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# Level 3 Earth and Space Science 2022

## 91413 Demonstrate understanding of processes in the ocean system

Credits: Four

| Achievement | Achievement with Merit | Achievement with Excellence |
|---|---|---|
| Demonstrate understanding of processes in the ocean system. | Demonstrate in-depth understanding of processes in the ocean system. | Demonstrate comprehensive understanding of processes in the ocean system. |

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

**You should attempt ALL the questions in this booklet.**

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

**YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.**

Merit

TOTAL 14

## QUESTION ONE: THERMOHALINE CIRCULATION

Thermohaline circulation, also called the Global Ocean Conveyor Belt, is the part of general oceanic circulation controlled by horizontal and vertical differences in temperature and salinity.

Adapted from: https://hchscollier.weebly.com/uploads/6/5/1/8/65182593/day_6_-_el_nino_la_nina_notes.pdf

Explain, in detail, the effects of temperature and salinity on the transport of matter and energy through thermohaline circulation.

Your answer should:

- include on the diagram above, labels where upwelling and downwelling occur
- explain the processes of upwelling and downwelling
- explain how downwelling drives thermohaline circulation
- comprehensively explain how heat energy and nutrients are transported through thermohaline circulation.

*An annotated diagram may assist your answer.*

.) ~~upwelling occurs at Atlantic Ocean~~

- At cold areas, particularly at high a latitude like polars and Atlantic ocean, due to ~~little~~ radiant ~~heat absorbed~~ the fact that the surface water ~~does not~~ absorbs just little ~~heat~~ bit of radiation radiated by the sun because of its low angle of incident, the surface water is cold and freezing and surrowaded by ~~alot~~ amount of salt. ~~When~~ Because the salt ~~penecentrates~~ into water and makes the mass ~~of water~~ inc and volume of water increase; the saline water becomes ~~mo~~ heavier ~~and being push~~ dow. As the more freezing water or ice it is on the surface, the heavier the water it is below. Due to it and the earth's gravity, the cold and deep water occuring of being pushed ~~moving down~~ down ~~of~~ water caused by the ice above is called ~~down~~ downwelling. The current starts moving around the world at ~~depth~~ these deep heights and. On the way it goes, it also brings ~~materials to human life~~ protein or occurs at Atlantic ocean

- Downwelling drives thermohaline circulation around the ~~world~~ world specifically to the south at deep heights. ~~And under the warm~~ And on the way it goes, it also brings nutrients when it meets ~~deep~~ animals or anything else at the deep layer of sea water.

- ~~It~~ When the thermohaline current reachs low a latitude particularly at equarator, due to direct heat from the sun, the water is warm and the current gets warmer and not dense anymore and it is bringed up again called upwelling like at Indian Ocean showned in the picture.

- But the other cold deep current continues to ~~wa~~ move toward east a ~~mo~~ until it reach Pacific Ocean and getting warmer and again we have upwelling due to being moved upward of the current.

There is more space for your answer to this question on the following pages.

. After that, ~~do~~ the upwelling drives the current back to the west and at high latitude ; it becomes cold and being pushed down by the ~~ice~~ ice again and the gravity again and we have thermohaline ~~circul~~ circulation.

- ~~And~~ Another factor that could drive the current is the wind from the sea

## QUESTION TWO: OCEANIC CARBON PUMPS

The ocean is important in the global carbon cycle, and is an important carbon sink.

Source: https://oceanacidifcationgeog5.wordpress.com/2015/03/10/ocean-acidification/

Explain, in detail, how carbon moves into the ocean, and how changes in atmospheric carbon dioxide impact ocean carbon chemistry.

Your answer should include:

- a detailed explanation of the biological ocean carbon pump
- an explanation of the processes involved in the physical ocean carbon pump (include equations)
- a comprehensive explanation of how the biological and physical carbon pumps may change with an increase in atmospheric carbon dioxide levels.

*An annotated diagram may assist your answer.*

-) Physical pump.

The ~~&~~ & $CO_2$ enters the ocean becomes soluble ~~and dissolves into~~ seac and dissolves into carbonic acid:

$$H_2 + CO_2 \rightarrow H_2CO_3$$

Then the carbonic acid continues to dissolve into $H^+$ ions and bicarbonate ions:

$$H_2CO_3 \rightarrow H^+ + HCO_3^-$$

Bicarbonate ions then dissociates into $H^+$ and carbonate:

$$HCO_3^- \rightarrow H^+ + CO_3^-$$

-) Biological pump:

When the carbon dioxide enters the ocean, the phytoplankton use $CO_2$ to photosynthesise ~~carbon~~ and store carbon inside ~~their~~ their body. ~~later~~ with Calcium, the carbonate ~~in int.~~ is used to build their shells (calcium carbonate shells)

$$CO_3^{2-} + Ca^+ \rightarrow CaCO_3$$

-) More Atmospheric $CO_2$ levels means more $CO_2$ dissolved ~~in~~ under ocean. That means there is less carbonate ions due to ~~to~~ the correcting of the sea for the ~~int~~ unbalance between reations. It can cause the equilibrium equation be reversed ~~&~~ or even worse ~~te~~ because the planktons ~~has~~ under the sea has less carbonate to build their ~~s~~ shells leading to lack of energy to survive and can lead to ~~t~~ extinction. ~~But~~ not only that but the ~~no~~ increasing level of acidity under the sea caused by more $CO_2$ dissolved can ~~d~~ also ~~kill~~ harms the sea ~~a~~ animals.

When the planktons olie ; its corps with carbonate go ~~deep~~ to deeper layer and becomes sedimentation.

There is more space for your answer to this question on the following pages.

## QUESTION THREE: OCEAN SURFACE SALINITY

**Average ocean surface salinity**

Adapted from: https://salinity.oceansciences.org/smap-salinity.htm

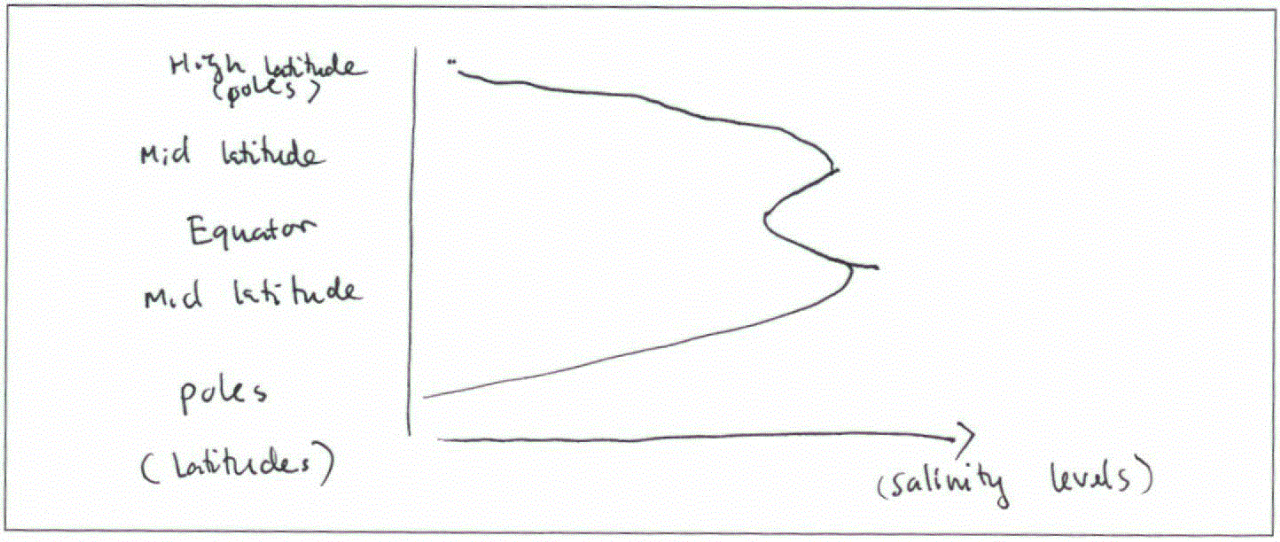
The ocean contains a large amount of salt in solution. The above map shows how the salinity of the surface layer of the ocean varies globally.

Explain, in detail, the factors that affect the global variations in surface ocean salinity.

Your answer should:

- explain the reasons why the ocean contains salt
- explain the processes that increase and decrease the salinity of the surface ocean layer
- discuss why salinity varies between the Equator, mid latitudes, and poles.

*An annotated diagram may assist your answer.*



Salinity levels is affected by many factors such as precipitation, evaporation, ice melting, ~~ete.~~ freezing, ...

) When the water is evaporated by heat of sun; it leaves alot of salt behind & result in more salt under the sea.

) When there is precipitation, the rain come in and more water fall down into the ocean and ~~mate it less salt~~ decrese the salinty level.

- At polars, due to litte ~~heat~~ radiation radiated by the sun, the water is so cold an, dense and freezing. ~~The salt water under the sea~~ and surrounded by ~~amount~~ amount of salt. As it get colder, the salt water is expelled as ice on the surface ~~water~~, 2-3 degrees colder than surface water, 0 degree. As the more it freezing, ~~the less~~ the less salt it is.

- ~~At~~ mid latitude, the heat absorbed from the sun is quite intense and causes alot of ~~evaporto~~ water evaporations leading to more salt ~~left~~ behind a resulting in ~~more~~ higher salinity levels.

- ~~At high~~ low latitude (Equator); ~~the heat~~ surface water absorb most heat from the sun and it is the most intense due to ~~the~~ its direct heat, the highest angle of incident. ~~It the water has most~~ there are most ~~evaporta~~ evaporation occurring ~~here~~ here leading to so much salt left behind but then there are also the most precipitation resulting in more water falling down and less salt. ~~Th~~

=> Thats why we see the salinity levels at ~~mid~~ equator is high but still lower than the mid latitude. The salinity level at poles is lowest

There is more space for your answer to this question on the following pages.

due to little heat absorbed from the sun.

**Extra space if required.**
**Write the question number(s) if applicable.**

QUESTION NUMBER

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QUESTION NUMBER

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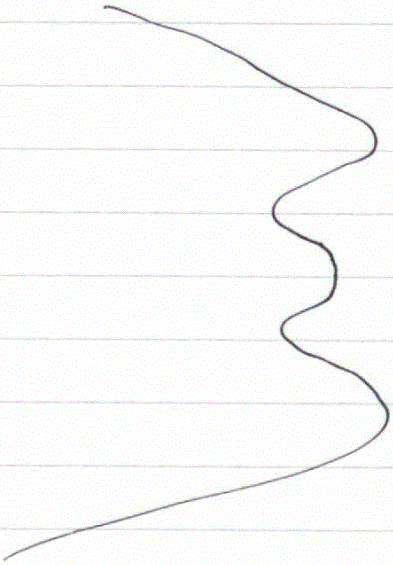
QUESTION NUMBER

5a Effect: evaporation, freezing of water → ↑ salinity
precipitation, ice → ↓ salinity
cold temp: ↑ dense ~~water~~, cold water ↑ salinity
warm temp: moist ↓ salinity.

penecentrate
cen

equarator equarator

go to equarator



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| **Standard** | 91413 | Display ID<br>NSN | | **Total score** | 14 |
|---|---|---|---|---|---|
| **Q** | **Grade score** | **Annotation** | | | |
| 1 | A4 | The candidate has identified areas of upwelling and downwelling and shown that heat and nutrients are moved within the current. While factors that drive downwelling have been explained, upwelling was overly descriptive which prevented the answer moving into M5 – M6 range. | | | |
| 2 | M5 | The candidate has shown evidence for a wide range of achieved mark points and has clearly answered the whole question. The chemical equations supplied are accurate and are supported by appropriate explanations for what is happening in respect to carbon compound conversion. To improve, more detail on the physical and biological pump need included. | | | |
| 3 | M5 | The candidate has clearly explained how evaporation and precipitation change the salinity of water. They link this explanation to the suns angle but for equatorial regions only. Salinity at polar and mid-latitude regions are described and needed better links to gain additional merit criteria. | | | |