4.4 Water pollution

Name: _____ Class: _____ Date: _____ **Total: 21 marks**

KEY WORDS point source • non-point source • biochemical oxygen demand (BOD) • eutrophication • indicator species • dead zone

Objective

Build the skills to answer exam questions on **water pollution** : sources and types of pollutants, **biochemical oxygen demand** , **eutrophication** , **indicator species** and pollution management.

You must be able to:

- tell point-source from non-point-source pollution, and name the main pollutants
- explain biochemical oxygen demand and the use of indicator species and biotic indices
- explain eutrophication as positive feedback
- evaluate pollution management at the source, the release and the clean-up stages

1 Key knowledge and worked examples

■ Water pollution

source	meaning	example
point	one clear source	a factory pipe, a sewage outlet
non-point	many spread-out sources	fertilizer runoff from farmland, urban street runoff

Pollutants include organic matter (sewage), nutrients (nitrate, phosphate), toxic metals (mercury), pesticides, plastics, oil and heat.

Biochemical oxygen demand (BOD): the oxygen used by microorganisms to break down organic matter in a water sample over 5 days. High BOD = much organic pollution = less oxygen left for animals.

Indicator species show water quality by their presence or absence: stonefly larvae need clean, oxygen-rich water; bloodworms and sludge worms tolerate low oxygen. A **biotic index** combines the counts of such species into one score.

Eutrophication (positive feedback):

1. nitrate and phosphate enter a lake or the sea;
2. algae grow fast (an algal bloom) and shade plants below, which die;
3. dead algae and plants are decomposed by bacteria, which use up oxygen (BOD rises);
4. fish and invertebrates die, adding more dead matter: more decomposition, less oxygen;
5. a **dead zone** with almost no oxygen may form (e.g. the Gulf of Mexico every summer).

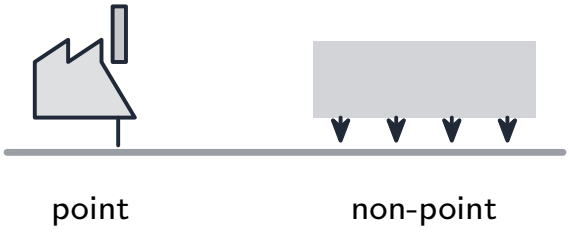
Management works at three levels:

level	**example**
change the human activity	use less fertilizer; phosphate-free detergents
control the release	buffer strips of vegetation; sewage treatment that removes nutrients
clean up and restore	dredge sediment; pump air into water; replant water plants

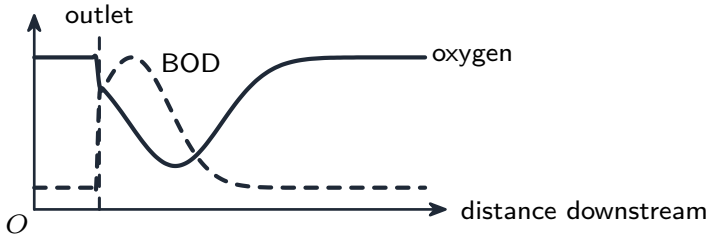
Answer shapes: in a sequence, write each step as cause → effect, and say where the oxygen goes.

2 Practice

2.1 Distinguish between point-source and non-point-source pollution, with **one** example of each. [2]



2.2 The graph shows dissolved oxygen and BOD downstream of a sewage outlet. Explain the changes in oxygen. [3]

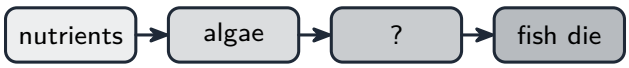


2.3 Students find many stonefly larvae upstream of a farm and only bloodworms downstream. Explain what this shows, and **one** advantage of indicator species over a single chemical test. [3]



3 Exam-style questions

3.1 Fertilizer runs off farmland into a lake.

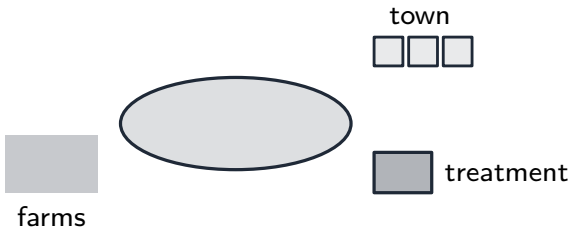


(a) Outline the process of eutrophication. [3]

(b) Explain why eutrophication is an example of positive feedback. [1]

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3.2 A lake suffers from eutrophication caused by farm runoff and town sewage.



Evaluate strategies at **three** levels to manage the problem. [5]

3.3 Plastics now occur in all oceans.



(a) Explain **two** ways plastics harm marine organisms. [2]

(b) Discuss whether a ban on single-use plastic bags is an effective way to reduce ocean plastic. [2]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

point: from one identifiable place, e.g. a factory outlet pipe; non-point: from many spread-out places, e.g. fertilizer runoff from farmland

2.2

below the outlet, organic matter is decomposed by bacteria, so BOD is high; bacteria use up oxygen, so dissolved oxygen falls; further downstream the organic matter is used up and oxygen dissolves from the air, so oxygen recovers

2.3

stoneflies need clean, oxygen-rich water, so upstream water is clean; bloodworms tolerate low oxygen, so downstream water is polluted, probably with organic matter or nutrients from the farm; indicator species show conditions over a long period, while a chemical test shows only one moment

3.1

(a) nitrate and phosphate cause rapid growth of algae; algae block light, so plants die; dead matter is decomposed by bacteria; bacteria use up oxygen, so fish and other animals die

(b) the dead animals add more organic matter, so decomposition and oxygen loss increase further

3.2

award up to [5]: change the activity: use less fertilizer, apply it at the right time, phosphate-free detergents: cheapest in the long term but needs farmer cooperation; control the release: buffer strips and sewage treatment that removes nutrients: effective but costly to build; clean-up: dredge nutrient-rich sediment, aerate water, remove algae: fast effect but expensive and only treats the symptoms; conclusion: prevention at the source is most sustainable, with clean-up for quick relief

3.3

(a) animals become entangled, or swallow plastic and starve; microplastics enter food chains and carry toxic chemicals

(b) bans can sharply cut bag use and are easy to understand; but bags are only a small part of ocean plastic, much of which comes from fishing gear and poor waste collection, so other measures are needed