

© International Baccalaureate Organization 2021

All rights reserved. No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without the prior written permission from the IB. Additionally, the license tied with this product prohibits use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, whether fee-covered or not, is prohibited and is a criminal offense.

More information on how to request written permission in the form of a license can be obtained from <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organisation du Baccalauréat International 2021

Tous droits réservés. Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite préalable de l'IB. De plus, la licence associée à ce produit interdit toute utilisation de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, moyennant paiement ou non, est interdite et constitue une infraction pénale.

Pour plus d'informations sur la procédure à suivre pour obtenir une autorisation écrite sous la forme d'une licence, rendez-vous à l'adresse <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

© Organización del Bachillerato Internacional, 2021

Todos los derechos reservados. No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin la previa autorización por escrito del IB. Además, la licencia vinculada a este producto prohíbe el uso de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales—, ya sea incluido en tasas o no, está prohibido y constituye un delito.

En este enlace encontrará más información sobre cómo solicitar una autorización por escrito en forma de licencia: <https://ibo.org/become-an-ib-school/ib-publishing/licensing/applying-for-a-license/>.

Mathematics: applications and interpretation
Standard level
Paper 1

Monday 1 November 2021 (afternoon)

Candidate session number

--	--	--	--	--	--	--	--	--	--

1 hour 30 minutes

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.
- Answer all questions.
- Answers must be written within the answer boxes 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: applications and interpretation formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.



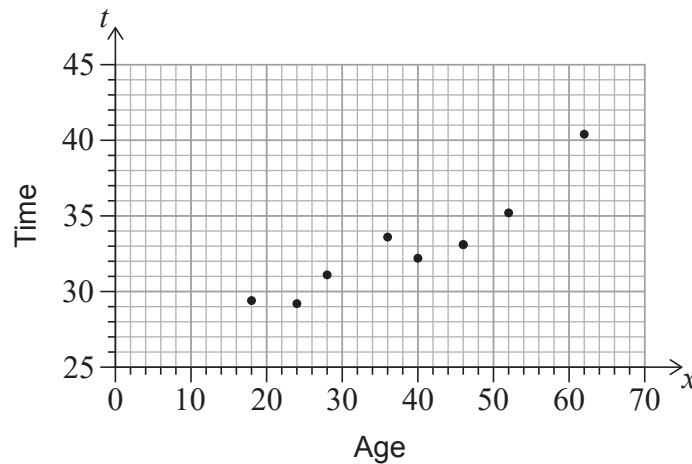
Answers must be written within the answer boxes provided. Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. Solutions found from a graphic display calculator should be supported by suitable working. For example, if graphs 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.

1. [Maximum mark: 6]

Eduardo believes that there is a linear relationship between the age of a male runner and the time it takes them to run 5000 metres.

To test this, he recorded the age, x years, and the time, t minutes, for eight males in a single 5000 m race. His results are presented in the following table and scatter diagram.

x, years	18	24	28	36	40	46	52	62
t, minutes	29.4	29.2	31.1	33.6	32.2	33.1	35.2	40.4



- (a) For this data, find the value of the Pearson’s product-moment correlation coefficient, r . [2]

Eduardo looked in a sports science text book. He found that the following information about r was appropriate for athletic performance.

Value of $ r $	Description of the correlation
$0 \leq r < 0.4$	weak
$0.4 \leq r < 0.8$	moderate
$0.8 \leq r \leq 1$	strong

- (b) Comment on your answer to part (a), using the information that Eduardo found. [1]
- (c) Write down the equation of the regression line of t on x , in the form $t = ax + b$. [1]

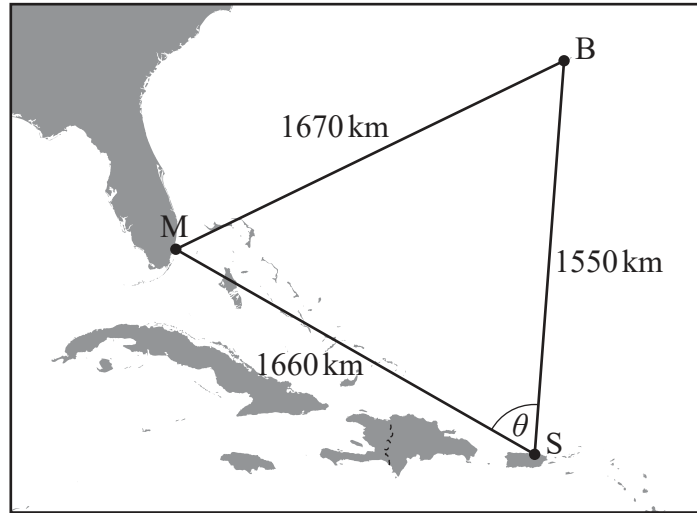
(This question continues on the following page)



2. [Maximum mark: 5]

The Bermuda Triangle is a region of the Atlantic Ocean with Miami (M), Bermuda (B), and San Juan (S) as vertices, as shown on the diagram.

diagram not to scale



The distances between M, B and S are given in the following table, correct to three significant figures.

Distance between Miami and Bermuda	1670 km
Distance between Bermuda and San Juan	1550 km
Distance between San Juan and Miami	1660 km

- (a) Calculate the value of θ , the measure of angle $M\hat{S}B$. [3]
- (b) Find the area of the Bermuda Triangle. [2]

(This question continues on the following page)



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

Answers written on this page
will not be marked.



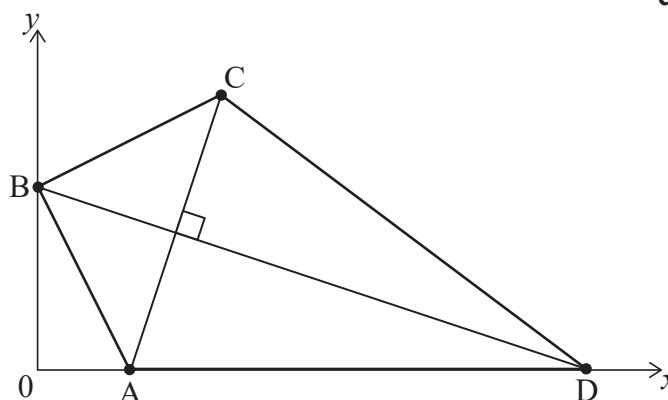
24EP06

4. [Maximum mark: 6]

Dilara is designing a kite ABCD on a set of coordinate axes in which one unit represents 10 cm.

The coordinates of A, B and C are (2, 0), (0, 4) and (4, 6) respectively. Point D lies on the x -axis. [AC] is perpendicular to [BD]. This information is shown in the following diagram.

diagram not to scale



- (a) Find the gradient of the line through A and C. [2]
- (b) Write down the gradient of the line through B and D. [1]
- (c) Find the equation of the line through B and D. Give your answer in the form $ax + by + d = 0$, where a , b and d are integers. [2]
- (d) Write down the x -coordinate of point D. [1]

(This question continues on the following page)



6. [Maximum mark: 5]

Inspectors are investigating the carbon dioxide emissions of a power plant. Let R be the rate, in tonnes per hour, at which carbon dioxide is being emitted and t be the time in hours since the inspection began.

When R is plotted against t , the total amount of carbon dioxide produced is represented by the area between the graph and the horizontal t -axis.

The rate, R , is measured over the course of two hours. The results are shown in the following table.

t	0	0.4	0.8	1.2	1.6	2
R	30	50	60	40	20	50

- (a) Use the trapezoidal rule with an interval width of 0.4 to estimate the total amount of carbon dioxide emitted during these two hours. [3]

The real amount of carbon dioxide emitted during these two hours was 72 tonnes.

- (b) Find the percentage error of the estimate found in part (a). [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

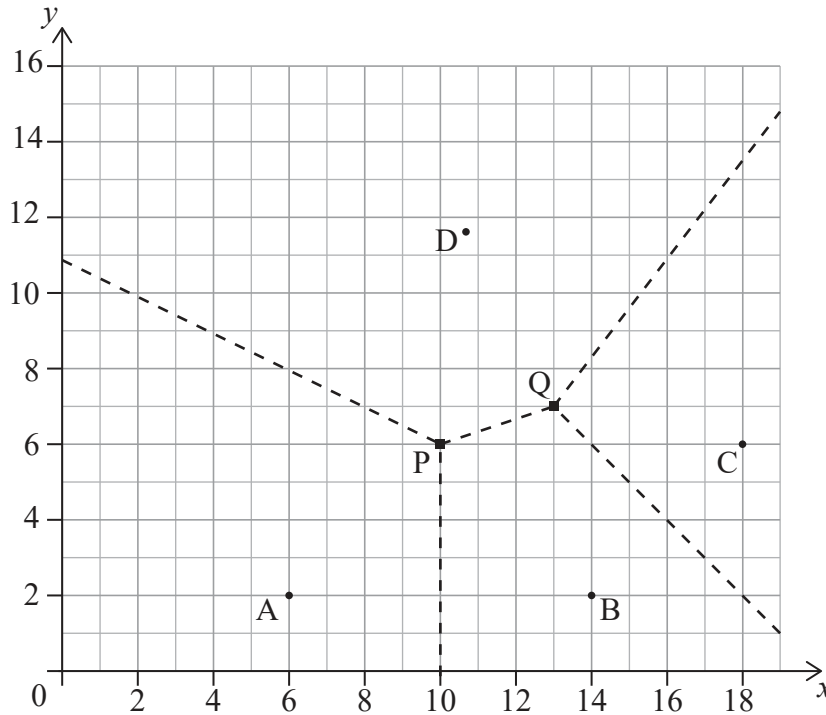


7. [Maximum mark: 6]

There are four stations used by the fire wardens in a national forest.

On the following Voronoi diagram, the coordinates of the stations are $A(6, 2)$, $B(14, 2)$, $C(18, 6)$ and $D(10.8, 11.6)$ where distances are measured in kilometres.

The dotted lines represent the boundaries of the regions patrolled by the fire warden at each station. The boundaries meet at $P(10, 6)$ and $Q(13, 7)$.



To reduce the areas of the regions that the fire wardens patrol, a new station is to be built within the quadrilateral ABCD. The new station will be located so that it is as far as possible from the nearest existing station.

- (a) Show that the new station should be built at P. [3]

The Voronoi diagram is to be updated to include the region around the new station at P. The edges defined by the perpendicular bisectors of $[AP]$ and $[BP]$ have been added to the following diagram.

- (b) (i) Write down the equation of the perpendicular bisector of $[PC]$.
(ii) Hence draw the missing boundaries of the region around P on the following diagram. [3]

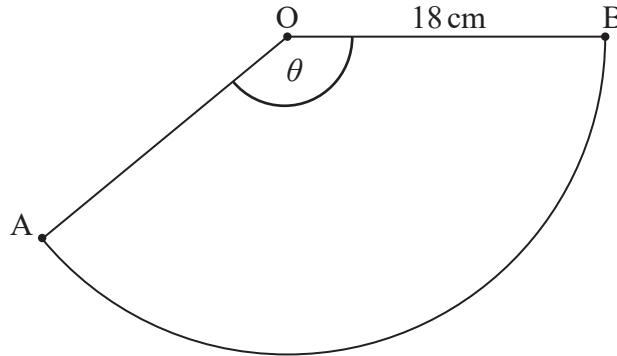
(This question continues on the following page)



8. [Maximum mark: 5]

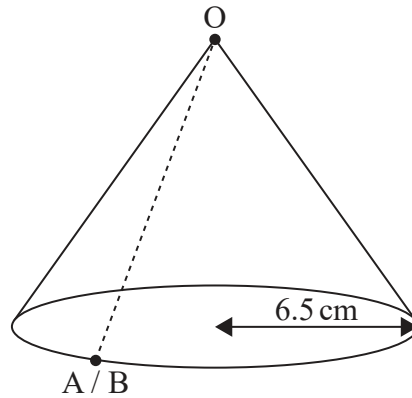
Joey is making a party hat in the form of a cone. The hat is made from a sector, AOB , of a circular piece of paper with a radius of 18 cm and $\hat{AOB} = \theta$ as shown in the diagram.

diagram not to scale



To make the hat, sides $[OA]$ and $[OB]$ are joined together. The hat has a base radius of 6.5 cm.

diagram not to scale



(a) (i) Write down the perimeter of the base of the hat in terms of π .

(ii) Find the value of θ .

[3]

(b) Find the surface area of the outside of the hat.

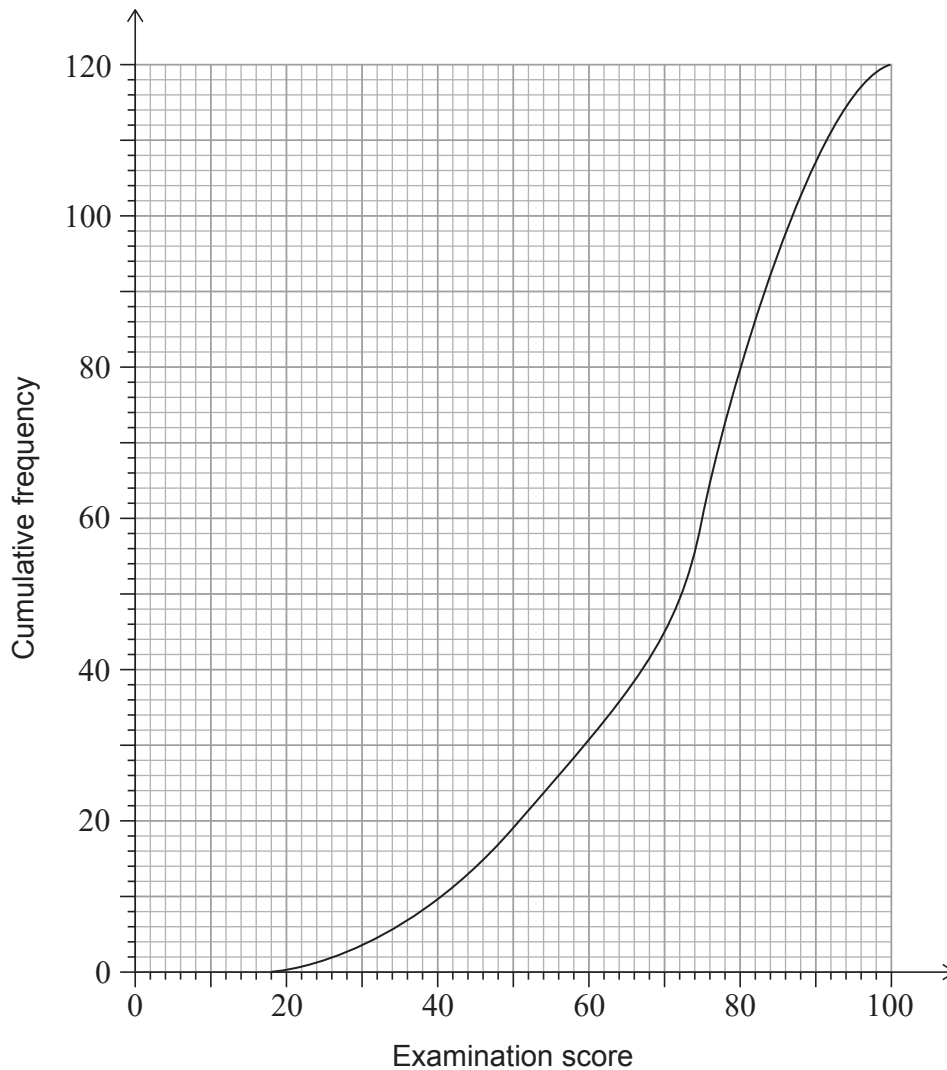
[2]

(This question continues on the following page)



9. [Maximum mark: 8]

A group of 120 students sat a history exam. The cumulative frequency graph shows the scores obtained by the students.



(a) Find the median of the scores obtained.

[1]

The students were awarded a grade from 1 to 5, depending on the score obtained in the exam. The number of students receiving each grade is shown in the following table.

Grade	1	2	3	4	5
Number of students	6	13	26	a	b

(b) Find an expression for a in terms of b .

[2]

(This question continues on the following page)



24EP16

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

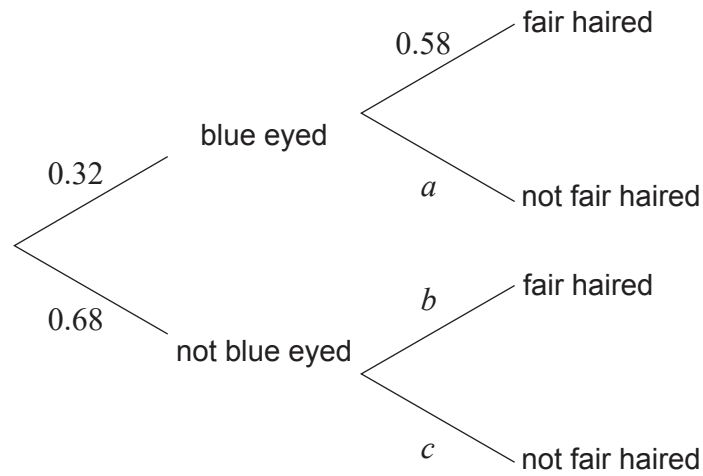
Answers written on this page
will not be marked.



24EP18

11. [Maximum mark: 5]

In a city, 32% of people have blue eyes. If someone has blue eyes, the probability that they also have fair hair is 58%. This information is represented in the following tree diagram.



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

(b) Find an expression, in terms of b , for the probability of a person not having blue eyes **and** having fair hair. [1]

It is known that 41% of people in this city have fair hair.

(c) Calculate the value of
(i) b .
(ii) c . [3]

(This question continues on the following page)



(Question 11 continued)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

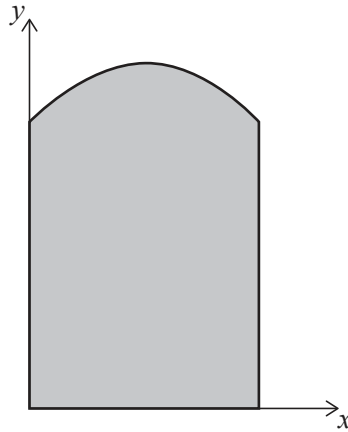


24EP21

Turn over

13. [Maximum mark: 8]

Irina uses a set of coordinate axes to draw her design of a window. The base of the window is on the x -axis, the upper part of the window is in the form of a quadratic curve and the sides are vertical lines, as shown on the diagram. The curve has end points $(0, 10)$ and $(8, 10)$ and its vertex is $(4, 12)$. Distances are measured in centimetres.



The quadratic curve can be expressed in the form $y = ax^2 + bx + c$ for $0 \leq x \leq 8$.

- (a) (i) Write down the value of c .
 - (ii) Hence form two equations in terms of a and b .
 - (iii) Hence find the equation of the quadratic curve. [5]
- (b) Find the area of the shaded region in Irina's design. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(This question continues on the following page)



Turn over

(Question 13 continued)



References:

2. Bermuda Triangle map [online] Available at: [https://commons.wikimedia.org/wiki/File:Bermuda_Triangle_map_\(de\).svg](https://commons.wikimedia.org/wiki/File:Bermuda_Triangle_map_(de).svg)
Thomas Römer. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.
(CC BY-SA 3.0) <https://creativecommons.org/licenses/by-sa/3.0/deed.en> [Accessed 17 December 2020] Source adapted.

All other texts, graphics and illustrations © International Baccalaureate Organization 2021



24EP24