basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MARINE SCIENCES P1

MAY/JUNE 2026

MARKS: 150

TIME: 2½ hours

This question paper consists of 15 pages.

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INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. This question paper consists of THREE sections. Answer the questions as follows:

   SECTION A: COMPULSORY
   SECTION B: COMPULSORY
   Consists of QUESTIONS 2 and 3.
   Answer BOTH questions in this section.
   SECTION C: Consists of QUESTIONS 4 and 5.
   It is COMPULSORY to answer ONLY ONE of the two questions in this section.

2. Write ALL the answers in the ANSWER BOOK.

3. Start the answers to EACH question at the top of a NEW page.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Present your answers according to the instructions of each question.

6. Do ALL drawings in pencil and label them in blue or black ink.

7. Draw diagrams, tables or flow charts only when asked to do so.

8. The diagrams in this question paper are NOT necessarily drawn to scale.

9. Do NOT use graph paper.

10. You must use a non-programmable calculator, protractor and a compass, where necessary.

11. Round off your FINAL numerical answers to TWO decimal places, where applicable.

12. Do NOT write outside the margins in the ANSWER BOOK.

13. Write neatly and legibly.

SECTION A

QUESTION 1

1.1 Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1.1 to 1.1.10) in the ANSWER BOOK, e.g. 1.1.11 D.

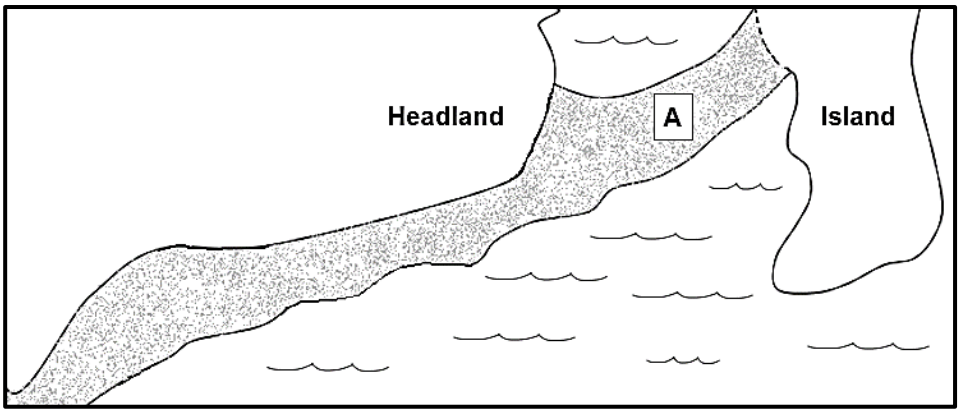
1.1.1 Which ONE of the following BEST describes the formation of a beach proper?

A Constructive waves erode sediment.
B Destructive waves deposit sediment.
C Constructive waves deposit sediment.
D Destructive waves erode sediment.

1.1.2 Which ONE of the following options BEST describes the waves associated with rip currents?

A Sand bars control how the waves break.
B Waves radiate outwards from a submerged reef.
C Swash causes diagonal movement of waves.
D Waves always diffract when approaching the shore.

1.1.3 The image below shows the top view of a coastal region. The shaded area shows the build-up of sediment.



[Source: Examiner]

Which ONE of the following is the CORRECT name for feature **A**?

A Spit
B Groyne
C Stack
D Tombolo

1.1.4 Which ONE of the following descriptions does NOT influence global ocean circulation?

A Prevailing surface winds
B Gravitational pull of the moon
C Converging surface currents
D The rotation of the Earth

1.1.5 Which ONE of the following BEST describes the bonds resulting in a polar molecule?

A Ionic bond between atoms that equally share electrons
B Covalent bond between atoms that equally share electrons
C Ionic bond between atoms that unequally share electrons
D Covalent bond between atoms that unequally share electrons

1.1.6 Which ONE of the following options gives the CORRECT difference between primary coastlines and shores?

	PRIMARY COASTLINES	**SHORES**
A	Mostly under water	Mostly above water
B	Composed of resistant rock	Composed of soft rock
C	Formed by tectonic forces	Formed by waves and wind
D	Angular-shaped sediment	Rounded sediment

1.1.7 The following statements describe the Ekman transport water movement within the Southern Hemisphere waters:

(i) Each successive deeper layer is deflected at a greater angle in relation to the prevailing wind.
(ii) The water deflection, from the prevailing wind's direction, occurs due to the Coriolis effect.
(iii) At a depth of approximately 100–150 metres, currents move in the opposite direction to surface currents, depending on latitude and wind strength.
(iv) The average resultant movement of water is approximately 90° to the direction of the prevailing wind, depending on its strength.
(v) Frictional drag of wind at the surface sets water in motion.

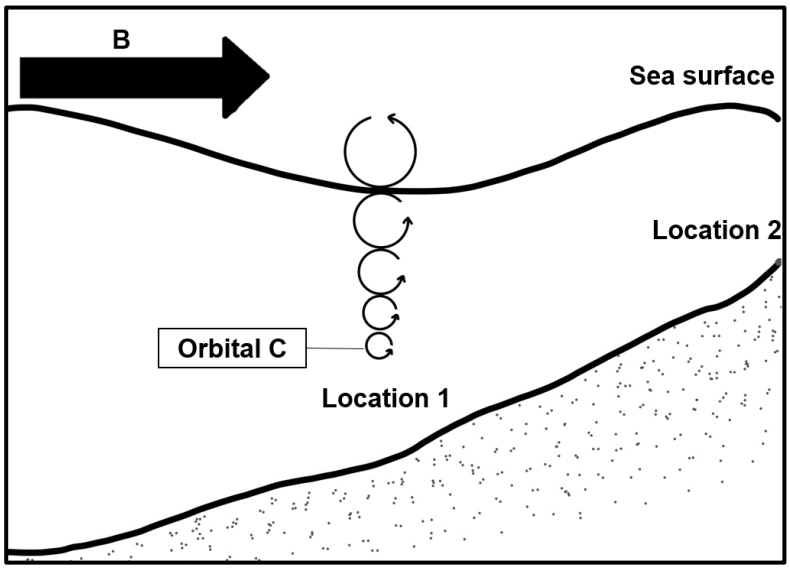
Which sequence gives the CORRECT order of the development of the Ekman transport?

A (v), (ii), (i), (iii), (iv)
B (ii), (v), (i), (iv), (iii)
C (v), (iv), (ii), (iii), (i)
D (i), (ii), (v), (iv), (iii)

1.1.8 Which ONE of the following options shows the CORRECT Köppen-Geiger classification for Kosi Bay?

A Bsk
B Cfa
C Cwb
D Bfa

1.1.9 The circular arrows in the image below show the movement of water particles when a wave passes over **Location 1**. Arrow **B** shows the direction in which the predominant wave travelled.



[Source: Examiner]

Which ONE of the following options CORRECTLY describes the movement of water in the wave as it approaches **Location 2**?

	SHAPE OF ORBITAL C	WAVE HEIGHT
A	Oval	Increase
B	Circular	Increase
C	Oval	Decrease
D	Circular	Decrease

1.1.10 Which ONE of the options below is NOT a use of compounds extracted from red algae?

A Gelling agent for desserts
B Binding agent in culture media
C Thickens dairy products
D Antioxidant added to multivitamins (10 x 2) **(20)**

1.2 Give the correct **scientific term/phrase** for each of the following descriptions. Write only the term/phrase next to the question numbers (1.2.1 to 1.2.10) in the ANSWER BOOK.

1.2.1 A liquid substance that is capable of dissolving most chemicals

1.2.2 Indirect measure of the abundance of a target species

1.2.3 A form of agriculture that combines raising fish in tanks with soilless plant cultures

1.2.4 The capacity of a solid item to float on a fluid or move upwards, by displacing the volume of that fluid that is equal in weight to that item

1.2.5 Large circular system of ocean currents that spirals about a central area

1.2.6 A part of a surface wave where there is the largest downward vertical displacement within the wave's cyclical movement

1.2.7 The long-term average weather of a region up to 30 years

1.2.8 When a molecule separates into smaller atoms or ions

1.2.9 An international convention on wetlands of international importance, especially for the protection of waterfowl habitats

1.2.10 A fishing method which involves towing nets along the sea floor

(10 x 1) **(10)**

1.3 Indicate whether each of the descriptions in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B** or **NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B** or **none** next to the question numbers (1.3.1 to 1.3.5) in the ANSWER BOOK.

COLUMN I		COLUMN II	
1.3.1	Refraction occurs when waves …	A: B:	move towards a headland with a submerged ridge move at an oblique angle to depth contours
1.3.2	Location where fossilised mussels wrapped in seaweed were found	A: B:	Drakensberg Mountains Cederberg Mountains
1.3.3	Fish are listed as orange on SASSI due to …	A: B:	the level of threat to the species associated bycatch
1.3.4	Glacial periods	A: B:	warmer average global temperatures the Earth's angle of inclination is greater
1.3.5	Offshore alluvial diamond dredging	A: B:	SA north-west coast KZN North Coast

(5 x 2) **(10)**

TOTAL SECTION A: 40

SECTION B

QUESTION 2

2.1 Study the hypothetical investigation below illustrating changes in the partial pressure of oxygen in the blood vessels of scuba divers at various depths.

Scientists wanted to determine the relationship between dive depth and the partial pressure of oxygen in the blood vessels of scuba divers.

The following method was used to carry out the investigation:

- Scuba divers were asked to dive to various depths.
- Blood samples were taken immediately before and after the dives.
- The partial pressure of oxygen in the blood vessels was measured.

The data were recorded in the table below.

ARTERIOLE BLOOD GAS MEASUREMENTS AT DIFFERENT DEPTHS

DEPTH (m)	AVERAGE PARTIAL PRESSURE OF OXYGEN (mmHg) IN ARTERIOLES
0 (surface)	100
10	200
20	300
30	400
40	500

[Adapted from Paganini, M et al. 2024. *Arterial blood gases in SCUBA divers at depth*]

2.1.1 (a) Calculate the pressure (in bars) experienced by a scuba diver at 30 m. (1)

(b) Draw a line graph showing the relationship between pressure (bar) and the average partial pressure of oxygen (mmHg) in arterioles. (8)

(c) Give a conclusion for this investigation. (2)

2.1.2 (a) Name the gas law that describes the reason for the trend seen in the graph drawn for QUESTION 2.1.1(b) above. (1)

(b) Explain how the law named in QUESTION 2.1.2(a) can help scuba divers to gain a better understanding of decompression sickness. (4)
(16)

2.2 A scuba diver takes a breath of 2,7 litres of air at the surface. If the diver descends to a depth 13 m, what will be the volume of the air in the diver's lungs? Assume that the temperature remains constant. **(4)**

2.3 Draw an annotated diagram illustrating the Earth's energy balance. **(5)**

2.4 Read the extract below about a dune management project and answer the questions that follow.

RESTORING HOUT BAY'S DUNES

Increasing urban development in Hout Bay in the Western Cape is preventing sediment from being transported naturally away from the area. This is causing problems such as windblown sand damaging nearby structures (shown in Image 1 below).

The following management plan was implemented to stabilise and rehabilitate the dunes in Hout Bay (shown in Image 2 below):

- Plant vegetation on the dunes.
- Install irrigation (watering) systems to stimulate the growth of plants.
- Install dune nets.

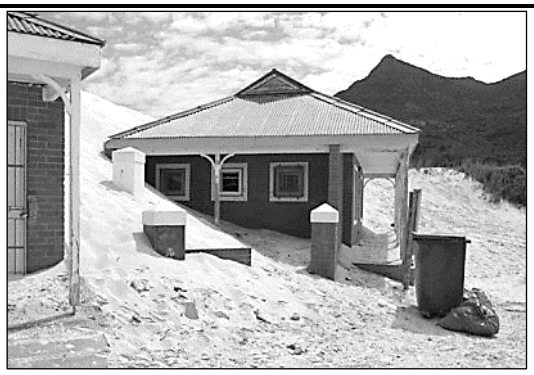


Image 1:
Building covered in windblown sand



Image 2:
Dune nets and vegetation in Hout Bay

[Adapted from https://resources.capetown.gov.za/documentcentre/documents/graphics/infographic_Hout% Bay_Dune_project.pdf]

2.4.1 Identify the type of engineering approach used in this coastal project. (1)

2.4.2 (a) Discuss the importance of installing irrigation systems for this dune management plan. (3)

(b) Explain how planting vegetation and installing nets, as shown in Image 2 above, will potentially assist in the formation of the dune. (4)

2.4.3 Give your opinion on whether the engineering approach used in this management plan will be successful in preventing damage to Hout Bay's infrastructure. Motivate your answer. (2)
(10)
[35]

QUESTION 3

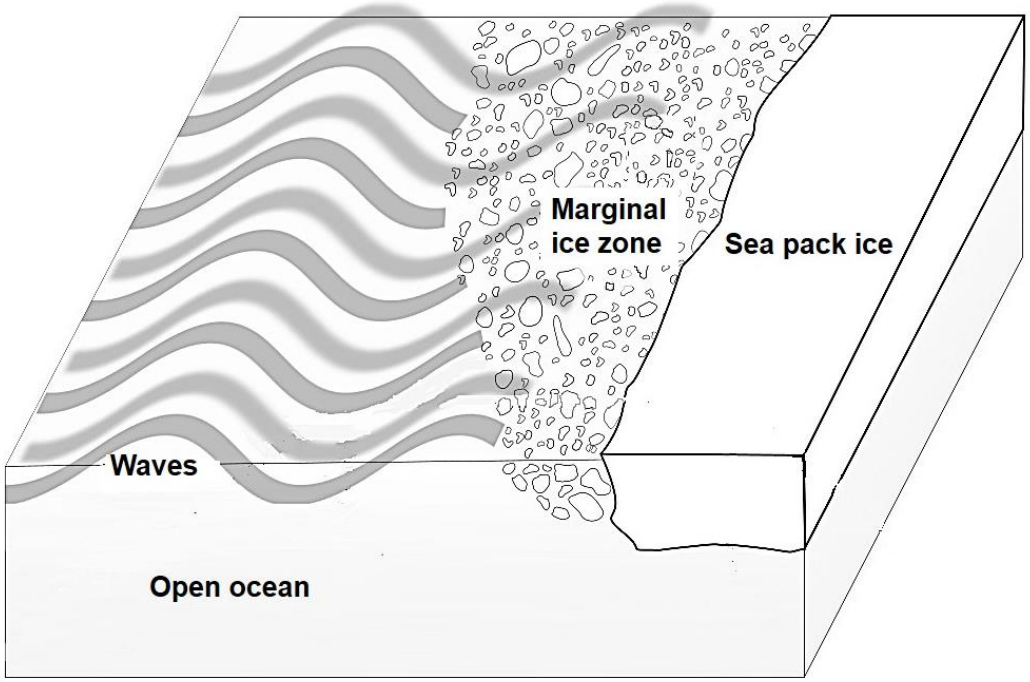
3.1 Refer to the infographic below about wave activity on sea pack ice in the polar regions to answer the questions that follow.

WAVE ACTIVITY ON SEA PACK ICE IN THE POLAR REGIONS

At the outer margins of polar sea ice cover, interactions occur between sea ice and ocean surface waves. During the summer months, the sea ice may be fractured by waves as the waves travel through this area. This results in a marginal ice zone with smaller ice pieces (shown in the diagram below).

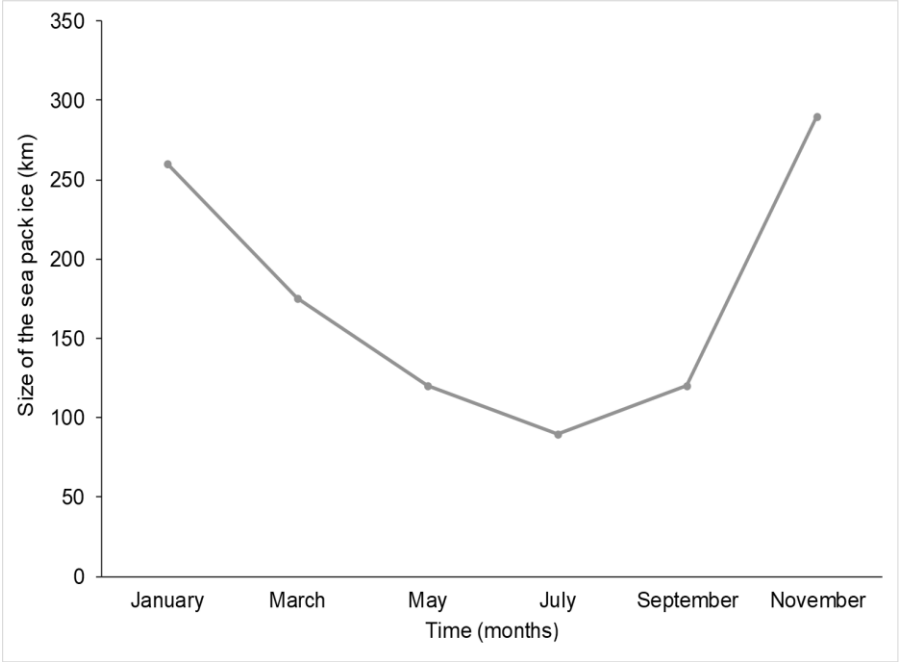
The scientists investigated how the distance the waves flow on the sea pack ice determines the size of the marginal ice zone in polar regions (results shown in the graphs below). It also showed how this impacted on the amount of melting ice which could potentially affect current shipping routes in this region.

WAVES TRAVELLING THROUGH THE ICE

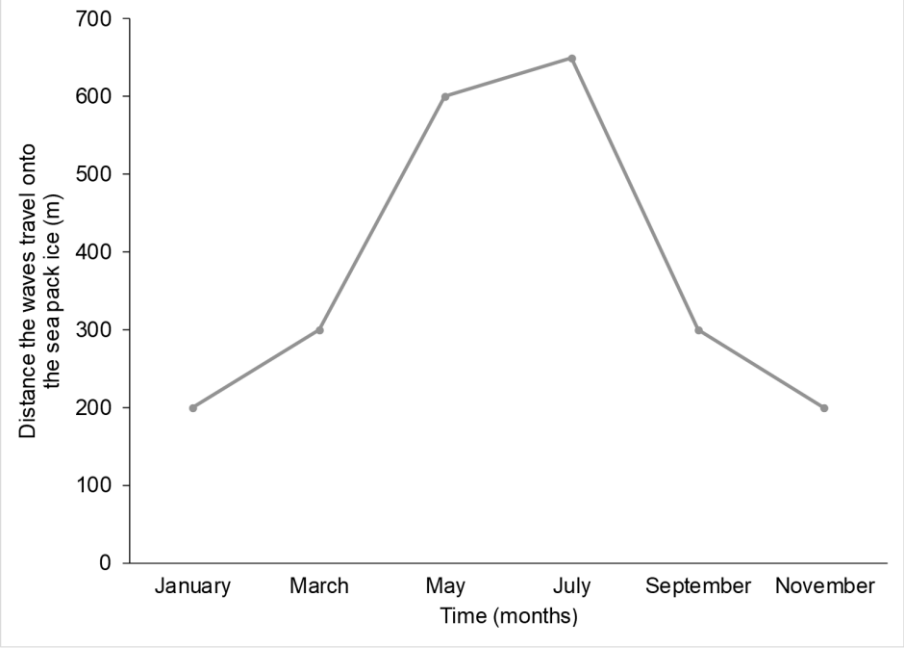


[Adapted from Roach, LA et al. 2019. *Advances in modelling interactions between sea ice and ocean surface waves*]

Line graph showing the seasonal change in the size of sea pack ice in the Arctic



Line graph showing the seasonal change in the distance the waves travel onto the sea pack ice in the Arctic



[Adapted from Roach, LA et al. 2019. *Advances in modelling interactions between sea ice and ocean surface waves*]

3.1.1 Describe how the interactions between ocean surface waves and sea pack ice would form the marginal ice zone, as illustrated above. (2)

3.1.2 Refer to the line graphs when answering the following questions:

(a) During which months would the marginal ice zone be the greatest? (1)

(b) Give the relationship between the size of the sea pack ice and the distance the waves travel onto the sea pack ice. (2)

3.1.3 (a) Describe the effect that an increased marginal ice zone at the Poles would have on global warming and, therefore, climate change. (3)

(b) Evaluate the impact of an increased marginal ice zone on the shipping economy around the polar regions. (3)
(11)

3.2 Read the text below and answer the questions that follow.

OCEAN CONVEYOR BELT COLLAPSE?

As the Earth heats up due to global warming, less ice is forming at the Poles and more ice sheets are melting, thereby releasing fresh water into the ocean. As a result, overturn at the Poles is reducing. Evidence shows that bottom water is warmer and less saline, with the effects being the strongest in the Southern Ocean.

[Adapted from https://e360.yale.edu/features/climate-change-ocean-circulation-collapse-antarctica]

3.2.1 Briefly describe what is meant by 'ocean conveyor belt' as used in the title of the text above. (2)

3.2.2 Explain how melting ice reduces overturn at the Poles, as stated in the text above. (3)

3.2.3 (a) Name TWO South African coastal regions that are influenced by the cold water from the Southern Ocean. (2)

(b) Briefly discuss TWO economic impacts that the reduced overturn in the Southern Ocean would have on the local communities along the coastal regions named in QUESTION 3.2.3(a). (4)
(11)

3.3 3.3.1 Give the main driver of an ENSO event. (1)

3.3.2 Tabulate the differences in *rainfall* and *sea temperature* along the Eastern Coast of Southern Africa during normal conditions and El Niño. (5)

3.3.3 The questions below are based on a headline from the *Farmers' Weekly* magazine, dated 20 December 2024, stating the following:

'SOUTH AFRICA'S HOPES ARE ON LA NIÑA FOR RELIEF'

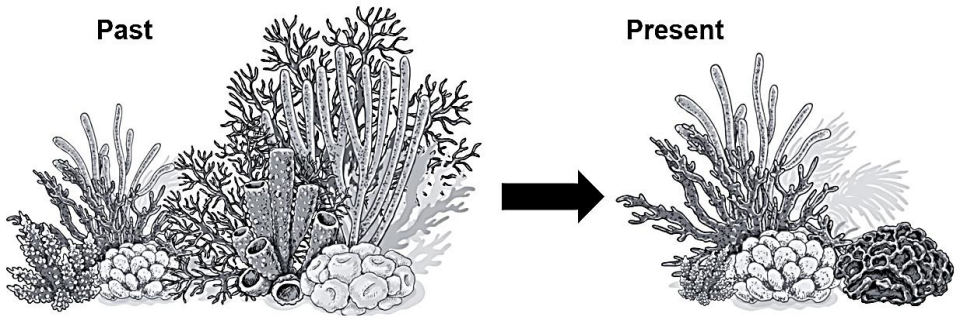
(a) Discuss what is meant by 'relief' for farmers, as stated in the headline shown above. (4)

(b) Give your opinion on whether the farmers should change the crop and livestock that they farm, considering the changes in ENSO cycles. Motivate your answer. (2)
(12)

3.4 Read the text below about the Great Barrier Reef to answer the questions that follow.

CLIMATE CHANGES CORAL COVER

The Great Barrier Reef in Australia lost half its coral cover in the past thirty years. The loss of coral cover has been linked to the changes in ocean pH levels.



[Adapted from https://www.aims.gov.au/sites/default/files.pdf]

3.4.1 (a) Name the chemical process that resulted in Australia's loss of coral, as seen in the image above. (1)

(b) Explain how the process named in QUESTION 3.4.1(a) resulted in the loss of coral. (3)

3.4.2 Explain ONE suitable mitigation measure that the international community can put in place to restore and conserve the Great Barrier Reef. (1 x 2) (2)
(6)
[40]

TOTAL SECTION B: 75

SECTION C

Answer any ONE question in this section.

Clearly indicate the QUESTION NUMBER of the chosen question.

NOTE: Your answer must be in the form of an essay. NO marks will be awarded for answers in the form of tables, flow charts or diagrams.

QUESTION 4

Refer to the hypothetical scenario below to answer the question that follows. Your answer must relate to this scenario specifically.

Residents from a small town along the KwaZulu-Natal (KZN) North Coast are protesting against the construction of a new gas power station. Most of these residents are already employed in the energy and mining sectors of this region. However, the community has been experiencing harmful impacts. As a result, many residents are looking into renewable energy alternatives.

Studies have shown that harnessing ocean energy from the Agulhas Current could be a viable alternative option for energy generation for this region. This current is one of the strongest ocean currents in the Southern Hemisphere. The current has eddies that could result in periods of no energy generation. However, the timing of these eddies can be accurately predicted.

[Adapted from https://naturaljustice.org/coastal-communities-at-the-coalface-of-fossil-fuels and http://archive.saeon.ac.za/enewsleter-archives/2019/april2019/doc01]

The local government has invited the community to participate in a discussion and voice their opinions. As a marine scientist, you have been asked to give advice to the community on whether conventional gas energy or ocean-current energy is best suited to provide electricity to their community. Ensure that you discuss EACH of the bullet points below.

- Discuss the potential long-term impacts on the local community if the use of fossil fuels are continued for energy generation.
- Evaluate how an Environmental Impact Assessment (EIA) for the new gas power station could reduce potential impacts for this community.
- With reference to the principles of ocean-energy harvesting, discuss how energy can potentially be harvested from the Agulhas Current.
- Discuss potential advantages AND disadvantages for this community of harvesting energy generated by the Agulhas Current.
- Give your opinion on whether *conventional gas energy* OR *ocean-current energy* is best suited for this community. Motivate your answer.

Content: (25)
Synthesis: (10)
[35]

QUESTION 5

Refer to the hypothetical scenario below to answer the question that follows. Your answer must relate to this scenario specifically.

The owner of an onshore recirculation aquaculture facility along South Africa's West Coast is exploring the potential of expanding their operation by establishing an offshore aquaculture facility. The new facility would be located a distance offshore and provide a larger area for fish farming. In addition, being offshore will allow the opportunity to harness renewable ocean energy that can be used by the facility.

However, this offshore facility presents significant challenges. Many of these challenges are shared with renewable ocean-energy companies. A local wave-energy company plans to assist in designing the aquaculture facility and will supply renewable electricity.

[Adapted from https://www.globalseafood.org/advocate/developments-in-offshore-aquaculture]

The owner of the facility has asked you for advice on a management plan. The goal is to increase sustainability while remaining cost-effective. Ensure that you discuss EACH of the bullet points below.

- Outline the advantages AND disadvantages of the recirculation aquaculture system for fish production.
- Describe, in detail, the holding system that would be best suited for an offshore aquaculture facility.
- Discuss the challenges of such a facility being located offshore AND explain how the system should be designed to overcome these challenges.
- Identify potential collaborators and evaluate the impact that these partnerships have on the sustainability of this facility.
- Give your opinion on which aquaculture facility, the recirculation system OR offshore farms, would be more cost-effective for this business and the local community. Motivate your answer.

Content: (25)
Synthesis: (10)
[35]

TOTAL SECTION C: 35
GRAND TOTAL: 150

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