Predicted paper · May 2027

IB Mathematics: analysis and approaches

Standard level · Paper 1

1 hour 30 minutes

Instructions

- Section A: 6 short questions, 40 marks. Answer in the spaces provided.
- Section B: 3 longer questions, 40 marks. Answer on lined paper.
- Total: 80 marks. Answer all questions.
- No calculator is allowed for this paper.
- Full marks are not necessarily awarded for a correct answer with no working: show your method.
- You need a clean copy of the mathematics: analysis and approaches formula booklet.
- Sit it in one go, timed. Then mark it with the mark scheme, honestly.

Name .....

Date .....

Score .....

Every question in this paper is new, written by Pietro Meloni to the shape of the papers set on the current syllabus. It is not IB material and it is not a leaked paper: it is a prediction of the topics and the style, for practice under timed conditions.

Mark scheme and the other papers in the set: scan the code

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Section A

1. The function f is defined by $f(x) = x^2 - 6x + 5$, $x \in \mathbb{R}$.

(a) Find the zeros of f. **[2]**

(b) Express $f(x)$ in the form $(x-h)^2 + k$, where $h, k \in \mathbb{Z}$. **[2]**

(c) Write down the coordinates of the vertex of the graph of $y = f(x)$. **[1]**

2. The third term of an arithmetic sequence $u_1, u_2, u_3, \ldots$ is 11 and the eighth term is 31.

(a) Find the common difference and the first term of the sequence. **[3]**

(b) Find the value of n for which $\sum_{k=1}^{n} u_k = 465$. **[3]**

3. In a group of 30 students, 18 study Spanish, 14 study German and 5 study neither of these two languages. A student is chosen at random from the group. Let S be the event that the student studies Spanish and G the event that the student studies German.

(a) Find the number of students who study both languages. **[2]**

(b) Find $\mathrm{P}(G \mid S)$. **[2]**

(c) Determine, with a reason, whether the events S and G are independent. **[2]**

4. Let $f(x) = \cos 2x + 3\sin x$.

(a) Find the exact value of $f\left(\frac{\pi}{6}\right)$. **[2]**

(b) Show that $f(x) = 1 + 3\sin x - 2\sin^2 x$. **[2]**

(c) Hence solve the equation $f(x) = 2$ for $0 \leq x \leq 2\pi$. **[3]**

5. Let $f(x) = x \ln x$, where $x > 0$.

(a) Find $f'(x)$. **[2]**

(b) Find the equation of the normal to the graph of f at the point where $x = \mathrm{e}$. Give your answer in the form $y = mx + c$. **[4]**

(c) Find the exact coordinates of the stationary point of the graph of f. **[2]**

6. Consider the expansion of $\left(2x - \frac{1}{x^2}\right)^6$.

(a) Find the term that is independent of x. **[4]**

(b) Hence, or otherwise, find the coefficient of x^3 in the expansion of $(1 + x^3)\left(2x - \frac{1}{x^2}\right)^6$. **[4]**

Section B

1. The function f is defined by $f(x) = \dfrac{2x-1}{x+2}$, for $x \in \mathbb{R}$, $x \neq -2$.

(a) Write down the equation of

(i) the vertical asymptote of the graph of f; **[1]**

(ii) the horizontal asymptote of the graph of f. **[1]**

(b) Find an expression for $f^{-1}(x)$. **[3]**

(c) Write down the domain of f^{-1}. **[1]**

(d) The function g is defined by $g(x) = x^2$, for $x \in \mathbb{R}$. Solve the equation $(f \circ g)(x) = 1$. **[3]**

(e) The graph of f is translated by the vector $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$ to give the graph of a function h. Show that $h(x) = -\dfrac{5}{x-1}$. **[2]**

(f) The graph of h is reflected in the y-axis and then stretched vertically with scale factor 2 to give the graph of a function k. Find an expression for $k(x)$. **[2]**

2. A particle P moves in a straight line. Its velocity v, in m s^{-1}, at time t seconds is given by

$$v(t) = 3t^2 - 12t + 9, \qquad 0 \leq t \leq 4.$$

At $t = 0$ the particle is at the origin O.

(a) Find the values of t for which P is at rest. **[2]**

(b) Find the acceleration of P when $t = 0$. **[2]**

(c) Find the minimum velocity of P. **[3]**

(d) Find an expression for the displacement $s(t)$ of P from O at time t. **[2]**

(e) Show that P is at O when $t = 3$. **[1]**

(f) Find the total distance travelled by P during the first 4 seconds. **[3]**

3. The function f is defined by $f(x) = 2\sin 2x + 1$, for $0 \leq x \leq \pi$.

(a) Write down

(i) the amplitude of f; **[1]**

(ii) the period of f. **[1]**

(b) Find the coordinates of the maximum point of the graph of f. **[2]**

(c) Solve the equation $f(x) = 0$. **[3]**

(d) Find $f'(x)$. **[2]**

(e) Find the equation of the tangent to the graph of f at the point where $x = \dfrac{\pi}{3}$. Give your answer

in the form $y = mx + c$. **[2]**

(f) The region R is enclosed by the graph of f and the x-axis, for $\frac{7\pi}{12} \leq x \leq \frac{11\pi}{12}$. Find the exact area of R. **[3]**

Predicted paper · May 2027

IB Mathematics: analysis and approaches

Standard level · Paper 2

1 hour 30 minutes

Instructions

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- Section B: 3 longer questions, 40 marks. Answer on lined paper.
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Mark scheme and the other papers in the set: scan the code

Section A

1. Lena invests 8000 USD in a savings account that pays a nominal annual interest rate of 3.6%, compounded monthly. No further deposits or withdrawals are made.

(**a**) Find the value of the investment after 5 years. Give your answer correct to the nearest cent. **[2]**

(**b**) Find the minimum number of complete years needed for the value of the investment to exceed 12 000 USD. **[3]**

2. A triangular plot of land is shown in the diagram, where AB = 85 m, BC = 62 m and $A\hat{B}C = 58°$.

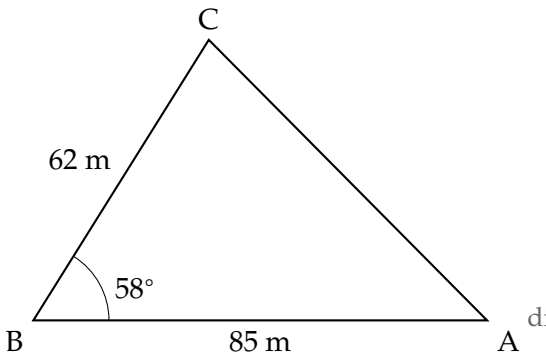


diagram not to scale

(**a**) Find the length of AC. **[2]**

(**b**) Find the size of $B\hat{A}C$. **[2]**

(**c**) The land is valued at 12 USD per square metre. Find the value of the plot. **[2]**

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3. The masses of the avocados grown in an orchard are normally distributed with mean 185 g and standard deviation 22 g.

(**a**) Find the probability that a randomly chosen avocado has a mass greater than 200 g. **[2]**

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(**b**) The heaviest 15% of the avocados are sold as *premium*. Find the minimum mass of a premium avocado. **[2]**

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(**c**) The masses of the avocados grown in a second orchard are also normally distributed, with mean 190 g and standard deviation σ g. In this orchard, 10% of the avocados have a mass less than 160 g. Find the value of σ. **[3]**

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4. A cup of coffee is left to cool in a room. Its temperature T, in degrees Celsius, after t minutes is modelled by

$$T(t) = 21 + A\,\mathrm{e}^{-kt}, \qquad t \geq 0,$$

where A and k are positive constants. The initial temperature of the coffee is 85°C and after 10 minutes its temperature is 60°C.

(**a**) Write down the value of A. **[1]**

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(b) Find the value of k. **[2]**

(c) Find the time taken for the temperature of the coffee to fall to 30°C. **[2]**

(d) Write down the equation of the horizontal asymptote of the graph of T, and state what it represents in this context. **[2]**

5. A closed cylindrical can has radius r cm and height h cm. The volume of the can is 330 cm^3.

(a) Show that the total surface area, S cm^2, of the can is given by $S = 2\pi r^2 + \frac{660}{r}$. **[2]**

(b) Find $\frac{\mathrm{d}S}{\mathrm{d}r}$. **[2]**

(c) Find the value of r for which S is a minimum, and the corresponding minimum surface area. **[3]**

6. A factory produces rechargeable batteries. Each battery, independently of the others, fails a quality test with probability 0.06. The batteries are packed in boxes of 20. Let X be the number of batteries in a randomly chosen box that fail the test.

(a) Find the probability that, in a randomly chosen box,

(i) exactly two batteries fail the test; **[2]**

(ii) at least three batteries fail the test. **[2]**

(b) Find the expected number of batteries in a box that fail the test. **[1]**

(c) An inspector selects n batteries at random from the production line. Find the smallest value of n such that the probability that at least two of these batteries fail the test is greater than 0.9. **[3]**

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Section B

1. A market gardener grows tomatoes in nine greenhouses. For each greenhouse she records the mean daily temperature, x degrees Celsius, during the growing season and the yield of tomatoes, y kilograms per square metre. The results are shown in the table.

Temperature, x (°C)	18.5	19.2	20.4	21.0	21.8	22.5	23.4	24.1	25.6
Yield, y (kg per m^2)	9.1	10.4	10.2	12.0	11.3	12.8	12.6	14.3	14.5

(a) Find the mean and the standard deviation of the yields. **[2]**

(b)

(i) Find Pearson's product-moment correlation coefficient, r, for these data. **[2]**

(ii) Interpret the value of r in context. **[1]**

(c) Find the equation of the regression line of y on x. **[2]**

(d)

(i) Use your regression line to estimate the yield in a greenhouse where the mean daily temperature is 21.5 °C. **[2]**

(ii) The gardener plans a new greenhouse with a mean daily temperature of 30 °C. Explain why the regression line should not be used to estimate its yield. **[1]**

(e) Interpret the gradient of the regression line in context. **[1]**

(f) Two of the nine greenhouses are chosen at random. Find the probability that both of them have a yield greater than the mean yield. **[2]**

2. A particle moves in a straight line. Its velocity, v m s^{-1}, at time t seconds is given by

$$v(t) = \mathrm{e}^{-0.3t}\,(5\sin t + 1)\,, \qquad 0 \le t \le 5.$$

(a) Write down the velocity of the particle when $t = 0$. **[1]**

(b) Find the value of t when the particle is first at rest. **[2]**

(c) Show that the acceleration of the particle is given by $a(t) = \mathrm{e}^{-0.3t}\,(5\cos t - 1.5\sin t - 0.3)$. **[3]**

(d) Hence, or otherwise, find the maximum velocity of the particle. **[3]**

(e) Find the displacement of the particle from its initial position when $t = 5$. **[2]**

(f) Find the total distance travelled by the particle during the first 5 seconds. **[2]**

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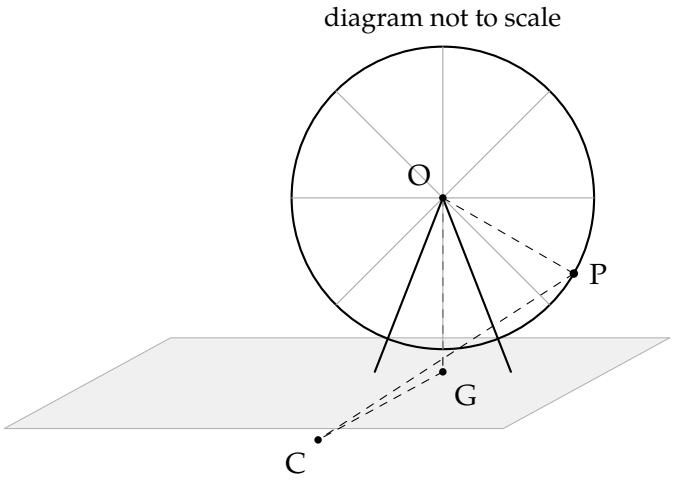
3. A Ferris wheel has radius 20 m. Its centre O is 23 m above horizontal ground, and G is the point on the ground directly below O. The wheel rotates at a constant rate in a vertical plane and completes one revolution every 12 minutes.

A cabin P is at the lowest point of the wheel when $t = 0$. The height, h metres, of P above the ground after t minutes is modelled by

$$h(t) = d - a\cos(bt),$$

where a, b and d are positive constants.

A camera is placed at a point C on the ground, 30 m from G, such that CG is perpendicular to the plane of the wheel. The diagram shows the wheel, the point C and the position of P when $t = 2$.



(a) Write down the value of a and the value of d. **[2]**

(b) Show that $b = \frac{\pi}{6}$. **[1]**

(c) Find the height of P above the ground when $t = 2$. **[2]**

(d) During one revolution, find the length of time for which P is more than 35 m above the ground. **[3]**

(e) Find the distance PG when $t = 2$. **[2]**

(f) Find the angle of elevation of P from C when $t = 2$. **[4]**