Government of **Western Australia**
School Curriculum and Standards Authority

ATAR course examination, 2017

Question/Answer booklet

INTEGRATED SCIENCE

Please place your student identification label in this box

Student number: In figures

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: non-programmable calculators approved for use in this 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.

Ref: 17-038

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	95	50
Section Three Extended response	2	2	60	56	30
				Total	100

Instructions to candidates

1. The rules for the conduct of the Western Australian external examinations are detailed in the *Year 12 Information Handbook 2017*. Sitting this examination implies that you agree to abide by these rules.

2. 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. 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.

3. 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.

4. Supplementary pages for the use of planning/continuing your answer to a question have been 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.

See next page

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. 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.

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1. Which one of the following lists the states of water occurring naturally on the Earth's surface?

   (a) liquid
   (b) liquid and gas
   (c) liquid and solid
   (d) liquid, solid and gas

2. The transformation of water vapour into liquid water is called

   (a) precipitation.
   (b) evaporation.
   (c) condensation.
   (d) solidification.

3 Which one of the following is a property of water that causes its molecules to bond to one another?

   (a) surface tension
   (b) polarity
   (c) dissolving ability
   (d) density

4. Which microorganisms are responsible for green algal blooms?

   (a) dinoflagellates
   (b) cyanobacteria
   (c) diatoms
   (d) rhodophyta

See next page

5 Four students each weighed a rock sample and obtained these data.

Student	Mass (g)
1	26.12
2	26.20
3	26.20
4	29.24

When using the data, they should

(a) use 26.20, as it was the most frequent answer.
(b) remove the lowest data point and average the rest.
(c) remove the highest data point and average the rest.
(d) calculate the average using all the data points.

6. In an investigation into the energy efficiency of light bulbs, a student measured the brightness of several bulbs using a luminance meter. All bulbs used the same amount of power and produced different amounts of light. The power used is

(a) a dependent variable.
(b) an independent variable.
(c) a measured variable.
(d) a controlled variable.

7. To maintain water content in their bodies freshwater fish lose

(a) large amounts of water in their urine.
(b) large amounts of salt through the gills.
(c) small amounts of water in their urine.
(d) small amounts of salt through the gills.

8. The removal of trees and overuse of irrigation on farming land may lead to

(a) dry-land salinity.
(b) eutrophication.
(c) lowering of the water table.
(d) biomagnification.

9. Water has a high specific heat capacity. This means that it

(a) can absorb large quantities of carbon dioxide.
(b) requires a relatively large amount of energy to increase its temperature.
(c) absorbs energy and cools quickly.
(d) requires a relatively small amount of energy to increase its temperature.

See next page

10. Perth has a growing population and falling rainfall. Government departments have attempted to respond to this problem to ensure there is an adequate supply of quality water. Which of the following strategies have been used?

(i) reducing consumption per person
(ii) desalinating sewage water
(iii) desalinating ocean water
(iv) recharging aquifers
(v) building more dams

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

11. The diversity and abundance of aquatic life are affected by which of the following conditions?

(i) salt concentration
(ii) dissolved nitrogen
(iii) nutrients – phosphates and nitrates
(iv) dissolved oxygen

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

12. There are various methods of generating electricity that have certain advantages and disadvantages. Which one of the following statements is correct?

(a) Wind power is an ideal base load supply.
(b) Nuclear power is inexpensive compared with natural gas.
(c) The efficiency of coal power stations is typically less than 40%.
(d) Hydroelectricity is renewable and has no environmental impacts.

13. Which one of the following is a non-renewable source of energy?

(a) coal
(b) biomass
(c) hydropower
(d) solar

See next page

14. Nuclear power generation can result in people being exposed to radiation which can have certain effects on the human body. Which of the following are typically associated with nuclear radiation?

    (i) nausea
    (ii) changes to deoxyribonucleic acid (DNA)
    (iii) burns
    (iv) memory loss

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

15. Electricity is generated in batteries by which process?

    (a) electromagnetism
    (b) electrochemistry
    (c) photovoltaics
    (d) photoelectricity

16. The same amount of heat was applied to two 50 g liquid samples. Sample A had low specific heat capacity while sample B had a high specific heat capacity. Which statement is correct?

    (a) A will absorb more heat.
    (b) B will absorb more heat.
    (c) A will become hotter.
    (d) B will become hotter.

17. The government of South Australia was considering allowing radioactive waste to be stored in the State. The **most** likely location for the storage site would be

    (a) deep underground.
    (b) above ground in desert areas.
    (c) in deep seawater.
    (d) in shallow concrete pits.

18. Electricity is generated using steam created from heat in a pressurised water reactor by

    (a) fusion.
    (b) fission.
    (c) convection.
    (d) conduction.

See next page

19. The energy transformations that occur in an internal combustion engine, in the order in which they occur, is

(a) mechanical → heat → chemical potential.
(b) chemical potential → kinetic → heat.
(c) kinetic → chemical potential → mechanical.
(d) chemical potential → heat → kinetic.

20. Energy consumption in the home can be reduced by which of the following?

(i) switching off appliances and lights when not in use
(ii) using more energy-efficient appliances
(iii) installing solar panels
(iv) buying ‘green power’

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

End of Section One

See next page

Section Two: Short response **50% (95 Marks)**

This section has **five (5)** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for the use of planning/continuing your answer to a question have been 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 **(24 marks)**

The Cape Grim Baseline Air Pollution Station in Tasmania was established in 1976 to monitor and study global atmospheric composition. It measures greenhouse gases such as carbon dioxide. Measurements have shown an increase of more than 20% in carbon dioxide since 1976. The table below shows how atmospheric concentrations of carbon dioxide changed between 1984 and 1995.

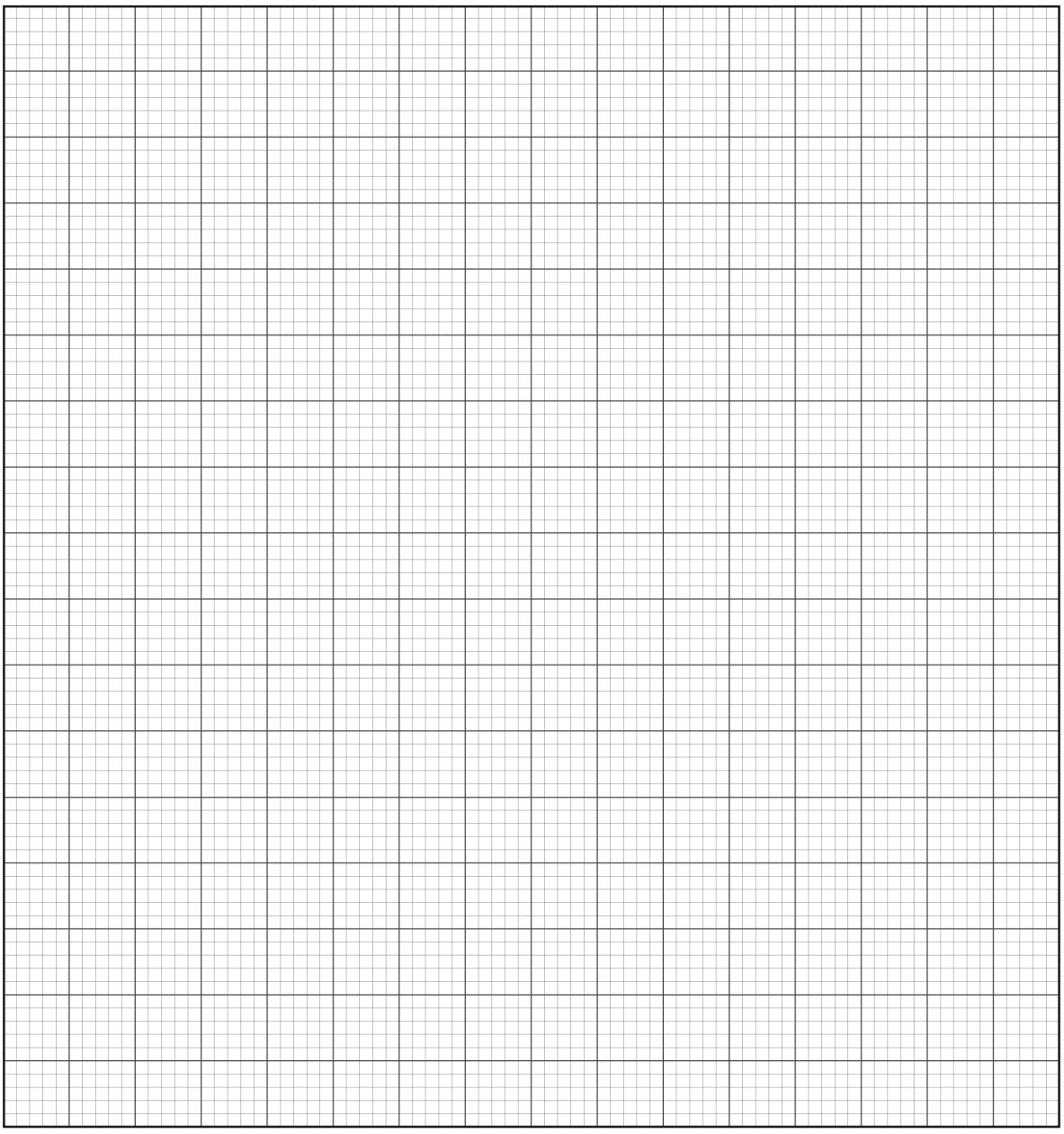
Atmospheric concentrations of carbon dioxide between 1984 and 1995 at Cape Grim

Year	Concentrations of carbon dioxide (parts per million)
1984	342.0
1985	344.0
1986	345.0
1987	346.5
1988	349.0
1989	350.5
1990	351.5
1991	353.0
1992	355.0
1993	353.0
1994	357.0
1995	360.0

Data to graph in part (a)

(a) Using the grid below, construct an appropriate graph showing the concentrations of carbon dioxide from **1990** to **1995** from the data in the table on page 8. (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.



(b) Use the data in the table on page 8 or your graph to predict the carbon dioxide concentration in 1997. (1 mark)

_____

_____

See next page

Question 21 (continued)

(c) In 2016, the carbon dioxide concentration was 401.56 parts per million. Calculate the percentage increase between 1995 and 2016. Show **all** workings. (2 marks)

(d) Suggest **one** reason why atmospheric concentrations of carbon dioxide have increased significantly since the Cape Grim Baseline Air Pollution Station was established in 1976. (1 mark)

(e) Draw a well-labelled diagram, illustrating how the release of additional greenhouse gases into the Earth's atmosphere is resulting in the enhanced greenhouse effect. (6 marks)

See next page

(f) In the table below, identify and describe **three** ways (other than the carbon dioxide example provided) in which using coal-based electricity production can affect the environment. (9 marks)

Source of the issue	The effect	How the environment is affected
Carbon dioxide is emitted	Enhances the greenhouse effect	Change in climate and hence ecosystems cannot be maintained e.g. coral reefs
1.		
2.		
3.		

See next page

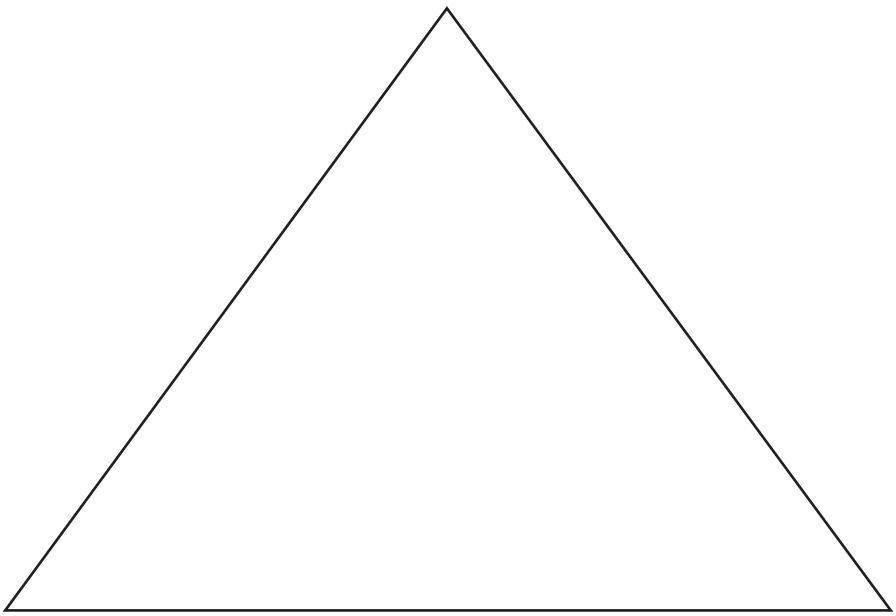
Question 22 **(14 marks)**

In Western Australia, commercial aquaculture produces fish (barramundi and rainbow trout) and freshwater crayfish (marron and yabbies). Rainbow trout were introduced to Western Australia in 1927 to provide recreational freshwater fishing in the south-west of the State. They were originally released into streams between Albany and Gingin but in most cases failed to establish self-sustaining populations due to the lack of suitable conditions. In 1971, a breeding and stocking (fish farming) program began at the Pemberton Freshwater Research Centre.

Rainbow trout are carnivores. They feed on smaller fish called redfin perch. Redfin perch feed on small crustaceans which eat algae. Rainbow trout can be a host for parasitic worms.

(a) Draw a food chain for the above organisms. (2 marks)

(b) Complete the energy pyramid below for this food chain. (2 marks)



(c) If a rainbow trout eats 1 kg of redfin perch, it gains only about 60 g in mass. Outline **two** reasons why so little of the mass of the redfin perch is converted into the mass of the rainbow trout. (4 marks)

One: _____

_____

_____

_____

Two: _____

_____

_____

_____

(d) In a rainbow trout farm, one of the most common causes of disease and death is poor water quality. Complete the table below, listing **three** key factors that affect water quality and name the test that can be used to measure each factor. (6 marks)

Water quality factor	Test used to measure factor
1.	
2.	
3.	

See next page

Question 23 **(17 marks)**

As Perth's rainfall has decreased, its water supply has been increasingly sourced from groundwater drawn from aquifers. Many homes also have 'bores' which pump water from shallow aquifers. As the population has grown, the demand on groundwater resources has increased.

(a) What is the original source of groundwater? (1 mark)

(b) List **four** negative consequences if the consumption of groundwater resources continues to increase. (4 marks)

One:

Two:

Three:

Four:

(c) List **two** strategies that could be used to ensure that the quantity of water resources in Western Australia is maintained. (2 marks)

One:

Two:

(d) After water is used in the home, it is usually pumped to wastewater treatment plants. Explain **why** domestic wastewater requires treatment before it can be returned to the environment. (2 marks)

See next page

(e) Explain **how** domestic wastewater can be treated to allow the water content to be returned to the environment. Include a flow diagram in your response. (5 marks)

Flow diagram

Rainfall in the south-west of Western Australia has fallen by about 15% since the mid-1970s. From 1911 to 1974, the average stream flow into Perth dams was 338 gigalitres. From 1975 to 2000, it was almost half this value, at 177 gigalitres. From 2001 to 2010, inflows halved again to approximately 75 gigalitres.

(f) Given that rainfall fell by 15%, explain how the stream flow could decrease by 75%. (3 marks)

See next page

Question 24 **(16 marks)**

Diffusion is an important process that allows gas exchange to take place in an aquatic organism.

(a) Explain how diffusion occurs. (2 marks)

(b) What is meant by the term 'concentration gradient' and how does it affect the rate of diffusion? (2 marks)

(c) In the table below, identify **three** important physical features of fish gills that enable their gas exchange surface to be efficient and outline how each feature helps the gas exchange process to occur. (6 marks)

Physical feature that enables the exchange surface to be efficient	How the physical feature helps the gas exchange process to occur
1.	
2.	
3.	

See next page

An investigation was carried out to study the effects of water temperature on the breathing rate of fish by progressively cooling the water in a fish tank. Animal ethics approval was granted to the researcher. The results are tabulated below.

(d) Complete the table by calculating the average breathing rate for the fish in water at 5 °C. (1 mark)

Breathing rate of fish (mL of water per minute) for different water temperatures

Fish no.	Temperature of water (°C)				
	25	**20**	**15**	**10**	**5**
1	41	35	28	22	9
2	50	42	29	18	no data
3	40	35	31	20	11
4	31	25	no data	no data	no data
5	51	42	34	22	12
6	42	37	30	19	10
7	41	35	28	17	7
Average	**42**	**36**	**30**	**20**	

(e) Refer to the data from the table to explain how temperature affects the breathing rate of fish. (3 marks)

The ‘no data’ in the table indicates that the fish have been removed from the investigation.

(f) Explain why the researcher was required to remove the fish. (2 marks)

See next page

Question 25 **(24 marks)**

As the global population increases, the demand for modern conveniences and therefore for energy (electricity) increases. Australia is investing in new technologies, such as solar energy, to meet this demand. However, it still relies on large-scale electricity generation by conventional power stations.

(a) Identify **one** fuel that is used in a conventional power station in Australia. (1 mark)

_____

(b) Draw a flow chart showing how large-scale electricity generation occurs in a power station using the fuel identified in part (a). For each part of your flow chart describe the process taking place. (8 marks)

See next page

(c) For the fuel you selected in part (a), in each of the following question parts, select a response by drawing a circle around the correct answer and then provide **one** reason to justify your response.

(i) The efficiency of the process by which the input fuel is converted into electricity is (2 marks)

High 50% or more	Low Below 40%

Reason: _____

_____

(ii) The relative amount of greenhouse gas emitted using this fuel is (2 marks)

High	Low

Reason: _____

_____

(iii) The suitability of this fuel for the provision of base load electricity supply is (2 marks)

High	Low

Reason: _____

_____

See next page

Question 25 (continued)

(d) For the fuel identified in part (a), state **one** advantage and **one** disadvantage of using this fuel for base load electricity supply in terms of economic and social impact. (4 marks)

Economic impact	Advantage
	Disadvantage
Social impact	Advantage
	Disadvantage

See next page

With the demand for energy (electricity) increasing, many countries are using both new technologies to produce energy and more efficient appliances to decrease the amount they use.

To save energy a warehouse in Perth decided to change its 100 W incandescent light globes to 20 W LED globes. The warehouse has its lights on 24 hours a day and has 200 lights.

(e) Calculate the energy saved each day by changing **all** the lights to LED globes. Show **all** workings. (5 marks)

Formula for Power: P = E/t

Answer: _____ J

End of Section Two

See next page

Section Three: Extended response **30% (56 Marks)**

This section contains **two (2)** questions. You must answer **both** questions. Write your answers in the spaces provided.

Supplementary pages for the use of planning/continuing your answer to a question have been 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 **(27 marks)**

As part of their Integrated Science studies, a group of students monitored the water quality of two wetlands located near their school. They sampled aquatic macro-invertebrates. Their results are shown in the table below.

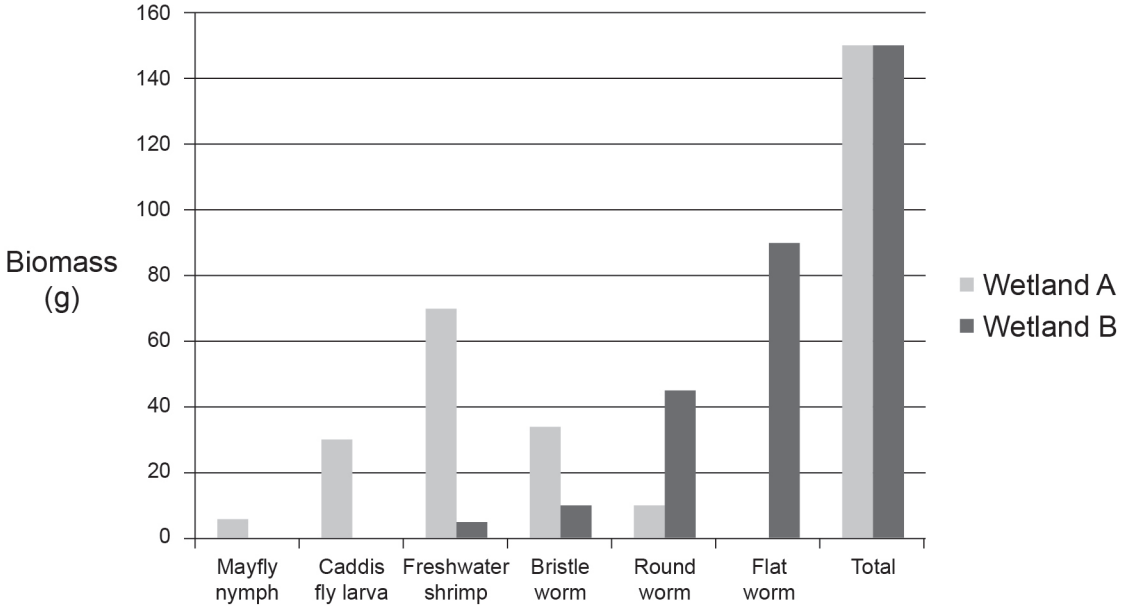
Table 1: The biomass of different invertebrate species found in two different wetlands

	Biomass (g)	
Invertebrate species	**Wetland A**	**Wetland B**
Mayfly nymph	6	0
Caddis fly larva	30	0
Freshwater shrimp	70	5
Bristle worm	34	10
Round worm	10	45
Flat worm	0	90
Total	**150**	**150**

See next page

They also produced a graph of their results which is shown below.

Graph 1: Biomass of different invertebrate species found in two wetlands



After conducting some internet research, they identified that different invertebrates survive at different levels of water pollution, as shown below.

Table 2: Levels of pollution and invertebrate species likely to be present

Level of pollution	Invertebrate species likely to be present
Zero	Mayfly nymph
Low	Caddis fly larva, freshwater shrimp
Medium	Bristle worm, round worm
High	Flat worm

(a) (i) Is Wetland A or Wetland B **more** likely to be polluted? Circle your answer. (1 mark)

Wetland A **Wetland B**

(ii) Use the information from Table 1 and Table 2 to outline **two** reasons to support your answer. (4 marks)

One: _____

_____

_____

Two: _____

_____

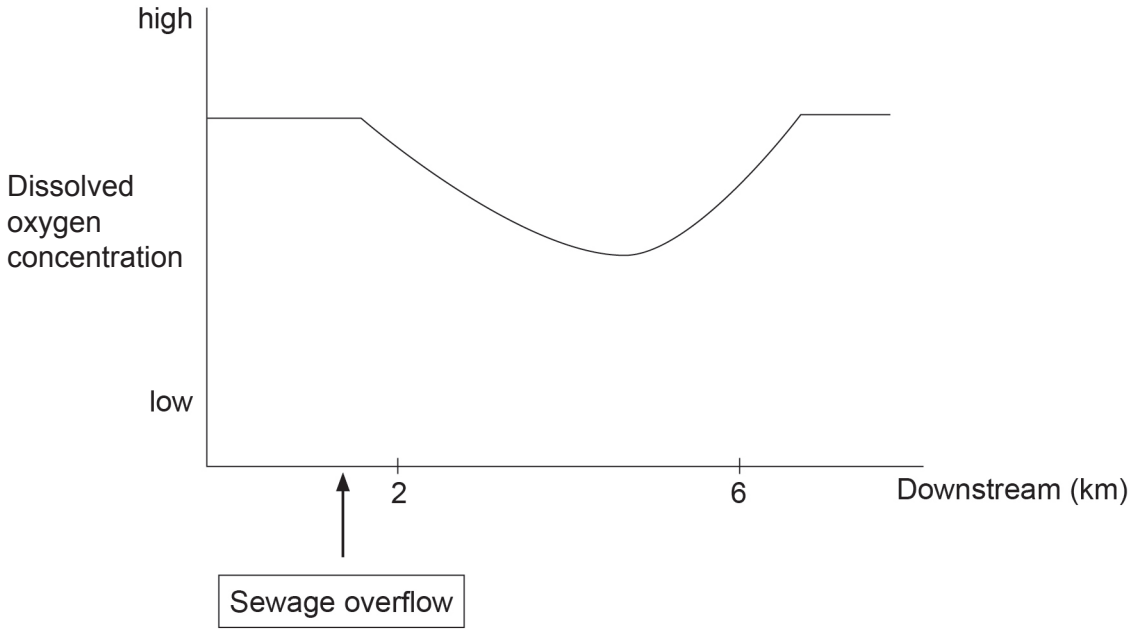
_____

See next page

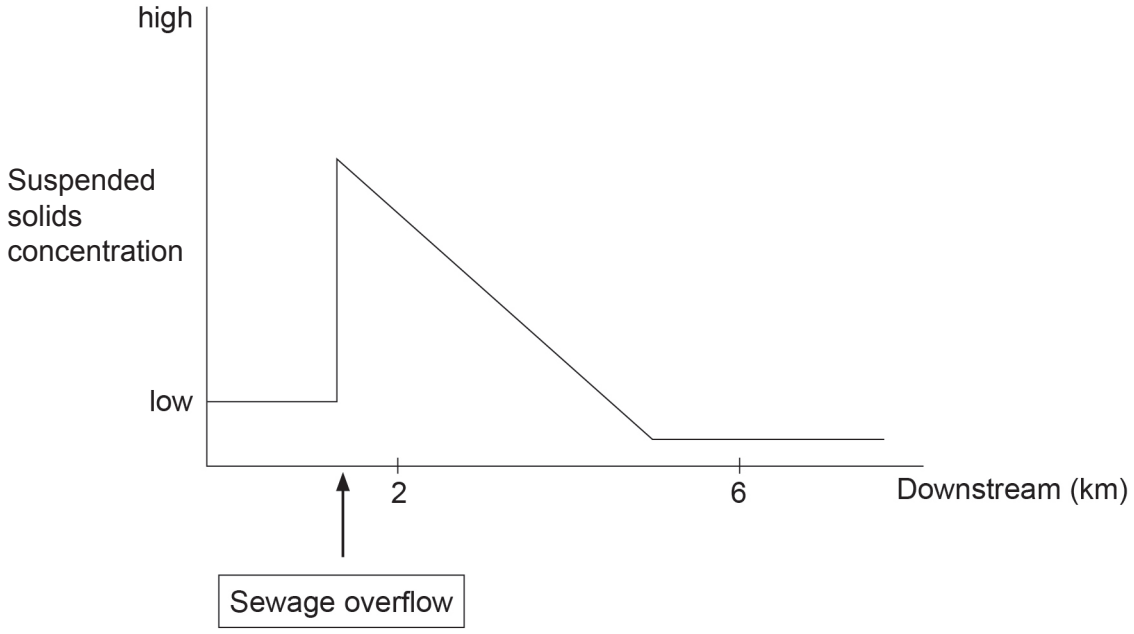
Question 26 (continued)

A truck carrying wastewater overturned near another wetland **C**, causing sewage to overflow into the environment. Two weeks after the sewage spill, the Integrated Science students took samples of water from wetland **C** at different distances downstream from where the sewage overflowed. The students plotted the results shown in Graph 2 and Graph 3.

Graph 2: Dissolved oxygen concentration downstream of sewage overflow



Graph 3: Concentration of suspended solids downstream of sewage overflow



See next page

Graph 2 and Graph 3 show how dissolved oxygen and suspended solids change according to the distance downstream from the sewage overflow.

(b) Identify how the values of dissolved oxygen and suspended solids change downstream at 2 km and downstream at 6 km. For each change you have identified, give a reason why it occurred. (8 marks)

Distance (km)	Dissolved oxygen	Suspended solids
2	What happened Reason	What happened Reason
6	What happened Reason	What happened Reason

See next page

Question 26 (continued)

A student, Cooper, was asked to conduct an investigation into the effect of salt on the growth of freshwater plants.

Cooper chose a plant known as 'pigface'. It is found growing naturally in the beach sand dunes of Perth. The plant tends to grow along the ground so he decided to measure the length of four plants each week.

Cooper bought four pigface plants in pots from various garden shops and numbered them 1, 2, 3 and 4. He measured the length of each plant. He placed them in the window of his bedroom in the sun.

Cooper made four 600 mL salt solutions:

Salt solution	Amount of salt
A	20 g
B	50 g
C	70 g
D	100 g

Daily he poured some salt solution on each plant and measured their length, as shown in the results table below.

Length of pigface plants using different salt solutions

Plant number	Salt solution used	Length (cm)				
		Original	Week 1	Week 2	Week 3	Week 4
1	A	14	19	23	28	32
2	B	12	15	18	20	21
3	C	16	19	21	22	22
4	D	8	10	11	12	12

(c) Write an hypothesis for this investigation. (2 marks)

(d) Complete the table below by calculating the weekly growth rates of the pigface plants used in the investigation. (4 marks)

Weekly growth rates for pigface plants using different salt solutions

Plant number	Salt solution used	Length (cm)			
		Week 1	Week 2	Week 3	Week 4
1	A				
2	B				
3	C				
4	D				

(e) Explain why Cooper used the difference in the length of the plants rather than their final length when analysing the effect of salt concentration on them. (2 marks)

(f) Identify **four** design faults (errors in method) in Cooper's investigation. (4 marks)

One:

Two:

Three:

Four:

(g) Can a valid conclusion be drawn from this experiment? Circle your answer and provide a reason for your answer. (2 marks)

Yes No

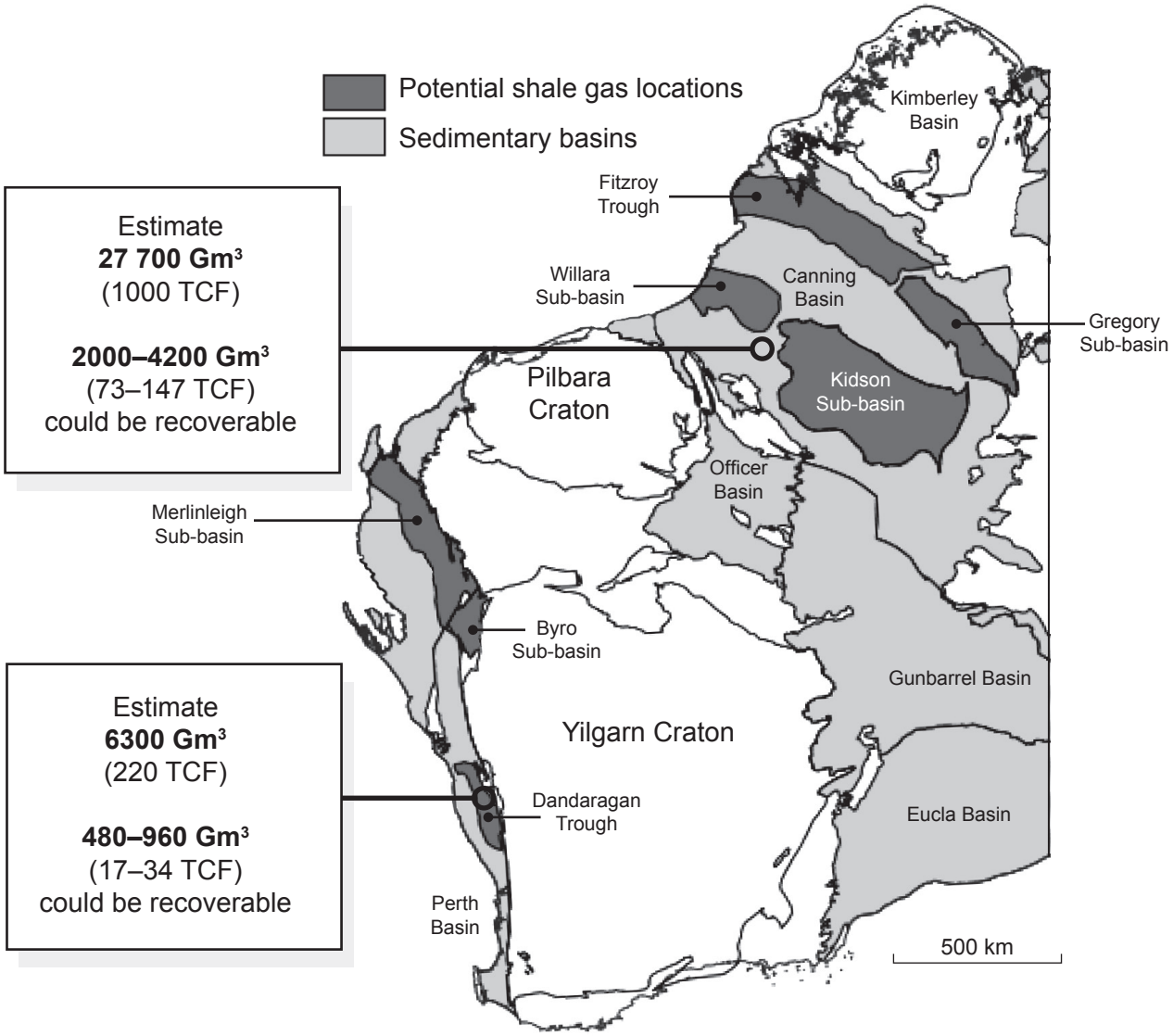
Reason:

See next page

Question 27 **(29 marks)**

When methane is trapped within shale, which is a sedimentary rock, it is called 'shale gas'. It is usually found between 2 km and 4 km below the surface. To release the methane from the shale, hydraulic fracturing (fracking) is used to break up the shale rock. This releases the gas, which is then piped to the surface.

Natural gas resource volumes are usually described in trillion cubic feet (TCF) or giga cubic metres (Gm^3). The figure below identifies the main onshore shale gas locations in Western Australia and the estimated volumes of gas they contain. Most of the natural gas produced in Western Australia comes from conventional sources located offshore along the Pilbara and Kimberley coasts, which are not shown on this map. There are approximately 150 TCF (4200 Gm^3) of natural gas resources offshore.



Gm^3 = Giga or billion cubic metres. Metric unit of measure for volumes of natural gas.

28 Gm^3 (1 TCF) is enough energy to supply a city of one million people with electricity for 20 years.

Western Australia currently produces around 28 Gm^3 of gas per year, mostly from the offshore.

See next page

(a) Describe the potential effect of fracking on the usable quantity of natural gas resources in Western Australia. (5 marks)

(b) Identify **one** social, **one** environmental and **one** economic reason why shale gas resources might not be developed in Western Australia. (3 marks)

Social: _____

Environmental: _____

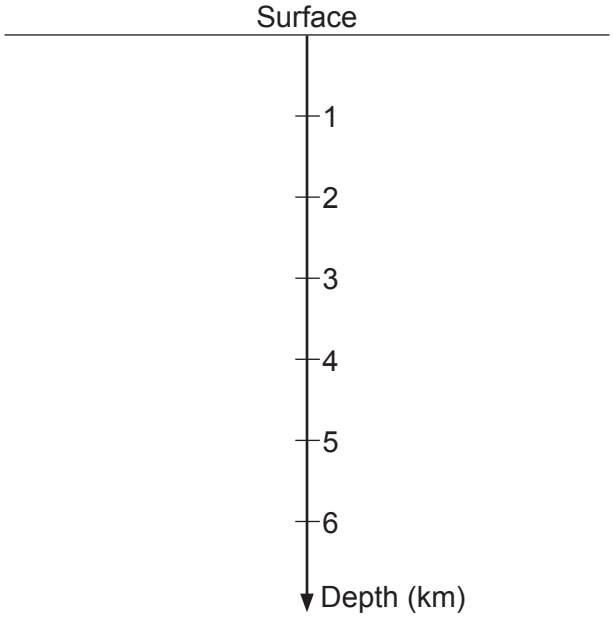
Economic: _____

See next page

Question 27 (continued)

The Dandaragan Trough (shown on the map on page 28), is a major source of water for the agricultural regions north of Perth. The aquifers in the trough used to supply drinking and agricultural water are approximately 26 m below the surface.

(c) Complete the simple depth profile for the aquifers and shale gas by marking the depth at which each would be located. Use this to discuss the potential impact of the extraction of shale gas on the quality of water in the aquifers. (5 marks)



While oil and natural gas can be used as fuels for internal combustion engines, these engines can also use biofuels.

(d) Explain what is meant by the term 'biofuel' and give **one** example. (3 marks)

Biofuel: _____

_____

_____

_____

Example: _____

(e) State why biofuels are considered a renewable source of energy. (1 mark)

_____

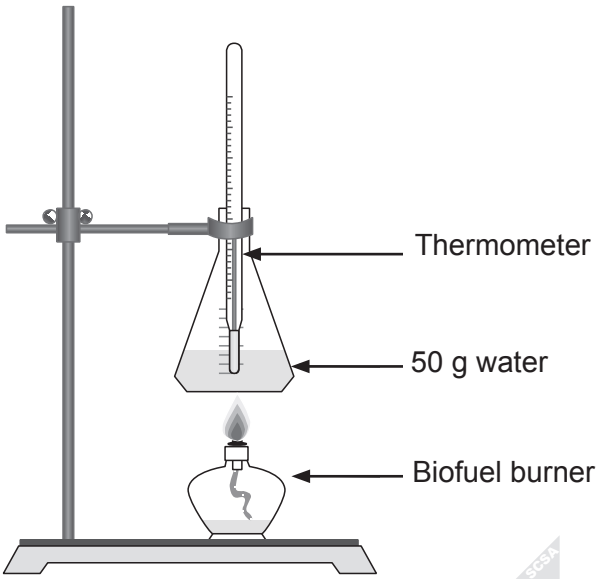
_____

(f) Name the original source of energy that is stored as chemical energy in biomass. (1 mark)

_____

Question 27 (continued)

Jane conducted an experiment to investigate the amount of energy produced when a particular biofuel is burned. The apparatus is shown in the diagram below. In this experiment, the temperature of 50 g of water increased from 20.5 °C to 37.2 °C. The mass of biofuel burned was 0.75 g.



(g) Given that the specific heat capacity of water is 4.186 joule/gram/degree Celsius, calculate the heat energy, in joules, taken in by the water after burning 0.75 g of the biofuel. Show **all** workings. (3 marks)

Equation: $E = mc\,\Delta T$

Answer: _____ J

See next page

(h) The chemical data sheet for the biofuel stated that it should release 21 670 J of heat per gram when burned. Calculate the temperature change of the water after burning 0.75 g of biofuel. Assume that the apparatus is 100% efficient. Show **all** workings. (3 marks)

Equation: $E = mc \Delta T$

(i) Calculate the energy output where the biofuel energy input (energy consumed) is 21 670 J and the process is 28% efficient. Show **all** workings. (3 marks)

$$\text{Energy efficiency} = \frac{\text{energy out}}{\text{energy in}} \times \frac{100}{1}$$

(j) List **two** reasons why part (i) is not 100% efficient. (2 marks)

One: _____

Two: _____

End of questions

Question number: _____

Question number: _____

Question number: _____

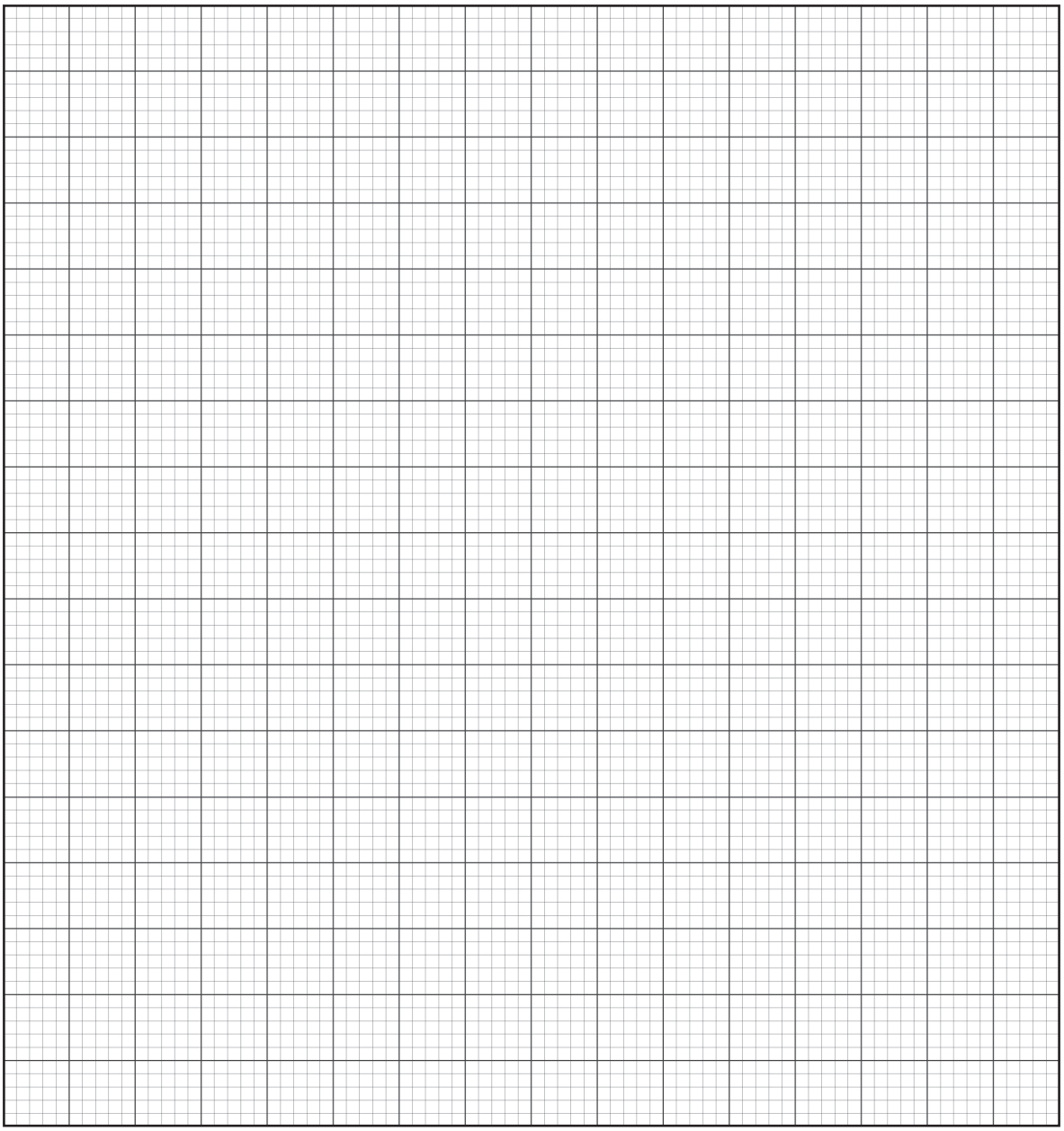
Supplementary page

Question number: _____

Supplementary page

Question number: _____

Spare grid



ACKNOWLEDGEMENTS

Question 21

Data source: CSIRO. (2017). *Air samples collected at Cape Grim under clean air (baseline) conditions.* Retrieved April, 2017, from http://www.csiro.au/greenhouse-gases/GreenhouseGas/data/CapeGrim_CO2_data_download.txt

Question 27

Information from: Department of Mines and Petroleum (DMP). (n.d.). *The facts about natural gas and fracture stimulation in Western Australia*. Retrieved January 28, 2017, from www.dmp.wa.gov.au/Documents/Petroleum/The_Facts_about_Fraccing_Brochure.pdf

Image from: Department of Mines and Petroleum (DMP). (n.d.). *The facts about natural gas and fracture stimulation in Western Australia*, p. 3. Retrieved January 28, 2017, from www.dmp.wa.gov.au/Documents/Petroleum/The_Facts_about_Fraccing_Brochure.pdf

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