Give all numerical answers to 3 sf unless the question states otherwise. You are expected to type out your answers onto the computer. 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. When their four children come home from school Max washes and dries their clothes while the children all have a shower. Max also prepares a meal for the children.

Max decides to work out the cost of the electricity used at this time. The cost of electricity is 34 p for each kilowatt in power rating per hour.

a) The washing machine has a rating of 1 500 watts and the length of time Max for the wash cycle that Matt uses is 1 hour 20 minutes.
   i) Write 1 500 watts in kilowatts
   ii) Show that the cost of the electricity is 51p per hour.
   iii) Show that the cost of electricity used in 1 hour 20 minutes is 68p.

4 marks

b) The tumble drier has a rating of 3 000 watts and takes 40 minutes. Calculate the cost of the electricity used for the tumble drier.

3 marks

The table shows the power rating for the other devices that Max and the children use:

Appliance	**Power Rating (watts)**
Shower	9 000
Oven	2 400
Hob (per ring)	1 500
Kettle	3 000

c) Each of the children takes 20 minutes in the shower. Calculate the total cost for the four children to shower.

2 marks

d) To cook the meal the Max uses the oven for 40 minutes, 2 hobs each for 10 minutes and the kettle for 6 minutes. Calculate the total cost of the electricity to make the meal giving the final answer to the nearest 1p.

3 marks

e) Find the total cost of the electricity used to wash and dry the clothes, cook the meal and for the children to shower giving the final answer to the nearest 1p.

2 marks

The electricity price of 34p per kilowatt hour is an increase of 80% from the previous year.

f) Calculate the cost of electricity per kilowatt hour a year ago.

3 marks

g) i) Assuming the cost continues to increase at 80% per year calculate the cost per kilowatt hour 5 years from now.

ii) Using your answer e) estimate the cost of electricity in 5 years time needed to wash and dry the clothes, cook the meal and for the children to shower.

5marks

h) Max decides to cut costs and the children are only allowed to shower for 5 minutes each, Max hangs the clothes on an airer and no longer uses the tumble drier. Max also cooks the meal in a microwave with power rating 900 watts for 10 minutes and no longer uses the oven and the hobs. Max still uses the washing machine and kettle for the same times.
Calculate the percentage reduction in the cost from the total cost found in e).

6 marks

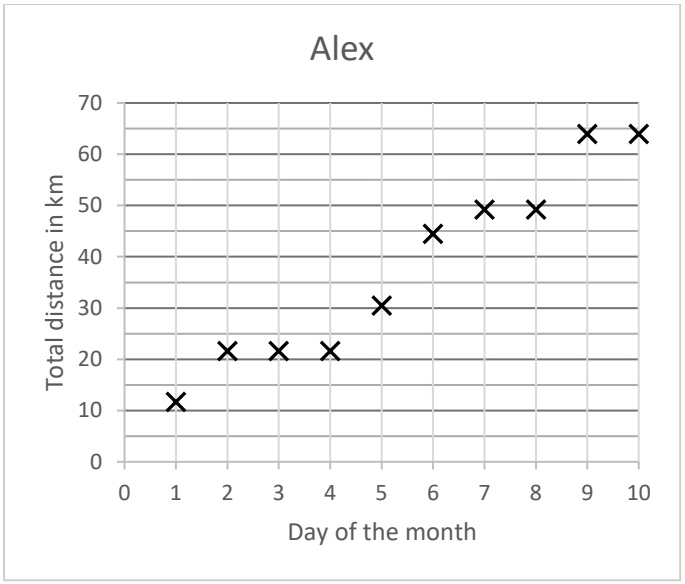
Total 28 marks

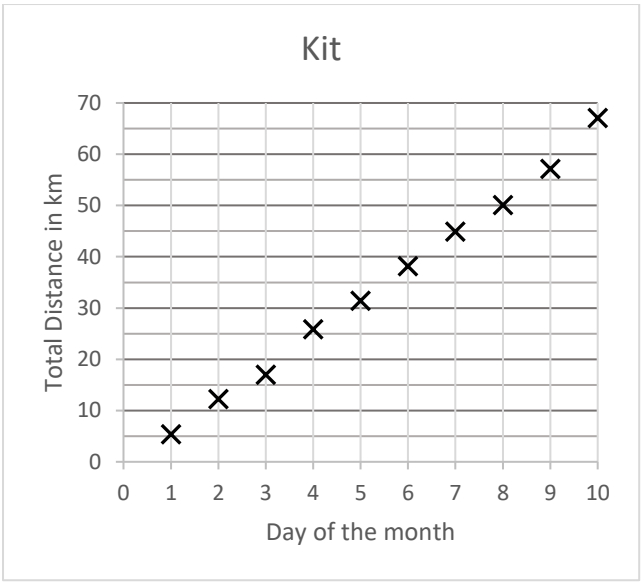
2. Two friends Alex and Kit take part in a monthly walking challenge. The challenge is to walk 150 km over the 30 days of the month.

a) How many km a day do they need to walk to meet the goal of 150 km at the end of the month?

1 mark

The graphs below show their total distance walked at the end of each day for the first 10 days.





b) i) How much farther did Alex walk than Kit on the first day of the month?

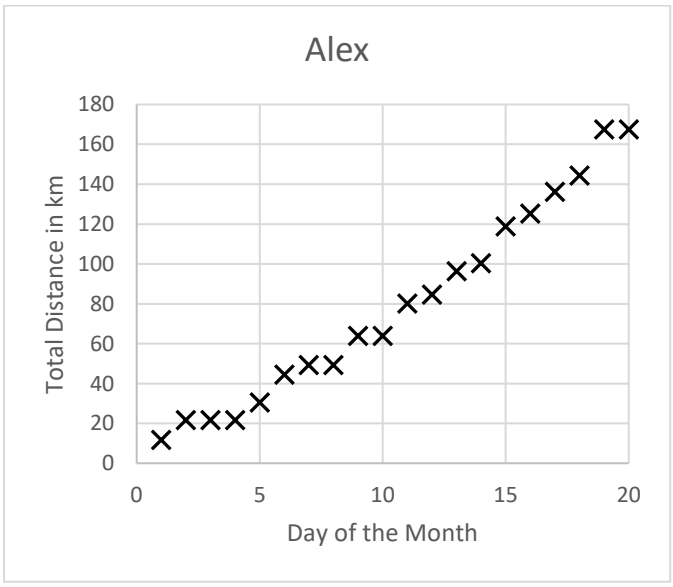
ii) Alex did not do a walk on the 10th day of the month. On which two consecutive days did Alex not do a walk?

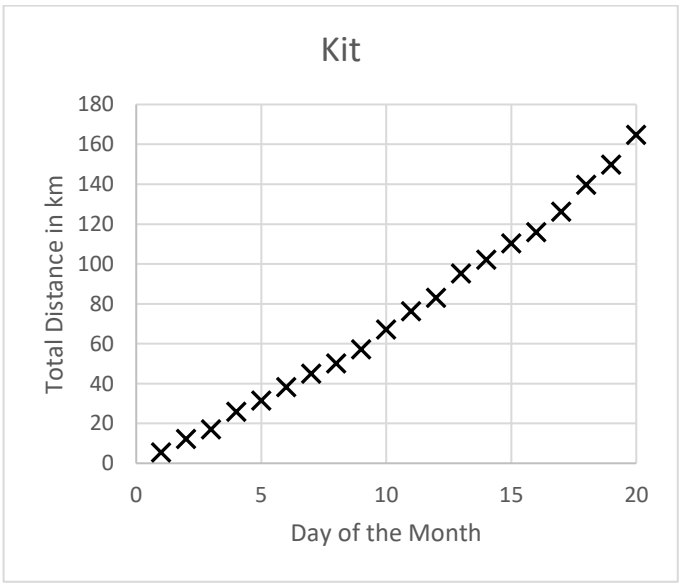
iii) On which two days did Alex walk more than 10km?

iv) Kit is walking roughly the same distance each day. Calculate an estimate for this distance.

4 marks

The following graphs show the total distance walked for the first 20 days.





c) i) The graphs show that both Alex and Kit have increased their overall rate of walking between the 10th and 20th day compared with the first 10 days. Give two different ways in which the graphs show this.

ii) The graph for Alex passes through the points (10, 64) and (20, 167). Calculate the equation of the line through these two points.

Give your answer in the form $y = mx + c$.

6 marks

d) The corresponding equation for Kit from the 10th to the 20th day is

$$y = 9.76x - 30.61.$$

i) By comparing this equation with your answer to cii) state which equation shows a faster daily rate? Give a reason for your answer.

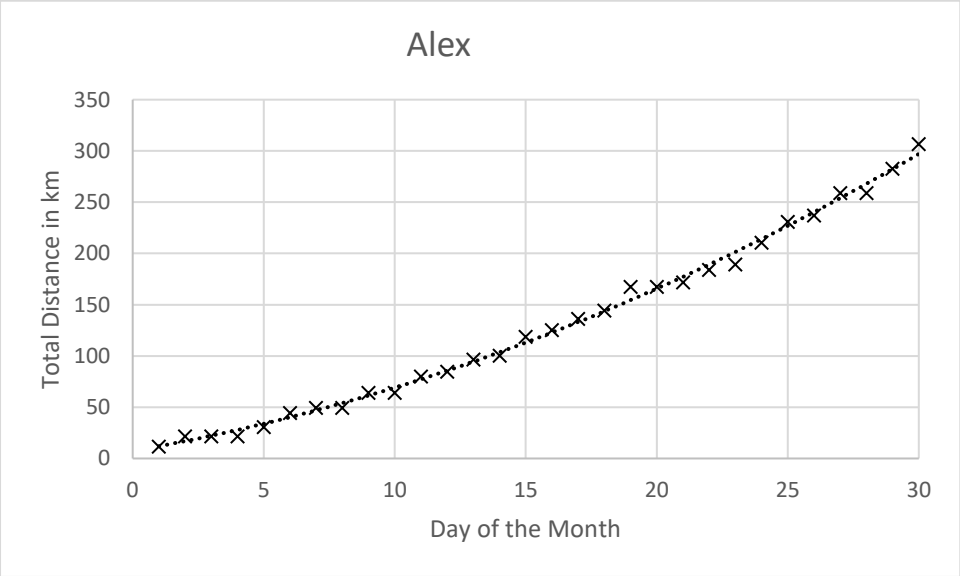
ii) Use the equation for Kit to estimate the total distance Kit would have walked at the end of the 30 days.

iii) Use the equation for Kit to predict how many days it would take Kit to reach 300km.

iv) Use your answer to cii) and the equation for Kit to determine on which day the equations would show that Alex and Kit would have walked roughly the same total distance.

10 marks

The following graph shows the data for the full 30 days for Alex.



The data has been modelled as a curve with the equation:

$$y = 0.1736x^2 + 4.4445x + 7.3282$$

e) i) Comment on how well the curve fits the data.

ii) Use the model to calculate how far Alex would walk in a month of 31 days.

iii) If Alex carries on the challenge for a further 30 days would a prediction for the distance walked in 60 days using the model be more or less realistic than using your answer to cii). Give a numerical reason and explanation for your answer.

7 marks

Total 28 marks

3. Asteroid 2023 BU passed close to Earth in January 2023. Its estimated diameter was 6m across.

a) A newspaper report claimed that the asteroid was about the size of a London Bus.

A London Bus is 10.5m long, 2.5m wide and 4.4m high.

i) How much bigger is 10.5 m than 6m? Give your answer as a percentage.

ii) Assume the bus is cuboid calculate the volume of the largest bus in m^3.

iii) Assume the asteroid is a sphere with diameter 6 m calculate its volume in m^3. Use the formula $V = \frac{4}{3}\pi r^3$ where r is the radius and V is the volume.

iv) Is the newspaper's claim justified? Give a reason for your answer.

7 marks

b) The Chelyabinsk meteor which entered the atmosphere in 2013 had an estimated diameter of 20m across.

The Chelyabinsk meteor had an estimated mass of 12 000 tonnes.

Use this mass to calculate an estimate for the mass of Asteroid 2023 BU.

You may assume that the Chelyabinsk meteor is also a sphere and that it has the same density as Asteroid 2023 BU.

4 marks

c) Asteroid 2023 BU passed by the earth at a distance with a closest distance of 9 967 km from the centre of the Earth. Assume the Earth has radius 6 378 km and the distance to the moon from the centre of the Earth is 384 400. Telecommunication satellites sit 36 000 km above the Earth.

i) Determine how far above the surface of Earth Asteroid 2023 BU passed.

Newspaper articles state that the distance the meteor passed by was just 1% of the distance from the surface of the Earth to the moon.

ii) Use your answer to c)i) to calculate a more accurate percentage for the distance the meteor passed compared to the distance to the moon.

iii) Determine the distance the meteor passed by as a percentage of the distance to the Telecommunication satellites.

5 marks

d) Asteroids about the size of Asteroid 2023 BU reach the Earth about once a year and are just seen as a bright flash. There are about 500 million of them near to Earth and about 0.1% are discovered by astronomical observers. Roughly how many of these are discovered? Give your answer in millions.

2 marks

e) Asteroids about the size of the Chelyabinsk meteor reach the Earth about once every hundred years and result in an airburst explosion which could cause injuries in a built up area. There are about 5 million near to Earth and about 0.4% are discovered. Roughly how many thousands of these are discovered?

2 marks

Total 20 marks

4.

The stopping distance for a car is the sum of the reaction distance and the braking distance.

The formula for the reaction distance in metres is given by $d = \frac{5sr}{18}$ where s is the speed in km/h and r is the reaction time in seconds.

The formula for the braking distance is $d = \frac{s^2}{250f}$ where s is the speed in km/h and f represents the coefficient of friction between the car and the track.

a) A racing driver travels at speeds of 360 km/h and has a reaction time of 0.2 seconds. The coefficient of friction is 0.8.

   i) Calculate the reaction distance for the racing driver.

   ii) Calculate the braking distance for the racing driver.

   iii) Calculate the stopping distance for the racing driver.

3 marks

b) A car driver is travelling at speed 60 mph on a wet road with a coefficient of friction of 0.4. The driver has a reaction time of 0.8 seconds.

   i) Using 5 miles = 8 km change the speed of 60 miles per hour to km per hour.

   ii) Hence find the stopping distance of the car.

iii) As the temperature falls the road becomes icy and the coefficient of friction falls to 0.1 By how much has the stopping distance increased?

iv) Determine the speed in miles per hour so that the braking distance on the icy road is the same as the braking distance at 60 miles per hour on the wet road.

10 marks

c) The police use tyre marks to determine the speed of a car. They have recorded a tyre mark of length 100m on a dry road with a coefficient of friction of 0.8.

i) Assuming the tyre marks represent the braking distance calculate the speed in km per hour.

ii) The police use formula $p = \sqrt{90fd}$ where d is the length of the tyre track in metres and f is the coefficient of friction to calculate the speed p in miles per hour. Calculate the speed of the car in miles per hour using this formula.

iii) Compare the speeds given by your answers to c)i) and c)ii).

iv) The police suspect that the 90 in their formula is not correct to 3 sf.

Find the value of k such that the braking distance formula gives the same speed as the formula $p = \sqrt{kfd}$.

11 marks

Total 24 marks