1.5 Further Vectors: 30-minute Pack

EDEXCEL 9FM0 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Two straight paths through a country park are modelled by the lines l1: r = (1, 2, -1) + s(2, -1, 2) and l2: r = (4, 0, 3) + t(1, 2, 2), where s and t are real parameters.

(a) Find the acute angle between l1 and l2, giving your answer in degrees to 1 decimal place. **(4)**

(b) State, with a reason, whether l1 and l2 are parallel, perpendicular or neither. **(2)**

(Total for Question 1 is 6 marks)

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2 The lines l_1 and l_2 have vector equations r = (-4i - 5j + 5k) + λ(-2i - j + 2k) and r = (i - 3j + 3k) + μ(i + 2k) respectively.

(a) Show that l_1 and l_2 intersect, and find the position vector of their point of intersection. **(5)**

(b) Find the acute angle between the lines, to 1 decimal place. **(3)**

(Total for Question 2 is 8 marks)

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3 The points A, B and C have position vectors 3j + 3k, -2i + j + 2k and -3i + 2j respectively, relative to a fixed origin O.

(a) Find the vector products AB x AC, and hence a vector perpendicular to the plane ABC (simplified). **(4)**

(b) Find a Cartesian equation of the plane ABC in the form ax + by + cz = d. **(3)**

(c) Find the perpendicular distance from the point Q with position vector 5i + 6j + k to the plane ABC, to 3 significant figures. **(3)**

(d) The line with equation r = (-3i - 3j - 3k) + t(-3i + 3j + 2k) meets the plane ABC at the point R. Find the position vector of R. **(3)**

(Total for Question 3 is 13 marks)

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Mark scheme · 1.5 Further Vectors: 30-minute Pack

Question 1

(a) finds the dot product of the direction vectors, (2,-1,2). (1,2,2) = 4 **M1**

(a) finds both magnitudes, $\sqrt{4+1+4}=3$ and $\sqrt{1+4+4}=3$ **M1**

(a) uses cos(θ) = (d1.d2)/(|d1||d2|) **M1**

(a) θ = awrt 63.6 degrees **A1**

(a) Answer: 63.6 degrees (1 dp)

(b) neither **B1**

(b) valid reason, e.g. dot product = 4 not equal to 0 so not perpendicular, and (2,-1,2) is not a scalar multiple of (1,2,2) so not parallel **B1**

(b) Answer: Neither parallel nor perpendicular

Question 2

(a) equates the i, j and k components to form simultaneous equations in λ and μ **M1**

(a) solves two of the equations **M1**

(a) λ = -2 and μ = -1 **A1**

(a) checks the third equation is satisfied, so the lines intersect **B1**

(a) position vector -3j + k **A1**

(a) Answer: -3j + k

(b) uses cos θ = |d1 . d2|/(|d1||d2|) **M1**

(b) d1 . d2 = 2 **A1**

(b) θ = 72.7 degrees **A1**

(b) Answer: 72.7 degrees

Question 3

(a) finds AB and AC **M1**

(a) AB = -2i - 2j - k, AC = -3i - j - 3k **A1**

(a) evaluates the vector product with the determinant method **M1**

(a) AB x AC = 5i - 3j - 4k, so a normal is 5i - 3j - 4k **A1**

(a) Answer: normal 5i - 3j - 4k

(b) uses n . r = n . a **M1**

(b) d = -21 **A1**

(b) 5x - 3y - 4z = -21 **A1**

(b) Answer: 5x - 3y - 4z = -21

(c) uses |n . q - d|/|n| **M1**

(c) $|3 - (-21)|/(5\sqrt{2})$ **A1**

(c) 3.39 **A1**

(c) Answer: 3.39

(d) substitutes the parametric form of the line into the plane equation **M1**

(d) t = 27/32 **A1**

(d) -(177/32)i - (15/32)j - (21/16)k **A1**

(d) Answer: -(177/32)i - (15/32)j - (21/16)k

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