Products from Petroleum

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Lesson Plan – Page 1

Secondary Pupils

Topic: Polymers and materials from oil

Topic Overview: Petroleum is part of our daily lives. Many products such as nylon, plastics, and rubber come from petroleum-based polymers.

Activity Overview: Pupils will investigate the processes involved in the formation of oil and oil-based products through 3 interactive activities which can be carried out over several days.

Core Experience and Outcome:

SCN 3-15b: Having contributed to a variety of practical activities to make and breakdown compounds, I can describe examples of how the properties of compounds are different from their constituent elements.

SCN 4-17a: I have explored how different materials can be derived from crude oil and their uses. I can explain the importance of carbon compounds in our lives.

Learning Intention:

I am learning how petroleum-based polymers make up many different products.

Success Criteria:

I can identify products that come from petroleum-based polymers.

Resources

Hydrocarbons Handout

Hydrocarbons Worksheet

Polymer Power Handout

How Much is a Litre Worksheet

Book Reference:
Oil and Natural Gas, pages 44-49

Materials per Group Activity 2:

- Molecule assembly set (can be purchased or simply a mix of marshmallows, gumdrops and cocktail sticks.)

Materials per Group Activity 3:

- PVA glue
- Borax solution
- Plastic cup
- Stirring stick

Key Vocabulary

Hydrocarbon: compounds made up of carbon and hydrogen. Hydrocarbons called alkanes are the simplest hydrocarbons. These compounds are named by using a prefix that tells the number of carbon atoms they contain and the root –ane.

Monomer: a relatively light, simple organic molecule that can join in long chains with other molecules to form a more complex molecule or polymer

Polymer: a huge, chain-like molecule made by combining many small molecules called monomers.

Petroleum: A liquid mixture of hydrocarbons that is present in suitable rock strata and can be extracted and refined to produce fuels.

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Teacher Information:

Read to pupils from Oil and Natural Gas, pages 44-45:

Oil is the world's top energy source, and over 80 percent of all the oil produced is used to provide energy to keep the world moving. Oil's energy is unlocked by burning it, which is why it can only ever be used once. A little is burned to provide heat for homes. A lot is burned to create steam to turn turbines and generate electricity. But most is burned in engines in the form of gas (petrol), diesel, maritime fuel oil, and aviation fuel for transportation. It takes 30 billion barrels of oil each day to keep all our cars and trucks, trains, ships and aircraft on the move.

pages 46-47:

Oil is not just a source of energy-it is also a remarkable raw material. Its rich mix of hydrocarbons can be processed to give useful substances known as petro-chemicals. Processing usually alters the hydrocarbons so completely that it is hard to recognize the oil origins of petrochemical products. An amazing range of materials and objects can be made from petrochemicals, from plastics to perfumes and bed sheets. We use many oil products as synthetic alternatives to natural materials, including synthetic rubbers instead of natural rubber, and detergents instead of soap. But oil also gives us entirely new, unique materials such as nylon.

pages 48-49:

Plastics play an incredibly important part in the modern world. They find their way into our homes in many different ways and forms, from boxes used to keep food fresh to TV remote controls. Plastics are essentially materials that can be heated and moulded into almost any shape. They have this quality because they are made from incredibly long, chainlike molecules called polymers. Some plastic polymers are entirely natural, such as horn and amber. But nearly all the polymers we use today are artificially made, and the majority of them are produced from oil and natural gas. Scientists are able to use the hydrocarbons in oil to create an increasing variety of polymers – not only for plastics, but also to make synthetic fibres and other materials.

Additional Information:

The most used by-product of crude oil is gasoline (petrol); however, today more than 6,000 products are produced wholly or in part, from petroleum. These products contain polymers.

A polymer is a huge, chain-like molecule made by combining many small molecules called monomers. A wide variety of polymers are obtainable because they can be made from different kinds of monomers, and monomers can be put together in many different ways to form polymers. They may be flexible or rigid, transparent or opaque, heat resistant or not, waterproof or water-soluble, electrical insulators or conductors, hard or soft, and elastic or not.

Nearly all the materials that make up living organisms involve polymers. These include such things as bone, cartilage, tendons, hair, enzymes, certain hormones, DNA, cotton, wool, wood and latex from rubber trees. These are called natural polymers.

Synthetic polymers made from petroleum are becoming more and more a part of our daily lives. We encounter these substances constantly in everything from plastic soda bottles to foam polystyrene cups to disposable nappies. Synthetic polymers are used to manufacture such a variety of items because chemists are able to design products with the specific properties required.

Establishing Prior Knowledge

- What is a molecule?
- What is a polymer?
- What are plastics made from?

Concept Introduction

Petroleum is part of our daily lives. Many products such as nylon, plastics, and rubber come from petroleum-based polymers. Scientists have been able to develop polymers with many different properties.

Elicitation Activity

Ask pupils to write down everything they see around the room that they think is made from petroleum. After 5 minutes, ask pupils to share some of the objects they have listed. Can they think of any other objects made from petroleum aside from those in the room? Explain that the following activities will help them recognise that there are many objects made from petroleum that we use in our daily lives.

Activity 1: Polymer Play

1. Ask for eight volunteers to demonstrate the concept of 'cross-linking.' Each volunteer represents a 'monomer' – one unit.

2. Ask the monomers to move freely around the room.

3. Ask the monomers to create two groups of four with each group of four joining hands to form a line which represents two short segments of a polymer chain. Explain that 'poly' means many and 'mer' means unit, thus a 'polymer' is many units linked together.

4. Allow each polymer chain to move around the room with hands linked. Point out that they can move relatively freely.

5. Explain that some polymer chains contain cross-linkers that connect the polymer chains together. Ask a ninth volunteer to act as a 'cross-linker' by holding the arm of one monomer in the middle of each of the polymer chains.

6. Ask the polymers to move around the room.

7. Prompt class discussion by asking the following questions: When was the polymer movement least restrictive? When was the polymer movement most restrictive? Were the polymers still able to move when the cross-linker was added? What does this activity tell us about the characteristics of polymers?

8. Pass out the 'Polymer Power' handout and discuss the items that pupils did not realise came from petroleum.

9. After discussing the 'Polymer Power' handout, read to pupils from *Oil and Natural Gas* 44-49.

Activity 2: Molecular Models

1. Split pupils into small groups and provide them with a copy of the Hydrocarbons handout to read.

2. Provide each group with a molecule assembly set (can be purchased or simply use a mix of marshmallows, gumdrops and cocktail sticks) and a Hydrocarbons worksheet.

3. Once the worksheet is completed, go over the answers.

4. Challenge pupils to build models of various hydrocarbons with their modelling set. Call out the name of a hydrocarbon and see which group can build it correctly the fastest.

Activity 3: Making Slime

This activity looks at altering an existing polymer by creating cross links. This dramatically alters the properties of the material.
You will need PVA glue, and Borax (buy online).

1. Stir 16 g borax into 500 ml warm water. It's okay if some borax remains un-dissolved. Allow solution to cool to room temperature.

2. Introduce PVA as the polymer you are going to use. This should be recognisable as glue to most pupils.

3. Pour the PVA into a plastic cup to a depth of approximately 3 cm. Add three drops of food colouring. **NB** – too much food colouring affects the consistency of the slime.

4. Stir while adding borax solution to the mixture a few drops at a time. This creates cross links between the long polymer molecules. Stir in the Borax and add a little more if necessary to get a good slime consistency. Too much Borax will make the mixture too runny.

5. The material can be stretched, broken, moulded and can be stored in a sealed plastic zip lock bag for later use. **NB**- you can further alter the properties of the 'slime' by adding a few drops of a starch solution (flour in water).

Safety: Wash hands after use, wear safety goggles; and gloves if sensitive skin.

Extension Ideas:

- Complete '**How much is a litre?**' activity using worksheet provided.

Home Links

- Challenge pupils to keep a Petroleum Products Diary for one day or even one hour, recording all of the petroleum products that they use during the specified time.

Hydrocarbons

Handout

Secondary Pupils

Oil and natural gas are naturally occurring hydrocarbons. Two elements, hydrogen and carbon make up a hydrocarbon. Hydrogen and carbon have a strong attraction to each other. As a result, they form many compounds.

Once purchased, the oil is taken to a refinery. At the refinery, crude oil is distilled and separated into its components or fractions. Distillation involves heating the petroleum until it boils. The vapour rises through the towers where it cools and condenses. The different hydrocarbon components that make up petroleum vaporise at different temperatures; thus when they are condensed, they separate out into different fractions. The fractions represent the diverse range of products that can be obtained from petroleum. The simplest hydrocarbon is methane. It has one atom of carbon and four atoms of hydrogen. Under normal pressure and temperature, methane is a gas. Methane is the main component of natural gas.

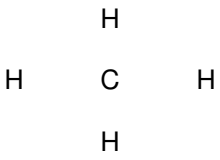
Ethane, propane and butane often occur with natural gas. Ethane is a liquefied petroleum gas (LPG), but LPGs are mainly propane and butane. When propane and butane are compressed at a normal temperature, they liquefy. When the pressure is released they turn into a gas; therefore, they can be used as portable fuel. LPG travels in a pressurised container as a liquid. When connected to a stove's burner and the pressure is released, LPG changes into a gas.

Hydrocarbons with more carbon and hydrogen atoms than propane and butane may be liquid or solid under normal conditions. Gasoline is a mixture of several hydrocarbons that are liquid under normal conditions. Crude oil is also a mixture that usually occurs as a liquid.

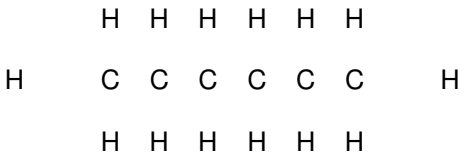
Tars and asphalts are solid hydrocarbon under normal conditions. Raising the temperature liquefies them. When a roofer heats tar, it liquefies and binds gravel or other roofing materials into a spreadable mixture. When it cools back to normal temperature, it solidifies to form a waterproof surface.

The chemical structure of two hydrocarbons is shown below.

Methane (CH_4 -simplest hydrocarbon)



Hexane (C_6H_{14})



Naming Hydrocarbons

Hydrocarbons called alkanes are the simplest hydrocarbons. These compounds are named by using a prefix that tells the number of carbon atoms they contain and the root -ane.

Prefix	# of Carbon Atoms	Use
Meth-	1	Natural gas, bottled fuel gas
Eth-	2	Natural gas, bottled fuel gas
Prop-	3	Natural gas, bottled fuel gas
But-	4	Natural gas, bottled fuel gas
Pent-	5	Solvent, paint thinner, cleaner
Hex-	6	Solvent, paint thinner, cleaner
Hept-	7	Motor fuel, solvent
Oct-	8	Motor fuel, solvent
Non-	9	Kerosene, diesel fuel, jet fuel, cracking stock
Dec-	10	Kerosene, diesel fuel, jet fuel, cracking stock

Polymer Power

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Handout

Secondary Pupils

Artificial Hearts
Aspirin
Baby Bottles
Baby Rattles
Balloons
Bandages
Basketballs
Bicycle Hand Grip
Blenders
Book Bags
Bubble Gum
Bubble Packing
Buttons
Cameras
Candles
Car Batteries
Carpet
CD Players
Ceiling Light Covers
Cellophane Tape
Chair Seats
Clarinets
Cleats
Clothing
Coasters
Coffee Mugs
Combs
Compact Discs/DVDs
Computers
Contact Lenses
Containers
Crayons
Credit Cards
Dashboards
Dentures
Deodorant
Digital Clocks
Disposable Diapers
Disposable Razors
Dyes
Earphones
Egg Cartons
Electrical Tape
Epoxy Glue
Erasers
Exercise Mats
Extension Cords
False Teeth
Fan Belts
Fertilizers
Fishing Bobbers
Fishing Line
Flea Collars
Floor Mats
Floor Wax
Flower Pots
Flutes
Food Preservatives
Food Storage Containers
Food Wraps
Football Pads and balls
Furniture Polish
Galoshes
Garbage Bags
Glasses
Glue
Golf Balls
Guitar Strings
Hair Dryers
Hair Spray
Hang Gliders
Hearing Aids
Helmets
Hockey Pucks
Ice Chests
Ice Cube Trays
Ink
Insecticides
Insulated Foam Cups
Insulation
Lawn Chairs
Life Jackets and Rafts
Lipstick
Luggage
Lunch Boxes
Mannequins
Measuring Tapes
Medical Equipment
Medicines
Milk Jugs
Model Cars/Airplanes
Movie Film
MP3 Players
Pacifiers
Paint and Paint Brushes
Panty hose
Parachutes
Particle Board
Patio Screens
Pencil Cases
Pens
Perfumes
Photographic Film
Photographs
Piano Keys
Ping Pong Balls
Plastic Bags
Plastic Cups
Plastic Eating Utensils
Playing Cards
Portable Radios
Protractors
Raincoats
Reflectors
Refrigerators
Roller Blades
Roofing
Rubber Bands
Rubber Ducks
Rubber Gloves
Rubber Tubing
Rulers
Safety Glasses
Sails
Seat Cushions
Shampoo Bottles
Shaving Cream
Shoe Soles
Shoestring Tips
Shrink Wrap
Skateboard Wheels
Snorkels
Soft Contact Lenses
Sponges
Sun Visors
Sunglasses
Surfboards
Sweaters
Swim Fins
Synthetic Fabrics
Table Tops
Tackle Boxes
Telephones
Tennis Balls
Tennis Racquets
Tents
Thermos Bottles
Tights
Tile
Tires
Toothbrushes
Toothpaste
Toys
Trash Cans
Umbrellas
Velcro®
Vinyl Siding
Vitamin Capsules
Volleyballs and nets
Waders
Watch Faces
Water Pipes
Wet Suits
Whistles
Wigs
Windbreakers
Windshield Wipers
Zippers

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Hydrocarbons

1 A hydrocarbon is a compound made from carbon and hydrogen only.

a Which of the following compounds is **not** a hydrocarbon? Circle the correct answer.

CH_4 C_2H_4 C_2H_6 C_2H_5OH C_3H_8

b Explain your answer.

_____

_____

Alkanes

2 There is a set of hydrocarbons called **alkanes**. Their names all end in –ane.

a Use classroom resources to complete the table below.

alkane	methane	ethane		butane
formula			C_3H_8	

b Do you notice a pattern? _____

c What would the formula of the next alkane be? _____

3 Use molecular models to make each of the four alkanes in the table.

Alkenes

4 There is another set of hydrocarbons called **alkenes**. Their names all end in – ene.

Which of the following compounds is **not** an alkene? Circle the correct answer.

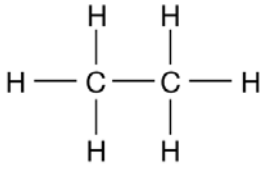
propene ethene butene pentene methane

Alkanes and alkenes

1 Alkanes are hydrocarbons which contain single covalent bonds only.

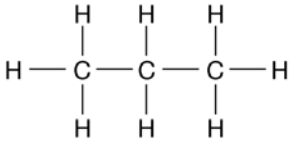
The displayed formula of an alkane shows these bonds:

ethane



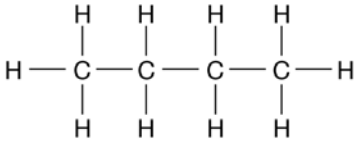
Name the following alkanes from their displayed formulae.

a



Name _____

b

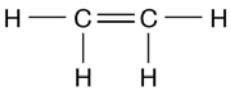


Name _____

2 Alkenes are hydrocarbons which contain one or more double covalent bond(s) between carbon atoms.

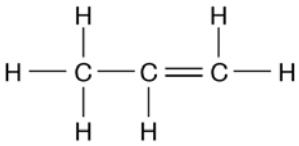
Name the following alkenes from their displayed formulae.

a



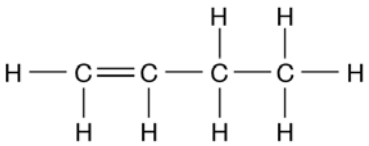
Name _____

b



Name _____

c



Name _____

Hydrocarbons

1 a C_2H_5OH

b C_2H_5OH has an oxygen atom in the formula so it cannot be a hydrocarbon, which contain carbon and hydrogen atoms only

2 a

alkane	methane	ethane	**propane**	butane
formula	**CH_4**	**C_2H_6**	C_3H_8	**C_4H_{10}**

b There is a pattern. The carbon atoms (C) increase by one each time; the hydrogen atoms (H) increase by two each time

c C_5H_{12}

4 Methane

Alkanes and alkenes

1 a Propane

b Butane

2 a Ethene

b Propene

c Butene

How much is a litre?

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Secondary Pupils

We use petrol everyday. It helps us get to school and work. It helps us get our groceries and clothes. But how is the price of a litre of petrol determined? Since petrol is refined from crude oil, you may think that the price of crude oil is what determines the price of petrol. But there are more factors than that involved.

According to the US Department of Energy, only about 58% of the price of petrol is determined by crude oil prices. Approximately 15% of the cost is due to taxes. About 27% of the cost is due to the cost of refining, distributing, and marketing the petrol.

Before complaining about the latest price increase in a litre of petrol, compare it with other products with which you are familiar. Try comparing the amount and price of petrol to the amount and price of other substances. You might just be amazed at what you pay for everyday, commonly used products such as:

Shampoo	Bottled Water	Coffee
Tomato Ketchup	Paint	Mouthwash

You may know the price of these items in the units in which they are sold. What are their prices if you convert their units to that of a litre?

1. How much is the current cost per litre of petrol? _____

HINT: Use a website like http://www.theaa.com/motoring_advice/fuel/ (which will give you the price in pence per litre (simply divide by 100 to get the price in pounds) or http://www.petrolprices.com/ (which will give you the highest and lowest cost for fuel in your area).

2. How much is the cost PER LITRE of common household liquids? Fill in the prices for the items listed and then choose some of our own to convert to complete the table.

HINT: Use the website of a local supermarket. Remember, 1ml = 1/1000th of a litre.

Item	Price per litre
Whole milk	
Caesar salad dressing	
Shampoo	
Hand wash	
Lemonade	