

NATURAL SCIENCES GRADE 9

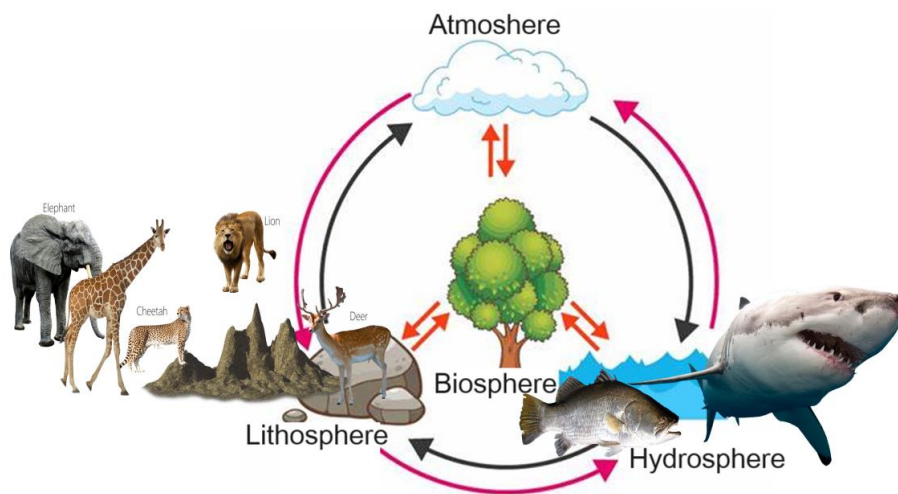
TEACHER GUIDE



EARTH AND BEYOND

SPHERES OF THE EARTH

- (a) The Earth makes up a system that allows the interaction of spheres.
- (b) The following are the spheres of the Earth:



- Atmosphere – it is the protective layer of gases.
- Hydrosphere – the water part of the Earth.
- Lithosphere – the rock and soil part of the Earth.
- Biosphere – the part of the Earth where organisms live and their requirements.

Answer the following questions:

1. What are the four spheres of the Earth?

- _____
- (a) Atmosphere
(b) Hydrosphere
(c) Lithosphere
(d) Biosphere

2. Describe each of the four spheres of the Earth.

- _____

- (a) Atmosphere – it is the protective layer of gases.
(b) Hydrosphere – the water part of the Earth.
(c) Lithosphere – the rock and soil part of the Earth.
(d) Biosphere – the part of the Earth where organisms live and their requirements.

3. What is a biosphere?

-
- Biosphere – the part of the Earth where organisms live and their requirements.

4. Mention organisms found in each sphere.

-
- Atmosphere - animals and plants
 - Hydrosphere – water animals and water plants
 - Lithosphere - insects, reptiles, worms etc.
 - Biosphere – all living organisms

LITHOSPHERE

(a) The lithosphere is the rocky rigid part of the Earth.

(b) The lithosphere includes soils, rocks, mountains, valleys, cliffs, land etc.

(c) The Lithosphere consists of three layers; viz. the **Core, Mantle and Crust**.

(d) The Inner core is solid while the outer core is liquid.

(e) The Mantle is the bigger part of the lithosphere, about 2900 km deep.

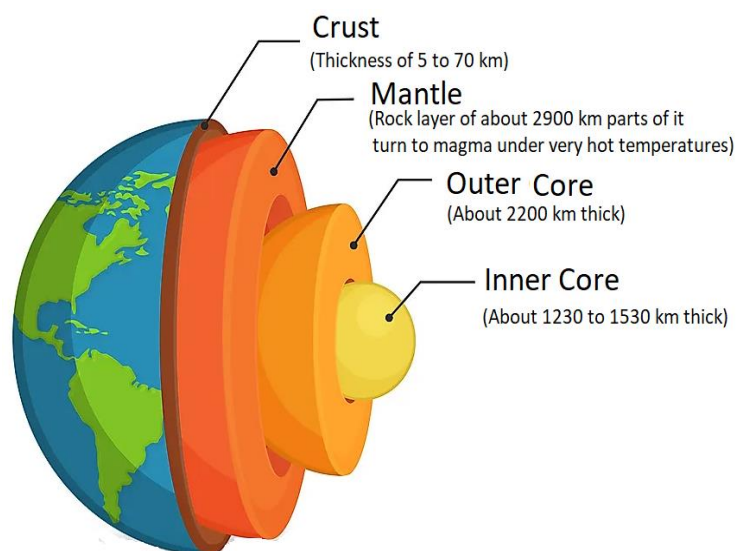
(f) The Mantle is 2900 km deep and is mainly magma with temperatures of up to 4500 °C.

(g) The Crust is the outer layer of the Earth and is like the skin of the Earth.

(h) Elements and compounds are found in the crust.

(i) Elements found in the earth's crust include copper, uranium, gold, silver, and

(j) Compounds producing minerals include iron oxide (hematite), silicon dioxide (sand or quartz) and calcium carbonate (chalk, lime or marble).



Answer the following questions:

1. What are the layers of the lithosphere?

-
- **Answer: The Core, Mantle and Crust.**

2. What do we find in the crust layer of the Earth?

-
- Answer: Elements, compounds, minerals and rocks.

3. Mention five elements found in the Earth's crust.

-
- Answer: About 98 % comprise copper, uranium, gold, silver, oxygen, silicon, aluminium, iron, calcium, sodium, potassium and magnesium

4. Which compounds are found in the lithosphere?

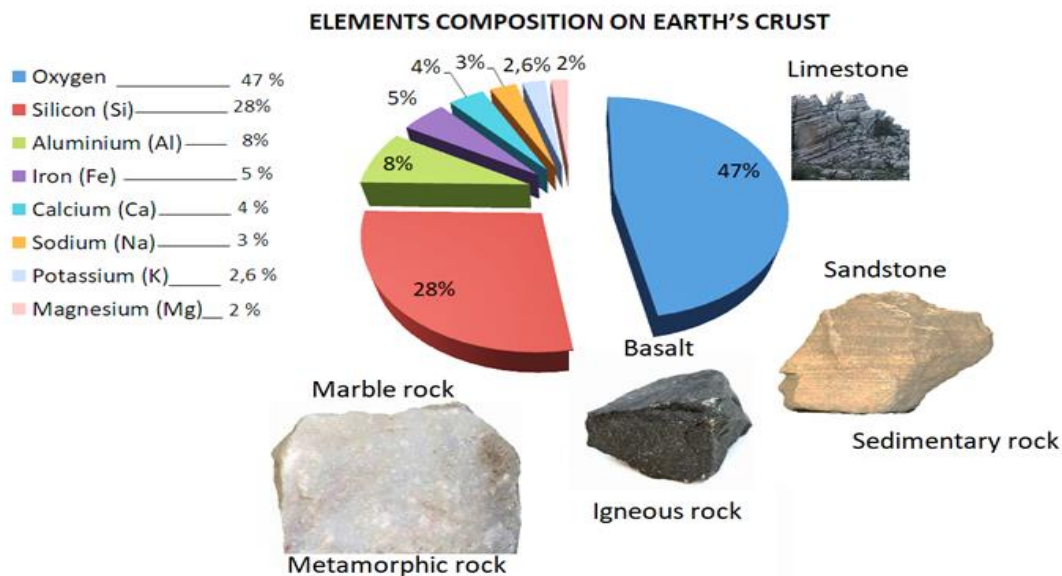
-
- Answer: iron oxide (hematite), silicon dioxide (sand or quartz) and calcium carbonate (chalk, lime or marble).

5. Which metals are obtained from the compounds iron oxide, sand and calcium carbonate?

-
- Answer: Iron (hematite), silicon (sand) and calcium

ELEMENTS ON THE EARTH'S CRUST

Use the diagram to answer some of the questions that follow:



1. List the elements found in the Earth's crust.

-
- Answer: oxygen, silicon, aluminium, iron, calcium, sodium, potassium and magnesium.

2. What are the percentages on the elements in the Earth's crust?

-
- Answer: oxygen 47%, silicon 28 %, aluminium 8 %, iron 5 %, calcium 4 %, sodium 3%, potassium 2.6 % and magnesium 2%.

3. Give examples of some stones found in the Lithosphere and the main rock they belong to. _____

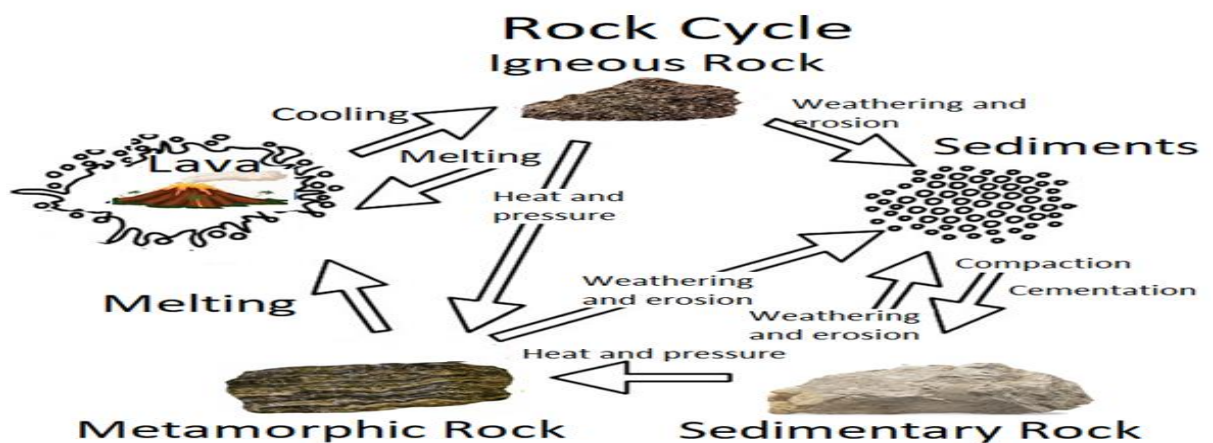
- Answer: Marble rock from metamorphic rock, basalt from igneous rock, sand stone and lime stone from sedimentary rock.

4. Discuss the difference between a rock and a stone.

-
- Answer: A stone would be smaller than and rock and rock is made of stone and mineral matter.

ROCK CYCLE

- (a) The rock cycle explains how the three main types of rocks change from one form to another.
- (b) The three main rock types are sedimentary, metamorphic, and igneous.
- (c) Metamorphic rock melts into magma when heat and pressure build up around it.
- (d) Magma is molten material that erupts from volcanoes.
- (e) When magma cools, it hardens and becomes igneous rock.
- (f) Sedimentary rock is made from sediments (small particles of rock and material).



- (g) Erosion and weathering (from heat, cold, wind, and water) break down rocks into smaller pieces.
- (h) These particles are transported and settle on top of each other, forming layers of sediments.
- (i) Heat and pressure can change the structure of rock, turning it into metamorphic rock.
- (j) If heat builds up around metamorphic rock, it melts into magma.
- (k) Magma is molten or semi-molten rock below Earth's surface, forming igneous rocks like pumice and granite.
- (l) When magma cools slowly beneath the surface, it forms intrusive igneous rocks, which are large.
- (m) When magma moves toward the surface, it becomes lava.
- (n) Lava is magma that flows out after erupting from a volcano.
- (o) When lava cools quickly, it forms smaller crystal rocks or rocks with a glassy texture.

Answer the following questions

Low Order Questions

1. What are the three main types of rocks in the rock cycle?

Answer: Sedimentary, metamorphic, and igneous.

2. What is magma?

Answer: Magma is molten or semi-molten rock below Earth's surface.

3. What happens when magma cools down?

Answer: It hardens and becomes igneous rock.

4. What is sedimentary rock made from?

Answer: Sedimentary rock is made from sediments, which are small particles of rock and material.

5. What process breaks down rocks into smaller particles?

Answer: Erosion and weathering.

Middle Order Questions

6. Explain how heat and pressure affect metamorphic rocks.

Answer: Heat and pressure can change the structure of a rock, transforming it into metamorphic rock by altering its minerals and texture.

7. How does magma differ from lava?

Answer: Magma is molten rock beneath Earth's surface, while lava is magma that has reached the surface after erupting from a volcano.

8. Describe the process of how sedimentary rocks form.

Answer: Sedimentary rocks form when particles of rocks and materials (sediments) are transported, deposited, and compacted over time, creating layers.

9. What happens to metamorphic rock when it is subjected to intense heat and pressure? _____

Answer: It melts into magma, which can later cool and form igneous rock.

10. What causes magma to become igneous rock?

Answer: When magma cools, it solidifies into igneous rock. If it cools slowly beneath the surface, it forms large intrusive igneous rocks.

11. How does erosion contribute to the rock cycle? _____

Answer: Erosion breaks down rocks into smaller particles that can be transported and deposited as sediments, which eventually form sedimentary rocks.

12. What is the difference between intrusive and extrusive igneous rocks?

Answer: Intrusive igneous rocks form when magma cools slowly beneath the Earth's surface, creating large crystals. Extrusive igneous rocks form when lava cools quickly on the surface, resulting in smaller crystals or glassy textures.

13. How are sedimentary rocks connected to the formation of metamorphic rocks?

Answer: Sedimentary rocks can be buried deep underground and subjected to intense heat and pressure, transforming them into metamorphic rocks.

14. Why do rocks undergo weathering and erosion?

Answer: Rocks are exposed to natural elements like heat, cold, wind, and water, which break them down into smaller particles over time through weathering and erosion.

15. How does the rock cycle illustrate the relationship between sedimentary, metamorphic, and igneous rocks?

Answer: The rock cycle shows how sedimentary, metamorphic, and igneous rocks are interconnected as they can change from one form to another through processes like melting, cooling, erosion, and heat/pressure.

High Order Questions

16. Analyze how the rock cycle would be affected if erosion and weathering did not occur. _____

Answer: Without erosion and weathering, sedimentary rocks would not form because sediments wouldn't be created or transported. This would disrupt the cycle, reducing the transformation of rocks and halting the creation of certain landforms.

17. Evaluate the role of volcanic activity in the formation of igneous rocks and its importance in the rock cycle. _____

Answer: Volcanic activity is crucial for the formation of extrusive igneous rocks as it brings magma to the surface where it cools to form lava. This process is essential in recycling Earth's materials and contributing to the rock cycle by creating new rock forms.

18. Predict what might happen to the Earth's surface if the process of rock melting into magma were to stop.

Answer: If rocks stopped melting into magma, volcanic activity would cease, and no new igneous rocks would form. Over time, the Earth's surface could become dominated by older rocks without renewal, leading to less geological activity and fewer changes in landforms.

MINING OF MINERAL RESOURCES

Extracting ores

- (a) Valuable minerals are extracted from the lithosphere by mining.
- (b) The minerals are contained in the ore which has a high concentration of the mineral.
- (c) While some minerals have to be mined and processed, minerals such as diamonds, sand and potash are found in their natural form.



Refining minerals

The mining of some minerals involves the physical or chemical extraction.

Iron

- (a) Iron is obtained from its ores in the form of **ferrous oxide** and **magnetite**.
- (b) The mining process involves **digging** and **blasting**.
- (c) A blast furnace is used to refine iron from other materials that are part of the iron ore.
In the past iron was produced by heating the iron ore with charcoal.
- (d) Years ago Iron was traditionally mined in KZN and certain parts of Limpopo.

Gold

- (a) Gold in its purest form is bright and slightly reddish yellow. Gold mining starts with breaking down the rock into smaller pieces no larger than the road gravel.
- (b) The ore is then ground into powder by steel ball in rotating drums. Extracted gold is then refined by methods such as amalgamation, cyanidation, carbon-in-pulp and floatation.
- (c) If the gold is still not pure, it is smelted by heating. The substance called flux is used and it bonds with the impurities and floats on top of the melted gold.
- (d) The contaminated mixture is hauled away as a solid waste.

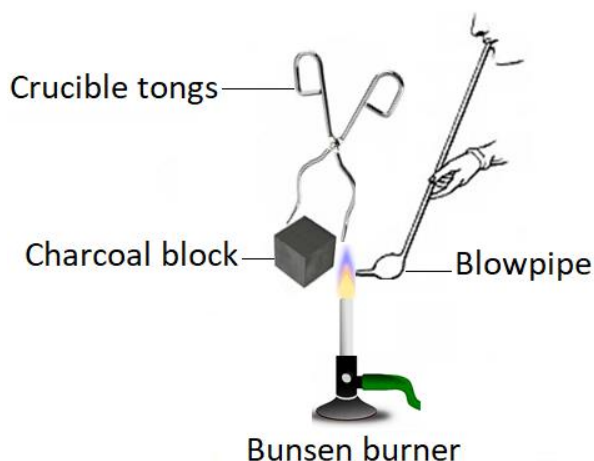
INVESTIGATION

Making lead (Pb) from lead oxide (PbO)

Aim: To extract lead from lead oxide

MATERIALS:

1. Lead(II) oxide (red)
2. Blowpipe
3. Charcoal block / Carbon block
4. Crucible tongs
5. Water
6. Bunsen burner / Sprit burner
7. Drinking straw (optional)
8. Spatula
9. Safety goggles



INSTRUCTIONS:

1. Make a hollow in the charcoal block.
2. Keep the loose charcoal particles in the hollow.
3. Wearing safety goggles add lead oxide in the hollow.
4. Make a paste of lead oxide and charcoal particles by adding a drop or two of water.
5. Attach a straw to the blowpipe and blow into the blue flame top where the lead (II) oxide-carbon paste is for 2 – 4 minutes.
6. Observe any change or keep blowing until there is a change.
7. Record your observations.

RESULTS:

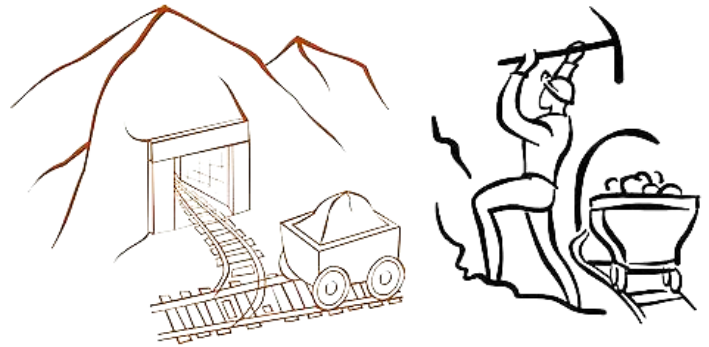
1. What colour change did you observe in this reaction?

- During heating, an orange colour should be observed
2. Write a chemical equation to represent the reaction.



MINING IN SOUTH AFRICA

- (a) Mining is very important in South Africa for the growth of the economy and job creation.
- (b) Mining, however, impacts negatively on the environment.
- (c) Some of the challenges include water pollution, dumps and destroying land for farming and disturbing wild live environment.
- (d) Do a research about mining activities in South Africa. In your research to the following:
 - i. Mention where the mine is.
 - ii. What the mine is mining.
 - iii. The mining method used to extract the mineral (physical or chemical)
 - iv. The impact of the mining activities on the environment.
 - v. Your research must be 4 pages at least and that must include your references.

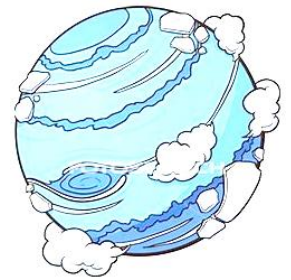


Structure of the research

1. Topic
2. Background (research)
3. Introduction
4. Body (Details of the research)
5. Results
6. Discussions
7. Conclusion
8. Bibliography

ATMOSPHERE

- (a) The mixture of gases around the Earth constitutes the atmosphere.
- (b) The atmosphere comprises Nitrogen (78%), Oxygen (21%) Carbon dioxide (1% or less) and other gases (1%).
- (c) The density of gas particles decreases with altitude.
- (d) The four layers of the atmosphere are (as you go up):



Troposphere

- (a) It extends to 10 km above Earth surface with more than 70 % of atmospheric gases.
- (b) The weather occurs in this region.
- (c) Organisms live in the region.

Stratosphere

- (a) It ranges between 10 – 50 km above the Earth's surface.
- (b) It has a very thin air.
- (c) Temperature changes (decreases) with altitude.
- (d) The ozone layer (O_3) which protects life from the harmful ultraviolet light is in this region.
- (e) Aeroplanes fly in this sphere.
- (f) Temperature can be calculated as: Temperature at a point + 1°C per 100 m.

Mesosphere

- (a) It extends from 50 – 80 km about the surface of the Earth.
- (b) It has thin air and cold temperatures.
- (c) Rocks (shooting stars) burn in this sphere.



Thermosphere

- (a) It starts at about 80km to about 350km above the surface of the Earth.
- (b) International Space Station is hosted in this region.
- (c) International Space Station serves as research laboratory for different fields of science including astronomy, physics and biology. It is in orbit at 330 – 450 km.
- (d) In the thermosphere radio waves are reflected back to Earth for TV and radio broadcast.

Answer the following questions:

1. Which layer is closest to the Earth's surface?

-
- Answer: The Troposphere.

2. What is the range of this sphere?

-
- Answer: 10 km above Earth surface

3. What is the composition of gases in this sphere?

-
- Answer: The atmosphere comprises Nitrogen (78%), Oxygen (21%) Carbon dioxide (1% or less) and other gases (1%).

4. Mention the other three spheres in their correct order and their range.

-
- Stratosphere 10 – 50 km above the Earth's surface
 - Mesosphere 50 – 80 km
 - Thermosphere 80 – about 350 km above the Earth's surface

5. In which sphere do we find the ozone layer?

-
- Answer: The stratosphere

6. What is the function of the ozone layer?

-
- Answer: It protects life from the harmful ultraviolet light.

7. The temperature in a town is 21°C at an altitude of 30 metres. If you go up by 200 metres to reach a height of 230m, what will be the temperature at that point?

-
- Temperature can be calculated as: Temperature at a point + 1 °C per 100 m.
 - At 30 metres temperature is 21°C
 - At 230 m = 21°C + (1 °C per 100 m) x 2
= 23°C

8. Explain the details of the Mesosphere.

-
- Answer: It has thin air and cold temperatures. It has thin air and cold temperatures. Rocks (shooting stars) burn in this sphere.

9. Discuss the relationship between height and the density of gas particles.

-
- Answer: The density of gas particles decrease with altitude.

10. What is the relationship between temperature and altitude?

-
- Answer: Temperature decreases altitude until in the troposphere

11. Discuss the conditions in the Thermosphere.

-
- Answer: The conditions in the thermosphere are extremely high / very hot to 2000 °C.

12. What is the International Space Station?

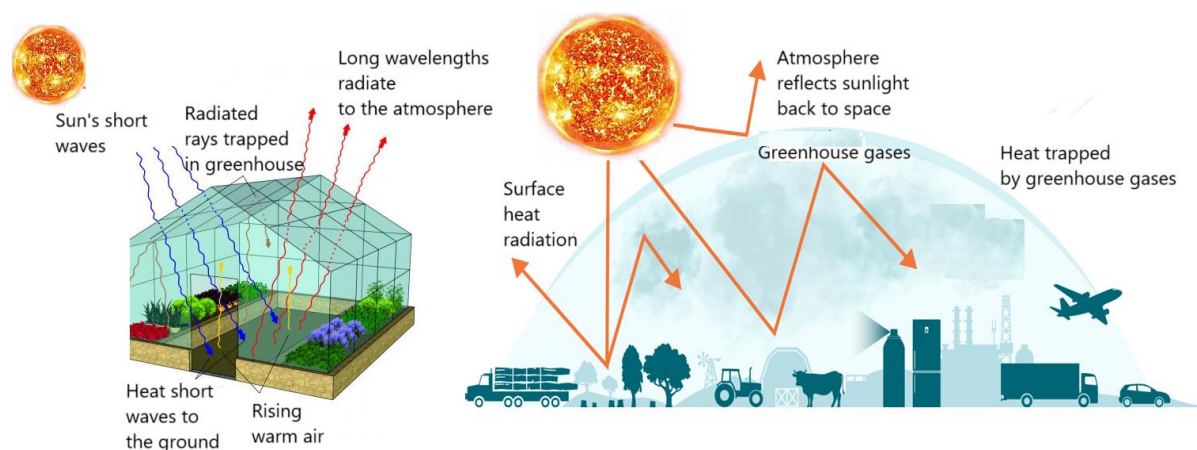
-
- Answer: International Space Station is a large spacecraft that is home to astronauts which serves as research laboratory for different fields of science including astronomy, physics and biology.

13. Discuss the importance of the ISS.

-
- Answer: It provides an opportunity for scientists to do research.

THE GREENHOUSE EFFECT

- (a) The lower part of the atmosphere (troposphere) and the surface of the Earth are kept warm by the greenhouse effect.
- (b) The greenhouse effect is caused by the presence of carbon dioxide, methane, carbon dioxide and other gases.



- (c) These gases are known as greenhouse gases.
- (d) The average temperature of the Earth (global warming) gradually increases as the volume of greenhouse gases increases.
- (e) Global warming leads to shortages of food, change in climate, rise in sea levels and mass extinction.

Answer the following questions:

Low Order Questions

1. What is the greenhouse effect?

Answer: The greenhouse effect is the process by which the lower atmosphere and Earth's surface are warmed due to the trapping of heat by greenhouse gases.

2. Name two gases that contribute to the greenhouse effect.

Answer: Carbon dioxide and methane.

3. What happens to the Earth's temperature as the volume of greenhouse gases increases? _____

Answer: The Earth's temperature gradually increases (global warming).

4. What is the lower part of the atmosphere called?
- _____

Answer: The troposphere.

5. Which phenomenon causes the Earth's surface to stay warm?
- _____

Answer: The greenhouse effect.

Middle Order Questions

6. Explain how greenhouse gases contribute to global warming.
- _____

Answer: Greenhouse gases trap heat in the Earth's atmosphere, preventing it from escaping into space. This trapped heat increases the Earth's average temperature, leading to global warming.

7. Why are greenhouse gases important for life on Earth?
- _____

Answer: Greenhouse gases are essential for maintaining Earth's temperature at a level suitable for life. Without them, the planet would be too cold for most living organisms to survive.

8. What would happen if there were no greenhouse gases in the atmosphere?
- _____

Answer: Without greenhouse gases, Earth's surface would be much colder, making it difficult for life to exist.

9. How does an increase in global warming affect sea levels?
- _____

Answer: An increase in global warming causes glaciers and ice caps to melt, which leads to a rise in sea levels.

10. How does climate change, caused by global warming, impact food production?
- _____

Answer: Climate change can disrupt weather patterns, leading to droughts, floods, and unpredictable growing seasons, which can cause food shortages.

High Order Questions

11. Analyze the relationship between global warming and mass extinction.

Answer: Global warming alters habitats and ecosystems, making it difficult for many species to survive. Changes in temperature, sea levels, and food availability can lead to mass extinction as species fail to adapt quickly enough to these rapid changes.

12. Predict the long-term consequences of rising greenhouse gas levels on future generations.

Answer: Future generations may face extreme weather conditions, higher sea levels, food and water shortages, increased natural disasters, and loss of biodiversity, making the planet less habitable.

13. Evaluate the role of human activity in the increase of greenhouse gases.

Answer: Human activities, such as burning fossil fuels, deforestation, and industrial processes, significantly increase the levels of greenhouse gases in the atmosphere, contributing to global warming and climate change.

14. How might changes in greenhouse gas levels affect global food security in the next 50 years?

Answer: If greenhouse gas levels continue to rise, unpredictable weather patterns and extreme climate conditions could lead to reduced agricultural productivity, causing food shortages and increased competition for resources.

15. Propose potential solutions to mitigate the effects of global warming and reduce greenhouse gas emissions.

Answer: Solutions could include transitioning to renewable energy sources (solar, wind), increasing energy efficiency, reforestation, reducing waste, promoting sustainable agriculture, and implementing policies to limit carbon emissions globally.

BIRTH, LIFE AND DEATH OF STARS



- (a) Stars live for a certain period of time.
- (b) Stars are born in clouds called **nebulae**.
- (c) A **nebula** is a cloud of gas and dust in space.
- (d) One cloud is a nebula; more than one are called nebulae.
- (e) A nebula collapses when gravity becomes strong enough to overcome the outward pressure of gas, leading the cloud to condense into denser regions that can eventually form a star.
- (f) When the temperature is high enough, **nuclear fusion** turns hydrogen into helium.
- (g) These processes create the colorful red, blue, and green swirls of light in space.
- (h) Young, hot stars appear blue because they have more fuel, while older stars look red as they run out of fuel and emit less energy.
- (i) Nebulae are mostly made of hydrogen, with 10% helium and small amounts of other elements.

Answer the following questions:

Low-Order

1. What is a nebula? _____
 - Answer: A nebula is a cloud of gas and dust floating in space.
2. What elements make up the majority of a nebula? _____
 - Answer: hydrogen, 10 % helium and a small fraction of other elements.
3. What is the process by which hydrogen is changed into helium in stars? _____
 - Answer: nuclear fusion
4. What color do young stars typically appear? _____
 - Answer: Young stars would appear bluer since they are hot with more fuel to burn.

Middle-Order Questions

5. How do the colors of stars help determine their age?

-
- Answer: Young stars would appear bluer since they are hot with more fuel to burn and the aging stars would appear redder since they are running out of fuel hence emitting less energy

6. Explain why aging stars emit less energy than young stars.

-
- Answer: It is because they are running out of fuel hence emitting less energy.

7. Describe the role of gravity in the formation of stars from nebulae.

-
- Answer: Gravity gathers and compresses gas and dust into a dense core, triggering the nuclear fusion that powers stars. Without gravity, the material in nebulae would not come together to form stars.

High – Order

8. What might happen if the nuclear fusion process in stars was different or did not occur?

-
- Answer: If fusion did not occur, stars would not have a stable energy source. As a result, stars would not shine, and the universe would be dark and cold.

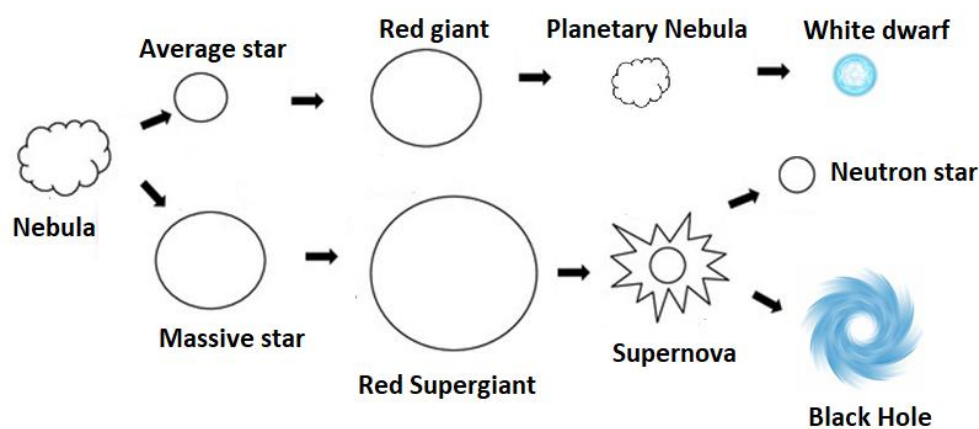
9. Evaluate the importance of helium in the life cycle of a star.

Answer: Helium is important for energy production and the production of heavier elements.

LIFE OF A STAR

- (a) A star's life cycle depends on the matter it carries.
- (b) The size of the star is determined by the matter available during its formation.
- (c) It begins with the hydrogen gas held together by gravity making it to spin.
- (d) As it spins it heats and turns into a protostar and later a star.
- (e) Large stars use their energy faster and do not live long and small stars live longer for the same reason.

Life Cycle of a star



- (f) Blue looking stars are hotter and of a younger age than red looking stars.
- (g) The Sun is said to have a 9 billion life span and it is halfway that.
- (h) Stars change hydrogen to helium and once they are out of energy, they swell up to form a "red giant."
- (i) A star can become brighter than it normally is and explode.
- (j) The explosion of a super red giant is known as a supernova.
- (k) A super nova can form when two stars come closer and one star stealing matter from the other star and ending up exploding from too much matter.
- (l) A supernova can also form when super giant star runs out of nuclear fuel and its core collapses followed by an explosion.

Answer the following questions:

Low – Order Questions

1. What determines the size of a star?

Answer: The size of a star is determined by the amount of matter available during its formation.

2. What gas is a star primarily made of at the beginning of its life cycle?

Answer: A star begins with hydrogen gas.

3. What color are young, hot stars?

Answer: Young, hot stars appear blue.

4. What is a supernova?

Answer: A supernova is the explosion of a super red giant star.

5. What happens when a star runs out of hydrogen?

Answer: When a star runs out of hydrogen, it swells up to form a red giant.

Middle-Order Questions

6. Explain why the amount of matter during a star's formation determines its size and life cycle. _____

- Answer: A larger amount of matter means more mass, which creates a stronger gravitational pull forming a larger, more massive star and vice versa.

7. What causes a protostar to transform into a fully formed star?

Answer: A protostar transforms into a fully formed star when nuclear fusion begins in its core, balancing the force of gravity pulling inward, and the star becomes stable, marking its transformation into a fully formed star.

8. Why do large stars burn through their energy faster than smaller stars?

Answer: Large stars burn through their energy faster than smaller stars because nuclear fusion occurs at a much faster rate depleting the star's energy faster.

9. Compare the lifespans of blue stars and red stars, explaining the differences in their temperatures and ages. _____

Answer:

- Blue looking stars are hotter and of a younger age than red looking stars.
- Blue stars are massive and burn through their fuel quickly, so they have relatively short lifespans
- Red stars can be very old, age slowly and are among the longest-living stars in the universe.

10. How does a star's hydrogen-to-helium fusion process relate to the formation of a red giant? _____

- **Answer:** The transformation of a star into a red giant is triggered by the depletion of hydrogen in its core.

11. Why does a star swell and become a red giant when it runs out of hydrogen?

- **Answer:** The large amount of energy produced by shell burning causes the outer layers of the star to **expand outward** dramatically resulting in the star swelling in size, becoming a **red giant**.

12. How can the interaction between two stars lead to a supernova?

- **Answer:** Mass transfer between the stars and the subsequent collapse of one of them would lead to a supernova.

High – Order Questions

13. Analyze how the Sun's progression into a red giant will affect life on Earth and the structure of the solar system.

-
- **Answer:** The Sun's progression into a red giant will spell the end of life on Earth and dramatically alter the structure of the solar system.

DEATH OF A STAR

- (a) Stars depend on energy generated from nuclear reaction.
- (b) The core of the star contracts and turn into a white dwarf once it runs out of energy.
- (c) The stars do not die the same way.
- (d) Small stars die peacefully turning into white dwarfs.
- (e) The death of giant stars is followed by a huge explosion known as the **supernova**.
- (f) This would sometimes result in a black hole.
- (g) When the hydrogen that fuels nuclear reactions begin to run out, the star starts dying.
- (h) The stars would eventually change colour and become red giants



Answer the following questions:

1. Where do stars get their energy?

-
- Answer: From nuclear reactions

2. Explain what happens to a star once it runs out of energy.

-
- Answer: The core of the star contracts and turn into a white dwarf once it runs out of energy.

3. Explain how small stars die.

-
- Answer: Small stars die peacefully turning into white dwarfs.

4. What is a supernova?

-
- Answer: The death of giant star which is followed by a huge explosion.

5. Discuss what happens when stars eventually run out of energy.

-
- Answer: When the hydrogen that fuels nuclear reactions begin to run out, the star starts dying.