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BIOLOGY

ENERGY TRANSFERS IN & BETWEEN ORGANISMS

Level & Board	AQA (A-LEVEL)
TOPIC:	NUTRIENT CYCLES
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	6
TOTAL MARKS	28

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Nutrient Cycles - 1

1.

Of all ecosystems, freshwater marshes have some of the greatest rates of net primary production (NPP) and gross primary production (GPP).

This ratio, known as carbon usage efficiency (CUE) or NPP:GPP. The CUE of freshwater marshes is high.

(a) Explain why freshwater marshes have a high CUE and the benefit of this using your understanding of NPP.

In your response, do not include any abiotic elements. **(2)**

(b) Soils found in freshwater marshes are often wet. Anaerobic conditions are produced by this.

Explain why these soils have low quantities of nitrite and nitrate ions and comparatively large concentrations of ammonium molecules using your understanding of the nitrogen cycle. **(2)**

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A student looked into how quickly a freshwater marsh plant grows.

With this equation, one may find a plant's growth rate (R).

$$R = \frac{(\ln W_2 - \ln W_1)}{t}$$

Where

\ln = natural logarithm

t = duration of the investigation in days

W_1 = plant biomass at the start of the investigation

W_2 = plant biomass at the end of the investigation

The student applied the above calculation, but instead of using biomass, she utilized height. She didn't want to kill the plants in order to calculate their biomass, which is why.

2.

(a) Identify the assumption the learner has made and offer a possible refutation. **(2)**

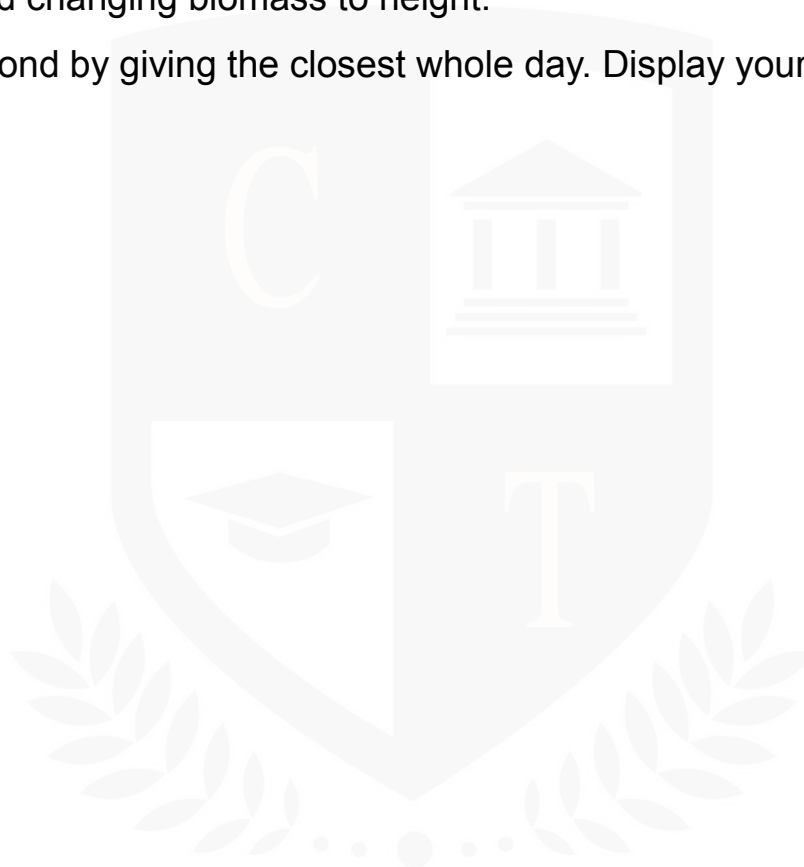
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(b) The student observed that the freshwater marsh plant had grown 268 mm in height and was now measuring 387 mm at the conclusion of the inquiry. The rate of growth (R), according to her calculations, is $0.097 \text{ mm m}^{-1} \text{ day}^{-1}$.

Using this data, find the length of the student's investigation by using the equation and changing biomass to height.

Please respond by giving the closest whole day. Display your work. **(2)**



3.

(a) Explain how saprobionts function in the nitrogen cycle. **(2)**

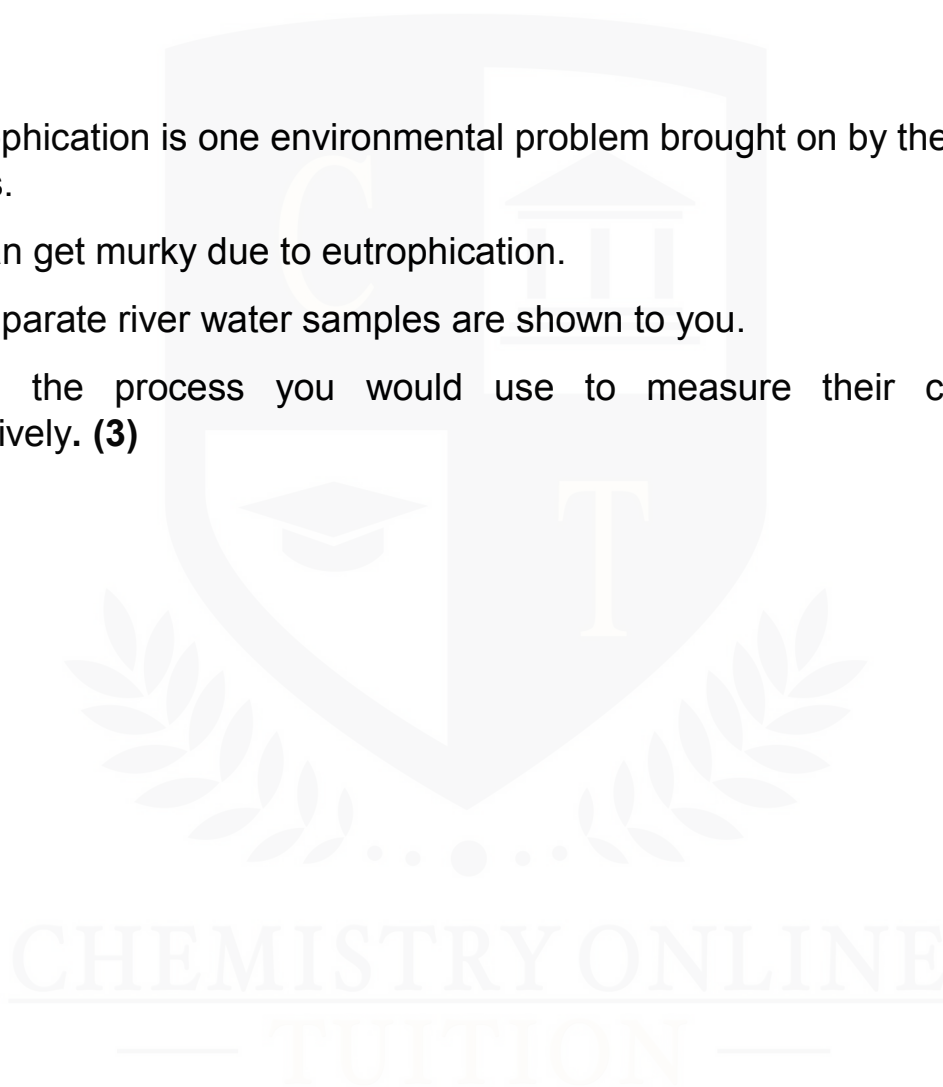
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(b) Eutrophication is one environmental problem brought on by the usage of fertilizers.

Water can get murky due to eutrophication.

Three separate river water samples are shown to you.

Describe the process you would use to measure their cloudiness quantitatively. **(3)**



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4.

Certain types of nitrifying bacteria oxidize ammonia in soil to produce nitrites and nitrates.

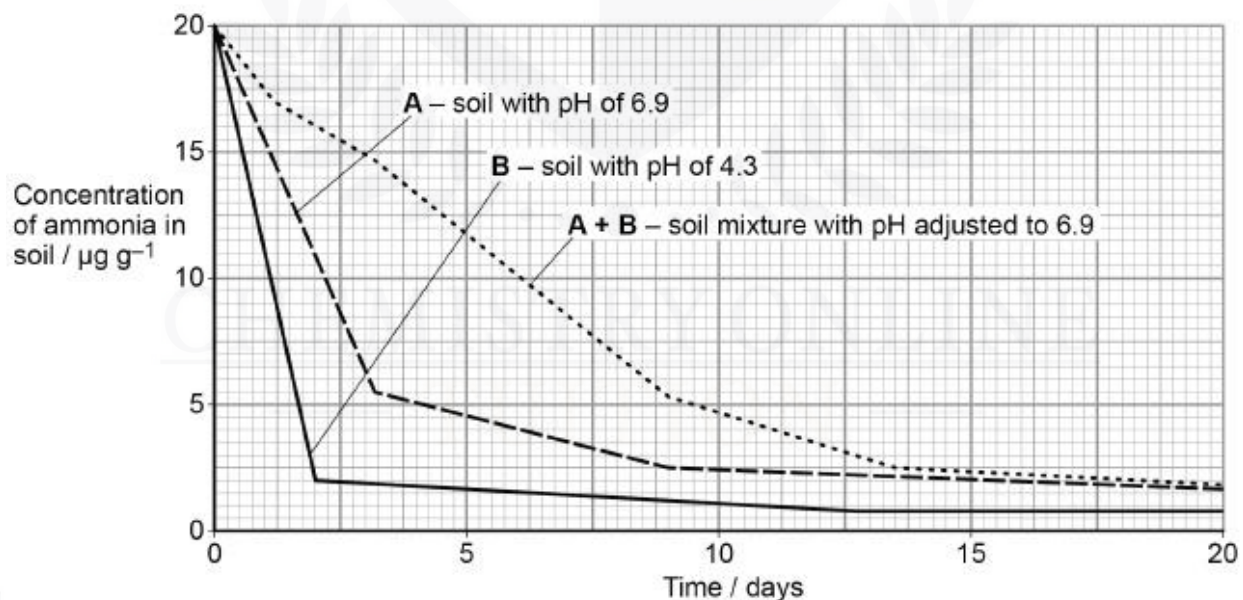
Researchers looked into whether there were distinct nitrifying bacterial groups in two soils with varying pH values. All of the various types of nitrifying bacteria found in each soil make up these communities. They collected soil samples from locations A and B.

The soil from site A had a pH of 6.9, while the soil from site B had a pH of 4.3, according to the results of the pH measurements.

Over the course of 20 days, the scientists assessed the ammonia content of soil samples. At the beginning, the mass and ammonia concentration of every sample were identical. They used a to measure the ammonia content of soil A.

Their results are shown in **Figure 1**.

Figure 1



(a) When measuring the ammonia content of soil, the scientists employed units of $\mu\text{g g}^{-1}$.

Explain the rationale behind the scientist usage of these units in this study.

(2)

(b) Determine the variation in the daily rate of ammonia breakdown in soils A and a between day 0 and day 2.

Display your work along with the units you used to get your answer. **(2)**

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(c) Based on the soil mixture experiment, the scientists deduced that the bacterial populations in soils A and B differed.

What proof does **Figure 1** offer to back up their claims? Give justification for your response. (3)



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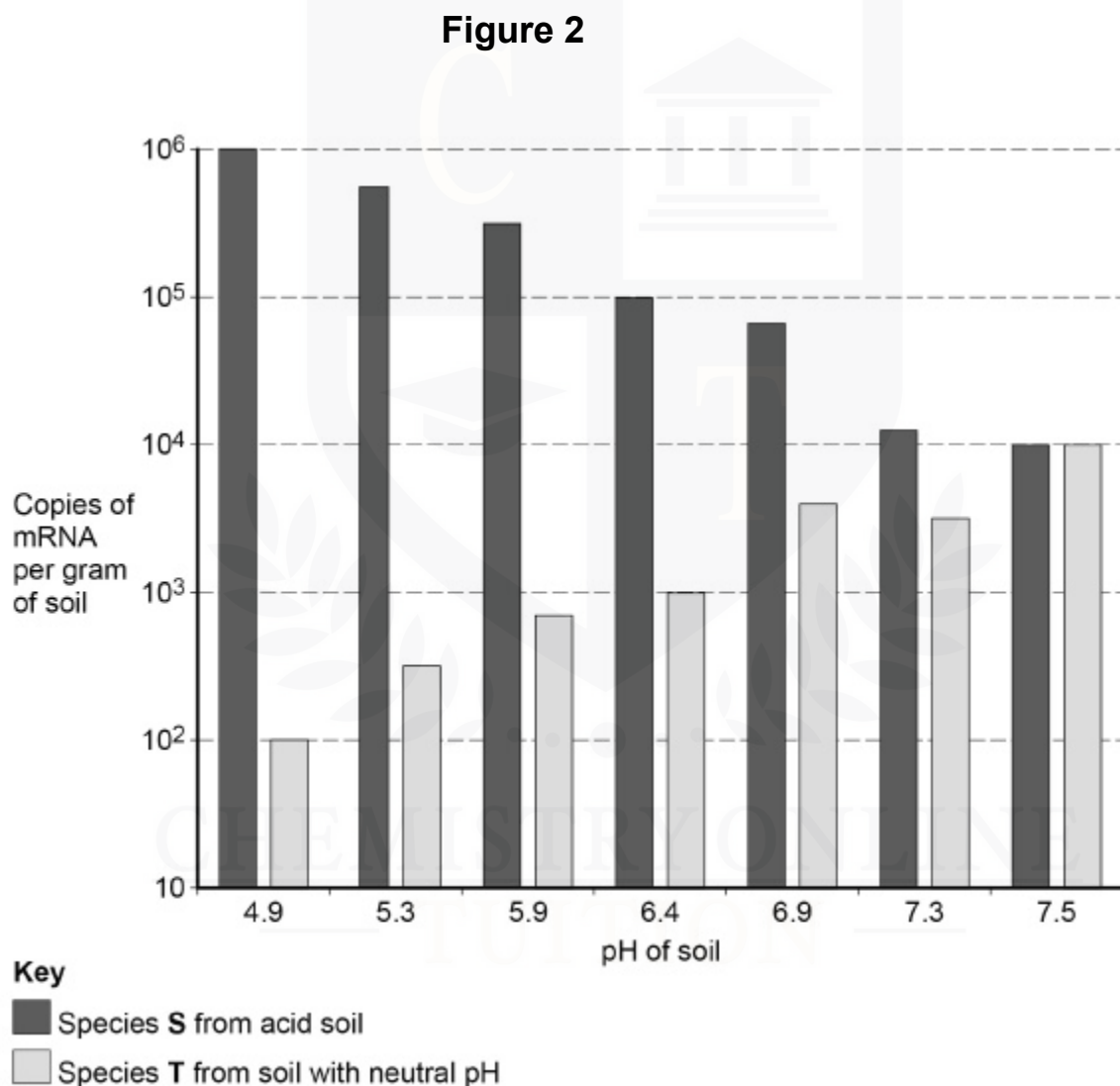
Ammonia monooxygenase is an enzyme that is involved in the oxidation of ammonia by nitrifying bacteria. The amoA gene is unique to each species of nitrifying bacteria and codes for the synthesis of ammonia monooxygenase.

In a follow-up study, the researchers ascertained the expression of the amoA gene in the S and T species of bacteria. While species T came from neutral-pH soil, species S came from acidic soil.

Separate cultures of each species were grown by the scientists on various pH-different soils.

They quantified the amount of amoA gene mRNA in every culture.

Figure 2 displays their findings.



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(a) Among which species was the quantity of mRNA copies most impacted by the pH shift of the soil from 4.9 to 7.5? Make a calculation to back up your response. **(2)**



(b) Using this technique, the researchers were able to gauge the amoA gene expression in each culture, but not the bacterial population increase.

Describe your reasoning. **(4)**

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6.

(a) In sterile glass vials, the scientists established their cultures.

Explain why sterilizing the bottles was required and offer an appropriate sterilization technique. **(2)**

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