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

Western Australian Certificate of Education
ATAR course examination, 2016
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: 16-038

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	6	6	90	95	50
Section Three Extended response	2	2	60	58	30
				Total	100

Instructions to candidates

1. The rules for the conduct of the Western Australian Certificate of Education ATAR course examinations are detailed in the *Year 12 Information Handbook 2016*. 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. Additional working space pages at the end of this Question/Answer booklet are for planning or continuing an answer. If you use these pages, indicate at the original answer, the page number it is planned/continued on and write the question number being planned/continued on the additional working space page.

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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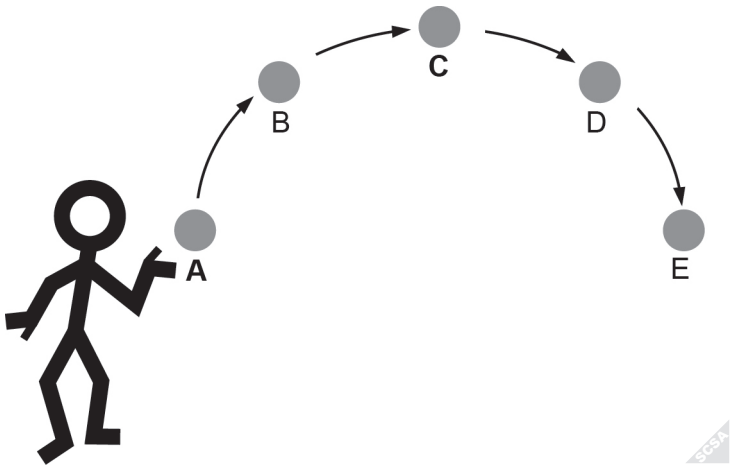
1. Which one of the following is a form of potential energy?

   (a) nuclear
   (b) heat
   (c) sound
   (d) light

2. The figure below shows a ball thrown into the air. Ignoring friction, which one of the following statements about the energy of the ball during the upward path, from **A** to **C**, is true?



   (a) total energy increases
   (b) kinetic energy increases
   (c) total energy remains the same
   (d) kinetic energy remains the same

3. The buoyancy experienced by a floating object will change with

   (a) the depth of the water in which it is floating.
   (b) the length of the floating object.
   (c) differences in water density.
   (d) the shape of the floating object.

4. Conventional large-scale electricity generation occurs in power stations that are fuelled by coal or gas. In these plants, the coal-fired power station

   (a) has a turbine while the gas-fired power station does not.
   (b) has a boiler while the gas-fired power station may not.
   (c) uses the waste gases to drive a turbine, while the gas-fired power station does not.
   (d) has a turbine before the boiler, while the gas-fired power station has a turbine after the boiler.

5. On a cold winter night, a woollen blanket keeps people warm **mostly** by preventing

   (a) conduction.
   (b) convection.
   (c) radiation.
   (d) evaporation.

Questions 6 and 7 refer to the table below about kitchen appliances that use electricity.

Kitchen appliance	**Power rating (Watts)**	**Operating time (seconds)**	Power = $\frac{\text{energy}}{\text{time}}$
kettle	2000	160	
toaster	1800	120	
microwave oven	800	220	
frying pan	1200	280	

6. For the given operating times, which appliance used the **most** energy?

   (a) kettle
   (b) toaster
   (c) microwave oven
   (d) frying pan

7. Each appliance uses electrical energy to heat a substance. Which one of the following statements is correct?

   (a) Work is done when each appliance transforms electrical energy into heat.
   (b) Power is released in each appliance to produce heat.
   (c) Potential electrical energy does work and makes heat energy.
   (d) Each appliance uses up kinetic electrical energy to produce heat.

8. The solid waste product from coal-fired power stations is called

   (a) fly ash.
   (b) pot ash.
   (c) waste coal.
   (d) charcoal.

See next page

9. Which of the following statements are reasons why car manufacturers are developing hydrogen fuel cell vehicles?

(I) Hydrogen is the most abundant element in the universe.
(II) Hydrogen fuel cells are cheap to manufacture.
(III) Oil reserves are declining.
(IV) Hydrogen fuel cells have lower environmental impact.

(a) I only
(b) II and III
(c) IV only
(d) all of the above

10. Pressurised water reactors generate electricity using

(a) induction.
(b) fusion.
(c) fission.
(d) combustion.

11. Most freshwater fish do **not** survive long when placed in salt water because the salt water

(a) does not provide as much support for their bodies as freshwater does and the fish are unable to control the function of the swim bladder.
(b) results in a difference in osmotic pressure and the water passes from the fishes' tissues into the surrounding water.
(c) contains salt ions and these tend to pass into the tissue faster than the freshwater leaves it and the accumulation of salt causes the fish to die.
(d) does not contain as much dissolved oxygen as freshwater and the fish are unable to extract enough oxygen from the salt water to survive.

12. Which one of the following **cannot** be explained by the existence of hydrogen bonding in water?

(a) the relatively high melting point of water
(b) the ability of water to dissolve other substances
(c) the expansion of water upon freezing
(d) the shape of the water molecule

13. When comparing the densities of ice and liquid water, ice is

(a) less dense than water, as ice particles are more closely spaced.
(b) less dense than water, as ice particles are arranged in an open lattice.
(c) more dense than water, as ice particles are more closely spaced.
(d) more dense than water, as ice particles are arranged in an open lattice.

See next page

14. Water molecules are polar because

    (a) electrons are shared equally among atoms, giving the molecules an overall zero charge.
    (b) one end of the molecule has a small negative charge and the other end has a small positive charge.
    (c) they consist only of hydrogen atoms that allow for bonding to other molecules.
    (d) one end of the molecule has a magnetic south pole while the other end has a magnetic north pole.

15. Porous layers of underground rock can be used to store water. This process is called

    (a) aquifer recharge.
    (b) recharge areas.
    (c) water-shedding.
    (d) reservoir refill.

16. Advances in the design of car engines have resulted in the

    (a) development of autonomous (self-driving) vehicles.
    (b) reduced use of alternative fuels.
    (c) possible use of nuclear fuels.
    (d) reduced impact on the environment.

17. Working ethically ensures that experiments and reports do not involve misconduct. Which one of the following is **not** an example of scientific misconduct?

    (a) altering experimental results
    (b) adding your name to an experiment report you did not work on
    (c) copying another person's work
    (d) writing a report that includes data with a typing error

18. The solubility of gases in water is affected by temperature,

    (a) pressure, nutrients and concentration gradient.
    (b) nutrients and concentration gradient.
    (c) pressure and concentration gradient.
    (d) pressure and nutrients.

See next page

19. Which of the following protective measures are specifically used to safeguard against exposure to radioactive substances?

(I) lead aprons
(II) safety glasses
(III) steel-capped boots
(IV) personal radiation monitoring badges

(a) I and IV
(b) I, III and IV
(c) II and IV
(d) all of the above

20. Which of the following are the main potable water resources for Western Australia?

(I) desalinated water
(II) surface water
(III) ground water
(IV) distilled water

(a) I and IV
(b) I, II and III
(c) II and III
(d) all of the above

End of Section One

See next page

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

This section has **six (6)** questions. Answer **all** questions. Write your answers in the spaces provided.

Additional working space pages at the end of this Question/Answer booklet are for planning or continuing an answer. If you use these pages, indicate at the original answer, the page number it is planned/continued on and write the question number being planned/continued on the additional working space page.

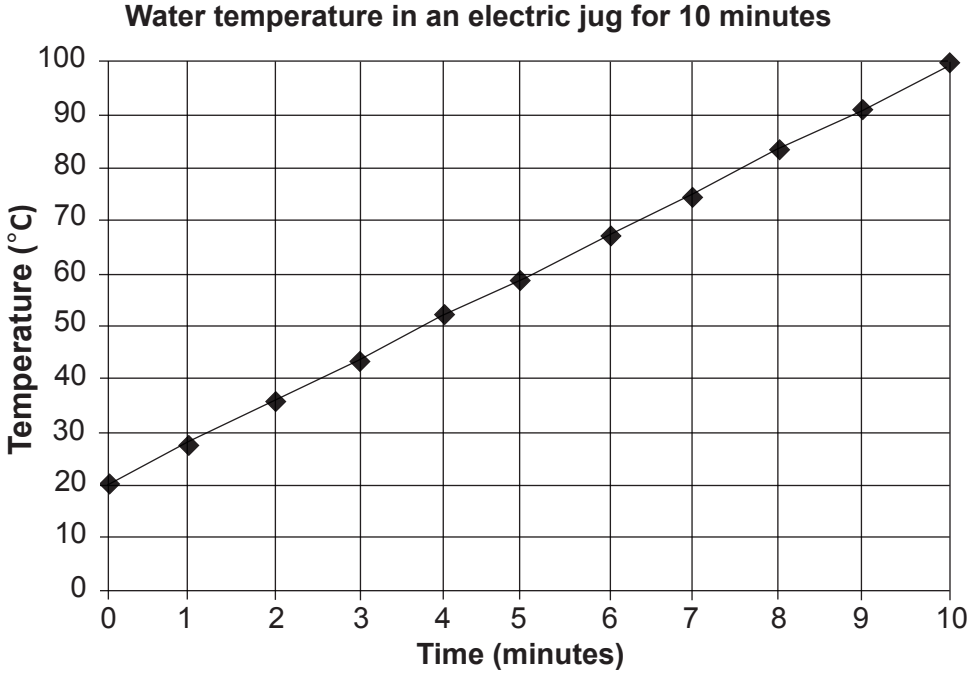
Suggested working time: 90 minutes.

Question 21 **(16 marks)**

A student recorded the following data when heating 3.0 L (3.0 kg) of tap water in an insulated electric jug. The jug was rated at 1500 J s^{-1}.

Time (minutes)	Temperature (°C)
0	20
1	28
2	36
3	44
4	52
5	59
6	67
7	75
8	83
9	91
10	99

The student then created the following graph of these results.



See next page

(a) Explain why the points on the plotted graph form a straight line. (2 marks)

(b) Using the equation $E = mc\Delta T$, calculate the specific heat capacity of water from the data provided in this question. (6 marks)

(c) The specific heat capacity of water is 4200 J kg^{-1} $°C^{-1}$ but this is **not** the result obtained from the data. One student suggests that the thermometer is inaccurate. If the thermometer was inaccurate, identify the type of error that the student encountered. Would the result be improved by repeating the experiment many times and averaging the results? Provide a reason for your answer. (3 marks)

See next page

Question 21 (continued)

(d) Identify **two** different possible sources of error that would affect the result obtained in part (b). (2 marks)

One: _____

_____

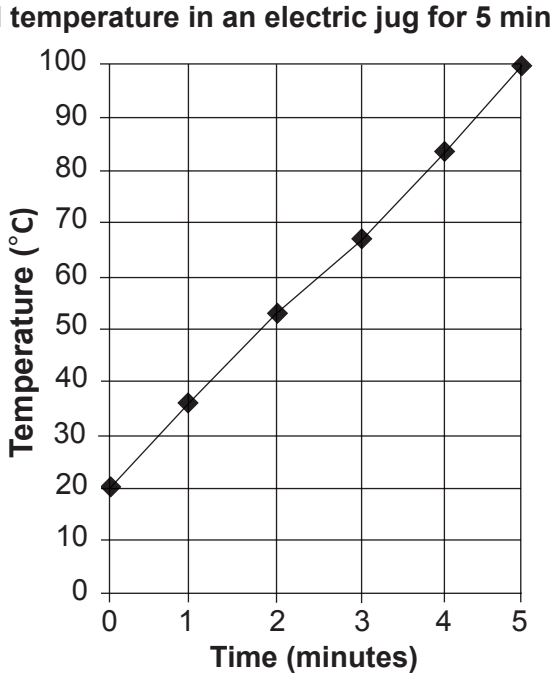
Two: _____

_____

Another student recorded the following data when heating 3.0 L (3.0 kg) of an unknown liquid in an insulated electric jug. The jug was rated at 1500 J s^{-1}.

Time (minutes)	Temperature (°C)
0	20
1	36
2	52
3	67
4	83
5	99

The student then created the following graph of these results.



See next page

(e) Compare the unknown liquid graph with the water graph on page 8. Use this information to estimate the specific heat capacity of the unknown liquid. Explain your answer by referring to the difference in the slope of the two graphs. (3 marks)

Estimated specific heat capacity: _____

_____

_____

_____

_____

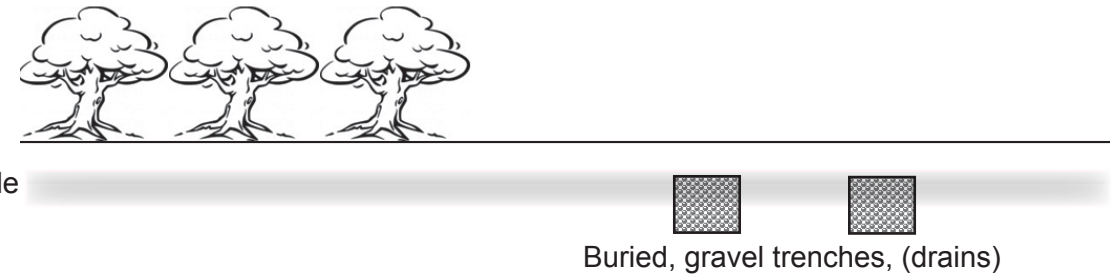
See next page

Question 22 **(14 marks)**

Rivers, lakes and groundwater are being used as water sources both for agriculture and domestic consumption. The changing patterns of land use have led to both the soil and the waterways becoming salty. In Australia the two principal methods of overcoming dry land salinity are:

- planting trees
- creating drains by digging trenches across the land, filling the trenches two-thirds full with gravel and then covering with soil.

These methods are shown in the diagram below.



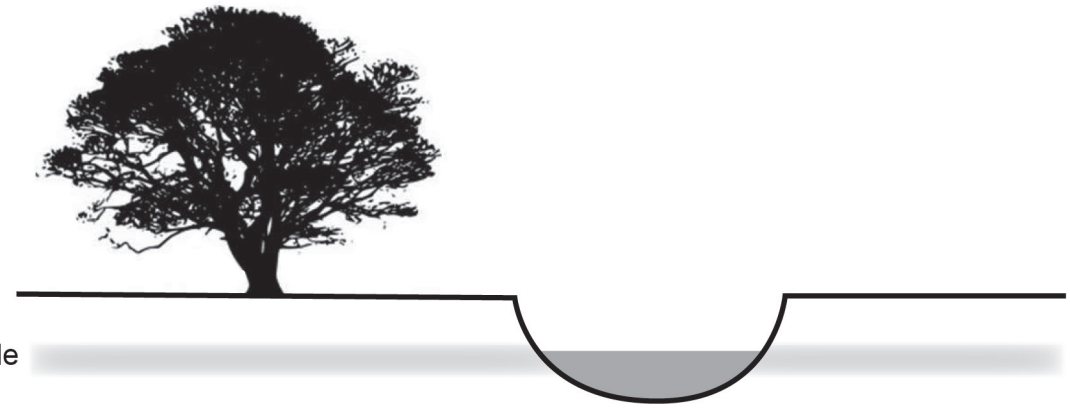
(a) Describe the process of dry land salinity. (3 marks)

(b) Explain how each method below reduces dry land salinity. (4 marks)

Tree planting:

Gravel trenches:

The lakes on the Perth plain are different from lakes in much of the world. Most lakes have a stream bringing water to the lake and another stream leaving it. On the Perth plain the lakes are depressions in the land surface that extend below the water table as shown below. They are isolated and develop their own ecosystems.



(c) Given that rainfall in Perth is decreasing, state **two** effects this will have on the varying ecosystems of the Perth lakes. (2 marks)

One: _____

_____

Two: _____

_____

(d) What is the origin of the groundwater in Perth? (1 mark)

_____

(e) If the decreasing rainfall trend continues and Perth relies more on groundwater for its drinking water, suggest **two** possible negative effects from this increase in groundwater consumption. State how each will affect our lifestyle. (4 marks)

One: _____

_____

_____

_____

Two: _____

_____

_____

_____

See next page

Question 23 **(13 marks)**

To keep warm Jack used a wood fire heater in his house like the one in the picture below. The room took some time to heat but Jack experienced warmth almost immediately while sitting one metre from the fire.

Wood fire heater

(a) With your knowledge of heat transfer and using the terms convection, conduction and radiation, describe how the heat energy being released from the burning wood reaches Jack. (4 marks)

See next page

(b) Describe **three** design features that can help to keep a house warmer in winter and cooler in summer. (6 marks)

One: _____

_____

_____

_____

Two: _____

_____

_____

_____

Three: _____

_____

_____

_____

(c) For each of the **three** design features you provided in part (b), identify the main method of heat transfer that is limited as a result of that design feature. (3 marks)

Feature from part (b)	Method of heat transfer that is limited
One:	
Two:	
Three:	

See next page

Question 24 **(21 marks)**

Several tests were performed over time to monitor an aquatic ecosystem. The following table summarises the results of tests that were performed on water samples from the aquatic ecosystem.

Water quality tests for 2010 and 2015

Test	2010	2015
dissolved oxygen	high	low
pH	7	6
turbidity	10 cm	50 cm
temperature	21°C	22°C
phosphates	0.101 mg/L	0.512 mg/L
nitrates	0.250 mg/L	0.886 mg/L

(a) Name the test or equipment used for the following water quality tests and explain the importance of the particular test for the monitoring of the health of the aquatic ecosystem.

(i) pH (3 marks)

Test or equipment: _____

Explanation: _____

_____

_____

(ii) Turbidity (3 marks)

Test or equipment: _____

Explanation: _____

_____

_____

(iii) Phosphates (3 marks)

Test or equipment: _____

Explanation: _____

_____

_____

See next page

(b) From the table on page 16, suggest a likely environmental effect of the recorded changes in (3 marks)

- pH: _____
- temperature: _____
- phosphates and nitrates: _____

(c) From the table on page 16, suggest a reason why the turbidity value changed. (2 marks)

_____

_____

_____

_____

(d) Identify **two** human activities that can result in reducing the quality, and hence the availability, of public drinking water supplies. (2 marks)

One: _____

Two: _____

(e) Explain how reverse osmosis produces fresh water from seawater. A well-labelled diagram should be included as a part of your answer. (5 marks)

_____

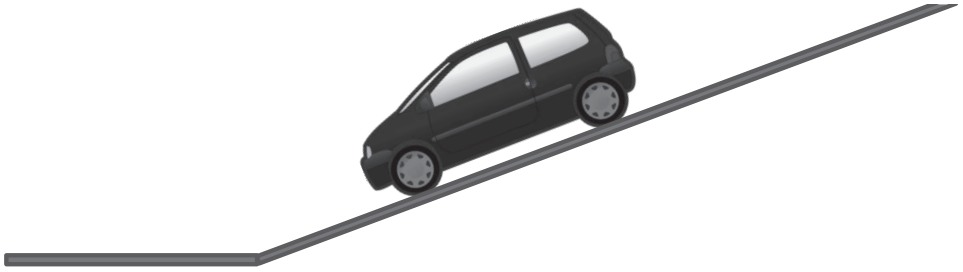
_____

_____

_____

Question 25 **(11 marks)**

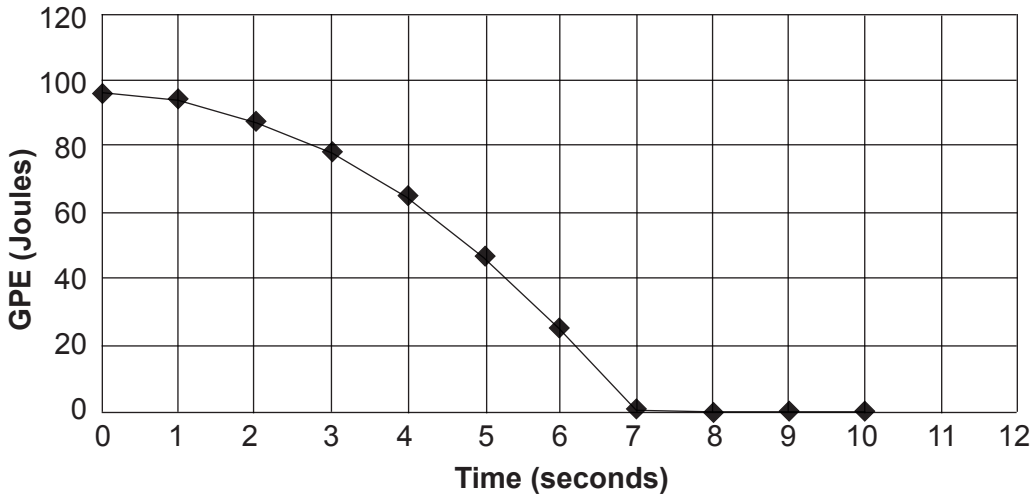
Two students, Chris and Kerry, were investigating the relationship between kinetic and potential energy. To do this they rolled a small toy car down a ramp as shown in the diagram below.



The gravitational potential energy (GPE) of the toy car was calculated at regular intervals as shown in the table and graph below:

Time elapsed (seconds)	GPE (Joules)
0	96
1	94
2	88
3	78
4	65
5	47
6	25
7	0
8	0
9	0
10	0

Gravitational potential energy of a toy car for 10 seconds



See next page

(a) Using the graph on page 18, determine the GPE of the toy car 1.5 seconds after launch. (1 mark)

(b) Why didn't the GPE of the toy car change between the 7 and 10 second marks? (2 marks)

(c) (i) Add a sketch of the kinetic energy of the toy car over 10 seconds to the graph on page 18. (2 marks)

(ii) Explain the relationship between the amount of kinetic energy, the amount of potential energy and the total energy of the toy car. (3 marks)

(d) The toy car used by Chris and Kerry was a model. Real cars use an internal combustion engine to generate motion. This type of engine is regarded as inefficient as less than 25% of the energy received from the combustion of fuel is used to move the car. List **three** ways in which energy is wasted when using an internal combustion engine. (3 marks)

How energy is wasted when using an internal combustion engine	
One:	
Two:	
Three:	

See next page

Question 26 **(20 marks)**

Energy can be derived from many sources, including some that are renewable and some that are non-renewable.

(a) Define what is meant by the terms renewable and non-renewable resources and give an example of each. (4 marks)

Renewable	Definition:
	Example:
Non-renewable	Definition:
	Example:

(b) Identify and describe **two** ways in which plant materials may be used to produce energy that can be used in vehicles or to produce electricity. Indicate if the energy resource is a renewable or non-renewable resource. (8 marks)

One: _____

_____

_____

_____

_____

_____

Resource type: _____

Two: _____

_____

_____

_____

_____

_____

Resource type: _____

See next page

(c) Nuclear energy can be used to provide heat or electricity. Draw an energy flow diagram to show how nuclear energy can be used to produce electrical energy. (4 marks)

(d) A large number of Western Australian homes have solar panels that provide electricity to the homeowners. Photovoltaic cells mounted in the solar panels produce electricity. Describe the process that occurs in the cells. (4 marks)

End of Section Two

See next page

Section Three: Extended response **30% (58 Marks)**

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

Additional working space pages at the end of this Question/Answer booklet are for planning or continuing an answer. If you use these pages, indicate at the original answer, the page number it is planned/continued on and write the question number being planned/continued on the additional working space page.

Suggested working time: 60 minutes.

Question 27 **(26 marks)**

In 2012, local residents found dead fish on the shores of the Swan River near Ascot Waters, close to parklands and a horse-racing track.

A scientist investigated the incident. She analysed the dead fish and concluded that the fish had died from a lack of oxygen, caused by an algal bloom.

(a) In lakes and rivers, algal blooms are associated with eutrophication. Describe the process of eutrophication and how this can lead to the death of fish in a river. (9 marks)

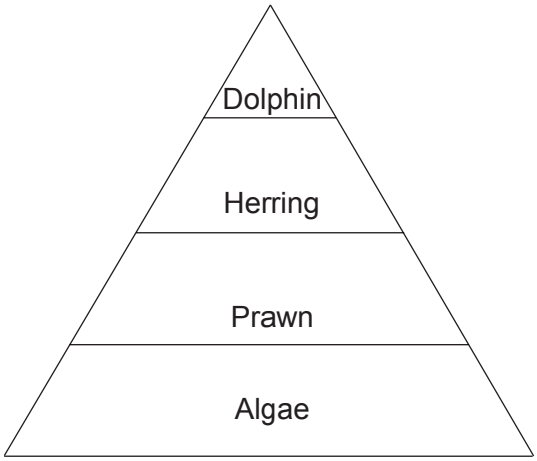
See next page

(b) Algal blooms produce a small quantity of poisonous substances in the river water. Explain how these poisons can kill cormorants (birds) through the consumption of fish (unaffected by the poisons) from the river. (4 marks)

(c) Name **two** substances that have the potential to biomagnify. Explain why these substances biomagnify and sodium chloride does not. (5 marks)

Question 27 (continued)

The available energy in aquatic systems can be understood by drawing energy pyramids. The data for a local marine environment are represented in the energy pyramid below.



(d) Explain why the system is represented as a pyramid rather than a square. (4 marks)

(e) Explain how the cycling of matter occurs in an aquatic ecosystem. Use an example to describe what would happen if matter is **not** recycled. (4 marks)

See next page

Question 28 **(32 marks)**

The following data shows the number of kilowatt hours (kW h) of energy that must be consumed to create 1.00 kW h of electricity in different types of power stations.

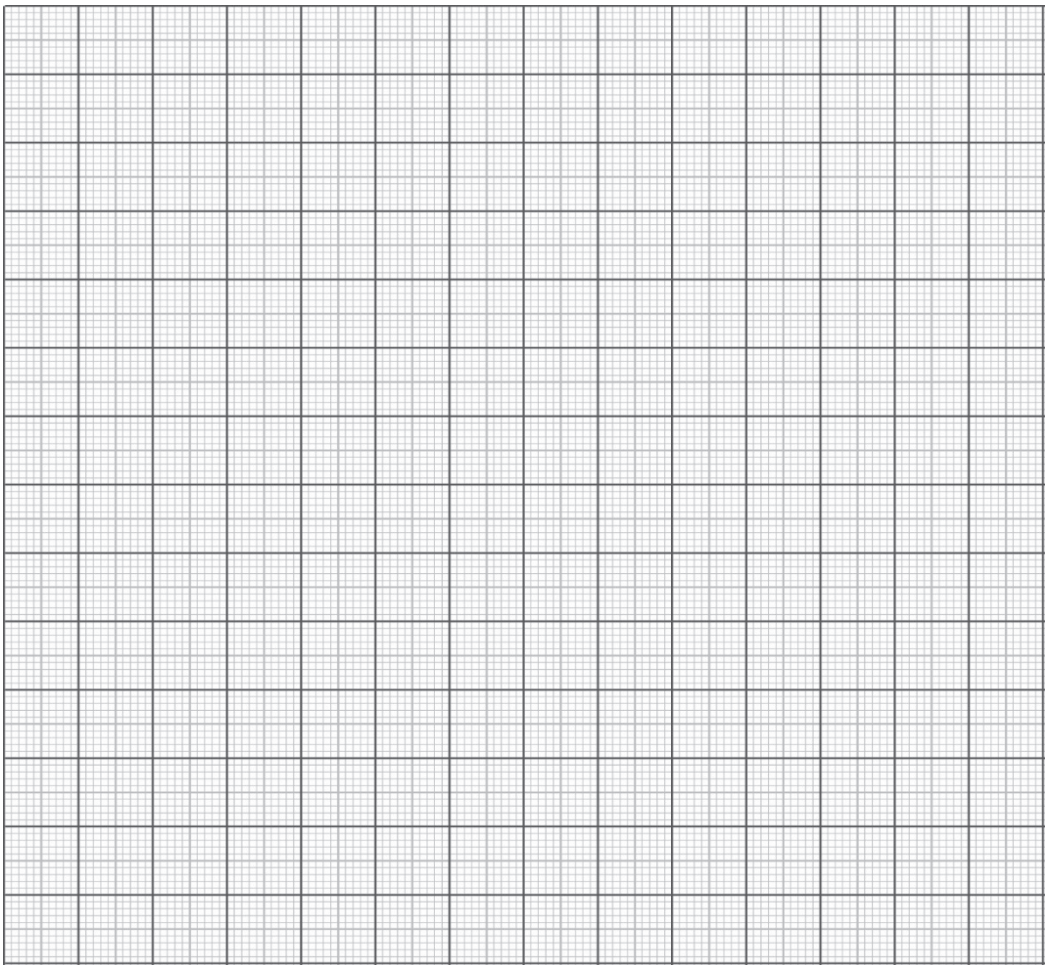
Gas and diesel power stations can be made more efficient by capturing waste heat and using it to preheat incoming raw materials. These are called 'combined cycle generators'. The total energy input from the various fuels required to produce 1.00 kW h of electricity is shown in the table below. Nuclear and coal power stations can only be used for steam generation.

	Energy source			
Power station type	**Coal (kW h)**	**Diesel (kW h)**	**Natural gas (kW h)**	**Nuclear (kW h)**
Steam generator	2.93	2.98	3.00	3.03
Gas turbine		3.93	3.30	
Internal combustion		3.02	2.78	
Combined cycle		2.88	2.22	

(a) Construct an appropriate graph showing the energy consumed by steam generators to produce 1.00 kW h of electricity using coal, diesel, natural gas and nuclear power.

(4 marks)

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



See next page

Question 28 (continued)

(b) With reference to your graph showing the energy consumed by steam generators and considering each method's environmental, economic and social impact, outline which method you would recommend for power generation. (4 marks)

(c) $\text{Efficiency} = \frac{\text{energy out}}{\text{energy in}} \times 100\%$

Using the information from page 25 and the above formula, calculate the efficiency of the following power stations. (4 marks)

Power station	Energy source	Efficiency
Steam generator	coal	
	nuclear	
Combined cycle	diesel	
	natural gas	

See next page

(d) On the basis of your answers to part (c), which type of power station is the most efficient? Provide **one** reason why you made this selection. (3 marks)

Most efficient power station: _____

Reason: _____

(e) Emissions from power stations contribute to the enhanced greenhouse effect. Explain what we mean by the 'enhanced greenhouse effect'. (4 marks)

(f) Explain why power stations that provide a base-load supply of electricity typically use non-renewable energy sources. (3 marks)

See next page

Question 28 (continued)

(g) Energy efficiency is also important in the home. Light bulbs range in energy efficiency. Outline the design of an investigation that you would use to determine the efficiency of the following light bulbs. (10 marks)

Type of light bulb	Incandescent bulb 	LED bulb 
Power rating (Watts)	15 W	15 W

In your design make sure you include:

- number of bulbs used of each type
- variables you would measure
- variables you would control
- a safety precaution
- expected results.

End of questions

Additional working space

Question number: _____

Additional working space

Question number: _____

Additional working space

Question number: _____

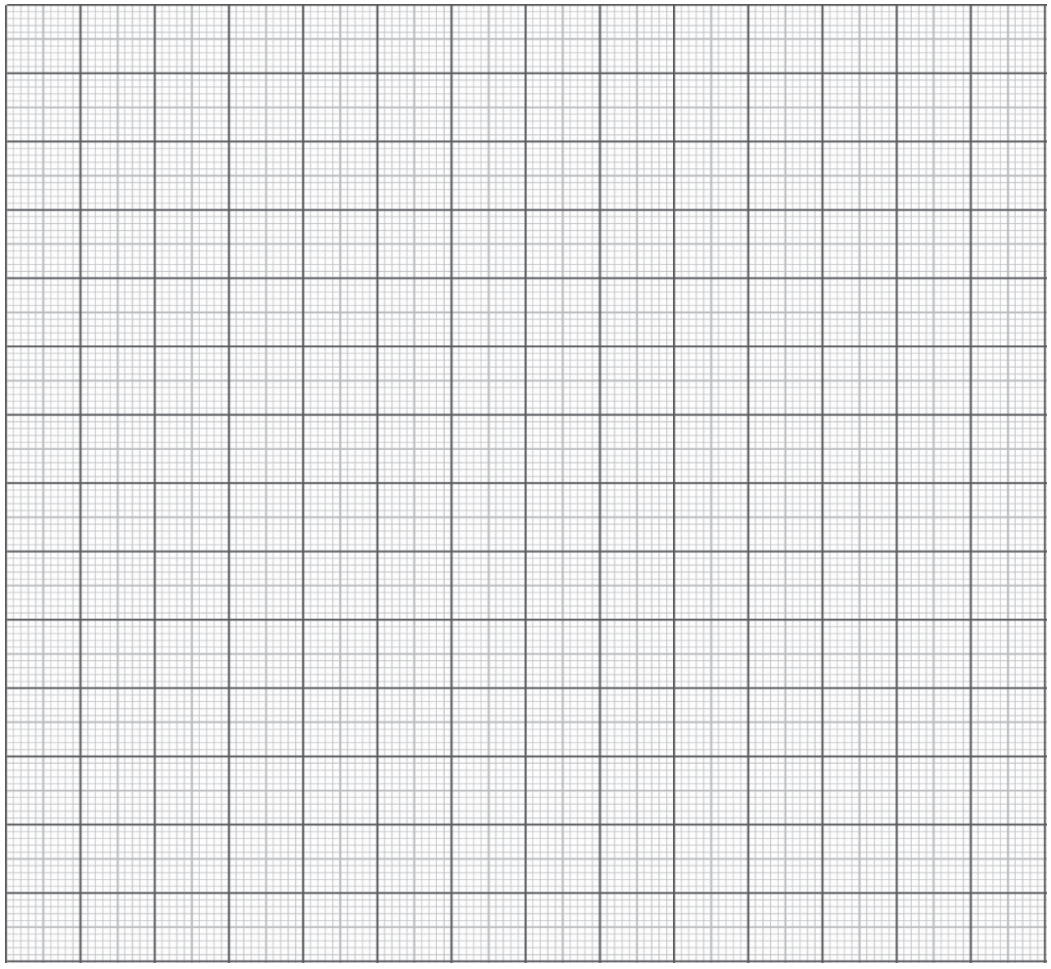
Additional working space

Question number: _____

Additional working space

Question number: _____

Question 28(a)



ACKNOWLEDGEMENTS

Question 22 Tree images: Ibrahim, M. (2008). *Tree outline clip art*. Retrieved June, 2016, from www.clker.com/clipart-24015.html

Question 25 Car image: Tobias. (2007). *Blue Twingo*. Retrieved June, 2016, from https://openclipart.org/detail/4670/blue-twingo

Question 27 Introductory text information from: Swan River Trust. (2012, July 30). *Algal bloom kills 4,000 fish*. Retrieved June, 2016, from www.fish.wa.gov.au/About-Us/Media-releases/Pages/_archive/Algal-bloom-kills-4,000-fish.aspx

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