C10aD Using the Earth's Resources and Potable Water: Exam Drill

AQA 8464 · Calculator allowed · about 95 minutes

Total Marks

Name: ______________________________ Date: ____ / ____ / ______

Answer ALL questions. Show all your working.

1 This question checks three key terms used throughout this topic.

(a) Define 'potable water'. **(1)**

(b) Define 'sustainable development'. **(1)**

(c) Define a 'finite resource'. **(1)**

(Total for Question 1 is 3 marks)

2 A water company evaporates 250 cm3 of a water sample to dryness in a pre-weighed evaporating basin. Mass of empty basin = 42.16 g. Mass of basin + dry residue (after evaporation) = 42.40 g.

(a) Calculate the mass of dissolved solids in the 250 cm3 sample. **(1)**

....

(b) Calculate the concentration of dissolved solids in the original water, in g per dm3 (1000 cm3). **(3)**

....

(c) State one reason why this evaporation method would not distinguish between different dissolved substances present in the sample, such as sodium chloride and calcium sulfate. **(1)**

(Total for Question 2 is 5 marks)

3 Erin sets up simple distillation apparatus to purify a sample of seawater: the seawater is heated in a flask connected to a condenser, and the distillate is collected in a separate beaker.

(a) Explain why the thermometer bulb should be positioned level with the side arm of the distillation flask, rather than in the liquid. **(2)**

(b) Erin notices bumping (violent, uneven boiling) as the seawater is heated. Suggest one change to the method that would reduce this, and explain why it works. **(2)**

(Total for Question 3 is 4 marks)

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4 Reverse osmosis and thermal distillation are both methods of desalinating seawater. A small desalination plant using reverse osmosis needs about 3.5 kWh of energy to produce 1 m3 of potable water. The same plant using thermal distillation needs about 11.0 kWh of energy to produce 1 m3 of potable water. Electricity costs 0.28 pounds per kWh.

(a) Calculate the cost of the energy used to produce 1 m3 of potable water by reverse osmosis. **(2)**

....

(b) Calculate the cost of the energy used to produce 1 m3 of potable water by thermal distillation. **(2)**

....

(c) State, using your answers, which method is cheaper in terms of energy costs, and by how much per m3. **(1)**

(Total for Question 4 is 5 marks)

5 Sewage (waste water) treatment includes screening, sedimentation, and both aerobic biological treatment of the effluent (liquid) and anaerobic digestion of the sludge (solid).

(a) Explain the purpose of the screening stage, which is carried out first. **(1)**

(b) Explain why the sludge produced is treated separately from the effluent, using anaerobic digestion. **(3)**

(Total for Question 5 is 4 marks)

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6 A supermarket compares the environmental impact of paper carrier bags and plastic (polythene) carrier bags, using a simplified life cycle assessment (LCA).

(a) State two of the main stages usually considered in a life cycle assessment. **(1)**

(b) Suggest one reason why an LCA might show that a paper bag has a greater environmental impact than a plastic bag at the raw material and manufacturing stage, even though paper is made from a renewable resource. **(2)**

(c) State one limitation of using life cycle assessments to compare products. **(1)**

(Total for Question 6 is 4 marks)

7 Recycling aluminium uses about 5% of the energy needed to extract the same mass of new aluminium from its ore (bauxite) by electrolysis. Extracting 1 tonne of new aluminium from its ore requires about 45000 kWh of energy.

(a) Calculate the energy needed to produce 1 tonne of aluminium by recycling instead of extraction. **(2)**

....

(b) Suggest one reason, other than the energy saved, why recycling metals such as aluminium is important for sustainable development. **(2)**

(Total for Question 7 is 4 marks)

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8 A water company is deciding how to increase the supply of potable water to a coastal town that currently relies on a nearby reservoir, which is becoming unreliable because of low rainfall. Two options are proposed: (1) build a desalination plant using reverse osmosis to treat seawater, or (2) build a pipeline to transport fresh water from a wetter region further inland. Evaluate the two options.

(Total for Question 8 is 6 marks)

9 A sample of tap water contains dissolved calcium ions at a concentration of 45 mg per dm3.

(a) Calculate the mass of calcium ions, in mg, present in a 2.5 dm3 bottle of this water. **(2)**

....

(b) Higher tier only. Give your answer to (a) in grams, and explain why water companies usually report such concentrations in mg per dm3 rather than g per dm3. **(3)**

(Total for Question 9 is 5 marks)

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10 A water treatment works is choosing between chlorination and ozone treatment to sterilise water before it is supplied to homes.

(a) State one advantage of using chlorine, rather than ozone, to sterilise water that is supplied to homes. **(1)**

(b) Suggest one disadvantage of using chlorine to sterilise drinking water. **(1)**

(c) Explain why water must still be sterilised, even after sedimentation and filtration have already removed solid particles. **(2)**

(Total for Question 10 is 4 marks)

Mark scheme · C10aD Using the Earth's Resources and Potable Water: Exam Drill

Question 1

- (a) **B1** water that is safe for a particular population to drink (it is not the same as pure water, and may contain low levels of dissolved substances/minerals), oe
- **(a) Answer: Water that is safe to drink; this is not the same as chemically pure water.**
- (b) **B1** development that meets the needs of the current generation, without compromising the ability of future generations to meet their own needs, oe
- **(b) Answer: Development that meets today's needs without compromising the ability of future generations to meet their own needs.**
- (c) **B1** a resource that is not replenished at a significant rate (or at all), so it will eventually run out, e.g. fossil fuels or metal ores, oe
- **(c) Answer: A resource that is not replenished at a significant rate, so it will eventually run out.**

Question 2

- (a) **B1** 0.24 g (42.40 - 42.16) cao
- **(a) Answer: 0.24 g**
- (b) **M1** uses the scale factor 1000 / 250 = 4, ecf from (a)
- (b) **M1** substitutes: 0.24 x 4
- (b) **A1** 0.96 g/dm3 cao
- **(b) Answer: 0.96 g/dm3**
- (c) **B1** the method measures the total mass of all dissolved solids left behind together, without separating or identifying the individual substances present, oe
- **(c) Answer: The method only measures the total mass of all dissolved solids together; it does not separate or identify individual substances.**

Question 3

- (a) **M1** this measures the temperature of the vapour as it leaves the flask (enters the condenser), oe
- (a) **A1** a steady reading of 100 degrees C confirms that (pure) water vapour, not another substance, is being boiled off and collected, oe
- **(a) Answer: It measures the temperature of the vapour leaving the flask; a steady 100 degrees C confirms pure water vapour is being collected.**
- (b) **B1** add anti-bumping granules to the flask before heating, oe
- (b) **B1** explains they provide points (nucleation sites) for bubbles to form, allowing smoother, more even boiling, oe
- **(b) Answer: Add anti-bumping granules before heating; they provide nucleation points for bubbles, giving smoother, more even boiling.**

Question 4

- (a) **M1** substitutes: 3.5 x 0.28
- (a) **A1** 0.98 pounds (98p) cao
- **(a) Answer: 0.98 pounds**
- (b) **M1** substitutes: 11.0 x 0.28
- (b) **A1** 3.08 pounds cao
- **(b) Answer: 3.08 pounds**
- (c) **B1** reverse osmosis is cheaper, by 2.10 pounds per m3 (3.08 - 0.98), ecf from (a) and (b)
- **(c) Answer: Reverse osmosis is cheaper, by 2.10 pounds per m3.**

Question 5

- (a) **B1** removes large solid objects/debris (e.g. rags, plastic, grit) from the waste water, oe
- **(a) Answer: Screening removes large solid objects and debris from the waste water.**
- (b) **M1** sludge is a thick, solid-rich material that would not be efficiently broken down by the aerobic process used for the liquid effluent, oe
- (b) **M1** anaerobic digestion (bacteria breaking it down in the absence of oxygen) can also produce useful biogas (methane) as a by-product, oe
- (b) **A1** the digested solid remains can then be used as fertiliser, oe
- **(b) Answer: Sludge is too solid-rich for the aerobic process used on effluent; anaerobic digestion breaks it down, produces useful biogas, and the digested solids can be used as fertiliser.**

Question 6

- (a) **B1** any two of: extracting and processing raw materials; manufacturing and packaging; use (and reuse); disposal (including transport throughout all stages), oe
- **(a) Answer: Example: extracting and processing raw materials, and manufacturing and packaging.**
- (b) **M1** producing paper requires cutting down trees, and uses more energy and water during processing and manufacturing than producing a lightweight plastic bag, oe
- (b) **A1** so, despite being renewable, the impact of extracting and processing the raw material and manufacturing may be greater for paper than for plastic, oe
- **(b) Answer: Producing paper uses more energy and water in processing than making a lightweight plastic bag, so despite being renewable, its raw-material and manufacturing impact can be greater.**
- (c) **B1** some impacts are difficult to quantify precisely (data may be estimated), or assessments can be biased depending on which factors are included or how they are weighted, oe
- **(c) Answer: Some impacts are hard to measure precisely, and assessments can be biased depending on which factors are included or weighted.**

Question 7

- (a) **M1** substitutes: 45000 x 0.05
- (a) **A1** 2250 kWh cao
- **(a) Answer: 2250 kWh**
- (b) **M1** identifies a valid reason, e.g. conserves finite raw materials/ores for future use, or reduces waste sent to landfill, or reduces mining-related habitat destruction, oe
- (b) **A1** links this to sustainable development: meets the material needs of the current generation without compromising the ability of future generations to meet their own needs, oe
- **(b) Answer: Recycling conserves finite raw materials for future use, meeting current needs without compromising the ability of future generations to meet their own needs.**

Question 8

- **Level 3** (5-6): A balanced evaluation that considers reliability, cost and environmental impact of both options, and reaches a justified recommendation.
- **Level 2** (3-4): Some evaluation of both options with at least one clear point on each, but the evaluation is not fully balanced or the recommendation is only partly justified.
- **Level 1** (1-2): Simple, undeveloped points about only one option, or a recommendation with little or no justification.
- **Indicative content:**
  - Desalination (reverse osmosis) uses the essentially unlimited supply of seawater, so it does not depend on rainfall and remains reliable even during future droughts
  - Desalination has a high energy demand and cost compared with treating fresh water, and produces a concentrated brine by-product that can harm marine life if released back into the sea without treatment
  - A pipeline from a wetter inland region relies on that region continuing to have a surplus of fresh water, so it is not fully drought-proof if the wider area is affected by low rainfall too
  - Building a pipeline involves significant construction cost and disruption over a long distance, plus ongoing energy costs to pump the water, especially if there is a change in elevation
  - Taking water from the inland region could also affect the water supply or ecosystems of that region if not carefully managed
  - A justified conclusion could recommend desalination for long-term reliability despite higher running costs, or the pipeline if it is cheaper and the inland region has a reliable surplus; either is valid if properly supported

Question 9

- (a) **M1** substitutes: 45 x 2.5
- (a) **A1** 112.5 mg cao
- **(a) Answer: 112.5 mg**
- (b) **M1** converts correctly: 112.5 mg = 0.1125 g, ecf from (a)
- (b) **M1** identifies that concentrations of dissolved substances in drinking water are usually very small (dilute), oe
- (b) **A1** so using mg/dm3 avoids very small decimal values (e.g. 0.045 g/dm3) and gives clearer, easier-to-read figures for typical drinking water concentrations, oe
- **(b) Answer: 0.1125 g. Concentrations of dissolved substances in drinking water are usually very small, so mg/dm3 avoids tiny decimal values and is clearer to read than g/dm3.**

Question 10

- (a) **B1** chlorine provides a residual disinfecting effect, continuing to kill microorganisms as the water travels through the pipe network to homes, whereas ozone breaks down quickly and gives no such lasting protection, oe
- **(a) Answer: Chlorine leaves a residual effect that keeps killing microorganisms as water travels through the pipe network, unlike ozone, which breaks down quickly.**
- (b) **B1** chlorine can give water an unpleasant taste or smell, or can react with organic matter in the water to form harmful by-products, oe
- **(b) Answer: Chlorine can give water an unpleasant taste or smell, or react with organic matter to form harmful by-products.**
- (c) **M1** sedimentation and filtration remove larger solid particles/debris but do not necessarily remove microorganisms (bacteria/pathogens) present in the water, oe
- (c) **A1** sterilisation is needed to kill any remaining microorganisms, making the water safe (potable) to drink, oe
- **(c) Answer: Sedimentation and filtration remove solids but not microorganisms, so sterilisation is still needed to kill remaining microorganisms and make the water safe to drink.**