Give all numerical answers to 3 sf. If you are typing your answers into the computer the use of mathematical typing software is not required so expressions such as 1.5^4 can be written as 1.5 ^ 4. You **do not** need to type out all stages of your answer just the key parts and the calculation that you have done to get to your answer. Intermediate working can be completed on paper which will **not be marked**. You should **use a scientific calculator,** but your method must be clear.

Paper C Total = 100 marks

1.

Online meeting apps have become very common. The data in this question is for one such app.

Daily Downloads	
January 2020	56 000
February 2020	170 thousand
March 2020	2.13 million

a) Work out how many more daily downloads there were

i) In February 2020 than in January 2020.

ii) In March 2020 than in February 2020.

iii) Do you think the daily downloads would have continued to increase at such a rapid rate - give a reason for your answer.

4 marks

Overall yearly	Quarterly	Revenue (millions of dollars)	Net Revenue (millions of dollars)
2018		121.5	- 4.1
	1st quarter 2019	60.1	- 1.3
	2nd quarter 2019	74.5	0.5
	3rd quarter 2019	90.1	- 0.6
	4th quarter 2019	105.8	1.2
2019		330.5	0.0
	1st quarter 2020	122	0.2
	2nd quarter 2020	145.8	5.5
	3rd quarter 2020	166.6	2.2
	4th quarter 2020	190.6	15.3
2020		625.0	…..

b) In the table above all figures have been rounded to 1 decimal place.

i) During which quarters of 2019 did the company make a net loss?

ii) How has the overall yearly revenue been found?

iii) Give a brief reason of why the overall net revenue for 2019 is not -0.2

iv) Between which two values should the overall net revenue for 2020 lie?

6 marks

c) i) The net revenue is less than the revenue. Give one possible reason for this difference.

ii) The revenue rather than the net revenue shows more clearly the steady growth in popularity of the app. How does the data support this?

iii) Between which two quarters of 2020 does the revenue show the highest percentage increase.

4 marks

d) At the end of March 2020 in the US there were 4.84 million users a day of the app. This was a 67% increase of the number of daily users in January and 151% increase of the number of daily users at this time in the previous year.

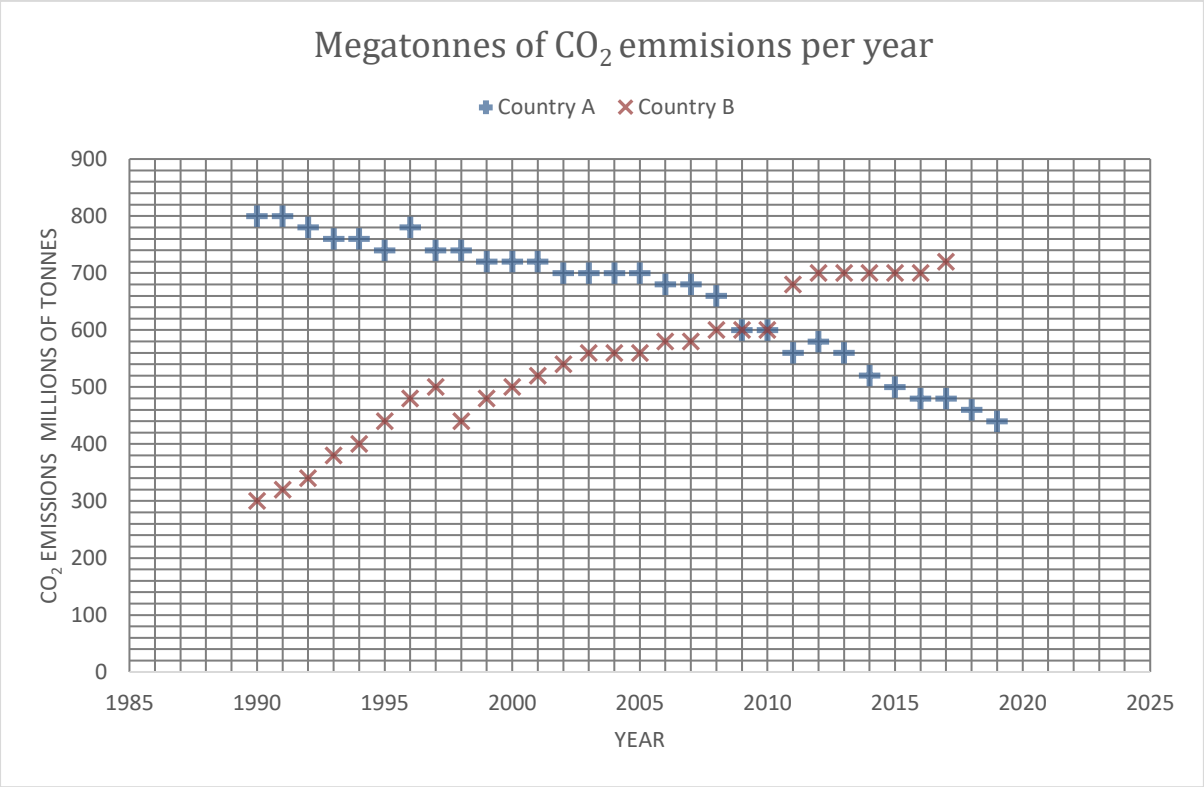
i) How many daily users were there in January?

ii) How many daily users were there in March 2019?

4 marks

<u>18 marks</u>

2.



The graph shows the yearly CO_2 emissions for two countries rounded to the nearest 20.

a) **For country A**

i) Describe the overall trend.

ii) Give a pair of consecutive years between the emissions have risen.

iii) Complete the following coordinates (1990, …..) (….. , 440).

iv) Use your coordinates in a) iii) to calculate the equation of a line passing through these two points. Give your answer in the form $y = mx + c$

9 marks

b) Country A is aimed to reach a target of 230 million tonnes in 2030 and zero million tonnes in 2050.

i) Using your equation from a) iv) comment on whether the target for 2030 seems reasonable.

ii) Using your equation from a) iv) find the year in which the CO_2 emissions would become zero if the overall trend shown by the graph continued.

4 marks

c) In 2012 country A decided to decrease the CO_2 emissions more rapidly

i) What evidence is there on the graph to support this?

ii) Using the coordinates for the data in 2012 and the (2050, 0) what was the rate of decrease per year needed to reach the zero emissions in 2050?

iii) Comment numerically on whether they were on track to meet this aim using the data for 2019.

5 marks

d) Compare the data sets for country A and country B. Write down 3 significant differences between them.

3 marks

e) For country B Hannah works out the equation of the line of best fit as

$y = 14.8x - 29100$ giving her figures to 3 sf

i) use your line in a) iv) to find where it intersects Hannah's line.

ii) comment on whether your answer seems reasonable compared with the data shown on the graph.

4 marks

f) Niamh works out the equations of 3 lines for each of the different sections of the graph

$y = 30.0x - 59400 \qquad 1990 \leq x \leq 1997$

$y = 12.2x - 23900 \qquad 1998 \leq x \leq 2010$

$y = 4.29x - 7930 \qquad 2010 \leq x \leq 2017$

i) What do the numbers 30.0 , 12.2 , and 4.29 tell you about the rate of CO_2 emissions?

ii) Give one advantage and one disadvantage of Niamh's method compared to Hannah's.

ii) Choose one of Niamh's equations or Hannah's equation to make what you consider to be the best prediction for the CO_2 emissions for country B in 2050 giving reasons for your choice of equation.

6 marks

<u>31 marks</u>

3. The table below shows energy consumption from the top four renewable sources in the US. All figures are given to 3 decimal places and are given in quadrillion British Thermal Units (Btu). A quadrillion in the US is 10^{15}. 1 Btu is approximately 1055 Joules.

	2015	2016	2017	2018
Hydroelectric power	2.321	2.472	2.767	2.667
Wind	1.777	2.096	2.343	2.486
Wood biomass	2.312	2.224	2.278	2.360
Biofuels	2.153	2.287	2.304	2.283

a) i) What is 3×10^{18} Joules in quadrillion Btu?

ii) From which renewable source did the energy consumption increase each year?

3 marks

b) i) From which renewable source did the energy consumption show the greatest overall increase in Btu from 2015 to 2018?

ii) What was this increase?

iii) Use your answer to b) ii) and assuming this trend continues estimate the energy consumption for this source in 2025.

4 marks

c) i) From which renewable source did the energy consumption show the lowest percentage increase from 2015 to 2018?

ii) What was this percentage increase?

iii) Use your answer to c) ii) and assuming this trend continues estimate the energy consumption for this source in 2021.

4 marks

d) In 2015 the total energy consumption from renewables was 9.720 quadrillion Btu and in 2018 it was 11.409 quadrillion Btu.

i) Give a reason why the figures in the table do not give these totals.

ii) Find the percentage out of the total power from renewables coming from Wind power in each of 2015 and 2018.

iii) Use your answer to d) ii) to estimate the percentage of the renewable total power coming from Wind in 2030 assuming that the percentage of renewables from Wind increases by the same amount each year.

5 marks

e) The energy consumption from Solar Power shows even bigger increases. In 2018 it was 0.917 quadrillion Btu, an increase of 115% on the consumption in 2015.

i) What was the energy consumption from Solar Power in 2015?

ii) Assume the percentage increase of 115% continues make a prediction of the energy consumption form solar power in 2030.

iii) Comparing the percentage of total renewable energy coming from solar power in 2015 to 2018 predict the percentage coming from solar power in 2030.

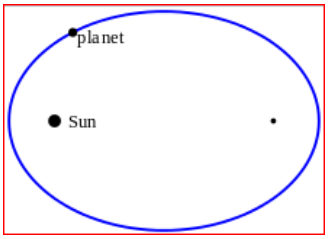
iv) Use your answers to e ii) and e iii) to predict how much energy will come from renewables in the US in 2030.

9 marks

<u>25 marks</u>

4.

In the early 1600's a German astronomer collected data on the planets. He discovered that the planets orbited the sun in elliptical shapes.



a) At its closest Mars is 206 million km from the sun and at is farthest it is 249 million km and it takes nearly 687 days to go around the sun (a Mars year)

i) Find the mean of these two distances.

The astronomical unit (AU) is a unit of length equal to the mean distance of Earth from the sun and is roughly 150 million km

ii) Find the mean distance of Mars from the sun in AU.

2 marks

b) Use the information in a) to **write down** the **four** missing numbers in the following table giving all numbers to 3 sf

Planet	Mean distance to sun (AU)	Time to go around the sun (days)
Venus	0.723	225
Earth	***b) i)***	***b) ii)***
Mars	***b) iii)***	***b) iv)***
Jupiter	5.20	4330

4 marks

c) i) For each of the planets above calculate $\frac{R^3}{T^2}$ where R is the mean distance to the sun in AU and T is the time in days to orbit the sun giving your answers to 3 sf.

ii) Calculate $\frac{GM}{4\pi^2}$ where M is the mass of the sun 1.99×10^{30} and G is the gravitational constant 1.488×10^{-34}

5 marks

d) Scientists deduced that $\frac{GM}{4\pi^2} = \frac{R^3}{T^2}$

Give a reason why the calculations of $\frac{R^3}{T^2}$ are not all exactly the same as $\frac{GM}{4\pi^2}$.

1 mark

e) The formula $\frac{GM}{4\pi^2} = \frac{R^3}{T^2}$ is also true for comets. Using your answer to c) ii)

i) What is the mean distance from the sun for a comet that orbits the sun in 100 Earth Years?

ii) What is the time in Earth years of the orbit for a comet whose distance from the sun varies from 1.05 AU to 5.87 AU?

6 marks

f) The formula $\frac{GM}{4\pi^2} = \frac{R^3}{T^2}$ can be adjusted for planets around other stars by changing M.

i) One such planet orbits a star with Mass 0.6 that of our sun. Potentially habitable planets are thought to lie between 0.1 to 1.3 AU from the star. What would be the difference in the orbit times for such planets.

ii) Another potentially habitable planet orbits a Red Dwarf star with period 35.2 days and mean distance 0.166 AU. What is the mass of its Red Dwarf star?

8 marks

<u>26 marks</u>