

22147405

**MATHEMATICAL STUDIES
STANDARD LEVEL
PAPER 1**

Candidate session number

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Tuesday 13 May 2014 (afternoon)

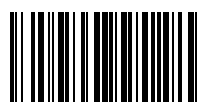
Examination code

1 hour 30 minutes

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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- A graphic display calculator is required for this paper.
- A clean copy of the **Mathematical Studies SL formula booklet** is required for this paper.
- Answer all questions.
- Write your answers in the boxes provided.
- Unless otherwise stated in the question, all numerical answers should be given exactly or correct to three significant figures.
- The maximum mark for this examination paper is [90 marks].



20EP01

Maximum marks will be given for correct answers. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. Write your answers in the answer boxes provided. Solutions found from a graphic display calculator should be supported by suitable working, for example, if graphs are used to find a solution, you should sketch these as part of your answer.

1. The average radius of the orbit of the Earth around the Sun is 150 million kilometres.

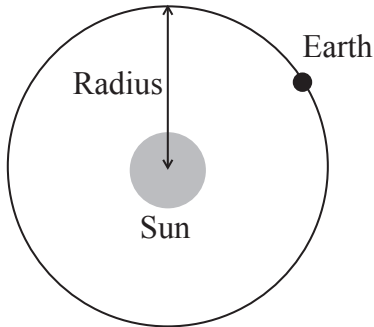


diagram not to scale

- (a) Write down this radius, in kilometres, in the form $a \times 10^k$, where $1 \leq a < 10$, $k \in \mathbb{Z}$. [2]

The Earth travels around the Sun in one orbit. It takes one year for the Earth to complete one orbit.

- (b) Calculate the distance, in kilometres, the Earth travels around the Sun in one orbit, assuming that the orbit is a circle. [2]

Today is Anna's 17th birthday.

- (c) Calculate the total distance that Anna has travelled around the Sun, since she was born. [2]

Working:

Answers:

- (a)
- (b)
- (c)



2. Two propositions p and q are defined as follows

p : Eva is on a diet
 q : Eva is losing weight.

(a) Write down the following statement **in words**.

$q \Rightarrow p$ [2]

(b) Write down, in words, the contrapositive statement of $q \Rightarrow p$. [2]

(c) Determine whether your statement in part (a) is logically equivalent to your statement in part (b). Justify your answer. [2]

Working:

Answers:

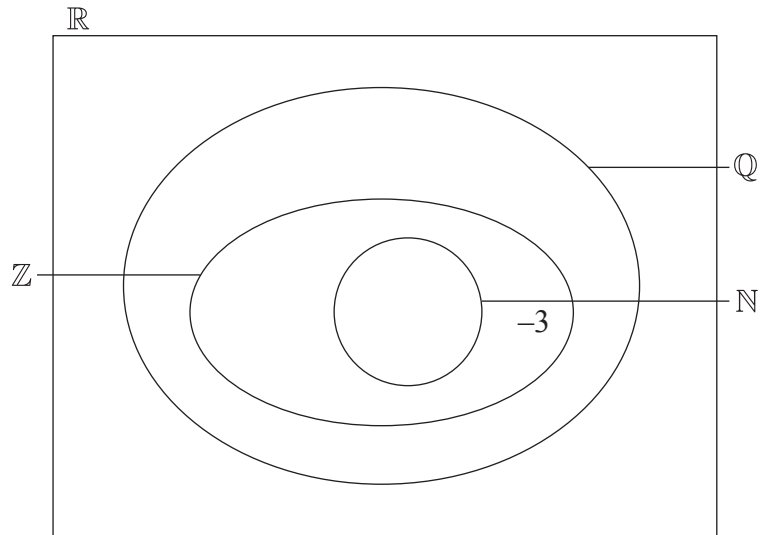
- (a)
-
-
- (b)
-
-
- (c)
-
-
-



3. The following Venn diagram shows the relationship between the sets of numbers

\mathbb{N} , \mathbb{Z} , \mathbb{Q} and \mathbb{R} .

The number -3 belongs to the set of \mathbb{Z} , \mathbb{Q} and \mathbb{R} , but not \mathbb{N} , and is placed in the appropriate position on the Venn diagram as an example.



Write down the following numbers in the appropriate place in the Venn diagram.

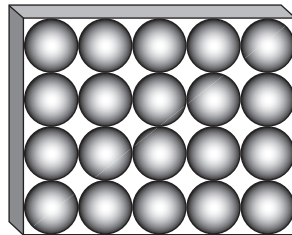
- (a) 4 [1]
- (b) $\frac{1}{3}$ [1]
- (c) π [1]
- (d) 0.38 [1]
- (e) $\sqrt{5}$ [1]
- (f) -0.25 [1]



4. Chocolates in the shape of spheres are sold in boxes of 20.
Each chocolate has a radius of 1 cm.

- (a) Find the volume of 1 chocolate. [2]
- (b) Write down the volume of 20 chocolates. [1]

The diagram shows the chocolate box from above. The 20 chocolates fit perfectly in the box with each chocolate touching the ones around it or the sides of the box.



- (c) Calculate the volume of the box. [2]
- (d) Calculate the volume of empty space in the box. [1]

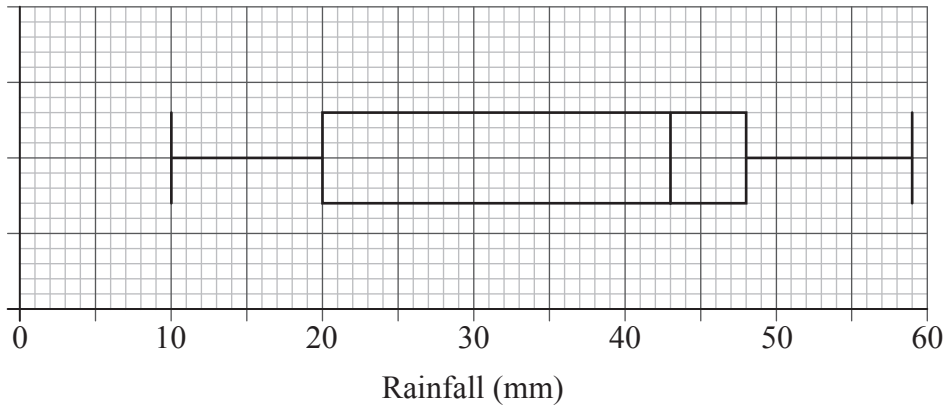
Working:

Answers:

- (a)
- (b)
- (c)
- (d)



5. The distribution of rainfall in a town over 80 days is displayed on the following box-and-whisker diagram.



- (a) Write down the median rainfall. [1]
- (b) Write down the minimum rainfall. [1]
- (c) Find the interquartile range. [2]
- (d) Write down the number of days the rainfall will be
 - (i) between 43 mm and 48 mm;
 - (ii) between 20 mm and 59 mm. [2]

Working:

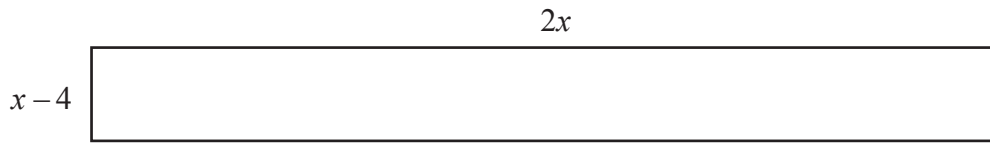
Answers:

- (a)
- (b)
- (c)
- (d) (i)
- (ii)



6. The surface of a red carpet is shown below. The dimensions of the carpet are in metres.

diagram not to scale



(a) Write down an expression for the area, A , in m^2 , of the carpet. [1]

The area of the carpet is 10 m^2 .

(b) Calculate the value of x . [3]

(c) Hence, write down the value of the length and of the width of the carpet, in metres. [2]

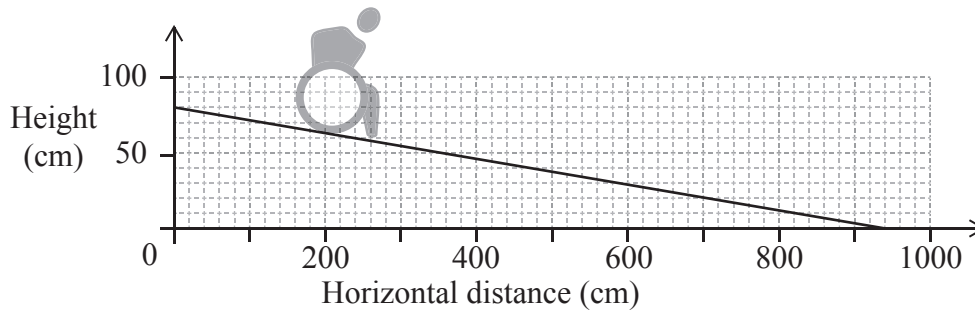
Working:

Answers:

- (a)
- (b)
- (c)



7. The diagram shows a wheelchair ramp, A, designed to descend from a height of 80 cm.

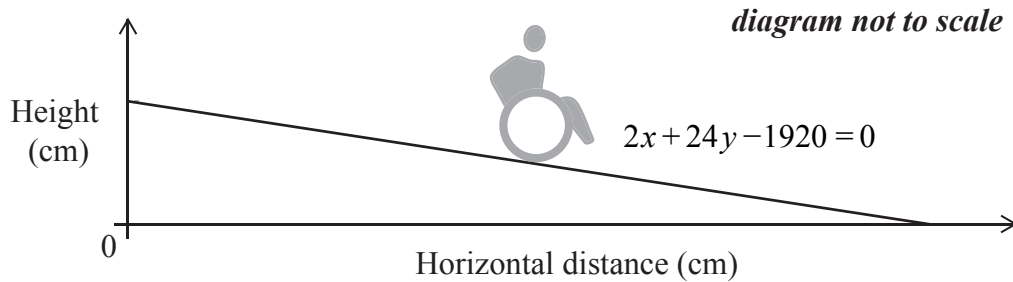


(a) Use the diagram above to calculate the gradient of the ramp. [1]

The gradient for a **safe** descending wheelchair ramp is $-\frac{1}{12}$.

(b) Using your answer to part (a), comment on why wheelchair ramp A is **not safe**. [1]

The equation of a second wheelchair ramp, B, is $2x + 24y - 1920 = 0$.



(c) (i) Determine whether wheelchair ramp B is safe or not. Justify your answer.

(ii) Find the horizontal distance of wheelchair ramp B. [4]

(This question continues on the following page)



(Question 7 continued)

Working:

Answers:

- (a)
- (b)
- (c) (i)
- (ii)



8. A group of 100 students gave the following responses to the question of how they get to school.

	Walk	Public transport	Car	Bicycle	Total
Female	18	13	14	3	48
Male	9	17	10	16	52
Total	27	30	24	19	100

A χ^2 test for independence was conducted at the 5% significance level. The null hypothesis was defined as

H_0 : Method of getting to school is independent of gender.

- (a) Find the expected frequency for the females who use public transport to get to school. [2]
- (b) Find the χ^2 statistic. [2]

The χ^2 critical value is 7.815 at the 5% significance level.

- (c) State whether or not the null hypothesis is accepted. Give a reason for your answer. [2]

Working:

Answers:

- (a)
- (b)
- (c)
.....
.....



9. *In this question give all answers correct to the nearest whole number.*

- (a) Fumie is going for a holiday to Great Britain. She changes 100 000 Japanese Yen (JPY) into British Pounds (GBP) with no commission charged.

The exchange rate between GBP and JPY is

$$1 \text{ GBP} = 129 \text{ JPY.}$$

Calculate the value of 100 000 JPY in GBP.

[2]

- (b) At the end of Fumie’s holiday in Great Britain she has 239 GBP. She converts this back to JPY at a bank, which does not charge commission, and receives 30 200 JPY.

- (i) Find the exchange rate of this second transaction.
- (ii) Determine, when changing GBP back to JPY, whether the exchange rate found in part (b)(i) is better value for Fumie than the exchange rate in part (a). Justify your answer.

[4]

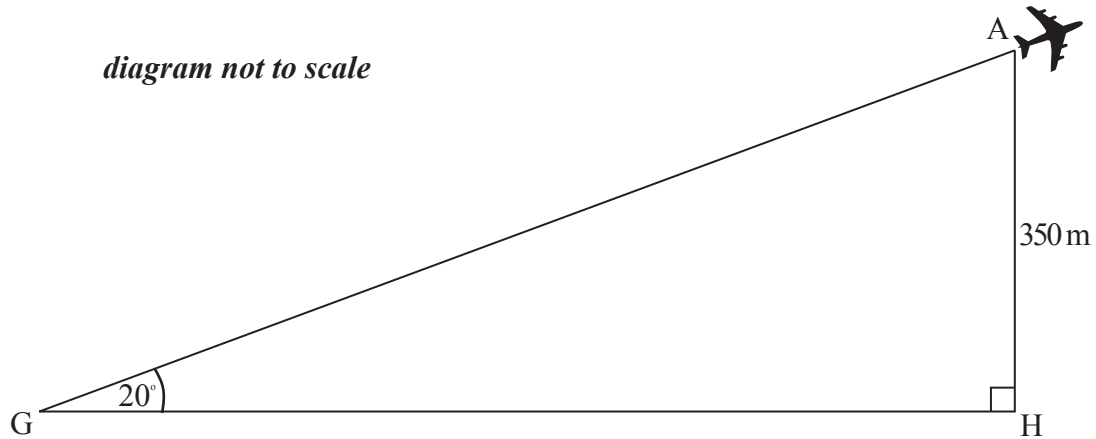
Working:

Answers:

- (a)
- (b) (i)
- (ii)
-
-



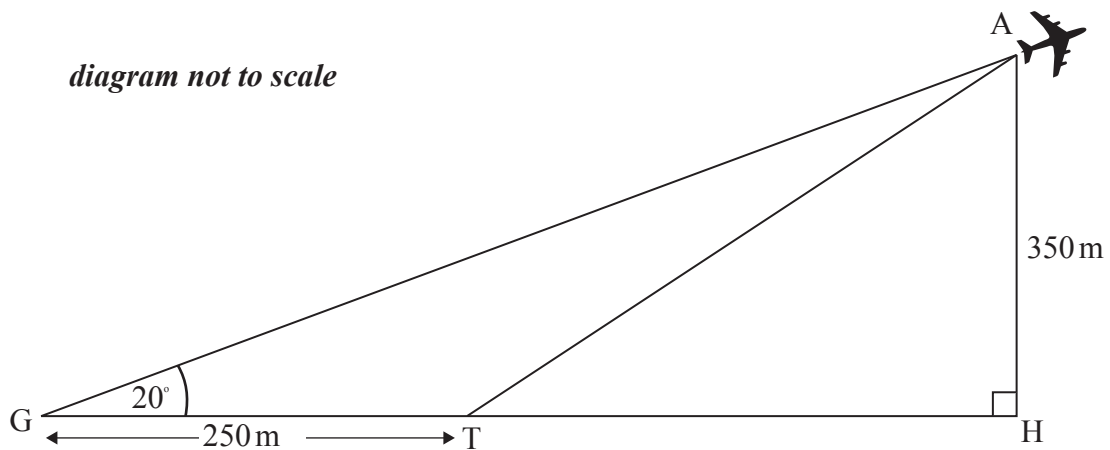
10. Günter is at Berlin Tegel Airport watching the planes take off. He observes a plane that is at an angle of elevation of 20° from where he is standing at point G. The plane is at a height of 350 metres. This information is shown in the following diagram.



- (a) Calculate the horizontal distance, GH, of the plane from Günter. **Give your answer to the nearest metre.**

[3]

The plane took off from a point T, which is 250 metres from where Günter is standing, as shown in the following diagram.



- (b) Using your answer from part (a), calculate the angle ATH, the takeoff angle of the plane.

[3]

(This question continues on the following page)



(Question 10 continued)

Working:

Answers:

- (a)
- (b)



11. In a trial for a new drug, scientists found that the amount of the drug in the bloodstream decreased over time, according to the model

$$D(t) = 1.2 \times (0.87)^t, t \geq 0$$

where D is the amount of the drug in the bloodstream in mg per litre (mg l^{-1}) and t is the time in hours.

- (a) Write down the amount of the drug in the bloodstream at $t = 0$. [1]
- (b) Calculate the amount of the drug in the bloodstream after 3 hours. [2]
- (c) Use your graphic display calculator to determine the time it takes for the amount of the drug in the bloodstream to decrease to 0.333 mg l^{-1} . [3]

Working:

Answers:

- (a)
- (b)
- (c)



12. A survey investigated the relationship between the number of cleaners, n , and the amount of time, t , it takes them to clean a school.

Number of cleaners, n	Time, t (minutes)
1	193
2	172
3	118
5	112
6	87

- (a) Use your graphic display calculator to write down the equation of the regression line t on n . [2]

- (b) Write down the value of the Pearson's product-moment correlation coefficient, r . [2]

- (c) Use your regression equation to find the amount of time 4 cleaners take to clean the school. [2]

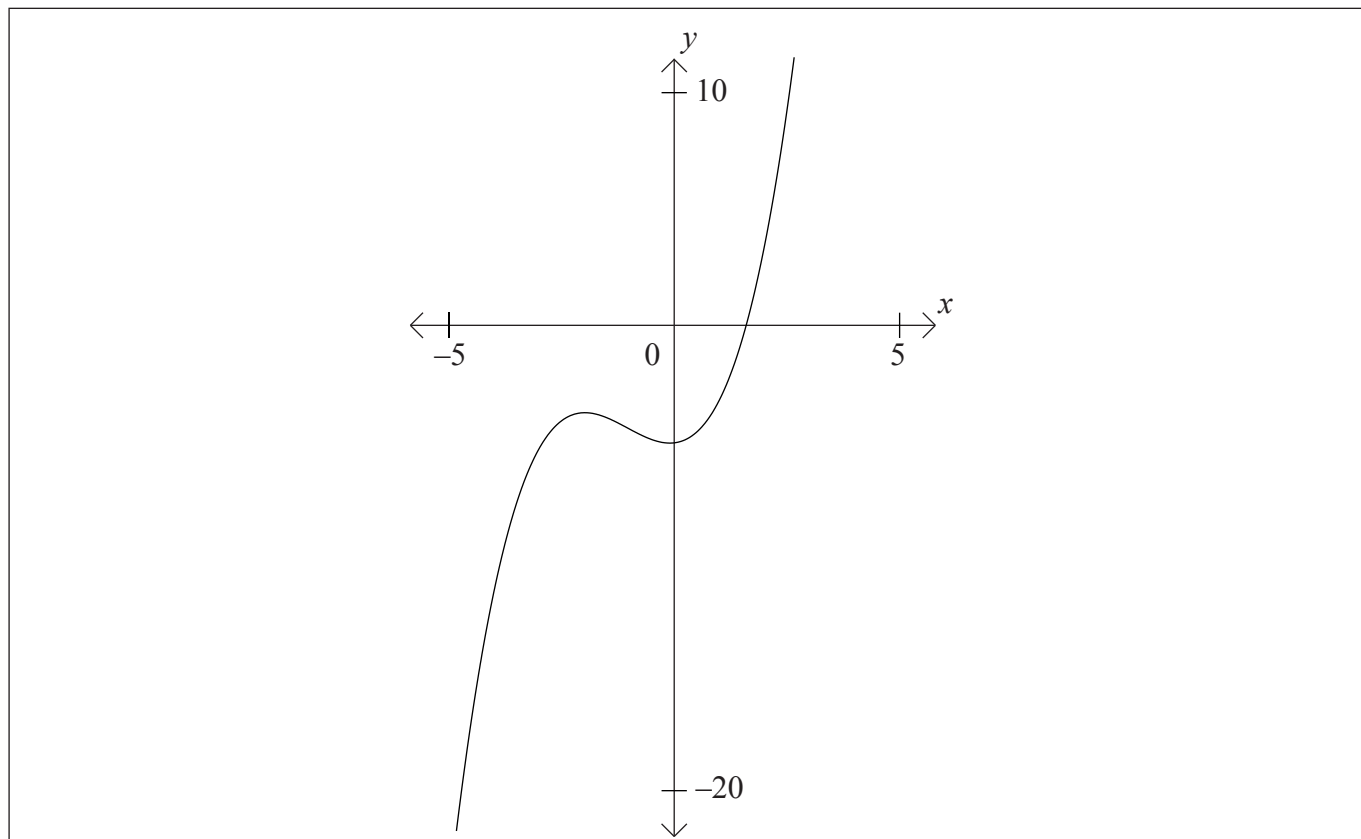
Working:

Answers:

- (a)
- (b)
- (c)



13. Consider the graph of the function $f(x) = x^3 + 2x^2 - 5$.



- (a) Label the local maximum as A on the graph. [1]
- (b) Label the local minimum as B on the graph. [1]
- (c) Write down the interval where $f'(x) < 0$. [1]
- (d) Draw the tangent to the curve at $x = 1$ on the graph. [1]
- (e) Write down the equation of the tangent at $x = 1$. [2]

(This question continues on the following page)



(Question 13 continued)

Working:

Answers:

(c)

(e)



14. The heights of apple trees in an orchard are normally distributed with a mean of 3.42 m and a standard deviation of 0.21 m.
- (a) Write down the probability that a randomly chosen tree has a height greater than 3.42 m. [1]
 - (b) Write down the probability that a randomly chosen tree will be within 2 standard deviations of the mean of 3.42 m. [1]
 - (c) Use your graphic display calculator to calculate the probability that a randomly chosen tree will have a height greater than 3.35 m. [2]
 - (d) The probability that a particular tree is less than x metres high is 0.65. Find the value of x . [2]

Working:

Answers:

- (a)
- (b)
- (c)
- (d)



15. A function is given as $f(x) = 2x^3 - 5x + \frac{4}{x} + 3$, $-5 \leq x \leq 10$, $x \neq 0$.

(a) Write down the derivative of the function. [4]

(b) Use your graphic display calculator to find the coordinates of the local minimum point of $f(x)$ in the given domain. [2]

Working:

Answers:

(a)

(b)



Please **do not** write on this page.

Answers written on this page
will not be marked.

