

**Mathematical studies**  
**Standard level**  
**Paper 2**

Friday 5 May 2017 (morning)

1 hour 30 minutes

---

**Instructions to candidates**

- 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 the questions in the answer booklet 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]**.

Answer **all** questions in the answer booklet provided. Please start each question on a new page. You are advised to show all working, where possible. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. 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. [Maximum mark: 14]

The following table shows the average body weight,  $x$ , and the average weight of the brain,  $y$ , of seven species of mammal. Both measured in kilograms (kg).

Species	Average body weight, $x$ (kg)	Average weight of the brain, $y$ (kg)
Cat	3	0.026
Cow	465	0.423
Donkey	187	0.419
Giraffe	529	0.680
Goat	28	0.115
Jaguar	100	0.157
Sheep	56	0.175

- (a) Find the range of the average body weights for these seven species of mammal. [2]
- (b) For the data from these seven species
- (i) calculate  $r$ , the Pearson’s product–moment correlation coefficient;
- (ii) describe the correlation between the average body weight and the average weight of the brain. [4]
- (c) Write down the equation of the regression line  $y$  on  $x$ , in the form  $y = mx + c$ . [2]

The average body weight of grey wolves is 36 kg.

- (d) Use your regression line to estimate the average weight of the brain of grey wolves. [2]

In fact, the average weight of the brain of grey wolves is 0.120 kg.

- (e) Find the percentage error in your estimate in part (d). [2]

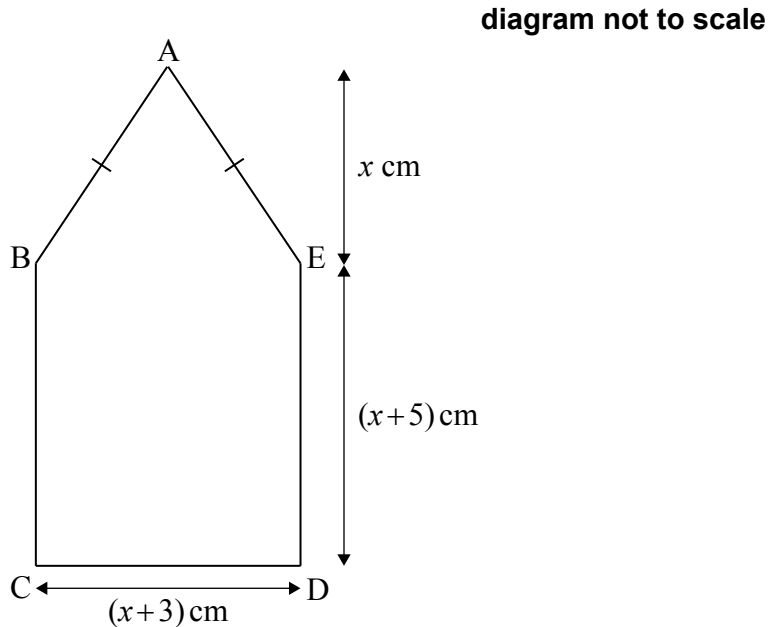
The average body weight of mice is 0.023 kg.

- (f) State whether it is valid to use the regression line to estimate the average weight of the brain of mice. Give a reason for your answer. [2]

2. [Maximum mark: 16]

The base of an electric iron can be modelled as a pentagon ABCDE, where:

BCDE is a rectangle with sides of length  $(x + 3)$  cm and  $(x + 5)$  cm;  
 ABE is an isosceles triangle, with  $AB = AE$  and a height of  $x$  cm;  
 the area of ABCDE is  $222 \text{ cm}^2$ .



- (a) (i) Write down an **equation** for the area of ABCDE using the above information.
- (ii) Show that the equation in part (a)(i) simplifies to  $3x^2 + 19x - 414 = 0$ . [4]
- (b) Find the length of CD. [2]
- (c) Show that angle  $\hat{BAE} = 67.4^\circ$ , correct to one decimal place. [3]

Insulation tape is wrapped around the perimeter of the base of the iron, ABCDE.

- (d) Find the length of the perimeter of ABCDE. [3]

F is the point on AB such that  $BF = 8$  cm. A heating element in the iron runs in a straight line, from C to F.

- (e) Calculate the length of CF. [4]

Turn over

3. [Maximum mark: 14]

Consider the function  $f(x) = 0.3x^3 + \frac{10}{x} + 2^{-x}$ .

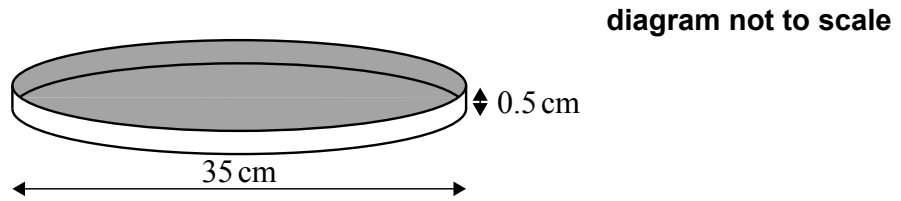
- (a) Calculate  $f(1)$ . [2]
- (b) Sketch the graph of  $y = f(x)$  for  $-7 \leq x \leq 4$  and  $-30 \leq y \leq 30$ . [4]
- (c) Write down the equation of the vertical asymptote. [2]
- (d) Write down the coordinates of the  $x$ -intercept. [2]
- (e) Write down the possible values of  $x$  for which  $x < 0$  and  $f'(x) > 0$ . [2]

Consider a second function,  $g(x) = 2x - 3$ .

- (f) Find the solution of  $f(x) = g(x)$ . [2]

4. [Maximum mark: 15]

A pan, in which to cook a pizza, is in the shape of a cylinder. The pan has a diameter of 35 cm and a height of 0.5 cm.



(a) Calculate the volume of this pan. [3]

A chef had enough pizza dough to exactly fill the pan. The dough was in the shape of a sphere.

(b) Find the radius of the sphere in cm, correct to one decimal place. [4]

The pizza was cooked in a hot oven. Once taken out of the oven, the pizza was placed in a dining room.

The temperature,  $P$ , of the pizza, in degrees Celsius,  $^{\circ}\text{C}$ , can be modelled by

$$P(t) = a(2.06)^{-t} + 19, t \geq 0$$

where  $a$  is a constant and  $t$  is the time, in minutes, since the pizza was taken out of the oven.

When the pizza was taken out of the oven its temperature was  $230^{\circ}\text{C}$ .

(c) Find the value of  $a$ . [2]

(d) Find the temperature that the pizza will be 5 minutes after it is taken out of the oven. [2]

The pizza can be eaten once its temperature drops to  $45^{\circ}\text{C}$ .

(e) Calculate, to the nearest second, the time since the pizza was taken out of the oven until it can be eaten. [3]

(f) In the context of this model, state what the value of 19 represents. [1]

**Turn over**

5. [Maximum mark: 15]

The table below shows the distribution of test grades for 50 IB students at Greendale School.

<b>Test grade</b>	1	2	3	4	5	6	7
<b>Frequency</b>	1	3	7	13	11	10	5

- (a) Calculate
  - (i) the mean test grade of the students;
  - (ii) the standard deviation. [3]
- (b) Find the median test grade of the students. [1]
- (c) Find the interquartile range. [2]

A student is chosen at random from these 50 students.

- (d) Find the probability that this student scored a grade 5 or higher. [2]

A second student is chosen at random from these 50 students.

- (e) Given that the first student chosen at random scored a grade 5 or higher, find the probability that both students scored a grade 6. [3]

The number of minutes that the 50 students spent preparing for the test was normally distributed with a mean of 105 minutes and a standard deviation of 20 minutes.

- (f) (i) Calculate the probability that a student chosen at random spent at least 90 minutes preparing for the test.
- (ii) Calculate the expected number of students that spent at least 90 minutes preparing for the test. [4]

6. [Maximum mark: 16]

Consider the function  $g(x) = x^3 + kx^2 - 15x + 5$ .

(a) Find  $g'(x)$ . [3]

The tangent to the graph of  $y = g(x)$  at  $x = 2$  is parallel to the line  $y = 21x + 7$ .

(b) (i) Show that  $k = 6$ .  
(ii) Find the equation of the tangent to the graph of  $y = g(x)$  at  $x = 2$ . Give your answer in the form  $y = mx + c$ . [5]

(c) Use your answer to part (a) and the value of  $k$ , to find the  $x$ -coordinates of the stationary points of the graph of  $y = g(x)$ . [3]

(d) (i) Find  $g'(-1)$ .  
(ii) Hence justify that  $g$  is decreasing at  $x = -1$ . [3]

(e) Find the  $y$ -coordinate of the local minimum. [2]