FOR OFFICIAL USE

National Qualifications 2024

Mark

X844/76/01 Applications of Mathematics

FRIDAY, 3 MAY

9:00 AM – 11:05 AM

X8447601

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day | Month | Year

Scottish candidate number

Total marks — 65

Attempt ALL questions.

You may use a calculator.

To earn full marks you must show your working in your answers.

State the units for your answer where appropriate.

You should refer to the pre-release material for Higher Applications of Mathematics which you can access electronically.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting.

Questions 4, 6 and 9 must be completed on software and then be printed.

Use **blue** or **black** ink.

Before leaving the examination room you must place this booklet and your printouts inside the clear envelope provided. You must give this envelope to the Invigilator, if you do not, you may lose all the marks for this paper.

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Information and instructions for candidates

The electronic files listed below are provided for you to use during this examination:

- **'Q4 Dracaena Plant.xlsx'** — a spreadsheet file containing 1 worksheet
- **'Q6 golf.csv'** — a spreadsheet file containing a data set
- **'Q6 Golf Answers.docx'** — a word processing file. Your output from the statistical software in questions 6 (a) (i) and (c) (ii) must be copied and pasted into this file for printing.
- **'Q9 Esme's Mortgage.xlsx'** — a spreadsheet containing 2 worksheets

You must display your name, SCN and centre name on all pages on each printout. Spaces have been provided in each electronic file for you to complete this information.

When printing spreadsheet files, ensure that:

- landscape orientation is used
- grid lines are shown
- row and column headings are shown
- the option 'Fit All Columns on One Page' is selected.

When printing word processing files ensure that portrait orientation is used.

Use this table to make sure you have all the printouts required.

Question	Printout	Completed (✓)
4 (a) and (b)	'Dracaena plant study' worksheet • value view • formula view This should include the graph.	
6 (all parts)	'Q6 Golf Answers.docx' This should include your statistical software output, and answers.	
9 (a)	'Mortgage' worksheet • value view • formula view	
9 (c)	'Increased payments' worksheet • value view • formula view	

Total marks — 65

Attempt ALL questions

1. Bailey takes out a loan for £4000 with an annual effective rate of interest of 29.9%.

(a) Calculate the monthly effective rate of interest. **1**

Bailey makes level monthly repayments of £250 at the end of each month.

(b) Complete the following loan schedule for Bailey's loan to show the loan outstanding at the end of month 2. **2**

Time (months)	Repayment (£)	Interest content of repayment (£)	Capital content of repayment (£)	Loan outstanding (£)
0				4000.00
1	250.00			
2	250.00			

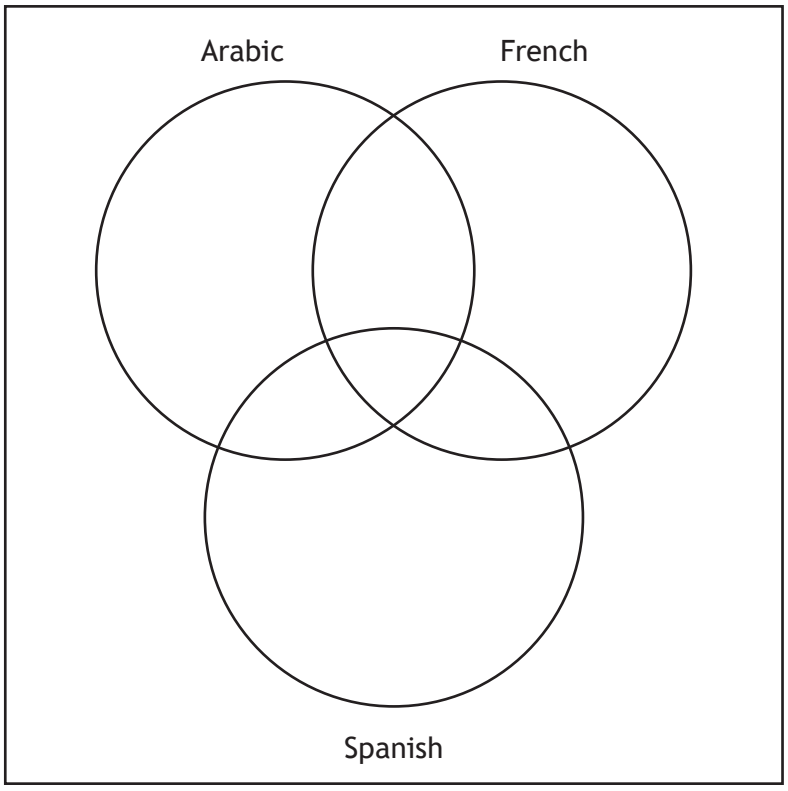
Space for working if required

2. A college offers language courses in French, Spanish and Arabic.

A group of students are asked which, if any, of these language courses they study at this college:

- 31 students study French, Spanish and Arabic
- 34 students study French only
- 7 students study Spanish only
- 13 students study Arabic only
- 51 students study French and Spanish
- 60 students study Spanish and Arabic
- 63 students study French and Arabic
- 14 students study no languages.

(a) Complete the Venn diagram to show this information. **3**



(An additional diagram, if required, can be found on *page 20*.)

2. (continued)

(b) A student is selected at random.

Determine the probability that the student studies Spanish and Arabic, but not French. **2**

[Turn over

3. A ship is being repaired.

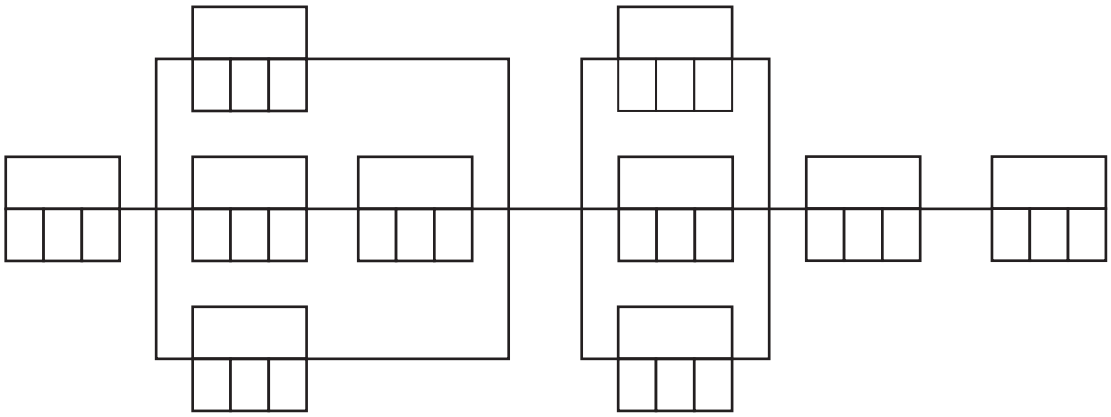
The propeller must be removed for the repair to be carried out.

The table shows the list of tasks required to complete this job, the time required for each task, and the order in which the tasks must be completed.

Task	Description	Preceding task	Duration (hours)
A	Disconnect electrics	none	2
B	Remove oils from system	A	12
C	Remove rudder	A	24
D	Disconnect oil pipes and hoses	A	8
E	Prepare oil pipes and hoses to be reconnected	D	4
F	Remove propeller blades	B, C, E	14
G	Disconnect propeller stern seals	B, C, E	12
H	Disconnect propeller shaft coupling	B, C, E	8
I	Remove propeller shaft coupling and internal pipes	F, G, H	6
J	Take out propeller shaft	I	8

(a) Complete the PERT chart showing the earliest start time and the latest completion time for each task. **5**

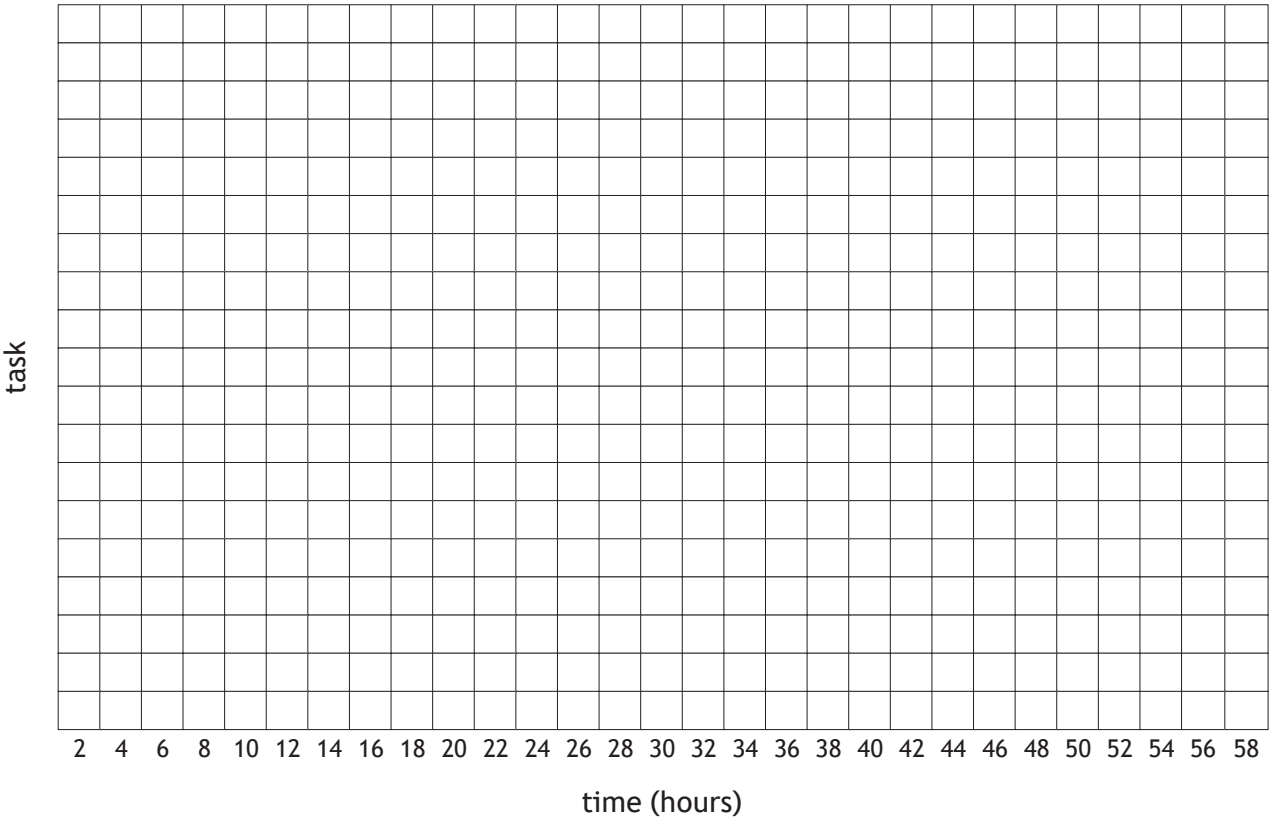
(An additional diagram, if required, can be found on *page 21*.)



3. (continued)

(b) Construct a Gantt chart without float times for this job. **3**

(An additional diagram, if required, can be found on *page 21*.)



(c) Determine the critical path and the minimum time required to complete the job. **2**

[Turn over

3. (continued)

During the job there are difficulties disconnecting the propeller shaft coupling (task H).

(d) Determine the maximum time that can be taken to disconnect the propeller shaft coupling without delaying the total completion time of the job. **1**

4. You must refer to the information on 'Dracaena plants and atmospheric carbon dioxide levels' given in the pre-release material when answering this question.

You must also refer to the spreadsheet file 'Q4 Dracaena Plant.xlsx' when answering this question.

You must complete parts (a) and (b) using the spreadsheet file.

Part (c) must be completed in the answer space provided.

A research scientist is studying the effect of Dracaena plants to improve indoor air quality in a kitchen showroom. They estimate that:

- large Dracaena plants reduce the concentration of carbon dioxide (CO_2) in the showroom by 13% each day
- each evening a heating system is left running. This adds enough CO_2 to increase the concentration in the showroom by 180 ppm.

At the start of the study the concentration of CO_2 in the showroom was 2000 ppm.

(a) Complete the 'Dracaena plant study' worksheet to estimate the concentration of CO_2 at the end of 30 days. **3**

The research scientist investigates the long-term concentration of CO_2 in the showroom.

(b) Extend the table in your worksheet to the end of 60 days.

Construct a graph to show what will happen to the concentration of CO_2 in the showroom.

Your graph must include an appropriate title and axes labels. **3**

(c) Explain whether the large Dracaena plants are effective at obtaining very good indoor air quality in the showroom. **1**

Print the 'Dracaena plant study' worksheet in value view and in formula view. Ensure the graph is positioned beside the table and is contained on one page in the printout.

5. Ewa deposited £4500 in a variable rate savings account on 1 January 2021.

The effective rates of interest for the savings account are as follows:

Dates	Interest rate
1 January 2021 to 31 March 2021	0.415% per **month**
1 April 2021 to 31 December 2021	4.7% per **year**
From 1 January 2022	2.6% per **year**

(a) Calculate Ewa's balance on 1 January 2024. **3**

On 1 January 2022 Blair opened an account with the same effective rates of interest. Blair has a savings goal of £6000 by 1 January 2024.

(b) Calculate the minimum deposit Blair should have made on 1 January 2022 to achieve this savings goal. **1**

6. You must refer to the spreadsheet file 'Q6 golf.csv' for the data, and the word processing file 'Q6 Golf Answers.docx' when answering this question.

You must complete parts (a) (i) and (c) (ii) using appropriate statistical software.

You must include all output from statistical software, and your answers in the word processing file 'Q6 Golf Answers.docx'.

A golf ball manufacturing company has designed a new golf ball which is more hard-wearing.

The company wants to determine whether there is a difference in the distances travelled by the current and new golf balls.

To measure the distances travelled by the current and new golf balls, a random sample of 40 of the current golf balls and a random sample of 40 of the new golf balls were subjected to distance tests using a mechanical hitting machine.

Data was collected for the distances travelled (in metres) of both the current and new golf balls.

The data was found to be approximately normally distributed.

(a) (i) Generate and state appropriate measures of location and spread for the current and new golf balls. **2**

(ii) Make two valid comparisons about the driving distances of both the current and new golf balls. **2**

(b) State appropriate null and alternative hypotheses to determine if there is a statistically significant difference between the distances travelled by the current and new golf balls. **1**

(c) (i) State which type of hypothesis test is appropriate to determine if there is a statistically significant difference between the distances travelled by the current and new golf balls. **1**

(ii) Perform the hypothesis test and state the p-value. **2**

(iii) Hence interpret the p-value, and the result of the hypothesis test, in context. **2**

Print the word processing file 'Q6 Golf Answers.docx'.

[Turn over

7. You must refer to the information on 'Deductions from salaries' given in the pre-release material when answering this question.

In the 2023/24 tax year, Tom was paid a gross salary of £4500 per month for 12 months, from the 6 April 2023.

His annual income tax deduction is £10,718.48.

Tom has opted out of paying any pension contributions.

(a) Calculate Tom's **net annual salary** for the 2023/24 tax year, after all deductions including National Insurance. **4**

7. (continued)

The Consumer Price Index (CPI) in April 2022 was 119.0 and in April 2023 was 128.3.

In April 2022, Tom's gross monthly salary was £4200.

In April 2023, his gross monthly salary was increased to £4500.

(b) Determine whether Tom's gross monthly salary increased in line with the CPI. **2**

[Turn over

8. An electric vehicle charging company has been awarded a contract to install 500 charging points in a city. As part of the contract a number of tasks must be completed including ordering and receiving charger parts and installing electric cables.

If the installation is delayed the company faces a fixed penalty of £75,000.

The company has identified the following two reasons for a possible delay:

- a shortage in parts for the chargers
- the electric cables will not be in place in time.

There is a 0.325 probability one or both of these delays will happen.

(a) Calculate the expected cost of a delay. **1**

The company is considering using the following control measures:

- Control Measure 1 — Import extra parts at a cost of £15,000.
- Control Measure 2 — Pay another firm to help lay the cables, at an additional cost of £16,000.

There is a 0.1 probability of a shortage in parts for the chargers.

There is a 0.25 probability that the electric cables will not be in place in time.

(b) Calculate the expected cost of a delay using:

(i) only control measure 1 **1**

(ii) only control measure 2. **1**

8. (continued)

The company will only use one control measure.

(c) Based on your calculations, explain which control measure the company should use in order to minimise expected costs. **1**

[Turn over

9. You must refer to the spreadsheet file 'Q9 Esme's Mortgage.xlsx' when answering this question.

You must complete parts (a) and (c) (i) using the spreadsheet file.

Part (b) (i), (b) (ii), and (c) (ii) must be completed in the answer box provided.

Esme is building an extension to her house.

She has been offered a £25,000 mortgage with an effective annual rate of interest of 3.5% over 5 years.

Open the 'Mortgage' worksheet.

(a) Complete the 'Mortgage schedule' to determine the level monthly repayment amount, and the final repayment amount. **4**

Esme needs new building insurance once the extension is completed.

She is choosing between the following two options.

Cost per year(£)	Total excess(£)
216.94	350
281.95	100

(b) (i) State one advantage of having a high excess amount on your insurance policy. **1**

One of the windows in Esme's house is broken and she has to decide whether to make a claim.

(ii) Explain why Esme may choose not to make a claim using her insurance policy. **1**

9. (continued)

The maximum monthly repayment allowed by the lender is £550.

Esme chooses to reduce the term of her mortgage by increasing her monthly repayments to the maximum amount.

Open the 'Increased payments' worksheet.

(c) (i) Complete the 'Increased payments schedule' for the reduced term and calculate the final repayment amount. **2**

(ii) Determine how much money this would save Esme over the term of her mortgage. **1**

Print the 'Mortgage' worksheet in value view and in formula view.

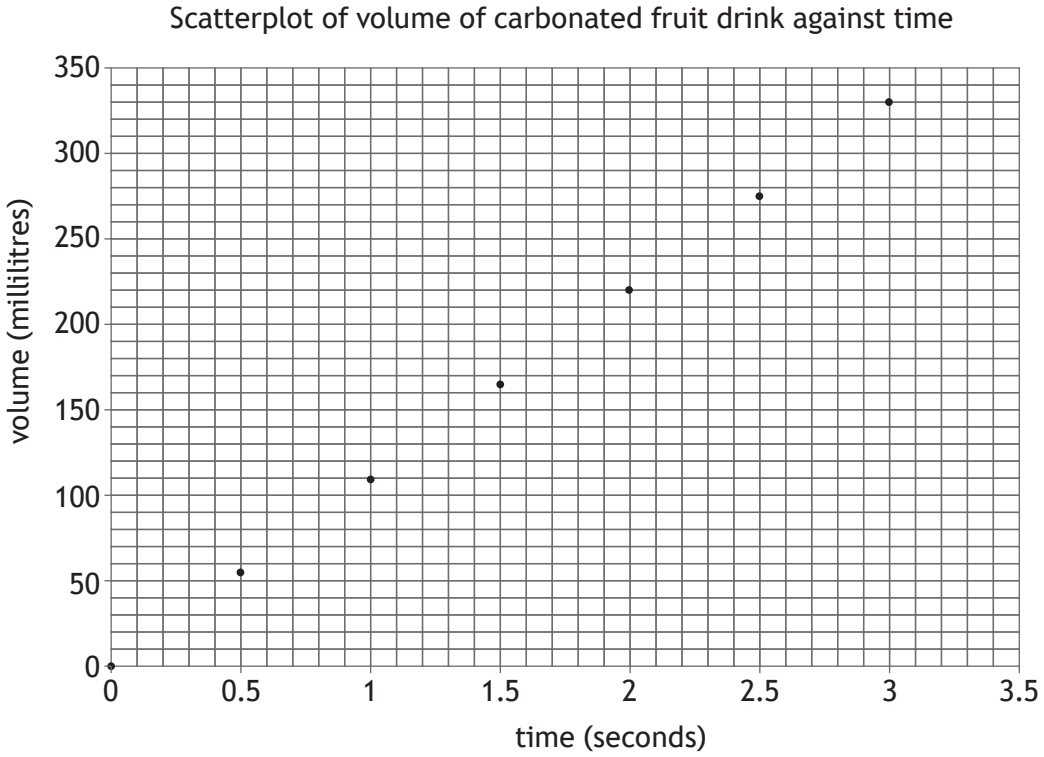
Print the 'Increased payments' worksheet in value view and in formula view.

[Turn over

10. A factory fills cans with a carbonated fruit drink.

The cans produced have a volume of 330 millilitres.

The graph below shows the relationship between time, in seconds, and volume of carbonated fruit drink, in millilitres, as a can is filled.



(a) State the type of relationship modelled in the graph. **1**

(b) Determine the rate at which each can is filled with carbonated fruit drink.

Your answer must include appropriate units. **2**

10. (continued)

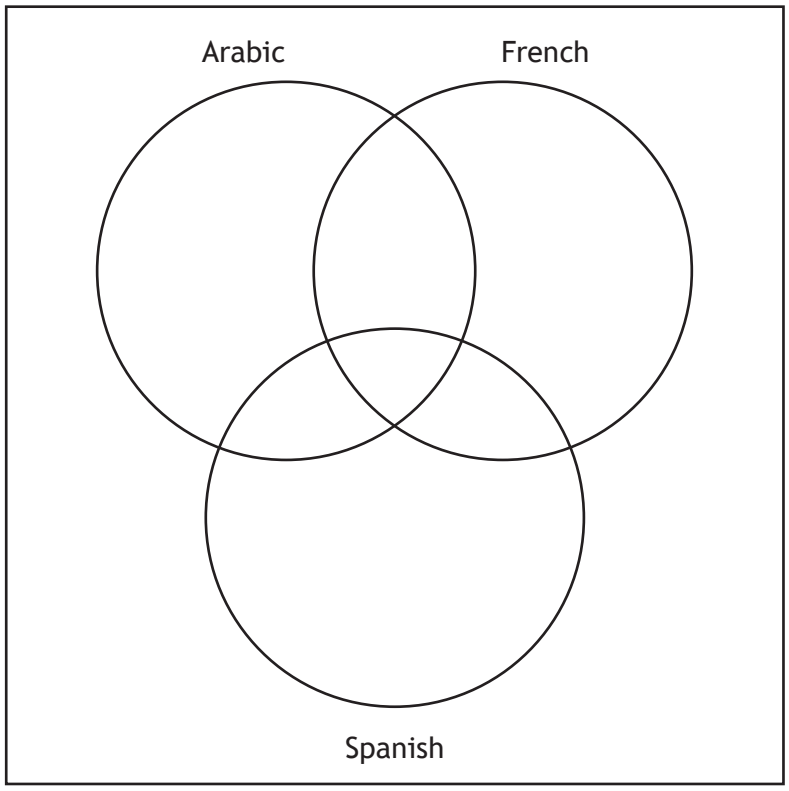
The factory can only fill the cans when there are staff present.
The machines in the factory can fill 5 cans at the same time.

(c) Estimate how many cans the factory can fill in one week.
State any assumptions you have made. **3**

[END OF QUESTION PAPER]

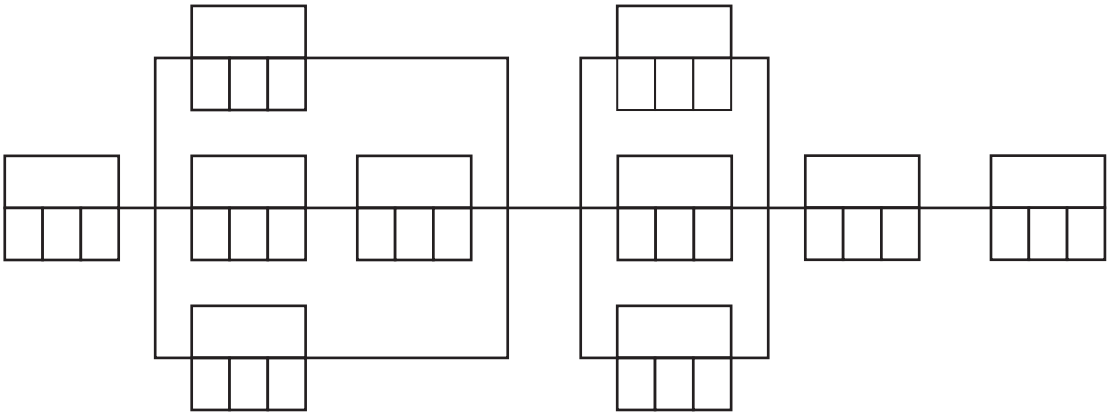
ADDITIONAL SPACE FOR ANSWERS

Additional diagram for use with question 2 (a)

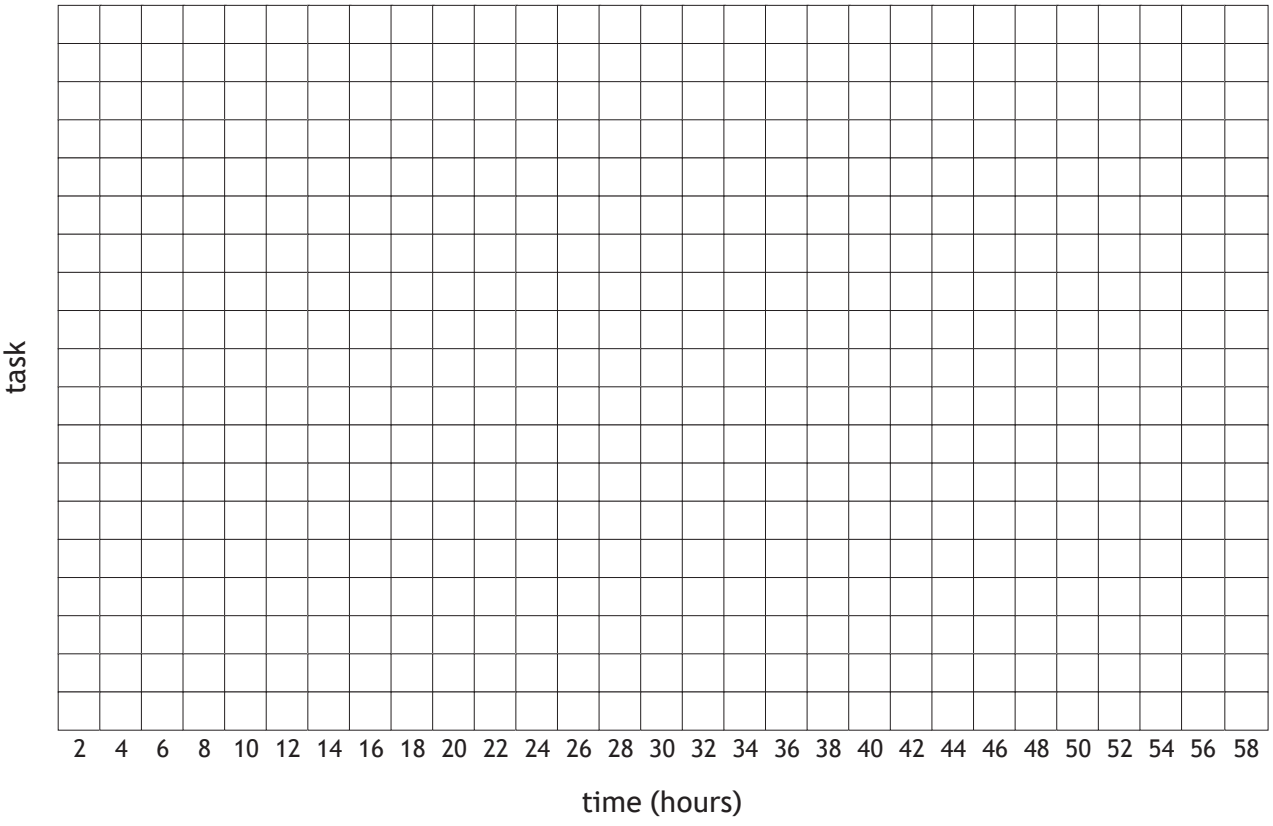


ADDITIONAL SPACE FOR ANSWERS

Additional diagram for use with question 3 (a)



Additional diagram for use with question 3 (b)



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