

Subject – Math(Higher Level)  
Topic - Vector  
Year - Nov 2011 – Nov 2019

Question 1

$$\begin{aligned}
 (a) \quad (i) \quad & |a-b| = |a+b| \\
 \Rightarrow & (a-b) \cdot (a-b) = (a+b) \cdot (a+b) \\
 \Rightarrow & |a|^2 - 2a \cdot b + |b|^2 = |a|^2 + 2a \cdot b + |b|^2 \\
 \Rightarrow & 4a \cdot b = 0 \Rightarrow a \cdot b = 0 \\
 & \text{therefore } a \text{ and } b \text{ are perpendicular.}
 \end{aligned}$$

(M1)  
A1  
A1  
R1

**Notes:** Allow use of 2-d components.

**Notes:** Do not consider sloppy vector notation, as we must see something to the effect that  $|a|^2 = a \cdot a$  is clearly being used for the M1.

**Notes:** Allow a correct geometric argument, for example that the diagonals of a parallelogram have the same length only if it is a rectangle.

$$\begin{aligned}
 (ii) \quad & |a \times b|^2 = (|a||b|\sin\theta)^2 = |a|^2|b|^2\sin^2\theta \\
 & |a|^2|b|^2 - (a \cdot b)^2 = |a|^2|b|^2 - |a|^2|b|^2\cos^2\theta \\
 & = |a|^2|b|^2(1 - \cos^2\theta) \\
 & = |a|^2|b|^2\sin^2\theta \\
 \Rightarrow & |a \times b| = |a||b|\sin\theta = (a \cdot b)
 \end{aligned}$$

M1A1  
M1  
A1  
AG  
[5 marks]

$$\begin{aligned}
 (b) \quad (i) \quad & \text{area of triangle} = \frac{1}{2} |\vec{AB} \times \vec{AC}| \\
 & = \frac{1}{2} |(b-a) \times (c-a)| \\
 & = \frac{1}{2} |b \times c + b \times (-a) + (-a) \times c + (-a) \times (-a)| \\
 & b \times (-a) = a \times b, \quad c \times a = -a \times c, \quad -a \times (-a) = 0 \\
 \text{hence, area of triangle is } & \frac{1}{2} |a \times b + b \times c + c \times a|
 \end{aligned}$$

(M1)  
A1  
A1  
M1  
AG

$$\begin{aligned}
 (ii) \quad & D \text{ is the foot of the perpendicular from B to AC} \\
 \text{area of triangle } \triangle ABC &= \frac{1}{2} |\vec{AC}| |\vec{BD}| \\
 \text{therefore,} \\
 \frac{1}{2} |\vec{AC}| |\vec{BD}| &= \frac{1}{2} |\vec{AB} \times \vec{AC}| \\
 \text{hence, } |\vec{BD}| &= \frac{|\vec{AB} \times \vec{AC}|}{|\vec{AC}|} \\
 &= \frac{|a \times b + b \times c + c \times a|}{|c-a|}
 \end{aligned}$$

A1  
M1  
A1  
AG

[7 marks]

Total [15 marks]

# Mathematics Hl Paper 21

**JL Elias**



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## **Table of Contents Mathematics Hl Paper 21**

1. Understanding the eBook Mathematics Hl Paper 21
  - The Rise of Digital Reading Mathematics Hl Paper 21
  - Advantages of eBooks Over Traditional Books
2. Identifying Mathematics Hl Paper 21
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Mathematics Hl Paper 21
  - User-Friendly Interface
4. Exploring eBook Recommendations from Mathematics Hl Paper 21

- Personalized Recommendations
- Mathematics HL Paper 21 User Reviews and Ratings
- Mathematics HL Paper 21 and Bestseller Lists
- 5. Accessing Mathematics HL Paper 21 Free and Paid eBooks
  - Mathematics HL Paper 21 Public Domain eBooks
  - Mathematics HL Paper 21 eBook Subscription Services
  - Mathematics HL Paper 21 Budget-Friendly Options
- 6. Navigating Mathematics HL Paper 21 eBook Formats
  - ePub, PDF, MOBI, and More
  - Mathematics HL Paper 21 Compatibility with Devices
  - Mathematics HL Paper 21 Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Mathematics HL Paper 21
  - Highlighting and Note-Taking Mathematics HL Paper 21
  - Interactive Elements Mathematics HL Paper 21
- 8. Staying Engaged with Mathematics HL Paper 21
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Mathematics HL Paper 21
- 9. Balancing eBooks and Physical Books Mathematics HL Paper 21
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Mathematics HL Paper 21
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Mathematics HL Paper 21
  - Setting Reading Goals Mathematics HL Paper 21
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Mathematics HL Paper 21

- Fact-Checking eBook Content of Mathematics HL Paper 21
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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