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91946R

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

# Level 1 Mathematics and Statistics RAS 2023

## 91946 Interpret and apply mathematical and statistical information in context

Credits: Five

# PILOT ASSESSMENT

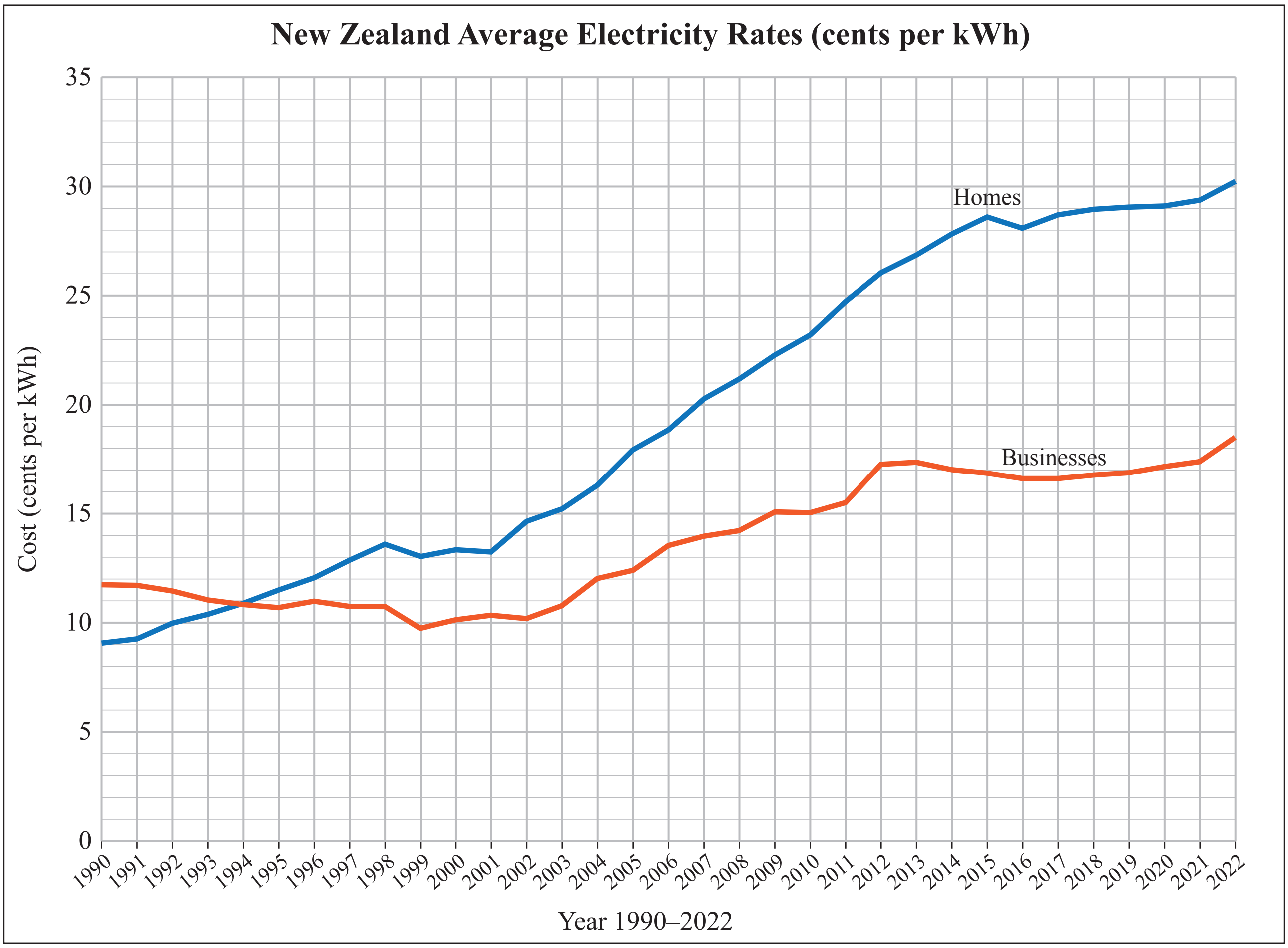
RESOURCE BOOKLET

Check that this booklet has pages 2–9 in the correct order and that none of these pages is blank.

## RESOURCE 1

**Definitions**:

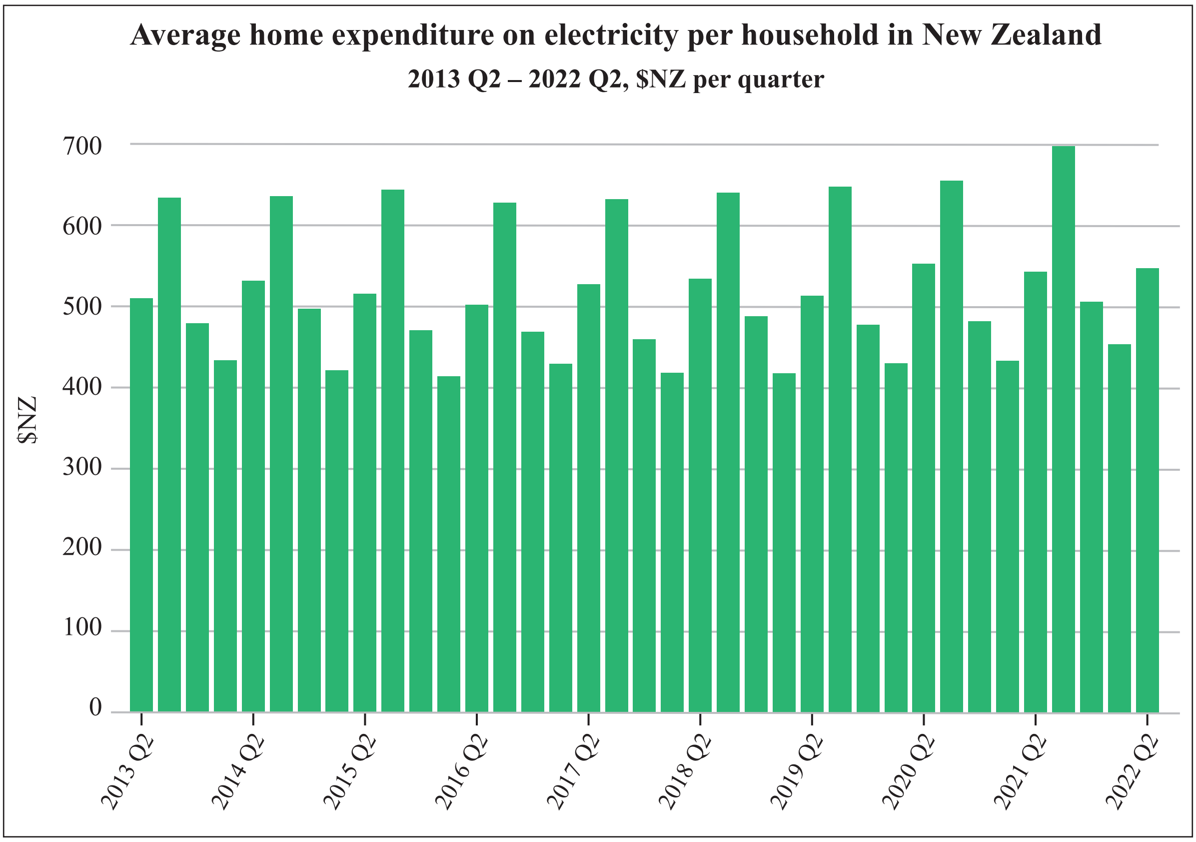
- A watt (W) is a unit of power, which is the rate at which energy is produced or consumed.
- A 100-watt light bulb needs a flow of 100 watts of electricity in order to work. A 60-watt light bulb needs a flow of only 60 watts to work.
- Since homes typically require thousands of watts to run, when talking about energy use, it is easier to use larger units like kilowatts (kW) (1000 watts) and megawatts (MW) (1000 kilowatts).
- An electricity bill will typically show how many kilowatt-hours a home consumes in a month.
- A watt-hour is a unit of measurement for energy. A kilowatt-hour means the energy consumption of a kilowatt of power for one hour.



## RESOURCE 2A

**Definitions**:

- *Average home expenditure* means the average amount of money spent on electricity by householders.
- *Per quarter* means that a year is divided up into four quarters, i.e. Q1 is January, February, March; Q2 is April, May, June; Q3 is July, August, September; Q4 is October, November, December.



**RESOURCE 2B**

| Year and Quarter | Average home expenditure on electricity per household in New Zealand ($ NZ) | Average home usage of electricity per household in New Zealand (kw/hour) |
|---|---|---|
| 2013 Q2 | $ 509.19 | 1824.44 |
| 2013 Q3 | $ 633.41 | 2365.22 |
| 2013 Q4 | $ 479.14 | 1698.49 |
| 2014 Q1 | $ 432.32 | 1493.44 |
| 2014 Q2 | $ 530.51 | 1855.38 |
| 2014 Q3 | $ 634.55 | 2281.67 |
| 2014 Q4 | $ 496.87 | 1721.30 |
| 2015 Q1 | $ 420.96 | 1421.80 |
| 2015 Q2 | $ 514.61 | 1826.33 |
| 2015 Q3 | $ 643.84 | 2373.71 |
| 2015 Q4 | $ 469.50 | 1663.69 |
| 2016 Q1 | $ 413.69 | 1398.64 |
| 2016 Q2 | $ 501.08 | 1730.51 |
| 2016 Q3 | $ 626.66 | 2261.29 |
| 2016 Q4 | $ 467.59 | 1622.89 |
| 2017 Q1 | $ 428.16 | 1433.04 |
| 2017 Q2 | $ 526.14 | 1818.70 |
| 2017 Q3 | $ 630.94 | 2258.35 |
| 2017 Q4 | $ 458.77 | 1570.13 |
| 2018 Q1 | $ 417.19 | 1373.08 |
| 2018 Q2 | $ 533.23 | 1829.83 |
| 2018 Q3 | $ 639.25 | 2277.53 |
| 2018 Q4 | $ 487.77 | 1670.15 |
| 2019 Q1 | $ 416.66 | 1364.28 |
| 2019 Q2 | $ 512.26 | 1742.73 |
| 2019 Q3 | $ 646.67 | 2317.30 |
| 2019 Q4 | $ 477.25 | 1638.26 |
| 2020 Q1 | $ 429.27 | 1396.02 |
| 2020 Q2 | $ 552.33 | 1881.30 |
| 2020 Q3 | $ 654.53 | 2305.93 |
| 2020 Q4 | $ 481.67 | 1631.05 |
| 2021 Q1 | $ 432.26 | 1404.80 |
| 2021 Q2 | $ 541.74 | 1798.79 |
| 2021 Q3 | $ 695.83 | 2385.95 |
| 2021 Q4 | $ 504.56 | 1654.05 |
| 2022 Q1 | $ 452.14 | 1422.27 |
| 2022 Q2 | $ 546.41 | 1736.39 |

Source:https://figure.nz/chart/ivlqVxSXkRa9OnXL

## RESOURCE 3

**Definitions**:

- *Off – peak plan*: Some companies offer a power plan with a cheaper night rate but a higher day rate. Homes that mainly use power at night (usually after 9pm) will likely make savings on their power bills.
- *Customer rating*: Customers are asked to rate how satisfied they are with their energy supplier. They award a rating between 1 and 10. This rating is then averaged out between all of the customers. The higher the rating, the more satisfied the customers are.
- *Contract term*: Some energy companies insist that the customers have to sign up to a required time period and cannot change to a different company within that time period.
- *Open term*: This is when an energy company will allow their customers to swap to a different company at any time.

| Company | Rhythm Energy | Wired 4 Power | Equator Energy | Shout |
|---|---|---|---|---|
| **Customer rating** | 6.4 | 3.7 | 7.9 | 8 |
| **Contract term** | Open term | 12 months | Open term | Open term |
| **Selling point** | Cheaper broadband rate | $50 credit | 100% renewable energy | $100 credit |
| **Add-ons** | Broadband bundle | Natural gas | None | None |
| **Anytime rate** | $0.1988 / kWh | $0.2146 / kWh | $0.2028 / kWh | $0.1675 / kWh |
| **Off-peak plan – Day rate** | $0.2113 / kWh | $0.2240 / kWh | $0.2146 / kWh | $0.1675 / kWh |
| **Off-peak plan – Night rate** | $0.1779 / kWh | $0.1685 / kWh | $0.1196 / kWh | $0.1675 / kWh |
| **Daily charge** | $2.9900 / day | $2.3089 / day | $1.7502 / day | $2.5070 / day |

Adapted from: https://www.powercompare.co.nz

## RESOURCE 4

**Definitions**:

- A megawatt (MW) is 1 000 000 watts of power i.e. a thousand times larger than a kilowatt. Megawatts are typically used to describe power capacities on large scales, such as those of a power plant or the amount of energy required to power an entire city.
- A megawatt is not the largest measure of power. After megawatts come gigawatts (GW) which is equal to one billion watts (1 000 000 000 watts). Gigawatts are used to describe amounts of power such as those generated by entire nations.

### New Zealand aims for 100% of its energy needs to be renewable energy by 2030

Author **Michael Lustig, Anna Duquiatan**
Theme **Energy**

About 20% of New Zealand's nearly 10 GW of operating power generation capacity is comprised of gas- and coal-fired resources, but those will soon be replaced as the country aims toward a 2030 deadline for 100% renewable energy, using a variety of different methods.

New Zealand also has a net-zero emissions target by the year 2050.

The majority of New Zealand's existing generating capacity comes from hydro resources.

More than 75% of nearly 1.6 GW of capacity in the future will be generated by wind power.

Genesis Energy Limited owns New Zealand's largest power plant, the Huntly complex.

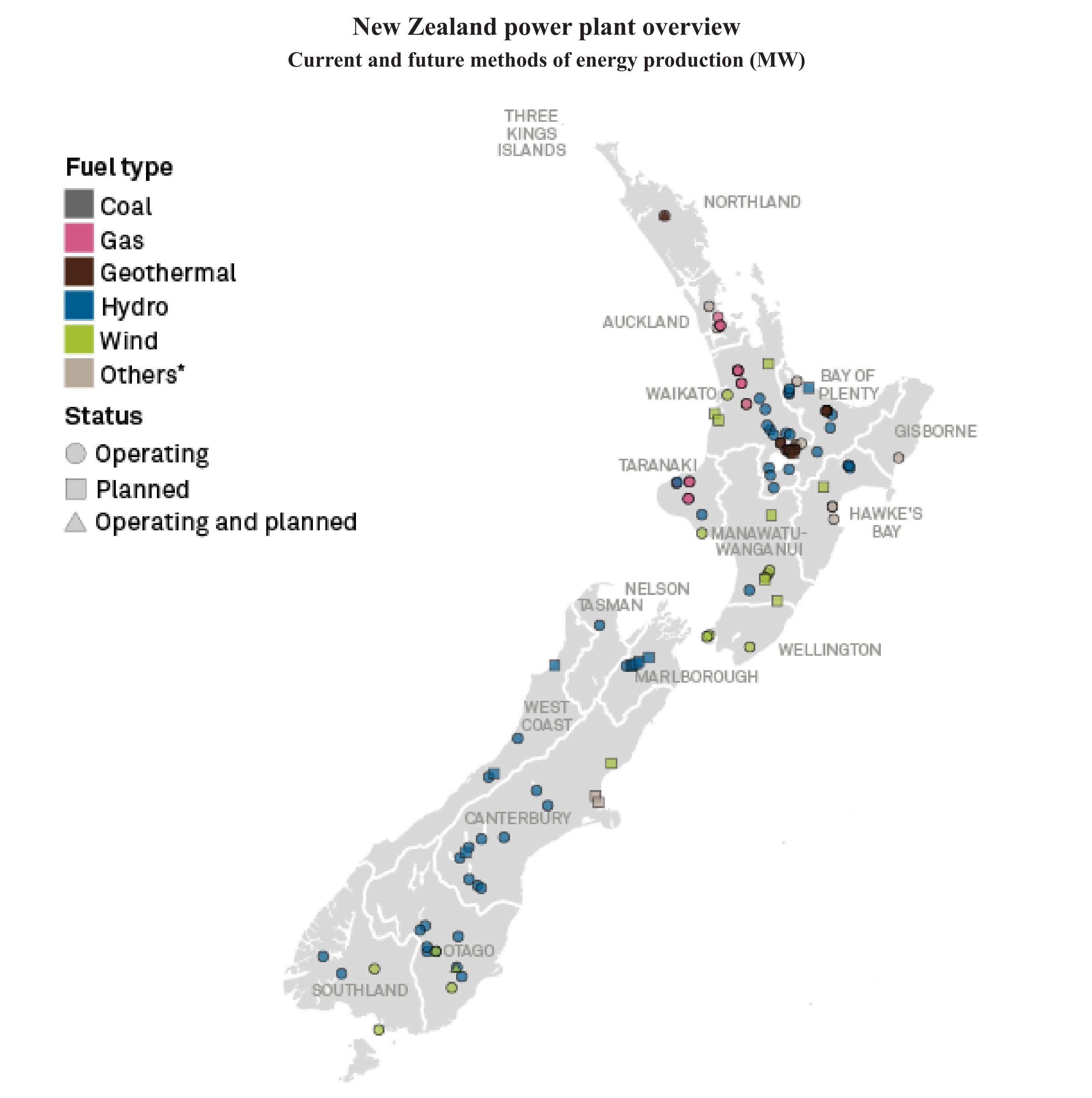
The four-unit coal-fired Huntly Steam Power Plant began operating in the first half of the 1980s.

Two units, each with 250 MW, are currently operating and a third has been temporarily closed down, while a fourth has been retired.

These units can also run on natural gas.

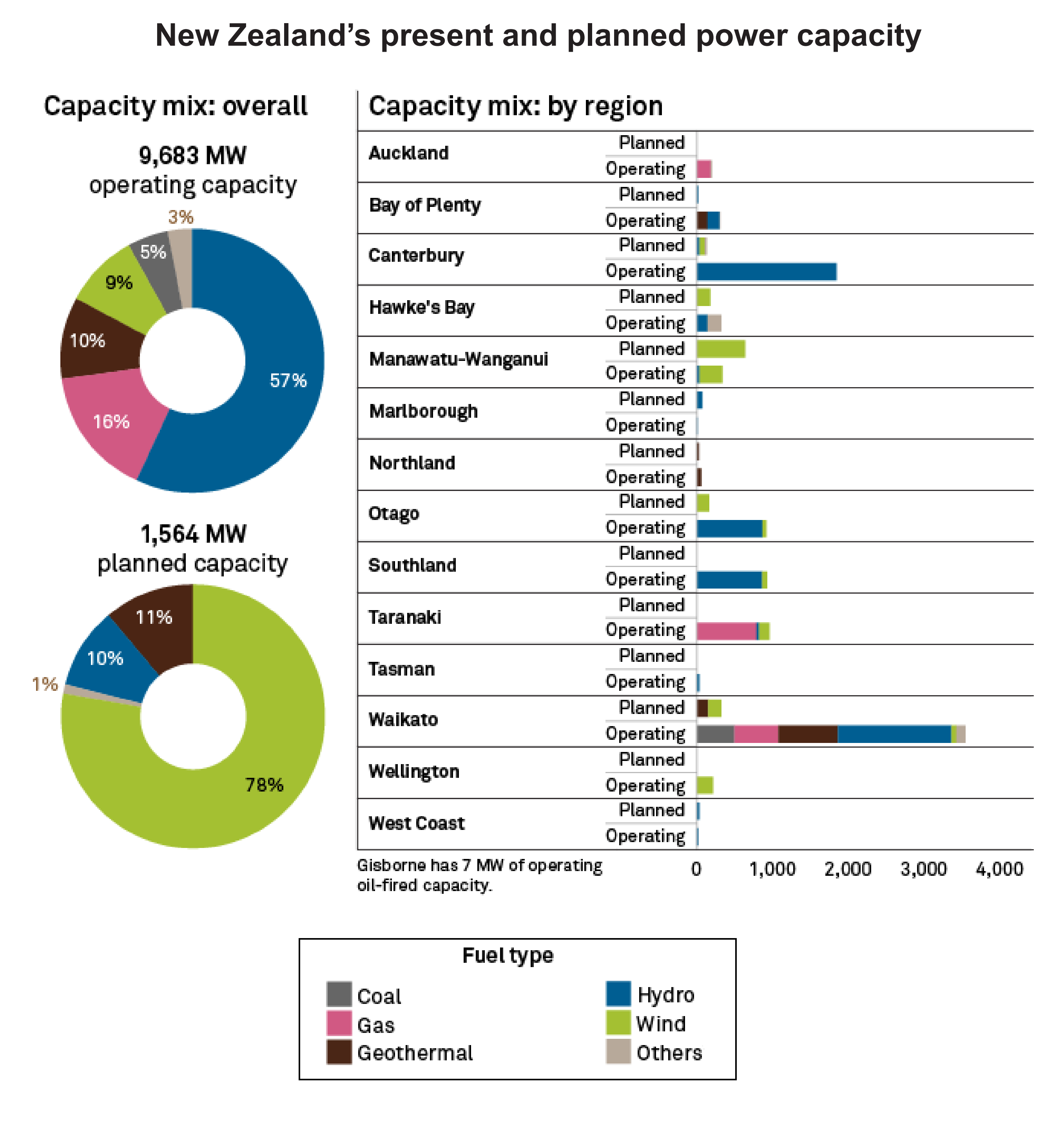
Adapted from: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/new-zealand-aims-for-100-renewables-portfolio-by-2030-69423542

## RESOURCE 5A




Adapted from: www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/new-zealand-aims-for-100-renewables-portfolio-by-2030-69423542

## RESOURCE 5B



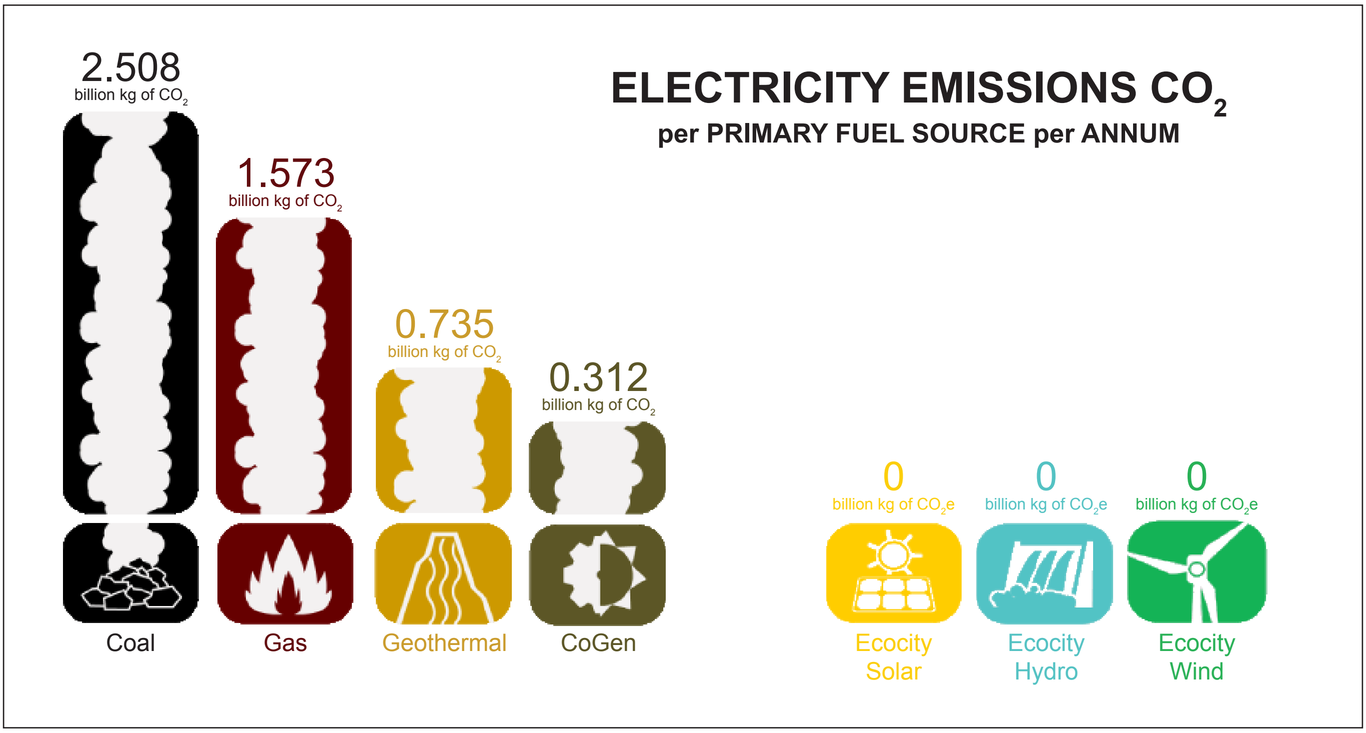

Adapted from: www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/new-zealand-aims-for-100-renewables-portfolio-by-2030-69423542

**RESOURCE 6**

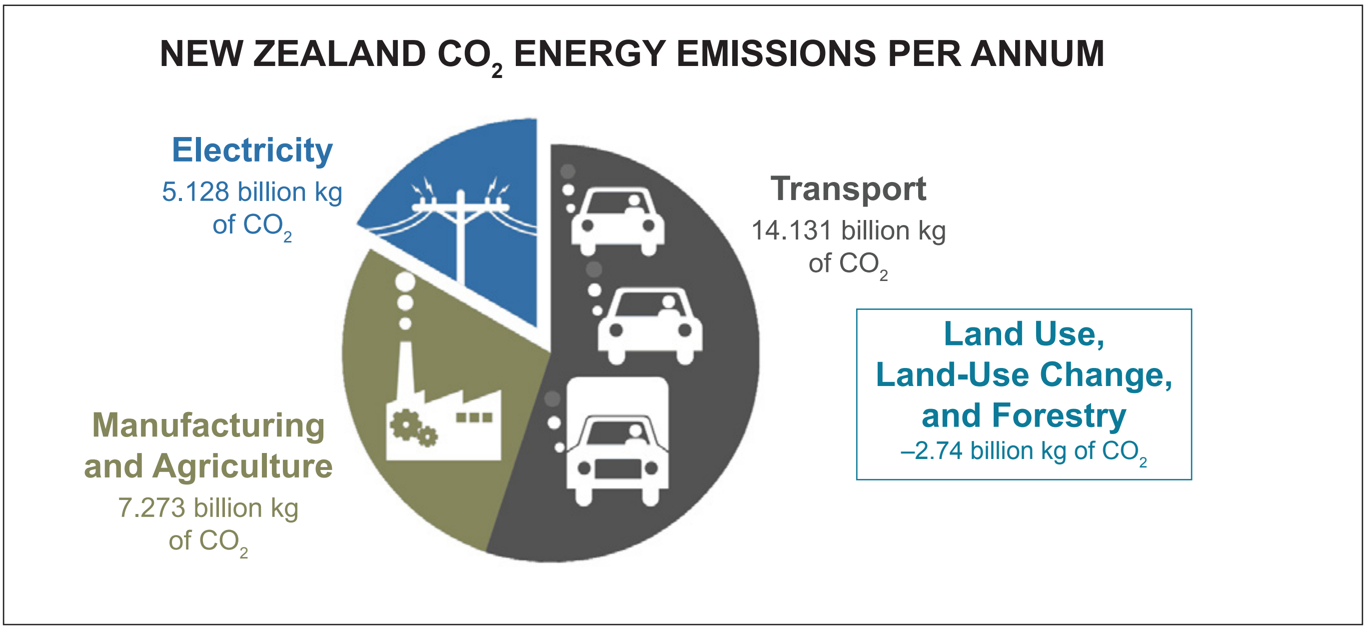
**Electricity Primary Fuel Emissions**
All types of electricity generation, including renewables, have some environmental impact such as greenhouse gas emissions associated with the construction, operation, distribution and transmission of renewable electricity.

However, what is not so impressive is that over 5 billion kilograms of $CO_2$ is still emitted from electricity generation in New Zealand each year.

The graph below shows the total emissions from the primary fuel source of thermal generation from coal, gas, geothermal (the form of energy conversion in which heat energy from within the Earth is captured and used), and CoGen (a very efficient technology to generate electricity and heat simultaneously).




Adapted from: https://ecotricity.co.nz/the-truth-behind-new-zealand-s-electricity-emissions




Source: Ministry for the Environment and EnergyLink (November 2017 electricity)

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New Zealand Qualifications Authority

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## 91946Q Interpret and apply mathematical and statistical information in context

Credits: Five

# PILOT ASSESSMENT

ASSESSMENT TASK

Check that this sheet is printed on both sides.

You are to compose a report on electricity usage in New Zealand. Your report will be divided into two parts. Section A is based on "Home" electricity usage, and Section B is based on electricity generation and the environment.

You will use the following questions below to form the basis of your report. You must refer to specific information contained in the Resource Booklet throughout your report.

Much of the information you will need can be found in the Resource Booklet provided.

## SECTION A: "HOME" ELECTRICITY USAGE

- Compare and comment on the prices per kW hour of electricity for "Homes" and electricity for "Businesses" between the years of 1990 and 2022.

  Use the information provided in Resource 1.

- There are many news articles claiming that the price of power has been increasing for New Zealand "Homes" customers.

  Comment on whether these claims can be supported.

  Justify your answer using the information from Resource 1 and Resources 2A and 2B in the Resource Booklet. Provide numerical evidence to support your answer where appropriate.

- Resources 2A and 2B provide information regarding the average "Homes" electricity expenditure and electricity usage per household in New Zealand.

  What conclusions can be made from this information?

  Justify and support your conclusions by providing calculations and referring to the information from Resource 1 and Resources 2A and 2B in the Resource Booklet.

  Provide at least TWO different comments.

- Using the information provided in Resource 3 in the Resource Booklet and your knowledge of a typical medium-sized New Zealand household, how should a household choose their electricity company?

  Discuss any assumptions and the limitations of your answer, giving at least TWO different supporting comments.

## SECTION B: ELECTRICITY GENERATION AND THE ENVIRONMENT

- Which electricity generation method creates the most environmental impact?

  Justify your decision with reference to the information provided in Resource 4 – 6.

- It is claimed that New Zealand is on track to reach 100% renewable energy target by 2030.

  Comment on this claim, using the information provided in Resource 4 – 6.

- With the information provided in the Resource Booklet and your own knowledge of emissions, what could the government do in order to reach "Zero Carbon Emissions by 2050" in New Zealand?

  Provide a detailed and justified response and discussion of one possible solution that the government could consider.

Mana Tohu Mātauranga o Aotearoa
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## 91946 Interpret and apply mathematical and statistical information in context

# EXEMPLAR

Achievement | TOTAL 04

Section A:

- From the graph, I can see that from 1990 to 1993, businesses cost more cents per kWh than homes. Then, from the years 1995 to 2022, electricity has cost more for homes than for businesses. In 1990, businesses used close to 12 cents per kWh, while homes used 9 cents per kWh. In 1994, both businesses and homes used 11 cents per kWh, and the years following, homes cost more than businesses. This could be due to the fact that businesses get offered special rates by energy companies, and so it costs less. Energy companies can offer businesses these deals, as the incredibly high demand for energy by businesses allow for companies to sell them at a lower cost and still make profit. Homes however, do not get these special offers, as they are not as large as a corporate business building, and so do not require as much energy as a business. The overall trend of the graph is that both are increasing. Additionally, there is a massive increase in the electricity rate between the years 2001 to 2015 for both graphs. This is possibly due to the fact that technology has been further developed and is more popular. Appliances such as TV's, smartphones, computers, laptops, could've led to more electricity being used, as it becomes more popular, and more mainstream.

- The claims can be supported due to the fact that the price of power is increasing for "Homes" customers. This is as the average electricity rates from 1990, were 9 cents per kWh, and in 2022, it was around 30 cents per kWh. However, from the years 2013 to 2022, the average home expenditure per household has stayed relatively the same. This could be due to the fact that technology has improved a lot from 1990 to 2013. This is as the appliances could've gotten more advanced, and thus require more energy. However from 2013 to 2022, computers, laptops, TV's, etc, are in most households, and the appliances in homes may not have improved as drastically, and so the energy it requires has not changed much. Additionally, in 1990, there was not as much demand for electricity as there is in 2022, and so the high demand for electricity now, may have made the price for electricity higher as well. So while the claims that the price of power has been increasing for New Zealand "Homes" customers overall, can be supported, in recent years, there is not much evidence that it has increased.

- From the graph, I notice that during the 3rd quarter of the year, the average usage of electricity peaks, and is the highest. This is possibly due to winter affecting the usage of appliances, as heating is required in order to stay warm. Additionally, the 1st quarter, being the months of January, February and March, is always the lowest, possibly due to summer and the warm temperature, where less appliances could be used. People could also be away on holiday, which means electricity is not used as much, as they are not at home. I notice that the seasonal trend is that leading up to the 3rd quarter, the expenditure increases each year, which then drops significantly in the 4th quarter. This is as the 4th quarter is in the months of October, November, and December, which is when the temperature starts to get warmer, and some families begin to go on holidays. An unusual feature I notice is that in the 3rd quarter of 2021, the expenditure is higher than the rest of the years. This could be due to the COVID-19 lockdowns forcing everyone to stay at home, and so more electricity is used. I notice that the overall trend shows that the average expenditure on electricity does not change that much, and it still costs relatively the same. This could be due to the fact that homes all have similar appliances, such as TV's, computers, fridges, etc, and there hasn't been any new revolutionary innovative piece of technology that has caused a demand for more electricity.

- Looking at all the electricity companies, Equator Energy seems to be the best plan for a typical medium-sized New Zealand household. This is as Equator Energy has a good customer rating, meaning other customers are satisfied with the company, which gives it a reputable look. Equator energy also has an open term, meaning if the family wanted to switch at any time, they could. Furthermore, Equator Energy uses 100% renewable energy, meaning that it is not only safer for the environment, which some customers may want, but can also last longer than every other company, as other companies may use fossil fuels, which are finite. This means that other companies may not be around in the future, as fossil fuels are finite, while Equator Energy utilises 100% renewable energy, which is infinite. The daily charge for Equator Energy is also significantly less than every other company. While the anytime rate and day rate are not cheapest, the night rate is the cheapest. Assuming the typical medium-sized NZ household would have 2 parents and 2 children, it would mean that the parents and children would be away during the day, due to work and school. This would mean that the off-peak plan could benefit them, as they may not be using as much power during the day, than they would during the night. However, the night rate is usually after 9pm, and so it would not be worth it for some families as it is quite late. Even so, the company is still an open term company, and so families would still have the option to choose between the anytime rate and the off-peak plan, depending on what suits them best. While the anytime rate is certainly not the cheapest option, all the other factors would still outweigh this disadvantage, as it is also not the most expensive.

Section B:

- The electricity generation method that creates the most environmental impact is coal. This is as from the graph, we can see that coal generates 2.508 billion kg of $CO_2$. This is nearly 1 billion more kg of $CO_2$ than gas, which produces 1.573 billion kg of $CO_2$. While we do not know which year this graph comes from, considering the large gap between coal and gas, it would be safe to assume that coal still produces the most $CO_2$ out of all the types of electricity generation in future years.

- The claim that New Zealand is on track to reach 100% renewable energy by 2030 could be true. This is as the majority of New Zealand's existing generating capacity already comes from hydro resources, which is a renewable source of energy. We can see in the map/overview that 57% of the operating capacity of power comes from hydro plants, and 9% of the power comes from wind plants. We can see that Wellington is very windy, so it is also a good place for many wind plants to be built. Places like Southland and Otago also get strong and consistent winds from the

Southern Ocean and Tasman Sea, and so more wind plants being built there would be beneficial. Furthermore, the South Island has a lot of lakes, and so they already have a lot of hydro plants operating there. Additionally, 78% of planned power capacity will come from wind plants, as it is eco-friendly, which when paired with the existing majority of renewable energy types, means that New Zealand's plan to reach 100% renewable energy by 2030 is definitely possible.

- A possible solution the New Zealand government could consider in order to reach zero carbon emissions by 2050, is to further expand upon the use of hydro and wind plants. This is as New Zealand already has a lot of hydro and wind plants, as our environment allows for lots of lakes and wind to be utilised, and so investing in more wind plants could be beneficial. This is as wind plants may be favoured over hydro plants, as there are already so many hydro plants in operation, and so wind plants would be more beneficial to use, as there are not as many. Moreover, too many hydro plants may be counter productive, as if there were too many hydro plants, there would not be enough water for all the hydro plants to use effectively, and it would've been a waste of space, time, and money building unnecessary hydro plants. Additionally, the government could also implement the use of solar panels, and use solar power as a type of energy source. This is as solar power is 100% renewable, and makes no carbon emissions so it should definitely be utilised more. Additionally, the best industry to target for limiting carbon emissions is the transport industry. This is as it not only produces the most carbon emissions, but also the fact that electricity and manufacturing has to be transported by vehicles that make carbon emissions. This means that there would be no point in prioritising cutting down on carbon emissions for the electricity and manufacturing industry, as they would still have to get transported by vehicles that make more carbon emissions than them both combined.

## Achievement

**Subject:** Mathematics and Statistics

**Standard:** 91946

**Total score:** 04

| Grade score | Marker commentary |
|---|---|
| A4 | The candidate has clearly understood the resources and has answered each prompting question. To achieve at Merit there would need to be more supporting evidence in the response to justify the statements made. |

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# Level 1 Mathematics and Statistics RAS 2023

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# EXEMPLAR

Achievement

TOTAL 04

SECTION A: "HOME" ELECTRICITY USAGE

The home's cost originally started at 9 cents per kWh, which is approximately 2 cents per kWh lower than the business cost, which starts at approximately 12 cents per kWh. Over the years, home increases at a faster rate and intersects with business in 1994 at 11 cents per kWh, meaning that the business has dropped by approximately 1 cent per kWh. This may be due to the fact that as the years go by, more people come in from out of New Zealand, which means more houses would be built, resulting in inflation. Houses had a steady increase up until 1998, where it stayed steady until 2001, then had a major increase of approximately 15.5 cents per kWh. This may be due to the increase in population, with houses causing more electricity usage. Businesses, on the other hand, had a very minor decrease of around 2 cents per kWh. This may be due to the fact that there may not have been many businesses. However, after 1999, business increased by nearly 10 cents per kWh, which could be due to more people coming in and starting businesses. Houses also typically use electricity longer, whether it's for the lights or the heater/AC. Most businesses are 9-5 meaning that the electricity they use is only for a certain amount of time. After Homes keep increasing overtime and business decreases, then it increases.  Overall, Homes have a faster increase than businesses and are at their peak; homes take over businesses, and by 2022, they will be nearly 14 kWh ahead of businesses.

The claim that the price of power has been increasing for New Zealand Homes can be supported. In 2014, the total average cost was $2094.25; in 2021, the average cost was $2147.39, meaning that the overall increase had been $53.14. However, looking closely at the four quarters individually, I can see that over the period of 7 years, it had minor decreases and increases up until 2019, when it had been increasing at an average cost of $47.50. This means that over the last 3 years, the prices have increased by $53.14, which overall means that the claim can be supported as inflation has occurred.

The home electricity expenditure usage per household in New Zealand is highest in Q3 and lowest in Q1. In Q3, which is July,August, and September, the prices are the highest,ranging from 600-700. This is due to the fact that it is winter during these months, meaning that electricity will not only be used for light but also for electric appliances such as an electric blanket, dryers and washing machines since the sun won't be to helpful, heaters (which may be more than 1), and devices. Q3 also stays the highest in price from 2013-2022. Another conclusion I can draw is that in Q1, the expenditure on electricity per household is the lowest from 2013-2022. In summer, it will be at its lowest due to the temperature going down, meaning the use of electrical appliances such as washing machines, dryers, heaters, and electrical blankets goes down. As the sun is out, there won't be much need for washing machines and dryers, Instead of using AC or fans in the summer, people want to open there windows to limit the use of electricity. In summer, the electricity usage will also be low as it is not daylight saving time, so it will not get dark early. Q1 is 300-400 lower than Q3, as Q1 ranges from 400-450.

For a medium-sized family in New Zealand, when looking for an electricity company, they should start by understanding their previous consumption of electricity and then compare the prices. By looking at their past usage, they can get an idea of how much money they can expect from companies, as they will know how much electricity they consume. Then comparing the prices, seeing if the prices are fixed, and how much it would cost will help them save money and understand which company is best for them. They could also look at the contract terms; some companies have an open term where you have the flexibility to leave anytime; others don't provide the same flexibility and have a contract term of a certain time that prevents you from changing companies. Looking at the contract term will be important,as you don't want to have limitations to a company that is not the best fit for you. Therefore, I believe comparing prices and understanding the contract terms will help you find an electrical company that suits your needs. Looking at customer ratings can also give you confidence when choosing a company and reassure you that it is a valid company.

SECTION B: ELECTRICTY GENERATION AND THE ENVIROMENT

The electricity generation method that creates the most environmental impact is coal. Coal provides 2.508 billion kg of $CO_2$ and is widely used considering it is reliable, affordable, and easy to supply. Electricity, manufacturing, agriculture, and transport are the industries from which coal emissions arise.

It has been claimed that New Zealand is on the right track to reach 100% renewable energy by 2030. This statement can be backed up as New Zealand currently uses 57% hydro, 9% Wind, and 10% geothermal, which are all renewable sources of energy. In the future, they are planning to increase Wind energy by 78%, Geothermal by 11%, and Hydro by 10%. Hydro, geothermal, and Wind are all definitions of Renewable energy. This leaves gas at 16% and coal at 5%, however, as stated, they will soon be replaced as the country aims towards 100% renewable energy. Overall, New Zealand is using 76% renewable energy currently but is planning to add more to make it 100% renewable and is also planning to replace Coal and Gas. These graphs indicate that New Zealand is on the right track, and the statement can be supported.

In order to reach “Zero Carbon Emissions by 2050” in New Zealand, the government can help reach this goal by setting up campaigns that not only run in public areas but are also compulsory for schools. By creating such campaigns and programs, it will spread awareness and draw attention to the issue. Making it compulsory for students to learn about this and understand it will make them alert and even encourage them to get better. Whether it is to change into reusable products or even just walk to school, these steps will contribute and help reach the goal by 2050. These programs could even run on the streets in crowded areas, handing out panfletes could influence New Zealand citizens to help make the country better. These programs can even be online, and with the use of popular platforms such as Tik Tok or Instagram, they can help change bad habits and reach a teen/young adult audience. I believe that a good way to reach the Zero Carbon emission goal by 2050 will only be possible if everyone does things to contribute, which could start by alerting everyone to make a change and encouraging them to do some things that may be hurtful differently.

## Achievement

**Subject:** Mathematics and Statistics

**Standard:** 91946

**Total score:** 04

| Grade score | Marker commentary |
|---|---|
| A4 | Apart from the response to the first question prompt, the candidate has either made unsupported (valid) statements or has not used a combination of sources to support their interpretation. |

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# Level 1 Maths and Statistics RAS 2023

## 91946 Interpret and apply mathematical and statistical information in context

# EXEMPLAR

Merit TOTAL 06

**Section A**

Compare and comment:

- Both homes and businesses are on an upwards pattern
- Homes have noticeably increased by more than businesses.
- Homes increased from 9 cents to around 30 cents which means it increased by a total of 21 cents over 32 years. This means that the average home electricity costs (cents per kwh) have increased by about 233.34% over 32 years.
- Businesses started at around 12 cents to around 18 cents meaning it increased by only 6 cents in total over 32 years. This means that the businesses average cost for electricity has increased by 50%.
- Businesses started by paying more for electricity than homes did from 1990-1994. They switched around and businesses gradually increased but the average cost of electricity for homes rapidly increased from around 2002-2014.

Claims be supported?

- Based on the information from the graph from resource 1 this claim seems to be true. This is because the homes have had a drastic increase on the graph whereas the businesses have only slowly increased over the years. This is also shown as the homes have increased by a total of 21 cents and businesses have increased by only 6 cents over the past 32 years.
- You can also see this from the information in the graph from resource 2A. In the first four quarters on the graph the average home expenditure was roughly Q2; $510 Q3; $630 Q4; $480 Q1; $430. This is lower than the final four quarters as they were roughly Q3; $700 Q4: $505 Q1; $450 Q2; $550. This means that in total Quarter 1 increased by $20, quarter 2 increased by $40, quarter 3 increased by $70 and quarter 4 increased by $25.
- In resource 2B you can see that even though the price of electricity has been increasing over the years, the usage of electricity has stayed roughly the same since 2013. This proves that the price is changing and it isn't the usage amount and that the claim made is true.

Conclusions from 2A and 2B

- Looking at the graph from resource 2A you can see that in every third quarter of the year there is a peak. I'm assuming that the 3rd quarter always peaks because it is the winter season, it is darker so more people would be using lights. Also since it is colder in winter more electricity would be used towards heating. You can see in resource 2B the numbers proving this and that in quarter three of every year not only is the average expenditure more, the average usage is also more. An example of this is how in 2019 Q3; $646.67 (which was during winter) which is $134.41 more expensive than quarter 2 (which wasn't winter time).
- The opposite also applies for this as you can see every first quarter of every year on the graph is always the lowest. I'm assuming it is because of summertime. I think it would be because less lights are needed because it is lighter, no heating is needed because it is hot and I also think less electricity in general would be used because people are out of their houses in the summer. You can also see this in resource 2B as every first quarter of every

year since 2013 has a drop and the usage and expenditure is lower than any of the other quarters. An example of this is in 2020 where Q1; $429.27 (summertime) which is $123.06 cheaper than quarter 2 (not summer).

- You can also see that the third quarter of 2021 is clearly the highest peak and you can see on resource 2B that the most money was spent and the most electricity was used. I believe this is because of the covid pandemic, I think more people would have been in their homes using more heating and power. We can compare this to 2013 quarter three where there were no pandemics, the expenditure was $633.41 and the usage was 2365.22kw. This is $62.42 less than 2021 and used 20.73kw less. Quarter three wasn't the only high quarter though, all the quarters in 2021 were quite high compared to other years. For instance, in 2016 the expenditure and usage was Q1;$413.69 & 1398.64kw Q2;$501.08 & 1730.51kw Q4;$467.59 & 1622.89kw. This is less than 2021 by Q1;$18.57 less & 6.16kw less Q2;$40.66 less & 68.28kw less Q4;$36.97 less & 31.16kw less.

How should a household choose their electricity company?

| **Company** | Rhythm energy | Wired 4 power | Equator energy | shout |
|---|---|---|---|---|
| **Anytime rate** | $0.1988 x 1800kw = $357.84 | $0.2146 x 1800kw = $386.28 | $0.2028 x 1800kw = $365.04 | $0.1675 x 1800kw = $301.5 |
| **Daily charge** | $2.99 x 31 = $92.69 | $2.3089 x 31 = $71.5759 | $1.7502 x 31 = $54.2562 | $2.5070 x 31 = $77.717 |
| **Off peak plan (day rate)** | 0.2113 x 800 = $169.04 | 0.2240 x 800 = $179.2 | 0.2146 x 800 = $171.68 | $0.1675 x 800kw = $134 |
| **Off peak plan (night rate)** | 0.1779 x 1000 = $177.9 | 0.1685 x 1000 = $168.5 | 0.1196 x 1000 = $119.6 | $0.1675 x 1000kw = $167.5 |
| **Total for off-peak plan** | $169.04 + $177.9 + $92.69 = $439.63 | $179.2 + $168.5 + $71.5759 = $419.2759 | $171.68 + $119.6 + $54.2562 = $345.5362 | $134 + $167.5 + $77.717 = $379.217 |
| **Total for anytime plan** | $357.84 + $92.69 = $450.53 | $386.28 + $71.5759 = $457.8559 | $365.04 + $54.2562 = $419.2962 | $301.5 + $77.717 = $379.217 |

- Judging from resource 2B, I'm going to assume that a typical medium-sized New Zealand household would use roughly 1800 kw/day of electricity and assuming that 1000kw get used at night time and 800kw get used during the day. (Also assuming there are 31 days in the month.)

- Judging from the table above, using equator energy on an off peak plan is the cheapest price. It is clearly the cheapest option at $345.5362 per month compared to the other off-peak plans. It is $94 cheaper than rhythm, $73.7 cheaper than wired 4 power and it's $33.7 cheaper than shout.
- For the anytime plans, shout is clearly the cheapest option at $379.217 whereas the other options are $450.53, $457.9559 and $419.2962.
- The option I picked is 100% renewable energy. Although, some customers might think it's a better deal to get the $100 credit from shout or the $50 credit from wired 4 power.
- Some customers might be big travellers who will be out of the house not using power so they may want to choose one that has a lower daily charge to suit them.

**Section B**

Which electricity generation method creates the most environmental impact

- As you can see in resource 6, coal has the biggest negative impact on the environment as it lets out the most carbon emissions into the environment. It produces 2.508 billion kgs of CO2 which is 2.508 billion kgs more than renewable sources like solar, hydro and wind power plants produce. Coal burning makes up only 5% of New Zealand's energy sources yet it still emits the most carbon. 16% of New Zealand's energy comes from gas plants yet coal still produces 935 000 000 kgs more even though it produces not nearly as much energy for us. Coal is still being produced in New Zealand purely because it is the cheapest power plant to run yet it is the worst for the environment.
- I believe hydropower is the power source that has the most positive impact on the environment today. Not only does it produce the most power for New Zealand but it also produces 0 kgs of CO2 into the atmosphere. It also doesn't require certain weather like sunny or windy conditions.

Comment on the claim

- I think New Zealand is definitely on track to reach 100% renewable energy by 2030 because in resource 5A-5B you can see all the planned operations and they are all renewable energy sources that don't produce any CO2. All New Zealand would have to do now is stop the production of electricity from coal, gas, cogen and geothermal plants.

What could the government do to reach zero carbon emissions by 2050

- More than 50% of New Zealand's carbon emissions per annum are caused by transport. To try and reduce their carbon emissions by 2050, New Zealand could possibly stop importing and producing cars that run on petrol. They could make only electric cars legal and advocate using electric cars over fuel cars. They should also make public buses electric and advise that more New Zealand citizens use the public bus. To ensure more people use the buses, they could make the cost to ride them cheaper or even free.
- Along with that, as they are already planning to start more renewable energy sources they could also illegalise unrenewable sites like coal, gas geothermal and cogen.
- The government could also advocate for more electricity heated households like heat pumps over having a fireplace.

- The government could also make a law that factories must use renewable electricity sources like solar power. They could also make a law that factories must use recyclable materials in their products when possible.

## Merit

**Subject:** Maths and Statistics RAS

**Standard:** 91946

**Total score:** 06

| Q | Grade score | Marker commentary |
|---|---|---|
| One | M6 | To attain Excellence, in Section A – the candidate needed to consider "how" to select an electricity provider – not decide which. The candidate also needed to use supporting evidence from the resources for their response to Section B(iii). |

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

# Level 1 Maths and Statistics RAS 2023

## 91946 Interpret and apply mathematical and statistical information in context

# EXEMPLAR

Merit TOTAL 06

Section A:

- From resource 1 we can find that the price of electricity for every kilowatt per hour which is in cents has steadily increased from 1990 to 2022. The price for cents per kWh for homes started at 9 cents per kWh and from 1990 to 2022 has risen to 30 cents per kWh. On the contrary, the price of electricity for businesses started at around 12 cents per kWh and from 1990 to 2022 has risen to around 18 cents per kWh. There is a big difference between the electricity rates for households and businesses as seen from above, there is a 12-cent difference between the two rates. The difference between household prices and business prices could be caused by some deals which apply to businesses. Because businesses use much more electricity, service companies may have different rates for these businesses as they use more of their services. The increase in electricity could be due to the increase in prices of other facilities such as manpower, land or maintenance which will cause the consumer prices to increase. From both sets of data, we can see a small dip in prices around 1998 to 1999, the reason for this slight decrease is unknown and could be caused due to worldwide situations or problems. After the year 2000, the prices have been on a steady increase with little slight decreases in prices, this could be due to the evolving technology which causes both households and businesses to use more electricity for items such as computers, printers etc.
- Yes, the claims that the price of power has been increasing for NZ homes is indeed true, we can see this from all resources 1, 2A and 2B. Though the price is increasing, the increase is only a slight increase and is hardly noticeable. From resource 1 we have already identified that the prices are indeed increasing, the cost per kWh for households started at 9 cents per kWh in 1990 and is now at 30 cents per kWh. The starting price for businesses in 1990 was at around 12 cents per kWh and has risen to 18 cents per kWh in 2022. This shows the increase in prices for electricity in both homes and businesses in NZ. In resource 2A we can see that the peaks for each year which are Q3 of each year are slowly increasing, with that said the increase is small and once again barely noticeable except for the increase in 2021. From the data we can see that in Q3 of 2020 the price cost was around $650 while in 2021 the price for Q3 sits around the $700 mark. This is a noticeable and significant increase as compared to the other years which have only increased each year by less than $10. From resource 2B we see the slight increase in prices once again. In Q2 of 2013 the average cost of electricity was $509.19, and the average usage of electricity was 1824.44 kWh. In Q2 of 2017 we can see that the average cost of electricity was $526.14, and the average usage of electricity was 1818.70 kWh.

This shows the increase throughout the years as the average household was paying more in 2017 than 2013 while using less electricity in 2017 compared to 2013.

- From resources 2A and 2B, a conclusion can be made that the price for electricity in NZ is slowly but steadily increasing while the amount of electricity by an average household stays in the same range. This conclusion is made because as seen from resource 2B, the average cost of electricity for Q2 of 2013 was $509.19, this was achieved while having the average usage of 1824.44 kWh. In 2022, the average cost of electricity was $546.41, while having only using 1736.39 kWh. This shows that even though the average use of electricity was much lower than 2013 in 2022 the cost of electricity in 2022 was still significantly higher than 2013, showing a difference of $37.22. In resource 1 we can also see the increase in prices for both houses and businesses. The rate for houses per kWh has increased by 18 cents from 1990 to 2022 and the rate for businesses has increased by 6 cents per kWh.
- The best option for an electricity company is Shout. Shout provides the lowest anytime rates and the lowest day rates. All day rates, night rates and anytime rates are all priced the same at $0.1675 per kWh, this means that for overall usage Shout is the best as there are no peaks where electricity making it ideal for homes where electricity is constantly used throughout the whole 24 hours of a day. Due to the fluctuation of New Zealand's weather the average household will most likely use electricity throughout the entire day, heaters during winter, fans and air conditioning during summer. Most households tend to have a parent who stays at home or works from home, increasing the electricity usage throughout the day. Shout also promotes $100 credit; this credit approximately helps pay for 5 days of electricity. Though Shout gives the best overall electricity prices depending on each household, Equator Energy may be better. Equator Energy provides higher day rates at $0.2146 per kWh as compared to Shout's $0.1675 but it also provides a lower night rate, at $0.1196 per kWh compared to Shout's $0.1675. The better choice is Shout assuming that there are people in the house during all times and electricity is being consumed but if during the day, both parents are out at work and all kids are at school, there is minimum amounts of energy being used during the day. This means that the better option could be Equator Energy as the common times with the most activity in the house is during night, the better night rates will help save money that way. The decision that Shout is better is also based on the assumption that electricity is being used daily. If a house was not as frequently used and lacks activity; for example, a nurse who mainly sleeps and works in the hospital once again Equator Energy may be the better choice. This is because Equator Energy has a daily charge of $1.7502 while Shout has a daily charge of $2.507.

Section B:

- Electricity generated using coal creates the most environmental impact. Resource 6 shows us that out of over 5 billion kgs of $CO_2$ emitted from electricity generation each year, 2.5 billion kgs come from coal generated facilities. Coal has the highest rates of $CO_2$ emissions while only taking up just 5% of New Zealand's operating capacity as seen in resources 5A and 5B.

- No, from the resources given I do not think New Zealand will be able to reach 100% renewable energy in 2030. With that said it is possible soon. Resource 5B tells us that 21% of current operating power comes from gas and coal powered resources and the total current operating capacity is 9,683 MW. The total planned capacity is 1,564 MW where only 1% comes from coal powered resources. The planned capacity is not nearly enough to cover the gap in the current operating capacity if coal and gas-powered resources were stopped. Coal and gas-powered resources provide 2,033.42 MW of our current capacity. The planned capacity is not nearly enough to fill this gap.
- One way the government could move towards zero carbon emission by 2050 is to increase the amount of power plants which use natural resources to produce power around the country. This means creating more windmills and wind powered facilities in windy areas such as Wellington or increasing the amount of hydro powered facilities in areas with more water such as the South Island or central North Island. An increase in solar powered facilities throughout the whole country could also help. To gain zero carbon emission the government must work in sections starting with electricity. To essentially run the country on 100% zero carbon emission power. The government will have to create enough facilities to fill the gaps which will be created by removing all coal, gas, geothermal and CoGen powered facilities. After gaining zero carbon emissions from electricity, the government must turn towards the manufacturing and agriculture aspects of our country and the transport throughout the country.

## Merit

**Subject:** Maths and Statistics RAS

**Standard:** 91946

**Total score:** 06

| Q | Grade score | Marker commentary |
|---|---|---|
| One | M6 | Good use of supporting evidence from the resources to justify interpretation and to answer the prompts. |

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

# Level 1 Mathematics and Statistics RAS 2023

## 91946 Interpret and apply mathematical and statistical information in context

# EXEMPLAR

Excellence

TOTAL 07

Section A

First Bullet point:
Comparing the 2 trend lines you can see that there is an overall increasing trend for both homes and businesses while the prices for “Homes” electricity per kW/hour has a steeper gradient and increase more as it increased by 21 cents over the last 32 years compared to businesses which increased by only 6.5 cents over the last 32 years. If you compare the 2 prices over the last 6 years you can also see that they have both become more stable and not rising as much per year lately and that they followed the same similar trend of increasing prices during 1999-2012 and have also both had a similar stable trend since 2016 onwards too. On average business kW/hour price rises 0.20 cents per year while compared to “homes” which rose 0.66 cents a year on average. You can also see business cent per kWh become cheaper from 1990-1999 before rising again compared to homes which has consistently been rising since 1990 as you can see through the trend line. They were also both the same price around 1994 which is when they intersected in cents per kWh as they both costed around 11 cents/ kWh. You can tell by the graph that businesses cents per kWh are cheaper than homes and this could be due to more demand from businesses meaning the fixed costs are more spread out and also because individual businesses can negotiate with the electricity provider.

Second bullet point: As you can see through recourse 1 graph.“Home” prices for Kw/hour has been increasing the last 32 years as it has increased by 21 cents over the last 32 years per kW/H as it started at 9 cents per kWh but rose to 30 cents per kWh. If you also look at recourse 2A and 2B you can see that the home expenditure (amount spent) per household has still increased a tiny bit on average in price. As of 2013 Q4 it was $479 for 1698 kw/hour compared to 2021 Q4 which was $504 for 1654 kw/hour. So you can see the price has increased even if the kw/ hour usage has decreased. The usage has decreased for a variety of reasons such as electricity appliances getting more and more efficient with energy thus using less electricity and people not being at home as often. The price for average overall expenditure has also increased a tiny bit over the years. As if you compare Q3 average home expenditures over the years 2018, 2019, 2020 and 2021 which respectfully costs $639.25, $646.67, $654.54 and $695.83 you can see how the price moved in an upward trend as the price for power becomes more expensive as well.You can also see that it peaks last year in price (2021 Q3 at $695.83 average) which shows how price has been increasing but this could also be due to covid meaning a lot more people stayed at home thus using more electricity as well but even so it still shows price has increased as there was similar usage level in 2015 Q3 (2373.71), 10 kw/ hour less but the price has still increased in 2021 Q3 compared to 2015 Q3 by $50. Which confirms the theory of prices increasing over the years.These claims can be supported because as you can see through the graph from recourse 1, the price for power has been increasing per kW/hour constantly over the last 32 years and through recourse 2B you can see even with the reduced fixed costs and efficient electricity tools the home expenditure is still slightly increasing too which shows how the price of power has been increasing. These claims can also be supported as there are enough values in order as there is a wide range of years in order to make an accurate claim.

Third bullet point: Looking at the graphs if we analyse graph 2A you can see a seasonal trend as it peaks during the winter (as homes use more electrical appliances because of the cold) and dips during the summer (less need for electrical appliances as it's already hot) which means that you can conclude that it peaks during Q3 and dips during Q1 and it hasn't changed throughout the years as every year they always mark the maximum and minimum average expenditure costs. Also there is no noticeable seasonal variation throughout the years so using both these points of information we can conclude the weather and the season has an effect on the amount of electricity used and money spent thus affecting the average home expenditure for each home every year and that the price doesn't vary too much year to year. It also peaked in price during 2021 Q3 as you can see through recourse 2B that the price and usage amount was the highest during that quarter. This could be due to covid but even so the usage levels weren't abnormally high so it shows the price has been steadily increasing over the years and how world events can change the amount of electricity used as well. You can also conclude also from graph 2B that the average price of electricity per kWh has gone up over the years as in 2013 Q2 it was $509 for 1824 kwH while in 2022 Q2 it was $546 for 1736 kWh which shows that the average price has gone up as you've used less electricity usage but the prices average for home expenditure has still increased. You can also make the conclusion that there isn't too much need for concern about price rising and becoming unaffordable as even though it spiked in 2021 Q3 this was due to covid so a one off event and in recourse 2A you can see that the following seasons didn't variate too much from the past few seasons so you can conclude that average home expenditure prices won't be getting more and more expensive every year yet and the overall trend is stable. You can also see through recourse 2A that there hasn't been too much of an increase in price even in the last 9 years which shows that power companies have been keeping the price to steady level even with inflation which also shows how they're keeping up with technological change and even when changing the price per kWh they aren't increasing the overall home expenditure by that much.

Fourth Bullet point: First of all medium sized NZ households should choose their electricity company based on what time they use electricity and how much electricity they use. If you look at a medium-sized NZ household in New Zealand, the amount of electricity they use and what time then I think the best option should be Shout electricity provider. Every household is different though so they should be choosing it based on the times they are using electricity and how much they are using it. Shout is a very good for medium sized household as it provides $100 credit which can help with bills especially in the economy and inflation that NZ has now and also because the anytime rate and off peak night and day rate are very low at $0.1675 / kWh. This isn't the cheapest compared to each individual plan for example night rate being cheaper with Equator energy ($0.1196/ kWh) so if a household is using electricity more often at night this may be a better option but overall if the household is using electricity a lot and often Shout would be cheaper in the long term as it has cheaper day rates as well as anytime rate compared to the other 3 plans. The daily charge matters a lot though as well as if you aren't home often, plans with high daily charge wouldn't be a good plan. The daily charge is quite high at $2.5070/ day for Shout compared to the cheapest option which is Equator energy at $1.7502/ day daily charge so choosing a electricity company is dependant on each family but on average in making this conclusion I'm assuming that medium sized households do use electricity often especially when kids come home from school and watch TV, do homework and stuff like that so I still think Shout would still be the best option but if a medium sized family doesn't use electricity too much or too often then they should make their decision based off of that instead. In making this conclusion I'm assuming that families use a lot of electricity and are using it all the time and also that the medium sized typical NZ family would be 2 kids and 2 adults. Some families might not use electricity at night or morning so may not get the added benefits of cheaper off-peak plans provided by Shout and I'm also assuming that a medium sized family wouldn't want a renewable option instead or any add ons as there aren't any included in the Shout plan/contract and no mention of renewable energy as well. There is also the added assumption that they are at home often as sometimes I noticed in real life that some medium sized families might not be at home too often, as the kids have school and the parents have work so the family members are not home during the day to really take advantage of Shout. Some limitations in choosing a power company and making this conclusion would be that if they were to be away from their house or are not using a lot of electricity and want to switch power companies. It would take 3-4 days to complete. So if you want to switch to a cheaper or better deal, it may take some time and for a lot of families every dollar counts so even if it is open term you can't just switch whenever you feel like or whenever the situation calls for instantly. It would mean it would take planning in advance to switch if you go on a vacation or are not going to be using a lot electricity for a time period or something. Another limitation is that not every power company is available everywhere in NZ so even if this is the best option for a medium sized family in NZ it may not be available to their home location if the power companies haven't set up the resources to deliver power to your home location which prevents you from choosing this plan. Overall because it is an open term plan meaning that there aren't a lot of restrictions on if you want to change the plan compared to Wired 4 Power which gives you some room for change in the future if something happens, and also because of the cheaper rates and selling point I think that Shout would be the best electricity plan for typical medium sized households in NZ as it provide you with that option and gives you a cheap deal. It also has the best customer rating out of the 4 options at 8 which shows just how pleased the customers who have used this power company before is, and could be a good representation of the quality of the service which may appeal for some families in NZ which makes it an even better and more reliable option as you NZ families should check the reviews beforehand on each power company before making their decision as some companies may not be as good and reliable in real life compared to how it looks on paper.

Section B

First bulletpoint: The electricity method that creates the most environmental impact would be coal as you can see through graph 6 that it generates the most kg's of Co2 per annum (2.508 billion) even though it only accounts for 5 percent of NZ operating capacity which shows that it is an extremely inefficient generation method and extremely bad for the environment as it creates the most emissions which harms the environment by far even though it is used so less in comparison to the other generation methods.Also because the unaccounted for damage such as mining and habitat destruction in order to use coal takes a toll on the environment too so coal is just overall inefficient and harmful for the environment.

Second bulletpoint: This claim could become true and is on track too as you can see through recourse 5B that the planned capacity consists of mostly renewable sources and only 1% percent non renewable. But this one percent planned capacity hinders NZ from reaching 100% as there would still be non renewable plants still operating and most likely won't close as soon as they are just opening so the companies need to make back their money first and if the government were to intervene it would take a massive investment as well. You can also see from recourse 4 shows that NZ still needs to cut down 0.25 GW of energy and replace them per year (as 20% of energy created is non renewable as of right now) in order to help NZ be on 100% renewable energy by 2030 but it is going in the right direction by making the planned power capacity 99 percent renewable sources (such as wind) but genesis energy who own the huntly steam power plant would need to shut the remaining 2/4 units as they consist of 500 MW of power by themselves. Which is run on a non renewable source and is powered by coal which is the most harmful generation method too and produces the most emissions as you can see through the top graph on recourse 6. Even if genesis energy switched those power plants to natural gas even though it would be better than coal, it would still not be completely non renewable and still would need to shut down completely in order to have NZ 100% renewable by 2030. You can also see through recourse 5A that there are still a dozen power plants operating and more planned non renewable sources (which is only 1% though; as Others* is specified on the website directed by the link too mean biomass oil and other non renewable sources) which hinder NZ's goals of 100% renewable energy. So in order to reach the goal these new power plants planned would have to be shut down as well. If the government does follow through with all these things there would be some consequences of closing down these power plants which would have to be dealt with, such as a power shortage. As the power sources have been shut down meaning more power plants would need to be built in the future to make up for the energy gap (have to still be renewable sources too in order to reach the 100% renewable goal). Also thinking about what to do with the abandoned powerplants as leaving them sitting there not doing anything isn't good for the environment either. So in conclusion this claim could become true but it would require a large investment and effort from the government as well as commitment in making sure that they don't open any non renewable powerplants and that they try to close the old operating powerplants as well. You can see by the graph such as recourse 5B that they have attempted too make this transition and are trying to accomplish this goal but some little things like opening those 2 non renewable powerplants seen on recourse 5A could hinder there overall progress.

Third bulletpoint: There are many solutions in order to be Zero Carbon emissions by 2050 but one possible effective solution would be to ban or restrict fossil fuel usage overtime and eventually try to completely minimise the use of fossil fuels and non-renewable sources by 2050. This is because fossil fuels account for the majority of electricity, transport and manufacturing emissions created. So by restricting the usage of it you can save billions of billions of emissions being produced and released into the atmosphere as you can see by the bottom graph of recourse 6 that transport accounts for 14.131 billion kg of Co2 produced. So by implementing these restrictions and switching to a more green option like electric cars would reduce emissions by an extreme amount if everybody co-operates. Also since it would be expensive for a lot of families, investing in public transport would help NZ too as you can see for other countries such as Great Britain, the better the public transport the less overall transport emissions created as there are less cars on the road releasing emissions. For electricity we are already heading in the right direction as you can see that most of the planned capacity through the pie chart on recourse 5B is non renewable and NZ is on track to reach the 100% renewable goal by 2030. But to completely reduce it to near 0 carbon emissions you would  have to shut down non renewable operating power plants as well as not planning anymore too. So the laws that restrict fossil fuels will help that as it forces companies to try to make the change for a more renewable energy source which in the end will help NZ get closer to achieving the "Zero Carbon emissions by 2050" goal but it won't reduce emissions completely for electricity as geothermal and cogen sources still release 1.047 billion kg of $CO_2$ so also trying to make those more energy efficient too could help the environment and decrease electricity emissions too. By restricting the fossil fuels like coal and oil through laws and other restricting methods you automatically reduce the amount of manufacturing emissions created as when you are transporting and creating buildings using a green way such as driving an electric car instead of using gas and oil it automatically decreases emissions produced on its own. In addition to these restrictions, planting a lot of trees and starting sustainable farming will help NZ actually become 0 carbon emissions by 2050 a lot more efficiently and easily. As you can see in the bottom graph on recourse 6 that forestry, land use and land use change accounts for 2.74 billion kg of $CO_2$ so by planting trees you automatically decrease the amount of forestry emissions in general and trees can help the additional emissions created as well. This lowers NZ's overall emissions per annum as well. Even if there is a little bit of carbon emissions produced NZ could still be net zero emissions as zero carbon emissions definition means to produce only what emissions the atmosphere can release sustainably. So even though we can't control the methane emissions produced by cows, if we try to control what we can, like by switching to renewable energy (through ecocity wind, hydro and solar) we can reduce the emissions produced so much that the environment can deal with those uncontrollable factors that are created. There are some limitations in this plan though such as the fact that even if you switch to renewable powerplants or electric cars they both still have their own effects on the environment even if they don't release emissions, such as land change when creating these new renewable powerplants such as a hydro dam. Also the batteries used in electric cars aren't great for the environment either and can have a lasting impact overtime. They are still better than the alternative non renewable methods we are using right now so using it will still have an overall positive effect and help NZ to reach its 0 carbon emissions goal. It would take a large effort from everybody though as you can through recourse 4 that other companies such as genesis energy own large non renewable power plants and would need to shut down such power plants in order to reduce emissions but this would hurt their profit so some companies might not co operate unless stricter laws are put in place. It also leave room for more power plants needed to be created, in order to fill the energy needs of the country left by the non renewable powerplants closing. The laws and restrictions required would also take a large investment from the government in terms of money and time and would  need to go through a lot of different processes to be official and in action as well. In the end this plan will be worth it though as it helps NZ to reach its zero carbon emissions goal by 2050.

## Excellence

**Subject:** Mathematics and Statistics

**Standard:** 91946

**Total score:** 07

| Grade score | Marker commentary |
|---|---|
| E7 | A good response to Section B (iii) that drew on the resources and ‘real world views.’ Apart from Section B (ii) – a detailed and accurate script. |

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New Zealand Qualifications Authority

# Level 1 Mathematics and Statistics RAS 2023

## 91946 Interpret and apply mathematical and statistical information in context

# EXEMPLAR

Excellence

TOTAL 07

Section A:

- For homes and businesses, the average prices for electricity per kW/hour both follow an increasing overall trend, from 1990 to 2022. The average electricity rate for homes starts at 9 cents per kW/hour and follows a steady increase until 1998, while for businesses it is around 12 cents per kW/h in 1990, this price decreases slightly until 1998. From 1994, after both average prices were 11 cents per kW/hour, prices for homes began to be more expensive than businesses and continued this way up to 2022. Both average prices for homes and businesses began increasing in around 2001, this begins to stop in 2012 for businesses and 2015 for homes. In 2022, prices for homes were 30 cents per kW/h, while for businesses it was around 18.5 cents per kW/h. Homes have been paying more money per kW/hour since 1994 on average, and this could be because businesses have deals with power companies as they use more energy and more frequently, being open during the day. While homes may require and use less electricity, with less or no people being there during the day, so would not be using lights/electricity.

- I agree with the claim that the price of power has been increasing for NZ homes customers being able to be supported. The average electricity rate follows an overall increasing trend, shown in Resource 1, while in Resource 2A the average home expenditure follows a slightly increasing trend, while showing a seasonal pattern. In 1998 the average electricity rate was around 14 cents per KWh, and increased to 28.5 cents per kWh in 2015. Since then, until 2022 the average rates follow a slightly increasing trend, with the average rate in 2022 being around 30 cents per kWh. In Resource 2A and 2B, in 2013 the highest average home expenditure was $633.41(Q3 - winter) on electricity per household, while the lowest average was $432.32 (Q1 - summer). In 2021, the highest average home expenditure was $695.83 (Q3 - winter), the highest average from 2013 Q2 and 2022 Q2 as well, while the lowest was $452.14 (Q1 - summer). The average home expenditures in NZ follow a slight increase.

- A conclusion we could make from this is that the average home expenditures per household in NZ follow a seasonal trend from 2013 Q2 to 2022 Q2 due to less usage of electricity per household on average. In Resource 2A, in the 4th quarter of every year the average home expenditures is the peak within that year, as shown in the year 2013 and 2022. Then, the average home expenditure reaches its lowest price within that year in the first quarter. This is because of less energy usage, as shown in Resource 2B. In the first quarter of a year, the average home usage is always less than in the last quarter. For example, in 2014, the average home usage of electricity per household was 1493.44 kW/h and the average home expenditure was $432.32 while in the last quarter it was 1721.30 kw/hour, around 200kW/h more and the average home expenditure was $496.87, around $70 more. Resource 2A and B covers 37 quarters, so is above the minimum sample size, so there is enough data to make conclusions about the quarters.

- However, this information may not be as useful as it only goes up to the second quarter of 2022. While that is relatively recent data, it is best to have an updated set to make conclusions, so up to 2023 Q2.
- Resource 1 proves less electricity is used in summer than in winter. This could be because in winter, heaters are used rather than aircons being used in summer, with heaters costing more on average. In summer, it is the long holiday where people go on vacation for a long time and so don't use as much electricity, but prices don't drop as low to around $0 average home expenditure because it is not for the whole quarter/summer and electricity is still required when no one is home (like for a refrigerator). So, from Resource 2A and B, we can see there is a seasonal pattern, but something that may affect our prediction of this seasonal pattern for prices and usage for the future, could be power cuts. This would lower the average home electricity usage, and so will lower home expenditure during that time. Global warming/climate change has also become an increased issue over the years, and so could influence the use of heaters and air conditioners. Inflation has also been occurring in New Zealand and so could affect prices, making them increase. Another pandemic may happen, forcing people to stay in their homes during lockdown, increasing the energy usage and so increasing prices. A suggestion I would make is to include/get data up to 2023, the second quarter.
- Another conclusion that can be made from Resources 2A and 2B are that the COVID-19 pandemic has had an effect on the average home expenditures. The lockdown of the pandemic occurred in the years 2020 and 2021. The average home expenditure in the 3rd quarter of 2021 has peaked and was around $50 more on average than the 3rd quarter of 2020. The higher prices are related to the seasonal pattern for average home expenditures, but this data suggests that average home expenditures have gone up in the Winter of lockdowns. This could be because people are staying at home, and not going to work, so are using more energy. Students are doing online learning and so are using their devices more frequently, as well as being home all day allows for usage of lights and other equipment being used for longer periods of time than it would've when they were not in lockdown. However, it is possible that it is just another winter with higher average home expenditures.

- Assuming a typical household has around 4 members, with 2 working adults and 2 children/students, the household should choose their electricity company based on customer ratings and prices for off-peak plans, if it is offered. In resource 3, it shows that there are many different things to consider, other things like contract terms, add-ons, anytime rates, day rate and night rate for off-peak plans, or even if a company has an off-peak plan for their customers, and daily charge.
- A typical household should focus on customer satisfaction because it sums up how households work with a certain energy company. This average rating would come from many different types of families and so is more typical to a household. From this you could see how it works for typical families as plans may not always be easy to figure out. They should also choose their electricity company based on rates. An off-peak plan is a better choice than an anytime rate because homes that mainly use

power at night will likely make savings on their power bills. It is better to spend less money on energy. Time families may use electricity after around 9pm is when charging their devices, and possibly using lamps over the night. They may use fans or heaters overnight too, as well as some students doing work after 9pm, the typical time for a night rate to start. This high energy usage after 9pm can save them more money if they were to choose a company that offers a more expensive anytime rate or no off-peak plan. They should choose an off-peak plan with the cheapest day and night rates possible, while considering other factors like customer satisfaction and daily charge, etc. A typical family is also away during the day with students at school and adults working.

- With this knowledge, with the options of companies in Resource 3, a company a household should choose Equator energy as they have the cheapest night rate ($0.1196/kWh) compared to other companies like Shout, which has no off-peak plan so has a night and day rate price of $0.1675/kWh, and Rhythm energy which has a night rate of $0.1779/kWh, and a day rate of $0.2113/kWh. Equator energy also has a customer satisfaction rating of 7.9/10, and is a close second to Shout with 8/10. Meanwhile Rhythm Energy has 6.4/10 and Wired 4 Power has 3.7/10. Additionally, Equator energy uses 100% renewable energy and is open term, so makes it easy for families to change companies. This is good as households need to know the plan that works for them, so may need to try different plans. Day rates tend to be more expensive than anytime rates, as shown in Resource 3. For Equator energy, the day rate is $0.2146/kWh, so is more expensive than their anytime rate of $0.2028/kWh. Another example of this is for Wired 4 Power, they have a day rate of $0.2240/kWh, which is more expensive than their anytime rate of $0.2146/kWh.

- However, in Resource 3 there is only information about 4 energy companies in NZ, and does not show whether these companies may offer different sorts of plans for certain families or whether they have any deals. So this may limit my recommendation of how a household may choose their electricity company as it does not offer all the information for the companies' plans. My assumption of a typical household may impact this recommendation too. This is as some households may not require as much energy during the night, with adults working at home during the day, and so may use a lot of energy during the day, increasing the price they would need to pay. So then an anytime rate may suit them more.Some households may not be willing to change their habits that may not suit an off-peak plan to ones that do.

Section B:

- The electricity generation method of coal creates the most environmental impact In Resource 6, you can see that per primary fuel source per annum, Coal creates 2.508 billion kg of carbon emissions, while other sources of thermal generation like gas creates 1.573 billion kg of carbon emissions, and another example is geothermal generation creating 0.735 billion kg of carbon emissions.

- I agree with this claim, New Zealand is on track to reach 100% renewable energy by 2030, which is in 7 years. Shown in Resource 5B, 74% of New Zealand's 9683 MW of operating capacity is renewable energy, with 57% of that being hydro. New Zealand also has a planned capacity of 1564 MW, none of those being for the power generated from gas or coal, and 78% being planned for wind. 99% of the planned capacity is for renewable energy.
- However, it does not specify the date/year of when this data was collected. By now, there may have been a significant change of plans, cancellation of certain planned power plants or new planned power plants, and a certain change in the operating capacity. Because of this, it is not certain that they have 74% renewable energy capacity and 99% of planned capacity being renewable.
- This is assuming that what Resource 5A and 5B specifies as 'Other,' are non-renewable types of energy. There are also some obstacles that they may face including the public being against this idea, as these changes from non-renewable energy to renewable energy may cause supply disruptions. The public may not be happy about the economic side, like changes to power plans and to costs of energy.

- Because, as shown in Resource 6, over 50% of carbon energy emissions per annum come from transport (14.131 billion kg of carbon energy emissions), less usage of transport creating carbon emissions can aid in NZ reaching their goal of Zero Carbon Emissions by 2050. The government could encourage usage of other types of transport like biking, walking, buses, and using a scooter and using less gas cars. This would therefore aid in the decrease of carbon emissions per annum if more people were to drive less. They can also do this by discouraging long road trips, driving on a particular day of the week, using certain types of vehicles, particularly ones that release a higher quantity of carbon emissions than standard vehicles, e.g. a large truck, having to carry a heavy load of items. All of these would be part of encouraging Kiwis to use/require gas cars less. This would be an entire movement of making New Zealand more accessible, and so can encourage others to use other forms of transport that don't produce or produce less carbon emissions. Over time, this can aid in their goal of reaching zero carbon emissions by 2050. If the government makes New Zealand a better place for transport other than vehicles, this does help.
- However, since this is more of a social movement, having to get the public on board may be an issue. This is also assuming that gas cars are the main source of carbon emissions for transport. There has been an issue regarding taxes, with businesses having to pay a large amount. Many people are not liking this and may not be in support of the banning of certain vehicles and driving on certain days because those are critical for businesses (e.g. transporting supplies). Some people may not live close to areas that they need access to, so are in places where things are not very accessible, may not like this idea as they may be very dependent on vehicles to get by. Because of this, I think that is why New Zealand should have the accessibility of places for residents involved in this plan.

- Although, there is a good chance people will get on board as other forms of transport like biking and walking are healthier and it all works towards a big goal of reaching net zero carbon emissions, especially with other environmental issues becoming increasingly more alarming. This is why they should do this plan. The government should get an updated set of data, the data shown in Resource 6 regarding NZ's carbon emissions per annum is from November of 2017. An updated set of data will help New Zealand see what they can focus on in order to reach their goal, as many things can happen in 4-5 years.

## Excellence

**Subject:** Mathematics and Statistics

**Standard:** 91946

**Total score:** 07

| Grade score | Marker commentary |
|---|---|
| E7 | A good response to Section A (iv). The candidate considers what is important to a family when deciding "how" to choose an electricity provider. They use evidence from the resources and consider limitations and assumptions in the context. |

# 1

91947R

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

# Level 1 Mathematics and Statistics RAS 2023

## 91947 Demonstrate mathematical reasoning

Credits: Five

# PILOT ASSESSMENT

RESOURCE BOOKLET

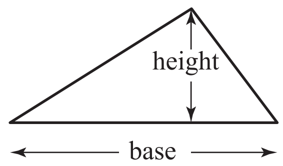
Refer to this booklet to answer the questions for Mathematics and Statistics RAS 91947.

Check that this booklet has pages 2–3 in the correct order and that none of these pages is blank.

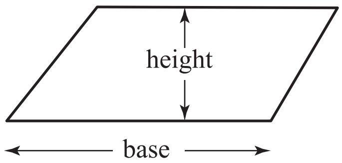
**YOU MAY KEEP THIS BOOKLET AT THE END OF THE EXAMINATION.**

## Measurement

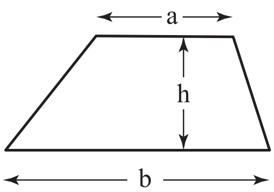
Area of triangle $= \frac{1}{2} \times \text{base} \times \text{height}$




Area of parallelogram = base × height




Area of trapezium $= \frac{1}{2}(a+b)h$

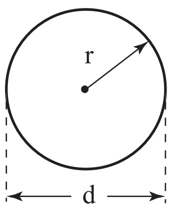



Circumference of circle $= \pi d$

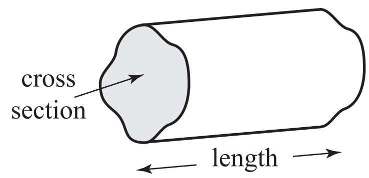
$= 2\pi r$

Area of circle $= \pi r^2$

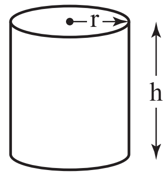
$\pi = 3.14$ to 2 decimal places




Volume of prism = area of cross section × length

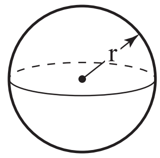



Volume of cylinder $= \pi r^2 h$



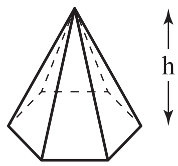

Volume of sphere $= \frac{4}{3}\pi r^3$

Surface area of sphere $= 4\pi r^2$

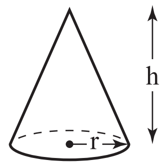



Volume of pyramid

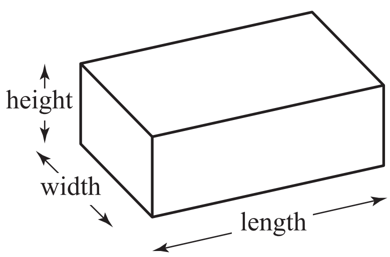
$= \frac{1}{3} \times \text{area of base} \times \text{height}$




Volume of cone $= \frac{1}{3}\pi r^2 h$



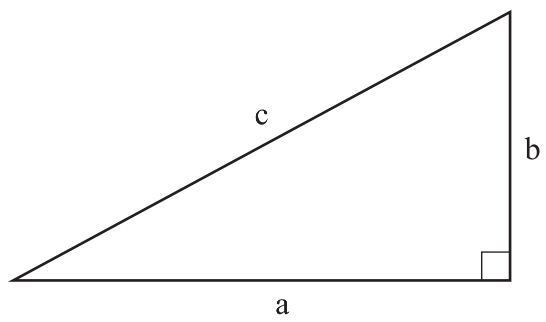

Volume of cuboid = height × width × length



## Right-angled Triangles

**Pythagoras' theorem**

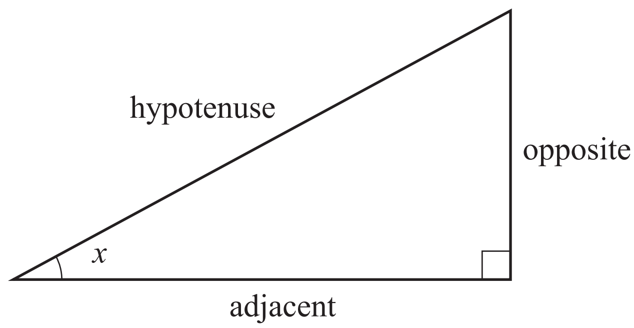
$a^2 + b^2 = c^2$




$\sin x = \dfrac{\text{opposite}}{\text{hypotenuse}}$

$\cos x = \dfrac{\text{adjacent}}{\text{hypotenuse}}$

$\tan x = \dfrac{\text{opposite}}{\text{adjacent}}$




*or*

opposite = hypotenuse $\times \sin x$

adjacent = hypotenuse $\times \cos x$

opposite = adjacent $\times \tan x$

1 hectare = 10 000 $m^2$ 1 litre = 1000 $cm^3$ 1 ml = 1 $cm^3$

Average speed = $\dfrac{\text{total distance}}{\text{total time}}$

Sum of internal angles of an $n$-sided polygon = $(n - 2) \times 180°$

Definition of bearings: "Bearings are measured from North, in a clockwise direction."

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

# Level 1 Mathematics and Statistics RAS 2023

## 91947 Demonstrate mathematical reasoning

# EXEMPLAR

Achievement

TOTAL 07

## QUESTION ONE

(a) Find the value of $T$ in the formula $T = \pi\sqrt{\frac{h \sin x}{g}}$ when $h = 2.5$, $g = 9.81$, $x = 75°$,

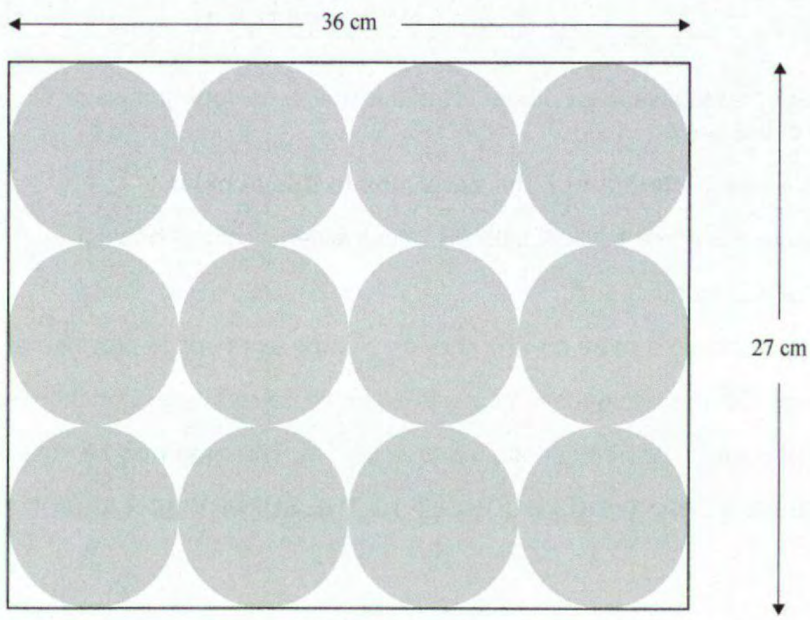
giving your answer correct to **four decimal places**.

$\pi \sqrt{\frac{2.5 \sin 75}{9.81}} = T = 1.5587$ (4 d.p.)

(b) The diagram below shows the top view of a rectangular box containing 12 cylindrical tins. The tins are all just touching each other and the sides of the box. Each tin is 15 cm high. Each tin has a label going all the way around its side, but not on the top or bottom. The box has dimensions of 27 cm by 36 cm by 15 cm.

*Diagram is NOT to scale*






Source: https://www.thewarehouse.co.nz/p/watties-condensed-tomato-soup-420g/R930548.html

(i) Find the **total area** of the labels of all of the tins in the box.

radius

36 cm ÷ 4 = 9 cm ÷ 2 ~~A~~ = 4.5 cm

27 cm ÷ 3 = 9 cm

2πr = 2 × π × 4.5 = 28.27 cm (2d.p.)

Base × height = area

area

28.~~7~~27 cm × 15 cm = 424.05 cm² × 12

area → A × N = TA     424.05 × 12 = 5088.6 cm²

↑ total area

number of tins

(ii) A different size rectangular box to part (i) has height 15 cm.

The box will also contain 12 cylindrical tins, which are all just touching each other and the sides of the box. The layout of the 12 tins within this box will be the same as in part (i).

Each tin is 15 cm high, and with radius $p$ cm.

Show that the **proportion** of the volume in the box that is NOT occupied by the tins is $\frac{(4-\pi)}{4}$.

volume ~~area~~ of box

h × w × L = ~~ar~~ volume

15 × 27 × 36 = 14580 cm²

πr²h = volume ~~area~~ of 1 can

π × 4.5² × 15 = 954.26 (2d.p.) × 12 = 11451.11 (2d.p.) cm²

~~area abea~~

Vb − Vc = vbw~~o~~oc ~~#~~ ← volume of box with out cans

volume of box ↑ volume of can

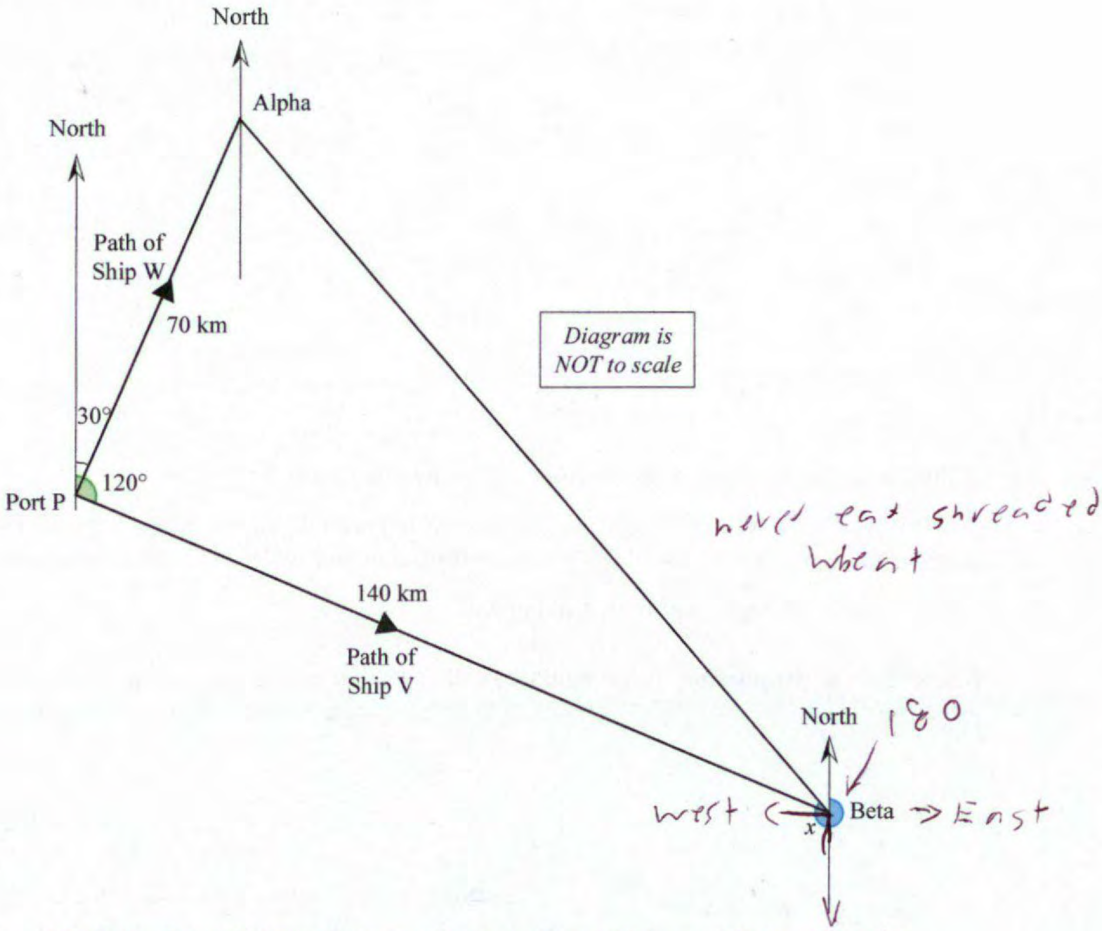
14580 − 11451.11 = 3128.89

$\frac{(4-\pi)}{4}$ = 0.2~~1~~312889 × 10000 = 3128.89

(c) Two ships leave Port P at the same time.

Ship W sails 70 km on a bearing of 030° to reach point Alpha.

Ship V sails 140 km on a bearing of 120° to reach point Beta.




(i) Find the direct distance between the two places Alpha and Beta.

~~$A^2 \times B$~~ ~~adjacent$^2$ + opposite$^2$ =~~

$A^2 + B^2 = c^2$ $140^2 + 70^2 = \sqrt{24500} = 156.52$ km (2dp.)

(ii) Find the bearing of Alpha from Beta, shown as angle $x$ in the diagram opposite.

*Show your working clearly.*

360 - 180 = 180 - 90 = 90 ÷ 3 = 30 = 120° west

(iii) The speed of ship W is $k$ km/hour, where $k$ is a positive constant.

The total time taken for the ships to complete their journeys to Alpha and Beta was four hours.

Find the speed of ship V, giving your answer in terms of $k$.

156.52 km/4 = 39.13 km/hour

V/W =

distance hours

D/h = K

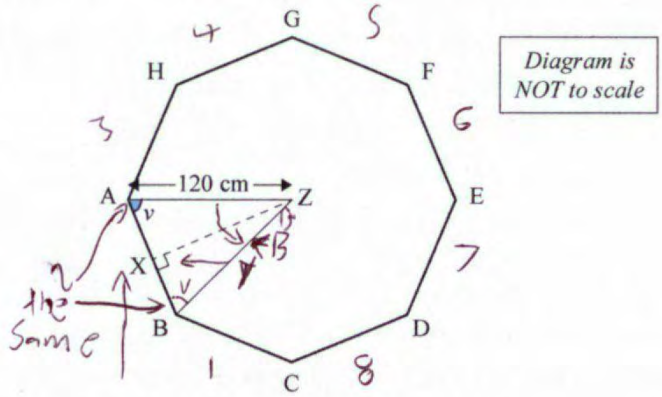
K + 140 = Time    K 140 = 5478.2

T/D = K    5478.2/140 = 39.13 km/hour

## QUESTION TWO

(a) The diagram below shows the top of a table which is in the shape of a regular octagon.

Length AZ = 120 cm. Point Z is at the centre of the octagon.




(i) Show that the size of $v$, angle ZAB, is 67.5°.

*Show your working clearly.*

Area of all angles = 180° − 67.5° = 112.5°

67.5 ÷ 2 = 1.3.5° because the

line in the centre is 90° so the

angles have to be the same

(ii) Find the area of the octagon.

~~A~~ AZ = BZ  120cm + 120cm = 240 cm −

~~n = number of sides of a polygon~~

opposite = X ~~adjacent~~

adjacent = B

opposite = adjacent × tan x X

120 × tan × 13.5 = ~~80 cm~~ 28.8

~~80 ×~~ 28.8 ~~X = Area~~ 120 = 3456 cm²

÷2 = 1728 cm²

(n − 2) × 180° = 180  × 8 = 13824

(iii) Another table, made in the same style, has its top in the shape of an $n$-sided regular polygon.

The length AZ = $p$ cm, where Z is at the centre of the table and A is one of the corners of the table.

Find the area of this new table top, giving your answer in terms of $n$ and $p$.

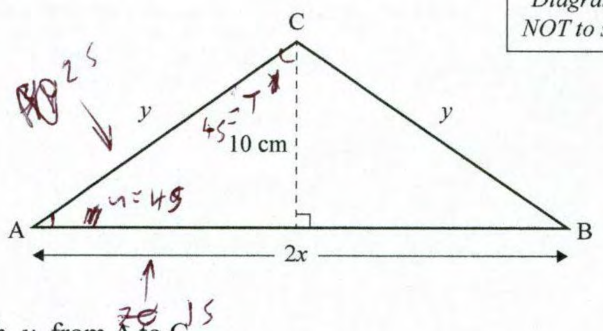
p x AB = Area ÷ 2 x n = area

(b) An isosceles triangle ABC has AB = $2x$ cm and AC = BC = $y$ cm.

The perimeter of the triangle ABC is 100 cm.

The length of the perpendicular from C to the line AB is 10 cm.

*Diagram is NOT to scale*




(i) Find the length, $y$, from A to C.

Give your answer in terms of $x$.

100 ÷ 2 = 50 − 10 = 40

180° − 90 = 90 ÷ 2 = 45°

y = 25   x = 15

(ii) Using Pythagoras' theorem, find the area of the triangle ABC.

*Support your answer with full mathematical working.*

15 × 2 = ~~30²~~ 30cm   30cm × 10 = 300 ÷ 2 = 150cm²

## QUESTION THREE

(a) (i) The table below represents points on a particular graph, $G_1$.

Find the equation of this graph.

$0 = 15$

| $x$ | $y$ |
|---|---|
| 1 | 20 |
| 2 | 25 |
| 3 | 30 |
| 4 | 35 |
| 5 | 40 |

) +5
) +5
) +5
) +5

$15 + x\,5 = y$

(ii) The table below represents points on another graph $G_2$.

Find the equation of this graph.

| $x$ | $y$ |
|---|---|
| 1 | 0 |
| 2 | 4 |
| 3 | 12 |
| 4 | 24 |
| 5 | 40 |

0
) +4
) +8
) +12
) +16
) +4
) +4
) +4

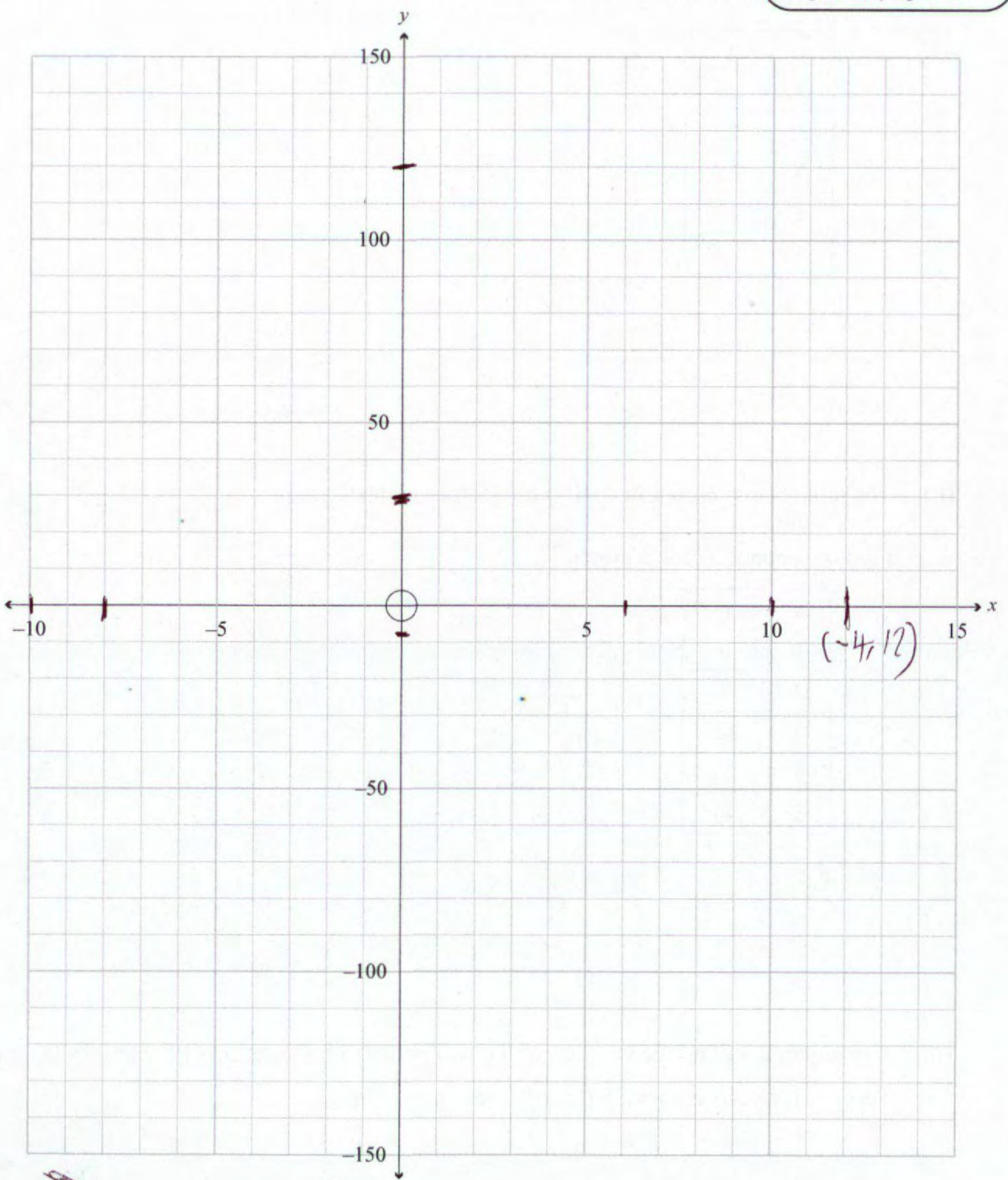
(iii) **Use algebra**, to find the $x$-values of the two points of intersection of the graphs $G_2$ and $G_1$.
*Support your answer with full mathematical working.*

They would intersect at
(5, 40) (x, y)
(10, 80) (x, y)

(b) Using the set of axes provided below, draw the two graphs of $y = 3x^2 - 14x - 120$ and $y = 10x + 24$.

**Using your graphs**, solve the equation $3x^2 - 14x - 120 = 10x + 24$.

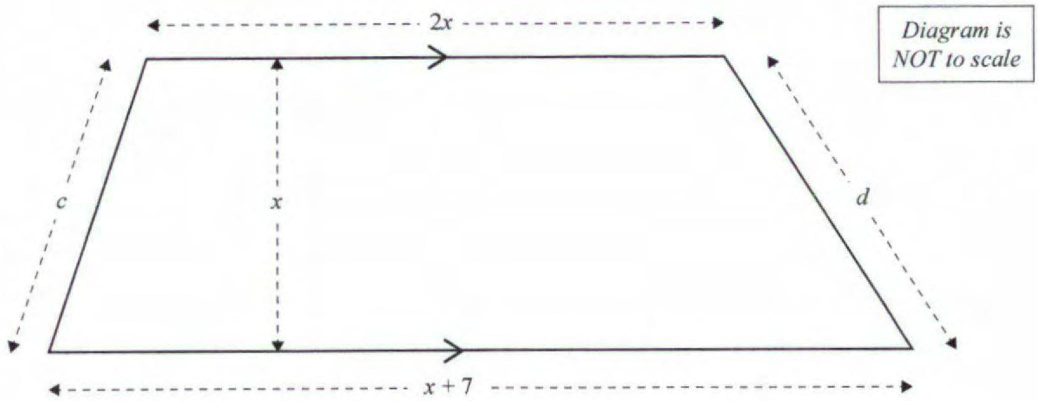
If you need to redraw your response, use the grid on page 12.




(-4, 12)

(c) The diagram below shows a trapezium with area of 20 $m^2$.

All lengths are in metres.




Find the value of $x$.

*Support your answer with full mathematical working.*

$\frac{1}{2}(a+b)h$   $20 \times 2 =$ ~~$20 \times 2$~~ $= 40$   $40 - 7 = 33$

Solve N

$\frac{1}{2}(2x + x + 7)x = -5, \frac{8}{3}$

$(x-1)(x+1)$

2   7

$1 \times 2$   $1 \times 7$

# Achievement

**Subject:** Mathematics and Statistics

**Standard:** 91947

**Total score:** 07

| Q | Grade score | Marker commentary |
|---|---|---|
| One | M5 | (a) Correct answer.<br>(b)(i) Correct answer.<br>(b)(ii) Incorrect answer.<br>(c)(i) Correct answer with appropriate working.<br>(c)(ii) Incorrect answer.<br>(c)(iii) Incorrect answer. |
| Two | N0 | (a)(i) Incorrect answer.<br>(a)(ii) Incorrect answer.<br>(a)(iii) Incorrect answer.<br>(b)(i) Incorrect answer.<br>(b)(ii) Incorrect answer. |
| Three | N2 | (a)(i) Correct answer.<br>(a)(ii) Incorrect answer.<br>(a)(iii) Incorrect answer.<br>(b) Incorrect answer.<br>(c) Did not set up correct equation or consistent factorisation (must show = 20). |

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

# Level 1 Mathematics and Statistics RAS 2023

## 91947 Demonstrate mathematical reasoning

# EXEMPLAR

Merit

TOTAL 15

## QUESTION ONE

(a) Find the value of $T$ in the formula $T = \pi\sqrt{\frac{h\sin x}{g}}$ when $h = 2.5$, $g = 9.81$, $x = 75°$,

giving your answer correct to **four decimal places**.

$\pi\sqrt{\frac{2.5\sin 75°}{9.81}} = 4.8595$

$T = 4.8595$

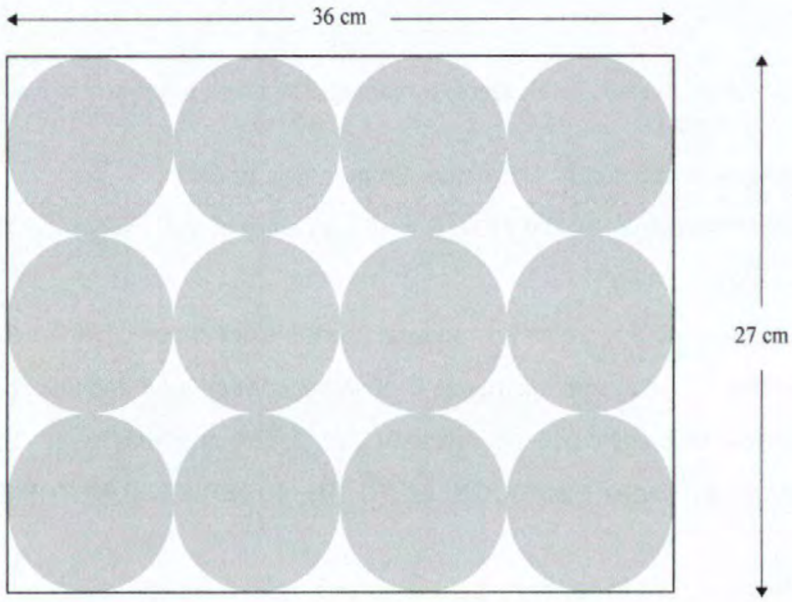
(b) The diagram below shows the top view of a rectangular box containing 12 cylindrical tins.
The tins are all just touching each other and the sides of the box. Each tin is 15 cm high.
Each tin has a label going all the way around its side, but not on the top or bottom.
The box has dimensions of 27 cm by 36 cm by 15 cm.

sphere $\frac{4}{3}\pi r^2$

cylinder $\pi r^2 h$

cone $\pi r^2 \frac{h}{3}$

*Diagram is NOT to scale*




Source: https://www.thewarehouse.co.nz/p/watties-condensed-tomato-soup-420g/R930548.html

height 15cm

cylinder surface area $= 2\pi rh + 2\pi r^2$



(i) Find the **total area** of the labels of all of the tins in the box.

side of cylinder surface area $= 2\pi rh$

~~$2\pi$~~ $36 \div 4 = 9$ $9/2 = 4.5$ $r = 4.5cm$

$2\pi \times 4.5 \times 15 = 424.12 cm$ (2dp)

$424.12 \times 12$ (cans) $= 5089.44cm^2$

(ii) A different size rectangular box to part (i) has height 15 cm.

The box will also contain 12 cylindrical tins, which are all just touching each other and the sides of the box. The layout of the 12 tins within this box will be the same as in part (i).

Each tin is 15 cm high, and with radius $p$ cm.

Show that the **proportion** of the volume in the box that is NOT occupied by the tins is $\frac{(4-\pi)}{4}$.

$12\pi p^2 15$

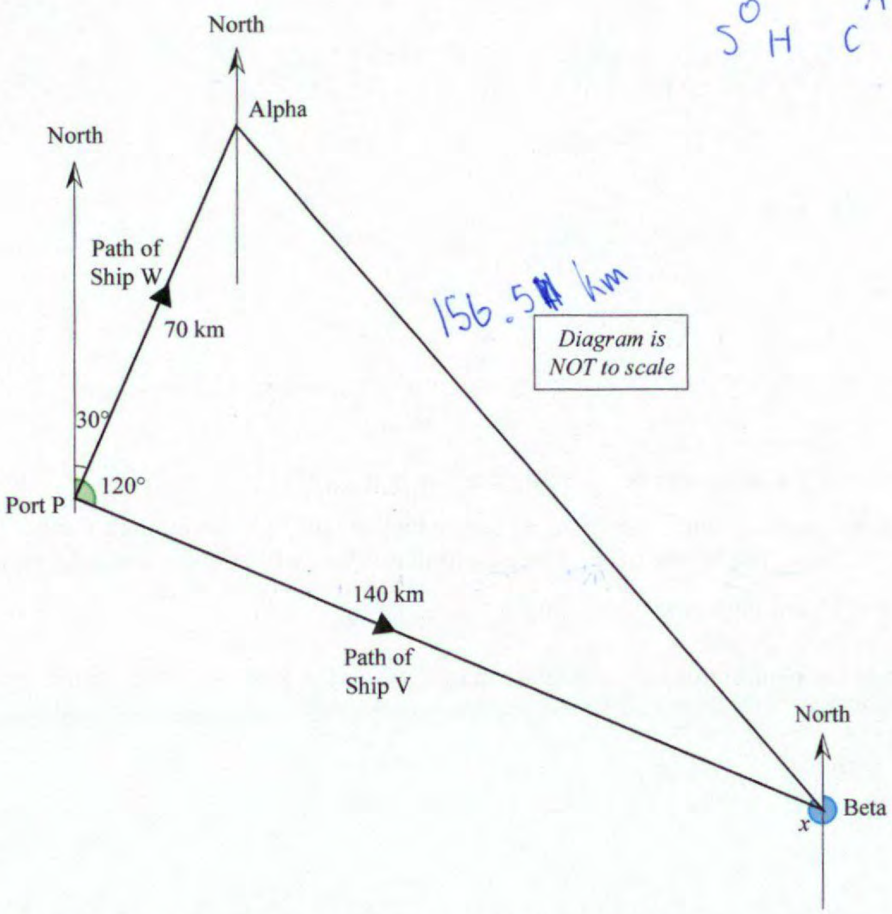
~~$12\pi p^2 h$~~

(c) Two ships leave Port P at the same time.

Ship W sails 70 km on a bearing of 030° to reach point Alpha.

Ship V sails 140 km on a bearing of 120° to reach point Beta.

SOH CAH TOA




4633

(i) Find the direct distance between the two places Alpha and Beta.

$a^2 + b^2 = c^2$

$70^2 + 140^2 = 24500 \quad \sqrt{24500} = 156.5$ (1 dp)

Distance between Alpha and Beta = 156.5 km

(ii) Find the bearing of Alpha from Beta, shown as angle $x$ in the diagram opposite.

*Show your working clearly.*

~~$\theta = \tan^{-1} \frac{opp}{adj}$~~ ~~$\tan^{-1}\left(\frac{70}{140}\right) = 0.4614$~~ ~~angle inside $x = 46.4°$~~

~~46.4 − 360~~ $\tan^{-1}\left(\frac{70}{140}\right) = 26.6$ (1dp) $26.6 - 360 = -333.4$

bearing $x = 333.4°$

(iii) The speed of ship W is $k$ km/hour, where $k$ is a positive constant.

The total time taken for the ships to complete their journeys to Alpha and Beta was four hours.

Find the speed of ship V, giving your answer in terms of $k$.

$k = \frac{d}{t}$ $\frac{70}{4} = 17.5$ km/h

$k = 17.5$

speed $= 17.5k$ km/h

## QUESTION TWO

(a) The diagram below shows the top of a table which is in the shape of a regular octagon.

Length AZ = 120 cm. Point Z is at the centre of the octagon.

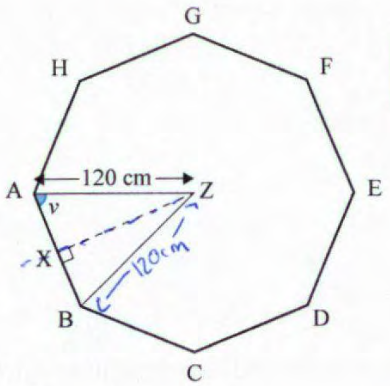



Diagram is NOT to scale

S O/H   C A/H   T O/A

All to 1dp

(i) Show that the size of $v$, angle ZAB, is 67.5°.

*Show your working clearly.*

~~opposite =~~ ~~opposite = sin θ × hypotenuse~~ ~~sin 67.5 × 120~~

~~Line BZ = 120cm~~ 360 ÷ 8 = 45 angle AZB = 45°

~~sin θ = opp/hyp~~ ~~sin⁻¹(120/120)~~ 180 − 45 = 135

since it isoceles, 135 ÷ 2 = 67.5 angle ZAB = 67.5°

(ii) Find the area of the octagon.

finding half triangle: opp = hyp × sin θ   120 × sin 67.5 = 110.9 (1dp)

line XZ = 110.9cm

$c^2 - b^2 = a^2$   $120^2 - 110.9^2 = 2101.2$   $\sqrt{2101.2} = 45.8$

line AX = 45.8cm

45.8 × 2 = 91.6cm   line AB = 91.6cm

$\frac{1}{2} \times b \times h$   $\frac{1}{2} \times 91.6 \times 110.9 = 5079.2\text{cm}^2$

5079.2 × 8 = 40633.6cm²

(iii) Another table, made in the same style, has its top in the shape of an $n$-sided regular polygon.

The length $AZ = p$ cm, where Z is at the centre of the table and A is one of the corners of the table.

$(n-2) \times 180^\circ$

Find the area of this new table top, giving your answer in terms of $n$ and $p$.

~~p = AZ p = 120~~ p = AZ n = amount of sides

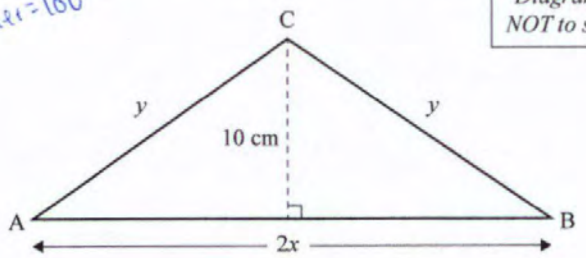
(b) An isosceles triangle ABC has AB = $2x$ cm and AC = BC = $y$ cm.

The perimeter of the triangle ABC is 100 cm.

The length of the perpendicular from C to the line AB is 10 cm.

*Diagram is NOT to scale*

perimeter = 100




(i) Find the length, $y$, from A to C.

Give your answer in terms of $x$.

page 13

~~$x = y^2 - 10^2$~~ ~~$2x + 2y = 100$~~ $y + x = 50$ $y + (50 - y) = 50$

$x^2 + 10^2 = y^2$ $y + x = 50$ $y + x = 50$ $y^2 - 50y = 50$

$2x + 2y = 100$ ~~$2x + 2(x + 50) = 100$~~ $x = 50 - y$

~~$2x + -2x + 50 = 100$~~

(ii) Using Pythagoras' theorem, find the area of the triangle ABC.

*Support your answer with full mathematical working.*

## QUESTION THREE

(a) (i) The table below represents points on a particular graph, $G_1$.

Find the equation of this graph.

| $x$ | $y$ |
|---|---|
| 1 | 20 |
| 2 | 25 |
| 3 | 30 |
| 4 | 35 |
| 5 | 40 |

0 | 1 2 3 4 5
15 | 20 25 30 35 40
+5 +5 +5 +5 +5

$y = 5x + 15$

(ii) The table below represents points on another graph $G_2$.

Find the equation of this graph.

| $x$ | $y$ |
|---|---|
| 1 | 0 |
| 2 | 4 |
| 3 | 12 |
| 4 | 24 |
| 5 | 40 |

0 1 2 3 4 5
0 0 4 12 24 40
+4 +8 +12 +16
+4 +4 +4

$y = 2x^2 - 2x$

(iii) **Use algebra**, to find the $x$-values of the two points of intersection of the graphs $G_2$ and $G_1$.
*Support your answer with full mathematical working.*

$y = 5x + 15$
$y = 2x^2 - 2x$
$y = 2x + 2$
$y^2 =$

$y$ ~~$= 5x + 15$~~
~~$y = 2x + 2$~~ $y = 2x - 2$
$2x - y = 2$

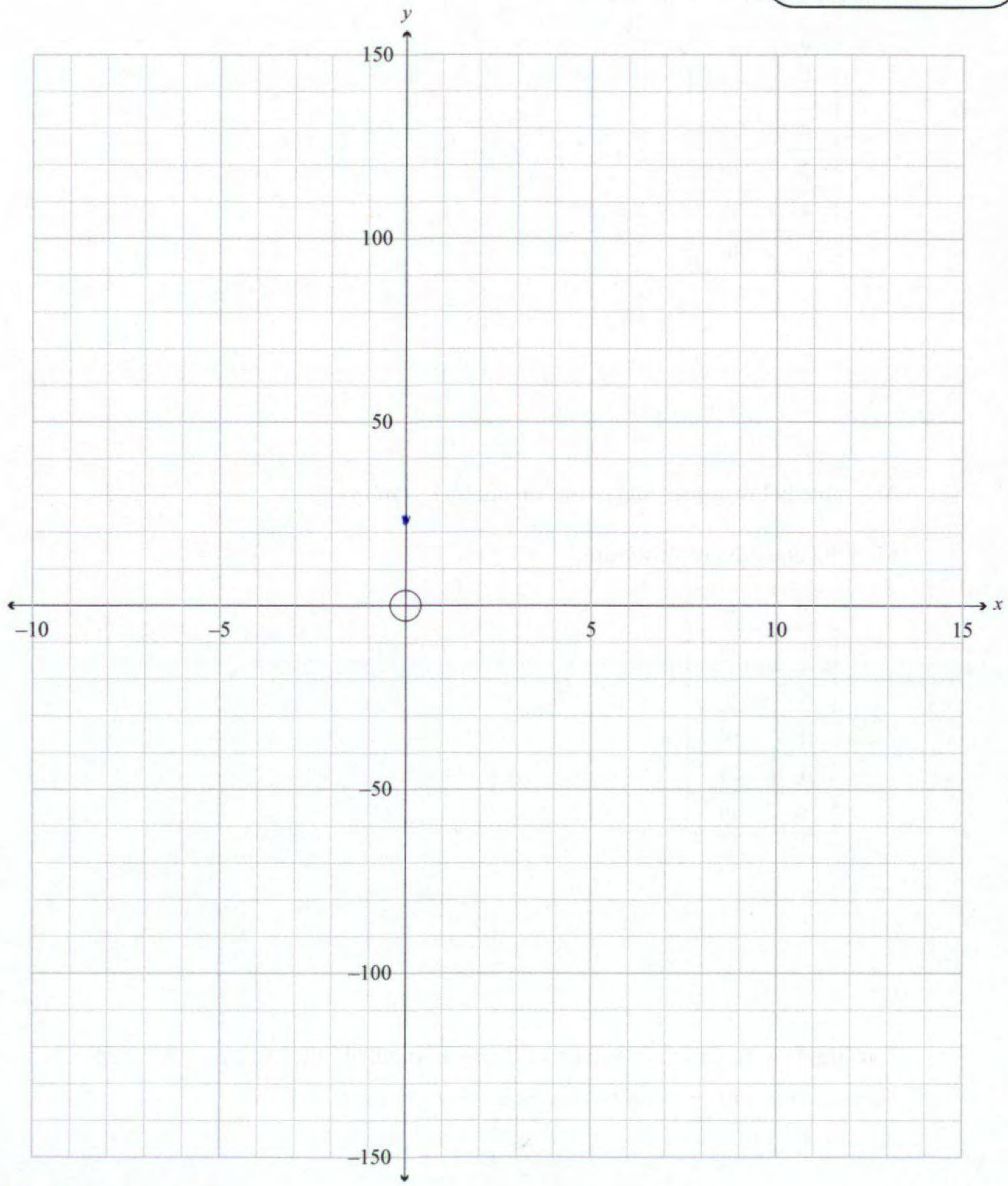
$y = 5x + 15$
$y = 2x - 2$

~~$y(2x - (5x + 15)$~~
$2x - (5x + 15) = 2$

(b) Using the set of axes provided below, draw the two graphs of $y = 3x^2 - 14x - 120$ and $y = 10x + 24$.

**Using your graphs**, solve the equation $3x^2 - 14x - 120 = 10x + 24$.

If you need to redraw your response, use the grid on page 12.



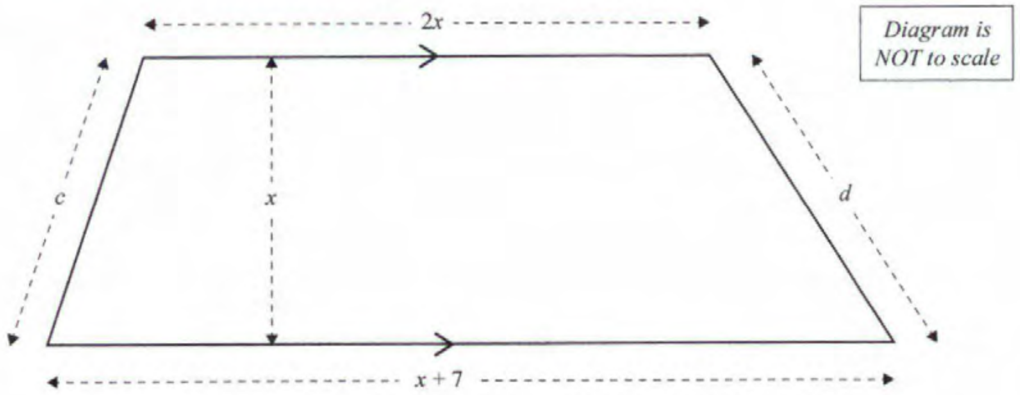

360
123469
24
15

$3x^2 - 14x - 120$

$3x^2 -$

(c) The diagram below shows a trapezium with area of 20 $m^2$.

All lengths are in metres.




Find the value of $x$.

*Support your answer with full mathematical working.*

## Merit

**Subject:** Mathematics and Statistics

**Standard:** 91947

**Total score:** 15

| Q | Grade score | Marker commentary |
|---|---|---|
| One | M5 | (a) Incorrect answer.<br>(b)(i) Correct answer.<br>(b)(ii) Found the volume of one tin or CAO.<br>(c)(i) Correct answer with appropriate working.<br>(c)(ii) Found, with appropriate working that ∠ABP = 26.57°.<br>(c)(iii) Incorrect answer. |
| Two | M5 | (a)(i) Clear and justified working to show that $v = 67.5°$.<br>(a)(ii) Correct answer but with premature rounding.<br>(a)(iii) Incorrect answer.<br>(b)(i) Found correct equation involving $x$ and $y$.<br>(b)(ii) No response. |
| Three | M5 | (a)(i) Correct answer.<br>(a)(ii) Both values of $x$.<br>(a)(iii) Incorrect answer.<br>(b) Incorrect answer.<br>(c) No response. |

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

# Level 1 Mathematics and Statistics RAS 2023

## 91947 Demonstrate mathematical reasoning

# EXEMPLAR

Excellence

TOTAL 24

## QUESTION ONE

(a) Find the value of $T$ in the formula $T = \pi\sqrt{\dfrac{h \sin x}{g}}$ when $h = 2.5$, $g = 9.81$, $x = 75°$,

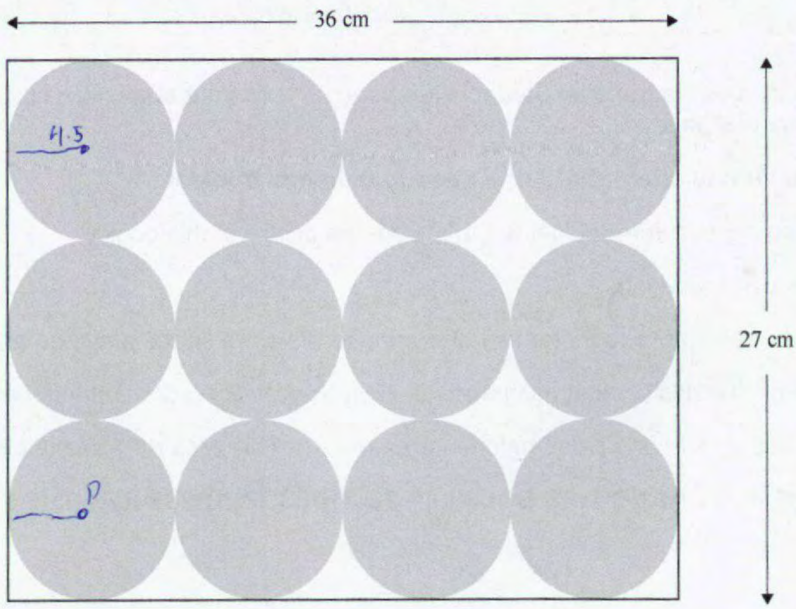
giving your answer correct to **four decimal places**.

$T = \pi\sqrt{\dfrac{2.3\sin(75)}{9.81}} = 1.5587.$ (4dp)
(use calculator)

(b) The diagram below shows the top view of a rectangular box containing 12 cylindrical tins.
The tins are all just touching each other and the sides of the box. Each tin is 15 cm high.
Each tin has a label going all the way around its side, but not on the top or bottom.
The box has dimensions of 27 cm by 36 cm by 15 cm.

*Diagram is NOT to scale*

$\pi r^2 h$ = volume
$2\pi rh + 2\pi r^2$ = S.A




Source: https://www.thewarehouse.co.nz/p/watties-condensed-tomato-soup-420g/R930548.html

(i) Find the **total area** of the labels of all of the tins in the box.

SA cylinder = $2\pi rh + 2\pi r^2$.

Since no top or bottom = $-2\pi r^2$. = $2\pi rh$.

radius = $36 \div 4 = 9 \div 2 = 4.5 cm^2$. height = 15. so $2\pi(4.5)(15) = 135\pi$.

$135\pi \times 12 = 1620\pi$.

$1620\pi = 5089.38 cm^2$. (2dp)

(ii) A different size rectangular box to part (i) has height 15 cm.

The box will also contain 12 cylindrical tins, which are all just touching each other and the sides of the box. The layout of the 12 tins within this box will be the same as in part (i).

Each tin is 15 cm high, and with radius $p$ cm.

Show that the **proportion** of the volume in the box that is NOT occupied by the tins is $\frac{(4-\pi)}{4}$.

Total length = 8p, width = 6p. volume box = h x w x l. l = 15.

$8p \times 6p \times 15 = 720p^2$.

volume cylinder = $\pi r^2 h$. r = p. so $\pi(p)^2(15) = 15p^2\pi \cdot \times 12 = 180p^2\pi$.

$\frac{(720p^2 - 180p^2\pi)}{720p^2 ~~180p^2\pi~~}$ so factor out $p^2$.

$\frac{p^2(720 - 180\pi)}{p^2(720)}$

so $\frac{720 - 180\pi}{720}$ ~~÷ 180 on both sides~~

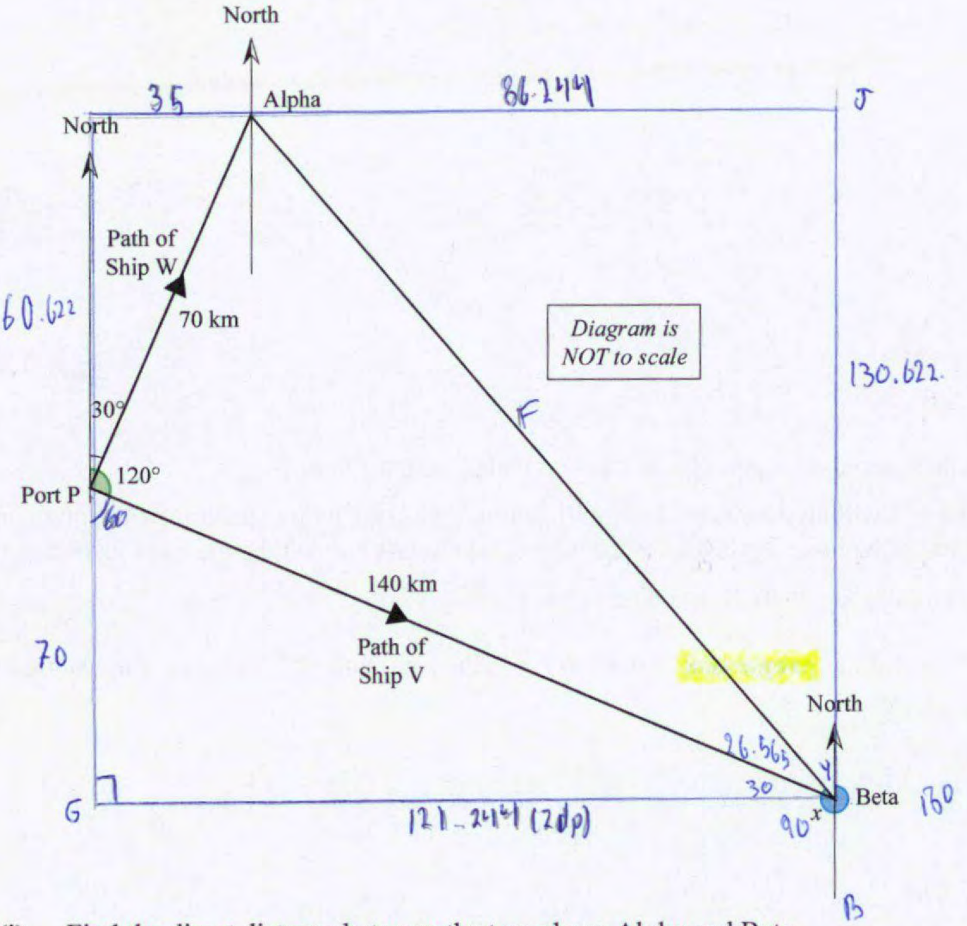
so factor out 180: $\frac{180(4-\pi)}{180 \times 4}$

$= \frac{4-\pi}{4}$ ✓

(c) Two ships leave Port P at the same time.

Ship W sails 70 km on a bearing of 030° to reach point Alpha.

Ship V sails 140 km on a bearing of 120° to reach point Beta.




(i) Find the direct distance between the two places Alpha and Beta.

From North to Alpha, use $70\sin(30) = 35$. ∠'s on St line $= 180° - ∠GPX = 60°$

From G to Beta use $140\sin(60) = 121.2424$ (3dp)

length AlphaJ $= 121.244 - 35 = 86.2424$.

For North port P, use ~~70tan~~ $70\cos(30) = 60.622$ (3dp)

For Port P, G use $140\cos(60) = 70$. $70 + 60.622 = 130.622$

Use $a^2 + b^2 = c^2$. $\sqrt{130.622^2 + 86.244^2} = c$, $c = 156.525$ km².

So from Alpha to beta is 156.525 km². (3dp)

or simplier way: $\sqrt{70^2 + 140^2} = 156.525$ km² (3dp)

due to right ∠ triangle

(ii) Find the bearing of Alpha from Beta, shown as angle $x$ in the diagram opposite.

*Show your working clearly.*

~~its on st line = 180° so North B = 180°. ∠GxB = 90°. Tan⁻¹~~
~~Tan⁻¹ ( 70 / 121.244 ) = 30° ∴ ∠GxP.~~

Use Tan⁻¹ ( Tan(y) = 86.244 / 130.622 = Tan⁻¹ 86.244 / 130.622 = y = 33.44°

∠ around point = 360°. 360 - ans = 326.56 so ∴ $\alpha$ = 326.56° (2dp)

(iii) The speed of ship W is $k$ km/hour, where $k$ is a positive constant.

The total time taken for the ships to complete their journeys to Alpha and Beta was four hours.

Find the speed of ship V, giving your answer in terms of $k$.

Average speed = Total distance / Total time.

Ship V went from port P to beta at 140km.

Ship W went from port P to Alpha at 70km hour and at k km/h.

So Ship W time = distance / speed  70/k is time it took so 4 - 70/k is time that ship V can use.

4 - 70/k = Time available. distance = 140. speed = distance / time =

140 / (4 - 70/k) = speed.

4/1 - 70/k = (4k - 70)/k

So ∴ speed of ship V = 140 / (4 - 70/k), simplify it = 140/1 ÷ (4k - 70)/k =

140/1 × k/(4k-70) = 140k/(4k-70)

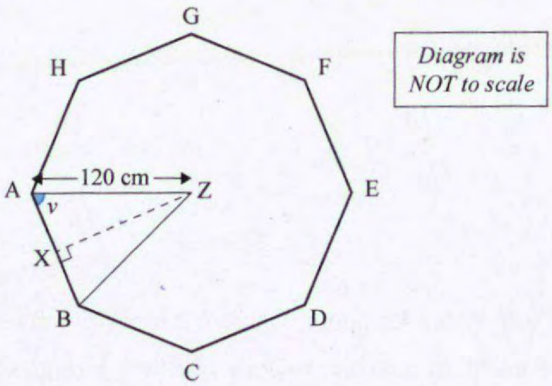
So ∴ speed of ship V = 140k/(4k-70) (simplified) km/h

V = 140 / (4 - 70/k) (unsimplified) km/h } equivilent

**QUESTION TWO**

(a) The diagram below shows the top of a table which is in the shape of a regular octagon.

Length AZ = 120 cm. Point Z is at the centre of the octagon.

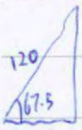



(i) Show that the size of $v$, angle ZAB, is 67.5°.

*Show your working clearly.*

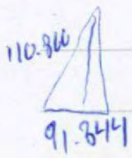
∠'s in octogon sum: (8-2)180 = 1080 ÷ 8 = 135. Bisects = 135 ÷ 2 = 67.5°. (1dp)

(ii) Find the area of the octagon.




so 120 sin(67.5) = 110.866 (3dp). = height (cm²)

½ base = 120 cos(67.5) = 45.922 cm² so full base = 91.844.




$A = \frac{1}{2} b \times h$

so $\frac{110.866 \times 91.844}{2}$ = 5091.188 cm² · ×8 tri =

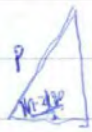
40,729.508 cm² total area. (3dp)

May be 40,729.504 due to rounding but it's 100% 40,729.50. (2dp)

(iii) Another table, made in the same style, has its top in the shape of an $n$-sided regular polygon.

The length AZ = $p$ cm, where Z is at the centre of the table and A is one of the corners of the table.

Find the area of this new table top, giving your answer in terms of $n$ and $p$.

So find angle sum: $\frac{(n-2)180}{n}$ = angle so  so use

$P\sin\left(\frac{(n-2)180}{n}\right)$ = length,

$P\cos\left(\frac{(n-2)180}{n}\right)$ = base. base x 2 = full base so $2P\cos\left(\frac{(n-2)180}{n}\right)$. (due to bisected it)

Area = $\frac{1}{2}$ b x h.

$\frac{\left(P\sin\left(\frac{(n-2)180}{n}\right)\right)\left(2P\cos\left(\frac{(n-2)180}{n}\right)\right)}{2}$ = one triangle area.

so n sided polygon = multiply by n

so

~~total area = n(Psin(n-2)180~~

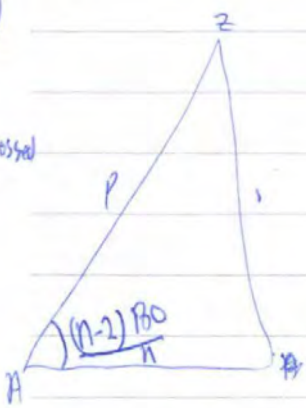
inside = $(n-2)(180) = \frac{180n-360}{n}$. so

$n\left(\frac{\left(P\sin\left(\frac{180n-360}{n}\right)\right)\left(2P\cos\left(\frac{180n-360}{n}\right)\right)}{2}\right)$

~~which is same as $n\left(\frac{\left(P\sin\left(\frac{180n-360}{n}\right)\right)\left(2P\cos\left(\frac{180n-360}{n}\right)\right)}{2}\right)$~~

~~equivalent~~

Note: The n doesn't matter position whether it's $n\left(\frac{\text{working}}{2}\right)$ or $\frac{n(\text{working})}{2}$ which is crossed out part.

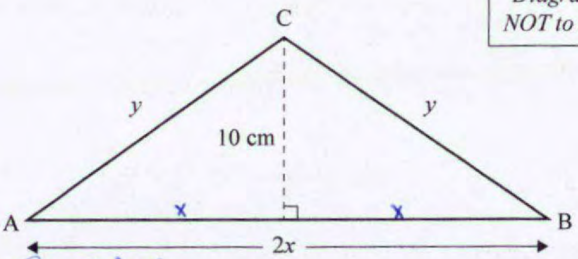


(b) An isosceles triangle ABC has AB = $2x$ cm and AC = BC = $y$ cm.

The perimeter of the triangle ABC is 100 cm.

The length of the perpendicular from C to the line AB is 10 cm.

*Diagram is NOT to scale*




~~Working at back~~

(i) Find the length, $y$, from A to C.

Give your answer in terms of $x$.

$2x+2y=100$

$2y=100-2x$ or using pythageros, $x^2+100=y^2$. $y=\sqrt{x^2+100}$

$y=\frac{100-2x}{2}=50-x$

using normal algebra, one pythageros. both valid. one simplified and other isn't.

(ii) Using Pythagoras' theorem, find the area of the triangle ABC.

*Support your answer with full mathematical working.*

Working at back, mini simplified working at bottom of the page in case unavailable. Area = 240 cm²

Please check back working there. Please note it is in final page, not the first ones of extra space if required.

$x^2+y^2=10^2$. ~~$\frac{2x \times 10}{2}$ area one~~

While perimeter = $2x+2y=100$, $y=\frac{100-2x}{2}$

so

$x^2+\left(\frac{100-2x}{2}\right)^2=10^2$, $\frac{(100-2x)}{2}\frac{(100-2x)}{2}$ $\frac{10000-400x+4x^2}{4}$

$x^2+\frac{4x^2-400x+10,000}{4}=100$

$\frac{4x^2+4x^2-400x+10,000}{4}=100$

$8x^2-400x+10,000=400$

$8x^2-400x+9600=0$ which is same as

$x^2-50x+1200=0$

I got $x=24$ at end, last page.

So area = $\frac{(10)(2(24))}{2}=240\text{cm}^2$

$a^2+b^2=c^2$, $a=x$, $b=10$, $c=y$. $x^2+10^2=y^2$.

While perimeter: $2x+2y=100$, $2y=100-2x$. $y=50-x$.

$x^2+10^2=y^2$. $x^2+100=(50-x)^2$. $x^2+100=x^2-100x+2500$

$100x=2400$, $x=24$ so ∴ $\frac{1}{2}b \times h$.

$b=2x$, $h=10$. $\frac{2(24)\times 10}{2}=\frac{480}{2}=240\text{cm}^2$

$240\text{cm}^2$.

## QUESTION THREE

(a) (i) The table below represents points on a particular graph, $G_1$.

Find the equation of this graph.

| $x$ | $y$ |
|---|---|
| 1 | 20 |
| 2 | 25 |
| 3 | 30 |
| 4 | 35 |
| 5 | 40 |

)5 )5 )5 )5

1st diff constant so $Y - Y_1 = m(X - X_1)$ while $m = 5$. $(1, 20)$ $X_1, Y_1$

Linear $Y - 20 = 5(X - 1)$

$Y = 5X + 15$

(ii) The table below represents points on another graph $G_2$.

Find the equation of this graph.

| $x$ | $y$ |
|---|---|
| 1 | 0 |
| 2 | 4 |
| 3 | 12 |
| 4 | 24 |
| 5 | 40 |

)4 )8 )12 )16 — )4 )4 )4

2nd diff constant. Quadratic. $a = \frac{\text{2nd diff}}{2} = 2x^2$ while $2 = a$.

$c = 0$ so $Y = 2x^2 + bx$, $0 = 2(1)^2 + b(1)$. $b = -2$

so ∴ $Y = 2x^2 - 2x$

(iii) **Use algebra**, to find the $x$-values of the two points of intersection of the graphs $G_2$ and $G_1$.
*Support your answer with full mathematical working.*

$Y = 2x^2 - 2x$, $Y = 5x + 15$. $2x^2 - 2x = 5x + 15$, $2x^2 - 7x - 15 = 0$. $-30$, $-7$; $-10$, $3$

$\frac{(2x - 10)(2x + 3)}{2} = 0$

$= (x - 5)(2x + 3) = 0$, $x = 5$, $x = -\frac{3}{2}$

(b) Using the set of axes provided below, draw the two graphs of $y = 3x^2 - 14x - 120$ and $y = 10x + 24$. (Plotted both with pencil)

**Using your graphs**, solve the equation $3x^2 - 14x - 120 = 10x + 24$.

*If you need to redraw your response, use the grid on page 12.*

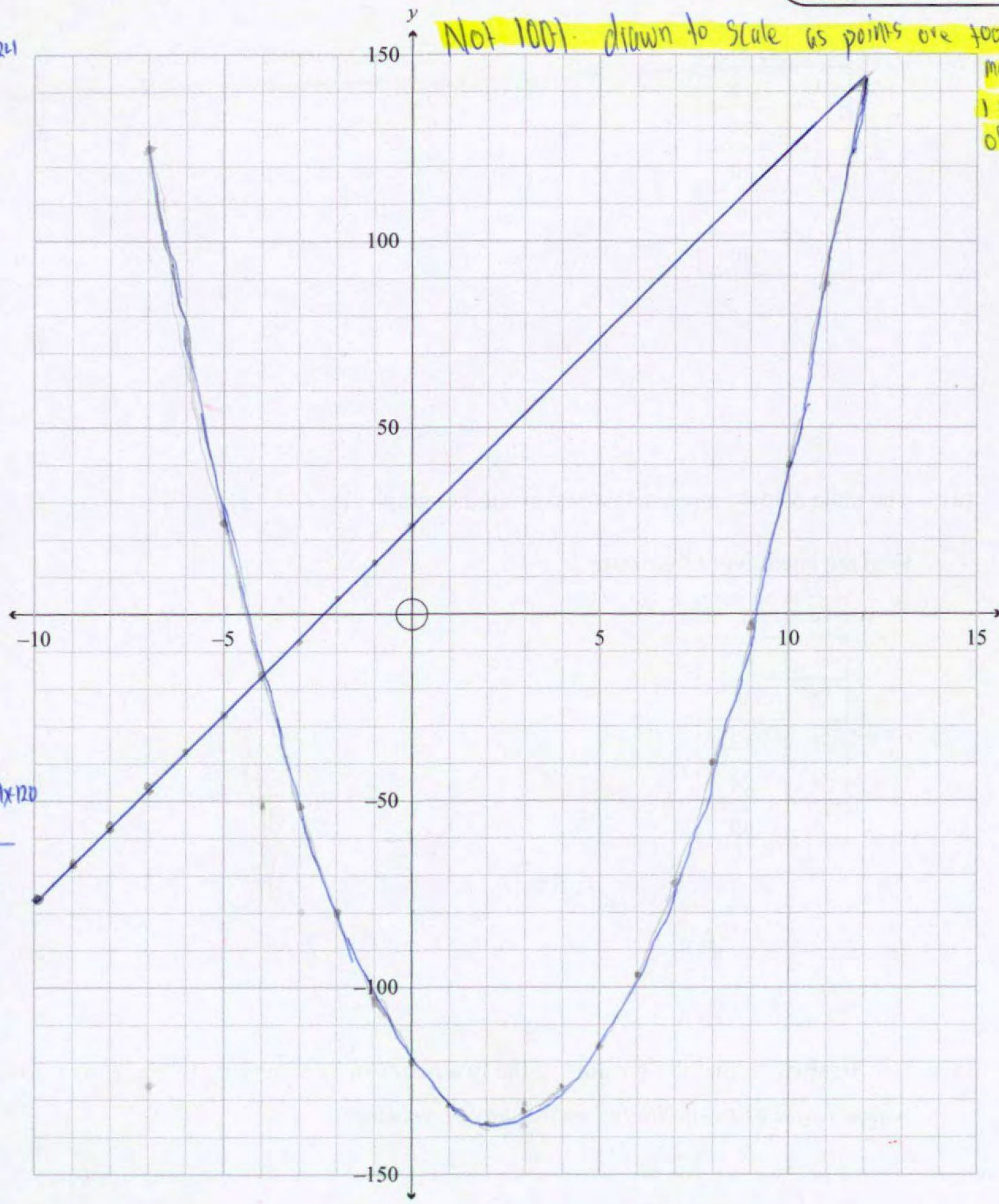
Not 100% drawn to scale as points are too far. may be 1 to 3 mm off.

Table 10x+24

| x | y |
|---|---|
| -10 | -76 |
| -9 | -66 |
| -8 | -56 |
| -7 | -46 |
| -6 | -36 |
| -5 | -26 |
| -4 | -16 |
| -3 | -6 |
| -2 | 4 |
| -1 | 14 |
| 0 | 24 |
| 1 | 34 |
| 2 | 44 |
| 3 | 54 |
| 4 | 64 |
| 5 | 74 |
| 6 | 84 |
| 7 | 94 |
| 8 | 104 |
| 9 | 114 |
| 10 | 124 |
| 11 | 134 |
| 12 | 144 |
| 13 | 154 |
| 14 | 164 |
| 15 | 174 |

Table $y = 3x^2 - 14x - 120$

| x | y |
|---|---|
| -10 | 326 |
| -9 | 249 |
| -8 | 184 |
| -7 | 125 |
| -6 | 72 |
| -5 | 25 |
| -4 | -16 |
| -3 | -51 |
| -2 | -80 |
| -1 | -103 |
| 0 | -120 |
| 1 | -131 |
| 2 | -136 |
| 3 | -135 |
| 4 | -128 |
| 5 | -115 |
| 6 | -96 |
| 7 | -71 |
| 8 | -40 |
| 9 | -3 |
| 10 | 40 |
| 11 | 89 |
| 12 | 144 |
| 13 | 205 |
| 14 | 272 |
| 15 | 345 |



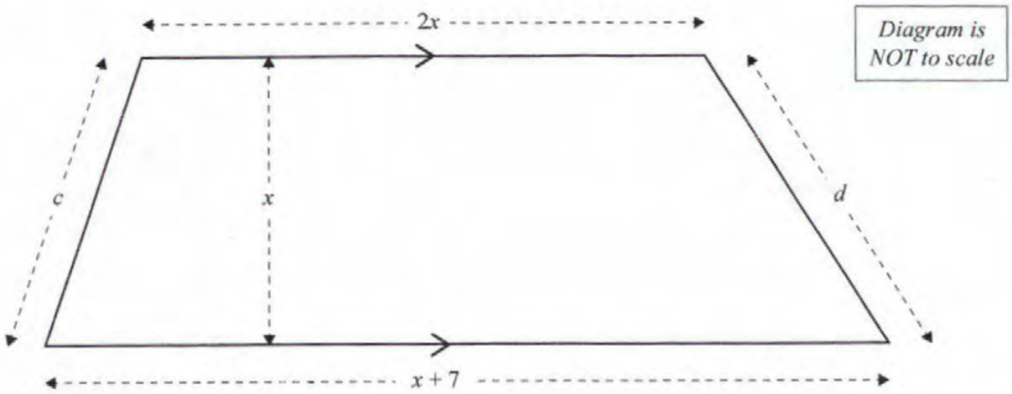

Visually seeing this, we can see that they intersect at (-4,-16) and at (12,144). graphs are just a visual way of solving equations, intersecting point = solve so ∴ solving, x=4, x=-12.

Proof: $3x^2-14x-120=10x+24$, $3x^2-24x-144=0$ $(3x-36)(x+4)=0$, $x=12, x=4$.

Rule: Intersecting points = solving.

(c) The diagram below shows a trapezium with area of 20 m$^2$.

All lengths are in metres.




Find the value of $x$.

*Support your answer with full mathematical working.*

area trapezium $= \frac{1}{2}(a+b)h$.

$= \frac{1}{2}(2x + x + 7)x$

$= \frac{1}{2}(3x+7)(x)$

$= \frac{1}{2}(3x^2+7x) = \frac{3x^2+7x}{2} = 20$

So $3x^2+7x=40$, $3x^2+7x-240=0$.

Factor then solve

$-120$, $7$

1 120
2 60
3 40
4 30
5 24
6 20
7 -
$-8$ $+15$

So $\frac{(3x+15)}{3}(3x-8)=0$

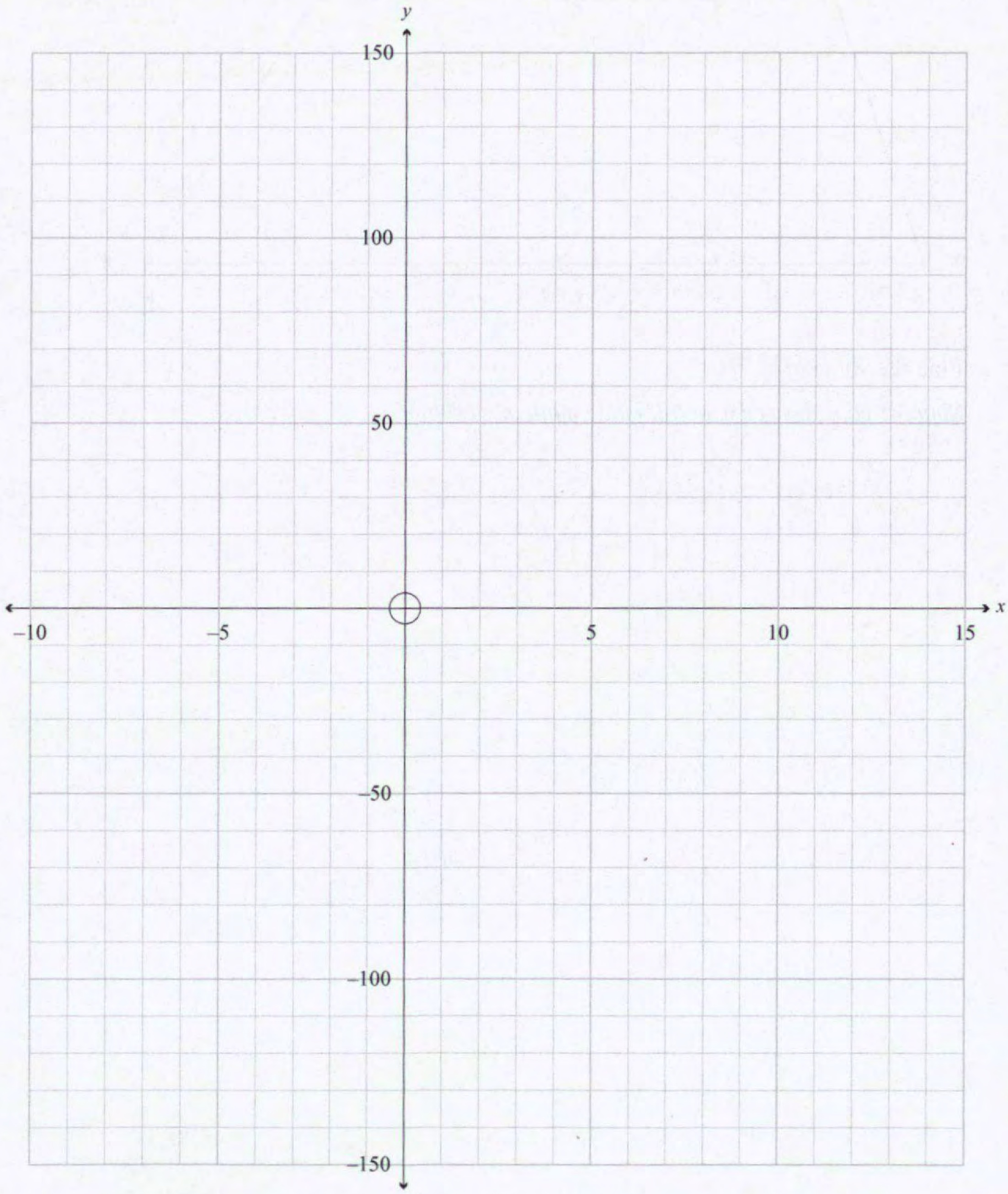
$=(x+5)(3x-8)=0$.

$x=\frac{8}{3}$, $x=-5$.

$x \neq -5$. $x$ must $>0$ due to dealing with potential real life situations $\therefore x=\frac{8}{3}$

**SPARE DIAGRAM**

If you need to redraw your response to Question Three (b), use the diagram below. Make sure it is clear which answer you want marked.



**Extra space if required.**
**Write the question number(s) if applicable.**

QUESTION NUMBER

Check end of page for working of 2bii.

**Extra space if required.**
**Write the question number(s) if applicable.**

QUESTION NUMBER

Check last page for working of 2bii.

**Extra space if required.**
**Write the question number(s) if applicable.**

QUESTION NUMBER

Check last page for working of 2bii.

$(50-x)(50-x) = 2500 - 50x - 50x + x^2$

**Extra space if required.**
**Write the question number(s) if applicable.**

QUESTION NUMBER

Here is working.

2bii. (Use pythageros therom, find area of triangle ABC).

$A^2 + B^2 = C^2$, so $A = x$, $B = 10$, $C = y$.

so $x^2 + 10^2 = y^2$. $x^2 + 100 = y^2$. ~~$y = \sqrt{x^2 + 100}$~~

~~While perimeter = $2x + 2y = 100$. $2x + 2(\sqrt{x^2+100})$~~

While perimeter = $2x + 2y = 100$. $2y = 100 - 2x$. $y = \frac{100-2x}{2} = 50 - x$.

$x^2 + 10^2 = y^2$. so $x^2 + 100 = (50-x)^2 = x^2 + 100 = (x^2 - 100x + 2500)$

so $x^2 + 100 = x^2 - 100x + 2500$.
$-x^2 - 100 \quad -x^2 + 100x$
$+100x$

$100x = 2400$. $x = 24$

Area $= \frac{1}{2}bh$.

$b = 2x$, $h = 10$. $\frac{2(24)(10)}{2} = 240 cm^2$

91947

## Excellence

**Subject:** Mathematics and Statistics RAS

**Standard:** 91947

**Total score:** 24

| Q | Grade score | Marker commentary |
|---|---|---|
| One | E8 | (a) Correct answer.<br>(b)(i) Correct answer.<br>(b)(ii) Provided correct volume of space. The candidate developed a chain of logical reasoning to calculate the volume of the box, NOT occupied by the tins in this box, with the radius of the tins given as a variable, thus forming a generalisation.<br>(c)(i) correct answer with working.<br>(c)(ii) correct bearing.<br>(c)(iii) provided correct expression for SV. The candidate formed a generalisation to determine the speed of a ship, given the speed of another ship and the time taken for both ships to travel a given distance. |
| Two | E8 | (a)(i) Clear and justified working to show that $v = 67.5°$.<br>(a)(ii) Correct answer.<br>(a)(iii) Finding a correct expression for the area of the whole polygon table. Candidate extended mathematical methods to solve the problem of providing a generalisation to determine the surface area of a polygon with n sides, given a length from the centre. Minor error ignored.<br>(b)(i) Found $y$ in terms of $x$.<br>(b)(ii) The candidate used a chain of logical reasoning to correctly calculate the area of a triangle, extending mathematical methods to solve a problem. |
| Three | E8 | (a)(i) Correct answer.<br>(a)(ii) Correct answer.<br>(a)(iii) Found both values of x.<br>(b) Both intersection points identified accurately and with evidence of use of an accurate graph. The candidate extended mathematical methods (graphing) to solve an equation.<br>(c) $x = \frac{8}{3}$ with evidence that $x = -5$ has been ignored. The candidate formed a generalisation to use the area of a trapezium and extended mathematical methods to solve a problem. |