# Integrated Science – General Year 12

## Task 1 – Unit 3

**Assessment type:** Science inquiry

**Conditions**

Period allowed for completion of the task

Research: one week

Excursion: one day

Analysis of data: two 60-minute lessons

**Task weighting**

6% of the school mark for this pair of units

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**Investigation – Measuring and comparing the abiotic factors of two aquatic ecosystems**

**(43 marks)**

**Background information**

The abiotic or non-living factors in an ecosystem include: temperature, turbidity, pH, dissolved oxygen, nitrate levels and phosphate levels. These non-living factors can have considerable impact on freshwater ecosystems, particularly if they impact on autotrophic organisms (also known as producers).

A summary of some abiotic factors is found below.

1. Temperature

Organisms have an upper and a lower temperature limit beyond which growth and reproduction will stop. There is an optimum temperature range within which maximum growth occurs. Water temperature decreases as the depth of the water increases. Temperature can also affect other abiotic factors, such as the amount of dissolved gases that can be held within the water body. Most local fish prefer temperatures of between 15 oC and 25oC. Fish can survive warmer water, but only for short periods of time.

Temperature is measured with a thermometer.

1. **Turbidity**

Turbidity is the measure of the amount of finely divided solids suspended in the water. These suspended solids may consist of plankton, organic and inorganic detritus, sand, clay or silt. These occur naturally in bodies of water, but may be added to by human activity. Increased levels of turbidity can affect aquatic organisms in several ways. Turbidity can:

* reduce the amount of light available to photosynthetic organisms, reducing aquatic plant growth
* affect food available for consumers
* affect gas exchange in organisms (silt blocking gas-exchange surfaces)
* act as a transporting medium for pollutants such as pesticides and heavy metals.

Turbidity is measured with a turbidity tube.

1. pH

pH is the measure of how acidic or basic a solution is. The normal range of pH in a freshwater system is between 6.0 and 9.0. A change in pH can have serious effects on the life in an aquatic ecosystem. It can cause the death of fish, larvae and eggs and it may also reduce the productivity of organisms. Higher levels of carbon dioxide in the water will lower the pH of the water, making it more acidic. The ideal range for freshwater aquatic organisms is between 6.5 and 8.

pH is measured with universal indicator and a pH chart.

1. Dissolved oxygen

Most organisms require oxygen for survival. Oxygen is available in the water in a dissolved form. The oxygen is produced from photosynthetic activities of water-living autotrophs (producers), diffusion at the air-water surface and mixing by wind. The level of oxygen is also directly related to:

* temperature – as the temperature of the water rises, the dissolved oxygen (DO) level falls and, as the temperature of the water falls, the DO level rises
* the amount of living material in a water body – the more organisms, including bacteria and fungi, the higher the level of biochemical oxygen demand and the lower the level of dissolved oxygen.Organisms are particularly sensitive to oxygen levels in their juvenile stages.

DO is measured in units of mg/L. The ideal range of DO for stream fish is 7–11 mg/L.

DO is measured using a DO meter.

1. **Nitrate**

About 80% of the air is nitrogen but most organisms cannot use it in this form. Nitrogen is needed to build proteins. Nitrogen found in the air can be converted into a useable form and released into the soil by organisms such as blue-green algae and some legumes. When an animal consumes a plant, it can then use this form of nitrogen. Nitrates contain nitrogen and usually enter aquatic ecosystems by the decomposition of dead plants and animals and their wastes. Humans introduce nitrates into these systems by sewage and excessive fertiliser use in gardens. The fertilisers end up in drains when sprinkler systems run onto roads and down drains. In some instances, it can lead to significant plant growth called algal blooms. These blooms initially produce greater quantities of DO; however, when they die, much more oxygen is consumed by the decomposers, leaving little oxygen available for other aquatic organisms. Nitrate levels are usually less than 1 mg/L. Concentrations over 10 mg/L will have an effect on any freshwater environment.

Nitrate levels are measured by nitrate probes.

1. **Phosphate**

Plants and animals require small doses of phosphorus (phosphates) for healthy growth and development. Freshwater ecosystems have very low supplies of phosphates compared with other ecosystems. Problems arise when there is a slight increase in these levels as this can also lead to algal blooms. Large streams have levels of phosphates around 0.1 mg/L while smaller streams have levels of only 0.01 mg/L. The impact is, therefore, much greater in smaller streams.

Phosphate levels are measured by the *total orthophosphate* test. The sample is added to chemicals and allowed to react. The chemicals turn dark blue when phosphate levels are high. A lighter shade of blue would indicate less phosphate in the sample.

**Task**

This task requires you to research the use of **two** different aquatic ecosystems (as directed by your teacher), attend an excursion, and present your findings in a scientific report. The **two** aquatic ecosystems have different surrounding land or water use. One of these is an area that has not been disturbed greatly by human activity and the other has significant development surrounding the area or catchment.

There are **three** phases to this assessment: pre-excursion, excursion and post-excursion.

**Pre-excursion – Research and planning**

In your research, you will determine to what extent the abiotic factors may be affected by the use of the land surrounding the aquatic ecosystem.

* Research the history of the two ecosystems. Research should include:
  + the use of the land surrounding the ecosystem
  + the possible effects of the land use on water quality
  + rainfall data for the ecosystem.
* Draw a landscape sketch of the two aquatic ecosystems, noting natural landforms and evidence of human activity. You may use Google Earth or any other suitable program or software.
* You will be allocated into a group of three. In your group:
  + practise using the following pieces of equipment:
  + thermometer (in air, water and mud)
  + turbidity tube
  + universal indicator and a pH chart
  + dissolved oxygen meter
  + nitrate probe
  + practise conducting the orthophosphate test on known concentrates.
* These pieces of equipment and tests will be used to measure **six** abiotic factors at your ecosystem.
* You must take readings at **five** different locations at each site. Discuss how your group will record the readings for each abiotic factor at the five different locations around the aquatic ecosystem. Remember you must average the data collected at each of the five locations at each ecosystem. Draw a table of results for the excursion.
* Each group must determine task responsibilities for each group member, at each ecosystem, to maximise the time available for the measurement of abiotic factors.

**Excursion – Collection of data**

Look at the first aquatic ecosystem and, in your group, decide on your **five** locations. You will take readings of the following **six** physical (abiotic) factors: temperature (air, water and mud),  
turbidity, pH, dissolved oxygen, nitrate and phosphate. On your landscape sketch, mark the five locations that you will collect physical data from.

* Before you commence, take notice of any disturbances caused by land use or evidence of human activity that you observe at the site. Record this information.
* Move to the first location and take and record the six abiotic factor measurements. Record this data.
* Continue until you have recorded the data for all five locations
* Repeat at the second ecosystem.

**Post-excursion**

**Process, evaluate and communicate findings in a scientific report**

1. Introduction:

* provide a brief history of the land use and development of the area surrounding each ecosystem
* discuss the possible effects of the land use on water quality
* include rainfall data for the **two** locations
* include a landscape sketch or photograph/s of each aquatic ecosystem (8 marks)

2. Materials: outline the equipment used (include quantities) (2 marks)

3. Method: describe the method used for gathering the data on the **six** abiotic factors

(14 marks)

4. Results:

* collate all the results for the physical measurements and land use observations
* represent all the data in a table
* include appropriate titles and headings
* include a column for the average of the abiotic factors taken at the **five** sites at each ecosystem (6 marks)

5. Discussion:

* identify any differences between the two ecosystems
* support your findings with data from the table
* relate these differences to the history and land use surrounding the two ecosystems
* account for any anomalous results
* suggest ways in which the collection of data could have been improved (8 marks)

6. Conclusion:

* summarise your findings
* suggest why there were differences between the **two** ecosystems
* discuss how the differences in **three** physical factors can affect the organisms living in each ecosystem (5 marks)

# Marking key for sample assessment task 1 – Unit 3

1. Introduction:

* provide a brief history of the land use and development of the area surrounding each ecosystem
* discuss the possible effects of the land use on water quality
* include rainfall data for the **two** locations
* include a landscape sketch or photograph/s of each aquatic ecosystem

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Brief history of the land use and development of the area surrounding each ecosystem | 1–2 |
| Possible effects of land use on the water quality of each ecosystem | 1–2 |
| Impact of rainfall data on physical factors at each ecosystem | 1–2 |
| Landscape sketch or photograph/s of each ecosystem | 1–2 |
| **Answer could include, but is not limited to:** | |
| Possible effects of land use and rainfall:   * run off from farms or agricultural systems may increase phosphate and nitrate levels * constant movement of water may increase dissolved oxygen levels * shaded area may reduce water and mud temperature * deeper aquatic ecosystem may have lower temperatures * a high rainfall may dilute the impact of phosphate and nitrate run off * a low rainfall may concentrate nutrients and increase temperature as the ecosystem dries out | |
| **Total** | **/8** |

2. Materials: outline the equipment used (include quantities)

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| --- | --- |
| **Description** | **Marks** |
| Provides a comprehensive list of materials and quantities  OR  List of materials and quantities included, but some omitted | 2  1 |
| **Total** | **/2** |

3. Method: describe the method used for gathering the data on the **six** abiotic factors

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Description of the procedure is clearly outlined in steps that can be followed  OR  Description of the procedure is brief, but includes relevant aspects | 2  1 |
| Provides a description of the **six** sampling techniques | 1–6 |
| **Answer could include, but is not limited to:** | |
| * temperature – place the thermometer in the water and, after two minutes, read the scale (repeat this procedure for air and water) * turbidity – take a sample of water from the water source and pour it into the turbidity tube. Hold the tube in one hand and look into the open end with your head about 10 to 20 cm above the tube, so that you can clearly observe the black mark on the bottom of the tube. Stop pouring the water when mark on the bottom of the tube just disappears and read scale marked on the side * pH – take a sample of water in a mini vial and add five drops of the universal indicator. Using the universal indicator colour chart, match the colour to the pH chart * dissolved oxygen concentration – place the probe into the sample of water and record the dissolved oxygen concentration * nitrate level – place the probe into the sample of water and record the nitrate concentration * phosphate level – take a water sample and add the first reagent (ammonium heptamolybdate) and shake vigorously. Add the second reagent (stannous chloride). The chemicals turn dark blue when phosphate levels are high. A lighter shade of blue would indicate less phosphate in the sample | |
| Indicates the equipment used to measure the **six** abiotic factors | 1–6 |
| **Answer could include, but is not limited to:** | |
| * temperature – measured with a thermometer * turbidity – measured with a turbidity tube * pH – measured with universal indicator * dissolved oxygen concentration – measured with a dissolved oxygen meter * nitrate level – measured with a nitrate probe * phosphates – measured by the total orthophosphate test | |
| **Total** | **/14** |

4. Results:

* collate all the results for the physical measurements and land use observations
* represent all the data in a table
* include appropriate titles and headings
* include a column for the average of the abiotic factors taken at the **five** sites at each ecosystem

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Data included from all groups | 1 |
| Data represented in a well-constructed table | 1–2 |
| Appropriate titles for table | 1 |
| Column for each factor | 1 |
| Column for averages | 1 |
| **Total** | **/6** |

5. Discussion:

* identify any differences between the two ecosystems
* support your findings with data from the table
* relate these differences to the history and land use surrounding the two ecosystems
* account for any anomalous results
* suggest ways in which the collection of data could have been improved

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Lists differences between the two locations | 1–2 |
| Supports the trends with data from the table | 1–2 |
| Relates the differences to the land use history | 1–2 |
| Accounts for anomalous results | 1 |
| Suggests ways in which the collection of data could be improved | 1 |
| **Total** | **/8** |

6. Conclusion:

* summarise your findings
* suggest why there were differences between the **two** ecosystems
* discuss how the differences in **three** physical factors can affect the organisms living in each ecosystem

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Provides a summary of the findings at each ecosystem | 1–2 |
| Relates land use to the differences in physical factors | 1–2 |
| Relates differences in three physical factors to the organisms living in each ecosystem | 1–3 |
| **Total** | **5** |
| **Answer could include, but is not limited to:** | |
| One mark for one point from three physical factors   * higher temperature can lower dissolved oxygen concentration   AND/OR   * turbidity – increased turbidity can reduce the amount of available light for photosynthetic organisms * this reduces aquatic plant growth which, in turn, affects food availability and oxygen concentration * the suspended particles can also help transport pesticides and heavy metals   AND/OR   * pH – lower pH values can be a result of increased carbon dioxide levels which can affect the enzyme action of aquatic organisms, leading to death   AND/OR   * most organisms require oxygen for survival so lower oxygen levels caused by increased water temperatures or an increase in the number of organisms can be lethal   AND/OR   * increased nitrate levels can lead to significant plant growth called algal blooms (initially, the blooms produce greater quantities of dissolved oxygen; however, when they die, much more oxygen is consumed by the decomposers, leaving little oxygen available for other aquatic organisms)   AND/OR   * increased phosphate levels lead to algal blooms | |