NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2024

MARINE SCIENCES: PAPER I

MARKING GUIDELINES

Time: 2½ hours 150 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

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SECTION A

QUESTION 1

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

1.2	1.2.1	Bar
	1.2.2	Broodstock
	1.2.3	Scarp
	1.2.4	Boyle's gas law
	1.2.5	Berm
	1.2.6	Valence electrons
	1.2.7	Generator
	1.2.8	Buoyancy
	1.2.9	Raceway
	1.2.10	Calcifiers/calcifying

1.3	1.3.1	A
	1.3.2	C
	1.3.3	B
	1.3.4	D
	1.3.5	B

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SECTION B

QUESTION 2

2.1 El Niño: A climate pattern characterised by weakened easterly winds and the spread of warm water across the Pacific, which has global impacts on weather patterns.

Global warming: The increase in Earth's average temperature due to human activities, particularly the emission of greenhouse gases.

2.2
1. more intense storms
2. destructive rainfall
3. longer and hotter heatwaves
4. loss of sea ice
5. food chain disruption
6. coral bleaching
7. sea level rise
8. change in global thermohaline circulation
9. loss of species diversity

2.3 unusually high Saharan dust levels
large amounts of stratospheric water vapor
changes in ocean circulation

2.4 has caused extreme weather events
including record-breaking heatwaves
record-breaking heatwaves in Mexico, Texas, China, and Europe
unusually high temperatures in Iran.

2.5 2.5.1 Antarctica multiple changes increased and decreased, 16 & 19% within periods ✓

2.5.2 Artic – mainly positive variation with a decline until 2003, then large decline with negative variation since 2013 ✓

Or Antarctic – large decline in recent years
(Additional option)

2.5.3 Any reasonable value between -2.3 and -4.6 for ice loss was accepted for the calculation

A decrease of –3.3% remaining equals 96,7%
Ice sheet 13,1 million sq. km
(Award marks for any reasonable value between -2.3 and -4.6 as exact values are difficult to extract from the figure)

$$\frac{96{,}7 \times 13{,}1 \text{ million sq. km}}{100} = 12{,}67 \text{ million sq. km}$$

2.5.4 Short-term fluctuations, such as the one observed during those years, are part of the natural variability inherent in the climate system and should not be confused with long-term climate change trends.

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QUESTION 3

3.1 Drawing inspiration/ studying/ idea ✓ from nature's design and processes to create innovative solutions for human challenges.

3.2 1. non-toxic
2. 300% stronger than other underwater adhesives
3. bonds to a wide range of materials.

3.3 Sharkskin-inspired swimsuits: The texture of sharkskin has inspired the development of swimsuits with a surface texture that reduces drag and improves swimmer performance.

Biofouling prevention: The use of antifouling coatings inspired by the properties of marine organisms, such as barnacles and mussels, to prevent the attachment of organisms on ship hulls and underwater structures.

Whale-inspired wind turbine blades/aeroplane wings: The design of wind turbine blades/aeroplane wings ✓ has been influenced by the bumpy leading edge of humpback whale flippers, which helps reduce drag and increase efficiency.

Bioluminescence-inspired lighting: The bioluminescent properties of marine organisms, such as jellyfish and deep-sea creatures, have inspired the development of energy-efficient lighting solutions that mimic the natural phenomenon.

Underwater adhesion inspired by sea creatures: Marine organisms like sandcastle worms and sea cucumbers have inspired the creation of adhesives and coatings that can stick underwater, offering potential applications in underwater repair and sealing.

Coral-inspired concrete: The porous and durable structure of coral reefs has influenced the development of concrete materials that are more resistant to erosion and have lower environmental impact.

Seaweed-based packaging: The flexible and biodegradable nature of seaweed has inspired the development of sustainable packaging materials as an alternative to conventional plastic.

Drag reduction inspired by dolphin skin: The texture of dolphin skin, with its hydrodynamic properties, has inspired the design of drag-reducing materials for applications in industries like aerospace and transportation.

Biodegradable sunscreen inspired by coral: Sunscreen formulations that are harmful to coral reefs have led to the development of biodegradable and reef – safe sunscreen alternatives, drawing inspiration from the natural sun protection mechanisms of corals.

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3.4 Candidates are only required to list the answers:

Sustainability: Biomimicry promotes sustainable solutions by drawing inspiration from ecosystems, which have evolved over billions of years to utilise resources and minimise waste efficiently.

Efficiency: Nature has perfected many processes and designs through evolution, resulting in highly efficient systems. By mimicking these natural designs, biomimicry can lead to more efficient technologies and processes.

Adaptability: Organisms in nature have developed adaptable strategies to survive and thrive in diverse environments. Biomimicry can harness these adaptable designs to create products and systems that can better withstand changing conditions.

Innovation: Nature's solutions to complex problems often involve innovative and unexpected approaches. By studying and mimicking natural systems, biomimicry can inspire novel solutions to human challenges.

Resilience: Natural systems are often resilient to disturbances and disruptions. By incorporating principles of biomimicry, human-made systems can become more resilient to environmental changes and shocks.

Bioinspired materials: Biomimicry can lead to the development of new materials inspired by natural structures and properties. These bioinspired materials often exhibit desirable properties such as strength, flexibility, and biodegradability.

Energy efficiency: Many natural processes are highly energy efficient. By mimicking these processes, biomimicry can contribute to the development of energy-efficient technologies and systems.

Health benefits: Biomimicry can lead to the development of products and technologies that are compatible with living systems, potentially reducing negative impacts on human health and well-being.

Biodiversity conservation: By studying and valuing the diversity of life on Earth, biomimicry encourages the conservation of biodiversity and the protection of natural habitats.

Cost-effectiveness: Biomimicry can lead to cost-effective solutions by utilising natural processes and materials that are readily available in the environment.

Multidisciplinary/collaborative: integrating ideas across disciplines and industries.
(Marks awarded for just listing the benefit without description.)

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QUESTION 4

4.1 This can increase their maximum monetary yield in the long run as well as appeal to ethical consumerism for consumers.

Being involved in sustainable fishing provides a good brand image and supports the 'green' branding that many companies are trying to promote to satisfy the environmentally conscious generations.
By supporting sustainable fishing, they are ensuring a supply of fish to sell in the future.

4.2 An 'MSC' fisherman now has a monetary incentive to fish sustainably, as he can now sell his fish for a slightly higher price with a reduced catch.

Increased demand for their product because it is certified by an environmentally concerned council.

4.3 Ethical consumerism, customers want to make environmentally friendly decisions and buy from reliable sources so as to 'do their part' in ensuring that the oceans are not overfished.

People may recognise that sustainable fishing is important and may want to support a company that does that.
It lowers the feeling of guilt many people feel when using a resource with a public image of being environmentally destructive.

4.4 Candidates' responses to this question should identify and discuss key challenges faced by fisheries in adopting sustainable practices. Look for thoughtful suggestions on how these challenges can be overcome, considering factors such as economic incentives, technological advancements, and community engagement.

Overfishing: Excessive fishing pressure can deplete fish stocks and disrupt marine ecosystems, making sustainable management difficult. ✓

Implement science-based fisheries management strategies, including catch limits and fishing quotas, ✓ to prevent overexploitation.

OR

Promote the adoption of selective fishing gear and techniques to minimise bycatch and unintended harm to non-target species.

Illegal, unreported, and unregulated (IUU) fishing: IUU fishing undermines efforts to achieve sustainability by circumventing regulations and exploiting loopholes, strengthen monitoring, control, and surveillance efforts through increased patrols, vessel tracking systems, and satellite technology.

OR

Enhance international cooperation and collaboration to combat IUU fishing through information sharing, enforcement agreements, and sanctions against offenders.

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Lack of effective governance and enforcement: Inadequate governance structures and enforcement mechanisms can hinder the implementation and enforcement of sustainable fishing practices.

Enhance transparency and accountability in fisheries management through stakeholder engagement, participatory decision-making processes, and robust legal frameworks.

OR

Invest in capacity-building initiatives to strengthen the institutional capacity of fisheries management authorities and enforcement agencies.

Unsustainable fishing practices: Some fishing methods, such as bottom trawling and dynamite fishing, can cause significant damage to marine habitats and ecosystems.

Promote the adoption of ecosystem-based fisheries management approaches that prioritise the health and resilience of marine ecosystems.

OR

Encourage innovation in fishing gear and techniques, such as using more selective and environmentally friendly gear, to minimise habitat destruction and ecosystem impacts.

Socioeconomic challenges: Fisheries-dependent communities may face economic hardships and social upheaval as a result of declining fish stocks and changing regulatory regimes.

Implement measures to support alternative livelihoods and economic diversification in fisheries-dependent communities, ✓ such as ecotourism, aquaculture, and sustainable agriculture.

OR

Ensure equitable distribution of benefits from fisheries management measures through revenue-sharing mechanisms and community-based fisheries management initiatives.

Climate change impacts: Climate change can disrupt marine ecosystems, alter fish distribution patterns, and exacerbate existing challenges faced by fisheries.

Integrate climate change considerations into fisheries management plans and strategies, including adaptive management approaches and ecosystem-based adaptation measures.

OR

Support research and monitoring efforts to better understand the impacts of climate change on fisheries and develop appropriate mitigation and adaptation measures.

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QUESTION 5

5.1 *Ecklonia maxima*

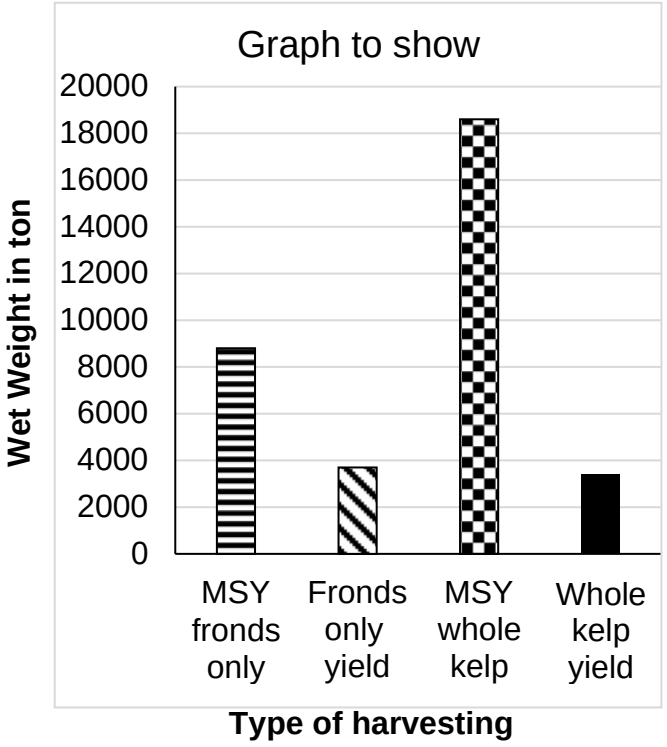
5.2 1. The flexible and elongated stipe of sea bamboo allows it to reach up towards the water surface, maximising exposure to sunlight.
2. Possesses efficient photosynthetic pigments that can capture and utilise available light at greater depths, enabling it to carry out photosynthesis even in low light conditions.
3. Hollow stipe/hollow bulb buoyant – fronds in sunlight near surface
4. Fronds with large flexible surface to intercept maximum light

5.3 Wave Dissipation: Kelp forests act as natural buffers by absorbing and dissipating the energy of ocean waves.
Sediment Accumulation: Kelp provides a physical barrier that traps and accumulates sediments along the shoreline.

5.4 alginate extraction
abalone feed
agricultural liquid plant growth enhancer (fertiliser)

5.5 Does not damage the growing tip/remove the whole plant, so speeds up regeneration.

5.6 5.6.1



Title – Graph to show … variables
Label X axis
Label types
Label Y axis units
Variables on correct axes
Bars equal in width / Spaces between bars

Bars infill different
Scale of axes
Correct plotting of values

5.6.2 The largest average sustainable catch that can be captured from a stock under existing environmental conditions.

5.6.3 Wet Weight in tons

5.6.4 1. year
2. harvest sites
3. Type of kelp

5.6.5 Both types of harvesting, only a portion of the allotted quota was harvested, with whole kelp harvesting the lowest portion of the allocated quota. **/** kelp was harvested sustainably

5.6.6 The ocean conditions may have prevented the harvesters from going to sea to harvest

OR

the resource available was less than the MSY difference in calculation.

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SECTION C

QUESTION 6

Organisms are generally found within a range of tolerances.

Wave action: Generally effect greater in intertidal region. Strong waves can dislodge or damage organisms.

The lower part of the shore experiences the highest wave action
High-energy zones are dominated by sturdy, wave-tolerant species, while low-energy zones more delicate organisms.

Organisms such as barnacles (cementation) and mussels use strong adhesive structures like byssal threads to anchor themselves to rocks, burrowing into sediment, or seeking shelter in crevices or seaweed to withstand wave impact.

Many intertidal organisms have streamlined or flattened bodies that reduce drag and enable them to withstand the force of waves.

This adaptation allows them to remain attached to the substrate and resist being washed away.

Organisms like limpets and chitons have low-profile shells or flattened bodies that reduce the exposed surface area.

This adaptation helps them withstand the impact of crashing waves and reduces the risk of being dislodged.

Some molluscs, such as certain types of snails, have robust shells that provide protection against wave action.

These shells act as a shield, buffering the organism from the force of waves and preventing damage.

Mobile organisms like crabs have the ability to move and seek refuge in crevices or rock pools during periods of high wave activity and certain species of seaweed are flexible and move with the waves.

Filter-feeding organisms, such as barnacles and mussels, have specialised feeding structures that allow them to capture food particles suspended in the water column.

By positioning themselves in areas of high-water flow, they can take advantage of the nutrient-rich currents generated by wave action.

Desiccation: Exposure to air during low tide causes desiccation stress. It influences zonation by limiting the distribution of species that are not well adapted to withstand long periods of dryness.

The higher part of the shore experiences the greatest level of desiccation

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Many intertidal organisms possess adaptations to retain moisture. They may have waxy coatings, mucous layers, or specialised structures that help reduce water loss through evaporation.
This moisture-retention mechanism allows them to withstand prolonged exposure to air during low tide periods.

Certain organisms, such as molluscs and bivalves, can tightly close their shells, sealing in moisture and protecting themselves from desiccation.

This adaptation helps maintain the necessary level of internal humidity during periods of air exposure.

Some organisms, like small crabs and worms, have adapted to live in crevices, burrows, or under rocks. These sheltered microhabitats offer protection from direct exposure to air and minimise desiccation risk.

During periods of extended desiccation, certain organisms enter a state of dormancy known as estivation. They reduce their metabolic activity and conserve energy until conditions become more favourable.

This adaptation allows them to survive prolonged periods of drought and lack of moisture.

Some intertidal organisms can regulate their internal salt and water balance, enabling them to tolerate fluctuations in salinity and prevent excessive water loss.

They actively regulate the concentration of solutes in their body fluids to prevent dehydration and maintain proper cellular function.

Certain species can quickly rehydrate themselves once submerged in water. They absorb moisture rapidly to replenish their tissues and restore normal physiological processes.

This adaptation allows them to recover from desiccation and resume their activities when the tide returns.

Temperature: Rocky shores experience temperature fluctuations between air and water. Organisms must tolerate variations in temperature to survive. Zonation can be influenced by species' thermal tolerance and adaptations to cope with temperature changes.

The higher part of the shore experiences the greatest level of heat stress

Organisms exhibit specific thermal tolerances, meaning they can only survive within a certain range of temperatures.

Different species have varying abilities to tolerate high or low temperatures, which leads to their distribution in specific temperature zones on the rocky shore.

High air temperatures during low tide can lead to heat stress and desiccation for intertidal organisms.

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To cope with heat stress, some organisms may have adaptations such as reflective or lighter-coloured body surfaces to reduce heat absorption, while others seek shelter in crevices or burrow into the substrate to minimise exposure. Some intertidal organisms possess physiological mechanisms to regulate their body temperature. They may adjust their metabolic rates or behaviour to maintain optimal body temperatures.

Certain snails can seek shade or migrate to cooler areas when temperatures rise.

Some species have the ability to acclimate to different temperature conditions. They can adjust their physiological processes, such as enzyme activity or metabolic rates, to better suit the prevailing temperatures.

Salinity: Intertidal zones are exposed to varying salinity levels due to rainwater or evaporation. Species adapted to specific salinity ranges can dominate zones, while others are restricted to areas with stable salinity.

The higher part of the shore experiences the greatest level of salinity ranges

Rocky shores experience salinity gradients due to inputs of freshwater from sources like rivers, rainfall, and tidal fluctuations.

These gradients create zones with varying salinity levels, ranging from high salinity in areas closer to the sea to lower salinity in areas affected by freshwater inputs.

Different species have varying abilities to regulate their internal salinity levels, enabling them to tolerate and thrive in specific salinity zones.

Osmoconformers and osmoregulators:

Some organisms are osmoconformers, meaning they adjust their internal salinity to match that of the surrounding environment. They are more limited in their distribution and are typically found in areas with relatively stable salinity.

Other organisms are osmoregulators, capable of actively regulating their internal salinity levels despite external fluctuations. This allows them to occupy a wider range of salinity zones on the rocky shore.

Organisms inhabiting areas with high salinity must deal with osmotic stress caused by water loss from their bodies.

They may have adaptations such as specialised excretory organs, or the ability to concentrate or excrete excess salt to maintain proper osmotic balance.

Organisms living in areas with lower salinity face challenges related to maintaining enough salt levels and preventing excessive water uptake.

Euryhaline species:

Some organisms, known as euryhaline species, are highly adaptable to a wide range of salinities. They can tolerate both high and low salinity conditions and occupy a broader distribution on the rocky shore.

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Light availability: Light availability decreases with depth and can impact the distribution of photosynthetic organisms.

Light intensity decreases with depth and can be limited by factors such as water clarity, turbidity, and the presence of shading structures on the rocky shore.

Different zones receive varying levels of light, ranging from intense sunlight in the upper zones to reduced light penetration in the lower zones.

The availability and intensity of light determine the types of photosynthetic organisms that can thrive in different zones, as well as the adaptations of organisms to survive under varying light conditions.

Organisms inhabiting areas with high light intensity must cope with potential challenges such as excessive light energy, heat, and desiccation.

They may have adaptations such as specialised pigments, protective compounds, and structural features (e.g., waxy coatings, sunscreens, or thalli orientation) to prevent damage from intense sunlight and reduce water loss.

Organisms living in areas with lower light intensity must maximise light capture and optimise their photosynthetic efficiency.

They may possess adaptations such as larger surface areas, increased chlorophyll content, or elongated structures to enhance light absorption and increase exposure to available light.

Some organisms exhibit light-dependent behaviours, such as vertical migration, to maximise their exposure to light.

They may move up or down the rocky shore in response to changing light conditions, seeking optimal light levels for growth and survival.

Light availability influences the competitive interactions between organisms. Those adapted to low light conditions may outcompete others in shaded areas while light-demanding species dominate in areas with high light intensity.
(Max 5 marks for each of wave action, desiccation, temperature, salinity, and light intensity).

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QUESTION 7

Three major biogeographical regions: cool temperate, warm temperate and subtropical.

Currents play a crucial role in nutrient availability, water temperature, and species distribution.

Agulhas Current: The warm Agulhas Current flows southward along the eastern coast of South Africa. It influences the subtropical region and brings warm, nutrient-poor waters – waters from the Indian Ocean.

Lower productivity – lower biomass

Higher diversity of tropical and subtropical species.

Benguela Current: The cold Benguela Current flows northward along the west coast of South Africa. (cool temperate)

brings cold, nutrient-rich waters from the Southern Ocean and is associated with upwelling areas.

The cold waters of the Benguela Current limit the diversity of certain species but support productive fisheries due to the upwelling of nutrient-rich waters.

Interplay between both creates a temperate southern region (warm temperate)

Zones

The upper eulittoral zone Around the spring high-tide mark, bordering on the spray or splash zone.

LITTORINA ZONE

Littorina (periwinkles) is abundant (common to all three biogeographic regions, East coast has 3 species). Purple lava algae, only on the South and West coast.

BALANOID ZONE

The middle eulittoral zone – Approximately between neap low- and high-tide marks, is characterised by barnacles, limpets and larger winkles, among many other invertebrates and algae. This zone is often divided into upper and lower zones around the tidal mean.

The mid-eulittoral zone is divided into two balanoid zones:

The upper balanoid zone – Named after the acorn/volcano barnacle family. The zone falls around the neap high point, down to the tidal mean wet during high tide. It has more animals than algae, including winkles, limpets and barnacles.

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The lower balanoid zone – From below the tidal mean to around the neap low point wet and dry during high tide. It has fewer barnacles, but more limpets, winkles and mussels, and far more algae. Where wave action is significant, mussels can form dense beds. East Coast –brown mussel, South and West Coast – black mussels.

Lower eulittoral (varying local names)

The lower eulittoral is distinct on each coastline, varying from a specialised extension of the balanoid zone on the east coast to a limpet belt on the south and west coasts.

The lower eulittoral zone – Around the spring low-tide mark, has more algae and wave-resistant animals such as limpets and mussels, as well as soft-bodied animals in calmer water.

Additional zones

For each South African coastline, an additional zone is noticeable in the intertidal area.

East Coast – There is a band of oysters towards the top of the upper balanoid called the oyster belt. There are also large zoanthid colonies in the lower balanoid, extending into the lower eulittoral zone.

South Coast – There is an additional band of pear-shaped limpets (*Scutellastra cochlear*) in the lower eulittoral zone, the cochlear zone.

West Coast – The cochlear zone also features increasing proportions of another dome-shaped limpet (*Scutellastra argenvillei*), making this the cochlear or argenvillei zone. Moving north, algae become far more abundant.

INFRATIDAL ZONE

similar in all three zones
usually wet red bait

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QUALITY OF CONTENT								
CRITERIA	The response shows a sophisticated understanding of the topic. The content is detailed and thoroughly addresses all aspects of the essay topic. The content selected is relevant, appropriate and accurate. Use of terminology is consistently accurate.	The response shows a clear understanding of the topic. The content is substantial and thoroughly addresses all aspects of the essay topic. There are minor flaws in the relevance / appropriateness / accuracy of the content selected. Use of terminology is consistently accurate.	The response shows an understanding of the topic. The content is substantial, but some gaps/ omissions are evident. OR Some content selected is not relevant / appropriate / accurate. Use of terminology is generally accurate.	The response shows a basic understanding of the topic. Gaps/omissions in content are evident. AND Some content selected is not relevant / appropriate / accurate. There are some inaccuracies in the use of terminology.	The response shows a limited understanding of the topic. Gaps/omissions in content are evident. AND Irrelevant and inappropriate content has been included with errors. There are significant inaccuracies in the use of terminology.	The response shows a superficial understanding of the topic. AND Significant gaps/omissions in content are evident. AND Most content is irrelevant / inappropriate / inaccurate.	The response shows no or little understanding of the topic. AND Most content is irrelevant / inappropriate / inaccurate.	

QUALITY OF DISCUSSION								
CRITERIA	The discussion is consistently focused, clear and concise. Flow is logical. Response is cohesive, showing sophisticated understanding, integration and linkage of all	The discussion is, for the most part, focused, clear and concise. Flow is logical. Response is cohesive, showing sound understanding, integration and linkage of all concepts.	The discussion is focused, clear and concise, with some lapses. Flow is, for the most part, logical. Response is cohesive, showing understanding, integration and linkage of concepts.	At times, the discussion is longwinded / rambling / repetitious / vague. Linkage and integration of concepts are not always clear.	The discussion is often longwinded / rambling / repetitious / vague. Linkage and integration of concepts are weak.	The discussion is longwinded / rambling / repetitious / vague, showing a poor understanding of the concepts.	The discussion is meaningless	
TOTAL MARK								**35**

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