multi-plugs.

1.2 People can see if food is in good condition without handling it.

1.3 Plastics packaging acts as a barrier to micro-organisms keeping medical equipment sterile. Plastics can be used safely for flexible equipment such as tubes. Items which have to be disposed of after use to ensure safety from contamination, for example syringes and gloves, can be manufactured cheaply. Plastics can be moulded into shapes which would otherwise require several components and be more difficult to keep clean.

1.4 Small plastics items, if discarded as litter, could be ingested by animals.

1.5 The only real safeguard is an education programme which persuades people not to create litter.

1.6 Goods can arrive in the same condition in which they left the factory; they are protected against the elements and against accidental damage.

2.1 Poor distribution systems in many developing countries mean that food takes a long time to reach the consumer from the farmer and so a lot of it goes off. Lack of refrigeration facilities means foods deteriorate more quickly.

2.2 Packaging keeps micro-organisms away from food, and protects delicate or fragile items from knocks and damage.

2.5 Hard-boiled eggs could be protected in bubble-wrap and dropped from increasing heights. Different thicknesses of wrap could be used.

3.1 The lower mass of the plastics bottles (compared to glass) means less fuel is needed.

3.2 The cost of manufacture, transport and disposal of plastics and glass bottles needs to be known.

3.3 Plastic bags...

- are stronger than paper bags – but the handles can break under a heavy load
- don't tear when wet as paper bags can
- can adjust to the shape of the shopping more easily than paper ones – but some paper bags are more rigid than plastic ones
- are easier than paper bags to use again for another purpose
- weigh less and take up less space when flat.

3.4 You will need to compare like with like. Only compare bags which can be used to carry equivalent loads.

3.5 The mass of packaging would increase by around 300%.

3.7

A	*from factory to warehouse to storage in the shops*	Transport costs are less because the lighter load would need less fuel to transport it. Plastic bottles can be made larger than glass ones, and fuel economies are made there.
B	*from storage in the shop to the shelves*	The human effort needed to move plastic bottles is less than that needed to move glass ones. This means that the work is done more quickly and at a lower cost.
C	*from shelves to check-out to home and storage*	As B, but also, the wear and and tear on the shopper is less as they have lighter loads to carry.

3.8 Metal will be similar to glass; card similar to plastics. None of the containers is as heavy as glass. None of the plastics is as heavy as metal.

3.9 Suggestions include

	Advantages	Disadvantages
Plastics	easy to mould	in the past less care has been taken in disposal
Glass	transparent	fragile
Metal	strong	sharp edges when broken
Card	light	complex laminated material

3.10

Advantages	Disadvantages
Plastic containers are easy to produce in all sizes and interesting shapes. They are strong and flexible, and are safe when broken. They offer good protection to contents against micro-organisms and light.	There is still progress to be made in establishing sensible recycling mechanisms.

4.1 Temperature *vs* time graphs can be plotted. The gradients of such graphs will show the relative rates at which heat energy is lost from the various containers. The same amount of liquid should be used each time, and measurement should start and end at the same temperature. The material under test should be used as a lid to the container to minimize heat loss by convection during the experiment.

Card 5

1.2 In any comparative assessment of 'eco-impact', the following considerations are vital:

[1] all stages in the manufacture, use and disposal of a product must be taken into account
[2] make it a 'fair test' by always comparing like with like
[3] the way measurements are made must always be appropriate for the circumstances and materials
[4] national and international standards should be adhered to

2.1 Examples might be:

Pots: for germinating seeds, growing seedlings, mixing paint, cleaning paint brushes, storing small items such as screws and nails
Trays: as coasters and for storage
Bags: as bin liners, shopping bags, and for storage

3.1 The fall in mass during the period shown is 46% for the yoghurt pot.

3.2 The thickness of the container's walls is reduced whilst retaining most of its strength.

3.3 Refills use thinner material and less of it than the original package; with jumbo packs, as the volume of a pack rises, the amount of material rises too - but not as quickly. If you double the pack's volume, you do not double the surface area of the plastic material needed. Packs of concentrate use far less packaging than diluted products.

4.1 11.45 million tonnes

4.2 1.1 million tonnes

4.3 Plastics are difficult to extract from the domestic waste stream; much of this has to be done by hand. Industrial plastics waste can often be collected separately from other waste to avoid the need for separation.

Card 6

1.1 Thermoplastic materials can be softened and re-used as the polymer; thermosets cannot. Getting these two products mixed up would cause a mess which would be impossible to separate.

1.2 If plastics are separated, the options for processing are much greater. They can be processed into the original polymer, or broken down into basic components. They can still be burnt to recover energy if that is felt to be useful.

1.3 Again, the options available with clear plastics are so much greater. You can easily make a dark coloured plastic from a light coloured one but not the other way round.

1.5 A good example of this is an ice cream tub where the tub is made of high density polyethene (code 2) and the lid of low density polyethene (code 4). Because of this, the lid is more flexible than the tub which is a useful property as the lid has to be flexed to remove it each time you want to eat the ice cream.

2.1 The density would need to be between 0.91 and 1.05 g/cm^3.

2.2 A density of between 1.05 and 1.34 g/cm^3.

2.3 Don't mix plastics with very similar densities.
Use water-soluble inks.
Light colours are easier to handle than dark ones.
Print information onto plastics rather than stick on labels.

2.4
[i] the price will fall - making the process less economic
[ii] this will rise - increasing costs
[iii] these will rise
[iv] this will fall - putting the whole enterprise into jeopardy

2.5 The public will begin to question the point of recycling and rapidly become disillusioned.

3.2 We need to know about the costs of processing for each of these methods, and the costs of other raw materials used (eg hydrogen).

4.2 Research indicates that sulphur dioxide, produced mainly by power stations, and nitrogen oxide, produced mainly by motor vehicles, account for approximately 98% of the total potential acidity in the atmosphere. The remaining 2% is hydrogen chloride. Of this, 0.5% can be attributed to municipal waste incinerators. The contribution to all acid gases from the burning of PVC is less than 0.25%.

4.3
The missing data are:

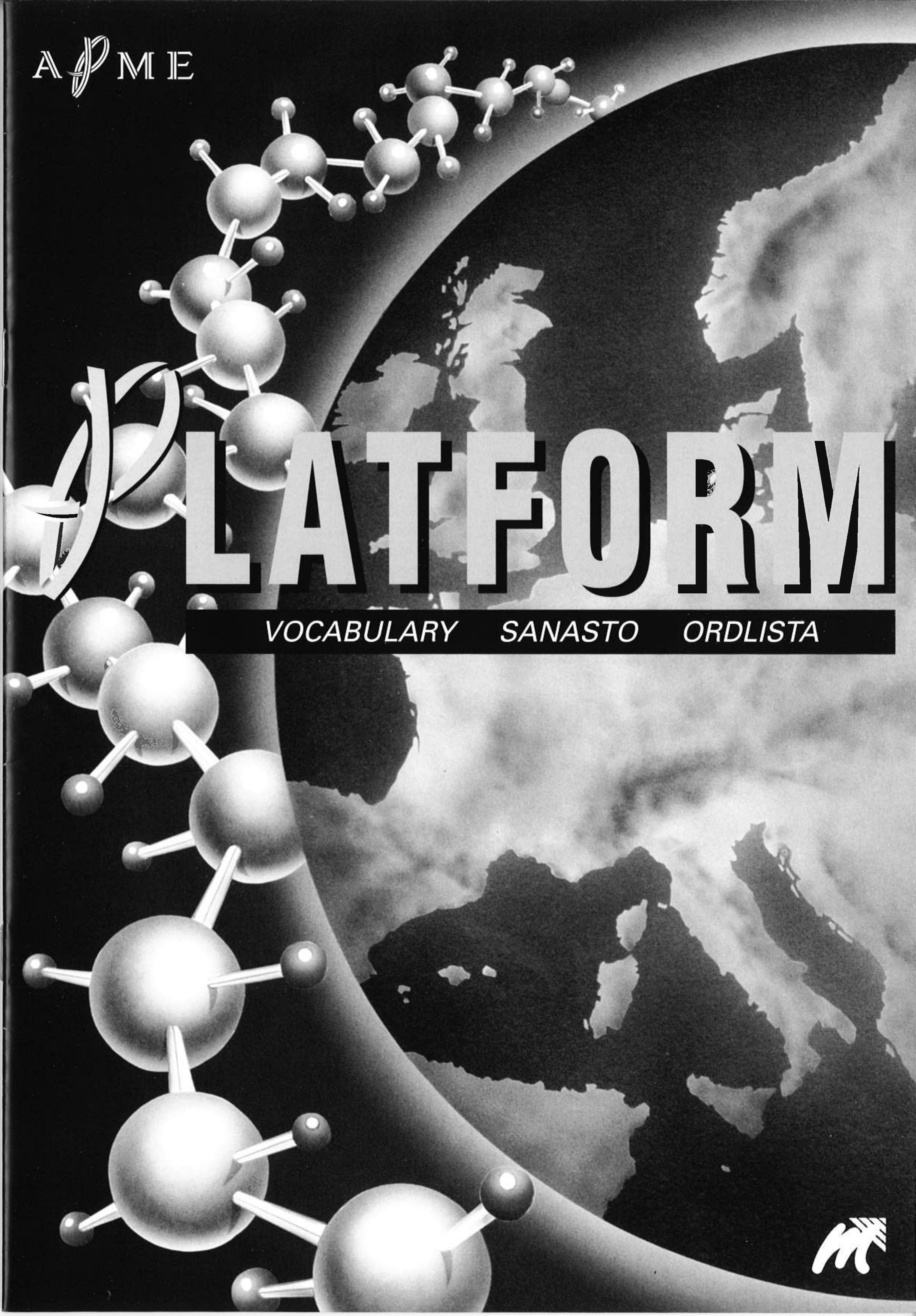
Amounts ('000 tonnes)	**1992**	**1993**	**1994**
Total plastics waste	15 230	**16 211**	17 505
Amount recycled	1 036	915	**1 108**
Amount from which energy is recovered	2 422	2 425	2 348
Total plastics waste recovered	**3 458**	3 340	3 456
Total percentage plastics waste recovered	22.7	20.6	19.7

Recycling of waste	Energy recovery from waste through burning
Recycling can separate out valuable resource materials from waste; eg glass, plastics and metals such as aluminium, copper and tin	This is useful if the energy released is captured and used as heating or as a means of generating electricity
Recycling can reduce industrial manufacturing costs	To be efficient, this needs to be done near population centres
Collecting for recycling is something everyone can do	'Clean-burn' technology is needed if this is to be done near cities but the pay-back is good
The economics of recycling don't always make sense; eg if you make a special journey by car to a recycling centre you run the risk of spending more energy on fuel than you save in the recycling process	Energy from waste reduces the volume and mass of waste for final disposal
The demand for recycled materials can be uncertain, eg because of changes in the price of raw materials process	Using waste for energy saves fossil fuels

APME

PLATFORM

VOCABULARY SANASTO ORDLISTA



1 INTRODUCING PLASTICS

convenient	mukava	bekväm
to increase	lisääntyä	öka
to replace	korvata	ersätta
to fulfil	täyttää	uppfylla

Activity One

an object	esine	föremål
commonly	yleisesti	vanligtvis
obvious	ilmeinen	självklar
an advantage	etu	fördel

extensively	laajasti	i stor utsträckning
a proportion	osuus	andel
steel	teräs	stål
approximately	noin	omkring
to contain	sisältää	bestå av
to result	johtaa, saada aikaan	resultera i
estimated	arvioitu	uppskattad
a reduction	vähennys	minskning

Activity Two

fuel	polttoaine	bränsle

widespread	laajalle levinnyt	utbredd
a structure	rakenne	sammansättning, struktur
to construct	rakentaa	konstruera, bygga
a tissue	kudos	vävnad
carbohydrate	hiilihydraatti	kolhydrat
a fibre	kuitu	fiber
a grain	jyvä	säd
based on	perustuva, rakentuva	uppbyggda av
to process	jalostaa, kehittää	förädla, behandla
a thread	lanka	tråd
a fabric	kangas	tyg
hydrogen	vety	väte
carbon	hiili	kol

petroleum	bensiini	bensin
a refinery	jalostamo	raffinaderi
solid	kiinteä	fast
depending on	riippuen	beroende av

The history of plastics

cotton wool	puuvillakuitu	råbomull
to treat	käsitellä	behandla
nitric acid	typpihappo	salpetersyra
an ornament	koriste	prydnadsföremål
a handle	kahva	handtag
a cuff	kalvosin	manschett
a collar	kaulus	krage
a source	lähde	källa
coal tar	kivihiiliterva	stenkolstjära
to provide	tarjota, tässä: toimi lähteenä	tillhandahålla, här: användas till
Bakelite	bakeliitti	bakelit
electrical	sähkö-	elektrisk
insulation	eristys	isolering
a case	runko, kuori	fodral, hölje, här: kamerahus
to observe	havaita, havainnoida	observera
to accelerate	kiihdyttää	påskynda
a search	etsintä	sökande
manufacture	valmistus	tillverkning
entered production	alettiin valmistaa	började produceras
a filament	ohut kuitu	tunn tråd
to spin	kehrätä	spinna
to weave	kutoa	väva
resin	hartsi	harts
to add	lisätä	tillsätta

Activity Four

a graph	käyrä	graf
to extend	jatkaa	dra ut, förlänga
to suggest	olettaa	föreslå
a level	taso	nivå
to reduce	alentaa	minska

2 THE RAW MATERIALS

raw materials	raaka-aineet	råmaterial
crude oil	raakaöljy	råolja
a compound	yhdiste, seos	förening, blandning
to process	*jalostaa, kehittää*	*bearbeta, förädla*
a mass	massa	massa
to boil	kiehua	koka
to separate	erottaa	separera, skilja åt
fractional distillation	jakotislaus	fraktionerad destillation
a fraction	osa, jae, murto-osa	del, bråkdel
individual	yksittäinen	enskild

a column	tässä: säiliö, astia	kolonn
refinery	jalostamo	raffinaderi
naphtha	teollisuusbensiini	nafta
kerosine	petroli	petroleum
gas oil	kaasuöljy	gasolja
a residue	sakka, jäännös, tässä: pohjaöljy	rest

Activity One

hydrocarbon	hiilivety	kolväte
carbon	*hiili*	*kol*
hydrogen	*vety*	*väte*
a diagram	kaavio, piirros	diagram, figur
a formula	kaava	formel
structural	rakenne-	struktur-
molecular	molekyyli-	molekyl-
a unit	yksikkö	enhet
to work out	selvittää	räkna ut
a boiling point	kiehumispiste	kokpunkt
to increase	kasvaa, lisääntyä	öka, stiga
to arrange	järjestää	ordna
in order	järjestyksessä	enligt, efter
a chemical bond	kemiallinen sidos	kemisk bindning

to take place	tapahtua	äga rum
to alter	muuntaa, muuttaa	förändra
a melting point	sulamispiste	smältpunkt
a property	ominaisuus	egenskap

cracking	krakkaus	krackning
a catalyst	katalyytti	katalysator, katalyt
heat treatment	lämpökäsittely	upphettning

reforming	muokkaus, reformointi	omändring, reformering
internal	sisäinen	inre
usefulness	hyödyllisyys	användbarhet
pressure	paine	tryck
a blend	sekoitus	blandning
steam	höyry	ånga
to convert	muuntaa, jalostaa	konvertera, förädla
a double bond	kaksoissidos	dubbelbindning
to react	tässä: yhdistää, liittää	förena
reactive	reaktiivinen, herkästi reagoiva	reaktiv
unreactive	inertti, reagoimaton	icke reaktiv
a chain	ketju	kedja
a liquid	neste	vätska
a solid	*kiinteä aine*	*fast ämne*

Activity Two

a bar magnet	magneettisauva	stavmagnet
to be carried out	tehdä (tutkimusta)	utföra (forskning)
oil seeds	öljykasvit	oljeväxter
rape	rapsi	raps
linseed	pellavansiemen	linfrö
genetic engineering	geeniteknologia	genteknologi
a yield	sato, tuotto	skörd, avkastning

3 POLYMERS AND PROCESSING

processing	*prosessointi, jalostus*	*behandling, förädling*
naphtha	*teollisuusbensiini*	*nafta*
density	tiheys	densitet
linear low density	lineaarinen pientiheys	linear låg densitet
chlorine	kloori	klor
oxygen	happi	syre

Activity One

sales	myynti, myyntiluvut	försäljning
a figure	kuvio, kaavio	figur
to summarize	tiivistä	sammanfatta
a period	ajanjakso	period
distinct	selvä, helposti erotettava	specifik, klart avskild
to soften	pehmentyä	mjukna
to harden	kovettua	hårdna

moulded	muotoiltu, valettu	formad, gjuten
thermoplastic	kestomuovi	termoplast, ej härdbar
thermosetting	kertamuovi	härdplast, härdbar
to alter	muuttaa, muuntaa	förändra, omforma
to consist of	koostua, muodostua	bestå av
a bond	*sidos*	*bindning*
to reform	*muuttua, reformoitua*	*omforma, reformera*
to slide	liukua	glida
cross-linked	verkkomainen	nätformad bindning
a property	*ominaisuus*	*egenskap*

Activity Two

a lump	pala, kimpale	klump, bit
to process	*jalostaa, muokata*	*förädla, behandla, forma*
along	pitkin	längs med
across	poikki, yli	tvärs över
solid	*kiinteä*	*fast*
rigid	jäykkä	styv, stel
manufacturing	*valmistus*	*tillverkning*
pliable	muokattava, taipuisa	formbar, böjlig
to squeeze	puristaa	klämma, pressa
a press	puristin, prässi	press
to solidify	kiinteytyä	stelna, bli fast
epoxy glues	epoksiliimat	epoxilim
to contain	sisältää	innehålla
to remove	poistaa	avlägsna, förflytta

Activity Three

a formula	*kaava*	*formel*
a compound	*yhdiste*	*förening*
a diagram	*kaavio, piirros*	*diagram, schema*
dustbins	roskapöntöt	soptunnor
pipes	putket	rör
bin liners	jätesäkit	sopsäckar
a detergent	pesuaine	tvättmedel
crates	korit, laatikot	korgar, lådor
wrappings	kääreet	emballage
crisps	perunalastut	potatischips
containers	astiat, säiliöt	kärl, behållare
fizzy drinks	hiilihappojuomat	kolsyrade drycker
oven-proof	uuninkestävä	ugnssäker
freezer tubs	pakasterasiat	fryskärl
upholstery	verhoilu	stoppning, klädsel
soles	kengänpohjat	sulor

Activity Four

a property	*ominaisuus*	*egenskap*
film wrap	kalvo, kelmu	plastfilm
coatings	päällysteet	beläggning, överdrag
cardboard	pahvi, kartonki	kartong, wellpapp
compares favourably	tässä: osoittautuu paremmaksi	här: visar sig vara bättre än
an investigation	tutkimus	undersökning
effectiveness	tehokkuus	effektivitet
a statement	väittämä, lausunto	påstående
to resist	kestää	hålla,motstå
pressure	paine	tryck
an extreme	äärimmäisyys	ytterlighet, här: extrem
moisture	kosteus	fuktighet
stiff	jäykkä	styv
flexible	joustava	böjlig
an application	sovellus	tillämpning
to tailor	tässä: viimeistellä	skräddarsy
additives	lisäaineet	tillsatsämnen
to convert	*muokata, muuntaa, jalostaa*	*förändra, förädla*
injection moulding	ruiskuvalu	formsprutning
to force	pakottaa	tvinga
a mould	muotti	form
gear wheels	hammaspyörät	kugghjul
compression	paine	kompression, tryck
moulding	muovaus	formning, gjutning, formpressning
blow	puhallus-	blås-
rotational	pyöritys-	rotations-
a paste	tahna	pasta
even	tasainen	jämn
a layer	kerros	lager
hollow	ontto	ihålig
blown film	puhalluskalvo	blåsfilm
extrusion	pursotus, ekstruusio	strängsprutning, extrudering
to seal	sulkea	sluta, försegla
to slit	halkaista	skära, klippa
a die	suulake	munstycke
calendering	mankelointi, kalanterointi	valsning, kalandrering

4 THE PROPERTIES OF PLASTICS

a property	*ominaisuus*	*egenskap*
a buggy	lastenvaunu	barnvagn
a joint	tässä: nivel	led
a valve	tässä: läppä	ventil, här: klaff
aerospace	ilmailu	luftfart
to rely on	luottaa, turvautua	lita på
engineering	tekninen suunnittelu	teknisk planering
superior	ylivertainen	överlägsen
durable	kestävä	hållbar
cost-effective	edullinen	förmånlig
convenient	*mukava*	*behaglig*
an insulator	*eriste*	*isolator*
flexible	*joustava*	*flexibel*
adaptable	helposti muokattava	formbar
capable of reuse	käytettävissä uudelleen	möjlig att återanvända

Activity One

to conduct	johtaa sähköä	leda elektricitet
transparent	läpinäkyvä	genomskinlig
to increase	*lisätä, lisääntyä*	*öka*
an advantage	*etu*	*fördel*
to rust	ruostua	rosta
jagged edges	teräviä reunoja	ojämna och vassa kanter
to pose	aiheuttaa	innebära, medföra
a hazard	vaaratekijä	fara, risk
to dispose of	hävittää	göra sig av med
litter	roska	skräp, avfall
a safeguard	suojakeino	skyddsåtgärd
resistant	kestävä	hållbar

Activity Two

developing	kehitys-	utvecklings-
to waste	*hukata*	*gå till spillo*
a consumer	kuluttaja	konsument
packaging	pakkaus	förpackning
a factor	tekijä	faktor
a shape	muoto	form
protection	suoja	skydd
expanded polystyrene	EPS, vaahdotettu polystyreeni, "styrox"	EPS,expanderad polystyren, "styrox"

an alternative	vaihtoehto	alternativ
corrugated cardboard	aaltopahvi	wellpapp
an investigation	*tutkimus*	*undersökning*
to compare	verrata	jämföra
effectiveness	tehokkuus	effektivitet
penetration	lävistäminen, tunkeutuminen	genomträngande, penetration
a screwdriver	ruuvimeisseli	skruvmejsel
quantity	määrä	mängd
fair	tasapuolinen	rättvis, jämn
bubble-wrap	kuplakalvo	bubbelfilm
delicate	hauras	känslig, ömtålig
crockery	saviastiat	lerkärl
a shell	kuori	skal

Activity Three

suggest	*tässä: mieti, pohdi*	*föreslå, fundera på*
a jet aircraft	suihkukone	jetplan
the cost of running	käyttökustannukset	driftskostnader
in terms of	(jonkin) suhteen	i förhållande till, här: med hänsyn till att
to depend on	*riippua*	*bero på*
to ensure	varmistaa	garantera
an impact	vaikutus	inverkan
card	kartonki	kartong
a container	*astia, säiliö*	*kärl, behållare*
to measure	mitata	mäta
to contain	*sisältää*	*innehålla*
a chart	kaavio, taulukko	tabell, diagram
to take up	viedä	upptaga, utgöra
a warehouse	varasto	lagerbyggnad
storage	varastohuone	lager
checkout	kassa	kassa
an advantage	*etu*	*fördel*
a disadvantage	haitta	nackdel
to summarise	tehdä yhteenveto	sammanfatta, summera
environmental issues	ympäristökysymyksiä	miljöfrågor

Activity Four

a beaker	malja, pikari	bägare
a vending machine	automaatti	varuautomat
an extent	määrä, laajuus	nivå, grad
a rate	nopeus	hastighet
a power supply	virtalähde	strömkälla
to replace	korvata	ersätta

an additive	lisäaine	tillsatsämne
required	vaadittava	nödvändig
to create	luoda	skapa

pigments	väriaineet	pigment
an impact	isku	stöt, slag
a modifier	tässä: vaimentava aine	modifierare
a plasticizer	pehmitin	mjukgörare
anti-static	sähköisyyttä vähentävä	anti-stat
an agent	tässä: aine	här: ämne, medel
to reduce	vähentää	minska, reducera
to adhere	tarttua	fastna
due to	takia	på grund av
an absorber	tässä: vaimennin	absorberare, dämpare
decomposition	hajottaminen	sönderfall
stabilizers	stabilisaattorit	stabilisatorer
to prolong	pidentää	förlänga
flame retardants	palonestoaineet	flamhämmare
flammability	syttyvyys	brännbarhet
fillers	täyteaineet	fyllnadsmedel
rigidity	jäykkyys	styvhet
inert	eloton	overksam
chalk	liitu	krita
clay	savi	lera
blowing agents	vaahdotusaine	jäsmedel
to release	vapauttaa, vapautua	frigöra
nitrogen	typpi	kväve
carbon	*hiili*	*kol*
a mould	*muotti*	*form*
to prevent	estää	förhindra
oxygen	*happi*	*syre*

resources	luonnonvarat	resurser
manufacture	*valmistus*	*tillverkning*
processing	*jalostus*	*behandling, förädling*
an amount	määrä	mängd
to require	vaatia	behöva, kräva

versatility	tässä: monikäyttöisyys	mångsidighet
a wrapping	*kääre*	*förpackning*

5 THE ENVIRONMENTAL IMPACT

environmental impact	ympäristövaikutus	inverkan på miljön
to relate to	liittyä	hänga ihop med
contribution	panos, vaikutus	bidrag
global warming	kasvihuoneilmiö	jordens uppvärmning
depletion	kuluttaminen, vähentyminen	förbrukning
finite	rajallinen	ändlig, begränsad
resources	*luonnonvarat*	*naturresurser*
to take into account	ottaa huomioon	ta med i beräkningen
a factor	tekijä	faktor
proper	asianmukainen	ordentlig, riktig
sound	järkevä	bra, vettig
a decision	päätös	beslut
cradle-to-grave	kehdosta hautaan	vaggan till graven
life-cycle	elinkaari	livs-cykel

an input	panos, syötös	tillförsel
an output	tulos	resultat, effekt
acquisition	hankinta	förvärvande, utvinning
manufacturing	*valmistus*	*tillverkning*
processing	*jalostus*	*förädling, bearbetning*
formulation	muotoilu	utformning
an effluent	päästö	utsläpp
distribution	jakelu	distribution
transportation	kuljetus	transport
airborne emissions	ilmansaasteet, päästöt	luftföroreningar
re-use	*uudelleenkäyttö*	*återanvändning*
maintenance	huolto, ylläpito	service
solid	*kiinteä*	*fast*
recycling	*kierrätys*	*återvinning*
waste management	jätehallinta	avfallskontroll
a stage	*vaihe*	*stadium, nivå*

Activity One

a diagram	*kaavio, piirros*	*diagram, schema*
to compare	*verrata*	*jämföra*
expanded polystyrene	*EPS, vaahdotettu polystyreeni, "styrox"*	*EPS, expanderad polystyren, "styrox"*
to consume	kuluttaa	konsumera, förbruka
steam	höyry	ånga
data	tiedot	uppgifter
a guideline	ohje, ohjeisto	riktlinje
practice	käytäntö, toimintatapa	beteende

economic issues	taloudelliset näkökohdat	ekonomiska aspekter
a flow diagram	vuokaavio	flödesdiagram
an item	esine	produkt
disposal	*hävittäminen*	*kasta bort, förstöra*
combustion	polttaminen	förbränning
recovery	hyödyntäminen, talteenotto	återvinning
treatment	*käsittely*	*behandling*
a landfill	kaatopaikka	avstjälpningsplats
a sketch	luonnos	skiss
to add	lisätä	tillsätta
artwork	kuvitus	teckning
to label	merkitä, tekstittää etiketter	uppmärka, förse med

Use of raw materials

crude oil	*raakaöljy*	*råolja*
limited	rajallinen	begränsad
steadily	tasaisesti	stadig
efficient	tehokas	effektiv

Savings during use

an extent	*määrä, laajuus*	*utsträckning*
to encourage	rohkaista	uppmuntra
an incentive	houkutin, kannustin	sporre
a refund	korvaus, hyvitys	ersättning
to reduce	*vähentää*	*minska*
to research	tutkia	undersöka, forska
to achieve	saavuttaa	uppnå

Activity Three

a percentage fall	prosentuaalinen pudotus	procentuell minskning
reduction	*väheneminen, vähentäminen*	*minskning*
refill pouches	täyttöpussit	refill-påsar, påsar för påfyllning
a concentrate	tiiviste	koncentrat
required	*vaadittava*	*som behövs*

Waste Issues

domestic waste	kotitalousjäte	hushållsavfall
a proportion	osuus	proportion, andel
card	*kartonki, pahvi*	*kartong*

Activity Four

a range	piiri, ala, sarja	här: antal
automotive	autoilu-, liikenne-	bil-, trafik-
distributive	jakelu-	distributions-
construction	rakennus-	byggnads-
to extract	ottaa talteen	utnyttja
suggest	*tässä: mieti*	*föreslå, fundera på*
industries	toimiala, teollisuudenhaara	industrigrenar

6 DEALING WITH WASTE

reduction	*väheneminen*	*nedskärning, minskning*
to recover	hyödyntää, palauttaa käyttöön	utnyttja, återvinna
combustion	*polttaminen*	*förbränning*
disposal	*sijoittaminen, hävittäminen*	*deponering, slutförvaring*
a landfill	*kaatopaikka*	*avstjälpningsplats*

Recycling

recycling	*kierrätys*	*återvinning*
to encourage	*suositella, rohkaista*	*uppmuntra*
sorting	lajittelu	sortering
to remove	poistaa	ta bort
a label	etiketti	etikett
contents	sisältö	innehåll
agriculture	maatalous	lantbruk
automotive	*autoilu-, liikenne-*	*bil-, trafik-*
construction	*rakennusteollisuus*	*byggnadssektorn*
to separate	lajitella, erotella	separera, sortera
multi-layer	monikerros-	flerskikts-

Activity One

suggest	*tässä:mieti, pohdi*	*föreslå, fundera på*
thermosetting	*kertamuovi*	*härdplast*
thermoplastic	*kestomuovi*	*termoplast*
to remain	*jäädä*	*förbli*
a container	*astia, säiliö*	*kärl, behållare*
a purpose	*tarkoitus*	*ändamål*
an item	*esine*	*produkt*
a lid	kansi	lock

an element	alkuaine	grundämne
chlorine	*kloori*	*klor*
density	*tiheys*	*densitet*
a charge	sähkövaraus	elektrisk laddning

Activity Two

a liquid	*neste*	*vätska*
to take into account	*ottaa huomioon*	*ta med i beräkningen*
design	*suunnittelu*	*planering, konstruktion*
a stage	*vaihe*	*stadium*
a recommendation	suositus	rekommendation
an ink	painoväri	tryckfärg
a demand	kysyntä	efterfrågan
to match	vastata	motsvara
a supply	tarjonta	utbud
storage	*varasto, varastointi*	*lager*
profitability	kannattavuus	lönsamhet
to reduce	*vähentää*	*minska*
public opinion	yleinen mielipide	allmän åsikt

Feedstock recycling

feedstock recycling	raaka-ainekierrätys kemianteollisuuteen	kemisk åtevinning
a potential	mahdollisuus	möjlighet
to unzip	tässä: purkaa	bryta upp
pyrolysis	pyrolyysi	pyrolys
a vacuum	tyhjiö	vakuum
gaseous	kaasumainen	i gasform
a hydrocarbon	*hiilivety*	*kolväte*
hydrogenation	hydraus	hydrering
hydrogen	*vety*	*väte*
gassification	kaasuuntuminen	förgasning
chemolysis	kemolyysi	kemisk omvandling

Activity Three

to summarize	*tiivistää, tehdä yhteenveto*	*sammanfatta*
a flow diagram	vuokaavio	flödesschema
to distinguish	erotella	särskilja, skilja på
a factor	*tekijä*	*faktor*
a benefit	etu	fördel, nytta

Energy from waste

reduction	*vähentäminen*	*minskning, reduktion*
lignite	ruskohiili	brunkol
equivalent	vastaava	motsvarande
combustible	*palava*	*brännbar*
to release	*vapauttaa, luovuttaa*	*frigöra*

Activity Four

domestic waste	*kotitalousjäte*	*hushållsavfall*
a district	alue, tässä: kaukolämpö-	distrikt, område, här: fjärrvärme
to incinerate	polttaa	förbränna
to level	suunnata	rikta
acid rain	happosade	surt regn
acidity	happamuus	försurning
to calculate	laskea	beräkna

a life-cycle	*elinkaari*	*livs-cykel*

Degradability

degradable	hajoava	nedbrytbar
an application	sovellus	tillämpning
a suture	ommel	suturtråd
a film	*kalvo, kelmu*	*plast-film, här: fiberduk*
to improve	parantaa	förbättra
a crop	sato	gröda, skörd

Landfill

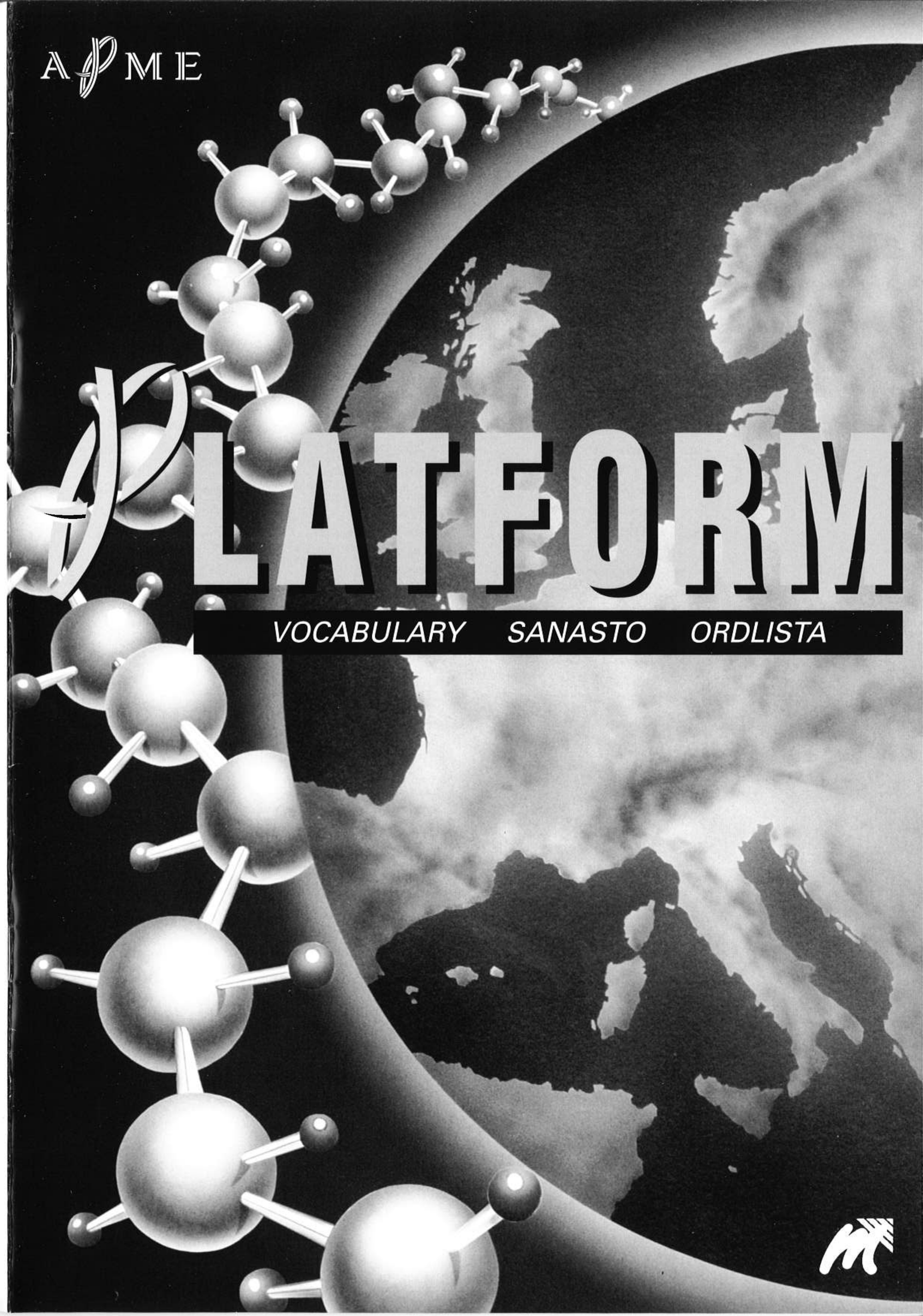
to dispose of	*sijoittaa, hävittää*	*kasta bort, här: deponeras*
a quarry	louhos	stenbrott
a clay pit	savikaivanto	lerschakt
an eye-sore	silmätikku	nagel i ögat
to restore	korjata, palauttaa entiselleen	reparera, återställa
gigantic	jättimäinen	gigantisk
a fibre	*kuitu*	*fiber*
concentrated	tiivistetty, väkevöity	koncentrerad
sewage	jätevesi	avloppsvatten
to seep	tihkua	sippra
a supply	varasto	lager, utbud, här: grundvatten
to line	vuorata	beklä, fodra
carbon	*hiili*	*kol*
explosive	räjähdysaltis	explosiv

Activity Five

an advantage	*etu*	*fördel*
a disadvantage	*haitta*	*nackdel*
an emission	*päästö*	*utsläpp*

legislation	lainsäädäntö	lagstiftning
to predominate	vallita	dominera
to affect	vaikuttaa	påverka

Painotalo Miktor Helsinki



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Muovimateriaalit ovat erottamaton osa yhteiskuntaa nyt ja tulevaisuudessa. Muovit ovat mukana ihmisen elämässä lastenrattaista lumilautaan ja legopalikoista CD-soittimeen. Monia kehittyneitä tuotteita ei voitaisi valmistaa ilman muovia. Muovia tarvitaan niin tekoniveliin ja -sydänläppään kuin useisiin kulkuneuvoihin polkupyörästä avaruusaluksiin.

Tässä peruskoulun yläasteelle ja lukion ensimmäiselle vuosikurssille suunnatussa opetuspaketissa kerrotaan muoveista englanninkielellä. Platform-opetuspaketti sopii hyvin kemian ja englannin yhdistävään opetukseen, mutta paketista löytyy materiaalia myös muiden oppiaineiden tunneille. Opetuspakettia voi käyttää esimerkiksi keskusteltaessa uusista materiaaleista, ympäristöstä tai jätekysymyksestä.

Platform-paketin rungon muodostavat kuusi englanninkielistä aihekorttia, jotka tarkastelevat muoveja raaka-aineista ympäristövaikutukseen. Englanninkielisten aihekorttien tukena on sanasto englannista suomeen ja ruotsiin sekä opettajille tarkoitettu ohjeisto. Lisäksi pakettiin kuuluu suomenkielisiä ohjeita laboratoriotöitä varten.

APME
ASSOCIATION OF PLASTICS MANUFACTURERS IN EUROPE

SUOMEN MUOVITEOLLISUUSLIITTO
FINSKA PLASTINDUSTRIFÖRBUNDET