

**Year 11 Mathematics Specialist  
Test 2 2016**

Calculator Assumed  
Vectors Chapters 3,4,8

**STUDENT'S NAME** \_\_\_\_\_

**DATE:**

**TIME:** 50 minutes

**MARKS:** 48

**INSTRUCTIONS:**

Standard Items: Pens, pencils, ruler, eraser.

Special Items: Three calculators, drawing instruments, notes on one side of a single A4 page (these notes to be handed in with this assessment)

Questions or parts of questions worth more than 2 marks require working to be shown to receive full marks.

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1. (6 marks)

Given  $\underline{a} = \begin{pmatrix} 24 \\ -7 \end{pmatrix}$  and  $\underline{b} = \begin{pmatrix} 8 \\ 15 \end{pmatrix}$ , determine

(a) a unit vector parallel to  $\underline{b}$  [2]

(b) a vector parallel to  $\underline{b}$  and four times as long [2]

(c) the size of the acute angle between  $\underline{a}$  and  $\underline{b}$  [2]

2. (4 marks)

The unit vector  $\hat{\mathbf{u}} = \begin{pmatrix} a \\ -b \end{pmatrix}$  is perpendicular to  $\begin{pmatrix} 4 \\ 3 \end{pmatrix}$ . If  $a > 0$ , determine the value of  $a$  and  $b$ .

3. (5 marks)

Given that  $|\mathbf{a}| = 7$ ,  $|\mathbf{b}| = 4$  and  $\mathbf{a} \cdot \mathbf{b} = 11$ , determine

(a)  $\mathbf{a} \cdot \mathbf{a}$  [1]

(b)  $\mathbf{b} \cdot \mathbf{b}$  [1]

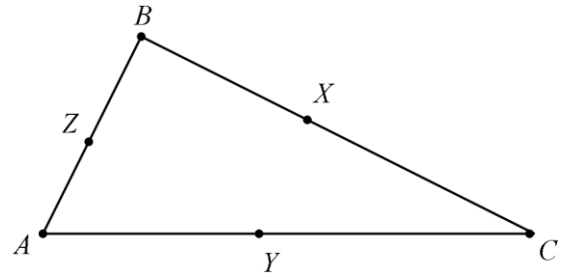
(c)  $(\mathbf{a} - \mathbf{b}) \cdot (\mathbf{a} - \mathbf{b})$  [2]

(d)  $|\mathbf{a} - \mathbf{b}|$  exactly [1]

4. (6 marks)

The diagram shows a triangle  $ABC$ . Points  $X$ ,  $Y$  and  $Z$  are the mid-points of  $BC$ ,  $CA$  and  $AB$  respectively.

Vector  $\vec{AZ} = \vec{a}$  and vector  $\vec{AY} = \vec{b}$



(a) Express in terms of  $\vec{a}$  and  $\vec{b}$

(i) the vector  $\vec{YZ}$

[1]

(ii) the vector  $\vec{CB}$

[1]

(b) Using your answers to part (a), write down two facts about the relationship between the lines  $YZ$  and  $CB$ .

[2]

(c) Express in terms of  $\vec{a}$  and  $\vec{b}$ , the vector  $\vec{AX}$ .

[2]

5. (5 marks)

The position vectors of the points  $A$ ,  $B$  and  $C$  are  $\underline{\underline{a}}$ ,  $\underline{\underline{b}}$  and  $\underline{\underline{c}}$  respectively.

Given that  $\underline{\underline{a}} = 5\underline{\underline{c}} - 4\underline{\underline{b}}$  determine, in terms of  $\underline{\underline{b}}$  and  $\underline{\underline{c}}$  only.

(a) the position vector of  $M$ , the mid-point of  $AB$ . [2]

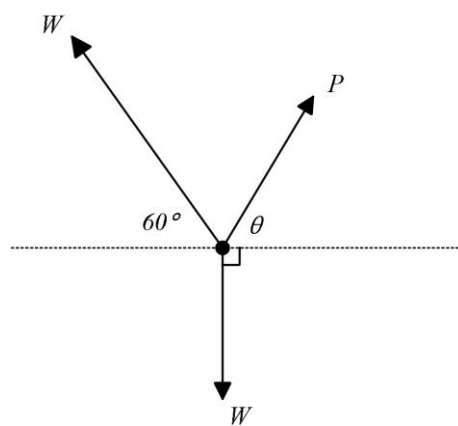
(b) the position vector of the point  $P$  which divides  $AC$  in the ratio  $1 : 4$  [3]

6. (3 marks)

Solve for the vector  $\underline{\underline{a}}$  if  $2\underline{\underline{a}} - \begin{pmatrix} 4 \\ -8 \end{pmatrix} = \begin{pmatrix} 17 \\ -36 \end{pmatrix} - 5\underline{\underline{a}}$

7. (5 marks)

The diagram below shows a particle in equilibrium under the forces shown. Determine the **exact** value of  $\tan \theta$ .



8. (6 marks)

To prove: The diagonals of a parallelogram bisect each other.

$ABCD$  is a parallelogram with  $\vec{AB} = \vec{a}$  and  $\vec{AD} = \vec{c}$ . The diagonals  $AC$  and  $BD$  meet at  $X$ .

If  $\vec{BX} = k\vec{BD}$  and  $\vec{AX} = t\vec{AC}$ , use the fact that  $\vec{AX} = \vec{AB} + \vec{BX}$  to show that  $k = t = \frac{1}{2}$

9. (8 marks)

An aircraft, whose speed in still air is  $300 \text{ kmh}^{-1}$ , flies in a straight line from  $R$  to  $S$ , a distance of 400 km. The bearing of  $S$  from  $R$  is  $195^\circ$ . There is a wind blowing from the east. Given that the pilot needs to set a course due south, calculate

(a) the speed of the wind [3]

(b) the time of the flight [2]

If the speed and direction of the wind are unchanged

(c) What course does the pilot need to set on the return flight from  $S$  to  $R$ ? [3]