



ATAR course examination, 2023

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 | 6 | 6 | 90 | 97 | 50 |
| Section Three Extended response | 2 | 2 | 60 | 57 | 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 2023: 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 preferably using a blue/black pen. Do not use erasable or gel pens.

- 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. Nuclear power plants use steam-powered turbines to generate electricity. Pressurised heat in water reactors produces steam by
 - (a) convection.
 - (b) conduction.
 - (c) radiation.
 - (d) evaporation.

2. Which of the following is a non-renewable energy source?
 - (a) hydropower
 - (b) biofuels
 - (c) nuclear energy
 - (d) wind power

3. Read the statements below.
 - (i) Energy cannot be created or destroyed.
 - (ii) Energy can be transferred or transformed into other forms of energy.
 - (iii) All energy is either potential or kinetic.

Which of these statements are true?

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

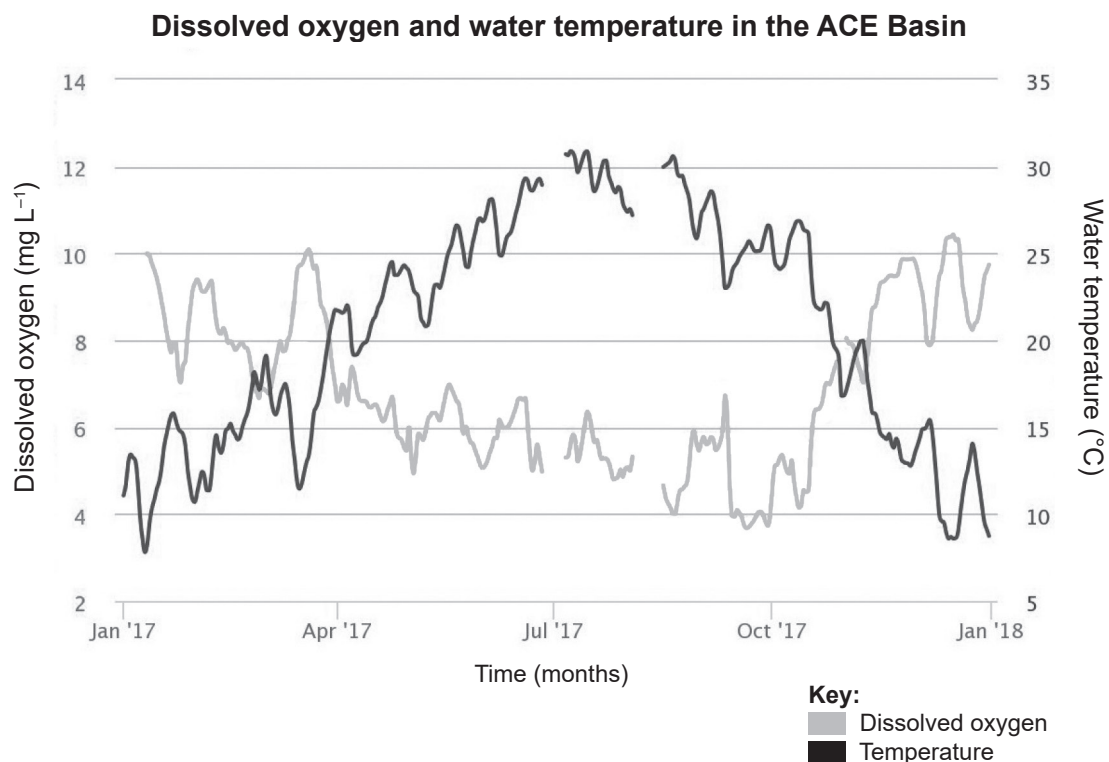
4. Coal and gas are commonly used in power stations to generate electricity. Which of the following statements is true?
 - (a) Both coal and gas power stations have turbines.
 - (b) Only gas power stations have turbines.
 - (c) Both coal and gas power stations use waste gases to drive the turbines and boilers.
 - (d) Only coal power stations have turbines.

See next page

5. Which of the following causes global temperatures to rise?
- (a) increased water vapour in the atmosphere
 - (b) decreased ice at the polar regions
 - (c) increased water in the oceans
 - (d) increased amounts of fresh water
6. Deforestation and the removal of trees and shrubs through clearing may lead to
- (a) an increase in groundwater turbidity.
 - (b) an increase in fresh groundwater.
 - (c) dry land salinity.
 - (d) eutrophication.
7. Physical and chemical environmental conditions impact the diversity and abundance of aquatic organisms. Which of the following are chemical conditions?
- (i) temperature
 - (ii) dissolved oxygen
 - (iii) turbidity
 - (iv) salt concentration
 - (v) nutrient levels, including nitrate and phosphate concentrations.
- (a) (i), (ii), (iv) and (v) only
 - (b) (i), (ii) and (iii) only
 - (c) (i), (ii) and (iv) only
 - (d) (ii), (iv) and (v) only
8. The internal temperatures of aquatic organisms are maintained at a stable level by the
- (a) volume of the aquatic organism.
 - (b) high specific heat capacity of water.
 - (c) surface area of the aquatic organism.
 - (d) surface area to volume ratio of the aquatic organism.
9. The upward force that a liquid exerts on an object is
- (a) uplift.
 - (b) gravity.
 - (c) density.
 - (d) buoyancy.

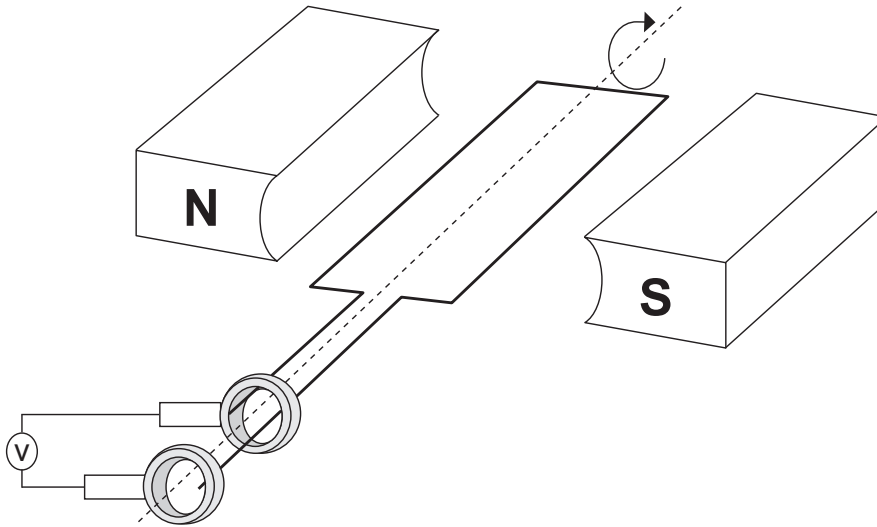
10. On a cold night, warmth gained by sitting near an open fire is **mostly** by
- (a) convection.
 - (b) radiation.
 - (c) conduction.
 - (d) condensation.
11. Fracking can be defined as pumping of
- (a) sand into the earth to open fractures to gain access to water supplies.
 - (b) a sand mixture into the earth to open fractures to gain access to natural gas and coal.
 - (c) fluid into the earth to open fractures to gain access to water supplies.
 - (d) a fluid mixture into the earth to open fractures to gain access to natural gas and oil.
12. Most saltwater fish will not survive for a long period of time when placed into fresh water because
- (a) there is too much buoyancy support, and their swim bladder does not function effectively.
 - (b) water moves by osmosis into the fish faster than they can remove it from their bodies.
 - (c) there is not enough dissolved oxygen in fresh water for them to survive.
 - (d) water moves by osmosis out of the fish faster than they can replace it in their bodies.
13. Which of the following statements about nuclear power plants is correct?
- (a) If an accident occurs in a nuclear power plant, the reactor will explode.
 - (b) Energy is produced because of a fusion reaction.
 - (c) Control rods are used to control the depth of the fuel rods.
 - (d) In normal operation, water used as a reactor coolant is radioactive.

Question 14 refers to the following graph showing changes to water temperatures and its effect on oxygen levels.



14. What is the relationship between water temperature and dissolved oxygen?
- (a) It is a positive relationship: dissolved oxygen levels increase with increasing temperature.
 - (b) It is a negative relationship: dissolved oxygen levels decrease with decreasing temperature.
 - (c) It is an inverse relationship: dissolved oxygen levels decrease with increasing temperature.
 - (d) There is no relationship shown between dissolved oxygen levels and temperature.
15. What would be the **main** reason for implementing new techniques to extract sources of non-renewable energy?
- (a) create new jobs in power plants in regional areas
 - (b) allow access to more resources in a shorter time
 - (c) prevent more environmental damage
 - (d) reduce the amount of electricity generated

Question 16 refers to the diagram below of a simple generator



16. Which of the following correctly names the energy conversion that occurs in this generator?
- (a) electrical to kinetic
 - (b) kinetic to magnetic
 - (c) magnetic to heat
 - (d) mechanical to electrical
17. Which of the following processes is used to generate electricity in batteries?
- (a) electrochemistry
 - (b) photovoltaics
 - (c) photoelectricity
 - (d) electromagnetism

Questions 18 to 20 refer to the table below about air conditioners.

Formulae: $P = \frac{E}{t}$ $Q = mc\Delta T$ Efficiency = $\frac{\text{energy out}}{\text{energy in}} \times 100$

| Brand of reverse-cycle split system | Type | Power rating (watts) | Operating time (s) | Temperature change (°C) |
|-------------------------------------|---------|----------------------|--------------------|-------------------------|
| Brand A | Heating | 4000 | 3600 | +5 |
| | Cooling | 3500 | 8000 | -4 |
| Brand B | Heating | 4300 | 2500 | +4.5 |
| | Cooling | 2900 | 8500 | -5.5 |
| Brand C | Heating | 4500 | 3200 | +4.2 |
| | Cooling | 1800 | 12 500 | -3.8 |
| Brand D | Heating | 5200 | 5000 | +3.1 |
| | Cooling | 2800 | 8500 | -6.2 |

18. For the given operating times, which brand uses the **least** amount of energy for cooling?

- (a) Brand A
- (b) Brand B
- (c) Brand C
- (d) Brand D

19. Given the information below, what is the heat capacity of the Brand D reverse-cycle split system while heating?

Each air conditioner was installed in a room and set to run for 4 hours. Each room was the same size and a beaker containing 10 g of water was placed in the centre of the room.

Specific heat of water = $4.1813 \text{ Jg}^{-1} \text{ }^\circ\text{C}^{-1}$

- (a) 129.670 J
- (b) 0.0129 J
- (c) 0.0130 J
- (d) 1296.700 J

20. If 28 500 watts of energy is available to the Brand A reverse-cycle split system for cooling and 1500 watts of that is lost as heat energy, what is its efficiency?

- (a) 52.6%
- (b) 5.3%
- (c) 94.7%
- (d) 9.5%

End of Section One

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Section Two: Short response

50% (97 Marks)

This section has **six** 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

(15 marks)

Renewable and non-renewable energy sources can be used to generate electricity.

- (a) Identify and discuss **three** environmental impacts related to the generation of electricity and the effect it has on the environment. (6 marks)

One: _____

Two: _____

Three: _____

The decision to invest in renewable energy technologies is informed by social, political, environmental and economic considerations.

- (b) Outline **one** example of how an economic consideration influences investment. (2 marks)

- (c) Identify **two** ways in which an electrical current can be generated. (2 marks)

One: _____

Two: _____

Workers at a nuclear power plant need to take protective measures to safeguard themselves against exposure to radioactive substances.

- (d) List **three** possible long-term side effects of radiation on the human body. (3 marks)

One: _____

Two: _____

Three: _____

- (e) State a material used in the construction of radioactive personal protective equipment (PPE) and outline how it reduces personal exposure. (2 marks)

Question 22

(13 marks)

Read the article below and answer the questions which follow.

What is global warming?

Global warming is the long-term heating of the Earth’s surface observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in the Earth’s atmosphere. The term ‘global warming’ is not interchangeable with the term ‘climate change.’ Since the pre-industrial period, human activities have increased the Earth’s average global temperature by 1 °C. Temperatures continue to increase by 0.2 °C per decade.

What is climate change?

Climate change is a long-term change in the average weather patterns. Changes observed in the Earth’s climate since the 1950’s are driven by human activities, particularly fossil fuel burning. This increases heat-trapping greenhouse gas levels in the Earth’s atmosphere, raising average surface temperatures. Natural processes, can also contribute to climate change, including internal variability (e.g. cyclical ocean patterns like El Niño and La Niña) and external forcings (e.g. volcanic activity, changes in the Sun’s energy output, variations in Earth’s orbit).

Scientists use observations from the ground, air, and space, along with computer models, to monitor and study past, present, and predict future climate change. Climate data records provide evidence of key indicators of climate change, such as global land and ocean temperature increases, e.g. rising sea levels, ice loss from Earth’s poles and mountain glaciers, frequency and the severity of extreme weather events e.g. hurricanes, heatwaves, wildfires, droughts, floods, and precipitation; and cloud and vegetation cover changes.

- (a) State **three** claims that are made in the article above about climate change and identify evidence from the article to support each claim. (6 marks)

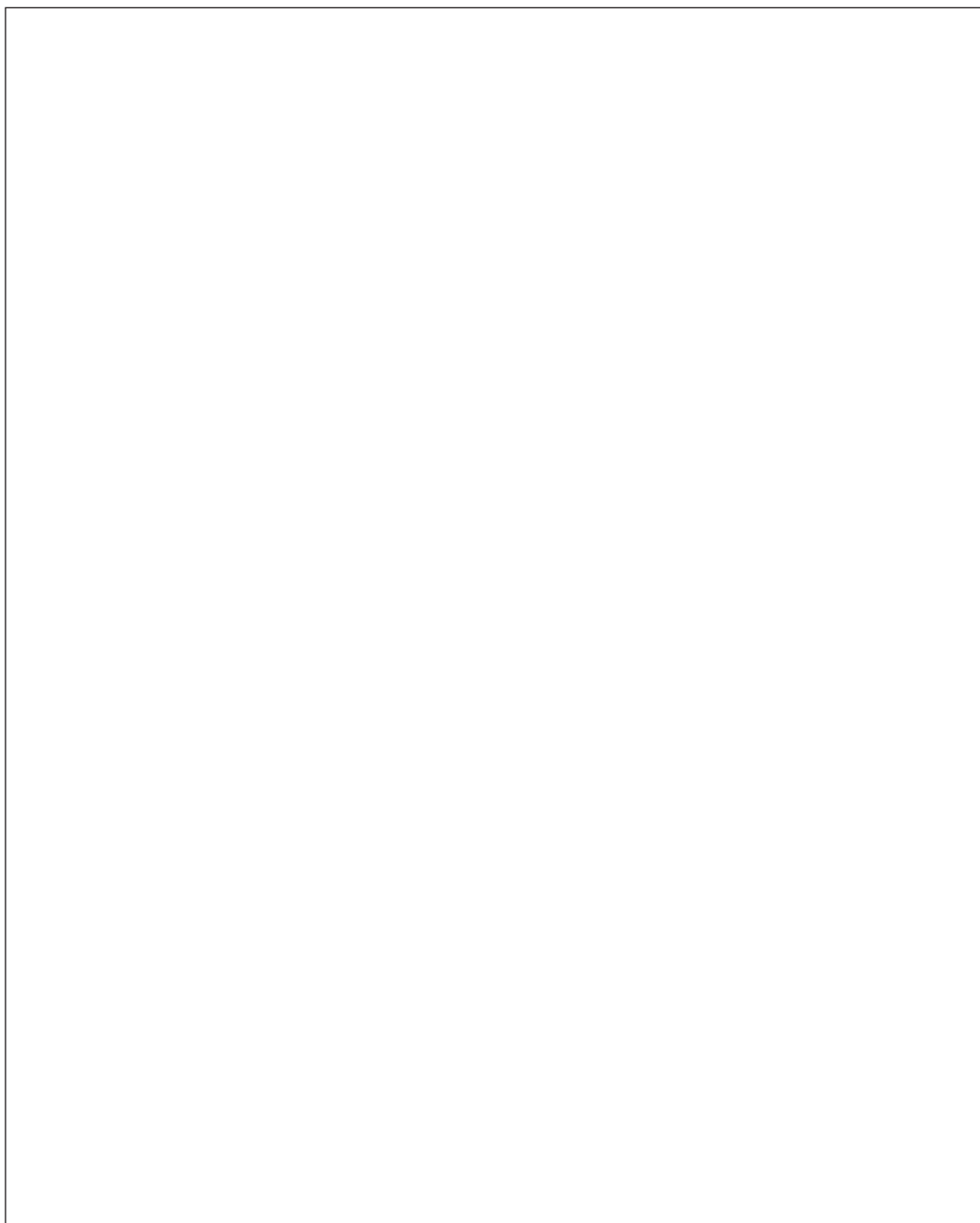
One: _____

Two: _____

Three: _____

- (b) (i) Define 'enhanced greenhouse effect'. (2 marks)

- (ii) Draw a labelled diagram to illustrate how the enhanced greenhouse effect impacts climate change. (5 marks)



Question 23

(12 marks)

Passive solar design involves the use of design features to take advantage of radiant heat to warm the home in winter and keep them cool in summer.

- (a) State **one** passive design feature for each of the following. (2 marks)

Orientation of the home

Wall materials

Solar panels can be used to offset and reduce the consumption of electricity. During the peak of summer, the sun produces approximately 1100 watts (W) of energy per square metre. This energy can be captured by the solar panels and converted into electricity.

| |
|---|
| Formulae: $P = \frac{E}{t}$ $Q = mc\Delta T$ Efficiency = $\frac{\text{energy out}}{\text{energy in}} \times 100$ |
|---|

- (b) A solar panel measuring 800 mm x 850 mm is installed on a roof. Calculate the power expected to be produced in summer if the panel is 100% efficient. Show all workings. (4 marks)

- (c) If an industrial solar panel produces 1500 W, calculate the amount of energy produced in 15 minutes. Show all workings. (3 marks)

- (d) If the solar panel in part (c) is 75% efficient, calculate how much useful energy is produced. Show all workings. (2 marks)

- (e) For the solar panel in part (c), where does the remaining 25% of energy go? (1 mark)

Question 24

(17 marks)

Energy to create electricity can be derived from a variety of sources. In the past most sources were non-renewable. However, more sustainable sources are now utilised and are referred to as 'renewable'. These have different effects on the environment.

- (a) Complete the table below by defining each source of energy and identifying an environmental impact of each. (4 marks)

| | Renewable resources | Non-renewable resources |
|----------------------|----------------------------|--------------------------------|
| Definition | | |
| Environmental impact | | |

- (b) Biofuels are an example of an energy source that can be used to generate electricity. Outline why they are considered 'renewable'. (2 marks)

Geothermal energy is another renewable source of energy.

- (c) (i) Define the term 'geothermal energy'. (1 mark)

- (ii) Draw a flow chart to show all the energy transformations that occur when using geothermal energy to generate electrical energy. (4 marks)

- (iii) State **one** advantage and **one** disadvantage of using geothermal power stations. (2 marks)

Advantage: _____

Disadvantage: _____

The decision to invest in geothermal energy as an alternative resource to oil and gas is often informed by environmental and economic considerations.

- (d) Outline **one** environmental consideration that could influence how geothermal energy might be utilised in the future. (2 marks)

- (e) Outline **one** economic consideration that could influence how geothermal energy might be utilised in the future. (2 marks)

Question 25

(26 marks)

Water naturally occurs in three states, solid, liquid and gas and has an essential role in sustaining life. Water changes from one state to another in the water cycle.

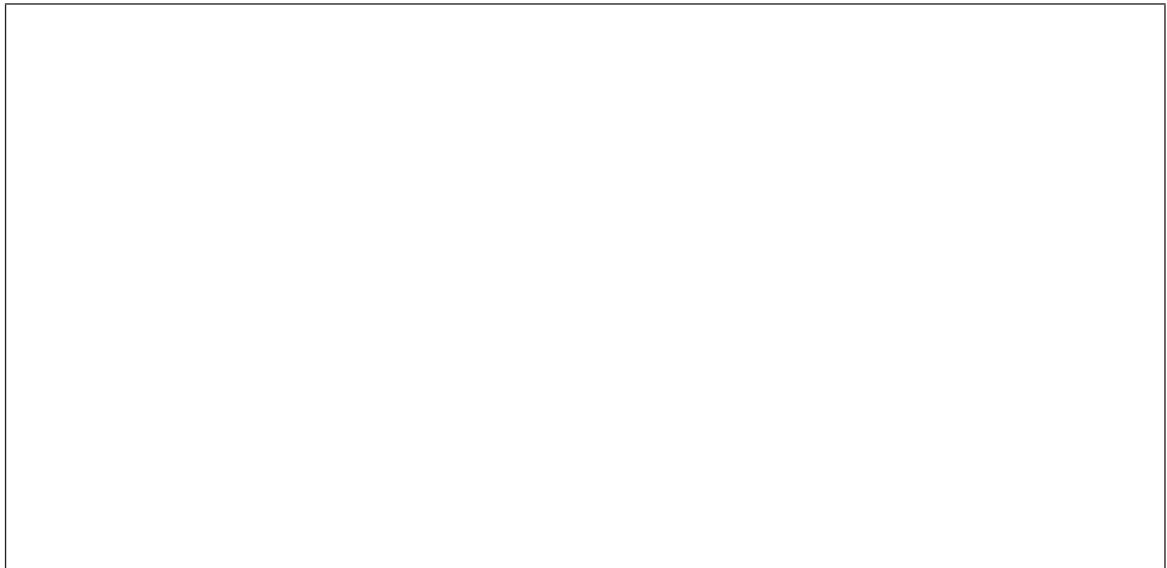
- (a) Name a process in the water cycle that produces the following changes of state. (2 marks)

Liquid to gas: _____

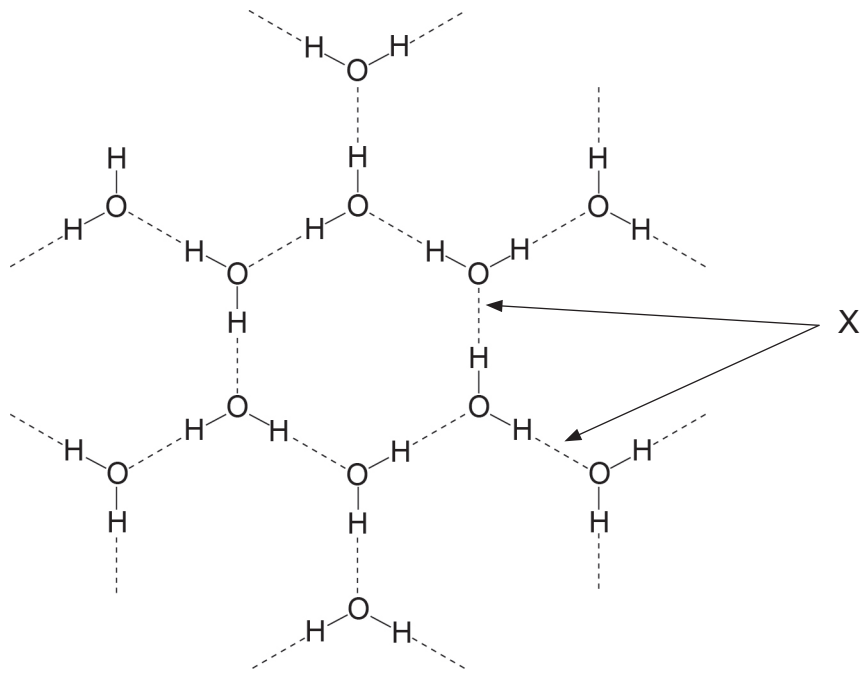
Gas to liquid: _____

Water in its liquid state exhibits many unique properties, one of which is a high surface tension.

- (b) Describe, with the use of a labelled diagram, the term 'surface tension'. (4 marks)



The diagram below shows water in solid form. Water is a polar molecule.



- (c) Name the bond indicated by the letter 'X'. (1 mark)

- (d) Outline how this bond results in solid water being less dense than water in its liquid form. (2 marks)

Question 25 (continued)

- (e) Define 'specific heat of water' and explain the impact polarity has on the specific heat of water. (5 marks)

The following table shows how Perth's water sources have changed over the last 42 years.

| Water source | 1980 (% of supply) | 2022 (% of supply) |
|------------------------------|--------------------|--------------------|
| Dams | 65 | 26 |
| Groundwater | 35 | 36 |
| Desalination | 0 | 35 |
| Groundwater/aquifer recharge | 0 | 3 |

- (f) Define the term 'potable water'. (1 mark)

- (g) (i) Using the data provided in the table above, explain why there was a decrease in the amount of water being supplied from dams between 1980 and 2022. (3 marks)

- (ii) Using the data provided in the table above, explain why there was an increase in the amount of water being supplied from desalination between 1980 and 2022. (2 marks)

Question 25 (continued)

'Managed aquifer recharge' is a strategy used to ensure there are sufficient quality water supplies to support population and industry.

- (h) State **one** benefit of managed aquifer recharge. (1 mark)

- (i) State **two** managed aquifer recharge methods. (2 marks)

One: _____

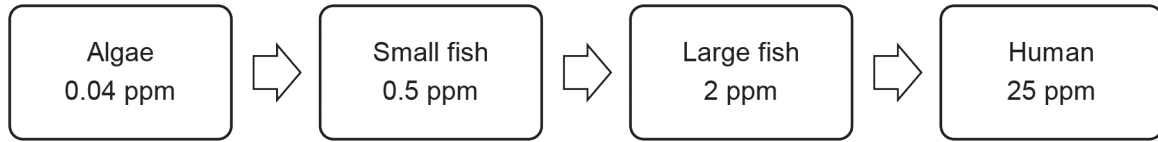
Two: _____

- (j) Explain the process of managed aquifer recharge, starting from abstraction. (3 marks)

Question 26**(14 marks)**

Ciguatoxin is a toxic chemical produced by algae found in tropical coral reefs. When fish feed on the algae they also ingest the toxin, and this is passed along the food chain. All animals in the food chain will suffer from ciguatoxin poisoning.

The food chain below shows the amount of toxin accumulated in each link of the chain.



- (a) Name the biological process illustrated by the example above. (1 mark)

- (b) Discuss why eating a large fish is more likely to cause poisoning in humans than eating a small fish. (5 marks)

Question 26 (continued)

- (c) Explain the likely impacts on the aquatic ecosystem if the environment in which the algae live becomes polluted with organic matter. (4 marks)

- (d) Define the term 'eutrophication'. (2 marks)

- (e) Outline how nutrients can enter aquatic environments such as rivers and estuaries. (2 marks)

End of Section Two

See next page

Section Three: Extended response**30% (57 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 27**(27 marks)**

Energy can be transferred and transformed into other types of energy. This energy can be used in our everyday lives to support our way of life.

- (a) List **four** ways in which the transformation of electrical energy can be utilised in the home. (4 marks)

One: _____

Two: _____

Three: _____

Four: _____

Question 27 (continued)

Energy transformations occur when you drive a car. These transformations allow a stationary car to generate motion.

- (b) Describe how the structure and function of the internal combustion engine takes advantage of energy transformations to generate motion. (7 marks)

Internal combustion engines are inefficient at transforming energy, with less than 25% of the energy received from the combustion being used to generate motion to move the car.

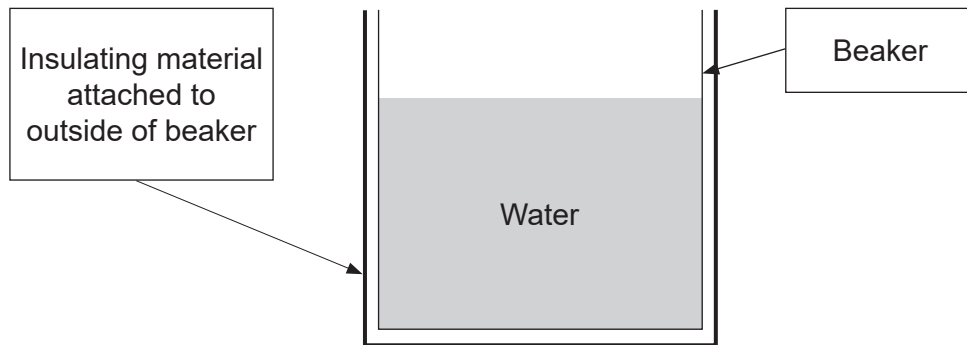
- (c) List **three** ways in which energy is wasted during internal combustion. (3 marks)

One: _____

Two: _____

Three: _____

A student was investigating the insulating properties of various materials for use in the home. The student wrapped a 250 mL beaker in each of the insulating materials, then poured 200 mL of water at 90 °C into the beaker, and left the beaker for five minutes before measuring the temperature again. The student's apparatus is shown below.



Some results of the student's experiment regarding the insulating material and final measurement of temperature are as follows:

Glasswool 67 °C, Wool 72 °C, Nylon 45 °C, Cotton Wool 68 °C, Polystyrene 85 °C.

(d) (i) Construct a table to organise the student's results. (3 marks)

(ii) State **two** improvements the student could make to the experiment. (2 marks)

One: _____

Two: _____

Question 27 (continued)

- (iii) State **two** possible sources of error in the student's experiment. (2 marks)

One: _____

Two: _____

- (iv) On the basis of the results of the student's investigation, identify which material is the best insulator. Justify your answer. (3 marks)

- (v) This experiment represents a practical example of energy transfer. Identify the type of energy transfer and explain how this energy transfer is occurring during the experiment. (3 marks)

Question 28**(30 marks)**

A science class had been investigating macro-invertebrates found in a local river and were curious to see if plans to clear large areas of land for farming close to the river could impact the aquatic life. The students were concerned that removing large trees from the area might lead to dry land salinity which might then impact salt levels in the river and the macro-invertebrate population. The current salt concentration of the water is 50 mg L^{-1} .

The class decided to carry out an investigation on the salt tolerance of brine shrimp. The materials they used included brine shrimp, saline solutions of different concentrations, an electronic balance, beakers, pipettes and tweezers.

The solutions prepared had the following salt concentrations:

| Solution | Concentration (mg L^{-1}) |
|----------|--------------------------------------|
| 1 | 4000 |
| 2 | 1000 |
| 3 | 500 |
| 4 | 250 |
| 5 | 100 |
| 6 | 50 |

The class was divided into five groups (A to E). Each group added 20 brine shrimp to each salt concentration solution. The beakers of brine shrimp were left on a windowsill in the classroom to replicate natural conditions. After three days, the number of brine shrimp that had died was recorded. The results are shown in the table below.

Number of dead brine shrimp in solutions of different salt concentrations after three days

| Group | Salt concentration (mg L^{-1}) | | | | | |
|-------------------|---|------------|----------|----------|------------|------------|
| | 4000 | 1000 | 500 | 250 | 100 | 50 |
| A | 10 | 9 | 9 | 6 | 3 | 0 |
| B | 9 | 8 | 7 | 5 | 2 | 1 |
| C | 10 | 8 | 6 | 5 | 2 | 0 |
| D | 10 | 9 | 6 | 4 | 1 | 1 |
| E | 9 | 8 | 7 | 5 | 1 | 0 |
| Class mean | 9.6 | 8.4 | 7 | 5 | 1.8 | 0.4 |

- (a) Propose a hypothesis for this investigation. (2 marks)

See next page

Question 28 (continued)

(b) Determine the following for this investigation. (3 marks)

Independent variable:

Two controlled variables:

One: _____

Two: _____

(c) Draw a column graph showing the class mean for the number of dead brine shrimp in each salt concentrate solution on the grid below. (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.

- (d) Outline the purpose of Solution 6 with a salt concentration of 50 mg L⁻¹. (2 marks)

- (e) Construct a conclusion for the investigation that would be supported by the results presented in the table on page 29 and/or your graph. (2 marks)

- (f) Should the students be concerned about the effects of dry land salinity on the macro-invertebrate survival rate in the river? Justify your answer. (3 marks)

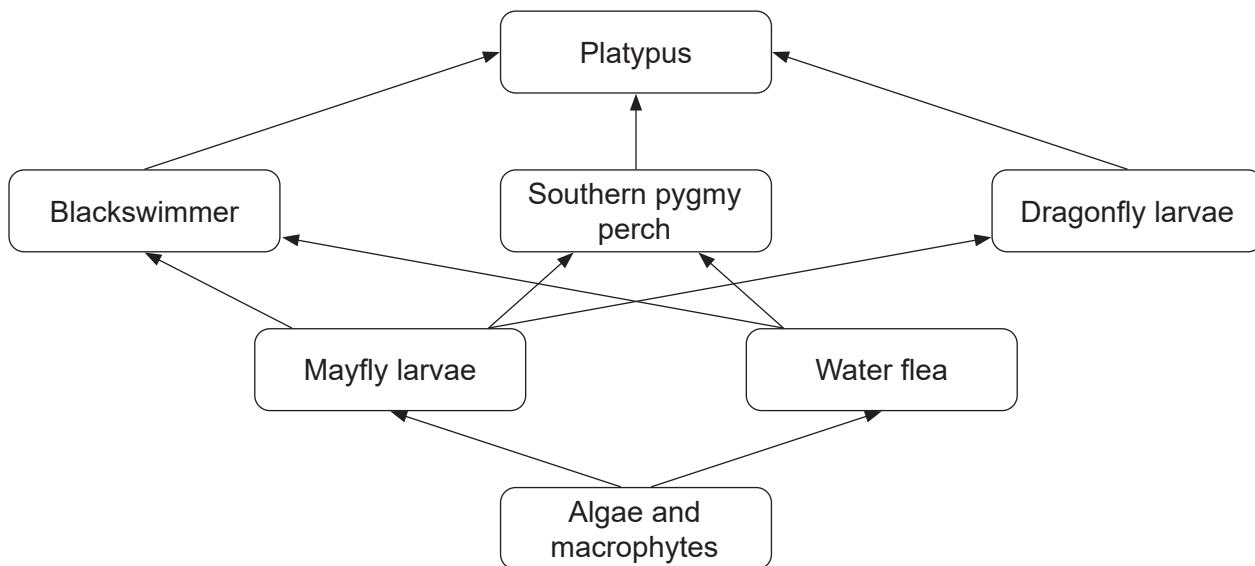
- (g) Describe **two** methods of reducing dry land salinity in the natural environment. (4 marks)

One: _____

Two: _____

Question 28 (continued)

A food web of the river ecosystem is shown below.



(h) Use the food web above to answer the following.

(i) Identify all producers in the food web. (1 mark)

(ii) Outline why producers are so important to any food web. (2 marks)

The overall health of any aquatic ecosystem, such as the river the students were investigating can be monitored using a variety of water quality tests. Apart from salinity, other factors that can be monitored include pH and turbidity.

(i) Describe the importance of monitoring turbidity in aquatic ecosystems. (2 marks)

Macro-invertebrates can be used to monitor aquatic health because of their sensitivity to changing water quality conditions.

- (j) Using the following headings, outline how macro-invertebrates could be sampled to monitor aquatic health. (4 marks)

Sampling equipment:

Sampling technique:

Data collected:

Analysis of results:

Spare grid for Question 28(c)



ACKNOWLEDGEMENTS

- Question 14** National Oceanic and Atmospheric Administration. (2018). [Chart of water temperature and dissolved oxygen in the ACE Basin, South Carolina January – December 2017]. Retrieved May, 2023, from https://www.nnvl.noaa.gov/StoryMaps/DITC/WaterQuality/Teachers/DITC_WaterQuality_ALLWorksheets_2018.pdf
- Question 22** Adapted from: NASA Global Climate Change. (n.d.). *Global Warming vs. Climate Change*. Retrieved May, 2023, from <https://climate.nasa.gov/global-warming-vs-climate-change/>
- Question 25(c)** 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-\[-...\]-like](https://www.quora.com/What-does-the-structure-of-the-[-...]-like)
- Question 25(g)** Adapted from: Water Corporation. (2023). *Impact on Water Sources* [Graph]. Retrieved June, 2023, from <https://www.watercorporation.com.au/Our-water>

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