

**MATHEMATICS
STANDARD LEVEL
PAPER 2**

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.
- Section A: answer all questions in the boxes provided.
- Section B: answer all questions in the answer booklet provided. Fill in your session number on the front of the answer booklet, and attach it to this examination paper and your cover sheet using the tag provided.
- Unless otherwise stated in the question, all numerical answers should be given exactly or correct to three significant figures.
- A clean copy of the **Mathematics SL formula booklet** is required for this paper.
- The maximum mark for this examination paper is [90 marks].

Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. In particular, 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. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. You are therefore advised to show all working.

SECTION A

1. [Maximum mark: 5]

Let $f(x) = 2x + 3$ and $g(x) = x^3$.

(a) Find $(f \circ g)(x)$. [2]

(b) Solve the equation $(f \circ g)(x) = 0$. [3]

2. [Maximum mark: 6]

The following table shows the Diploma score x and university entrance mark y for seven IB Diploma students.

Diploma score (x)	28	30	27	31	32	25	27
University entrance mark (y)	73.9	78.1	70.2	82.2	85.5	62.7	69.4

- (a) Find the correlation coefficient. [2]

The relationship can be modelled by the regression line with equation $y = ax + b$.

- (b) Write down the value of a and of b . [2]

Rita scored a total of 26 in her IB Diploma.

- (c) Use your regression line to estimate Rita's university entrance mark. [2]

[illegible]

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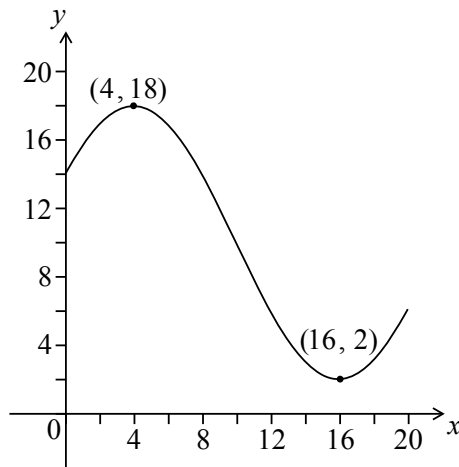
4. [Maximum mark: 5]

Consider the expansion of $(x+3)^{10}$.

- (a) Write down the number of terms in this expansion. [1]
- (b) Find the term containing x^3 . [4]

5. [Maximum mark: 8]

Let $f(x) = p \cos(q(x+r)) + 10$, for $0 \leq x \leq 20$. The following diagram shows the graph of f .



The graph has a maximum at $(4, 18)$ and a minimum at $(16, 2)$.

- (a) Write down the value of r . [2]
- (b) (i) Find p .
- (ii) Find q . [4]
- (c) Solve $f(x) = 7$. [2]

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SECTION B

Answer **all** questions in the answer booklet provided. Please start each question on a new page.

7. [Maximum mark: 15]

The number of bacteria in two colonies, A and B, starts increasing at the same time.

The number of bacteria in colony A after t hours is modelled by the function $A(t) = 12e^{0.4t}$.

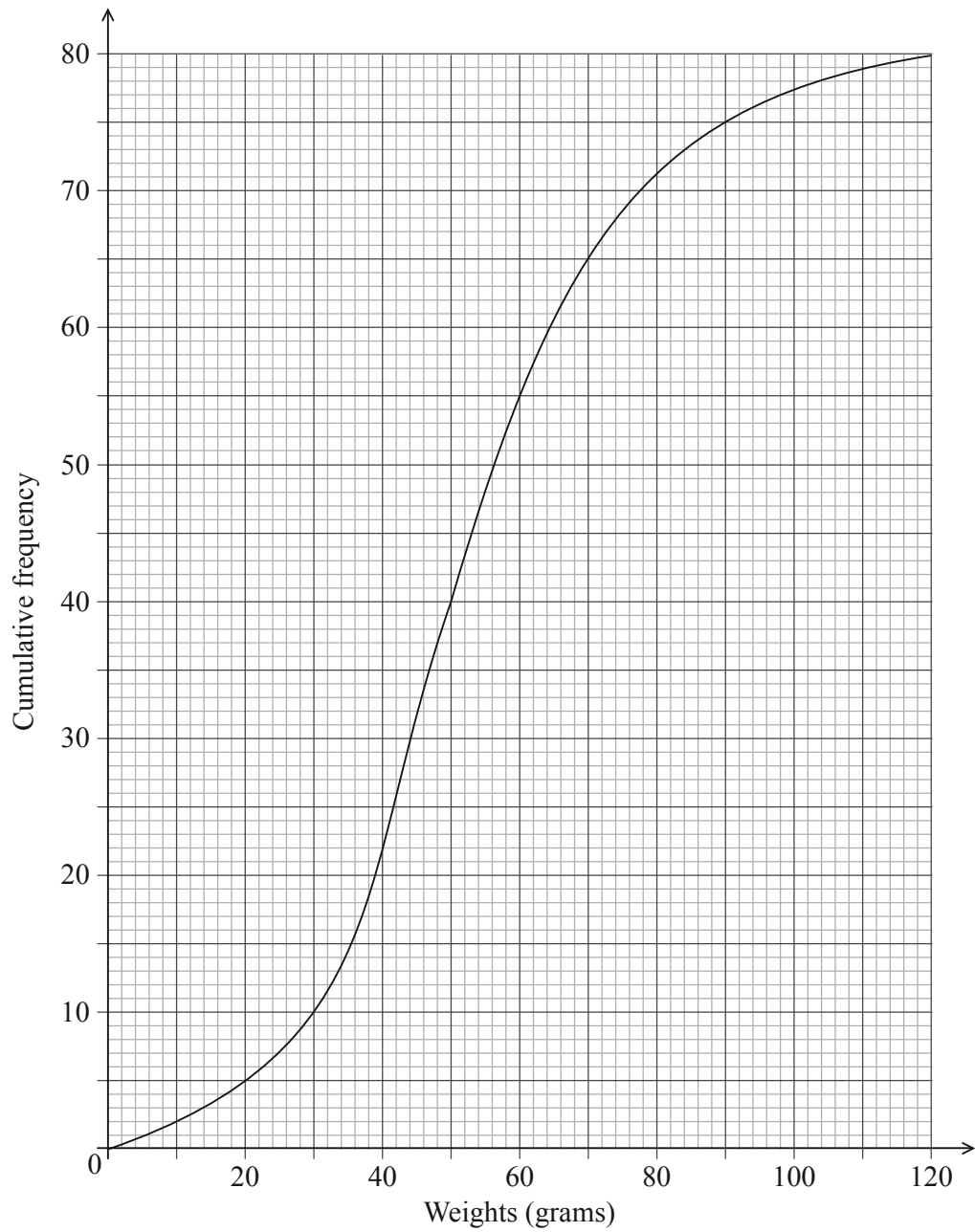
- (a) Find the initial number of bacteria in colony A. [2]
- (b) Find the number of bacteria in colony A after four hours. [3]
- (c) How long does it take for the number of bacteria in colony A to reach 400? [3]

The number of bacteria in colony B after t hours is modelled by the function $B(t) = 24e^{kt}$.

- (d) After four hours, there are 60 bacteria in colony B. Find the value of k . [3]
- (e) The number of bacteria in colony A first exceeds the number of bacteria in colony B after n hours, where $n \in \mathbb{Z}$. Find the value of n . [4]

8. *[Maximum mark: 16]*

The weights in grams of 80 rats are shown in the following cumulative frequency diagram.



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(Question 8 continued)

- (a) (i) Write down the median weight of the rats.
- (ii) Find the percentage of rats that weigh 70 grams or less. [4]

The same data is presented in the following table.

Weights w grams	$0 \leq w \leq 30$	$30 < w \leq 60$	$60 < w \leq 90$	$90 < w \leq 120$
Frequency	p	45	q	5

- (b) (i) Write down the value of p .
- (ii) Find the value of q . [4]
- (c) Use the values from the table to estimate the mean and standard deviation of the weights. [3]

Assume that the weights of these rats are normally distributed with the mean and standard deviation estimated in part (c).

- (d) Find the percentage of rats that weigh 70 grams or less. [2]
- (e) A sample of five rats is chosen at random. Find the probability that at most three rats weigh 70 grams or less. [3]

9. [Maximum mark: 15]

Let $f(x) = \cos\left(\frac{\pi}{4}x\right) + \sin\left(\frac{\pi}{4}x\right)$, for $-4 \leq x \leq 4$.

- (a) Sketch the graph of f . [3]
- (b) Find the values of x where the function is decreasing. [5]
- (c) The function f can also be written in the form $f(x) = a \sin\left(\frac{\pi}{4}(x+c)\right)$, where $a \in \mathbb{R}$, and $0 \leq c \leq 2$. Find the value of
- (i) a ;
- (ii) c . [7]

