NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2023

# MARINE SCIENCES: PAPER II

## MARKING GUIDELINES

Time: 2½ hours 150 marks

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**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 MULTIPLE-CHOICE

1.1

| | | | | |
|---|---|---|---|---|
| 1.1.1 | B | | 1.1.6 | D |
| 1.1.2 | A | | 1.1.7 | B |
| 1.1.3 | C | | 1.1.8 | D |
| 1.1.4 | C | | 1.1.9 | B |
| 1.1.5 | A | | 1.1.10 | C |

1.2

| | COLUMN A | COLUMN B |
|---|---|---|
| 1.2.1 | A perforated plate by which the entry of seawater into the vascular system of an echinoderm is controlled. | Madreporite |
| 1.2.2 | A range of tiny protective nippers extending from the skin of some echinoderms. | Pedicellariae |
| 1.2.3 | The small bones in the inner ear of a fish, which assist with hearing. | Otoliths |
| 1.2.4 | A rod of firm connective tissue supporting and possibly enclosing a dorsal nerve cord. | Notochord |
| 1.2.5 | Offspring are born at a relatively advanced stage of development and can fend for themselves with limited parental care. | Precocial |
| 1.2.6 | Producing young by means of eggs hatched within the parent's body. | Ovoviviparous |
| 1.2.7 | Sensory outgrowths around the mouths of hagfish. | Barbels |
| 1.2.8 | Increases the length and surface area of a shark intestine, enabling efficient digestion and absorption. | Spiral valve/gut |
| 1.2.9 | A group of animals having a notochord that is not divided into vertebral segments. | Protochordate |
| 1.2.10 | Male sharks use these to introduce sperm into the female's cloaca. | Claspers |

1.3

| | COLUMN I | COLUMN II | Answer |
|---|---|---|---|
| 1.3.1 | Hagfish | 1. Teeth made of keratin.<br>2. Eyes do not form images. | C |
| 1.3.2 | Deuterostomes | 1. Urochordata<br>2. Echinodermata | C |
| 1.3.3 | Red bait | 1. Pharyngeal gill slits extract food.<br>2. Tunic is made of tough protein. | A |
| 1.3.4 | Tunicate | 1. Tadpole-like larva swims and does not feed.<br>2. Adult sessile and filter feeds. | C |
| 1.3.5 | Baleen whales | 1. Have one blowhole on top of their head.<br>2. Females are usually smaller than the males. | D |

## SECTION B

## QUESTION 2

2.1 2.1.1 They graze on algae and other plant material, preventing excessive algal growth that can smother marine habitats.

By controlling algae, sea urchins help maintain biodiversity in ecosystems.

Sea urchins are prey for a variety of predators.
Control growth of kelp

2.1.2 Bioturbation: As they move along the seabed, sea urchins burrow into the sediment.

Habitat formation: Some species of sea urchins create burrows in rocky substrates or coral reefs, which can provide shelter for small organisms like shrimp and juvenile fish.

Environmental indicator: The abundance and health of sea urchin populations can serve as indicators of the overall health of marine ecosystems.

Restoration efforts: In some cases, sea urchins have been used in ecological restoration projects. Introducing sea urchins to degraded areas can help control algae and promote the recovery of damaged marine habitats.
Bodily wastes – nutrient recycling

2.2 removal of larger fish that prey on sea urchins
warmer waters
altered ocean conditions that favour sea urchin survival and reproduction
increase algal growth

2.3 2.3.1 Some sea urchin species can adjust their feeding preferences based on the availability of different food, switching from kelp scraps to live kelp. This adaptability allows them to remain effective grazers even when their primary food source changes.

2.3.2 Sea urchins possess a specialised mouth structure called Aristotle's lantern, which is a complex chewing apparatus made up of five tooth-like plates. These plates are used to scrape and break down plant material and algae.

Sea urchins have a radial symmetry that allows them to approach their food from various angles, enabling efficient grazing on surfaces.

Sea urchins employ a repetitive and continuous feeding behaviour, moving slowly across the substrate and grazing as they go. This behaviour ensures thorough coverage and consumption of available food sources.

2.4 Abundance

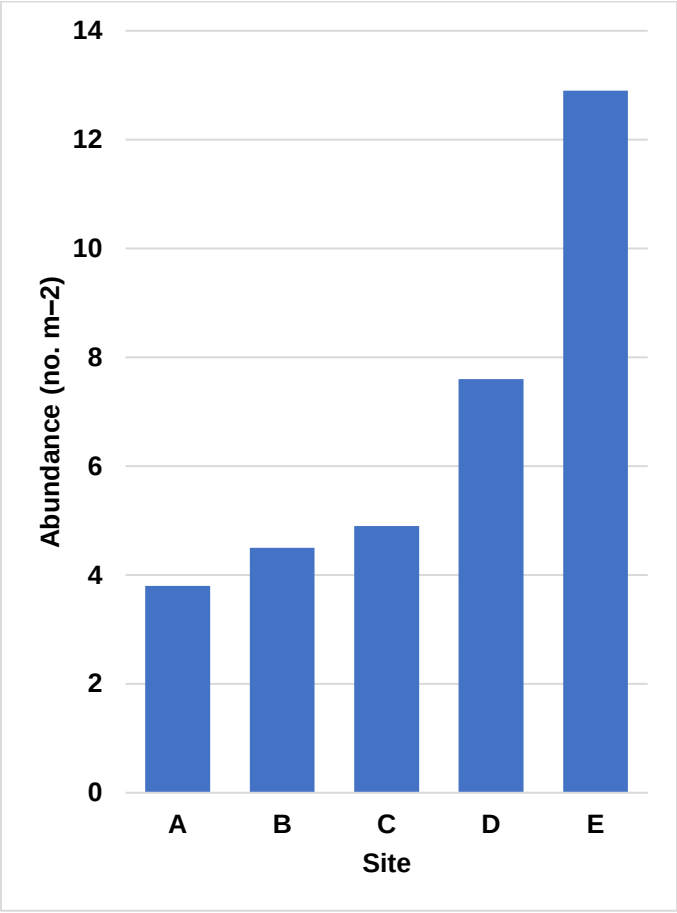
2.5 Year of study
Sampling strategy
Water depth
Type of kelp
Size of kelp

2.6 total area = ((3 × 5 m) + (4 × 1 m)) × 10 m
= (15 m + 4 m) × 10 m
= 190 $m^2$

Area sampled = 20$m^2$

% area covered = $\frac{20\ m^2 \times 100}{190\ m^2}$ = 10,53 %

2.7 Graph to show average abundance of adult kelp (>150 mm stipe length) per $m^2$ of *E. maxima*




Title and both variables
Correct axes used for both variables
Appropriate scale for each axis
*y*-axis – correct label and units
*x*-axis – correct label
Bars same width
Correctly plotted data points

2.8 At sites where the kelp occurred in the greatest densities, sea urchins occurred at the lowest densities

or

while at sites where the kelp occurred in the lowest densities, sea urchins occurred at the highest densities
and reason
suggesting that sea urchins may be responsible for controlling the densities of kelp at the sample sites

2.9 Test is made of a heavy material ($CaCO_3$).
Urchin spines are made of a heavy material.
A large portion of their body would be filled with a dense water vascular system which would have a large mass.
Gonads high in fats which are low density.

2.10 Urchins are slow, almost sedentary.
Reduced nervous coordination.
A loosely arranged network of nerves feeds each arm or sector, radiating from a nerve ring around the central axis.
There is no central ganglion or brain.
Most echinoderms are sensitive to light, touch, and chemical substances.
No specific sense organs, although parts of the body have greater concentrations of receptors.

Unlikely to sense pain, therefore cannot be regarded as inhumane.

## QUESTION 3

- A shark's liver (A) constitutes 25% of its total body mass.
- A shark's liver is filled with a type of oil called squalene which has a low density.
- A shark's skeleton (B) is made of cartilage which is strong, flexible, and light, weighing about half the density of bone.
- The shark uses its large pectoral fins (C) which are situated on either side of its body to create lift beneath them due to hydrofoil cross section and positive attack angle (front edge tilted upwards) – "dynamic lift" but requires the shark to swim constantly.
- Tails of sharks (D) are (heterocercal) large dorsal lobe because they are asymmetrical – produce an upward-directed torque.
- Some sharks can gulp air into their stomachs (E), reducing their density
- Lift generated because of their flattened snouts (F) and belly
- Mark allocated for liver even if label incorrect

## QUESTION 4

4.1 Water is more viscous/dense to move over respiratory surface **OR** there is less oxygen in the water so a greater volume must be moved over the respiratory surface.

4.2 Water enters the gas exchange surface the same way as food enters the fish's body, unwanted food particles might be in the water.
Gill rakers filter out food particles before the water passes through the gills to keep them clean.

4.3
- Gill filaments
- lamellae

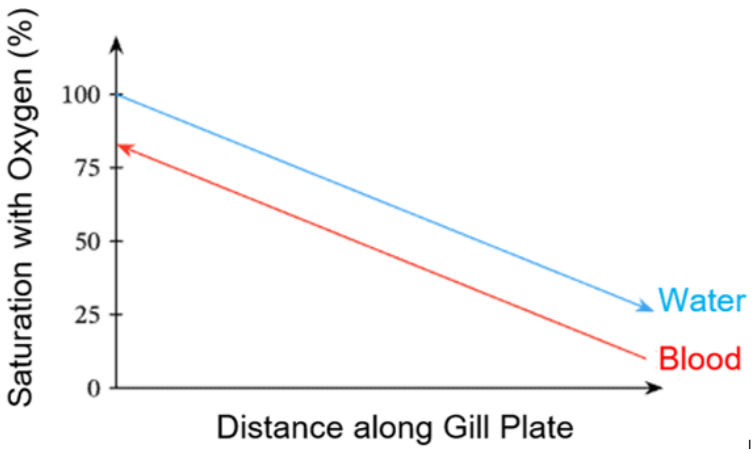
4.4 If fish did not have a circulatory system, increasing size would increase diffusion distance and would limit the size

Blood absorbs the oxygen, and then carries it around the body to every cell where it is needed for respiration, so diffusion distance is not limited.

4.5
- There is a continual supply of oxygen-rich water.
- All the water taken into the mouth will pass over the gills.
- Ventilation requires less energy – no exhalation

4.6




Must have arrows

4.7 Between the body core and the muscle blocks. or swimbladder and blood

4.8 Most fish are ectothermic and active fish need to retain body heat in order to function at high levels or retain body heat can live in cold waters
Adjust buoyancy so they can remain neutrally buoyant

## QUESTION 5

5.1 oviparity

5.2 Waterproof skin/scales or scutes.
The ability to lay hard-shelled or leathery-shelled eggs./Amniotic egg

5.3 Turtles glide and flap their flattened forelimbs to produce the necessary forces required for swimming and remaining in a fixed position to graze.

Marine iguanas swim with a snake-like motion with laterally flattened tails and hold themselves against the bottom with their long claws to graze.

5.4 5.4.1 Females

5.4.2 Find a new cooler nesting site.
Lay eggs earlier or later in the season.
Lay eggs deeper in the sand

## SECTION C

**Answer must be in the form of an essay.**
**25 marks for content.**
**10 marks: allocated as per the rubric.**

## QUESTION 6

| Aspect of Adaptation | Cetaceans | Pinnipeds |
|---|---|---|
| | • Entirely aquatic – only adapted to movement underwater. | • Pinnipeds breed on land (or ice) so they must be able to move about on land as well. |
| Body shape | • Streamlined and fusiform (torpedo-shaped), reducing drag and resistance. | • Torpedo-shaped, although less streamlined than cetaceans due to body fat and musculature. |
| Streamlining | • No external ear flaps or external genitalia.<br>• external projections reduce water resistance and the drag created by turbulence. | • Highly reduced or lost ear flaps, external genitalia **–** external projections reduce water resistance and the drag created by turbulence. |
| | • Some very sparse hair.<br>• The outer layer is soft and spongy and reduces turbulence at the skin–water interface by expanding and contracting in response to the flow of water. | • Some retained fur coat to trap a layer of warm air next to the body aids in streamlining or lost hair – layer of blubber. |

(maximum 6 comparisons)

| | | |
|---|---|---|
| Hind limb modification | • Lack external hind limbs, reduced pelvic girdle. | • Flippers (webbed) adapted for propulsion and steering. |
| Forelimbs | • Modified into flippers that lack joints (stiffened), mainly used for steering and stabilisation. | • Flippers are more flexible with jointed appendages, aiding in manoeuvrability and efficient propulsion. Used to pull the body along on land. |
| Tail (Flukes) | • Horizontal tail flukes for propulsion, driven by powerful vertical movements<br>• for steering and stabilisation during swimming. | • Horizontal tail flippers used for steering and stabilisation, less efficient for propulsion than cetacean flukes. |
| Dorsal fin and flipper functionality | • Dorsal fins aid stability. | • No dorsal fin. Flippers used for steering and balance. |
| Tail modification | • Horizontal tail flukes for thrust. | • Webbed hind limbs for swimming. |
| | • Highly specialised for efficient high-speed swimming, suitable for open ocean environments. | • Exhibit more versatile locomotion, including agile movements in water and manoeuvrability on land. |

(maximum 6 comparisons)

| | | |
|---|---|---|
| Feeding Behaviour | • Active predators – hunt underwater using echolocation.<br>• Filter feeders feed on plankton | • Varied diet; some species hunt underwater, while others forage on land or ice. Eyesight and hearing are adapted for both air and water, and they have an advanced tactile system in their whiskers. |
| Social Structure | • Often live in complex, highly social groups (pods). | • Social but less complex; some solitary species. Large groups during breeding season – territorial. |
| Communication | • Use vocalisations such as clicks and songs. | • Communicate through vocalisations, body postures, and movements. |
| Reproduction | • Occurs entirely in water | • Occurs entirely on land |

(maximum 4 comparisons)

| **Disadvantage of cetaceans** | **Advantages of pinnipeds** |
|---|---|
| • Cetaceans face growing vulnerability due to human activities.<br>• These activities include habitat degradation, pollution, and getting entangled in fishing gear.<br>• These threats have caused a decrease in the populations of certain cetacean species. | • Pinnipeds use land for specific activities: basking in the sun and breeding.<br>• Land-based behaviour helps conserve energy, regulate body temperature, and provide protection for their offspring from aquatic predators.<br>• Breeding on land offers a safe environment away from potential threats in the water. |
| • Cetaceans are fully aquatic and lack the capability to access land. | • Pinnipeds exhibit efficient movement capabilities on both land and in water.<br>• Their flippers, designed for propulsion underwater, serve a dual purpose, allowing them to navigate effectively on land as well.<br>• This adaptability in locomotion makes pinnipeds versatile across different environments. |
| • They cannot come ashore, which restricts their options for escaping predators or finding shelter on land during adverse circumstances. | • Pinnipeds can evade aquatic predators, like sharks and orcas, by seeking refuge on land.<br>• This avoidance tactic decreases their susceptibility when compared to cetaceans.<br>• The option to retreat to land provides pinnipeds with a safe haven from the ongoing hazards of the ocean environment. |
| | • This adaptability enables them to explore various ecological niches and enhance their foraging tactics.<br>• Seasonal migrations are a key part of their survival strategy, helping them optimise their access to food resources. |
| | • Pinnipeds gather in large colonies during breeding season.<br>• Complex social interactions are observed within these colonies.<br>• Some pinnipeds engage in group foraging.<br>• Group foraging involves cooperative hunting for fish and prey.<br>• Safety in numbers is a key benefit of this behaviour rather than cooperation. |

(maximum 7 to be integrated into essay)

| **Advantages of cetaceans** | **Disadvantage of pinnipeds** |
|---|---|
| • Cetaceans possess streamlined bodies, purpose-built for efficient swimming.<br>• This adaptation reduces water resistance (drag) and allows them to glide smoothly through their aquatic habitat.<br>• Their streamlined form enhances speed and agility, which are essential for both hunting prey and avoiding predators underwater. | • Pinnipeds, while suited for aquatic life, face vulnerability on land.<br>• They are particularly at risk from terrestrial predators such as polar bears.<br>• Limited mobility and agility on land increase their susceptibility, particularly as juveniles. |
| • Cetaceans possess adaptations for efficient deep diving.<br>• Specialised lungs and the ability to control blood flow to vital organs enable them to explore the ocean's depths.<br>• This capability allows them to access abundant food sources that are typically out of reach for most pinnipeds. | • Coastal development and human activities disrupt pinniped breeding and haul-out sites,<br>• stress populations and disrupt vital life processes such as breeding and pup rearing. |
| • Cetaceans possess complex communication systems.<br>• These systems include echolocation and various vocalisations.<br>• Essential for underwater navigation, food finding, and social bonding. | |
| • Cetaceans exhibit intricate social structures.<br>• Promote cooperation among individuals.<br>• Advantages in hunting, protecting offspring, and ocean navigation. | • Pinnipeds gather in large colonies during breeding season.<br>• Complex social interactions are observed within these colonies.<br>• Some pinnipeds engage in group foraging.<br>• Group foraging involves cooperative hunting for fish and prey.<br>• Safety in numbers, rather than cooperation, is a key benefit of this behaviour. |
| • Cetaceans are globally distributed, inhabiting nearly all oceans.<br>• Larger area.<br>• They demonstrate adaptability to various marine environments. | • Restricted range. Limited to coastal areas and ice sheets. |

(maximum 7 to be integrated into essay)

## QUESTION 7

| | Predatory | Filter-feeding |
|---|---|---|
| Anatomy and feeding | • Body shape varies but is generally more robust than filter-feeders. | • Elongated body shape with streamlined features. |
| | • Homodont teeth are present for grasping and tearing prey. | • Possess baleen plates, which are comb-like structures for filtering prey. |
| | • Some special modifications, e.g. narwhals | • Hundreds of these plates are lined up in a row and attached to the whale's upper jaw. |
| | • There is a huge range of feeding behaviours largely based on a variety of tooth arrangements – teeth in toothed whales are mostly for seizing prey, not for chewing. | • The baleen is made of keratin which frays at the edges producing comb-like strands that help to filter out small animals. |
| | • Toothed whales mainly feed on single prey items. | • Filter tiny prey by the hundreds to thousands of individuals. |
| | • Mouth size varies based on prey type, but not as large as filter-feeders. | • Mouth is large and wide to engulf large volumes of water. |
| | • Tail flukes tend to be larger, aiding in stability during filter-feeding. | • Tail flukes can be adapted for sudden bursts of speed and agility during hunting pursuits. |

(maximum 6 comparisons)

| | | |
|---|---|---|
| Size and movement: | • Predation strategies vary among different species, leading to a range of sizes.<br>• Some exhibit sexual dimorphism in size, with females being larger for maternal reasons. | • Generally larger in size to efficiently capture and process krill and plankton.<br>• Large size enables energy storage during migrations and fasting periods. |
| | • Tend to be more agile and fast, allowing for effective hunting.<br>• Smaller size enhances manoeuvrability and agility for hunting and capturing prey.<br>• Hunting requires bursts of speed and agility, leading to a more dynamic lifestyle. | • Generally slower-paced lifestyle due to the energy-efficient nature of feeding on abundant but smaller prey. |
| | • Tend to be more active, agile and mobile due to the need to search and pursue prey. | • Spend long periods of time feeding and migrating to areas with high prey concentrations.<br>• Limited movement required for feeding allows for more energy conservation. |
| | • Can engage in long migrations to follow prey populations. | • Often exhibit migratory patterns based on the availability of prey. |

(maximum 6 comparisons)

| | | |
|---|---|---|
| Communication and social interactions: | • Engage in complex hunting strategies and tactics to capture diverse prey.<br>• Some known for their cooperative hunting behaviours. | • Often lead more sedentary lifestyles due to the energy-efficient feeding method.<br>• Some known for their cooperative hunting behaviours – bubble blowing. |
| | • Communication plays a crucial role in coordinating group hunting activities. | • Communication is important for social interactions during feeding and migration. |
| | • Predatory whales often live in social groups for cooperative hunting.<br>• Exhibit a wider range of vocalisations for complex communication.<br>• Intense social bonds are formed among pod members, enabling collaborative hunting strategies.<br>• Some predatory whales, like orcas, have distinct 'dialects' unique to their specific pods. | • Filter-feeders are generally less socially active due to solitary feeding.<br>• Limited need for complex communication related to group hunting.<br>• Communication might involve simpler calls for maintaining distance or coordinating mating activities. |
| | • They use echolocation, or biological sonar, to navigate.<br>• Use high-frequency sound. | • May produce lower-frequency sounds for long-distance communication during migration. |
| | • Vocalisations may include whistles, clicks, and echolocation signals for locating and hunting prey. | • Sounds may include songs or calls to coordinate group activities or locate prey. |

(maximum 7 comparisons)

Filter-feeder best strategy:

| Advantages of filter-feeding | Disadvantages of predation |
|---|---|
| 1. Efficient harvesting of plankton and krill resources. | 1. Demands more energy due to active pursuit and capture of prey. |
| 2. Economical energy expenditure through relatively sedentary lifestyle. | 2. Risk of physical injury when hunting larger or more dangerous prey. |
| 3. Adaptation to migratory patterns following seasonal food availability. | 3. Success dependent on availability of prey species, leading to potential fluctuations. |
| 4. Potential for cooperative feeding strategies, enhancing prey capture success. | 4. Face competition and predation risks from other marine species and potential larger predators. |

(maximum 6)

**OR**

Predation best strategy:

| Advantages of predation | Disadvantages of filter-feeding |
|---|---|
| 1. Diverse diet, allowing adaptation to varying food availability. | 1. Dependency on plankton blooms makes them vulnerable to changes in ocean conditions. |
| 2. Opportunistic feeding and scavenging behaviours broaden food sources. | 2. Competition for limited plankton resources from other species. |
| 3. Complex social structures and cooperative hunting tactics improve success rates. | 3. Limited diet diversity primarily focused on plankton and krill. |
| 3. Potential for higher energy gain from preying on larger, energy-dense prey. Shared effort | |

(maximum 6)

| **INTRODUCTION (5)** | **Excellent (5)** | **Good (4)** | **Average (3)** | **Below Average (2)** | **Poor (1)** |
|---|---|---|---|---|---|
| | Exceptionally engaging and captivating. Provides a clear overview of the scientific topic, showcasing its relevance and sparking curiosity.<br><br>Establishes a strong foundation for the essay's scientific concepts, making the reader excited to delve deeper. | Clear and effective. Introduces the scientific topic and offers insightful context.<br><br>Encourages the reader to anticipate the scientific content of the essay, maintaining their interest. | Adequate. Introduces the scientific topic and provides context but requires more detail and clarity.<br><br>Ensures the reader gains a basic understanding of the scientific focus. | Ineffective. Lacks engagement, fails to capture the reader's interest in the scientific topic, and offers limited context.<br><br>The scientific focus is vague or unclear, making it challenging for the reader to anticipate the scientific content. | Highly ineffective. Fails to establish the scientific topic, lacks context, and doesn't convey the importance of the subject matter.<br><br>Leaves the reader uninterested and unlikely to continue reading about the scientific topic. |

| **CONTENT (25)** | **22–25** | **18–21** | **14–17** | **10–13** | **6–9** | **3–6** | **0–2** |
|---|---|---|---|---|---|---|---|

| **CONCLUSION (5)** | **Excellent (5)** | **Good (4)** | **Average (3)** | **Below Average (2)** | **Poor (1)** |
|---|---|---|---|---|---|
| | The conclusion expertly restates the thesis or main points, offering a succinct and powerful summary.<br><br>It effectively synthesises the key arguments and evidence presented in the essay, creating a cohesive narrative.<br><br>It provides meaningful reflections, insights, or recommendations that leave a strong and lasting impression on the reader. | The conclusion effectively restates the thesis or main points, providing a concise summary.<br><br>It demonstrates a clear understanding of the essay's key arguments and evidence.<br><br>It offers thoughtful insights or suggestions for further exploration related to the topic. | The conclusion adequately restates the thesis or main points.<br><br>It attempts to summarise the key arguments made in the essay.<br><br>It may offer a brief reflection or insight into the broader implications of the topic. | The conclusion briefly restates the thesis or main points but lacks depth.<br><br>It may attempt to tie loose ends but does so ineffectively or superficially.<br><br>There is minimal synthesis of ideas, and it doesn't leave a lasting impression. | The conclusion lacks a clear restatement of the thesis or main points.<br><br>It does not offer any insights or closing thoughts related to the topic.<br><br>It may introduce new information or ideas not previously discussed. |

**Total: 150 marks**