MEGA LECTURE

AQA (GCSE Notes)

Chapter 10: Using Resources

Q1. What are the main ways humans use the Earth's natural resources?
Answer: Humans use the Earth's natural resources for a variety of purposes such as producing energy (like burning fossil fuels), making materials (like metals from ores), growing food (through farming and fishing), providing water for drinking and cleaning, and constructing buildings and infrastructure (like using wood, stone, and clay). These resources support our everyday needs and industrial development.

Q2. Give two examples of natural resources used to provide shelter.
Answer: Two examples of natural resources used to provide shelter are wood and clay. Wood from trees is used for construction, furniture, and roofing. Clay can be used to make bricks and tiles. These materials have been used for centuries to build homes and buildings.

Q3. How does agriculture supplement natural resources?
Answer: Agriculture supplements natural resources by using soil, water, sunlight, and nutrients to grow crops and raise animals for food, clothing, and materials like cotton and wool. It ensures a renewable supply of resources needed for human survival and reduces reliance on wild ecosystems for food.

Q4. What is the difference between renewable and finite resources?
Answer: Renewable resources can be replaced naturally over a short period of time, such as solar energy, wind energy, or crops. Finite resources, also known as non-renewable, are available in limited amounts and cannot be replaced quickly, such as oil, coal, and natural gas. Once used, finite resources may take millions of years to form again.

Q5. Name two examples of renewable resources used in everyday life.
Answer: Two examples of renewable resources used in everyday life are solar energy and wood. Solar energy is used to generate electricity and heat, while wood is used for cooking, heating, and making furniture and houses. These resources can be replenished with proper management.

Q6. Give two examples of finite resources obtained from the Earth.
Answer: Two examples of finite resources are crude oil and metal ores. Crude oil is used to produce fuels like petrol and diesel, while metal ores are mined to extract metals like iron, copper, and aluminium. These resources are limited and cannot be replaced quickly once used.

Q7. Explain how chemistry contributes to sustainable development.
Answer: Chemistry contributes to sustainable development by helping create processes and products that use fewer resources, generate less waste, and reduce environmental harm. For example, green chemistry focuses on designing products and reactions that minimise toxic

substances. Chemistry also helps in recycling, improving energy efficiency, and creating sustainable materials.

Q8. What is meant by the term "sustainable development"?
Answer: Sustainable development means using natural resources in a way that meets current human needs without damaging the environment or reducing the ability of future generations to meet their needs. It involves balancing economic growth, environmental protection, and social well-being for long-term stability.

Q9. Why is it important to reduce the use of finite resources?
Answer: Reducing the use of finite resources is important because they are limited and cannot be quickly replaced once used. Overuse leads to depletion, environmental damage, and dependence on imports. Conserving these resources helps protect the planet, reduce pollution, and support long-term human needs.

Q10. How can the use of energy in manufacturing be made more sustainable?
Answer: The use of energy in manufacturing can be made more sustainable by using renewable energy sources like wind or solar, improving energy efficiency through better technology, and recycling materials to reduce the need for raw resource extraction. Sustainable practices also include reducing waste and adopting greener chemical processes.

Q11. What kind of products can be made using natural resources?
Answer: Products made from natural resources include paper from trees, glass from sand, plastic from crude oil, metal tools from ores, fabrics from cotton, and fuels like petrol from oil. These products are part of everyday life and support various human activities such as transport, housing, and communication.

Q12. Give an example of a natural resource that has been replaced by a synthetic product.
Answer: One example is rubber. Natural rubber from rubber trees has been replaced in many cases by synthetic rubber, which is made from crude oil. Synthetic rubber is used in tyres, footwear, and many industrial applications due to its durability and resistance to wear and tear.

Q13. What role does chemistry play in food production?
Answer: Chemistry plays a role in food production by helping develop fertilisers to improve crop yield, pesticides to protect plants from pests, and preservatives to increase the shelf life of food. It also contributes to understanding nutrition, food safety, and the processing of food to meet demand.

Q14. How can chemistry help reduce environmental impact from industry?
Answer: Chemistry helps reduce environmental impact by designing cleaner processes, developing less harmful substances, and finding ways to recycle or reuse materials. Chemists can create alternatives to toxic chemicals and improve waste treatment methods, thus reducing pollution and conserving natural resources.

Q15. What is meant by environmental impact in the context of chemistry?
Answer: Environmental impact refers to the effect that chemical processes and products have on the environment. This includes pollution of air, water, and soil, resource depletion, and harm to living organisms. Chemists study these impacts to develop safer and more eco-friendly alternatives.

Q16. How can chemists help reduce pollution from manufacturing processes?
Answer: Chemists can reduce pollution by designing processes that use fewer harmful chemicals, produce less waste, and require less energy. They can also develop catalysts that speed up reactions efficiently and create biodegradable products that break down naturally without harming the environment.

Q17. What is a key challenge when disposing of waste materials from products?
Answer: A key challenge is ensuring that waste is safely disposed of without harming people or the environment. Many waste materials are toxic, non-biodegradable, or hard to separate and recycle. Proper disposal methods and innovative recycling techniques are needed to handle this issue effectively.

Q18. What is meant by 'stored energy' in used products?
Answer: Stored energy in used products refers to the energy that was used to make the product and is still contained within it. For example, metals and plastics require a lot of energy to produce. Recovering and reusing these materials helps save energy and reduce environmental impact.

Q19. How can chemists reduce waste during the manufacturing process?
Answer: Chemists reduce waste by designing efficient reactions that use all reactants, using catalysts to lower energy needs, and developing closed-loop systems where waste is reused. They also work on improving purification processes and recycling by-products to minimise the amount of waste generated.

Q20. Why is changing land use a concern for environmental chemists?
Answer: Changing land use, such as deforestation or building on natural habitats, can lead to loss of biodiversity, soil erosion, and pollution. Environmental chemists study these impacts and look for ways to reduce harm by developing sustainable practices and materials that require less land use.

Q21. What are some ways chemists can study the effects of human activity on the Earth?
Answer: Chemists study the effects by analysing air, water, and soil samples to detect pollutants, measuring greenhouse gases, studying acid rain formation, and using models to predict environmental changes. They also research ways to reverse or reduce these impacts through sustainable technologies.

Q22. Give an example of a chemical process that uses less energy than traditional methods.
Answer: One example is the use of bioleaching to extract metals from ores. Instead of using high-temperature smelting, bioleaching uses bacteria to separate metals like copper. This method uses less energy, produces less pollution, and is more sustainable for low-grade ores.

Q23. Why is it important to recycle materials from end-of-life products?

Answer: Recycling materials saves natural resources, reduces energy consumption, and decreases the amount of waste sent to landfills. It also reduces the need to extract and process raw materials, which can be harmful to the environment. Recycling helps in conserving materials for future use.

Q24. What types of graphs or charts can be used to show data about natural resources?

Answer: Line graphs can show changes over time, bar charts can compare quantities, pie charts can show proportions, and scatter plots can show relationships between variables. These visual tools help make data easier to understand and interpret for analysis and decision-making.

Q25. What skills are needed to interpret information from graphs or charts?

Answer: Skills include understanding labels and units, identifying trends and patterns, comparing data, calculating differences, and drawing conclusions. Being able to read and evaluate graphs helps in analysing scientific data and making informed decisions about the use of natural resources.

Q26. How does using orders of magnitude help in understanding environmental data?

Answer: Orders of magnitude help compare values on a large scale, especially when the numbers are very different in size. For example, if one process releases 10^6 tonnes of CO_2 and another releases 10^3 tonnes, orders of magnitude show that the first is 1,000 times larger. This makes it easier to understand the scale of environmental impacts and to decide which issues need more urgent attention or stronger control measures.

Q27. What does the term "finite resource" mean?

Answer: A finite resource is a natural material that will eventually run out because it is not replenished on a human timescale. Once used, it cannot be replaced quickly enough to meet ongoing demand. Examples include fossil fuels like coal and oil, and metal ores. These resources take millions of years to form, so they are considered non-renewable and must be used carefully.

Q28. How does timber as a resource fit into the idea of sustainability?

Answer: Timber is considered a sustainable resource when it is harvested responsibly. This means planting new trees to replace the ones that are cut down. If trees are replanted and forests are managed well, the supply of timber can continue indefinitely. This contrasts with finite resources, which cannot be replaced once used. Sustainable use of timber helps protect ecosystems and reduces environmental damage.

Q29. Why are fuels considered finite resources?

Answer: Fuels like coal, oil, and natural gas are called finite because they were formed over millions of years from dead plants and animals. We are using them much faster than they are naturally replaced. Once they run out, we cannot quickly produce more. This is why there is growing interest in renewable energy sources, which do not run out and can be used over and over again.

Q30. How can comparing renewable and non-renewable resources help in planning for the future?

Answer: Comparing renewable and non-renewable resources helps us make better decisions about energy use and conservation. By understanding which resources are limited and which can be used long-term, governments and industries can plan energy policies that reduce dependence on finite resources and invest in sustainable alternatives like wind and solar power, helping to reduce environmental harm and improve energy security.

Q31. What is potable water?

Answer: Potable water is water that is safe to drink. It does not contain harmful levels of microbes, salts, or other contaminants. It may not be chemically pure, as it can contain small amounts of harmless dissolved substances, but it is clean and safe for human consumption. Potable water must meet certain health standards to be used for drinking, cooking, and personal hygiene.

Q32. Why is potable water not considered pure water in a chemical sense?

Answer: In chemistry, pure water means water made up of only H_2O molecules, with no other substances dissolved in it. Potable water, while safe to drink, usually contains small amounts of dissolved minerals or chemicals, such as fluoride or calcium, which are not harmful. Since it is not 100% H_2O, it is not considered chemically pure, even though it is safe for human use.

Q33. What are the key qualities of potable water?

Answer: Potable water must be clear, colourless, and free from harmful microbes and toxic chemicals. It should not have an unpleasant taste or smell. It may contain small amounts of harmless dissolved minerals. The water must be tested regularly to ensure it meets safety standards. The main goal is to make sure the water does not cause illness when consumed.

Q34. What are the sources of fresh water in the UK?

Answer: In the UK, fresh water comes mainly from surface water like rivers, lakes, and reservoirs, and from underground sources known as aquifers. The choice of source depends on the local geography and climate. In wetter areas, surface water is more common, while in drier regions, groundwater may be used. Rainwater eventually feeds both of these sources.

Q35. What is the first step in producing potable water from fresh water?

Answer: The first step in making potable water from fresh water is filtration. This process removes large particles like leaves, twigs, and grit. It helps to prepare the water for further treatment by removing physical debris. This step is important because it protects equipment used in later stages and helps improve the overall quality of the treated water.

Q36. How does filtration help in producing potable water?

Answer: Filtration removes solid particles from the water, such as sand, dirt, and organic matter. It makes the water look clearer and helps reduce the number of microbes. Filtration also prepares the water for sterilisation by making it easier to treat. Cleaner water allows chemicals like chlorine to work more effectively in killing germs. It is an essential step in water treatment.

Q37. Why is sterilisation necessary in water treatment?

Answer: Sterilisation kills harmful microbes like bacteria, viruses, and parasites that can cause diseases. Even after filtration, some microorganisms may remain in the water. If not removed, these microbes can lead to serious health problems. Sterilisation ensures the water is safe to drink by destroying these invisible threats, protecting people from illnesses such as cholera and dysentery.

Q38. Name two agents used to sterilise potable water.

Answer: Two common agents used to sterilise potable water are chlorine and ultraviolet (UV) light. Chlorine is a chemical that kills bacteria and viruses by reacting with their cell walls. UV light damages the DNA of microbes, preventing them from reproducing. Both methods are effective and widely used in water treatment plants around the world.

Q39. How does chlorine sterilise water?

Answer: Chlorine sterilises water by reacting with the cell walls of bacteria and viruses. This reaction damages the structure of the microbes, killing them or making them inactive. Chlorine is effective at low concentrations and can remain in the water, providing continued protection as it travels through pipes. However, it must be carefully controlled to avoid harmful by-products.

Q40. What is the role of ultraviolet light in water treatment?

Answer: Ultraviolet (UV) light sterilises water by damaging the DNA of microorganisms. When microbes are exposed to UV radiation, their genetic material is altered, stopping them from reproducing or functioning properly. This kills or disables the microbes, making the water safe to drink. UV treatment does not leave any chemicals in the water, which is an advantage over chemical methods.

Q41. Why might some areas need to use salty water for drinking purposes?

Answer: Some regions have limited access to fresh water sources like rivers and lakes. In dry or desert areas, or on islands, the only available source of water may be seawater or salty groundwater. In these situations, the water must be treated through desalination to make it safe to drink. This process allows people to access potable water even in places with scarce freshwater supplies.

Q42. What is desalination?

Answer: Desalination is the process of removing dissolved salts and minerals from salty water to make it safe for drinking. This process is often used with seawater or brackish water. The two main methods are distillation and reverse osmosis. Desalination provides a solution in areas where fresh water is not available but is more expensive and energy-intensive than other methods.

Q43. Name one method used to desalinate seawater.

Answer: One common method used to desalinate seawater is reverse osmosis. In this method, salty water is forced through a special membrane that allows water molecules to pass through but blocks the salt and other impurities. This process produces clean, fresh water suitable for drinking and other uses, though it requires significant energy to maintain pressure.

Q44. How does reverse osmosis work to remove salt from water?

Answer: In reverse osmosis, salty water is pushed through a semi-permeable membrane using high pressure. The membrane has tiny pores that let water molecules pass through but block larger salt ions and other contaminants. As a result, clean water collects on one side while the salt and impurities stay behind. It's an effective but energy-demanding way to purify water.

Q45. Why is desalination considered energy-intensive?

Answer: Desalination is energy-intensive because processes like reverse osmosis and distillation require a lot of energy to operate. In reverse osmosis, high pressure must be maintained to force water through the membrane. In distillation, heat is used to boil and condense water. Both methods consume large amounts of electricity or fuel, making them expensive and less eco-friendly.

Q46. What are the advantages and disadvantages of using ozone for sterilising water?

Answer: Ozone is a powerful disinfectant that kills microbes quickly and leaves no chemical taste in water. It is effective against bacteria, viruses, and protozoa. However, ozone treatment requires special equipment and does not leave a lasting effect in water, unlike chlorine. This means microbes could grow back later. Also, producing ozone needs electricity, which increases costs.

Q47. What problems might occur if drinking water contains too much salt?

Answer: Drinking water with too much salt can cause health problems like high blood pressure and kidney damage. It can also lead to dehydration, as the body uses more water to remove the excess salt. Salty water may taste unpleasant and can corrode pipes and appliances. This is why salt levels must be reduced through treatment before water is safe to drink.

Q48. Why is it important to remove microbes from drinking water?

Answer: Microbes like bacteria, viruses, and parasites can cause serious illnesses if consumed in drinking water. Diseases such as cholera, typhoid, and diarrhoea can spread quickly through contaminated water. Removing microbes is essential to prevent outbreaks and protect public health. Sterilisation processes make sure the water is safe and free from harmful organisms.

Q49. What is the difference between treating ground water and treating salty water?

Answer: Groundwater usually needs simple treatment like filtration and sterilisation to remove dirt and microbes. It often contains minerals but not much salt. Salty water, like seawater, requires desalination to remove high levels of salt before it can be used. Desalination is more complex and energy-intensive than treating groundwater, making it more costly and technically demanding.

Q50. How does local climate affect the methods used to produce drinking water?

Answer: In areas with heavy rainfall, fresh water from rivers and lakes is easily available and cheaper to treat. In dry climates, where fresh water is limited, people may rely on groundwater or desalination of seawater. The local climate also affects how much water is needed and how often. Treatment methods are chosen based on what water sources are available and how much water is required.

Q51. What is the main reason for treating wastewater before releasing it into the environment?
Answer: The main reason for treating wastewater is to remove harmful substances that could damage the environment and human health. Wastewater often contains harmful microbes, toxic chemicals, and organic matter that can pollute water bodies, kill aquatic life, and spread diseases. Treating it reduces pollution, protects ecosystems, and ensures water is safe for humans and wildlife.

Q52. Why must organic matter be removed from sewage and agricultural wastewater?
Answer: Organic matter must be removed because it can decompose and use up oxygen in water, which aquatic organisms need to survive. When too much organic matter enters rivers or lakes, bacteria break it down, consuming large amounts of dissolved oxygen. This leads to oxygen depletion, killing fish and other aquatic life. Removing it helps maintain water quality and biodiversity.

Q53. Explain why harmful microbes in sewage must be treated before the water is released.
Answer: Harmful microbes in sewage, such as bacteria, viruses, and parasites, can cause diseases in humans and animals if they enter drinking water supplies or recreational water sources. Treating sewage removes or kills these pathogens, reducing the risk of illness and protecting public health. It also helps prevent the spread of waterborne diseases like cholera and dysentery.

Q54. What is the purpose of screening in sewage treatment?
Answer: Screening is the first step in sewage treatment and involves removing large solid objects such as sticks, plastics, nappies, and other debris. These items could damage equipment or clog pipes if not removed. Screening ensures that the rest of the treatment process runs smoothly and efficiently by preventing blockages and mechanical failures.

Q55. Describe what happens during the grit removal stage of sewage treatment.
Answer: In the grit removal stage, sewage flows through a chamber where sand, gravel, and other heavy particles settle out due to gravity. These materials are too heavy to stay suspended and sink to the bottom. Removing grit is important to prevent abrasion and wear on the machinery used later in the treatment process.

Q56. What is produced during sedimentation in the sewage treatment process?
Answer: During sedimentation, solid waste particles settle to the bottom of a tank, forming a thick sludge, while the liquid part, known as effluent, stays on top. This process separates most of the solid waste from the liquid. The sludge is further treated, while the effluent goes on to the next stage of treatment.

Q57. What are the two main products of sedimentation in sewage treatment?
Answer: The two main products are sludge and effluent. Sludge is the thick solid material that settles at the bottom of the tank and contains most of the organic matter. Effluent is the clearer liquid that remains above the sludge and contains dissolved and suspended materials. Both are treated further in separate processes.

Q58. Explain the role of anaerobic digestion in treating sewage sludge.
Answer: Anaerobic digestion is used to break down organic matter in sewage sludge without oxygen. Microorganisms decompose the sludge in sealed tanks, producing biogas (mainly methane and carbon dioxide), which can be used for energy. This process reduces the volume of waste, kills harmful microbes, and recovers energy from waste.

Q59. What conditions are required for anaerobic digestion to occur?
Answer: Anaerobic digestion requires the absence of oxygen, suitable temperatures (typically between 35–55°C), and the presence of anaerobic bacteria. The sludge must be kept in sealed tanks where these bacteria can break down organic materials. The environment must be carefully controlled to ensure the bacteria thrive and produce biogas efficiently.

Q60. Describe how aerobic biological treatment is used in wastewater treatment.
Answer: In aerobic biological treatment, air or oxygen is added to the wastewater to encourage the growth of aerobic microorganisms. These microbes break down organic matter in the effluent into harmless substances. The process usually occurs in aeration tanks where the water is mixed and oxygenated. It helps remove organic pollutants and reduces the risk of water pollution.

Q61. Why is oxygen important in the aerobic treatment of effluent?
Answer: Oxygen is vital because aerobic bacteria need it to survive and break down organic matter in the wastewater. Without enough oxygen, the bacteria cannot function effectively, and the treatment process would slow down or stop. Oxygen ensures that organic pollutants are decomposed into carbon dioxide and water, making the effluent cleaner.

Q62. Compare the processes of anaerobic digestion and aerobic treatment in sewage systems.
Answer: Anaerobic digestion occurs in the absence of oxygen and is used to break down sludge. It produces biogas, which can be used as fuel, and reduces waste volume. Aerobic treatment, in contrast, uses oxygen and targets the liquid effluent, using bacteria to decompose organic matter. While anaerobic digestion saves energy and recovers gas, aerobic treatment is faster and more efficient at removing pollutants from liquid.

Q63. How is potable water different from pure water?
Answer: Potable water is water that is safe to drink and may contain small, harmless amounts of dissolved minerals and substances. Pure water, in contrast, contains only H_2O molecules with no dissolved substances. Potable water doesn't need to be chemically pure; it just needs to meet safety standards for human consumption, which often means it has been filtered and disinfected.

Q64. What are the key challenges in obtaining potable water from salt water?
Answer: The main challenges include high energy costs and equipment maintenance. Desalination methods like distillation and reverse osmosis require a lot of energy to remove salt and other minerals. These methods are expensive and not environmentally friendly if fossil fuels are used. Salt brine disposal is also a problem, as it can harm marine life.

Q65. Explain why it is easier to obtain potable water from groundwater than from wastewater.
Answer: Groundwater is usually cleaner than wastewater because it has been naturally filtered through soil and rock. It typically contains fewer pollutants and microbes, so less treatment is needed to make it potable. Wastewater, on the other hand, contains organic waste, harmful microbes, and possibly toxic chemicals, requiring more complex and costly treatment processes.

Q66. What are the main steps in treating industrial wastewater?
Answer: Treating industrial wastewater involves several steps, which may include neutralising acids or alkalis, removing harmful chemicals, filtering solids, and biological treatment to break down organic matter. Depending on the industry, the treatment may also involve special processes to remove heavy metals or dyes. The goal is to reduce pollution before releasing water back into the environment.

Q67. Why does industrial wastewater sometimes require removal of harmful chemicals?
Answer: Industrial wastewater can contain toxic chemicals such as heavy metals, solvents, or acidic substances that can harm humans, animals, and plants. These substances can pollute water sources and damage ecosystems. Removing harmful chemicals before releasing the water ensures environmental safety and protects drinking water supplies.

Q68. Describe one environmental benefit of treating wastewater properly.
Answer: One major benefit is the protection of aquatic life. Proper treatment removes harmful substances and reduces oxygen-depleting materials, allowing fish and other aquatic organisms to survive. It also prevents pollution of rivers, lakes, and oceans, which helps maintain biodiversity and supports healthy ecosystems.

Q69. What are the potential consequences of not treating sewage before releasing it?
Answer: If sewage is not treated, it can pollute rivers and oceans, spreading diseases and killing aquatic life. Harmful microbes can infect humans through contaminated water. Organic matter can cause oxygen depletion, leading to dead zones in water bodies. It also creates bad odours and can damage tourism and local economies.

Q70. Explain the importance of sedimentation in separating solids from wastewater.
Answer: Sedimentation allows heavier solid particles in wastewater to settle at the bottom of a tank by gravity. This process separates most of the solids from the liquid, making it easier to treat each part. Removing solids early in the process reduces the load on later treatment stages and improves the overall efficiency of the wastewater treatment system.

Q71. Why are the Earth's resources of metal ores considered limited?
Answer: Metal ores are limited because they are non-renewable resources that took millions of years to form. Once we mine and use them, they cannot be replaced quickly. The supply of high-grade ores is decreasing, making extraction harder and more expensive. As demand increases, it's important to use metals wisely and recycle them when possible.

Q72. What is meant by low-grade copper ores?

Answer: Low-grade copper ores contain a small amount of copper compared to high-grade ores. They are not rich enough to be mined profitably using traditional methods. However, new methods like phytomining and bioleaching can extract copper from them in a more sustainable and cost-effective way, even though the process may be slower.

Q73. Describe how phytomining helps extract copper from low-grade ores.

Answer: In phytomining, plants that absorb copper from the soil are grown on land containing low-grade copper ores. The plants are harvested and burned, and the ash produced contains copper compounds. These compounds can then be extracted using chemical processes. This method allows copper to be recovered without traditional mining.

Q74. Explain why phytomining is considered more environmentally friendly than traditional mining.

Answer: Phytomining is less harmful to the environment because it does not involve digging or blasting, which can damage habitats and cause pollution. It reduces soil erosion, energy use, and greenhouse gas emissions. It also allows metal extraction from waste materials and contaminated land, turning waste into a useful resource.

Q75. What is bioleaching and how does it work to extract metal compounds?

Answer: Bioleaching uses bacteria to break down metal compounds in low-grade ores. The bacteria feed on the minerals and produce a solution containing metal ions. For example, they convert copper compounds into soluble copper ions, which can be collected from the solution and purified. This method is slower but cheaper and causes less environmental damage than traditional mining.

Q76. What role do bacteria play in the process of bioleaching?

Answer: In bioleaching, bacteria are used to extract metals from ores. These bacteria feed on the sulfide minerals found in low-grade ores, breaking them down and producing a solution called leachate that contains metal ions like copper. The metal ions can then be recovered from this solution. The bacteria essentially help convert insoluble metal compounds into soluble forms, making it easier to extract the metal.

Q77. How is the copper compound obtained from phytomining converted into pure copper?

Answer: In phytomining, plants absorb copper compounds from the soil. When these plants are harvested and burned, the resulting ash contains copper compounds. These compounds are dissolved in acid to produce a solution of copper ions. The copper ions can then be extracted by either electrolysis or displacement using scrap iron to produce pure copper metal.

Q78. Describe the process of burning plants in phytomining and what is produced.

Answer: In phytomining, after plants absorb copper compounds from the soil, they are harvested and burned. Burning the plants breaks down the organic material and leaves behind ash, which contains the copper compounds that were present in the plant tissues. This ash can then be

processed further to extract the copper, either by dissolving it in acid or by using displacement reactions.

Q79. How does displacement using scrap iron extract copper from copper compounds?
Answer: Scrap iron is more reactive than copper, so it can displace copper from copper salt solutions. When scrap iron is added to a solution containing copper ions (like copper sulfate), the iron reacts with the copper ions, forming iron ions and releasing copper metal. This simple and cost-effective method helps recover copper from solution.

Q80. Why is scrap iron used in the displacement of copper from copper salt solutions?
Answer: Scrap iron is cheap, easily available, and more reactive than copper. Because of its higher reactivity, iron can displace copper from its salt solutions, such as copper sulfate. This makes it a cost-effective way to extract copper from leachate or other solutions containing copper ions.

Q81. Describe how electrolysis is used to obtain copper from copper compounds.
Answer: Electrolysis involves using electricity to split compounds into their elements. In copper extraction, a solution of copper ions is used as the electrolyte. A copper electrode is placed as the cathode (negative electrode), and a more impure copper or carbon electrode is used as the anode (positive electrode). When electricity is passed through the solution, pure copper forms on the cathode.

Q82. Compare the use of displacement and electrolysis in copper extraction.
Answer: Displacement uses a more reactive metal like iron to extract copper from solutions, while electrolysis uses electricity to separate copper ions from solution. Displacement is cheaper and easier, but electrolysis produces purer copper. Electrolysis is more expensive due to electricity use but is essential for producing high-purity copper used in electrical wiring.

Q83. What are the advantages of using biological methods like bioleaching over traditional mining?
Answer: Biological methods like bioleaching are less damaging to the environment, require less energy, and can extract metals from low-grade ores that would be unprofitable to mine using traditional methods. They also reduce the need for blasting and moving large amounts of rock, making them more sustainable and suitable for locations with limited mining infrastructure.

Q84. What are the disadvantages of using phytomining for copper extraction?
Answer: Phytomining is slower than traditional mining methods and depends on plant growth, which can be affected by weather and soil quality. It also yields a lower amount of copper per cycle and requires large areas of land. Additionally, the process of burning the plants and handling acidic solutions can have environmental and safety concerns.

Q85. How long does bioleaching typically take to produce usable metal compounds?
Answer: Bioleaching is a slow process that can take months to years to produce significant amounts of metal compounds. The rate depends on factors like temperature, bacterial activity, and the type of

ore. This slow pace can be a drawback when compared to faster, traditional methods of metal extraction.

Q86. Why is it important to develop alternative methods for metal extraction?
Answer: Alternative methods like bioleaching and phytomining help reduce environmental impact, save energy, and allow us to extract metals from low-grade ores that would otherwise be waste. They also support sustainable resource use and reduce the carbon footprint of mining activities, which is important as high-grade ore reserves are becoming scarcer.

Q87. Explain how phytomining reduces the need to dig and move large amounts of rock.
Answer: Phytomining uses plants to absorb metal compounds directly from the soil. Since the metal is concentrated in the plants, there is no need to dig or transport large amounts of rock. This reduces the disruption to the land, lowers fuel use, and limits the production of mining waste, making the process more environmentally friendly.

Q88. What is a leachate solution in the context of bioleaching?
Answer: A leachate solution is the liquid that forms when bacteria break down the ore in bioleaching. It contains dissolved metal ions such as copper. This solution can be collected and processed to recover the metal, usually through displacement or electrolysis. The leachate is the key product of the bioleaching process.

Q89. Why might biological methods of metal extraction be more suitable for poorer countries?
Answer: Biological methods like bioleaching and phytomining require less equipment, energy, and infrastructure than traditional mining. They are cost-effective and environmentally friendly, making them suitable for countries with limited financial and technical resources. These methods also allow use of low-grade ores that are commonly found in poorer regions.

Q90. How does the use of bacteria in metal extraction help reduce environmental damage?
Answer: Bacteria used in bioleaching work at low temperatures and avoid the need for explosives, high temperatures, or toxic chemicals. This reduces air and water pollution, conserves energy, and minimises habitat destruction. Bioleaching also produces less waste compared to traditional mining, making it a greener alternative.

Q91. Why might phytomining be considered a renewable method of metal extraction?
Answer: Phytomining is considered renewable because it relies on plant growth, which can be repeated in cycles. As long as plants can be grown and absorb metal compounds from the soil, the process can continue without depleting finite resources like high-grade ores. It also has a smaller environmental impact than conventional mining.

Q92. What type of plants are commonly used in phytomining and why?
Answer: Plants that are used in phytomining are known as hyperaccumulators. These plants can absorb unusually high amounts of metal compounds from the soil without being poisoned. Examples

include certain types of ferns and alpine plants. They are chosen because of their ability to grow in metal-rich soils and extract metals efficiently.

Q93. What happens to the metal compounds in ash produced from burning plants in phytomining?

Answer: When the plants are burned, the organic material is destroyed and the metal compounds are left in the ash. These compounds can be dissolved in acid to produce a solution containing metal ions. From this solution, the metal can be extracted using displacement with a more reactive metal or by electrolysis.

Q94. Describe how copper ions are displaced by iron in solution.

Answer: When iron is added to a solution containing copper ions, a displacement reaction occurs because iron is more reactive than copper. The iron atoms lose electrons and form iron ions, while the copper ions gain those electrons and are reduced to copper metal. This process is used to recover copper from solution.

Q95. Why is electricity required in the process of electrolysis?

Answer: Electricity is needed in electrolysis to drive a non-spontaneous chemical reaction. It provides the energy required to break down compounds into their elements. In copper extraction, it causes copper ions in solution to gain electrons at the cathode and form pure copper metal, which deposits on the electrode.

Q96. How can students evaluate the effectiveness of bioleaching and phytomining?

Answer: Students can evaluate these methods by comparing their environmental impact, cost, time taken, and yield of metal against traditional methods. They can look at case studies, examine how much copper is recovered, how long it takes, and the energy used. They should also consider long-term sustainability and practical challenges.

Q97. What safety precautions are needed during the phytomining process?

Answer: During phytomining, safety precautions include wearing protective gear when handling acid and ash, ensuring proper ventilation during plant burning, and following guidelines for safe disposal of waste materials. Care must also be taken to avoid contamination of nearby soil and water, and to handle plants grown on metal-rich soil responsibly.

Q98. Describe one limitation of using bioleaching in large-scale copper extraction.

Answer: One major limitation of bioleaching is the slow rate of extraction. It can take several months or even years to recover a significant amount of copper, which makes it less suitable for large-scale or urgent copper demand. Additionally, the bacteria need specific conditions to thrive, which may not be easy to maintain.

Q99. How do scientists test the quality of copper obtained by biological methods?

Answer: Scientists test the purity of the copper by using chemical analysis techniques such as spectroscopy or electrochemical tests. They measure the concentration of copper and any impurities

present. The copper's physical properties, such as conductivity, may also be tested to ensure it meets industry standards for use.

Q100. How can phytomining and bioleaching support sustainable development goals?
Answer: These methods reduce environmental damage, require less energy, and use waste materials or low-grade ores. They help reduce reliance on high-impact mining and make metal extraction accessible to developing countries. This supports sustainable development by promoting cleaner production methods, reducing resource depletion, and protecting ecosystems.

Q101. What is meant by a life cycle assessment?
Answer: A life cycle assessment (LCA) is a method used to evaluate the environmental impact of a product throughout its entire life. This includes every stage from extracting raw materials, manufacturing, using the product, and finally disposing of it. It helps to identify areas where environmental harm can be reduced and encourages the development of more sustainable products and processes.

Q102. Name the four main stages included in a life cycle assessment.
Answer: The four main stages in a life cycle assessment are: 1) extraction and processing of raw materials, 2) manufacturing and packaging, 3) use of the product, and 4) disposal at the end of the product's life. Each stage is assessed to understand how much energy is used and how much pollution is caused.

Q103. Why is it important to assess the use of energy during a product's life cycle?
Answer: Assessing energy use during a product's life cycle is important because energy often comes from burning fossil fuels, which releases greenhouse gases like carbon dioxide. These gases contribute to climate change. Knowing where the most energy is used helps to improve energy efficiency and reduce environmental damage.

Q104. Give an example of a product where transport has a big impact on its life cycle assessment.
Answer: Imported fruits like bananas or mangoes have a big transport impact in their life cycle assessment. These products are often grown in distant countries and transported over long distances using ships, trucks, or planes. This transport uses a lot of fuel and adds to air pollution and greenhouse gas emissions.

Q105. Why is it difficult to give exact numerical values to pollutant effects in a life cycle assessment?
Answer: It is difficult to give exact numerical values to pollutant effects because not all pollution has the same impact and different types of pollution affect the environment in different ways. Also, the way pollution is measured can vary, and some data may be missing or estimated, leading to uncertainty in the results.

Q106. What are selective life cycle assessments?
Answer: Selective life cycle assessments are assessments that only include some parts of a product's life cycle or focus only on certain environmental impacts. They do not consider the full picture and may be biased depending on what is included or left out.

Q107. How can selective life cycle assessments be misused?
Answer: Selective life cycle assessments can be misused to make a product look better for the environment than it actually is. Companies might leave out parts of the process that cause the most pollution or only highlight positive impacts, which can mislead consumers.

Q108. What kind of value judgements might affect the results of a life cycle assessment?
Answer: Value judgements can affect which impacts are considered more important. For example, one person might think global warming is more important than water pollution, while another might disagree. These opinions can influence how data is interpreted and what the final result shows.

Q109. Why is it important to include disposal in a life cycle assessment?
Answer: Disposal is important in a life cycle assessment because it can have a large environmental impact. Some products end up in landfills, which can cause pollution, while others may be incinerated, which releases greenhouse gases. Including disposal helps to find better waste management solutions.

Q110. How is water usage included in a life cycle assessment?
Answer: Water usage is included in a life cycle assessment by measuring how much water is used during the raw material extraction, manufacturing, use, and disposal stages. High water usage can lead to shortages, especially in areas where water is already limited, so it is an important part of the environmental impact.

Q111. Give two ways in which raw material extraction impacts the environment.
Answer: First, raw material extraction can damage natural habitats, leading to loss of biodiversity. Second, it often involves heavy machinery and transport, which uses fossil fuels and releases greenhouse gases. Both of these contribute to environmental harm.

Q112. What is meant by the term 'limited resource'?
Answer: A limited resource is something that exists in a fixed amount and cannot be replaced quickly once used. Fossil fuels, minerals, and metal ores are examples of limited resources. Using them too quickly can lead to shortages and environmental problems.

Q113. Why is energy use a concern during the manufacturing stage of a product?
Answer: Energy use during manufacturing is a concern because it often relies on non-renewable energy sources like coal or oil, which release harmful gases into the atmosphere. These gases contribute to climate change and air pollution, so reducing energy use helps protect the environment.

Q114. How could the use of renewable energy improve a product's life cycle assessment?
Answer: Using renewable energy like solar or wind power reduces the amount of greenhouse gases

released during manufacturing and other stages. This lowers the product's environmental impact, making its life cycle assessment more favourable and sustainable.

Q115. Why might a product that lasts a long time have a better life cycle assessment?
Answer: A long-lasting product means fewer replacements are needed over time, reducing the need for new raw materials, manufacturing, and transport. This lowers the total energy use and pollution across its life cycle, improving its environmental profile.

Q116. How can using recycled materials reduce environmental impact?
Answer: Using recycled materials reduces the need for new raw material extraction, which often harms the environment. It also uses less energy compared to making products from scratch, helping to cut down on emissions and conserve resources.

Q117. In a simple LCA comparison, what might make a plastic bag seem better than a paper bag?
Answer: A plastic bag might seem better if it uses less energy and water to produce and transport than a paper bag. If it is reused multiple times and properly recycled, its overall environmental impact can be lower than that of a single-use paper bag.

Q118. Why is the number of times a product is used important in a life cycle assessment?
Answer: The more times a product is used, the more its environmental impact is spread out over time. A reusable item like a shopping bag or water bottle becomes more efficient and sustainable the more it is used, improving its life cycle assessment.

Q119. How can the use of ratios help compare environmental impacts in life cycle assessments?
Answer: Ratios can help show the impact per use or per unit of production. For example, if one bag is used 100 times and another only once, ratios can compare the pollution or energy used per use, making it easier to judge which is more sustainable.

Q120. Describe one limitation of carrying out a full life cycle assessment.
Answer: One limitation is the difficulty in collecting all accurate and complete data. Some stages may not be fully documented or may rely on estimates, which can affect the reliability of the results. This can lead to uncertainty or biased conclusions.

Q121. What are the advantages of using recycled materials instead of new raw materials?
Answer: Using recycled materials saves energy, reduces pollution, and preserves natural resources. It also decreases the waste that ends up in landfills and reduces the need for damaging processes like mining or logging. This helps the environment in multiple ways.

Q122. Why is recycling metals considered better than extracting new metals?
Answer: Recycling metals uses less energy than extracting new metals from ores, which often involves mining, crushing, and heating. It also reduces the destruction of landscapes, saves limited resources, and produces less pollution, making it more environmentally friendly.

Q123. How does mining contribute to environmental damage?
Answer: Mining can destroy habitats, pollute soil and water with chemicals, and cause air pollution from dust and emissions. It also uses a lot of energy and creates large amounts of waste rock, which can lead to long-term damage to ecosystems.

Q124. Give two examples of products that can be reused.
Answer: Glass bottles and cloth shopping bags can both be reused. Reusing these items reduces the need to make new ones, saves energy, and lowers the overall environmental impact when compared to single-use alternatives.

Q125. What happens to glass bottles when they are recycled?
Answer: When glass bottles are recycled, they are first sorted by colour, cleaned to remove labels and residues, and then crushed into small pieces called cullet. The cullet is melted and reshaped into new glass products, which uses less energy than making new glass from raw materials.

Q126. Explain how scrap steel can reduce the need for extracting iron.
Answer: Using scrap steel reduces the need to extract iron from its ore because it allows the recycling of already processed metal. This avoids the energy-intensive process of extracting iron from iron ore in a blast furnace, which involves mining, transporting, and heating the ore with carbon. Recycling scrap steel uses less energy and helps conserve natural resources by reducing the demand for raw materials.

Q127. What is meant by the term 'reforming' in recycling?
Answer: Reforming in recycling refers to the process of changing the shape or form of a material so that it can be used again. For example, plastic bottles may be melted and reformed into fibres for clothing or new containers. This process allows materials to be reused without the need to create new products from raw materials, which saves energy and reduces waste.

Q128. How does recycling reduce energy use?
Answer: Recycling reduces energy use because it takes much less energy to reprocess used materials than to extract and refine new raw materials. For instance, recycling aluminium saves up to 95% of the energy needed to produce it from bauxite ore. Less energy is used for heating, processing, and transportation, making recycling a more energy-efficient option.

Q129. Why is separation needed before recycling materials?
Answer: Separation is necessary because different materials require different recycling processes. Mixing materials like paper, plastic, and metals can contaminate the recycling stream and reduce the quality of the final recycled product. Proper separation ensures that materials can be processed efficiently and helps produce high-quality recycled products.

Q130. How does the type of material affect how it is recycled?
Answer: Different materials have different recycling methods. For example, metals are usually melted, plastics are sorted and reformed, and glass is crushed and remelted. Some materials like

mixed plastics or composite materials are more difficult to recycle. The ease of recycling depends on the chemical and physical properties of the material.

Q131. What is the environmental impact of disposing of non-recycled plastics?
Answer: Non-recycled plastics often end up in landfills or the environment, where they can take hundreds of years to break down. They can pollute oceans, harm wildlife, and release toxic chemicals. When burned, plastics release greenhouse gases and other pollutants. This contributes to environmental degradation and climate change.

Q132. How can using reusable items help reduce waste?
Answer: Using reusable items like cloth bags, bottles, and containers reduces the need for single-use products, which often end up as waste. It helps decrease the amount of material that goes to landfill, reduces the demand for raw materials, and lowers the environmental footprint of consumer products.

Q133. Why are building materials considered limited resources?
Answer: Building materials like sand, gravel, and metals come from natural sources that are not infinite. Overuse or unsustainable extraction can lead to resource depletion and environmental damage. As these materials take millions of years to form, they are considered non-renewable or limited in availability.

Q134. What is the benefit of crushing and melting glass for recycling?
Answer: Crushing and melting glass allows it to be reused to make new glass products without needing to use new raw materials like sand. It reduces the energy required compared to producing new glass, lowers greenhouse gas emissions, and helps conserve natural resources.

Q135. Why might some materials not be reused directly?
Answer: Some materials may be contaminated, damaged, or degraded in quality, making direct reuse unsafe or impractical. Others might not fit new design specifications. In such cases, the material might need to be recycled or processed before it can be reused.

Q136. How can using recycled metal reduce carbon emissions?
Answer: Recycling metal uses significantly less energy than extracting and refining metal ores. For example, recycling aluminium saves about 95% of the energy needed for production from ore. Less energy use means fewer fossil fuels burned, which leads to lower carbon dioxide emissions and a smaller carbon footprint.

Q137. What factors should be considered when evaluating ways to reduce resource use?
Answer: Factors include the energy required, environmental impact, cost-effectiveness, availability of materials, and ease of implementation. Also, how long the product lasts, whether it can be reused or recycled, and how much waste it creates are important in determining the best approach to reduce resource use.

Q138. What role does consumer behaviour play in reducing resource use?
Answer: Consumer choices impact the demand for products and resources. By choosing products with minimal packaging, buying recycled goods, or reusing items, consumers can help reduce waste and the use of raw materials. Awareness and responsible consumption contribute significantly to sustainable resource use.

Q139. Give an example of a product where recycling requires more energy than reuse.
Answer: Glass jars are an example. Cleaning and reusing them uses less energy than collecting, transporting, crushing, melting, and reforming them into new jars. Reusing avoids the high temperatures needed to melt glass, making it a more energy-efficient choice than recycling in this case.

Q140. Why is transportation considered in a product's life cycle?
Answer: Transportation contributes to the total environmental impact of a product by using fuel and producing emissions. Long-distance transport increases the carbon footprint. Evaluating transport helps identify ways to reduce emissions and choose more sustainable local options.

Q141. How can packaging affect a product's life cycle assessment?
Answer: Packaging materials add to the total environmental impact. If packaging is excessive, non-recyclable, or made from non-renewable materials, it increases waste and emissions. Using lightweight, recyclable, or biodegradable packaging improves a product's life cycle assessment.

Q142. Describe how recycling can reduce landfill use.
Answer: Recycling diverts waste from landfills by turning used materials into new products. This reduces the volume of waste that needs to be buried, helps conserve space, lowers the risk of soil and water pollution, and reduces methane emissions from decomposing organic waste in landfills.

Q143. Why might some materials be more difficult to recycle than others?
Answer: Some materials are difficult to separate, have low market value, or degrade during processing. Mixed materials like laminated packaging or contaminated plastics can't be recycled easily. Also, specialised facilities may be needed, making recycling economically or technically challenging.

Q144. How does the quality of recycled materials affect product performance?
Answer: Recycled materials may have lower purity, strength, or consistency than new materials. This can affect the durability, appearance, or safety of products. Manufacturers may need to mix recycled with new materials or avoid using recycled content for products needing high precision or strength.

Q145. What are the benefits of using local materials instead of imported ones?
Answer: Using local materials reduces transportation distances, which lowers fuel use and emissions. It supports local economies, ensures better supply control, and may require less

packaging. Local sourcing often reduces the product's environmental footprint and improves sustainability.

Q146. How can governments encourage more recycling of materials?
Answer: Governments can provide recycling bins, run awareness campaigns, set regulations for packaging, and offer incentives for companies and households to recycle. They can invest in recycling infrastructure and impose fines for improper waste disposal to promote sustainable practices.

Q147. Why might recycling processes still have environmental impacts?
Answer: Recycling involves energy use, transport, and emissions. Some processes release pollutants or use chemicals that affect the environment. While better than raw material extraction, recycling still contributes to greenhouse gases and may produce waste that needs careful management.

Q148. What is one way of comparing the environmental impact of two similar products?
Answer: A life cycle assessment (LCA) can be used to compare the total environmental impact of two products from raw material extraction to disposal. It looks at energy use, emissions, waste, and resource use, helping to identify which product is more environmentally friendly overall.

Q149. Explain the importance of using significant figures in life cycle data.
Answer: Using significant figures ensures that the data presented in a life cycle assessment reflects the precision of the measurements. It avoids giving a false sense of accuracy and ensures fair comparison between products. It also helps in clear communication of reliable, realistic results.

Q150. How can graphical data be used to compare different products in a life cycle assessment?
Answer: Graphs like bar charts or pie charts can visually represent data such as carbon emissions, energy use, or waste for different products. This makes it easier to compare environmental impacts side by side, helping users or decision-makers choose more sustainable products.

Q151. What is corrosion and how does it affect materials?
Answer: Corrosion is a chemical process where metals react with substances in their environment, such as oxygen and water, leading to the gradual destruction of the metal. It weakens the material, changes its appearance, and reduces its strength and durability. For example, iron corrodes by forming rust, which flakes off and exposes more metal to the environment, making the material unsafe or unusable over time.

Q152. Explain why rusting is considered a type of corrosion.
Answer: Rusting is considered a type of corrosion because it involves the chemical reaction of iron with water and oxygen, which causes the metal to deteriorate. It is specific to iron and forms iron oxide, commonly known as rust. This process damages the metal over time and is just one example of corrosion, which can happen to other metals as well.

Q153. What two conditions are needed for iron to rust?
Answer: Iron needs both oxygen (from air) and water (moisture) for rusting to occur. Without either of these, rusting cannot take place. This is why iron doesn't rust in completely dry air or in environments where water is not present.

Q154. Describe a simple experiment to show that both air and water are needed for rusting.
Answer: Take three test tubes with iron nails. In one, add only dry air using a drying agent and seal it. In the second, add water that has been boiled to remove air and seal it with oil. In the third, add tap water and leave it exposed. After a few days, only the third nail will rust, showing that both air and water are required for rusting to occur.

Q155. How can painting a metal help to prevent corrosion?
Answer: Painting creates a physical barrier between the metal and the environment, preventing moisture and oxygen from reaching the metal's surface. This stops the chemical reaction that causes corrosion. As long as the paint layer remains intact, it can protect the metal effectively.

Q156. What is the purpose of greasing a metal surface?
Answer: Greasing a metal surface creates a water-repellent coating that prevents moisture and air from reaching the metal. This helps protect the metal from rusting and corrosion, especially in machinery and tools that are used outdoors or in damp conditions.

Q157. How does electroplating protect a metal from corrosion?
Answer: Electroplating involves coating a metal object with a thin layer of another metal that is more resistant to corrosion, such as chromium or nickel. This outer layer acts as a barrier, preventing the metal underneath from coming into contact with water and oxygen.

Q158. Why does aluminium not corrode easily?
Answer: Aluminium forms a thin, tough layer of aluminium oxide on its surface when exposed to air. This oxide layer sticks firmly to the metal and acts as a protective barrier, preventing further corrosion and protecting the metal underneath from damage.

Q159. What is meant by sacrificial protection?
Answer: Sacrificial protection is a method of preventing corrosion in a metal by attaching a more reactive metal to it. The more reactive metal corrodes instead of the protected metal. It is commonly used with iron and steel by attaching metals like zinc or magnesium, which "sacrifice" themselves to protect the main structure.

Q160. Why is zinc used to protect iron from rusting in galvanising?
Answer: Zinc is more reactive than iron and readily oxidises. When iron is coated with zinc (galvanising), the zinc layer protects the iron both physically and chemically. If the zinc layer is scratched, the zinc still corrodes instead of the iron, offering sacrificial protection.

Q161. Explain how zinc protects iron in terms of reactivity.
Answer: Zinc protects iron because it is higher in the reactivity series. It reacts with oxygen and

water more easily than iron does. So, when both metals are present, zinc corrodes in place of iron. Even if the protective coating is damaged, zinc will continue to protect the iron by corroding first.

Q162. What happens to the zinc during sacrificial protection?
Answer: During sacrificial protection, zinc gradually corrodes by reacting with oxygen and moisture in the environment. It forms zinc oxide, which gets used up over time. As long as some zinc remains, it continues to protect the iron from rusting.

Q163. Why does the presence of salt increase the rate of rusting?
Answer: Salt increases the conductivity of water, which speeds up the movement of ions involved in the rusting process. This accelerates the electrochemical reactions between iron, oxygen, and water, making iron rust faster, especially in coastal or winter conditions where salt is present.

Q164. Describe how sacrificial protection can be used to protect a ship's hull.
Answer: To protect a ship's hull, blocks of a more reactive metal like zinc or magnesium are attached to the hull below the waterline. These metals corrode instead of the steel hull. As they corrode, they prevent rust from forming on the hull, which prolongs the life of the ship's structure.

Q165. Why is iron more likely to rust than aluminium?
Answer: Iron does not naturally form a strong protective oxide layer like aluminium does. When iron oxidises, it forms rust that flakes off, exposing more metal to air and water. Aluminium forms a stable oxide layer that sticks to the surface and prevents further oxidation.

Q166. What does the term "galvanising" mean?
Answer: Galvanising is the process of coating iron or steel with a layer of zinc. This zinc layer protects the metal underneath from rusting by acting as a barrier and also by providing sacrificial protection because zinc is more reactive than iron.

Q167. How would you test whether a metal has rusted?
Answer: You can test for rust by observing any reddish-brown flakes on the surface of the metal. You can also check for a mass increase due to oxidation or perform a chemical test for iron(III) oxide. Another method is to use an indicator like phenolphthalein with potassium hexacyanoferrate to detect the presence of rust ions.

Q168. Explain the role of oxygen in rusting.
Answer: Oxygen reacts with iron in the presence of water to form iron oxides. This is a slow chemical reaction that produces rust. Oxygen acts as an oxidising agent, accepting electrons from iron and forming iron(III) ions that combine with water to form hydrated iron(III) oxide, or rust.

Q169. Explain the role of water in rusting.
Answer: Water is necessary for rusting because it acts as a medium in which ions can move. It also helps in dissolving oxygen and provides the environment needed for the electrochemical reactions that convert iron into rust. Without water, rusting cannot take place.

Q170. Why is it important to protect iron from rusting?
Answer: Rusting weakens iron and steel structures by making them brittle and causing loss of material. Over time, this can lead to structural failures, safety hazards, and costly repairs. Preventing rusting helps in preserving the strength, appearance, and functionality of iron-based materials.

Q171. What are the advantages of using grease to prevent rusting?
Answer: Grease creates a barrier that repels water and prevents oxygen from reaching the metal surface. It is easy to apply and suitable for moving parts like bike chains or tools. Grease also helps reduce friction and wear, offering both protection and lubrication.

Q172. What are the limitations of using paint to protect against rust?
Answer: Paint can chip, crack, or peel over time, exposing the metal underneath to air and moisture. Once the paint layer is broken, rusting can start quickly. Also, it requires regular maintenance and reapplication to remain effective as a rust-preventive method.

Q173. What is an alloy?
Answer: An alloy is a mixture of a metal with one or more other elements, usually metals or sometimes non-metals. Alloys are made to improve the properties of the original metal, such as strength, hardness, corrosion resistance, or appearance.

Q174. Why are alloys often used instead of pure metals?
Answer: Alloys are stronger, harder, and more resistant to corrosion than pure metals. Pure metals can be soft and easily damaged. By mixing with other elements, alloys can be tailored to have the properties needed for specific uses, like stainless steel, which is stronger and doesn't rust easily.

Q175. What two metals are used to make bronze?
Answer: Bronze is made by mixing copper and tin. The tin gives the alloy strength and hardness, while the copper provides resistance to corrosion. Bronze is used in statues, coins, and tools due to its durability and attractive appearance.

Q176. What two metals are used to make brass?
Answer: Brass is made by combining copper and zinc. The mixture of these two metals creates an alloy that is harder and more durable than pure copper. The amount of zinc can vary depending on the desired strength and colour of the brass. It is often used for decorative purposes, musical instruments, and fittings due to its bright gold-like appearance and resistance to tarnishing.

Q177. Name three metals commonly used to make jewellery-grade gold alloys.
Answer: The three metals commonly added to gold to make jewellery-grade alloys are copper, silver, and zinc. These metals are mixed with pure gold to improve its strength, hardness, and durability. Copper adds a reddish tint and hardness, silver gives a lighter yellow colour, and zinc helps to reduce oxidation and improve casting. This alloying makes gold more suitable for daily wear.

Q178. What does 24 carat gold mean?
Answer: 24 carat gold means the gold is 100% pure with no other metals mixed in. It is the highest

possible carat value and contains 24 parts gold out of 24. Although it is very valuable, pure gold is soft and easily bent or scratched, so it is not usually used for everyday jewellery, which is why lower carat gold alloys are preferred for durability.

Q179. What percentage of gold is in 18 carat gold?
Answer: 18 carat gold contains 75% pure gold. This is calculated by dividing 18 by 24 (since carat is out of 24), which gives 0.75 or 75%. The remaining 25% is made up of other metals like copper, silver, or zinc. This alloy is commonly used in jewellery because it provides a good balance between purity and strength.

Q180. Describe the properties of high carbon steel.
Answer: High carbon steel is a strong, hard material that is less ductile and more brittle than low carbon steel. It contains a higher percentage of carbon, which increases its hardness and strength. However, it is less malleable and more prone to cracking under stress. It is used in tools, cutting instruments, and springs where strength is more important than flexibility.

Q181. What are the properties of low carbon steel?
Answer: Low carbon steel is relatively soft and malleable, meaning it can be shaped and bent without breaking. It contains a small amount of carbon, which gives it some strength but keeps it ductile and easy to work with. It is not as hard as high carbon steel, but it is more resistant to breaking under stress. It is commonly used in car bodies, construction, and wires.

Q182. Why is stainless steel useful for making kitchen utensils?
Answer: Stainless steel is resistant to rust and corrosion, which makes it ideal for kitchen use where it comes into contact with water and food. It is strong, durable, and easy to clean. The chromium in stainless steel forms a protective oxide layer on the surface that prevents rust, even with frequent washing. It also looks attractive and doesn't react with most foods.

Q183. Which metals are added to iron to make stainless steel?
Answer: Stainless steel is made by adding chromium and sometimes nickel to iron. Chromium helps form a passive layer of chromium oxide that protects the steel from corrosion. Nickel improves the overall corrosion resistance and makes the steel more ductile and lustrous. These added metals make stainless steel stronger and more durable than plain iron.

Q184. Why is stainless steel resistant to corrosion?
Answer: Stainless steel is resistant to corrosion because it contains chromium, which reacts with oxygen in the air to form a thin, invisible layer of chromium oxide on the surface. This layer acts as a barrier and prevents water and air from reacting with the iron underneath. If scratched, the layer reforms quickly, making the metal self-healing and long-lasting.

Q185. What is the main advantage of using aluminium alloys?
Answer: The main advantage of using aluminium alloys is their low density combined with increased strength. Pure aluminium is soft, but when alloyed with other elements like copper, magnesium, or

silicon, it becomes stronger while maintaining its lightweight nature. This makes aluminium alloys ideal for uses where reducing weight is important, such as in aircraft and cars.

Q186. Give one use of bronze and explain why it is suitable.
Answer: Bronze is often used to make statues and medals. It is suitable for this because it is hard, resistant to corrosion, and has an attractive appearance. The alloy of copper and tin gives bronze strength and durability, making it ideal for long-lasting outdoor sculptures. Its resistance to weathering and wear makes it ideal for decorative and functional purposes.

Q187. Give one use of brass and explain why it is suitable.
Answer: Brass is used in musical instruments like trumpets and trombones. It is suitable because it is easy to shape, has good acoustic properties, and resists corrosion. The combination of copper and zinc creates a metal that is strong but still workable, and it has a bright appearance. Its non-rusting quality also ensures the instruments stay in good condition.

Q188. Why are aluminium alloys used in aircraft manufacture?
Answer: Aluminium alloys are used in aircraft manufacture because they are strong yet lightweight, which improves fuel efficiency and performance. Reducing the aircraft's weight allows it to use less fuel and carry more load. The alloys also resist corrosion, which is important for long flights in various weather conditions. These properties make aluminium alloys ideal for the aviation industry.

Q189. How does adding carbon to iron change its properties?
Answer: Adding carbon to iron increases its hardness and strength but reduces its malleability and ductility. The more carbon added, the harder the steel becomes. This makes it suitable for tools and cutting instruments. However, too much carbon can make the steel brittle and prone to cracking. Adjusting the carbon content allows manufacturers to tailor the steel's properties for different uses.

Q190. Which alloy would you use to make a spring: high or low carbon steel? Why?
Answer: High carbon steel would be used to make a spring because it is harder and more elastic than low carbon steel. These properties allow the spring to bend and return to its original shape without deforming. The added carbon gives the steel the strength and toughness needed for repeated stress, making it suitable for mechanical and suspension springs.

Q191. A metal is 75% gold. How many carats is it?
Answer: If a metal is 75% gold, it is 18 carat gold. Carat is a measure of the purity of gold out of 24 parts. So, 75% of 24 is 18, which means the alloy contains 18 parts gold and 6 parts other metals. This level of purity gives the gold a good balance between appearance, value, and durability, which is why 18 carat gold is widely used in jewellery.

Q192. Why is pure gold not used for making jewellery?
Answer: Pure gold is not used for making jewellery because it is too soft and easily bent or scratched. This makes it unsuitable for items like rings or chains that are worn daily. To improve its

strength and durability, gold is alloyed with other metals like copper, silver, or zinc. These metals make the gold harder and more resistant to damage while keeping its attractive appearance.

Q193. What is meant by the density of a metal?

Answer: The density of a metal is the amount of mass it has in a given volume, usually measured in grams per cubic centimetre (g/cm³). It tells us how heavy a metal is for its size. A high-density metal feels heavier than a low-density one of the same size. Density affects how metals are used—for example, lightweight metals are better for transport or aerospace uses.

Q194. Why is low density an important property for aluminium alloys?

Answer: Low density is important for aluminium alloys because it makes them lightweight, which is crucial in industries like aerospace and transport. A lower weight means better fuel efficiency and easier handling. Even though aluminium is light, alloying it with other elements increases its strength, allowing it to be used in applications where both strength and low weight are required.

Q195. Describe one benefit of using an alloy over a pure metal.

Answer: One benefit of using an alloy over a pure metal is improved strength and durability. Pure metals are often too soft or reactive for practical use, but when mixed with other elements, their properties can be enhanced. For example, alloying iron with carbon makes steel, which is stronger and more versatile. Alloys can also be designed for specific purposes, such as resistance to corrosion or improved conductivity.

Q196. What is the role of tin in bronze?

Answer: Tin in bronze increases the hardness and strength of the alloy compared to pure copper. It also improves corrosion resistance, making bronze suitable for tools, statues, and marine hardware. The tin alters the structure of the copper, making it more wear-resistant and durable. This allows bronze to be used in situations where pure copper would be too soft or would corrode.

Q197. What is the role of zinc in brass?

Answer: Zinc in brass acts as a strengthening and hardening agent. It makes the alloy stronger than pure copper while still maintaining good workability. Zinc also affects the colour of brass, giving it a more golden tone. Additionally, zinc contributes to the corrosion resistance of brass, which is important in plumbing fittings and musical instruments where durability is needed.

Q198. How would you work out the percentage of gold in a given carat value?

Answer: To work out the percentage of gold in a carat value, divide the carat number by 24 and multiply by 100. For example, for 18 carat gold: (18 ÷ 24) × 100 = 75%. This formula tells you how much of the alloy is pure gold. It helps jewellers and customers understand the gold content and value of an item. A higher percentage means the item contains more pure gold.

Q199. Explain why alloying metals can improve their strength.

Answer: Alloying metals can improve their strength because the atoms of the added elements disrupt the regular structure of the base metal. This makes it harder for the layers of atoms to slide

over each other, which is what happens when a metal is bent or stretched. The disruption prevents deformation, making the alloy harder and more resistant to wear, stress, and corrosion.

Q200. Describe how you would evaluate whether a new alloy is suitable for building materials.
Answer: To evaluate whether a new alloy is suitable for building materials, you would test its mechanical properties like strength, flexibility, and resistance to corrosion. You would also assess its durability in different environmental conditions, cost-effectiveness, ease of manufacture, and long-term maintenance. Comparing it to existing materials helps determine if the alloy performs better and meets safety and design standards.

Q201. What are the raw materials used to make soda-lime glass?
Answer: The raw materials used to make soda-lime glass are sand (silicon dioxide), limestone (calcium carbonate), and sodium carbonate (soda). These materials are mixed and then heated to a very high temperature until they melt. Once melted, the mixture is cooled and solidified to form soda-lime glass, which is commonly used for windows and bottles due to its transparency and relatively low melting point.

Q202. Why does borosilicate glass melt at a higher temperature than soda-lime glass?
Answer: Borosilicate glass melts at a higher temperature than soda-lime glass because it contains boron trioxide (B_2O_3) in addition to the usual glass materials. This addition changes the structure of the glass, making it more resistant to heat and thermal shock. As a result, it has stronger bonds within its structure, requiring more energy (heat) to break them, hence the higher melting point.

Q203. Describe the process of making clay ceramics such as pottery and bricks.
Answer: Clay ceramics like pottery and bricks are made by shaping wet clay into the desired form and then heating it in a kiln at high temperatures. The heat removes water and causes chemical changes that harden the clay and give it strength. This process is called firing. The result is a strong, brittle material that is resistant to heat and often waterproof, making it ideal for building materials and containers.

Q204. What is the role of sodium carbonate in the production of soda-lime glass?
Answer: Sodium carbonate is added to the glass mixture to lower the melting point of silicon dioxide (sand). This makes the manufacturing process more energy efficient and easier, as it allows the sand to melt at a lower temperature. Without sodium carbonate, sand would require extremely high temperatures to melt, which would be impractical and expensive for large-scale glass production.

Q205. How does the structure of thermosetting polymers differ from thermosoftening polymers?
Answer: Thermosetting polymers have a structure with strong cross-links between the polymer chains. These cross-links form a rigid three-dimensional network that does not melt or soften when heated. In contrast, thermosoftening polymers consist of individual polymer chains that are not chemically bonded to each other. These chains can slide past one another when heated, making them soft and flexible.

Q206. What monomer is used to make both low density and high density poly(ethene)?
Answer: The monomer used to make both low density (LD) and high density (HD) poly(ethene) is ethene (C_2H_4). The difference between LD and HD poly(ethene) lies in the conditions used during polymerisation, such as temperature, pressure, and the use of catalysts, which affect the arrangement and density of the polymer chains.

Q207. How does changing the conditions affect the type of poly(ethene) formed?
Answer: Changing the reaction conditions affects the structure and properties of poly(ethene). High-pressure and high-temperature conditions produce low density poly(ethene) (LDPE), which has branched chains and is more flexible. Using lower pressure, a catalyst, and controlled temperature produces high density poly(ethene) (HDPE), which has straight chains packed closely together, making it more rigid and stronger.

Q208. Why do thermosetting polymers not melt when heated?
Answer: Thermosetting polymers do not melt when heated because they have strong covalent cross-links between the polymer chains. These cross-links form a rigid network that prevents the chains from moving, even when heat is applied. Instead of melting, thermosetting polymers will char or burn when exposed to high temperatures, which makes them ideal for high-heat applications.

Q209. What allows thermosoftening polymers to be reshaped after heating?
Answer: Thermosoftening polymers can be reshaped after heating because they do not have cross-links between their polymer chains. The weak intermolecular forces between the chains allow them to slide past each other when heat is applied, making the material soft and flexible. Once cooled, the material hardens again, allowing it to be remoulded multiple times.

Q210. How does cross-linking in thermosetting polymers affect their properties?
Answer: Cross-linking in thermosetting polymers creates a strong and rigid three-dimensional structure. This structure gives thermosetting polymers high thermal and chemical resistance and prevents them from melting when heated. It also makes them harder and more durable but less flexible than thermosoftening polymers. Once set, they cannot be reshaped, making them suitable for permanent applications.

Q211. What are the main differences in the structure of LD poly(ethene) and HD poly(ethene)?
Answer: LD poly(ethene) has a branched structure, meaning the polymer chains have side branches that prevent them from packing closely together. This gives LDPE a lower density, making it softer and more flexible. In contrast, HD poly(ethene) has straight, unbranched chains that pack tightly together, resulting in a higher density, stronger, and more rigid material.

Q212. What type of polymer would you use for making plastic bottles and why?
Answer: High density poly(ethene) (HDPE) is commonly used for making plastic bottles because it is strong, rigid, and resistant to impact. Its closely packed polymer chains give it the durability needed to hold liquids without breaking or deforming. Additionally, HDPE is resistant to many chemicals and does not leach harmful substances, making it safe for storing food and drink.

Q213. What is the function of a matrix in a composite material?

Answer: The matrix in a composite material acts as the binding substance that surrounds and holds the reinforcement in place. It helps to distribute the load evenly across the material, protects the reinforcement from damage and corrosion, and maintains the shape and structure of the composite. The matrix also helps transfer stress between the reinforcement particles or fibres.

Q214. What is the function of the reinforcement in a composite?

Answer: The reinforcement in a composite provides strength and rigidity. It is the main component responsible for enhancing the mechanical properties of the material, such as tensile strength, toughness, and impact resistance. Reinforcements can be fibres or particles, and their role is to resist deformation and absorb stresses, improving the overall performance of the composite.

Q215. Give two examples of composite materials used in daily life.

Answer: Two common examples of composite materials used in daily life are fiberglass and reinforced concrete. Fiberglass consists of glass fibres embedded in a plastic matrix and is used in car bodies, boats, and helmets. Reinforced concrete contains steel bars within concrete to improve its strength and is widely used in buildings, bridges, and roads.

Q216. How does the structure of a composite affect its overall properties?

Answer: The structure of a composite, including the type of matrix and reinforcement, affects its overall strength, flexibility, weight, and durability. A well-designed composite has a strong interaction between the matrix and reinforcement, allowing the material to withstand stress and resist wear and tear. The arrangement and proportion of components determine how the composite behaves under different conditions.

Q217. Compare the properties of soda-lime glass and borosilicate glass.

Answer: Soda-lime glass is less resistant to heat and thermal shock compared to borosilicate glass. It melts at a lower temperature and is more likely to crack with rapid temperature changes. Borosilicate glass, on the other hand, is made with boron trioxide, which improves its heat resistance and makes it more durable for laboratory glassware and kitchen use. Both are transparent, but borosilicate is stronger and more reliable in high-heat situations.

Q218. Compare the properties of glass and clay ceramics in terms of strength and thermal resistance.

Answer: Glass is generally more transparent and smoother but can be more brittle and prone to shattering. It has moderate thermal resistance, especially borosilicate types. Clay ceramics, like pottery and bricks, are opaque and more porous but have better heat insulation properties. They are also strong under compression and retain their shape at high temperatures, making them suitable for construction and cooking uses.

Q219. In what situation would clay ceramics be a better choice than metal?

Answer: Clay ceramics are a better choice than metals when heat insulation and corrosion resistance are needed, such as in cooking pots, bricks, and tiles. They do not rust, are less

expensive, and do not conduct electricity or heat as easily as metals. This makes them suitable for applications where heat retention or electrical insulation is more important than flexibility or tensile strength.

Q220. What properties make polymers suitable for food packaging?
Answer: Polymers used in food packaging are lightweight, flexible, and resistant to moisture and chemicals. They form airtight seals that help keep food fresh by preventing contamination and spoiling. Many food-grade polymers are transparent, allowing visibility of contents, and are easily shaped into films and containers. Some polymers are also biodegradable or recyclable, helping reduce environmental impact.

Q221. Why are metals often used in electrical wiring instead of polymers?
Answer: Metals are used in electrical wiring because they are excellent conductors of electricity. Materials like copper and aluminium have free-moving electrons that allow electric current to flow easily. Polymers, on the other hand, are insulators and do not conduct electricity, which is why they are used as coatings or casings for wires to prevent electric shocks and short circuits.

Q222. Describe how the properties of a composite can be tailored by changing the matrix and reinforcement.
Answer: The properties of a composite can be adjusted by choosing different types of matrix materials (such as plastic, metal, or ceramic) and reinforcements (such as glass fibres, carbon fibres, or metal particles). For example, using a flexible matrix with strong fibres can produce a tough yet lightweight material. Adjusting the amount and orientation of reinforcement can also change the strength, stiffness, and resistance to heat or chemicals.

Q223. What is one disadvantage of using thermosoftening polymers in high-temperature environments?
Answer: One major disadvantage of using thermosoftening polymers in high-temperature environments is that they soften and may melt when exposed to heat. This limits their use in situations where they must maintain shape and strength under high temperatures. As a result, they can become deformed or fail if used in electrical appliances, ovens, or car engine parts where heat is constantly present.

Q224. Why are thermosetting polymers used in plug sockets and electrical casings?
Answer: Thermosetting polymers are used in plug sockets and electrical casings because they are heat-resistant and do not melt when exposed to high temperatures. They also act as electrical insulators, which makes them safe for use around electricity. Their rigid structure helps them maintain shape and protect internal components, reducing the risk of fire or electric shock.

Q225. How does the flexibility of LD poly(ethene) make it useful in certain products?
Answer: The flexibility of low density poly(ethene) (LDPE) makes it ideal for use in plastic bags, cling film, squeeze bottles, and packaging. Its branched structure allows it to bend and stretch easily

without breaking. This flexibility makes it easy to shape and wrap around items, providing protection and convenience, especially in consumer goods and food storage applications.

Q226. What does the density of a polymer tell you about its molecular structure?
Answer: The density of a polymer tells you how closely packed its polymer chains are. A high-density polymer means that the chains are packed tightly together, often with fewer branches, which makes the material stronger and less flexible. A low-density polymer has more branching and more space between the chains, making it softer and more flexible. So, density is linked to the arrangement and packing of the molecules in the structure.

Q227. Why do thermosoftening polymers have lower melting points than thermosetting polymers?
Answer: Thermosoftening polymers have lower melting points because they have weak intermolecular forces between the polymer chains. These forces are easy to overcome when heated, allowing the polymer to soften and melt. In contrast, thermosetting polymers have strong covalent bonds forming cross-links between chains, which do not break easily with heat, giving them much higher melting points.

Q228. What property of thermosetting polymers makes them ideal for use in frying pan handles?
Answer: Thermosetting polymers are ideal for frying pan handles because they do not melt or soften when heated. They have strong covalent cross-links between polymer chains that give them high thermal resistance and maintain their shape and strength at high temperatures, making them safe and durable for handling hot cookware.

Q229. Explain how the structure of a polymer affects whether it is thermosetting or thermosoftening.
Answer: The structure of a polymer affects its thermal behaviour based on the presence or absence of cross-links. Thermosoftening polymers have linear or branched chains with weak intermolecular forces, allowing them to melt when heated. Thermosetting polymers, however, have a rigid three-dimensional network due to covalent cross-links between chains, making them set permanently after being heated once.

Q230. Which type of polymer would be more suitable for injection moulding and why?
Answer: Thermosoftening polymers are more suitable for injection moulding because they can be melted, reshaped, and cooled multiple times without undergoing chemical changes. Their weak intermolecular forces allow them to be easily moulded into different shapes under heat and pressure, making them ideal for mass production processes like injection moulding.

Q231. What is the difference between the bonding in thermosoftening and thermosetting polymers?
Answer: The bonding difference lies in the type and strength of forces between chains. Thermosoftening polymers have only weak intermolecular forces between their chains, which can be

broken by heating. Thermosetting polymers, however, have strong covalent bonds forming cross-links between chains, which do not break with heat and make the material hard and heat-resistant.

Q232. How do intermolecular forces affect the properties of thermosoftening polymers?
Answer: In thermosoftening polymers, the weak intermolecular forces allow the chains to slide past each other when heated. This makes them flexible, soft, and able to melt when heated. The weakness of these forces gives thermosoftening polymers their ability to be reshaped and moulded, which is useful for making products that need to be formed into different shapes.

Q233. How does adding plasticisers to polymers change their properties?
Answer: Plasticisers are added to polymers to make them softer and more flexible. They work by getting between the polymer chains and reducing the forces between them. This allows the chains to move more freely, making the material less brittle and easier to bend. Plasticisers are commonly used in materials like PVC to make them suitable for flexible products like cables and hoses.

Q234. What property of clay allows it to be shaped before heating?
Answer: Clay contains tiny particles that can hold water. When clay is wet, the water acts as a lubricant between the particles, allowing them to slide over each other. This makes the clay soft and mouldable so it can be shaped into different forms. Once it is shaped, the clay is heated to harden and set it permanently.

Q235. Why does wet clay become hard when heated?
Answer: When wet clay is heated, the water evaporates and the clay particles bond more tightly together. The heating process causes chemical changes and the formation of strong bonds between the particles, making the structure hard and rigid. This process is known as firing and it transforms the soft, mouldable clay into a solid ceramic material.

Q236. What is one limitation of using clay ceramics compared to metals?
Answer: One limitation of clay ceramics is that they are brittle and can break easily if dropped or hit with force. Unlike metals, which can bend and absorb impact without breaking, ceramics are not very tough and can crack or shatter under stress. This makes them less suitable for applications where strength and flexibility are important.

Q237. What are the advantages of using composites in construction?
Answer: Composites are often stronger and more durable than the individual materials they are made from. They can be designed to have specific properties like high strength-to-weight ratio, resistance to corrosion, and improved thermal stability. In construction, this means structures can be lighter, longer-lasting, and more resistant to weather and chemical damage compared to traditional materials.

Q238. What property of borosilicate glass makes it suitable for laboratory glassware?
Answer: Borosilicate glass is resistant to thermal shock, meaning it can withstand sudden temperature changes without cracking. This is important in laboratory settings where glassware may

be heated and cooled repeatedly. Its durability and resistance to chemical corrosion also make it ideal for handling various chemicals safely.

Q239. Why are composites often more expensive to produce than single-material products?
Answer: Composites are more expensive because they involve combining multiple materials, often through complex processes. The manufacturing steps may require special equipment, more time, and skilled labour to ensure the different components bond properly and produce the desired properties. Also, some reinforcing materials like carbon fibre are costly to produce.

Q240. Give an example of a composite used in aerospace engineering and explain its benefit.
Answer: Carbon fibre-reinforced polymer is a common composite used in aerospace. It combines the strength and stiffness of carbon fibres with the light weight of a plastic matrix. This makes it ideal for aircraft parts because it reduces the overall weight of the aircraft, improving fuel efficiency, while still being strong enough to handle the stress of flight.

Q241. What is meant by the term "matrix" in the context of composite materials?
Answer: In a composite material, the matrix is the main substance that holds everything together. It surrounds and supports the reinforcement (like fibres) and transfers forces between them. The matrix also protects the reinforcement from damage and environmental effects. It can be made of polymers, metals, or ceramics depending on the composite's purpose.

Q242. Why might a manufacturer choose a polymer over a metal for a specific product?
Answer: A manufacturer might choose a polymer instead of a metal because polymers can be lighter, cheaper, corrosion-resistant, and easier to mould into different shapes. For example, in making containers, insulation, or certain machine parts, polymers are more practical because they reduce weight and cost, and they don't rust like metals.

Q243. Why are clay bricks used for building rather than soda-lime glass?
Answer: Clay bricks are strong, heat-resistant, and durable, making them ideal for building structures. They can support weight and insulate heat effectively. Soda-lime glass, on the other hand, is brittle and can break easily. It also does not provide good insulation or strength for structural purposes, so it's more suitable for windows than for walls.

Q244. How can the thermal resistance of a material affect its application?
Answer: Materials with high thermal resistance can withstand heat without melting or breaking down. This makes them suitable for use in products that are exposed to high temperatures, like ovenware or engine parts. Materials with low thermal resistance would not be suitable in such applications, as they would deform or fail under heat.

Q245. Why is high-density poly(ethene) less flexible than low-density poly(ethene)?
Answer: High-density poly(ethene) has straight polymer chains that pack closely together, making the material harder and more rigid. In contrast, low-density poly(ethene) has branched chains that

prevent tight packing, resulting in a softer and more flexible material. The structure affects how the chains move and how tightly they are held together.

Q246. What does the arrangement of polymer chains tell you about its density?
Answer: If polymer chains are straight and packed closely together, the polymer has a high density. If the chains are branched or irregular and spaced apart, the density is lower. The arrangement of the chains directly affects how tightly the material is packed, which influences its strength, flexibility, and melting point.

Q247. What makes glass transparent, and why is this property useful?
Answer: Glass is transparent because its structure does not absorb visible light. Light passes through without being scattered much because the atoms are arranged in a way that doesn't interrupt the light's path. This property is useful for windows, lenses, and screens where visibility and light transmission are important.

Q248. How are the physical properties of composites better than the individual materials?
Answer: Composites combine the strengths of different materials. For example, a fibre may provide strength while the matrix gives flexibility. Together, the composite can be stronger, lighter, more durable, or more resistant to damage than each component on its own. This allows for custom materials tailored to specific performance needs.

Q249. What type of structure does thermosetting plastic have that prevents melting?
Answer: Thermosetting plastics have a cross-linked structure made of strong covalent bonds between polymer chains. This rigid three-dimensional network holds the chains in place and prevents them from moving or sliding past each other when heated. As a result, the plastic does not melt but instead retains its shape or chars.

Q250. Describe one situation where a composite is better than a polymer.
Answer: In making bicycle frames, a composite like carbon fibre-reinforced polymer is better than a regular polymer because it offers high strength and stiffness while staying lightweight. A pure polymer would not provide enough strength for the load and stress during cycling. The composite gives better performance and durability for demanding use.

Q251. What is the Haber process used to manufacture?
Answer: The Haber process is used to manufacture ammonia. Ammonia is an important chemical used in the production of fertilisers, explosives, and cleaning products. It is especially important for making nitrogen-based fertilisers that help crops grow, supporting global food production.

Q252. Name the two raw materials required for the Haber process.
Answer: The two raw materials required for the Haber process are nitrogen and hydrogen. Nitrogen is usually obtained from the air, while hydrogen is typically produced from natural gas or other hydrocarbons through processes such as steam reforming.

Q253. What is the source of nitrogen for the Haber process?
Answer: Nitrogen is obtained from the air, which contains about 78% nitrogen. The nitrogen is separated from the air by liquefying it and then using fractional distillation to isolate the nitrogen gas for use in the Haber process.

Q254. What is the source of hydrogen for the Haber process?
Answer: Hydrogen is mainly obtained by reacting methane from natural gas with steam in a process called steam reforming. This reaction produces hydrogen gas and carbon monoxide. The hydrogen is then separated and purified before being used in the Haber process.

Q255. What catalyst is used in the Haber process?
Answer: Iron is used as the catalyst in the Haber process. It helps increase the rate of reaction between nitrogen and hydrogen to form ammonia without being used up in the reaction. The iron catalyst allows the reaction to proceed faster and at a lower temperature than it would without the catalyst.

Q256. What temperature is used in the Haber process?
Answer: The Haber process is carried out at a temperature of around 450°C. This temperature is a compromise between a reasonable rate of reaction and a decent yield of ammonia, as lower temperatures would increase yield but make the reaction too slow.

Q257. What pressure is used in the Haber process?
Answer: The pressure used in the Haber process is around 200 atmospheres (approximately 20 MPa). High pressure helps increase the yield of ammonia, as the forward reaction involves fewer gas molecules and is favoured by high pressure according to Le Chatelier's Principle.

Q258. Write the balanced word equation for the Haber process.
Answer: Nitrogen + Hydrogen ⇌ Ammonia. This means that nitrogen gas reacts with hydrogen gas to form ammonia in a reversible reaction, which reaches a dynamic equilibrium under controlled conditions.

Q259. Why is the Haber process described as a reversible reaction?
Answer: The Haber process is described as a reversible reaction because ammonia can break down back into nitrogen and hydrogen under the same conditions. This means both the forward and reverse reactions can happen, and a balance is eventually reached between the two, called dynamic equilibrium.

Q260. What happens to ammonia when the gases are cooled?
Answer: When the gases are cooled after the reaction, ammonia condenses into a liquid because it has a higher boiling point than nitrogen and hydrogen. This allows ammonia to be removed from the gas mixture, while the unreacted nitrogen and hydrogen can be recycled.

Q261. What happens to the unreacted nitrogen and hydrogen after cooling?
Answer: After the ammonia is removed by cooling and condensing it, the unreacted nitrogen and

hydrogen gases are collected and recycled back into the reaction chamber. This makes the process more efficient and reduces waste of raw materials.

Q262. Why is iron used as a catalyst in the Haber process?
Answer: Iron is used as a catalyst in the Haber process because it speeds up the rate at which nitrogen and hydrogen react to form ammonia. It lowers the activation energy needed for the reaction and allows the process to happen more efficiently at lower temperatures and costs.

Q263. Why is 450°C used instead of a lower temperature to favour ammonia production?
Answer: Although a lower temperature would favour the production of ammonia (because the reaction is exothermic), the rate of reaction would be too slow at lower temperatures. 450°C is chosen as a compromise—it is hot enough for a reasonable reaction rate and still gives a fair yield of ammonia.

Q264. Why is high pressure used in the Haber process?
Answer: High pressure is used in the Haber process because it shifts the position of equilibrium towards the production of ammonia. Since the reaction reduces the number of gas molecules (from 4 to 2), high pressure helps increase the ammonia yield by favouring the forward reaction.

Q265. Why is pressure not increased further than 200 atmospheres?
Answer: Increasing the pressure further than 200 atmospheres would increase ammonia yield slightly, but it would be very costly and dangerous. High-pressure equipment is expensive and requires more energy to operate, so 200 atmospheres is a good compromise between cost and efficiency.

Q266. How does increasing temperature affect the position of equilibrium in the Haber process?
Answer: Increasing the temperature shifts the position of equilibrium towards the reactants because the forward reaction (making ammonia) is exothermic. This means that high temperatures reduce the ammonia yield, although they do increase the rate of reaction.

Q267. How does increasing pressure affect the position of equilibrium in the Haber process?
Answer: Increasing the pressure shifts the position of equilibrium towards the production of ammonia. This is because the forward reaction results in fewer gas molecules (4 molecules become 2), and high pressure favours the side with fewer gas molecules.

Q268. What is the effect of a catalyst on the rate of the Haber process?
Answer: A catalyst increases the rate of the Haber process by lowering the activation energy needed for the reaction between nitrogen and hydrogen. It allows the reaction to proceed faster without affecting the equilibrium position or the yield of ammonia.

Q269. Explain the trade-off between yield and rate in the Haber process.
Answer: In the Haber process, lower temperatures give a higher yield of ammonia but make the reaction very slow. Higher temperatures increase the rate of reaction but lower the ammonia yield.

Therefore, a compromise temperature (around 450°C) is used to balance a good yield with a reasonable reaction speed.

Q270. Why is ammonia removed as a liquid during the Haber process?
Answer: Ammonia is removed as a liquid because it has a higher boiling point than nitrogen and hydrogen. Cooling the gas mixture after the reaction condenses the ammonia, allowing it to be separated easily. This also shifts the equilibrium to produce more ammonia as it is removed.

Q271. What is meant by dynamic equilibrium?
Answer: Dynamic equilibrium is the state reached in a reversible reaction when the rate of the forward reaction is equal to the rate of the reverse reaction. At this point, the concentrations of reactants and products remain constant, although both reactions are still happening.

Q272. What would happen to the equilibrium position if the temperature in the Haber process was reduced?
Answer: If the temperature in the Haber process was reduced, the equilibrium position would shift towards the products, increasing the ammonia yield. However, the rate of reaction would also decrease, meaning it would take much longer to reach equilibrium.

Q273. How is ammonia used to produce fertilisers?
Answer: Ammonia is used to produce fertilisers by reacting it with acids such as nitric acid to make ammonium nitrate. It can also be used to make ammonium phosphate and urea. These compounds are rich in nitrogen, an essential nutrient for plant growth in agriculture.

Q274. Name three elements found in NPK fertilisers.
Answer: NPK fertilisers contain nitrogen (N), phosphorus (P), and potassium (K). These three elements are essential for healthy plant growth: nitrogen helps with leaf development, phosphorus supports root growth, and potassium improves flower and fruit production.

Q275. What is the role of fertilisers in agriculture?
Answer: Fertilisers provide essential nutrients to the soil that plants need to grow. They help increase crop yields by ensuring plants receive enough nitrogen, phosphorus, and potassium. Fertilisers improve soil fertility and help farmers produce more food efficiently on the same land.

Q276. What does NPK stand for in NPK fertilisers?
Answer: NPK stands for Nitrogen (N), Phosphorus (P), and Potassium (K), which are the three essential elements found in compound fertilisers. These elements are important for plant growth. Nitrogen promotes leafy growth, phosphorus supports root development and flower/fruit production, and potassium helps with overall plant health and resistance to disease.

Q277. Name one compound of nitrogen used in NPK fertilisers.
Answer: One compound of nitrogen commonly used in NPK fertilisers is ammonium nitrate (NH_4NO_3). This compound is widely used because it provides both fast-release nitrate and

slower-release ammonium forms of nitrogen, which helps ensure a consistent supply for plant growth over time.

Q278. Name one compound of phosphorus used in NPK fertilisers.
Answer: One compound of phosphorus used in NPK fertilisers is ammonium phosphate ($(NH_4)_3PO_4$). This compound supplies phosphorus in a form that plants can easily absorb and also provides some nitrogen. Phosphorus is essential for energy transfer and root development in plants.

Q279. Name one compound of potassium used in NPK fertilisers.
Answer: One compound of potassium used in NPK fertilisers is potassium chloride (KCl). It is commonly used because it is cost-effective and provides a soluble form of potassium, which is vital for water regulation and enzyme activation in plants.

Q280. How is nitric acid made from ammonia?
Answer: Nitric acid is made from ammonia in the Ostwald process. In this process, ammonia is oxidised in the presence of a platinum-rhodium catalyst at high temperature and pressure to form nitrogen monoxide (NO). This gas is further oxidised to nitrogen dioxide (NO_2), which is then dissolved in water to form nitric acid (HNO_3). This method is widely used in the industry.

Q281. Why can't phosphate rock be used directly as a fertiliser?
Answer: Phosphate rock cannot be used directly as a fertiliser because it is insoluble in water and therefore cannot be absorbed by plant roots. To make it useful for plants, it must be processed with acids to produce soluble phosphate compounds that plants can take in through their roots and use in metabolic processes.

Q282. What acid is used to treat phosphate rock to make ammonium nitrate?
Answer: Nitric acid (HNO_3) is used to treat phosphate rock to make ammonium nitrate. When phosphate rock reacts with nitric acid, it produces phosphoric acid and calcium nitrate, and the phosphoric acid is then reacted with ammonia to produce ammonium phosphate, which is a key ingredient in NPK fertilisers.

Q283. What is formed when phosphate rock reacts with nitric acid?
Answer: When phosphate rock reacts with nitric acid, it forms phosphoric acid and calcium nitrate. The phosphoric acid can be used further to make fertilisers like ammonium phosphate. This process increases the solubility and usability of phosphorus for plant uptake.

Q284. What is formed when phosphate rock reacts with sulfuric acid?
Answer: When phosphate rock reacts with sulfuric acid, it forms a mixture called single superphosphate. This mixture contains calcium sulfate and calcium phosphate, which are more soluble and can be absorbed by plants more effectively than untreated phosphate rock.

Q285. What is formed when phosphate rock reacts with phosphoric acid?
Answer: When phosphate rock reacts with phosphoric acid, it forms triple superphosphate. This

product is rich in phosphorus and is more concentrated than single superphosphate, making it more effective as a fertiliser for boosting root development and flowering in plants.

Q286. What is the purpose of treating phosphate rock with acids?
Answer: The purpose of treating phosphate rock with acids is to convert the insoluble phosphate into soluble forms that plants can absorb. This treatment makes the phosphorus available in the soil for plant roots, increasing the effectiveness of the fertiliser and improving crop yields.

Q287. Compare the production of fertilisers in the lab and in industry in terms of scale.
Answer: In the lab, fertilisers are produced in small quantities using batch processes for learning or testing. In contrast, industrial production is carried out on a much larger scale, often continuously, to meet high demand. Industrial methods are more efficient and economical for mass production.

Q288. Compare the purity of fertilisers made in the lab and in industry.
Answer: Fertilisers made in the lab are usually purer because precise amounts of reactants are used and contaminants are avoided. In industry, although the processes are efficient, the products may contain small impurities due to large-scale equipment and conditions, though these are usually safe and acceptable for agricultural use.

Q289. Describe one safety precaution taken when preparing fertilisers in a laboratory.
Answer: One safety precaution is wearing protective clothing such as goggles, gloves, and a lab coat to avoid contact with corrosive acids like nitric or sulfuric acid. Using a fume hood is also important to prevent inhalation of harmful fumes during reactions involving ammonia or acids.

Q290. Why are formulations used in fertilisers?
Answer: Formulations are used in fertilisers to combine different essential nutrients in specific proportions tailored for different plant needs and soil conditions. This ensures that plants get a balanced supply of nitrogen, phosphorus, and potassium, improving growth and reducing nutrient waste.

Q291. What is meant by the term "formulation"?
Answer: A formulation is a mixture that has been designed as a useful product by combining specific amounts of substances. In the context of fertilisers, a formulation includes the right balance of nutrients and additives to suit particular types of crops or soil conditions.

Q292. Name a salt that can be made by reacting ammonia with nitric acid.
Answer: A salt that can be made by reacting ammonia with nitric acid is ammonium nitrate (NH_4NO_3). This salt is commonly used in fertilisers because it provides both nitrogen in the ammonium and nitrate forms, which plants can easily absorb.

Q293. Why is ammonium nitrate a useful fertiliser?
Answer: Ammonium nitrate is a useful fertiliser because it contains two forms of nitrogen: ammonium and nitrate. Plants can absorb both forms, which helps them grow quickly and healthily. It is highly soluble in water, so it is effective for delivering nitrogen directly to plant roots.

Q294. Why are integrated processes used in the production of NPK fertilisers?
Answer: Integrated processes are used in the production of NPK fertilisers to increase efficiency, reduce costs, and minimise waste. These processes allow for the reuse of by-products, better energy use, and continuous operation, making production more sustainable and economically viable.

Q295. What are the advantages of recycling unreacted nitrogen and hydrogen in the Haber process?
Answer: Recycling unreacted nitrogen and hydrogen in the Haber process improves efficiency by reducing waste and saving on raw materials. It increases the overall yield of ammonia without needing more reactants, making the process more cost-effective and environmentally friendly.

Q296. Why is ammonia removed from the reaction mixture in the Haber process?
Answer: Ammonia is removed from the reaction mixture in the Haber process because the reaction is reversible. Removing the ammonia shifts the equilibrium towards the products, encouraging the formation of more ammonia and increasing the overall yield according to Le Chatelier's Principle.

Q297. Why is ammonia stored as a liquid in industry?
Answer: Ammonia is stored as a liquid in industry to reduce its volume and make storage and transport easier and safer. Liquid ammonia is more stable and less likely to escape into the air compared to its gaseous form, reducing the risk of toxic exposure and loss.

Q298. What type of reaction is ammonia reacting with an acid to form a salt?
Answer: The reaction of ammonia with an acid to form a salt is a neutralisation reaction. Ammonia acts as a base and reacts with an acid like nitric acid to produce a salt such as ammonium nitrate, releasing water in the process.

Q299. Why is the reaction between ammonia and nitric acid exothermic?
Answer: The reaction between ammonia and nitric acid is exothermic because it releases energy when new bonds are formed in the product, ammonium nitrate. The energy released is greater than the energy needed to break the bonds in the reactants, resulting in a temperature increase.

Q300. Explain how the availability and cost of energy affects the conditions used in the Haber process.
Answer: The Haber process requires high temperature and pressure, which consume a lot of energy. If energy is expensive or in limited supply, it becomes important to optimise conditions to reduce costs. Lowering temperature increases yield but slows the reaction, so a balance is needed. Efficient catalysts and recycling gases help save energy, making the process more sustainable and economically viable.