



ATAR course examination, 2021

Question/Answer booklet

INTEGRATED SCIENCE

Please place your student identification label in this box

WA student number: In figures

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In words

Time allowed for this paper

Reading time before commencing work: ten minutes

Working time: three hours

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer booklet

Multiple-choice answer sheet

Number of additional
answer booklets used
(if applicable):

To be provided by the candidate

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: up to three calculators, which do not have the capacity to create or store programmes or text, are permitted in this ATAR course examination

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of examination
Section One Multiple-choice	20	20	30	20	20
Section Two Short response	5	5	90	113	50
Section Three Extended response	2	2	60	60	30
Total					100

Instructions to candidates

- The rules for the conduct of the Western Australian external examinations are detailed in the *Year 12 Information Handbook 2021: Part II Examinations*. Sitting this examination implies that you agree to abide by these rules.

- Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Sections Two and Three: Write your answers in this Question/Answer booklet.

- You must be careful to confine your answers to the specific questions asked and to follow any instructions that are specific to a particular question.
- Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Section One: Multiple-choice**20% (20 Marks)**

This section has **20** questions. Answer **all** questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 30 minutes.

1. When a drop of detergent is added to water,
 - (a) the surface tension weakens.
 - (b) attraction between water molecules strengthens.
 - (c) it is easier to make a paper clip float.
 - (d) the detergent floats on the water.

2. The Government of Western Australia has banned the taking of large fish, such as snapper, from Cockburn Sound because small traces of heavy metals have been found in the mussels from the area. Taking and eating fish from the area is a risk due to the process of
 - (a) turbidity.
 - (b) osmoregulation.
 - (c) eutrophication.
 - (d) biomagnification.

3. The rate of flow of charged particles through a conductor is the
 - (a) current.
 - (b) voltage.
 - (c) resistance.
 - (d) power.

4. The water cycle gets its energy from
 - (a) oxygen.
 - (b) the Sun.
 - (c) run-off.
 - (d) hydropower.

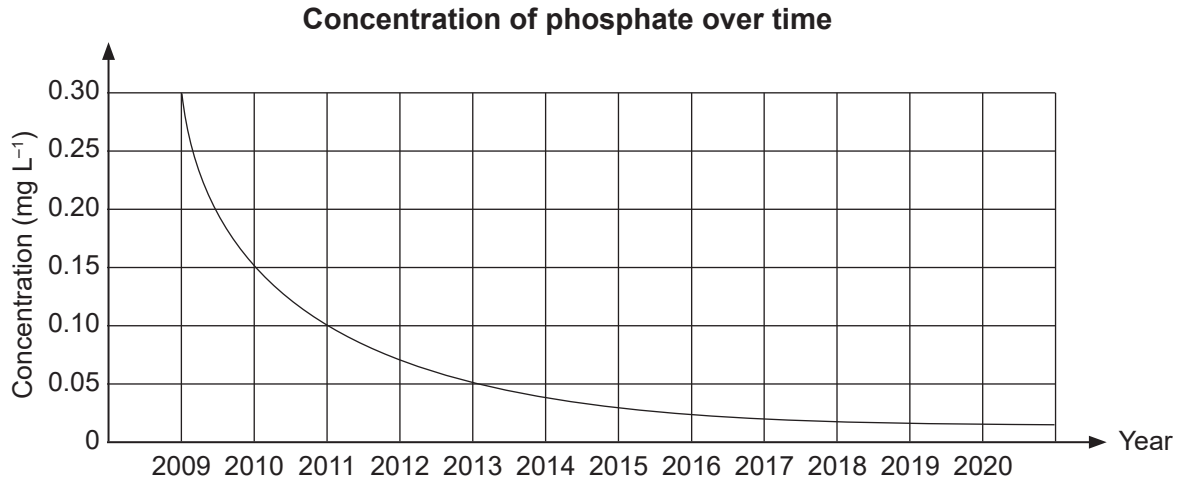
5. The production of electricity from uranium in nuclear power stations is controversial in the community because it
 - (a) produces a large amount of heat that contributes to the enhanced greenhouse effect.
 - (b) is an inefficient method of electricity production and the raw material is rare.
 - (c) has significant challenges for safe transport and storage of hazardous waste.
 - (d) is a major cause of the enhanced greenhouse effect and contributes to air pollution.

See next page

6. An experiment is conducted to test the hypothesis that an increase of nitrates in water will increase algal growth. An appropriate controlled variable for this experiment would be to use water
- (a) containing no nitrates.
 - (b) containing no algae.
 - (c) with a temperature of 4 °C.
 - (d) with a temperature of 20 °C.
7. Water molecules are polar. This means that the oxygen
- (a) and hydrogen ends are slightly negative.
 - (b) and hydrogen ends are slightly positive.
 - (c) end is slightly positive and the hydrogen end is slightly negative.
 - (d) end is slightly negative and the hydrogen end is slightly positive.
8. What do the water properties of cohesion, surface tension and adhesion have in common? All
- (a) increase when temperature decreases.
 - (b) are produced by ionic bonding.
 - (c) are properties related to hydrogen bonding.
 - (d) are related with non-polar covalent bonds.
9. Development of hydraulic fracturing techniques can result in
- (a) reducing the overall lifetime of fossil fuel sources.
 - (b) increasing the dependency on coal-fired power stations.
 - (c) increasing the amount of gas available for power stations.
 - (d) reducing the use of bioethanol fuels.
10. Choose the correct statement regarding geothermal energy.
- (a) Geothermal energy is used only for heating purposes.
 - (b) Geothermal hot dry rocks can be used to produce steam for electricity generation.
 - (c) Geothermal energy can be used in all regions due to heat energy stored in the Earth's crust.
 - (d) Geothermal energy produces more greenhouse gas emissions than do fossil fuels.
11. Experimental results are considered reliable when
- (a) the results are published.
 - (b) the results are similar each time the experiment is repeated.
 - (c) measurements are recorded using the smallest units possible.
 - (d) more variables are controlled during the experiment.

Questions 12 and 13 refer to the information and graph below.

A processing plant for the production of fertiliser was located next to a stream. A scientist studying the water quality measured the concentration of phosphate downstream from the processing plant over a number of years and recorded her measurements. The data is shown in the graph below.



12. What was the change in phosphate concentration between 2009 and 2011?
- 0.15 mg L⁻¹
 - 0.20 mg L⁻¹
 - 0.25 mg L⁻¹
 - 0.30 mg L⁻¹
13. The concentration of phosphate in stream water that is acceptable for human consumption is less than 0.05 mg L⁻¹. From what year could the water from this stream be safe for human consumption?
- 2010
 - 2013
 - 2014
 - never
14. Which of the following statements about electricity generation is correct?
- Coal-fired power stations are a reliable source of a base load electricity supply.
 - Coal-fired power stations are more efficient than nuclear power stations in producing electricity.
 - Solar power is a reliable source of energy.
 - Wind turbines provide an efficient and reliable source of renewable energy.

15. Which of the following statements about nuclear power stations are correct? Nuclear power stations

- (i) do not produce greenhouse gas emissions.
- (ii) cannot provide base load energy supply.
- (iii) are cheaper to run than coal power stations.
- (iv) use fuel with a higher energy density than coal.
- (v) are the most expensive type to build.

- (a) i, ii and iv
- (b) i, ii and v
- (c) ii, iii and iv
- (d) i, iii, iv and v

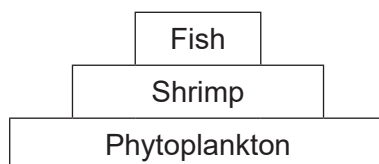
16. Which of the following statements **best** describes an ecosystem?

- (a) the different species in a particular environment
- (b) all of the different communities within a biome
- (c) all of the different organisms in the biosphere
- (d) a community and the physical environment with which they interact

17. Consider the following food chain.

Phytoplankton → Shrimp → Fish

This food chain can be represented as the biomass pyramid shown below.



The reason for the shape of this biomass pyramid is that

- (a) there are fewer fish than shrimp or phytoplankton.
- (b) less matter is available at each trophic level due to indigestible material.
- (c) all of the energy that enters a trophic level is lost as heat.
- (d) organisms in higher trophic levels do not need as much energy as organisms in lower trophic levels.

18. Which of the following are methods for directly heating a home?
- (i) thermal mass
 - (ii) burning of wood
 - (iii) solar panels
 - (iv) burning of fossil fuels
 - (v) consumption of electricity
- (a) i and ii
 - (b) i, iii and v
 - (c) ii, iii and iv
 - (d) ii and iv
19. Electricity is generated in a nuclear power plant using steam formed from heat produced by nuclear fission. Nuclear fission is when
- (a) two light nuclei combine to release energy.
 - (b) two heavy nuclei combine to release energy.
 - (c) a heavy nucleus splits and releases energy.
 - (d) a light nucleus splits and releases energy.
20. Which of the following forms of waste from nuclear power plants are most suitably stored deep underground?
- (i) spent reactor rods
 - (ii) protective aprons
 - (iii) metal nuclear fuel cases
 - (iv) equipment and tools used in such plants
- (a) i only
 - (b) i and ii
 - (c) iii and iv
 - (d) i, ii and iv

End of Section One

See next page

Section Two: Short response

50% (113 Marks)

This section has **five** questions. Answer **all** questions. Write your answers in the spaces provided.

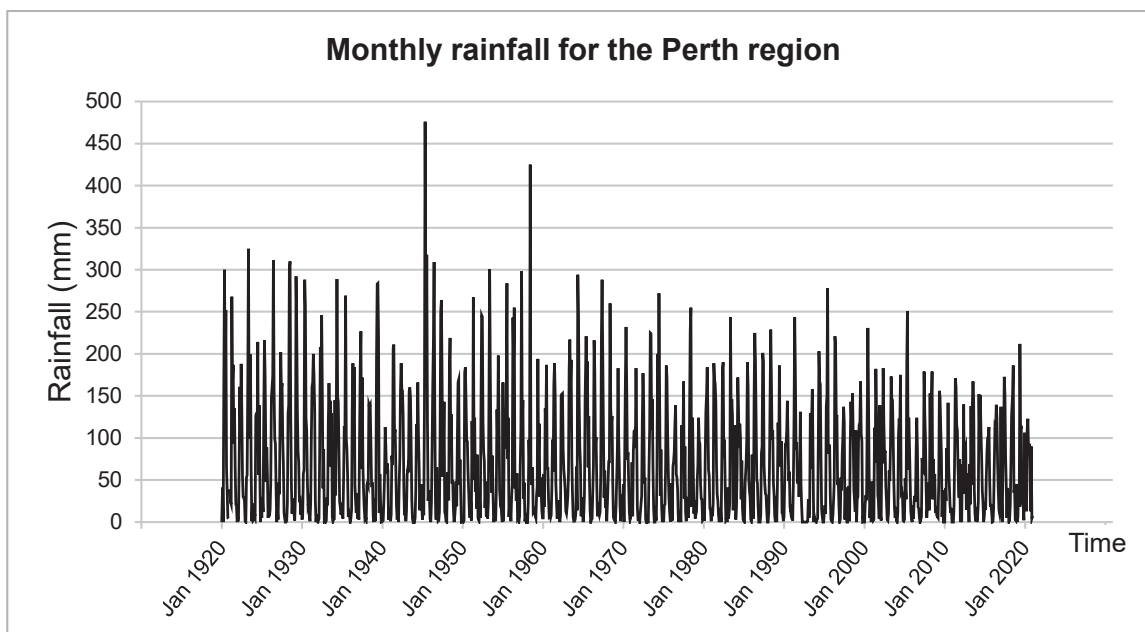
Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 90 minutes.

Question 21

(27 marks)

The Perth region’s monthly rainfall for the last 100 years is shown in the graph below. The graph shows fluctuations, but the trend is a decrease over time.



Traditionally, rainfall has had a significant impact on our water sources.

- (a) What effect would this decrease in rainfall have on the water cycle and water resources? (4 marks)

The Water Corporation, which is the principal supplier of water in Western Australia, is moving toward making our water resources more climate resilient. Sea water and wastewater are two alternative climate-resilient water sources currently being used.

- (b) Identify **three** wastewater treatment processes used to remove organic matter and solids. (3 marks)

One: _____

Two: _____

Three: _____

- (c) Identify **three** additional processes used to make wastewater potable so it can be used for aquifer recharge. (3 marks)

One: _____

Two: _____

Three: _____

The water cycle is responsible for the natural purification and redistribution of water around the planet.

- (d) (i) Describe **two** ways in which the water cycle processes act to purify water. (4 marks)

One: _____

Two: _____

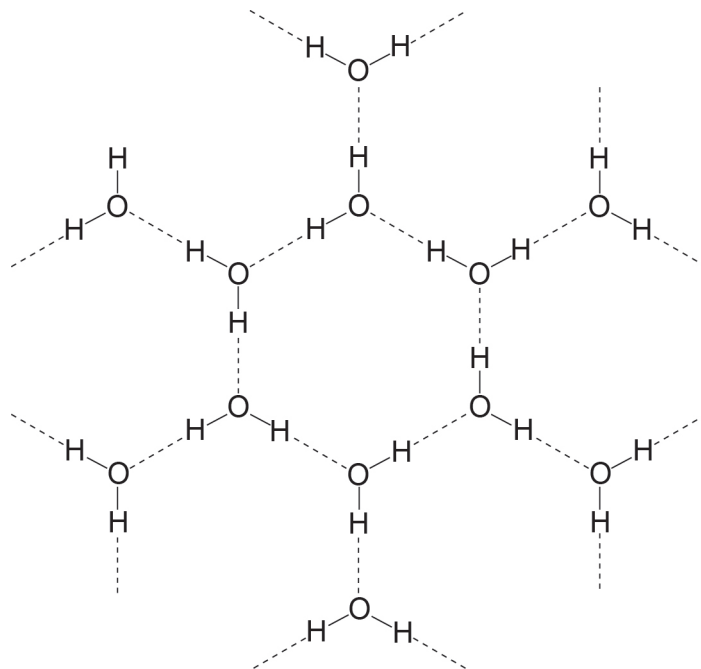
- (ii) Describe **two** ways in which the water cycle processes act to redistribute water. (4 marks)

One: _____

Two: _____

Question 21 (continued)

As water moves through the water cycle it experiences changes in state. The following diagram represents water molecules in the solid form.



(e) (i) Explain why water in the solid form has the arrangement shown. (3 marks)

(ii) What physical property results from this arrangement? (1 mark)

- (f) Most of the Earth's ice is located at the poles, including sea ice, ice sheets and ice shelves. Explain how melting sea ice affects climate regulation. (5 marks)

Question 22

(20 marks)

The Department of Water and Environmental Regulation (the Department) monitors the health of our river and estuary systems, stormwater drains and groundwater. Increased concentrations of nutrients in these water systems can lead to eutrophication.

- (a) List **three** possible sources of excess nutrients. (3 marks)

One: _____

Two: _____

Three: _____

- (b) Identify **two** abiotic changes and **two** biotic changes that occur during eutrophication. (4 marks)

Abiotic changes	Biotic changes
One:	One:
Two:	Two:

The Department also monitors other conditions to assess the quality of our waterways. The results of a two-month testing and monitoring period are shown in the table below.

Test	First month	Second month
Dissolved oxygen	high	low
pH	7	6
Turbidity	40 cm	10 cm
Temperature	21 °C	22 °C
Phosphates	0.101 mg L ⁻¹	0.312 mg L ⁻¹

- (c) For each of the following tests performed by the Department, name the equipment used to perform the test and describe the importance of the test in monitoring water quality. (9 marks)

pH test

Equipment used: _____

Importance of test: _____

Turbidity test

Equipment used: _____

Importance of test: _____

Phosphate test

Equipment used: _____

Importance of test: _____

- (d) Macro-invertebrate sampling provides additional information on water quality. Identify **two** pieces of information that can be gained from macro-invertebrate sampling and outline what these indicate about water quality. (4 marks)

One: _____

Two: _____

Question 23

(19 marks)

Commonly used bulbs are halogen bulbs, compact fluorescent lamps (CFLs), and light-emitting diodes (LEDs).



Halogen



CFL



LED

A study found that a 40 W halogen bulb used 750 J of electrical energy when run for a certain amount of time. The halogen bulb produces 400 J of light energy during this time.

- (a) Calculate the energy wasted by the halogen bulb. (1 mark)

Answer: _____

- (b) Name the form of wasted energy. (1 mark)

- (c) Where does the wasted energy produced by the halogen bulb go? (1 mark)

- (d) Calculate the energy efficiency of the halogen bulb. Show **all** workings. (2 marks)

$$\text{Efficiency} = \frac{\text{energy out}}{\text{energy in}} \times 100$$

Answer: _____

- (e) Calculate the time taken to run the study. Show **all** workings. (3 marks)

$$P = \frac{E}{t}$$

Answer: _____

The power usage, life span and cost of three bulbs of equal light intensity are shown in the table below.

Bulb	Power usage	Life span	Cost
Halogen	40 W	2000 hours	\$8.00
CFL	12 W	10 000 hours	\$5.00
LED	8 W	40 000 hours	\$6.50

- (f) Using the information provided in the table, state which bulb would be best to use, outlining **two** reasons for your choice. (3 marks)

Bulb: _____

One: _____

Two: _____

Question 23 (continued)

Halogen bulbs will no longer be sold in Australia from the end of 2021.

A school currently uses ten 40 W halogen bulbs in every classroom, for seven hours each day. They plan to replace all of the halogen bulbs in every classroom with 8 W LED bulbs.

- (g) Determine the energy saved in a classroom each day, if all the bulbs are replaced with LED bulbs. Show **all** workings. (4 marks)

Answer: _____

The school is also looking at other ways in which it can reduce its energy consumption.

- (h) Suggest **two** passive solar design methods that could be used to reduce energy consumption in the existing buildings. Describe how each method achieves a reduced energy consumption. (4 marks)

Method one: _____

Description: _____

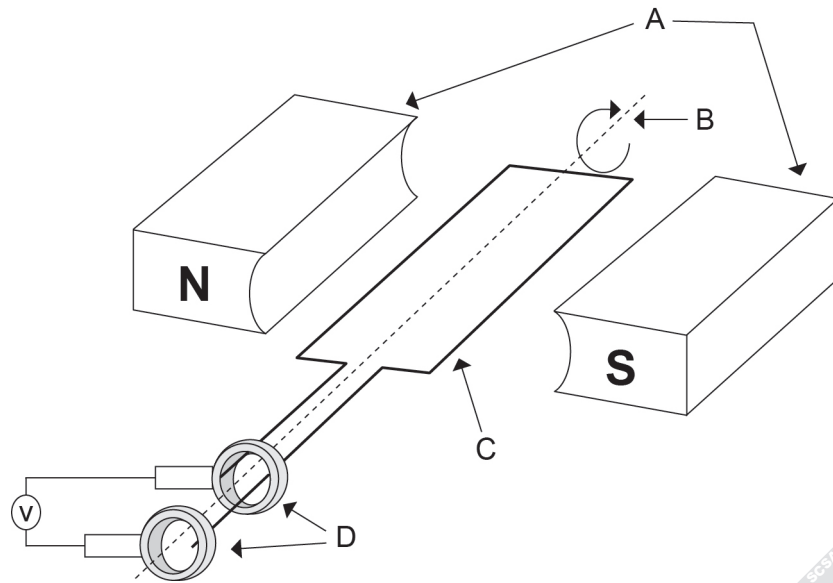
Method two: _____

Description: _____

Question 24

(22 marks)

Power stations use generators for electricity production. Below is a diagram showing the structure of a simple generator.



- (a) Identify the components labelled A and C. (2 marks)

A: _____

C: _____

- (b) What would component B be attached to in a power station? (1 mark)

- (c) Name the principle that is applied in a generator for the production of electricity. (1 mark)

- (d) Explain how an electric current is produced in the simple generator shown above. (4 marks)

Question 24 (continued)

The three main components of a dry cell are the graphite rod, zinc anode and electrolyte paste.

- (e) Label the diagram of the dry cell with the components listed above. (3 marks)

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The diagram shows a dry cell with three empty rectangular boxes for labeling. Three horizontal lines extend from the right side of the dashed box to the left side of each of the three boxes, indicating where labels should be placed.

- (f) What process occurs at the zinc anode within the dry cell? (1 mark)

- (g) What happens during the reactions in a dry cell to produce an electrical current? (2 marks)

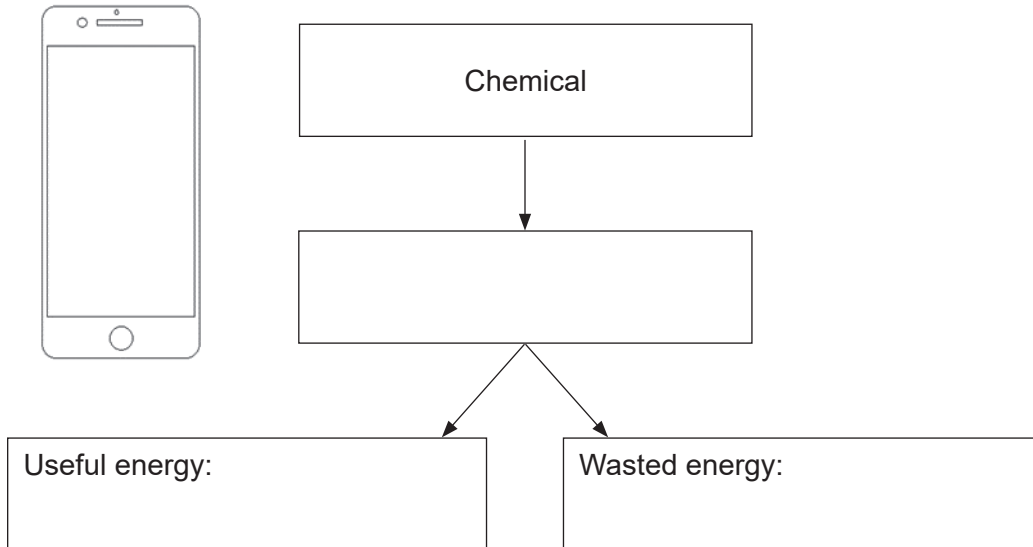
- (h) Give **two** benefits batteries provide over other forms of electricity generation. (2 marks)

One: _____

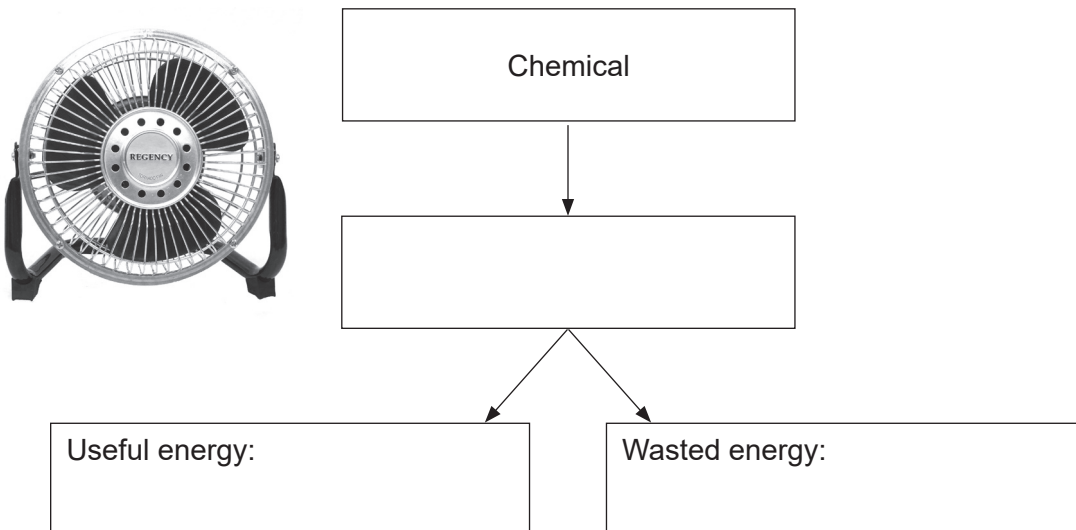
Two: _____

- (i) Both devices shown below use a battery. Complete the diagram for each device by:
- showing the initial energy transformation that occurs
 - identifying **one** useful form of energy and **one** wasted form of energy that results from the energy transformation. (6 marks)

Device 1



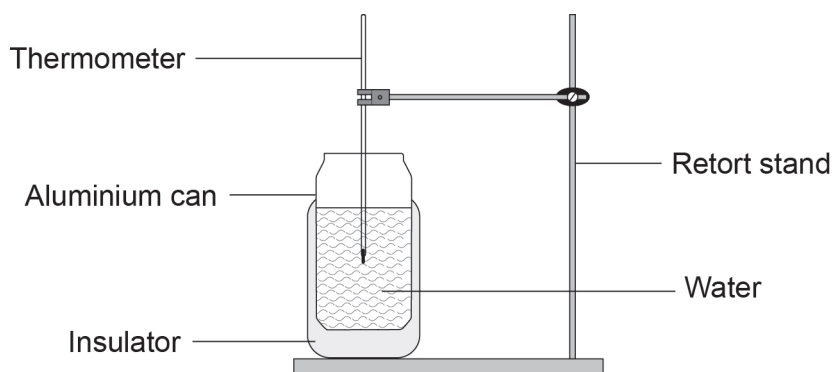
Device 2



Question 25

(25 marks)

A group of students investigated the effectiveness of different insulators. Their aim was to determine which material provided the best insulation when covering an aluminium can. The diagram below shows the equipment used.



The students used the following method.

1. Place the aluminium can inside the insulator.
2. Fill the can with 300 mL of hot water.
3. Place the thermometer in the can and record the initial temperature.
4. Record the temperature every 3 minutes, for 21 minutes.

Their results are recorded in the table below.

Time (min)	Temperature of water using each insulator (°C)					
	None	Newspaper	Wool cloth	Cotton wool	Foam can holder	Plastic wrap
0	59	57	58	57	55	60
3	55	56	57	56	54	56
6	53	55	55	55	53	54
9	51	54	54	54	52	52
12	50	53	53	53	50	52
15	49	52	52	53	50	51
18	48	51	52	52	49	51
21	47	51	52	52	49	51
Temperature change	12	6	6	5		9

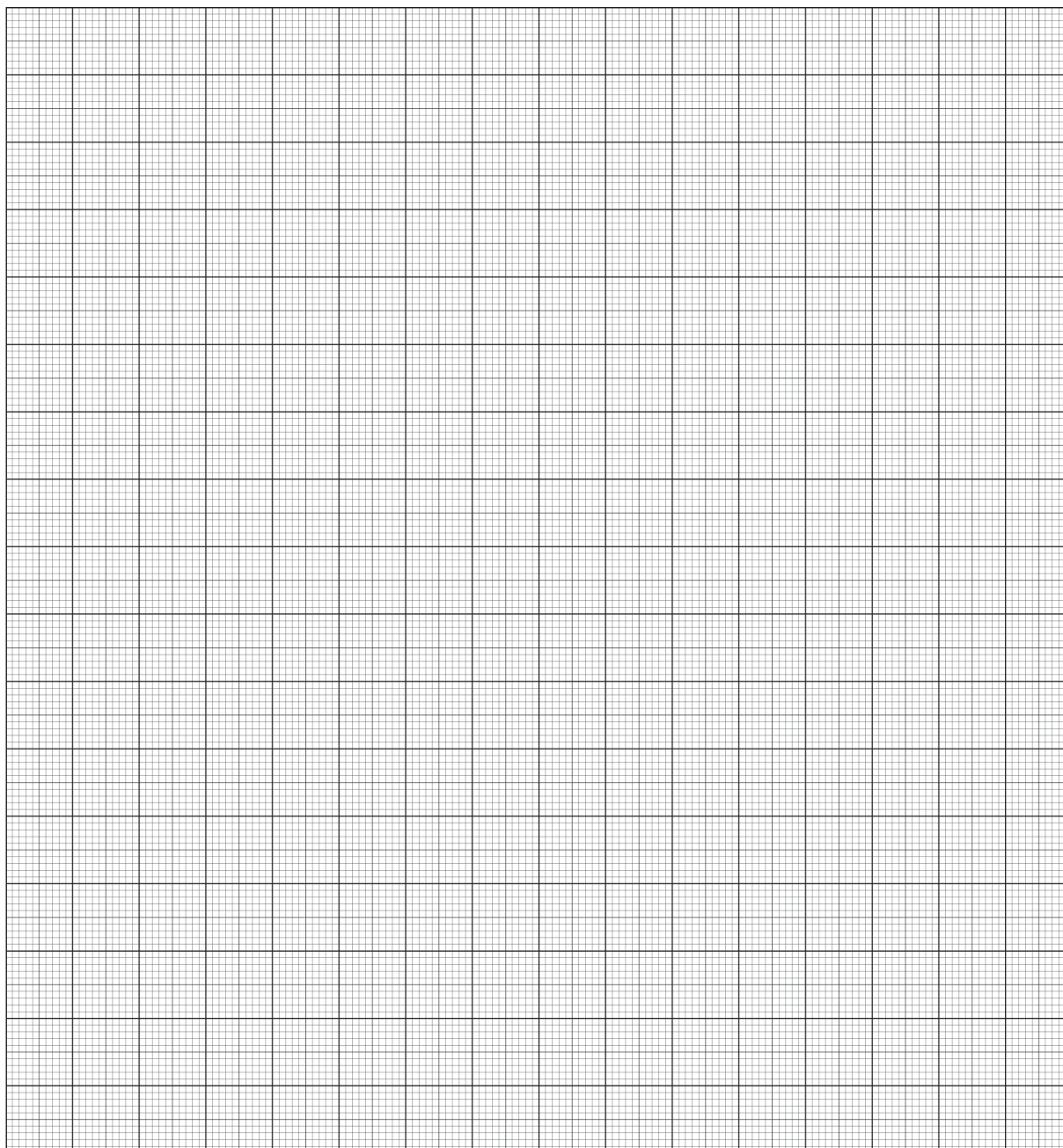
(a) Identify the independent and dependent variables for this investigation. (2 marks)

Independent variable: _____

Dependent variable: _____

- (b) Write a possible hypothesis for the experiment. (1 mark)

- (c) Graph the data of the foam can holder and the plastic wrap on the following grid. (5 marks)



A spare grid is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare grid.

See next page

Question 25 (continued)

- (d) Describe how the **four** methods of heat transfer act to cool the water in the can. (8 marks)

One: _____

Two: _____

Three: _____

Four: _____

- (e) Use the results from the table to calculate the heat energy, in joules, lost by the water when using the foam can holder for insulation. Show **all** workings. (3 marks)

Use the formula $Q = mc\Delta T$, where the specific heat capacity of water is $4.180 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$.

Note: 1 mL of water has a mass of 1 g.

Answer: _____

- (f) Another group of students also tested the foam can holder using a different amount of water. They recorded a temperature change from 55 °C to 51 °C and an energy loss of 5852 J. Calculate the mass, in grams, of the water used. Show **all** workings. (4 marks)

Answer: _____

- (g) Identify **two** factors that should be considered to ensure the validity of the results for this investigation. (2 marks)

One: _____

Two: _____

End of Section Two

See next page

Section Three: Extended response

30% (60 Marks)

This section contains **two** questions. You must answer **both** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 60 minutes.

Question 26

(34 marks)

The Paris Agreement is a legally-binding international treaty on climate change. As part of Australia’s commitment to the Paris Agreement, a National Greenhouse Gas Inventory is submitted annually. The table below shows data from the March 2020 report.

Sector	Annual emissions (Mt CO ₂ -e)		Percentage change (%)
	Year to March 2019	Year to March 2020	
Energy – electricity	180.5	172.9	-4.2
Energy – stationary energy excluding electricity	100.0	102.7	2.7
Energy – transport	100.1	99.7	-0.4
Energy – fugitive emissions	55.7	55.8	0.2
Industrial processes and product use	34.8	34.6	-0.6
Agriculture	72.0	68.0	
Waste	13.0	13.1	1.0
Land use, land use change and forestry	-19.7	-18.1	8.0
National inventory total	536.4	528.7	-1.4

Note: Mt CO₂-e = mega tonnes of carbon dioxide equivalent.

- (a) Describe the change in emissions from 2019 to 2020 in the transport sector. (2 marks)

- (b) The percentage change for the agriculture sector is missing from the table. Calculate this value. Show **all** workings. (3 marks)

Answer: _____

- (c) The electricity sector has shown the greatest decrease in annual emissions. Describe how this sector produces greenhouse gas emissions. (2 marks)

- (d) For the National Greenhouse Gas Inventory, measurements are made as Mt CO₂-e, or mega tonnes of carbon dioxide equivalent.

- (i) State **two** greenhouse gases, other than carbon dioxide, that contribute to this national measurement. (2 marks)

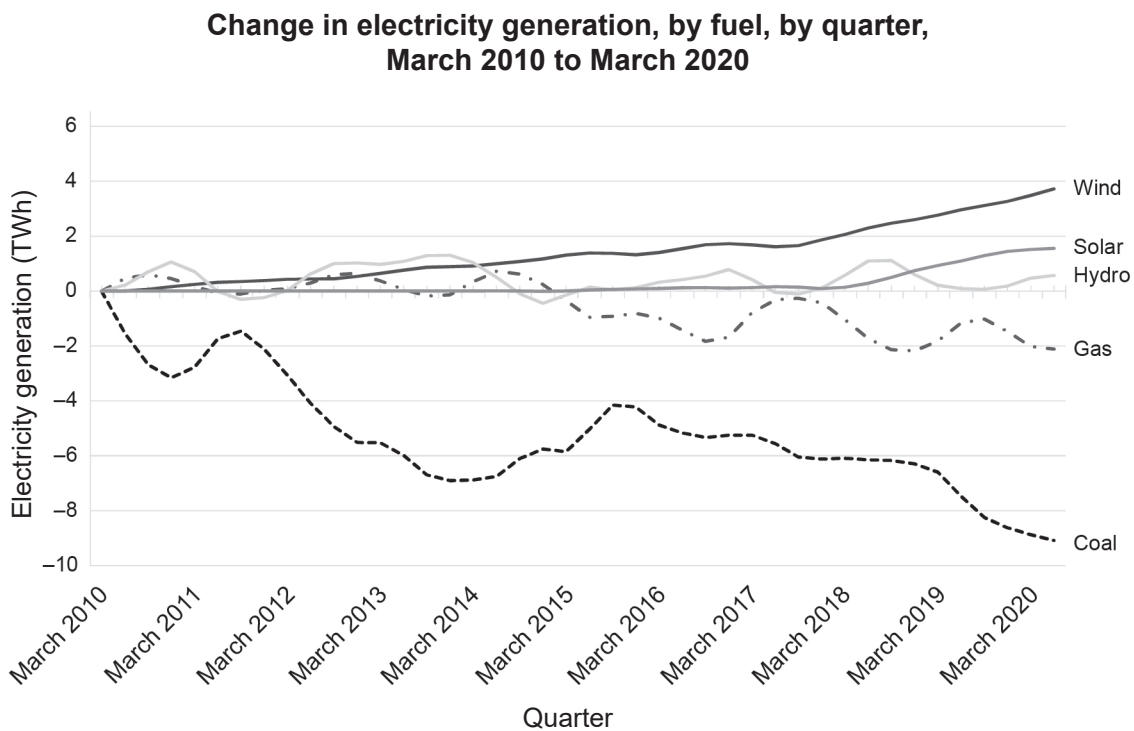
One: _____

Two: _____

- (ii) Explain how these gases contribute to the enhanced greenhouse effect. (4 marks)

Question 26 (continued)

The graph below shows the change in the amount of electricity generated, in terawatt hours (TWh), from different fuels in Australia.



(e) Classify the fuels in the graph as renewable or non-renewable. (2 marks)

Renewable	Non-renewable

(f) Using the data in the graph, account for the decrease in annual emissions for electricity generation shown in the table on page 24. (3 marks)

- (g) Name the device that can produce electricity from solar energy and explain how this device generates electricity. (5 marks)

Device: _____

Explanation: _____

The graph shows that the use of wind for energy has increased since 2010. A further 21 845 MW of capacity is proposed for Australia in the future.

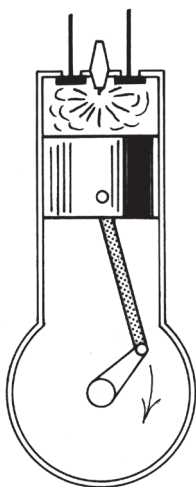
- (h) Give **one** economic and **one** environmental consideration for using wind for energy production. Justify your consideration. (4 marks)

Economic: _____

Environmental: _____

Question 26 (continued)

The transport sector has produced the third highest level of emissions. The most commonly used engine in vehicles is the internal combustion engine.



- (i) Explain what occurs during the power/combustion stage of the four-stroke internal combustion engine, as shown in the diagram above. (4 marks)

The transport sector has also decreased emissions slightly. One strategy is to use alternative engines with a reduced greenhouse gas impact.

- (j) Identify an existing alternative engine and describe how its design assists in the reduction of greenhouse gas emissions. (3 marks)

Question 27

(26 marks)

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- (a) Name **three** activities on or around the dam that could cause contamination to its water. (3 marks)

One: _____

Two: _____

Three: _____

- (b) Explain where the salt has come from to cause the salinity problem in the dam. (5 marks)

Question 27 (continued)

- (c) Describe **one** strategy to reduce dry land salinity and outline how this strategy works to achieve this reduction. (4 marks)

- (d) Apart from salinity, another risk of contamination to the dam water is turbidity. Give **one** possible cause of turbidity. (1 mark)

- (e) Describe the effect higher salinity would have on the buoyancy of aquatic animals. (2 marks)

- (f) Electrical conductivity can be used to determine salinity levels. Describe what a low electrical conductivity reading indicates. Justify your answer. (2 marks)

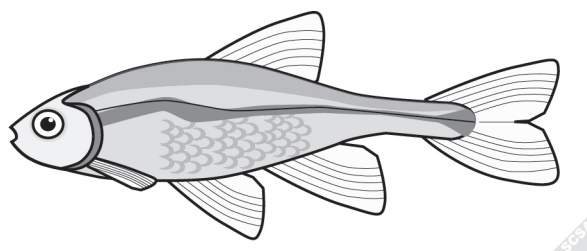
(g) The high salt concentration of the water would affect the freshwater fish that live in the dam.

(i) Name the process that fish use to balance internal salt and water concentrations.

(1 mark)

(ii) Use the diagram of the fish below to show how freshwater fish perform this process.

(3 marks)



Annual inflow of fresh water from contributing rivers into the Wellington Dam has fallen. From 1972 to 1999, the average inflow was 124 billion litres per year. It is currently 78 billion litres per year and is expected to continue to drop.

(h) Provide **one** valid reason for this reduction in water inflow to the dam.

(1 mark)

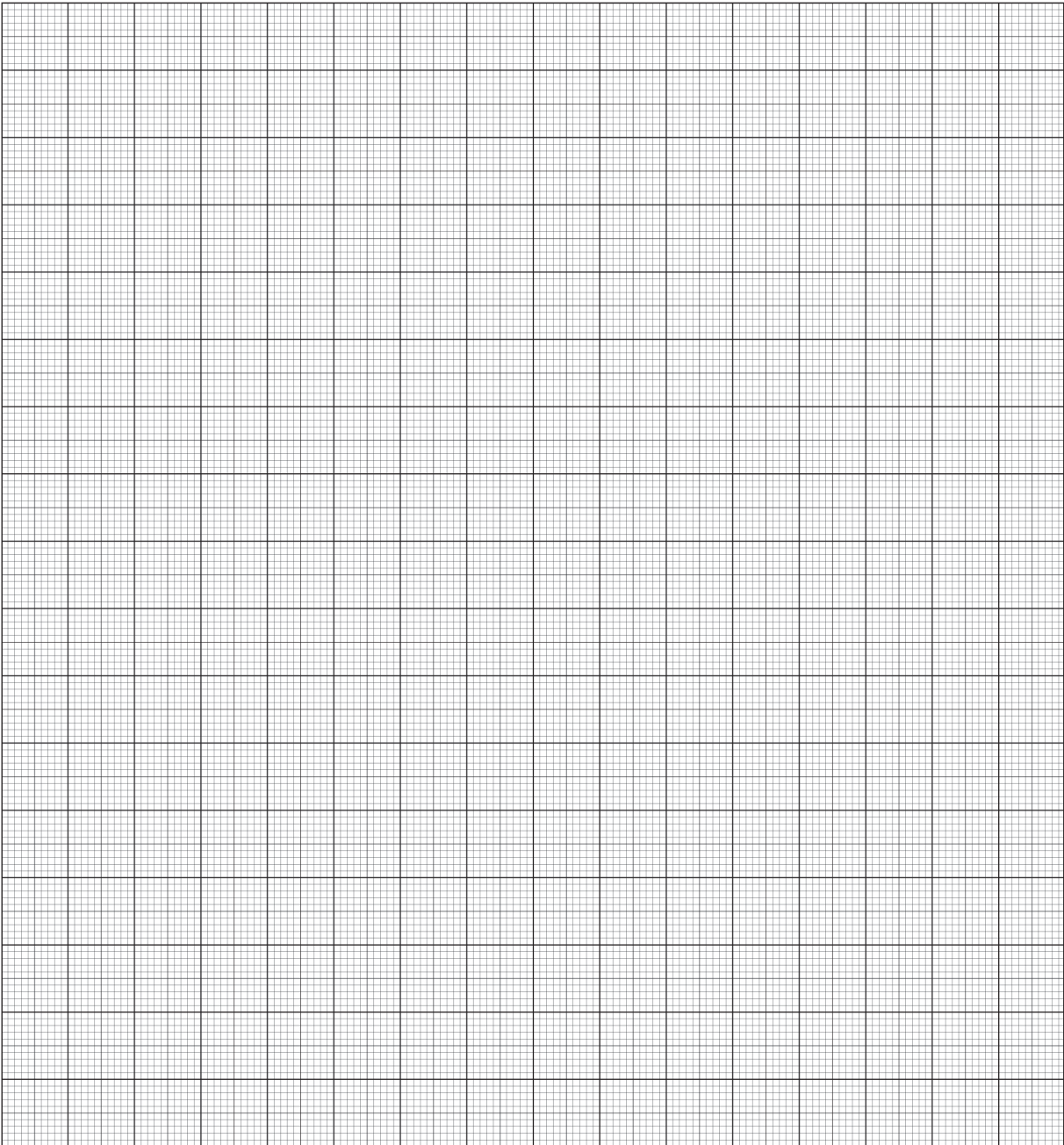
Question 27 (continued)

Increasing development and population growth in the South-West region of Western Australia is placing greater demands on the supply of potable water.

- (i) Identify a strategy that could be used to process the saline water in the dam to provide potable water. (1 mark)

- (j) Describe **one** process for treating the saline water from the dam to produce potable water. (3 marks)

Spare grid



ACKNOWLEDGEMENTS

- Question 21(a)** Data from: Water corporation. (2021). *Perth rainfall 1920–2020* [Data]. Retrieved June, 2021, <https://www.watercorporation.com.au/Our-water/Rainfall-and-dams/Rainfall>
- Question 21(e)** Smith, K. (2011). [Diagram representing water molecules in the solid form]. Retrieved June, 2021, from <https://www.quora.com/What-does-the-structure-of-the-hydrogen-bonding-of-ice-look-like>
- Question 22** Information from: Department of Water and Environmental Regulation. (n.d.). *Eutrophication (nutrient enrichment)*. Retrieved July, 2021, from <https://www.water.wa.gov.au/water-topics/waterways/threats-to-our-waterways/statewide-river-assessment>
- Question 23** Kotivalo. (2015). [Photograph of frosted bulb]. Retrieved June, 2021, from [https://commons.wikimedia.org/w/index.php?search=\[..\]light+bulb&title=Special:MediaSearch&go=Go&type=image](https://commons.wikimedia.org/w/index.php?search=[..]light+bulb&title=Special:MediaSearch&go=Go&type=image)
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