ACADEMIC YEAR 2020-21

NOTES 1

CH: 2 ENERGY AND THE ENVIRONMENT

GRADE: 10 SUBJECT: EVM

NAME: ROLL NO:

Fossil fuel formation:

Fossil fuels:

- The natural resources such as crude oil, natural gas and coal are formed from the **remains** of plants and animals that died millions of years ago.
- Fossil fuels are non-renewable.
- They took a very long time to form and we are using them up faster than they can be replaced - once they have all been used up, they cannot be replaced.
- Fossil fuels are also **finite resources**.
- They are no longer being made or are being made extremely slowly.

How crude oil and natural gas were formed

- Millions of years ago, huge numbers of microscopic animals and plants - plankton or sea creatures died and fell to the bottom of the sea.
- Their remains were covered by (layers of) mud.
- As the mud sediment was buried by more sediment, it started to change into rock as the temperature and pressure increased.
- The plant and animal remains were altered chemically by this process, and slowly changed into crude oil and natural gas.
- requires anaerobic conditions
- The oil moved upwards through the spaces in permeable rock.
- It became trapped if it reached impermeable rock.
- **Oil companies** can drill down through the impermeable rocks to get it out.
- They are then able to turn it into products we can use, such as **petrol** and **diesel**.

Formation of a coal

- Coal was formed from dead plants about 300 million years ago.
- Tectonic activity raises sea levels, covering and killing vegetation.
- When the plants died, they settled to the bottom of swamps or on sea beds
- Plant debris accumulates and is buried under layers of mud and sand in a process known as sedimentation.
- This protects the debris from the air and slows down the decomposition process
- Protecting from air – this process is anaerobic (lack of oxygen)
- Formed a thick layer of **peat**
- The sedimentary basin gradually sinks under the weight of the sediments, and the layers of dead plants are subjected to rising temperatures that gradually "cook" them, leading to their transformation.
- Pressure and heat over millions of years turned plant remains (vegetation) to **coal**

Energy resources classification

Energy resources as **non-renewable or renewable**:

- renewable: biofuels (bioethanol, biogas and wood), geothermal power, hydro-electric power, tidal power, wave power, solar power, wind power

Non-renewable energy:

- Non-renewable energy resources cannot be replaced once they are all used up
- non-renewable: fossil fuels, nuclear power using uranium

Fossil fuels – coal

Advantages:

- Coal is a ready-made fuel which is cheap to mine and convert to electricity – it lasts longer than oil or gas.

Disadvantages:

- When burned, coal gives off atmospheric pollutants, including greenhouse gases.

Fossil fuels – oil

Advantages:

- Oil is a ready-made fuel which is cheap to extract and convert into energy. It is used in industry and transport.

Disadvantages:

- When burned, oil gives off atmospheric pollutants, including greenhouse gases. There is a limited supply of oil.

Fossil fuel – natural gas

Advantages:

- Gas is a ready-made fuel and relatively cheap.
- It is used in houses for heating and cooking and is a slightly cleaner fuel than coal and oil.

Disadvantages:

- When burned, it gives off atmospheric pollutants, including greenhouse gases. There is a limited supply of gas.

Nuclear fuels

- Nuclear fuels release energy through nuclear reactions, rather than through chemical reactions.
- The main nuclear fuels are **uranium** and **plutonium**.
- In a nuclear power station, the energy released is used to boil water.
- The expanding steam spins turbines, which then drive generators to produce electricity.
- Nuclear power is the fifth-largest source of electricity in India after coal, gas, hydroelectricity and wind power

Nuclear Power plants in India:

- kaiga (KA), kakrapar (GJ), kudankulam (TN), madras(kalpakam-TN), Narora (UP), Rajasthan (RJ), Tarapur (RJ)

Advantages:

- Unlike fossil fuels, nuclear fuels do not produce carbon dioxide or sulfur dioxide

Disadvantages:

- Like the fossil fuels, nuclear fuels are non-renewable energy resources.
- They will run out one day if we keep on using them.
- If there is an accident, large amounts of radioactive material could be released into the environment.
- In addition, nuclear waste remains dangerously radioactive and harmful to health for thousands of years.

- It must be stored safely.

Wind energy

- The wind is produced as a result of large movements of air, driven by energy from the Sun.
- This means that the **kinetic energy** in wind is a renewable energy resource.
- As long as the Sun exists, the wind will too.

Wind turbines:

- Wind turbines use the wind to drive turbines directly.
- They have huge blades mounted on a tall tower.
- The blades are connected to a 'nacelle', or housing, which contains gears linked to a generator.
- As the wind blows, it transfers some of its kinetic energy to the blades, which turn and drive the generator.

The main features of a wind turbine

Advantages:

- Wind is a renewable energy resource.
- There are no fuel costs and no harmful polluting gases are produced.

Disadvantages

- Wind farms are noisy and may spoil the view for people living near them.
- The amount of electricity generated depends on the strength of the wind.
- If there is no wind, there is no electricity.

Water energy

- Like the wind, water can be used to drive turbines directly.

There are several ways that water can be used. These include

- waves,

- tides, and
- Falling water in hydroelectric power schemes.

Waves

- The water in the sea rises and falls because of waves on the surface.
- Wave machines use the kinetic energy in this movement to drive electricity generators**.**

Tides

- Huge amounts of water move in and out of river mouths each day because of the tides.
- A tidal barrage is a barrier built over a river estuary to make use of the kinetic energy in the moving water.
- The barrage contains electricity generators, which are driven by the water rushing through tubes in the barrage**.**

Hydroelectric power

- Like tidal barrages, HEP stations use the kinetic energy in moving water.
- But the water usually comes from behind a dam built across a river valley.
- The water high up behind the dam has a lot of gravitational potential energy.
- This is transferred to kinetic energy as the water rushes down through tubes inside the dam.
- The moving water drives electrical generators, which may be built inside the dam.

Advantages

- Water power in its various forms is a renewable energy resource.
- There are no fuel costs and no harmful polluting gases are produced.
- Tidal barrages and hydroelectric power stations are very reliable and can be easily switched on.

Disadvantages

- It has been difficult to scale up the designs for wave machines to produce large amounts of electricity.
- Tidal barrages destroy the habitats of estuary species, including wading birds.
- Dams flood farmland and push people from their homes.
- The rotting vegetation underwater releases methane, which is a greenhouse gas.

Geothermal energy

- Hot water and steam from deep underground can be used to drive turbines. This is called geothermal energy.

Volcanic areas

- Several types of rock contain radioactive substances such as uranium.
- These release energy, which warms up the rocks.
- In volcanic areas, the hot rocks heat water, and this may rise to the surface naturally as hot water and steam.
- Here the steam can be used to drive turbines and electricity generators.

Hot rocks

- In some places, the rocks are hot, but no hot water or steam rises to the surface.
- In this case, deep wells can be drilled down to the hot rocks and cold water pumped down.
- The water runs through cracks in the rocks and is heated up.
- It returns to the surface as hot water and steam.

Advantages

- Geothermal energy is a renewable energy resource.
- There are no fuel costs and no harmful polluting gases are produced.
- The hot water and steam can be used to heat buildings directly
- Used successfully in some countries, such as New Zealand and Iceland.

Disadvantages

- Most parts of the world do not have suitable areas where geothermal energy can be exploited.
- Can be expensive to set up and only works in areas of volcanic activity.
- Geothermal and volcanic activity might calm down, leaving power stations redundant.
- Dangerous elements found underground must be disposed of carefully.

Solar energy

- The Sun is a renewable energy resource.
- As long as it exists and continues to shine, it will release energy.

Solar cells

- A solar cell is a device that converts light energy directly into electrical energy.
- Some pocket calculators use solar cells, and you may have seen large panels of solar cells on house roofs.
- You may have seen solar cells powering road signs in remote areas.
- Very large arrays are used to power satellites in orbit around Earth

Solar heating

- Do not confuse solar cells with solar panels, which use energy from the Sun to heat up water.
- These may also be put onto house roofs so that they can absorb the Sun's energy.

Advantages

- Solar energy is potentially infinite energy supply.
- There are no fuel costs and no harmful polluting gases are produced.
- Solar cells can provide electricity in remote locations where there is no mains electricity.
- Single dwellings can have own electricity supply.

Disadvantages

- Solar cells are expensive and inefficient, so the cost of their electricity is high.
- Solar cells do not work at night and not as well when it is cloudy.
- Manufacture and implementation of solar panels can be costly.

Biofuels – biomass

- It is generated from decaying plant or animal waste, or organic material and can be burned to provide energy.
- It is a cheap and readily available source of energy.
- If crops are replaced, it can be a long-term, sustainable energy source.
- When burned, it gives off atmospheric pollutants, including greenhouse gases

Biofuels – wood

- Obtained from felling trees, burned to generate heat and light

Biofuels (bioethanol)

- Bioethanol is plant matter that has been fermented to produce a petrol substitute

Biofuels (biogas)

- Biogas is gas made from the decomposition of organic matter from landfill sites, plant waste or sewage waste
- The gas can be burned in thermal power stations
- biogas is produced from waste so it usually cheap
- Power stations that burn fossils fuels can be easily converted to burn biofuels
- Land given over to biofuel production – increasing food prices

Energy demand

- Energy demand is the term used to describe the consumption of energy by human activity

Energy needs:

- Nearly everything requires energy and a way to use energy is by transferring it from one energy store to another

Energy is need in:

- Homes - for cooking, heating and running appliances
- Public services, e.g. schools and hospitals - running machinery and warming rooms
- Factories and farms - operating heavy-duty machines and production chains
- Transport - buses, trains, cars and boats all need a fuel source and some trains and trams connect to an electricity supply
- However, producing and distributing electricity can cause damage to the environment.
- Releasing energy from some stores causes pollution and harmful waste products.
- Burning fossil fuels releases carbon dioxide, adding to the greenhouse effect, and sulphur dioxide which causes acid rain.

There is a range of factors that affect the demand for energy across the world:

- domestic demand,
- industrial demand,
- transport,

- personal and national wealth, and
- climate

Domestic demand:

At home we are using increasing amounts of energy to power, light and heat our homes

Domestic demand is made up of the following:

- Heating
- Cooling
- Water heating
- Running appliances (washers, dryers, refrigerators etc.)
- Lighting
- Electronics (computers, games consoles, TVs, DVD players, etc.)
- As levels of income increase, we purchase more products and consequently our energy consumption increases

Industrial demand:

- Globally, industrial demand uses over 50 percent of all energy consumed each year
- Much of this demand is driven by increasing levels of income and demand for consumer products

The main areas of industrial demand come from producing the following:

- Iron and steel
- Chemicals and petrochemicals
- Metals
- Paper
- Food machinery
- Minerals
- Many of these products go on to be assembled into finished goods that consume yet more energy in production.
- If the global economy grows, industrial energy consumption will also increase.

Transport:

- Humans are increasingly mobile and this, along with our demand for goods from across the world, can be seen in the rising demand for energy used in transportation, which has doubled since 1970

The main area of energy demand are:

- Shipping
- Passenger vehicles
- Road freight
- Air travel
- Rail
- The vast majority of the energy demand comes from individual cars and trucks on the road
- Globally, there are now over 1 billion cars on the road

Personal and national wealth:

- Increasing levels of personal wealth can be lead to increased demand for energy as people are likely to consume more and purchase more goods that require electricity
- They may also purchase larger houses, which need more energy to light, heat or cool them
- As increase in levels of national wealth will also lead to an increase in energy consumption as countries will build more power stations and infrastructure (schools, roads, hospitals, water pipes), all of which consume energy

Climate:

- It is also important to consider the role that weather and climate play in influencing demand for energy
- Long periods of cold weather will lead to more energy consumed to heat houses
- Conversely, a warm spell may reduce energy consumption in some countries as people will be outside more and heating their home less
- However, in hot regions nearer the equator, more energy may be consumed cooling houses with air conditioning and fans

Conservation and management of energy resources

- The rapid increase in demand for energy driven by consumption, population growth and economic development is currently being met by fossil fuels
- These finite, non-renewable energy sources will run out in the future
- Their use, while providing many benefits, causes significant environmental challenges – from climate change to water and air pollution, as well as conflicts between and within countries
- Much of the energy we use is wasted through inefficient use, so it is vital that people around the world conserve and manage energy resources
- Given the global need to reduce carbon dioxide emissions and that some countries are not energy secure, there are several key strategies being used

Key strategies being used to reduce carbon dioxide emissions

- Change the energy mix by moving to more renewable sources of energy
- Reduce consumption through use of energy efficient technology and education
- Research and develop existing and new energy sources
- Use government policy to reduce energy demand from transport

Changing the energy mix

- By shifting electricity production toward renewable energy sources, countries can reduce their demand for non-renewable energy sources
- However, this requires significant investment and not all parts of the world have the same potential for using renewable energy
- Currently, despite the obvious advantages of cleaner and renewable fuels, many of the decisions are influenced by the relative cost
- Fossil fuels are currently cheaper and easier to use, although this will not remain the case forever
- Some governments offer incentives like loans and grants to install renewable energy sources in homes, which encourage people to reduce their reliance on fossil fuels

Reducing consumption

- Houses – increasing or shifting energy supplies to a more renewable mix can take time and money, and may not be possible in some countries
- However, all countries can work on their methods of reducing consumption
- Key to this is the development of more energy-efficient technology and new building design and planning that takes into account energy use
- In some cities, large building are connected to the control rooms of the national supply grid
- These smart buildings can reduce consumption quickly to manage a sudden increase in demand elsewhere
- Reducing lighting, shutting down elevators and turning off air conditioning or heating temporarily will lead to reductions in energy consumption
- Education – reducing consumption through technological fixes is important as it takes decisions out of the hands of consumers
- However, saving energy only to keep wasting it through inefficient behaviour is still unsustainable
- This is why education is vital educating consumers about strategies to reduce consumption by changing their behaviour can lead to dramatic results
- Many schools and companies around the world are working toward reducing energy use by conducting energy audits and identifying areas that can be addressed

For example:

- Leaving lights, heating or air conditioning on in empty rooms
- Leaving electronic items like TVs, DVD players and computers on standby
- Leaving heating on, but opening windows when it feels too hot
- Leaving taps running
- Boiling too much water in a kettle

- Educating people from a young age about the need to save energy will help transform behaviours and ultimately lead to a reduction in energy use
- However, it is important to remember that the number of devices, appliances and vehicles is increasing, so although there are gains from education these could be outweighed by the number of new devices that need power
- To address this, countries must change the energy mix and develop new technologies to reduce demand alongside education programmes
- Vehicles – we have already seen that passengers vehicles are responsible for a significant amount of the global energy demand each year, as well as air pollution and congestion in cities and towns
- It is possible to make significant reductions in energy consumption by increasing the fuel efficiency of vehicles – making them go further for every litre of fuel burned
- Making cars out of lighter materials will also allow them to use less energy as the fuel taken to accelerate will be reduced
- Furthermore, taxing of older, less-efficient and more fuel-efficient vehicles, which in turn can lead to reduced energy demand
- However, all of these changes relate to cars that burn petrol, which is refined from crude oil
- It is possible to reduce energy consumption in these cars by moving toward biofuels.
- Biodiesel can be made from waste vegetable oil
- Oil is collected from factories and shops that use vegetable oil in large quantities, processed and then used to create a mixture of diesel and vegetable oil
- The resultant fuel can then be used in adapted diesel vehicles
- This reduces oil consumption but only currently operates on a small scale
- The most successful biofuel is bioethanol, which powers every light vehicle in Brazil, with a mixture of up to 22 percent ethanol (made from sugarcane) and petrol

- The USA is also a world leader in using ethanol to power vehicles
- Perhaps the most significant way of reducing oil consumption in cars is to increase the development of hybrid and electric vehicles
- Hybrid cars use a petrol engine that charges an electric power unit and the car will switch between each unit to maximise fuel consumption
- Some cars now feature kinetic energy recovery systems that collect the energy used in braking and feed it back into the power system – reducing the energy consumed
- There are also fully electric vehicles available with no petrol engine at all
- These require charging every day and use electricity, which may come from fossil fuels
- They use less energy than other cars and cause less pollution
- Increasingly charging points for electric cars are visible in towns and cities
- There is an increasing number of hybrid and fully electric vehicles on the road today

Government policy

- Obviously not everyone is driving an electric car today
- The current situation across the planet is that cities are dominated by petrol and diesel-powered vehicles
- Some cities have decided to take action to reduce the number of cars on the road
- In London, UK, there is a congestion charge for all vehicles entering a clearly marked zone
- The daily fee was designed to force people to car share, use public transport, walk or cycle to work
- This was successful, although 10 years 0n, the number of vehicles entering the city has risen to a level higher than before it was introduced.
- Without the charge it would probably be higher still
- In Singapore, the government introduced a highly successful MRT (mass rapid transit) system of underground trains that run cheaply and efficiently, alongside ERP (electronic road pricing) and a variable tax up front – making cars very expensive in encouraging greater use of public transport and reducing demand for energy

Research and development

- Another option for managing energy resources is increasing the supply of energy
- Huge sums of money are invested into both developing, new energy sources and further exploiting existing sources
- However, the success of these schemes is reduced if fossil fuel energy prices are low, as there is less incentive to make more energy due to costs of research and development
- In 2016, global oil prices were at a low of around US$100 less than in 2007
- When the price is high, looking for alternatives becomes economically viable

We are now beginning to see the impact of the high oil price in the last decade with alternative energy sources being produced:

- **Oil from tar sand in Alberta, Canada**

  Fracking:

- Fracking is the hydraulic fracturing of gas and oil rich shale rocks
- They are fractured by injecting high pressure chemicals and fluid into wells
- The shale rock fractures releasing the hydrocarbon from that location back to the surface

- Deep water oil production off the coast of Brazil
- Innovation is the development of solar panels
- Developing larger-scale wave generation schemes
- Researching methods to extract oil from deep in wells that cannot be accessed through current techniques
- In future, there will be an increasing need for engineering and scientists to develop innovative methods of energy generation to replace our reliance on fossil fuels
- There is debate and uncertainty over when they will run out, but expanding consumption of finite resource will lead to an inevitable exhaustion of supplies

Impact of oil pollution

Causes of pollution

- Global demand for oil is high, but the largest consumers of oil are not always the largest suppliers
- Sometimes the oil is in inaccessible locations, such as **deserts** or **offshore** in deep water, and often the main population centres are some distance from the oil fields and refineries
- This means that oil needs to be transport from the **source** to the refinery and from there onwards to a variety of **distribution networks**
- Oil is transported across the oceans in large **ships** or across land using **pipelines**
- From extraction to transporting to refining, there are a number of places that oil can enter marine or coastal **ecosystems** and cause significant pollution: offshore oil extraction, pipelines and shipping

Offshore oil extraction

- When oil is discovered and extraction offshore, there is a greater risk of an uncontained oil spill than on land
- Although oil rigs are fitted with safety valves that shut the well if an accident occurs, sometimes these fail
- Oil can enter marine and coastal ecosystems if the oil-well head on the seabed is damaged, and fixing these is **very challenging** and **time consuming** in deep water
- There can also be spilled when being transferred to ships or through pipelines to shore
- Oil rigs are also vulnerable to **strong winds** and there have been examples where spills have occurred following hurricanes in the **Gulf of Mexico**

Pipelines

- Oil pipelines are the most common method of transporting oil on land
- They sometimes run for several thousand kilometres, crossing a range of terrain, climates and even countries
- The largest pipelines are capable of transporting over a million barrels of oil each day along vast distances powered by **pumps** that are controlled by monitoring stations
- The pipe sometimes leak due to **corrosion**, **metal fatigue** and **human error** in construction
- They are also vulnerable to **accidental collisions** and there have been pipelines that have been attacked and disabled during conflicts – leading to oil entering the local ecosystems
- There have been hundreds of recorded pipelines spills across the world, with the largest of these in **North America**, spilling hundreds of thousands of litres of oil into nearby rivers – with devastating effects

Shipping

- Pipeline spill are more common, but oil spills caused by maritime accidents are more commonly reported in the media
- There have been a number of high-profile oil tanker spills that dumped large quantities of **crude oil** directly into the sea
- There were caused by the **weather**, **metal fatigue**, **collisions** and **navigation errors**
- The largest oil spill from tankers happened in **1979**, when two ships collided in the **Caribbean sea**, spilling **333 million litres of oil**
- However, much of the oil did not wash up onto the nearby coastline, but was carried away by **ocean currents**
- Perhaps the most widely known oil tanker spill is the **Exxon Valdez**, which in 1989 – through **human error** – ran aground in the **pristine Prince William sound** in **Alaska**, **USA**
- This oil spill comprised 42 million litres of crude oil, killing an estimated 250 000 seabirds, 2800 sea otters and 300 seals
- While not the largest spill in history, the environmental impact and clean-up efforts were massive
- The oil company was eventually ordered to pay US$500 million in damages to the locals, fishermen and businesses damaged by the disaster

The impact on marine and coastal ecosystems

- Oil floats on salt water and usually spreads out rapidly to form an **oil slick**
- Eventually the slick thins out to leave a thin sheen of oil on the water
- The oil itself is poisonous to birds, mammals and fish that come into contact with it on the surface and when it washes up onto beaches and coral reefs
- The clean-up operation can also be harmful to ecosystems due to the detergents used
- Each oil spill is different in terms of type of oil, weather conditions, location and scale

Impact of oil spills

Birds:

- Inability to fly
- Starvation
- Oil reduces the water repelling abilities of feathers meaning birds die of exposure
- Swallow oil and are poisoned
- Suffer eye irritation
- Drowning

Marine mammals:

- Skin or eye irritation
- Destroys the insulation of fur-bearing mammals, which leads to exposure
- Food sources damaged
- Chemical burns
- Choking
- Species decline inhale oil when breathing on the surface

Beaches

- Oil absorbed into beach sediment
- Accumulation of toxins in clams, crabs, shell fish - poisoning food chains
- Reduction in tourism
- Rocks coated with oil
- Plants and grasses killed
- Tar balls form on the sand
- Clean-up operations release detergents onto the beach

Coral reefs

- Oil mixed with detergents used for cleanup is more damaging to reef ecosystems
- Reduced photosynthesis slows plant growth
- Coral death or reduced growth
- Buildup of toxicity
- Coral bleaching
- Reduced fish population

Management of oil pollution

- Oil pollution has a devastating effect on ecosystems, which can take many years to recover
- Due to rising demand for oil over time, by 2013 the global oil tanker fleet comprised about 11 000 tankers weighing 490 million tonnes when empty
- Between 2000 and 2013, overall capacity increased by over 70 percent
- There are also around 500 offshore rigs that are drilling for new oil resources and countries production platforms globally

- In 2012, there were over 1.78 billion tonnes of oil transported by ship, this is significant amount of oil, so there is an increased risk of spills
- Given the environmental, economic and social costs of oil spills, there have been many attempts to develop **strategies for reducing oil spills** in marine and coastal ecosystems

MARPOL (International convention for the prevention of pollution from ships)

- In the mid-20th century, ships regularly dumped waste oil at sea with little regard for the impact
- A number of high-profile oil spills led to the development of a new international marine treaty in 1973, which was amended in 1978
- MARPOL was designed to eliminate marine pollution in the sea
- The treaty has **six sections**, each addressing a different kind of **marine pollution**
- Section one relates to **oil pollution** and specifically bans ships from releasing oil waste from engines and tanks into the sea
- Ships are now fitted with **oil discharge monitoring equipment** – a GPS tracking system than reports oil released into the sea

Double – hulled oil tankers

- MARPOL has been effective at reducing deliberate oil discharge into the sea
- The treaty also includes provisions on reducing the consequences of accidents, such as **ships running aground**, **colliding** or **sinking**
- Modern ships use **GPS** and **accurate charts** to navigate so the risk of running into rocks has been reduced, but not removed
- Collisions can also occur in busy ports and shipping lanes
- In 1992, MARPOL was updated to include regulations that require oil tankers to now be fitted with **double hulls** that protect the cargo in the event of a collision

- Furthermore, single-hulled tankers have been **phased out** and there are strict regulations on how oil should be carried, including a **ban** on carrying oil in the **front** of the ship where it is most at risk from a collision

Dealing with oil spills

- Even with new technology and international laws, accidents do happen and oil enters marine and coastal ecosystems

- Each spill is different in terms of the amount and type of oil, the environment affected and the clean-up options
- Some spills disperse naturally, but others require significant intervention to minimise the impact on ecosystems and to clean up the soil

There are several methods that are deployed in most oil spills:

- **Booms** – temporary floating barriers to oil which can prevent the oil from spreading
- These are less effective in high waves
- **Chemical dispersants** and **biological agents** – these break down oil into very small droplets, which can then biodegrade
- They are delivered by specialised boats and planes
- **Skimmers** – boats that skim(collect) spilled oil from the water's surface for processing and recovery
- **Sorbents** – materials like peat moss, which are used to absorb oil
- **Controlled burning** – a method of burning freshly spilled oil, usually while it is floating on the water surrounded by booms
- **High-pressure hoses** – for washing oil off beaches
- **Vacuum trucks** –to remove spilled oil from beaches or the water's surface