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Mathematics: applications and interpretation
Standard level
Paper 1

Thursday 6 May 2021 (afternoon)

Candidate session number

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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]**.

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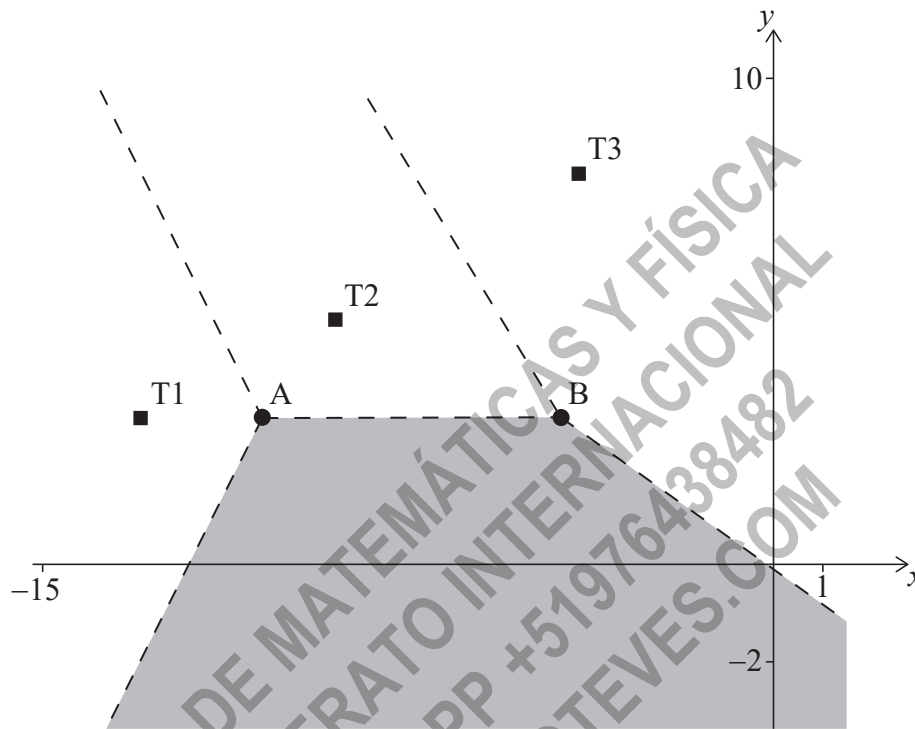


5. [Maximum mark: 6]

The Voronoi diagram below shows three identical cellular phone towers, T1, T2 and T3. A fourth cellular phone tower, T4 is located in the shaded region. The dashed lines in the diagram below represent the edges in the Voronoi diagram.

Horizontal scale: 1 unit represents 1 km.

Vertical scale: 1 unit represents 1 km.



Tim stands inside the shaded region.

(a) Explain why Tim will receive the strongest signal from tower T4. [1]

Tower T2 has coordinates $(-9, 5)$ and the edge connecting vertices A and B has equation $y = 3$.

(b) Write down the coordinates of tower T4. [2]

Tower T1 has coordinates $(-13, 3)$.

(c) Find the gradient of the edge of the Voronoi diagram between towers T1 and T2. [3]

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(Question 5 continued)

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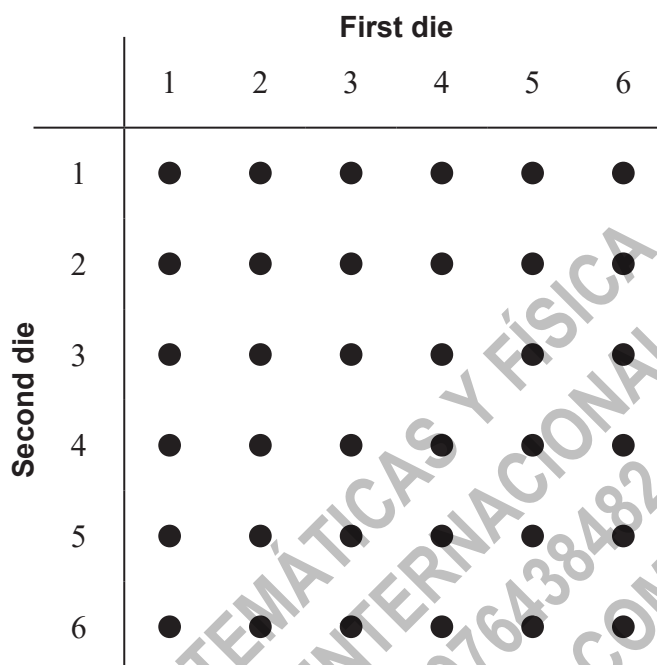


20EP07

Turn over

10. [Maximum mark: 7]

A game is played where two unbiased dice are rolled and the score in the game is the greater of the two numbers shown. If the two numbers are the same, then the score in the game is the number shown on one of the dice. A diagram showing the possible outcomes is given below.



Let T be the random variable “the score in a game”.

(a) Complete the table to show the probability distribution of T . [2]

t	1	2	3	4	5	6
$P(T=t)$						

- (b) Find the probability that
- (i) a player scores at least 3 in a game.
 - (ii) a player scores 6, given that they scored at least 3. [3]
- (c) Find the expected score of a game. [2]

(This question continues on the following page).



(Question 10 continued)

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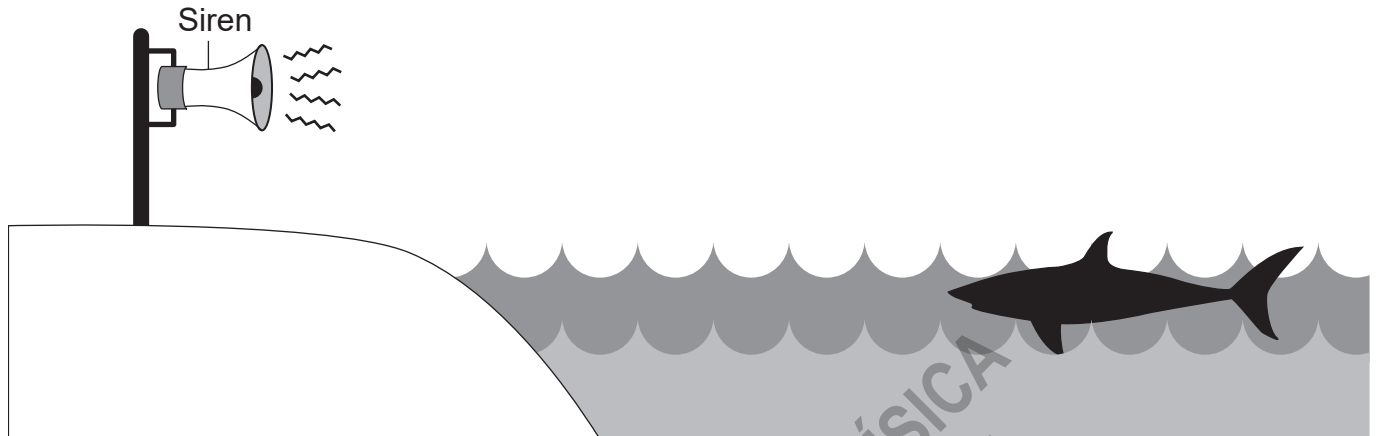


20EP13

Turn over

11. [Maximum mark: 6]

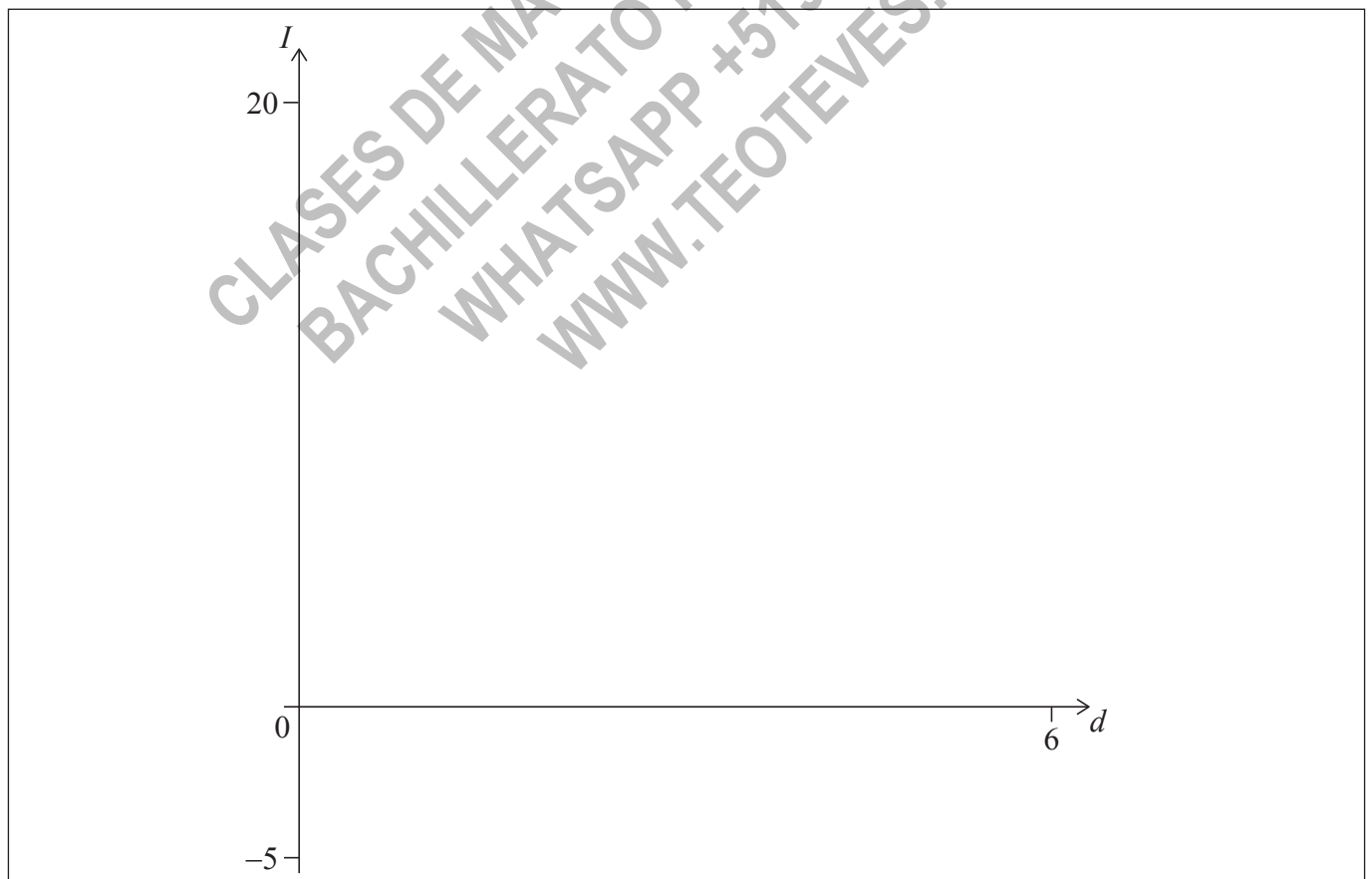
If a shark is spotted near to Brighton beach, a lifeguard will activate a siren to warn swimmers.



The sound intensity, I , of the siren varies inversely with the square of the distance, d , from the siren, where $d > 0$.

It is known that at a distance of 1.5 metres from the siren, the sound intensity is 4 watts per square metre (W m^{-2}).

- (a) Show that $I = \frac{9}{d^2}$. [2]
- (b) Sketch the curve of I on the axes below showing clearly the point (1.5, 4). [2]



(This question continues on the following page)



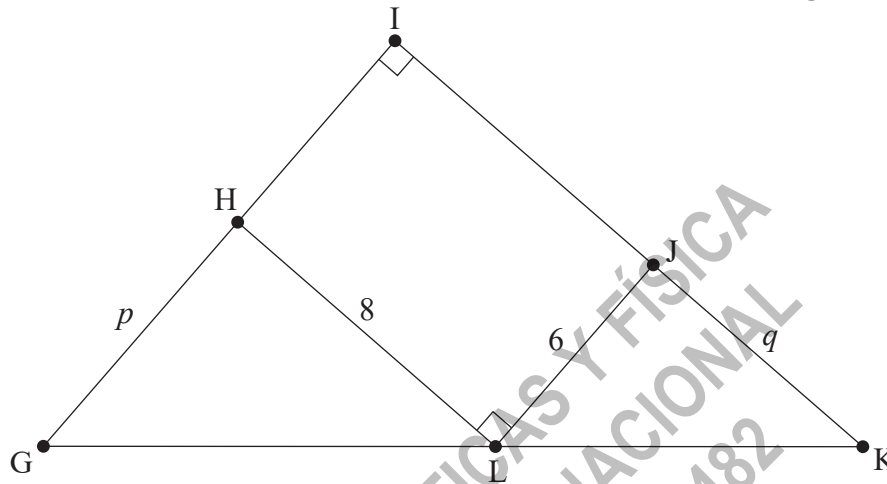
20EP14

12. [Maximum mark: 8]

Ellis designs a gift box. The top of the gift box is in the shape of a right-angled triangle GIK.

A rectangular section HIJL is inscribed inside this triangle. The lengths of GH, JK, HL, and LJ are p cm, q cm, 8 cm and 6 cm respectively.

diagram not to scale



The area of the top of the gift box is A cm².

(a) (i) Find A in terms of p and q .

(ii) Show that $A = \frac{192}{q} + 3q + 48$.

[4]

(b) Find $\frac{dA}{dq}$.

[2]

Ellis wishes to find the value of q that will minimize the area of the top of the gift box.

(c) (i) Write down an equation Ellis could solve to find this value of q .

(ii) Hence, or otherwise, find this value of q .

[2]

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(Question 12 continued)

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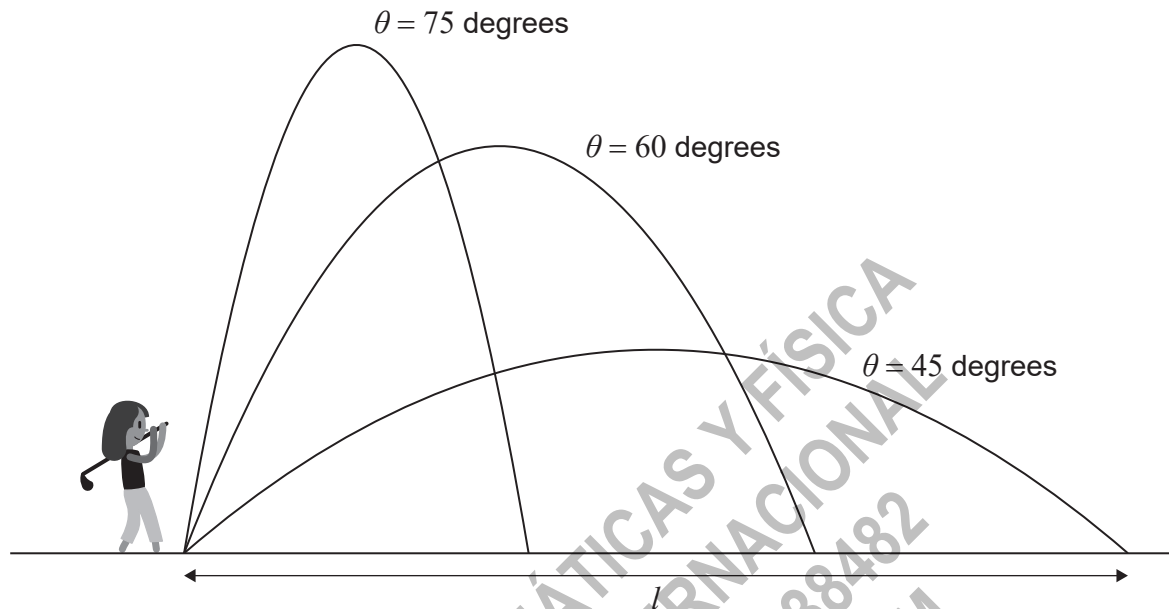
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20EP17

13. [Maximum mark: 8]

Sieun hits golf balls into the air. Each time she hits a ball she records θ , the angle at which the ball is launched into the air, and l , the horizontal distance, in metres, which the ball travels from the point of contact to the first time it lands. The diagram below represents this information.



Sieun analyses her results and concludes:

$$\frac{dl}{d\theta} = -0.2\theta + 9, \quad 35^\circ \leq \theta \leq 75^\circ.$$

(a) Determine whether the graph of l against θ is increasing or decreasing at $\theta = 50^\circ$. [3]

Sieun observes that when the angle is 40° , the ball will travel a horizontal distance of 205.5 m.

(b) Find an expression for the function $l(\theta)$. [5]

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Answers written on this page
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20EP20