basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MARINE SCIENCES P1

MAY/JUNE 2026

MARKING GUIDELINES

MARKS: 150

These marking guidelines consist of 21 pages.

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PRINCIPLES RELATED TO MARKING MARINE SCIENCES

1. **If more information is given than marks allocated**
   Stop marking when the maximum number of marks is reached, and draw a wavy line and write 'max' in the right-hand margin.

2. **If, for example, three reasons are required and five are given**
   Mark the first three reasons irrespective of whether these first three are correct or not.

3. **If a whole process is given when only a part of the process is required**
   Read the whole process given and credit the relevant part.

4. **If comparisons are asked for, but descriptions are given**
   Accept the description if the differences or similarities are clearly stated.

5. **If diagrams are given with annotations when descriptions are required**
   Mark the description.

6. **If flow charts are given instead of descriptions**
   Mark the description only.

7. **If a described sequence is muddled and links do not make sense**
   Where sequence and links are correct, marks are given. Should a logical sequence resume, marks are given.

8. **Non-recognised abbreviations**
   Accept the abbreviation if it is first defined in the answer. If the definition is not defined, do not give credit for the unrecognised abbreviation, but credit the rest of the answer if correct.

9. **Wrong numbering**
   If the answer fits into the correct sequence of questions, but the wrong number is given, credit the answer if the answer is in the correct order.

10. **If the language that is used changes the intended meaning**
    Do not accept the answer.

11. **Spelling errors**
    If a word is recognisable (if read out loud), accept the answer, provided it does not mean something else in Marine Sciences terminology or if it is out of context.

12. **In QUESTION 1.1 of SECTION A, only accept and credit the correct letter.**

13. **Be sensitive to the sense of an answer, which may be stated in a different way.**

14. **Title**
    All illustrations (e.g. diagrams, graphs and tables) must have a title written above or below.

15. **Code-switching of official languages (terms and concepts)**
A term or concept written in any official language other than the learner's assessment language used in their answers should be credited, if it is correct. A marker that is proficient in Marine Sciences content and the official language used should be consulted. This is applicable to all official languages.

16. **Changes to the marking guidelines**
No changes must be made to the marking guidelines. The provincial internal moderator must be consulted, who in turn will consult with the national internal moderator (and the Umalusi moderators who will be consulted, where necessary).

17. **Official marking guidelines**
Only marking guidelines bearing the signatures of the national internal moderator and the Umalusi moderators and distributed by the National Department of Basic Education via the provinces must be used.

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SECTION A

QUESTION 1

1.1
1.1.1 C ✓✓
1.1.2 A ✓✓
1.1.3 D ✓✓
1.1.4 B ✓✓
1.1.5 D ✓✓
1.1.6 C ✓✓
1.1.7 A ✓✓
1.1.8 B ✓✓
1.1.9 A ✓✓
1.1.10 D ✓✓

(10 x 2) (20)

1.2
1.2.1 Universal solvent ✓/water/H_2O
1.2.2 Catch Per Unit Effort ✓
1.2.3 Aquaponics ✓
1.2.4 Positive buoyancy ✓
1.2.5 Gyre ✓
1.2.6 Trough ✓
1.2.7 Climate ✓
1.2.8 Dissociates ✓/dissociation
1.2.9 RAMSAR ✓ (Convention)
1.2.10 (Demersal) trawling ✓

(10 x 1) (10)

1.3
1.3.1 Both A and B ✓✓
1.3.2 B only ✓✓
1.3.3 Both A and B ✓✓
1.3.4 None ✓✓
1.3.5 A only ✓✓

(5 x 2) (10)

TOTAL SECTION A: 40

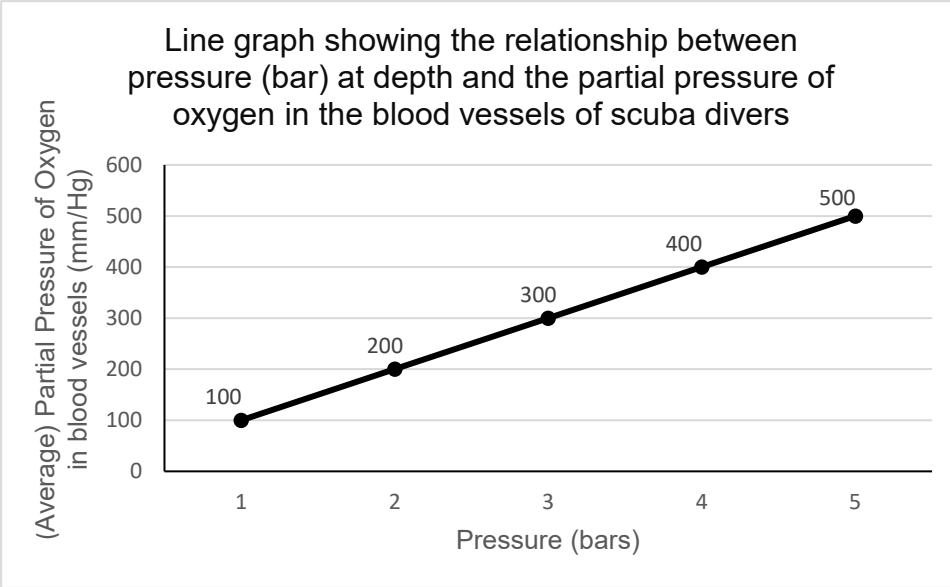
SECTION B

Important notice: more potential responses are given in these marking guidelines than marks allocated per question.
'/' means that either the first or the following phrase provided in these marking guidelines is allocated marks.

QUESTION 2

2.1 2.1.1 (a) P = (30/10) +1 = 4 bar ✓(answer and unit) (1)

(b)



MARKING GUIDELINES	
CRITERIA	**MARK ALLOCATED**
Appropriately descriptive heading, above or below the graph (**H**)	½
Heading is appropriately descriptive (needs to have both variables: Pressure and partial pressure of oxygen (**V**)	½
Type of graph (Format: Line graph) (**T**)	½
X-axis variable correct (**I**)	½
Y-axis variable correct (**D**)	½
X-axis label correct: Pressure (**XL**)	½
Y-axis label correct: Partial pressure of oxygen (**YL**)	½
X-axis correct unit of measurement (bar) (**XM**)	½
Y-axis correct unit of measurement (mmHg) (**YM**)	½
X-axis scale (**XS**)	½
Y-axis scale (**YS**) (needs zero)	½
Origin of line (**O**) – not going through the origin	½
Plotting: any 4 points plotted correctly (**P**)	4 x ½

(8)

If the candidate plotted Depth (m) on X-axis, lose marks for, **V, XL**, **XM and P**

(c) As the pressure increases the partial pressure of oxygen in the arterioles increases.

Both variables present 1 mark ✓
Direction of conclusion 1 mark ✓ (2)

2.1.2 (a) Henry's Law ✓ (1)

(b)
- The higher the pressure surrounding a body ✓
- the more nitrogen gas is absorbed into the tissue of that body. ✓
- The deeper a scuba diver descends, the more water there is above the diver, thereby a greater water pressure is exerted on the scuba diver's body. ✓
- With increased pressure, more nitrogen gas will be absorbed into the bloodstream when spending long periods of time in deep water. ✓
- With more nitrogen in the tissue over an extended time, there is a higher potential of nitrogen bubbles forming (when ascending), ✓
- increasing the risk of decompression sickness, the longer they stay at those depths. ✓

Any 4 (4)
(16)

2.2 $P_1 = 0 + 1$
$= 1$ bar
$V_1 = 2,7$ litres

$P_2 = 1,3 + 1$
$= 2,3$ bar
$V_2 = X$

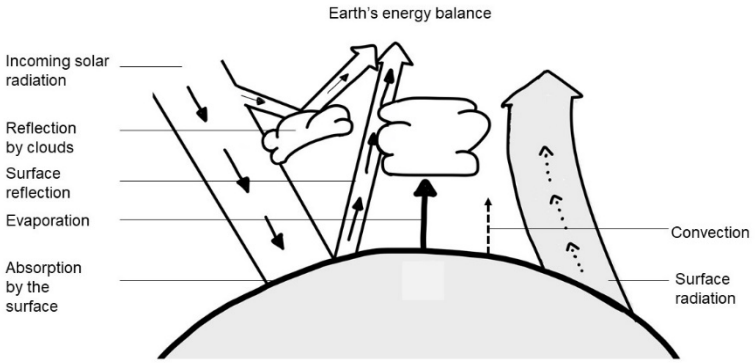
Temperature is constant

$P_1V_1 = P_2V_2$ ✓ **OR** $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ **OR** $V_2 = \frac{P_1V_1}{P_2}$

$V_2 = \frac{(1 \text{ bar})(2,7 \text{ litres})}{(2,3 \text{ bar})}$ (✓ substitution)

= 1,17 ℓ (✓ for correct answer and ✓ unit) **(4)**

2.3



MARKING GUIDELINES		
CRITERIA	**ELABORATION**	**MARK ALLOCATION**
Correct drawing **(D)**	The drawing shows: Earth's surface, incoming and outgoing radiation	½
Suitable heading **(H)**	Descriptive heading	½
Drawing technique	Drawing in pencil (**TP**) Drawing solid lines (not more than 45-55% shading – marker's discretion) (**TS**)	½ ½
Annotations (**A**)	Mark any 4 (incoming solar radiation, reflection by clouds and surface, absorption by the surface, convection, surface radiation, evaporation)	4 x ½
Annotations linked (**L**)	Annotations linked to corresponding process/ Key system used	½
Process direction (**P**)	Arrow(s) indicating movement of radiation	½
		(5)

2.4 2.4.1 Soft engineering ✓ (1)

2.4.2 (a)
- **The continuous water supply will ensure that the sand remains wet ✓*/ Vegetation will receive adequate water supply for growth**
- The moisture from irrigation causes the wet particles/sand grains to adhere together, ✓
- making the particles that are stuck together larger/heavier, ✓
- slowing the movement of particles in the air and causing grains to drop. ✓
- Moist or wet sand requires greater wind speed ✓ to move the grains on the ground, therefore
- wet sand does not move when subjected to those wind speeds. ✓
- The roots of the vegetation will stabilise the sediment, ✓
- reducing the movement of the sediment on the dunes ✓

(1 Compulsory mark ✓*/ + Any 2) (3)

(b)
- (Onshore) wind blows the sediment inland. ✓
- When sediment reaches an obstacle (plants and nets) the air movement carrying sediment slows down. ✓
- The sediment falls and is <u>deposited</u>. ✓
- (Pioneer) plants/nets stabilise the dunes through the root systems✓
- which encourages sand to build up. ✓
- (Embryo) dunes form on the windward side of the nets. ✓
- The dune nets and plants prevent sediment from being carried towards the area being protected from sand. ✓

(Any 4) (4)

2.4.3 **IF YES**

- Nets are cheaper, therefore more nets can be implemented, ensuring more sand gets trapped on the dunes, causing less damage to infrastructure ✓
- Plants are more attractive in appearance, which will bring in more profits from tourism, therefore more money can be spent on restoring damaged infrastructure ✓

IF NO

- Nets are easily damaged, therefore they may not be successful at trapping sand, causing more damage to infrastructure ✓
- Nets are manufactured from nylon or plastic. Wind-damaged nets would increase microplastics in the coastal zone ✓
- Hard engineering, such as groynes, will be a potentially better long-term solution, therefore decreasing the damage to infrastructure for the future ✓

(Mark only allocated for Yes or No if answer is motivated)
(Any logical relevant answer, marker discretion for insightful thinking) (2)

(10)
[35]

QUESTION 3

3.1 3.1.1
- The waves transfer (kinetic) energy to the sea pack ice upon impact, ✓
- breaking the sea pack ice into smaller pieces ✓ (2)

3.1.2 (a)
- Between May and September ✓/Summer months in the Arctic (1)

(b)
- As the waves travel further onto the sea pack ice, the size of the sea pack ice decreases ✓✓

OR

- As the distance the waves travel onto the sea pack ice decreases, the size of the sea pack ice increases ✓✓ (2)

3.1.3 (a)
- The increased marginal ice zone has more broken up pieces of ice than the sea pack ice ✓
- therefore, has lower reflectivity ✓/ the albedo on Earth would be lower.
- Less heat is then lost into space ✓
- increasing the average temperature of the Earth ✓
- and the rate of climate change ✓
- increased unpredictability of the climate ✓/more extreme conditions such as storms

(1 Mark for albedo, 1 mark for global warming and 1 mark for climate change)
(Any logical relevant substantiating answer, marker discretion for insightful thinking) (3)

(b)
- The ice fragments could puncture/damage the hulls of ships ✓
- reducing the number of ships/ship traffic in the polar regions ✓
- therefore, there will be a loss of income for the shipping industry ✓

OR

- More boats would be able to travel through the area as the ice melts ✓
- decreasing the need to use alternative shipping routes ✓
- therefore, there will be an increase of income for the shipping industry ✓

(Any logical relevant substantiating answer, marker discretion for insightful thinking) (3)

(11)

3.2 3.2.1
- The ocean conveyor belt is the largest global oceanic current on Earth. ✓
- It is the continuous movement of water around Earth, ✓
- caused by the differences in density ✓/temperature/salinity,
- between extremely large masses of ocean water. ✓

(Mark any 2) (2)

3.2.2 (Melting ice releases fresh water)
- reducing the salinity of surface sea water at the poles. ✓
- This reduces the density of the surface sea water compared to deeper sea water ✓
- **therefore, less water sinks ✓*/replacing bottom water.**

(Compulsory ✓* mark and any 2) (3)

3.2.3 (a)
- Northwest coast ✓
- Southwest coast ✓
- South coast ✓

(Any 2) (2)

(b)
- The change in global ocean circulation will result in a lower income/decrease in employment ✓
- due to fewer fish in the waters of the regions, as fish will migrate towards cooler temperatures ✓

OR

- An increase in 'production' cost of fishing ✓/decrease in profit
- due to fishing boats needing to travel further to catch target fish species which has migrated further away ✓

OR

- A decrease in income from tourism/recreational fishers visiting the area ✓
- resulting from a decrease in biodiversity/target fish migrating elsewhere ✓

OR

- A decrease in income from tourism ✓ (e.g. visiting the Namaqualand flowers)
- due to increased temperature of sea water, which could potentially change the climate along the coast ✓ (e.g. increase precipitation)

(Mark any 2 pairs, mark first 2 pairs)
(**Any logical relevant answer, marker discretion for insightful thinking**) (4)

(11)

3.3 3.3.1 Change/Fluctuation in the normal trade wind patterns in the Pacific Ocean Basin area✓ (1)

3.3.2 Table illustrating the difference between El Niño and normal events for surface water temperature and rainfall

	Normal	El Niño
Rainfall	High rainfall ✓	Less rainfall than normal conditions ✓
Sea temperature	Warm ✓/Hot	Warmer than normal conditions ✓

(1 table + 4 content) (5)

3.3.3 (a)
- South Africa would have been experiencing El Niño ✓/dry conditions
- La Niña brings wet/cool conditions ✓/more rainfall
- Farmers rely on rainfall for their crops ✓/livestock
- Less financial stress on farmers, as profit will be made from crops and livestock ✓ (4)

(b) **IF YES**

- Farmers have no control over changes in weather systems; therefore, it is better to farm with crops that can easily adapt to a change in weather ✓/crops that can survive in a wide range of precipitation and temperature levels
- Farmers could potentially change to livestock which are better suited for indoor environments, to survive potential flood events ✓ example poultry, which are smaller in size, therefore more can be farmed within a controlled indoor environment

IF NO

- There will always be fluctuations of weather conditions, therefore, the farmers should change their farming methods instead of changing the crops being farmed with ✓
- It will potentially be expensive to change the infrastructure and machinery needed for new crops and different livestock to farm with ✓

(Mark only allocated for Yes or No if answer is motivated)
(Any logical relevant answer, marker discretion for insightful thinking) (2)

(12)

3.4 3.4.1 (a) Ocean acidification ✓ (1)

(b)
- Due to the increased levels of absorption of CO_2 by the ocean ✓
- There is an increase in the quantity of carbonic acid that forms ✓
- The pH of sea water is reduced ✓/ more acidic
- causing less calcium and carbonate to be available to the corals ✓/ binding together/less aragonite
- **Corals are then unable to form their hard structures ✓*/weakens their structure making them more vulnerable to environmental effects**

(1 compulsory mark ✓* and any 2) (3)

3.4.2
- International agreements by political leaders ✓
- creates a significant reduction in global CO_2 emissions ✓/to reduce sea temperature rise

OR

- Penalise people/companies if they do not follow international laws regarding CO_2 ✓ (such as United Nations Environmental Programme UNEP)
- to ensure that people/companies/decision makers keep to international laws/regulations ✓

OR

- Provide incentives for people/companies who are reducing their carbon emissions ✓
- to encourage people/companies/decision makers to follow international laws ✓

OR

- Negotiate with leaders/provide incentives for countries to not withdraw from international agreements ✓
- to ensure climate change research continues ✓

(Mark any pair, mark first pair)
(Any logical relevant answer, marker discretion for insightful thinking) (2)

- **(6)**
[40]

TOTAL SECTION B: 75

SECTION C

When marking essays:
- *Markers should indicate with the designated letter.*
- *Compulsory marks per section are indicated with ✓*.*
- *The breakdown of the synthesis marks is indicated on the rubric for the essays.*
- *Credit valid responses which may be provided by the candidate from other sources.*
- *Markers need to allocate a minimum of four marks per subsection.*
- *A maximum of two marks for the opinion.*
- *Excluding the opinion, the other seven marks may be awarded for any of the sections being discussed.*

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ASSESSING THE PRESENTATION OF THE ESSAY

MARK ALLOCATION	2	1	0
INTRODUCTION 2 marks (INTR)	The introduction shows a contextual link that the candidate understands what the question is, by: Correctly stating in their own words what the question is about AND describing the intention/purpose of the essay.	Some attempt to write an introduction/ stated intention of essay but to a large extent using the wording from the question. Unclear that candidate fully understands the topic. Stated the intention of the essay in their own words.	There is no introduction. Starts with the asked content straight away. Provides randomly arranged facts. Restating the question
USE OF PARAGRAPHS 2 marks (PAR)	The internal structure of a paragraph clearly planned. One main aspect/idea discussed in a paragraph. If more than one aspect is discussed in a paragraph, the connection is clearly visible.	Some paragraph division but is unclear (not linked) why content is grouped in these paragraphs.	All content sections written as one paragraph.

RELEVANCE 2 marks (REL)	Sufficient information with many good points made, 50% or more of the content is relevant to the question asked.	An attempt to write on the topic, but only 26% to 49% of the content discussed in the essay is relevant to the question asked.	25% or less of the content that the learner addressed is relevant to the topic asked.
LOGICAL SEQUENCE 2 marks (LSEQ)	Paragraphs show logical sequence and are demonstrably linked to each other.	Generally clear sequence but some facts not in place – content provided is correct but is meant to be in a different (relevant) paragraph. Essay poorly planned.	Very difficult to read the essay as no logical sequence. Many facts with no clear layout. Clearly unplanned.
CONCLUSION 2 marks (CONC)	Clearly bringing the aspects discussed in the essay together in a final paragraph in own words.	An attempt to write a conclusion, but closely quotes the words of the question asked. Still shows linkage of the topic to their response.	No conclusion. Learner clearly stopped after the content paragraphs – no attempt to pull the ideas together.

(10)

QUESTION 4

INTRODUCTION GUIDELINES

- Includes conventional energy and renewable energy **OR** communities and energy generation
- Does not repeat/reproduce wording of the question

LONG-TERM IMPACTS OF FOSSIL FUELS (G)

- The burning of fossil fuels releases harmful particles into the atmosphere, which could result in an increase in high-energy weather events such as tropical storms in the region, ✓
- this could result in damaged infrastructure ✓
- The harmful gases (such as (SO_2) sulphurous gases and (NO_X gases) nitrogenous gases) released could potentially cause health problems ✓ for the community such as asthma and lung cancer.
- Fossil fuels are a non-renewable resource, that means that the community will eventually run out of fuel for energy generation. ✓
- If the community runs out of fossil fuels it could negatively affect healthcare facilities ✓/schools/businesses which could further
- increase economic pressure on the community ✓/increase the number of people subjected to poverty in the area.
- The transportation of fossil fuels could result in environmental pollution and infrastructure damage in the area ✓

(Any logical relevant substantiating answer, marker discretion for insightful thinking)

Min 4

EIA (E)

- An EIA allows a specialist to determine the impact that the gas power plant will have on the environment ✓
- to preserve the town's historical ✓/cultural/economic/social/environmental values.
- Examples of impacts include air pollution ✓/water pollution
- Recommendations can be made to minimise the impact of the construction and operation of the gas power station, ✓
- while still being able to meet the requirement of producing enough energy for the town ✓/provide jobs.
- The EIA will identify potential mitigation measures that can reduce the environmental and health risks to the community ✓
- such as reducing the amount of groundwater contamination ✓/gas emissions.

(Any logical relevant substantiating answer, marker discretion for insightful thinking)

Min 4

PRINCIPLES OF HARVESTING OCEAN ENERGY FROM AGULHAS CURRENT (P)

- The power of ocean currents is generated by the sun's influence on surface winds and the steady forces from Earth's rotation ✓/Coriolis effect
- The generation of electricity is achieved by the water movement ✓ of the current
- causing the rotation of a turbine ✓/curved blades/multiple-propeller underwater mechanism.
- The mechanical energy is converted to electrical energy ✓ via a
- generator ✓ which would need to be
- anchored to the seabed. ✓
- With the Agulhas Current being a fast/strong current, it would make harvesting energy economically viable in this region ✓

Min 4

OCEAN-CURRENT ENERGY

Advantages (AC):

- Ocean-current energy can lower carbon emissions ✓ /contribute to climate change mitigation/reduce damage to the environment caused by conventional methods such as water and air pollution.
- Ocean-current energy is a renewable energy source, therefore, it will not deplete over time ✓ ensuring long-term sustainability for the community.
- The Agulhas Current is very strong (the strongest current on the planet) and the timing of the eddies can be predicted, meaning the community could design a plan to ensure continued energy generation during times when eddies are present. ✓
- Engineers can design generators that manage the different current directions in eddies. ✓
- Developing new local energy infrastructure could promote local innovation and skills into other renewable energy options. ✓
- The community could gain energy independence, reducing reliance on national grid ✓/non-renewable fossil fuels/sourcing of oil/diesel products international for example from Iran.
- Local residents would need additional training, allowing for opportunities of up skilling the community. ✓
- It will not negatively impact the health of the local residents. ✓

Min 2

Disadvantages (DC):

- Local community would need training to work in a new field, training is expensive. ✓
- Designing the system to withstand the extra force of the Agulhas Current will be challenging ✓/expensive.
- Setting up infrastructure/specialized equipment to harness energy from the Agulhas Current can be very expensive. ✓
- The installation of the system can be challenging in a dynamic ocean environment where waves caused by storms may delay the installation ✓/saline waters will corrode the equipment.
- The installation of the systems could impact local marine ecosystems which could have unintended consequences on the community ✓ such as a migration of important fish stocks out of the area.
- Ocean-based energy systems require regular maintenance, and the remote nature of the installation site can make access difficult ✓/increase repair times/costs.
- Equipment may break under the strength of the Agulhas Current. ✓

- Variations in ocean conditions, such as seasonal changes or extreme weather events, could impact energy generation, leading to potentially unreliable energy production ✓ at times.
- The energy output depends on the strength and consistency of the Agulhas Current. ✓
- If visible parts of the energy-harvesting infrastructure are placed close to shore, they could potentially affect the local tourism industry ✓, especially in areas where natural beauty is a major draw.
- May have conflicts with other sectors such as fisheries, marine conservation in MPAs, and international maritime operations, which could delay or complicate the project. ✓

(Any logical relevant substantiating answer, marker discretion for insightful thinking)

Min 2
Max (23)

OPINION (J)

IF 'CONVENTIONAL GAS ENERGY'

- Conventional energy is already well established in the community and therefore, provides reliable jobs ✓/employment for the local community.
- It is cheaper to operate and maintain ✓ as it is already established.
- Provides a reliable energy source to the area. ✓
- Gas-powered energy has less environmental impacts than coal. ✓

IF 'OCEAN-CURRENT ENERGY'

- Eskom infrastructure is failing and requires expensive maintenance and fixing. ✓
- Ocean-current energy could restore the health of the local community which have for many years suffered the impacts of generating coal-powered energy. ✓
- This type of energy generation is a renewable resource and therefore, it is sustainable ✓/it could benefit the community for many future generations.
- Starting renewable energy projects could attract investors (local and international funding sympathetic to renewable energy plants). ✓
- The community could gain many valuable skills that could be transferable to other higher paying careers, thereby making community members more employable and are then able to take up higher paying careers ✓

(Any logical relevant substantiating answer, marker discretion for insightful thinking)

Max (2)

CONCLUSION GUIDELINES

- Includes conventional energy and renewable energy **OR** communities and energy generation
- Does not repeat/reproduce wording of the question

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

QUESTION 5

INTRODUCTION GUIDELINES
- Includes land-based and offshore aquaculture farms **OR** aquaculture and local communities
- Does not repeat/reproduce wording of the question

RECIRCULATION SYSTEM (R)

Advantages (AR)
- There are more possibilities for locations for recirculation facilities compared to offshore facilities. ✓
- There is a lower amount of water required as water is pumped through the system repeatedly. ✓
- Recirculation processes produce high-quality filtered water. ✓
- The farmer or aquaculturalist has more control over water quality, therefore, the system is not easily affected by weather conditions.✓
- Recirculation systems produce the highest production return per area of land. ✓
- Recirculation systems are land-based and therefore, can directly contribute to the livelihoods of coastal or inland communities ✓ through food security/employment.
- Farmed species that are enclosed in tanks have a smaller chance of escaping the facility and therefore, there is a lower probability of compromising the wild stock genetically. ✓

Min 2

Disadvantages (DR)
- Intensive aquaculture farms require an extensive filtration process (mechanical and biological) to remove waste from the system which uses a lot of energy. ✓
- Recirculation systems are highly dependent on electricity, making backup generators essential ✓ because loss of grid power could kill off the fish very quickly.
- Recirculation systems are expensive ✓ due to the increased level of technology required.
- Recirculation systems require more resources to build, maintain and operate the system. ✓
- Genetic integrity of the species can be compromised due to inbreeding at the facility. ✓
- Important ecosystems (e.g. mangroves) are destroyed to build the facilities. ✓

Min 2

(Any logical relevant substantiating answer, marker discretion for insightful thinking)

OFFSHORE HOLDING SYSTEM (H)

- **The holding system best suited for offshore aquaculture is sea cages. ✓***
- Sea cages are typically used to farm fish species. ✓
- Sea cages can be designed in the shape, size, volume best suited for the species being farmed ✓/particular sea conditions in the area.
- The cages can be moved from one location to another ✓ depending on the sea state/ the sea conditions and the season.
- Oxygen levels are normally maintained by algal photosynthesis ✓/aerators depending on how much oxygen is naturally flowing through the cages.

- The fish are managed, fed and harvested directly from the cages. ✓
- The fish in sea cages require high quality feed. ✓
- Fish waste is managed by the water movement through the cage ✓ - can drop out of the bottom of the cage to the seabed.
- Sea cages should be placed where ocean movements/currents disperse the nutrients/fish waste to avoid eutrophication. ✓
- Sea cages can be designed as multi-layered cages, ✓ where
- the upper layer consists of sea cages containing the fish species and the lower layer consists of sea pens containing seaweed and bivalves ✓ which
- absorb and clean the waste products ✓ that settle down from the cages above.

✓* compulsory mark + minimum 3

CHALLENGES TO OFFSHORE SYSTEMS (S)

Challenges of being located offshore include:
- Corrosion/sand-abrasion can cause the structures of these systems to break down and require more regular maintenance✓ therefore,
- non-corrosive materials should be used to build the systems ✓ such as pvc (composite plastics) piping for the frames of the sea cages.

- Force of the waves, currents or winds can be so large and powerful that mechanisms simply break under the extreme force ✓ therefore,
- the systems need to be robust enough to stand up to extreme sea states. ✓

- Biofouling from opportunistic marine organisms settle on any exposed surfaces and can prevent the amount of available oxygen ✓/result in eutrophication/weaken the cages due to the heavy mass of the organisms breaking the nets.
- A solution is to paint the mechanisms with anti-fouling paints, ✓ such as those used on the hulls of ships, to prevent the organisms from sticking.

- Costs are high due to construction costs ✓/constant maintenance of offshore systems,
- therefore, the systems need to be priced to compete with relatively inexpensive onshore systems. ✓

- The build up of algae due to the increased nutrients from waste could result in eutrophication. ✓
- There has to be a multi-layered cage system with bivalves/seaweed in the bottom layer to absorb the extra nutrients. ✓

mark minimum 2 pairs
(Any logical relevant substantiating answer, marker discretion for insightful thinking)
Min 4

IMPACT OF COLLABORATIVE PARTNERSHIPS (E)

Examples of partners that the offshore aquaculture farm owner could potentially collaborate with are:

- A local wave energy company will provide expertise in the design and maintenance of the system ✓/provide renewable energy
- ensuring the continued success in the operation of the system over a long period of time. ✓

- The local community could have shares in the facility ✓/be employed at the facility
- resulting in potential long-term employment at the farm, ensuring the continued successful operation of the farm. ✓

- Financial institutions could invest in the system ✓/farm
- which could reduce the overall costs the owner of the farm would have to invest. ✓

- Universities/researchers could provide technical expertise ✓
- improving the long-term efficiency of the farm ✓/improving the overall quality of the product/collecting data for their research will guide future development in this farm's techniques. ✓

- Conservation organisations/ecotourism ventures providing educational trips for school groups/tourists ✓
- Funds to be used to maintain the facility and minimise the environmental costs ✓

(example 1 mark ✓ and corresponding sustainability 1 mark ✓)
(Any logical relevant substantiating answer, marker discretion for insightful thinking)
minimum 2 examples and 2 corresponding sustainability (23)
Min 4
Max

OPINION (J)

IF 'RECIRCULATION'
- The farm is already set-up and therefore management operation costs will not increase ✓
- Recirculation farms are land-based and are therefore, more easily accessible for the employees and maintenance. ✓

IF 'OFFSHORE'
- Cheaper maintenance and operating costs due to low level of technology required for sea cages. ✓
- Renewable ocean energy could assist in decreasing cost of electricity for the business ✓/community.

(Any logical relevant substantiating answer, marker discretion for insightful thinking)
Max (2)

CONCLUSION GUIDELINES

- Includes land-based and offshore aquaculture farms **OR** aquaculture and local communities
- Must NOT include the wording of the question.

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

TOTAL SECTION C: 35
GRAND TOTAL: 150

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