

Practice Case study on desalination

Introduction

This case study is similar to the Unit 4 Examination but without the unseen final source. Note, however, that this activity has not been subject to the careful evaluation and revision of questions undertaken by AQA during the preparation of operational exam papers.

Suggested Answers

1	- increasing population - decline in rainfall - economic growth Any 2 for 1 mark	1
2	use of wind power/renewable/no CO₂ emissions from wind	1
3	- not fully renewable /other sources of electricity will be required - wind output only sufficient at maximum wind speed - this wind farm could have been used to replace a coal fired power station for other uses - environmental damage from discharge	2
4	- describe a range of social and economic factors - that might influence future situation - gives a range of possible outcomes - informs policy makers of likely outcomes resulting from their decisions (HSW He, Hg)	3
5	- Africa is lowest in world, - global average figure is higher - development will increase consumption in Africa	2
6	- water supply is becoming inadequate in many places - desalination may be the only possible source - desalination requires high energy input	2
7i	salt /sodium chloride	1
7ii	it is removed from sea water	1
7iii	- raises salt concentration locally - some organisms adapted to particular <u>salt concentration</u> - some organisms harmed by <u>change in salt concentration</u>	2
8	- echinoderms present in summer 2003 - absent in 2004 in 2 sites - plant started in September 2003 - timing suggests that plant harmed echinoderms - harbour results show minimal overall change (HSW Bc)	3
9i	June 2003 to August 2004	1
9ii	Yes - seems to indicate yes but not confirmed - worst balance is near desalination plant - best balance is harbour where saline lowest Not confirmed - balance was not studied in a year before the plant - only over one year period - error bars overlap at 16m /overlap	3

	No more than 2 points from either section (HSW Bc, Ae)	
10	Advantage • makes results available internationally • less chance of unnecessary duplication • common terminology disadvantage • much harder to write/ gives advantage to native English speakers • papers less accessible to non-elite who do not speak English (HSW Ec)	2
11	• both gather data in the natural environment over time period • ecological monitoring does not change the conditions (It may study the effects of some external change) • field-based experiment changes the conditions during monitoring in a controlled way • (HSW Bg, Cd)	2
12	• need for baseline data before the plant starts operation • otherwise impossible to know that a change has taken place • need for sampling of several/at least 5 reference locations • to allow for normal variation • need for repeat sampling • at same time of year (HSW Af, Bd, Bf, Bg)	4
13	• needed for peer review • not possible to evaluate results without knowledge of features such as sample size/controls... • not possible to repeat work without details (HSW Eb)	2
14	• research reported in 'grey' literature/ not publically available /not peer reviewed • not enough well trained researchers in marine ecology • not enough funding for marine ecology • lack of awareness that discharge might present a problem • journals may have accepted poor quality papers too easily • until recently most plants in Middle East. Environmental issues may be lower priority there (HSW Ea, Ec, Eh, Fa)	4

15. Use 4 level mark scheme. Points might include some of the following:

Need for desalination:

Outline of process: takes in sea water
 waste discharged to sea
 waste very salty,
 waste also includes other contaminants

Discharge effect: mainly on benthic organisms/examples
 organisms adapted to particular salinity
 other contaminants may be particularly harmful

Need for new research: contradictory results from other studies
 depends on local conditions
 depends on plant design

Research design: data from before and after plant needed
several locations
need to repeat over several years

Need for volunteers: too much data for a few scientists
information vital for this new plant
and to inform future developments

16. Use 4 level mark scheme. Points might include:

In favour

Water essential for: health
agriculture
industry

Growing demand from: population increase
rising standard of living

Sea water readily available

With caveats:

Important to use renewable energy

Environmental impact can be minimised with careful plant design

Against

Climate change: water shortage due in part to climate change
desalination greenhouse gas emissions will make this worse

new renewable energy sources should be used to replace existing power stations not process water

Saving water: reduce meat eating
more efficient irrigation
use 'grey' water
more efficient appliances

Ecosystem: US compared to Denmark
long term damage possible
lack of research
will run out of suitable sites

With caveats:

Some locations may have no alternative

Careful design and renewable energy source can minimise impact

level of response	descriptors:	mark range
good – level 4	• clear exposition of science explanations relevant to the issue; • appropriate and effective use of the relevant ideas about how science works; • good overall grasp of the range and nature of the issue(s); • interprets arguments presented, recognising evidence, claim and counterclaim; • writes well structured argument using a range of evidence to reach a reliable conclusion; • fluency and accuracy of expression, with only minor errors of grammar, punctuation or spelling.	10-12
competent – level 3	• good attempt at exposition of science explanations; • use of some relevant ideas about how science works; • general grasp of the range and nature of issue(s); • interprets arguments presented, recognising some of the main components • writes structured argument using some evidence to reach a conclusion; • accuracy of expression, with some errors of grammar punctuation or spelling	7-9
limited – level 2	• exposition of science explanation minimal or inaccurate • minimal use of ideas about how science works; • grasp of some features of the issue(s); • interprets only part of arguments presented • arguments presented but with weak structure and/or minimal evidence • accuracy of expression, but with serious errors of grammar punctuation or spelling	4-6
inadequate – level 1	• exposition of science explanation confused • use of ideas about how science works absent or wrong • appears not to understand the issue; • cannot interpret the argument presented • argument presented as just a claim with no structure or evidence • expression unclear with serious errors of grammar punctuation or spelling	1-3
0	incorrect or no response	0
	Total	12

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Instructions and Advice

- Use your own words, rather than simply repeating those used in the sources, to show your understanding of the points being made.
- Section A: Questions on your appreciation and understanding of the case study material. You are expected to demonstrate an understanding of ideas about How Science Works in answering these questions.
- Section B: Questions that ask you to demonstrate your ability to write an appropriate explanation for a given audience and to write an argued opinion on an issue raised by the case study material. You are expected to make extensive use of the information in the sources in answering both these questions.

Source A: Australia turns to Desalination Amid Water Shortage

<http://www.npr.org/templates/story/story.php?storyId=11134967>

Source B: Desalination no solution to water crisis: WWF

<http://www.reuters.com/assets/print?aid=USL1834918020070619>

Source C: Large scale desalination: is there enough energy to do it?

<http://lightbucket.wordpress.com/2008/04/04/large-scale-desalination-is-there-enough-energy-to-do-it/>

Source D: Preliminary results of the monitoring of the brine discharge produced by the SWRO desalination plant of Alicante (SE Spain)

Y. Fernandez-Torquemada*, J.L. Sanchez-Lizaso, J.M. Gonzalez-Correa

www.desline.com/articoli/6678.pdf

Source E: Impacts of desalination plant discharges on the marine environment: a critical review of published studies

http://ipac.kacst.edu.sa/eDoc/2011/191463_1.pdf

You may find the following glossary useful when reading Source D.

psu is a unit of salt concentration. It is very nearly the same as parts per thousand.

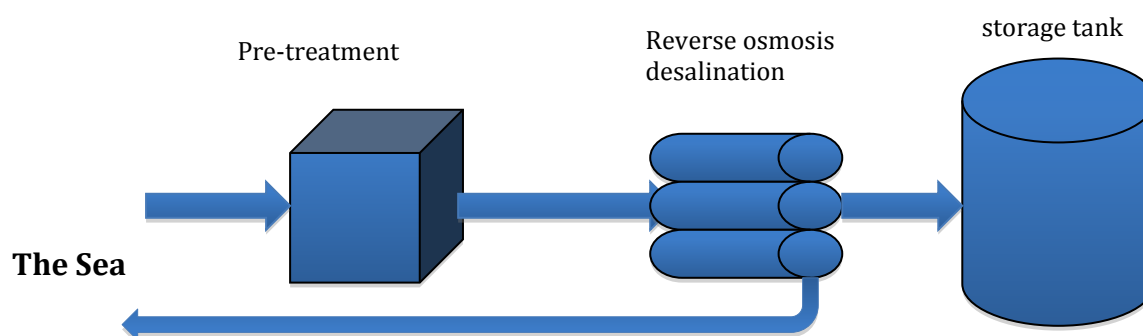
Benthic organisms are those that live on or close to the sea bed

Posidonia oceanica is a sea grass that lives in meadows on the sea floor and provides an important ecosystem.

Echinoderms are a group of species that include star fish and sea urchins

Section A

1. Give two reasons cited in **Source A** for the shortage of water in Perth. (1 mark)
2. **Source B** claims that greenhouse gas emissions make desalination an unsustainable solution to water shortages. Why might the managers quoted in Source A claim that this does not apply to the Perth plant? (1 mark)
3. Some people, however, are not convinced that setting up a wind farm makes the process sustainable. What points can be made to support this position? (2 marks)
4. **Source C** uses two scenarios to calculate the worldwide energy that might be used for desalination. Explain why scenarios are used in this way to forecast future situations. (3 marks)
5. In Africa the average annual fresh water consumption is only 25m³, this includes industry and agriculture. Is it reasonable for the author of **Source C** to have used the figure for Denmark, rather than Africa value in making the “low” predictions? Explain your answer. (2 marks)
6. **Source C** ends with the sentence ‘We may end up “drinking energy”’. Explain what this means. (2 marks)

Figure 1 Outline of sea water desalination plant

7. This question relates to the issues discussed in **Sources D** and **E**. **Figure 1** shows the main features of a modern desalination plant. The water is pumped at high pressure through very fine membranes.
 - (i) What is the main chemical waste product that is returned to the sea?

(1 mark)

(ii) Why does a desalination plant produce this waste chemical?

(1 mark)

(ii) Why might this waste present a risk to the local ecosystem?

(2 marks)

Questions 8 and 9 are about **Source D**.

8. What do the data in Figure 6 suggest about the effect of the desalination plant on the echinoderms. Explain your answer.

(3 marks)

9. The third diagram in Figure 7 shows the balance between new growth and the death of shoots of *Posidonia oceanica*, a sea grass, an important indicator of the health of the plants.

(i) Over which period was this balance studied?

(1 mark)

(ii) Do these data confirm that the discharges from the desalination plant have harmed the sea grass?

(3 marks)

The remaining questions in this section relate mainly to **Source E**. You do not need to read Results 3.1 on salinity, temperature and contaminants or 3.3 on impact minimisation.

10. The list of references for Source E shows that all the papers appear to be written in English. The journal Desalination in which Source D is published requires its authors to write in English. Comment on the advantages and disadvantages of the use of English by all the scientists involved.

(2 marks)

11. Source E says that it summarises information obtained from laboratory and field-based experiments, and ecological monitoring studies. Explain the difference between a field-based experiment and a monitoring study.

(2 marks)

12. In the second paragraph of their conclusion the authors of Source E say; “The one area where evidence is clearly lacking is in field-based ecological monitoring. Unfortunately, many of the published ecological monitoring programs do not appear to be scientifically defensible assessments of impacts.”

Explain two features of a monitoring program on the effects of desalination that are required for it to be *scientifically defensible*. You may find recommendation 2 in the Discussion useful.

(4 marks)

13. In the abstract the authors of source E say 'Many of the monitoring studies lacked sufficient detail with respect to study design'.

Explain why the scientific community expects scientists to publish the details of the study design.

(2 marks)

14. Desalination is providing an increasing proportion of water all over the world. However the authors found only a small number of papers on ecological monitoring that they considered worth including in their summary in Table 3.

Suggest some reasons why which might explain why there are so few good papers published on the subject.

(4 marks)

(total for this section 36)

Section B

15. Imagine that students in a city such as Perth are to be asked to volunteer to help in an ecological monitoring program before and after the opening of a new water desalination plant.

Write an information leaflet to encourage the students' participation. It should explain the environmental issue, why this new research is necessary and how the information will be gathered. It should be about one page long.

(12 marks)

16. The WWF says, "Desalination no answer to water crisis".
The author of source C says, "there are no fundamental showstoppers to desalination on a massive scale".

Give your opinion on the role of desalination in meeting the world's need for fresh water, supporting your argument with evidence from this case study or other sources.

(12 marks)